# SUPPLEMENTARY INFORMATION 1 PROPERTIES OF THE PWC REPRESENTATION

The representation presented in section 2.3 was initially inspired by the concept of wavelet footprints (Dragotti and Vetterli, 2002) where the more general case of piece-wise polynomial signals is considered from a wavelet analysis perspective. The *maximally sparse* representation for PWC signals demonstrated in wavelet footprints is reformulated here using standard linear algebra and extended to arbitrary vector lengths. This also allows us to establish a correspondence between sets of breakpoints and a *nested structure* of vector subspaces which we use here to demonstrate the representation properties.

Mathematically, a PWC vector x can be completely characterized by its change locations (i.e., breakpoints) and the constant values of the regions in between (i.e., segment amplitudes):

DEFINITION 1 (PWC vector). A piece-wise constant vector  $\boldsymbol{x} = (x_1, \ldots, x_M)^t$  is characterized by an ordered set of K discontinuity locations  $\mathcal{I} = \{i_1 < i_2 \ldots < i_K\} \subset \{1, \ldots, M-1\}$  ( $i_k$  denotes the beginning position of segment k) and a vector with the corresponding K+1 segment amplitudes  $\boldsymbol{a} = (a_0, \ldots, a_K)^t$ . Thus:

$$\boldsymbol{x}^{t} = \begin{pmatrix} a_{0}, \dots, a_{0}, a_{1}, \dots, a_{k-1}, a_{k-1}, a_{k}, a_{k}, \dots, a_{K} \\ \uparrow_{1} & \uparrow_{i_{1}} \end{pmatrix} \quad (22)$$

With this definition it is easy to show that the breakpoint sets  $\mathcal{I}$ s induce the following vector subspace properties:

LEMMA 1 (PWC Vector Subspaces). Let  $S_{\mathcal{I}}$  be the set of all PWC vectors **x** that have breakpoint locations contained in  $\mathcal{I}$ , and segment amplitudes  $\boldsymbol{a} \in \mathbb{R}^{K+1}$ . Then, we have that:

*i*)  $S_{\mathcal{I}}$  is a subspace of  $\mathbb{R}^M$  of dimension K + 1. *ii*)  $S_{\mathcal{I}_1}$  is a subspace of  $S_{\mathcal{I}_2}$  if and only if  $\mathcal{I}_1 \subset \mathcal{I}_2$ 

PROOF. It is clear that i) holds since, first, for any  $x_1, x_2$  with breakpoints in  $\mathcal{I}$ , but different amplitudes  $a_1$  and  $a_2$ ; we have that  $x_3 = x_1 + x_2$  may remove existing breakpoints but never create a breakpoint outside  $\mathcal{I}$ , thus  $x_3 \in S_{\mathcal{I}}$  because it will always have breakpoints contained in the same  $\mathcal{I}$ , and  $a_3 = a_1 + a_2$ . Second, for any  $x_1 \in S_{\mathcal{I}}$  and for all  $\alpha, x_4 = \alpha x_1$  will also have breakpoints contained in  $\mathcal{I}$  with  $a_4 = \alpha a_1$  and thus will belong to  $S_{\mathcal{I}}$ . Furthermore, when  $\mathcal{I}$  is fixed x and a vector spaces are isomorphic and hence  $S_{\mathcal{I}}$  has dimension K + 1; thus, ii) readily follows from i).

Part ii) of the lemma is equivalent to saying that any PWC vector  $\mathbf{x} \in S_{\mathcal{I}}$  can be represented as a linear combination of step vectors in  $S_{\{k\}}, k = i_1, \ldots, i_K$ . With this principle in mind, we now introduce a basis for PWC signal representation that has some desirable properties.

THEOREM 1 (PWC Basis). Define a matrix  $F = [f_0, f_1, ..., f_{M-1}]$ , with columns  $f_i$  where  $f_0 = \mathbf{1}_M / \sqrt{M}$  is a constant vector and the remaining columns are step vectors:

$$\boldsymbol{f}_{i}\left(\boldsymbol{m}\right) = \begin{cases} -\sqrt{\frac{M-i}{iM}} & \boldsymbol{m} \leq i \\ \sqrt{\frac{i}{M(M-i)}} & \boldsymbol{m} > i \end{cases}$$
(23)

Then, we have the following properties:

*i*) (Complete Basis): *The columns of*  $\mathbf{F}$  *are a basis for*  $\mathbb{R}^M$ *, i.e., for any*  $\boldsymbol{x} \in \mathbb{R}^M$  *there exists a unique*  $\mathbf{w}$  *such that*  $\boldsymbol{x} = \boldsymbol{F}\boldsymbol{w}$ .

*ii)* (Nested Structure): The columns of  $F_{\mathcal{I}} = [f_0, f_{i_1}, \dots, f_{i_K}]$ are a basis for the vector subspace  $S_{\mathcal{I}}$ , formed by PWC vectors with breakpoints at  $\mathcal{I} = \{i_1 < i_2 \dots < i_K\}$ .

iii) (Maximal Sparseness): Any PWC vector  $\mathbf{x} \in S_{\mathcal{I}}$ , can be written as  $\mathbf{x} = \mathbf{F}\mathbf{w}$ , where  $\mathbf{w}$  has as many as  $|\mathcal{I}| + 1$  non-zero entries, which is the minimal amount possible (maximal sparseness). Moreover, if the non-zero weights are  $\mathbf{w}_{\mathcal{I}} = [w_0, w_{i_1}, \dots, w_{i_K}]$ , we can write  $\mathbf{x} = \mathbf{F}_{\mathcal{I}}\mathbf{w}_{\mathcal{I}}$ , where the subscript  $\mathcal{I}$  denotes that only the columns of  $\mathbf{F}$  (resp. components of  $\mathbf{w}$ ) at the positions corresponding to the indices in  $\mathcal{I}$  are included.

In order to better understand the previous theorem, we will explain how the basis has been constructed. First, if **x** is a constant vector, i.e., it has no discontinuities,  $\mathcal{I} = \emptyset$ , the dimension of  $S_0 = S_{\mathcal{I}=\emptyset}$  is one and can be spanned by the constant vector  $f_0$ . Then, for  $k = 1, \ldots, M-1$  the vector spaces  $S_k = S_{\mathcal{I}=\{k\}}$  of PWC vectors with a single discontinuity between k and k+1 can be spanned by adding the element  $f_k$ , a step vector with a breakpoint at that position. Moreover, the set of vectors now forms a complete basis: from Lemma 1.ii) any  $\mathbf{x} \in S_{\mathcal{I}}$  can be represented by linearly combining  $\{f_0, f_{i_1}, \ldots, f_{i_K}\}$ . This proves ii) in the theorem, as well as i) when  $\mathcal{I} = \{1, \ldots, M\}$ .

Clearly i) holds, since **F** is a square invertible matrix, with the rows of its inverse  $F^{-1}$  forming the *dual basis*:

$$F^{-1} = \left[\tilde{f}_{0}, \dots, \tilde{f}_{M-1}\right]^{t}$$
(24)  
$$\tilde{f}_{0} = \frac{1}{\sqrt{M}} \mathbf{1}_{M}$$
  
$$\tilde{f}_{k}(m) = \begin{cases} -\sqrt{\frac{k(N-k)}{N}} & m = k - 1\\ \sqrt{\frac{k(N-k)}{N}} & m = k\\ 0 & \text{otherwise} \end{cases}$$

The most appealing property for our specific application is iii), since copy number vectors will have very few breakpoints ( $K \ll M$ ) which makes **w** a sparse representation. We can prove iii) by the following argument. First, we cannot have less than K + 1 non-zero elements because this is the minimum required to form a basis for  $S_{\mathcal{I}}$ . Then, for all  $m \notin \mathcal{I}$ , we have that  $x_m - x_{m-1} = 0$ , and using the dual basis,  $w = F^{-1}x$ , we have that for all  $m > 0 w_m = 0$  if and only if  $x_m - x_{m-1} = 0$ . Thus, there are exactly K + 1 nonzero elements, which is indeed the minimum (so the representation is maximally sparse).

## 2 ALTERNATIVE APPROACHES TO SBL TO EXPLOIT THE PWC REPRESENTATION

Similar problems that involve solving the minimizing problem stated in (8) have already been addressed both in the signal processing and in the statistics literature, leading to similar strategies and methods which are given different names (see Table 4). However, as is discussed in this section, most of these existing methods are severely limited by the high collinearity/coherence (lack of orthogonality) between the columns of  $\mathbf{F}$ .

The first class of strategies, greedy methods, consists of reducing the search space of all possible predictor subsets  $2^M$  by assuming that the best set of  $K_1$  predictors will often be a subset of the best 
 Table 4. Relationship between signal processing methods for overcomplete expansions and methods in statistics for variable selection in multiple regression

	Signal Processing	Statistics
Greedy Method	s:	
MP-FS	Matching Pursuit (Mallat	Forward Selection (Seber
	and Zhang, 1993)	and Lee, 2003)
OMP	Orthogonal Matching Pur-	
	suit (Pati et al., 1993)	
Relaxation meth	nods:	
MoF-Ridge	Method of Frames (Chen	Ridge regression (Hastie
	et al., 1998)	et al., 2001)
BP-Lasso	Basis Pursuit (Chen et al.,	Lasso (Hastie et al., 2001)
	1998)	

Methods are paired when a similar version of equation (7) is solved (i.e., when the same metrics are chosen). But note that there will be differences in how  $\lambda$  is adjusted, and the size or types of design matrices **F** that are used.

set of  $K_2$  predictors, for  $K_2 > K_1$ . If this assumption is correct, the set of best predictors can be constructed sequentially as in MP-FS; where we start selecting the vector (regressor) with largest projection (largest F-score), and keep adding the vector that most reduces the energy of the residual. This strategy is only optimal when **F** is orthogonal, or nearly optimal (Donoho *et al.*, 2006) when the coherence of **F** ( $C = \max \langle f_k, f_j \rangle k \neq j$ ) is small and the signal is "sufficiently" sparse (i.e.,  $||w||_0$  is small). It is important to note that this result cannot be applied to our case, since the coherence of **F** approaches 1, i.e., the set of vectors considered here is highly coherent.

The second class of strategies is based on replacing the  $l_0$  sparseness measure  $\|w\|_0$  by some other  $l_p$  measure, such that more efficient optimization methods (such as linear programming, projection or gradient methods) can be used. For example, for p =2 (i.e.,  $||w||_2$ ), we would have a ridge regression in which the two square norms can be easily combined resulting in  $\hat{w}_{rigde}$  =  $(F^tF + \lambda I)^{-1}F^ty$ . However,  $\hat{w}_{ridge}$  is not sparse at all in  $l_0$ sense, and thus we would be interested in using a small as possible p. The  $l_1$  norm is often used, because it is is the minimal one for which the constraints form a convex set and thus convex optimization or linear programming can be used to solve the problem. This is the strategy behind basis pursuit (Chen et al., 1998) and lasso (Hastie et al., 2001), for which there exist a similar result as in MP (Donoho et al., 2006) showing that if the coherence is small then minimizing for  $l_1$  is equivalent to minimizing for  $l_0$ . Therefore, when **F** is highly coherent, as in our case, these techniques lead to sub-optimal performance and a new approach is needed.

#### 2.1 Comparison to SBL approach

In previous work (Pique-Regi *et al.*, 2007) we demonstrated using the same performance evaluation procedure as in section 3.1 (Willenbrock and Fridlyand, 2005) that the SBL approach presented in this paper had a significantly superior performance than the techniques in Table 4 for the specific application of CNA detection.

The precision-recall operating curves (PROC) were generated for each approach by obtaining the sensitivity and FDR for detected CNA in the simulated CGH dataset at each operating point (Figure 7). SBL had the best performing PROC curve as compared to other approaches for all given values of  $\delta$  (data shown only for  $\delta = 2$ ).



Fig. 7. PROC operational curves for sensitivity vs. false discovery rate in detecting real copy number changes within a  $\delta = 2$  sample precision window in the dataset introduced by Willenbrock and Fridlyand (2005).

### **3 SBL ALGORITHM DETAILS**

#### 3.1 The role of the parameter *a* in SBL

The parameter *a* controls the shape of the prior distribution over the weights p(w) specified by the hierarchical prior defined by  $p(w|\alpha)$  (12) and  $p(\alpha)$  (13). Following Tipping (2001), the  $\alpha$ hyperparameters can be integrated out to find the marginal "effective" prior p(w):

$$p(\boldsymbol{w}) = \int p(\boldsymbol{w}|\boldsymbol{\alpha}) p(\boldsymbol{\alpha}) d\boldsymbol{\alpha}$$
$$= \prod_{m=1}^{M-1} \int p(w_m | \alpha_m) p(\alpha_m) d\alpha_m$$
$$= \prod_{m=1}^{M-1} p(w_m)$$
(25)

where  $p(w_m)$  is:

$$p(w_m) = \int p(w_m | \alpha_m) p(\alpha_m) d\alpha_m$$
$$= \frac{\Gamma(a+1/2)}{\Gamma(a)\sqrt{2\pi a}} \sqrt{\frac{a}{b}} \left(1 + \frac{w^2}{2b}\right)^{-\left(\frac{1}{2} + a\right)}$$
(26)

a t-distribution with 2a degrees of freedom and a scale parameter of  $\sqrt{a/b}$ . When  $b \rightarrow 0$  and a is small, this distribution peaks very sharply at 0, and has very thick flat tails, as shown in Figure 8.

The log of p(w) gives us the sparseness cost measure:

$$\log p\left(\boldsymbol{w}\right) = C\left(a,b\right) + \left(1 + \frac{a}{2}\right) \sum_{m=0}^{M-1} \log \left(1 + \frac{w_m^2}{2b}\right)$$



Fig. 8. Plot of the marginal prior distribution on a single weight for different choices of the hyperparameter a. To make the plot we approximated  $b \rightarrow 0$  by b = 1E - 80, that is a similar conceptual plot as would be drawing a delta function by a normal distribution with  $\sigma = 1E - 80$ .

and we are interested in the case when  $b \rightarrow 0$ , which gives (18):

$$\log p(\boldsymbol{w}) \xrightarrow[b \to 0]{} C(a) + (1+2a) \sum_{m=0}^{M-1} \log |w_m|$$

This sparseness cost is depicted for a single nonzero weight and several a in Figure 8 and for multiple nonzero weights and a single a in Figure 3. The approximately flat tails makes this sparseness cost a good approximation of the  $l_0$  norm, and much more desirable than the  $l_1$  norm (i.e. Laplacian prior). Considering specifically a in (18) and Figure 8, we can see that the sparseness penalty is proportional to (1 + 2a). For example, in Figure 8 (left), for a = 1 we get a penalty of around 300 for large coefficients as compared to 100 when  $a \sim 0$ , i.e. (1 + 2a) times higher. Therefore, we can increase the sparseness by increasing a, this takes mass away from the tails and puts it on the "delta" (point mass at 0) by decreasing the rate on the tail decay. In Figure 8 (right), the tail decay rate is about (1+2a) on the natural logarithmic scale.

The parameter *a* also has an impact on the convergence rate of the EM algorithm, i.e., the speed of the SBL algorithm. In our experiments, for higher sparseness settings (fewer breakpoints and larger *a*), the algorithm converges faster than for smaller *a*. This is also supported with the following argument. The  $\alpha_m^{-1}$  parameters, either converge to 0 (breakpoint discarded) or to a finite point (breakpoint accepted). The EM algorithm rate of convergence is governed by the maximum eigenvalue of the Jacobian matrix of the EM mapping defined in (17), (McLachlan and Krishnan, 1997). In that situation, 1/(1 + 2a) would pull out of the derivative of  $\alpha_m^{-1}$  in (17); thus speeding up convergence since the maximum eigenvalue is divided by 1/(1 + 2a).

In conclusion, the a parameter controls the sparseness in the SBL algorithm, and the speed of the algorithm. An increase of a leads to a sparser result, fewer breakpoints, and faster convergence.

## 4 BACKWARD ELIMINATION ALGORITHM DETAILS

The backward elimination (BE) procedure could be used alone for CNA detection. It is based on considering our PWC model (6) as a classical variable regression selection problem,  $y \sim Fw$ ; where the regressors  $w_i$  with less impact on the residual are sequentially

removed one by one. To the best our knowledge, this simple procedure has never been proposed as a standalone technique for CNA detection. This is a greedy approach, which is suboptimal since we may eliminate breakpoints that could be more significant at a later stage. Since errors can be added by each greedy decision, this algorithm tends to be more reliable when the number of regressors (i.e., candidate breakpoints) is smaller. Compared to forward selection (FS), backward elimination (BE) has been seen to perform better in situations where, as in our case, the columns of F have high degree of collinearity (Kohavi and John, 1997). Furthermore, the structure of F, the design matrix, can be exploited to efficiently find and remove each breakpoint and produce a ranking list as detailed in Algorithm 2.

Using standard linear regression, for a given fixed breakpoint set  $\mathcal{I}$ , the least squares estimate for the breakpoint weights  $w_{\mathcal{I}}$  is found by solving the normal equations:

$$\boldsymbol{F}_{\mathcal{I}}^{t}\boldsymbol{y} = \boldsymbol{F}_{\mathcal{I}}^{t}\boldsymbol{F}_{\mathcal{I}}\hat{\boldsymbol{w}}_{\mathcal{I}}$$
$$\hat{\boldsymbol{w}}_{\mathcal{I}} = \left(\boldsymbol{F}_{\mathcal{I}}^{t}\boldsymbol{F}_{\mathcal{I}}\right)^{-1}\boldsymbol{F}_{\mathcal{I}}^{t}\boldsymbol{y}$$
(27)

which gives the orthogonal projection  $\hat{x}_{\mathcal{I}}$  of the vector y on  $\mathcal{S}_{\mathcal{I}}$  as:

$$\hat{\boldsymbol{x}}_{\mathcal{I}} = \boldsymbol{F}_{\mathcal{I}} \hat{\boldsymbol{w}}_{\mathcal{I}} \tag{28}$$

$$\hat{\boldsymbol{x}}_{\mathcal{I}} = \boldsymbol{F}_{\mathcal{I}} \left( \boldsymbol{F}_{\mathcal{I}}^{t} \boldsymbol{F}_{\mathcal{I}} \right)^{-1} \boldsymbol{F}_{\mathcal{I}}^{t} \boldsymbol{y}$$
(29)

and the residual sum of squares  $RSS_{\mathcal{I}}$  or norm of the error is:

$$RSS_{\mathcal{I}} = \|\boldsymbol{y} - \hat{\boldsymbol{x}}_{\mathcal{I}}\|^2$$
$$= \|\boldsymbol{y} - \boldsymbol{F}_{\mathcal{I}} \hat{\boldsymbol{w}}_{\mathcal{I}}\|^2$$
(30)

All these operations can be solved efficiently by noticing again that  $H_{\mathcal{I}} = (F'_{\mathcal{I}}F_{\mathcal{I}})^{-1}$  is a symmetric tridiagonal matrix, with main diagonal  $h_0$  (19) and first off-diagonals  $h_1$  (20) (see lines 2 and 3 of Algorithm 2).

The criteria to decide which breakpoint to remove can be seen in three different but equivalent ways.

First, we might consider removing the breakpoint which increases the least the  $RSS_{\mathcal{I}}$ . If we denote  $RSS_j$  to be the residual sum of the squares after removing  $i_j$  from  $\mathcal{I}$ , then the increase in RSS is:

$$RSS_j - RSS_{\mathcal{I}} = \frac{\hat{w}_{\mathcal{I}}^2(j)}{h_0(j)}$$
(31)

Furthermore, when the noise is normal  $N(0, \sigma^2 I)$ ,

$$F_j = \frac{RSS_j - RSS_{\mathcal{I}}}{RSS_{\mathcal{I}}/(M - K)}$$
(32)

is distributed as  $F_{1,M-K}$  distribution (M is the number of candidate breakpoints, and  $K = |\mathcal{I}|$  the number of breakpoints in the model). If the  $\sigma^2$  is known, or M >> K, then  $RSS_{\mathcal{I}}/(M-K) \to \sigma^2$  and  $F_{1,\infty} \sim \chi_1^2$ ; thus

$$t_j^2 = \frac{RSS_j - RSS_{\mathcal{I}}}{\sigma^2} = \frac{\hat{\boldsymbol{w}}_{\mathcal{I}}^2(j)}{\sigma^2 \boldsymbol{h}_0(j)}$$
(33)

is distributed as a  $\chi_1^2$  distribution.

Second, if we assume that the noise is normal  $N(0, \sigma^2 I)$ , and  $\sigma^2$  is known. Then the least squares estimate for  $\hat{w}_{\mathcal{I}}$  is also normally distributed:

$$\hat{\boldsymbol{w}}_{\mathcal{I}} \sim N\left(\boldsymbol{w}_{\mathcal{I}}, \boldsymbol{H}_{\mathcal{I}}/\sigma^2\right) \tag{34}$$

Therefore, under the hypothesis that  $w_{\mathcal{I}}(j) = 0$ 

$$t_{j} \equiv \frac{\hat{w}_{\mathcal{I}}(j)}{\sqrt{\sigma^{2} \boldsymbol{h}_{0}(j)}} \sim N(0, 1)$$
(35)

Third, developing what  $t_j$  represents in terms of y and  $\sigma^2$  by performing all the operations in (27), we can see that:

$$t_{j} = \frac{\left(\frac{1}{i_{j+1}-i_{j}}\sum_{m=i_{j}+1}^{i_{j+1}}y_{m}\right) - \left(\frac{1}{i_{j}-i_{j-1}}\sum_{m=i_{j-1}+1}^{i_{j}}y_{m}\right)}{\sigma\sqrt{\frac{1}{i_{j+1}-i_{j}} + \frac{1}{i_{j}-i_{j-1}}}}$$
(36)

which can be interpreted as the difference between the sample mean of the right and the left segment of  $i_j$  breakpoint divided by the square root of the variance of that difference. Even if the noise is not normal, but has a finite variance  $\sigma^2$ , (36) tells us that as the size of the segments increases, under the null hypothesis of no difference,  $t_i$  will converge to N(0, 1) because of the central limit theorem.

Recalculation of the weights after each removal, can be done efficiently with very few (a constant amount of) operations using the weights already calculated (see lines 9,12 and 16 on Algorithm 2). Thus the overall order of complexity to rank a breakpoint set  $\mathcal{I}$  is linear with the size of the set  $O(|\mathcal{I}|)$ .

### 4.1 The role of the *T* parameter in BE ranking

The ranking provided by the backward elimination procedure, Algorithm 2, can be used to quickly return a breakpoint set with different degrees of sparseness that contains the breakpoints with the strongest evidence. This is done by cutting the ranking r at some specified threshold T, such that all the remaining breakpoints have a  $|t_j| \ge T$ . Both true positives and false positives will decrease with increasing level of sparseness, i.e. higher T; but if  $P(|t_j| \ge T | w_j = 0) < P(|t_j| \ge T | w_j \neq 0)$  the expected proportion of false breakpoints on the returned set, i.e. the false

discovery rate FDR, will be monotonically decreasing with T. The previous condition is true for Gaussian noise but will also be true for other symmetrically bell shaped noise distributions.

Additionally, we can associate a *p*-value for any particular value of *t*, or a significance cutoff  $\alpha = P(|t_j| \ge T| w_j = 0)$  for any T, if we assume the noise is normal, using (35). If the noise is not Gaussian, the *p*-value will still be a good a approximation for the breakpoints with large flanking segments (i.e. the two neighboring breakpoints are far apart), since *t* will converge to a normal distribution under the null hypothesis for any iid finite variance noise. Alternatively, or for small segments we could estimate the *p*-value by a resampling method or replace the *t* score by a non-parametric ranksum test. In any case, it is important to notice that the computed *p*-value is associated with a single breakpoint in one of the many possible segmentations; thus, it does not take into account all the possible segmentations that are effectively tested during the algorithm, i.e. multiple hypothesis testing or multiple comparison problem.

Commonly used tools to solve this problem are not recommended here because they do not take into account the special correlation structure that exists between the t scores of overlapping or neighboring segmentations, and the independence between the t scores separated by one breakpoint or more. Solving the problem of the multiple testing in this scenario, in the sense of being able to provide a T that controls for the FDR being bellow some bound is beyond the scope of this paper. However, since the FDR is monotonically decreasing with T, we can adjust it to achieve a particular degree of sparseness, and then estimate the FDR that corresponds to that T either using results from multiple samples, replicates or by a resampling procedure.

### **5 SEGMENT ALTERATION DETECTION**

The SBL and BE procedures are segmentation approaches that make no assumptions on the amplitude of the reconstructed segments. The objective is to provide a nearly optimal set of amplitudes and breakpoint positions that best fits the hybridization intensities observed in the array as described in (8). Once the breakpoints are fixed, in order to achieve the minimal residual error RSS, the amplitude corresponding to each segment is given by the average hybridization level of all the probes that fall inside that segment. The consequence of this model, is that segments that correspond to the same underlying copy number state may be given a different reconstruction amplitude; and, an additional step has to be done to classify these segments into a copy number (0, 1, 2, 3, 4, ...) or alteration status (*Non-Altered, Gain* and *Loss*).

There already exists two alternatives to perform this additional step, since it is also required in other segmentation procedures like DNAcopy (Olshen *et al.*, 2004) and CGHseg (Picard *et al.*, 2005). The first alternative, also used in smoothing and thresholding methods (Pollack *et al.*, 1999; Huang *et al.*, 2004), assumes or estimates a baseline *Non-Altered* mean hybridization level and classifies all the segments whose amplitude are significantly above (bellow) that level as *Gain (Loss)*, or *Non-Altered* otherwise. The second alternative is the MergeLevels algorithm (Willenbrock and Fridlyand, 2005), that reduce the number of different reconstruction amplitudes by recursively merging those that are the least significantly different. The final smaller set of levels may be associated with a copy number state (0, 1, 2, 3, 4, ...).

Other CNA detection approaches, specially those that are based on HMMs automatically incorporate the classification encoded in the different states of a hidden variable associated with each probe. However, as we discussed in the introduction, this may not be a good model when the number of hidden states that has been assumed does not match the true number of underlying mean hybridization levels. This is specially likely to occur when analyzing tumor samples which represent mixtures of cells with different copy number state, because cancer genomes are inherently unstable and heterogeneous (Garraway *et al.*, 2005).

### 6 ADJUSTMENT OF THE SBL AND BE PARAMETERS IN GADA

Both the SBL or the BE procedure could be used independently to estimate copy number changes. However, the best results and flexibility are obtained with the combination of these two algorithms as was discussed in section 2.8.

The objectives of this section are: 1) show that SBL and BE elimination produce breakpoint sets that are subsets of those obtained from higher sparseness settings, higher T or a, and can produce equivalent breakpoint sets; 2) propose a strategy for efficient parameter adjustment in the most general case; 3) evaluate the effectiveness of this strategy in the Willenbrock and Fridlyand simulated dataset.

The experiments consist of drawing simulated chromosomes of different lengths M (M=100, 200, 500, 1000 and 2000 probes per chromosome), in the following conditions:

- i. Simulation of null hypothesis, (no breakpoints) using normal noise with different levels of variance.
- ii. Simulation of normal copy number variations (few breakpoints and short segments) with real noise obtained by randomly sampling segments of data of size M from a pool of a normal (diploid genome) CEPH cell line samples analyzed by Affymetrix 250K Nsp array platform.
- iii. Simulation on cancer copy number variations, by sampling random chunks of data of size M from cancer samples analyzed in section 3.3.
- iv. Evaluation on the simulated dataset analyzed in section 3.1, (only M=100).

For i. to iii. we simulated L = 10000 chromosomes, for the last case iv. all the  $L = 500 \times 20 = 2000$  chromosomes of size M = 100 were used. Each sample, i.e. chromosome, was analyzed with different options of a and T, and the returned breakpoint sets were evaluated using different metrics. The sparseness of each set was computed as the number of returned breakpoints divided by the size of the chromosome, i.e.  $|\mathcal{I}|/M$ , and  $\lambda$  denotes the average sparseness across all samples. When comparing two breakpoint sets  $\mathcal{A}$  and  $\mathcal{B}$  obtained for the same sample but with different parameter settings, we denote  $\mathcal{A} \cap \mathcal{B}$  the set of common breakpoints, which in our case includes all breakpoints in  $\mathcal{A}$  such that there exists a breakpoint in  $\mathcal{B}$  less than  $\delta$  probes away (if there are two breakpoints in  $\mathcal{A}$  closer than  $\delta$  to a breakpoint on  $\mathcal{B}$  then only the closest one is assigned to the intersection). We then computed the averages of the following metrics along the L simulated samples:

$$P\left(\mathcal{A}=\mathcal{B}\right) = \frac{|\mathcal{A}\cap\mathcal{B}|}{|\mathcal{A}\cup\mathcal{B}|} \qquad (37) \qquad P\left(\mathcal{A}\subset\mathcal{B}\right) = \frac{|\mathcal{A}\cap\mathcal{B}|}{|\mathcal{A}|} \qquad (38)$$

which represent respectively the proportion of breakpoints that are the same on both sets, i.e. concordance, and the proportion of breakpoints on A that are also in B, i.e., inclusiveness of A in B.

### 6.1 Experiments adjusting a and T in GADA

In Figure 9, we can see that the initial breakpoint sets provided by SBL (at T = 0), a higher *a* setting increases sparseness (bottom plots T = 0); but at the same time the breakpoints remain the same since the  $P(A \subset B) > 99\%$  in all the cases. That means that breakpoint sets obtained with higher *a* tend to be subsets of those obtained with lower *a*.

As T increases we can see on the bottom plot that we are monotonically obtaining sparser sets. The breakpoints that we are removing with BE might be different depending on the initial conditions; for example, a = 0.8 already has a high degree of sparseness so it will not start removing anything until T > 2.88, where the sparseness will start to curb down and eventually will converge to the curves obtained with lower a. On the top plot, we can see that this convergence is not only on the degree of sparseness alone but also on the breakpoint sets themselves too, since as T increases concordance goes to 1. That means that as we increase T we remove the extra part that it was in the breakpoint set obtained with lower a and we end up with the same breakpoints. Following the example with a = 0.8, we can see in Figure 9 A, that for T > 4.15, the concordance to starting with a lower a is higher than 80%; and for T > 4.25 and T > 4.35 we obtain concordances that are respectively higher than 90% and 95%.

This results indicate that we can adjust the sparseness of the result equivalently with a and T in a wide margin of settings to give the same breakpoint set. This behavior has been observed in all the experiment settings (i.-iv.). If there is something to be detected, true copy number alterations or outliers ii. then the probability of detection is higher and the high concordance is reached for smaller values of T than in the i. case (compare A and C, and B and C, on Figure 9). For iii. case (data not shown) the concordance is even higher since cancer samples contain more CNA. The size of the chromosome M have also some impact on the convergence; on chromosomes with larger M high concordance is reached at a higher T, but for M > 2000 it does not move further more to the right. Additionally, our results on case i. are exactly the same for different noise power  $\sigma^2$  because both a and T have already been corrected by  $\hat{\sigma}^2$ .

### 6.2 Strategy to adjust a and T in GADA

Adjusting sparseness with T can be done at no additional computational cost, while adjusting a requires to run the EM algorithm again. Thus, a good strategy is to select a small a for SBL that provides an initial breakpoint set that reduces most of the unlikely breakpoints but still ensures a high sensitivity; i.e. we do not want to miss anything on the first step that would require us to switch back to a lower a. Then, the final degree of sparseness will be adjusted with T.

From the previous experiment in concordance between sets, we can see that a good sensitivity means that we do not remove anything

that would not be removed with a lower a at the same T. The worst case, i.e. requiring a higher T for the same concordance, is where there is nothing to be detected. In other words, the true copy number alterations that produce an observation that resembles more pure Gaussian noise are the hardest to be detected.

Moreover, dense arrays (higher M) will be more sensitive because CNA will be sampled with more probes and will produce statistically larger t. Thus, small arrays will be those requiring the smallest T to be highly sensitive. Even smallest arrays with 100 probes per chromosome, T = 4 provides enough initial sensitivity. Thus, we find that a = 0.2 should be small enough in general, and is the value that we have always used in all the results on section 3.

It is always possible to determine if a = 0.2 (or any other choice) is small enough for a particular T of interest by rerunning the algorithm with a lower a, e.g. a = a/2, and checking if the set of breakpoints returned for that particular T and different a's are essentially the same (e.g., > 95% concordant).

#### 6.3 Sensitivity to the adjustments of a and T

We will use the simulation case iv., to evaluate the impact of the parameter setting strategy described in the previous section in terms of accuracy. This is the same dataset as the one used in section 3.1 and by Willenbrock and Fridlyand (2005), where the underlying breakpoints are known, so we can exactly evaluate the FDR and the sensitivity for different choices of T and a.

In Figure 10, curves corresponding to different a have different starting point in terms of sensitivity and FDR, but as T increases we decrease the FDR and similar operational points in terms of sensitivity and FDR are reached compared to those obtained from different a. The proposed a = 0.2 in the previous section offers and initial sensitivity and FDR such that all the remaining points in the curve are reached adjusting only T, providing all the levels of sensitivity or FDR that we might be interested in using without having to switch to another a.

Compared to CBS, we are able to obtain a wider margin of operating points of the PROC curve. Moreover, independently of the initial a we always have a point with similar or better average performance either in terms of FDR or sensitivity.



Fig. 10. PR operational curves for sensitivity vs. false discovery rate in detecting copy number changes within  $\delta = 2$  probe window. Each line corresponds to SBL+BE with different starting breakpoint sets (a = 0.05, 0.1, 0.2, 0.5, 0.8, 1.0, 1.5) and varying T (T increases as we traverse the curve from right to left, i.e. FDR decreases). The light green curve represents the operating points obtained by CBS with different  $\alpha = 1E - 4, 0.001, 0.002, 0.005, 0.01, 0.05$ 



Fig. 9. The four panels (A,B,C and D) represent a different experimental dataset, with the results of applying different settings of a and T parameters. Each color corresponds to different setting of a = 0.01, 0.05, 0.1, 0.2, 0.5, and the x-axis increasing values of T or its associated significance level  $log_0(\alpha)$ . On the top plot we have represented the inclusiveness  $P(\mathcal{I}_a \subset \mathcal{I}_{a=0.01})$  (dashed line); and the concordance  $P(\mathcal{I}_a = \mathcal{I}_{a=0.01})$ . The concordant breakpoints are defined within a window of  $\delta = 2$  probes. The bottom plot represents the sparseness which on A and B also represent specificity because there are no underlying breakpoints. A and B use the normal noise simulation described in i. with chromosome lengths of M = 500 and M = 2000 (different noise levels  $\sigma^2$  generate exactly the same curves); and C and D use the simulation described in ii. with chromosome lengths of M = 500 and M = 1000.

# 7 SUPPLEMENTARY RESULTS TABLES AND FIGURES

Table 8. Differences in copy number breakpoint placing between chips

 Table 5. Significant copy number alterations found in four neuroblastoma cell lines

Chr.	SK-N-BE2	SMS-KAN	LAN-6	CHLA-20
1:		-(pEnd-p13.3)	-(pEnd-p36.12)	
	+(p21.3-qEnd)		+(p21.1-qEnd)	+(p21.1-qEnd)
2:	+(pEnd-p21)	+(pEnd-p24.1)	+(pEnd-p22.1)	++(pEnd-p16.1)
	++p24.3 MYCN	++p24.3 MYCN		+(p16.1-q31.1)
		++p24.1	+q35	
		-q22.1		
		-q23.3		+(q32.2-q37.2)
3:	-(pEnd-p14.2)		-(pEnd-p14.3)	
		+(p12.1-p11.1)		
4:				-(p16.1-p15.33)
		-(q12-q22.1)		-p24 KLHL5
		-q22.3	+(q35.1-q35.2)	+(q34.1-qEnd)
5:			-(q35.3-qEnd)	+q11.2
6:			-(q12-p16.3)	
			-(q22.31-qEnd)	
			q26 <b>PARK</b>	
7:			+(pEnd-p15.1)	
			-q21.1 AHR	+7
			-(p14.3-q11.21)	
			-(p11.21-q11.22)	-q33 SEC8L1
8:			-(pEnd-p12)	
			-(q22.1-q23.3)	+q21.3
	q24.23			+(q22.2-q24.1)
9:			-p24.2 GLIS3	
			-(p23-p21.2)	
			p21.3MTAP	
			-p13.3RECK	
10:		+(pEnd-p11.23)		
		-q22.3 PTPRE		
11:	+(q13.1-qEnd)	-(q14.2-q23.3)	+(q13.4-q25)	-q14.1
			(q25-qEnd)	+q22.1 CNTN5
12:			+(q23.3-q24.33)	+12
			++ q24.33	
13:			-q31.1	
14:			-(q23.2-qEnd)	
			+0(q31.3) TTC8	
15:				
16:		+16q	+(pEnd-p13.3) LEP	
17:				
	-(pEnd-q11.2)		-(pEnd-q11.2)	+17
			+(q21.2-qEnd)	
18:	-18			+(p11.23-qEnd)
19:		-(q13.2-q13.33)		+19p
20:	-p13			
21:				
22:				
X:	Х	XX	х	XX

Table listing the most significant copy number alterations T = 5, that have been found on at least two of the platforms (Xba,Nsp,Sty,Nsp+Sty) being analyzed.

		MAD	[BP]	K-S p-value			
Chips compared	# cases	GADA	CBS	GADA larger	CBS larger		
$\min\left( Xba - St \right)$	y ,  Xba	-Nsp :					
	59	95670	93132	0.54	0.76		
Nsp - Sty :							
	61	88024	71265	0.35	1.0		
$ (Nsp\&Sty) - \overline{Illumina} :$							
	91	22784	21388	0.58	0.95		

For the confirmed breakpoints and excluding those near the centromere, we computed the median absolute difference in breakpoint location between chips (units in base pairs [BP]), and the p-value associated with the Kolmogorov-Smirnoff test for the hypothesis that differences are stochastically larger (i.e. less accurate) in one algorithm vs. the other. No significant changes in accuracy have been found.

Table 6.	Copy	number	breakpoints	found	on all	platforms
	~~~~~/				~ ~ ~ ~ ~ ~ ~ ~	P

name         Cytholand         No.	Cell-line	Chr &	GADA Position [BP]				CBS Position [BP]						
SLX-BL2         1p12.3         9941970         9961870         9960215         9961215         9961412         995180         1979364           SLX-BL2         2p24.3         1614969         1643002         1645022         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         164502         17991630         179723         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1797103         1616104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1615104         1617125         1617114	name	Cytoband	Xba	Nsp	Sty	Nsp+Sty	Illumina	-	Xba	Nsp	Sty	Nsp+Sty	Illumina
SK. NEE         201.3         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1977800         1777403         1777409         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         17774490         1777449         17774490         1777449         17774490         1777449         17774490         17774490         177	SK-N-BE2	1p21.3	97045920	96895983	97183094	96895983	96808701		96602215	96564172	95918556	96486927	96808701
Bak. Ku         2p-21.3         1p-141000         1p-44.0001         1p-44.0011         1p-44.0111         1p-44.0011         1p-44.0111 <td>SK-N-BE2</td> <td>2p24.3</td> <td>15977810</td> <td>15978001</td> <td>15977810</td> <td>15978001</td> <td>15979864</td> <td></td> <td>15977810</td> <td>15978001</td> <td>15977810</td> <td>15978001</td> <td>15979864</td>	SK-N-BE2	2p24.3	15977810	15978001	15977810	15978001	15979864		15977810	15978001	15977810	15978001	15979864
Six R-R0         pi-12         ci Six Six         ci Six Six <td>SK-N-BE2</td> <td>2p24.3</td> <td>16419609</td> <td>16453092</td> <td>16462002</td> <td>16462002</td> <td>16463522</td> <td></td> <td>16419609</td> <td>16453092</td> <td>16462002</td> <td>16462002</td> <td>16465097</td>	SK-N-BE2	2p24.3	16419609	16453092	16462002	16462002	16463522		16419609	16453092	16462002	16462002	16465097
SK.N. BIZ         8/14/23         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137749783         137746978         137747935         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         137746978         13784697         13874627         13714978         13874177         1386424         135714977         1386424         135714977         1386424         135714977         1386424         135714977         1386424         135714977         1386424         135714977         1386424         135714977         1386424         135714977         1386424         138714977         1386424         138714977         1386424         138714977         1386424         138714977         1386424         138714977         1387147         13744978         1387147         13744978         13871477         13871477         13871477         13871477 <td>SK-N-BE2 SK-N-BE2</td> <td>2p21 3p14.2</td> <td>48447814</td> <td>61301823</td> <td>480/1628</td> <td>4/029503</td> <td>47840828</td> <td></td> <td>48447814</td> <td>61301823</td> <td>480/1628</td> <td>61241447</td> <td>4/840828</td>	SK-N-BE2 SK-N-BE2	2p21 3p14.2	48447814	61301823	480/1628	4/029503	47840828		48447814	61301823	480/1628	61241447	4/840828
Six.N=B2	SK-N-BE2	8q24.23	137748993	137757306	137735555	137747078	137747933		137748993	137746403	137735555	137746403	137747933
Six.NB2         II_IS11         6430115         6430015         6533042         6531045         6631015         66710723         6633042         6631045         9230784         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         9210783         <	SK-N-BE2	8q24.23	137892295	137955330	137924208	137924208	137919630		137892295	137931617	137924208	137931617	137919630
Six.N=BE2         1741.1.2         2810086         2826478         28247634         2810086         28264878         2826478         2826478           Six.N=BE2         292413         1571100         10528735         10620162         10711725         10628184         10528157         10568241         1585417         1056062           Six.Six.N         2921.3         15711007         1586241         1553157         1056706         1072807         10570807         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         10570871         2146771         2247541         2247571         2247541         2247571         2247541         2247571         2247541         2247571         2477571         5058748         5059074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         5569074         55	SK-N-BE2	11q13.1	64310154	64977325	65339642	65010150	65335248		64310154	64977325	65339642	65339642	65193464
Six A-Biz         206160         277972         3036010         3036010         3036010         2087115         2046160         277972         3036010         2087115           SMS-KAN         2p.21.3         16171071         15862241         15863241         15866241         15721007         15862241         15861241         1571007         15862241         15861241         1571007         15862241         15861241         1571007         15862241         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557501         1557502         22475511         22475511         22475511         22475511         22475511         22475511         2247551         2247551         22475511         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247551         2247555         2247555         2247555         2247555         2247555         2247555         2247555         2247555         2247555         2247555         22475555         22475555         22475555<	SK-N-BE2	17q11.2	28109086	28263828	28164827	28283675	28247634		28109086	28263828	28164827	28266739	28214976
SMS-KAN         [1]3.1         [16]17501         [16]2384.5         [16]17252         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257         [16]271257	SK-N-BE2	20p13	2406160	2773972	3036010	3036010	2987115		2406160	2773972	3036010	3036010	2987115
SMS.EX.         12,1100         12,000         12,000         12,0000         12,0000         12,0000         12,00000         12,00000         12,00000           SMS.EX.         20,11         22,00071         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,01521         22,015211         22,01521         22,015211	SMS-KAN	1p13.3	108157301	107888773	108203626	108218567	108177825		108157301	108208349	108186644	108178227	108177825
SMS-KAN         2-04.1         2189702         1199499         2201932         2201932         2201932         2201932         2209373           SMS-KAN         3-02.1         8384015         8210511         8384901         8201971         2247531         22475473         22475473         2247541         22475731         2247541         22475473         838691         838691         890017         416523           SMS-KAN         3-01.1         8516320         9501944         9501230         5501944         90124737         8161523         5501944         90124737         8161523         5501944         90124737         816152         9501944         9012438         901243         9501944         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438         9012438	SMS-KAN SMS-KAN	2p24.3 2p24.3	15/21907	15868241	15853157	15868241	15869663		15/2190/	15868241	15853157	15868241	15869663
SMS-KAN         2941.         2240771         2247541         2247547         2247573         22466771         2247571         2247573         22466771         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         2247571         22475711         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         2247628         <	SMS-KAN	2p24.5 2n24.1	21887032	21974989	22013932	22013932	21992435		21887032	21974989	22013932	22013932	21992435
SMS-KAN         5µ1-1         8134015         2010511         814023         8140323         8147334         8143023         9437640         9437640         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90340740         90307176         90374747	SMS-KAN	2p24.1	22466771	22475341	22470539	22475341	22475673		22466771	22475341	22470539	22475341	22475673
SMS-KAN         Spl1.1         SBI-6152         904/67/4         9102/237           SMS-KAN         4q12         5508885         5508905         5508905         5508905         5508905         5508907         5508905         5508907         5508907         5508907         5508907         5508907         5508907         5508907         5508907         508907         508907         508907         508907         508907         508907         508907         10958238         12969118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         2009118         201818         1101812         14466112         201818         110182         120018         1209011         201818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818         1101818	SMS-KAN	3p12.1	83843045	84210511	84386931	83873910	84165323		85157384	84137907	84386931	83960187	84165323
SMS-KAN         4µ12         55048904         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         550400         550400         550400         550400         550400         550400         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         5504004         55040000         55040000         5504	SMS-KAN	3p11.1	88163152	90346746	97369003	90346746	90472437		88163152	90346746	96620438	90346746	90472437
SMB-KAN         04/22.2         94/27/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94/97/211         94	SMS-KAN	4q12	55018889	55049094	55058835	55049094	55040244		55152302	55049094	55056941	55049094	55040244
SMB-KAN         Inpl1.2.3         302/365         304/3753         30/2/1148         3089588         30/2/158         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1148         30/2/1	SMS-KAN	4q22.2	94894653	94792613	94948871	94957181	94937901		94894653	94833508	94919018	94872717	94940338
Subserver         Houses         Houses         Houses         Houses         Houses         Houses           SMS-KAN         H14-2         853744         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124         8538124 <td>SMS-KAN</td> <td>10p11.23</td> <td>30297356</td> <td>30435753</td> <td>30/21148</td> <td>30685964</td> <td>30559838</td> <td></td> <td>30297356</td> <td>30552253</td> <td>30/21148</td> <td>30/21148</td> <td>30551022</td>	SMS-KAN	10p11.23	30297356	30435753	30/21148	30685964	30559838		30297356	30552253	30/21148	30/21148	30551022
NMK-KAN         1141-2         8533123         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124         8533124 <th< td=""><td>SMS-KAN</td><td>10q20.2</td><td>130102560</td><td>129082011</td><td>130148252</td><td>130148252</td><td>130172807</td><td></td><td>130095140</td><td>130168048</td><td></td><td>130148252</td><td>130172807</td></th<>	SMS-KAN	10q20.2	130102560	129082011	130148252	130148252	130172807		130095140	130168048		130148252	130172807
SMS-KAN11q3.31177347411773126511782374811782374811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811782314811781231481178123148117812314811781231481178123148117812314811781231114116331141163311141163311781331115133111513131151313115131311513131151313115131311513131151313115123131141231481178123111781231117	SMS-KAN	11q14.2	85287454	85435237	85383124	85383124	85381622		85287454	85367689	85383124	85383124	85381622
SMS-KANl9q13.24570670458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270458702704587027045870270 </td <td>SMS-KAN</td> <td>11q23.3</td> <td>117735474</td> <td>117791205</td> <td>118235879</td> <td>118235879</td> <td>117802601</td> <td></td> <td>117735474</td> <td>117791205</td> <td>117823148</td> <td>117823148</td> <td>117802601</td>	SMS-KAN	11q23.3	117735474	117791205	118235879	118235879	117802601		117735474	117791205	117823148	117823148	117802601
SMS-KAN         [9q]1.33         57641156         57390701         5734324         57641156         57390701         57374324           LAN-6         [1q]2.11         [1q]2.01         [1q]2.0	SMS-KAN	19q13.2	45796700	45571967	45879279	45879279	45910451		45796700	45571967	45879279	45879279	45910451
LAN-6         1p36.33         2140048         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         22476248         24875802         14310562         14300562         14308562         14308562         14308562         14308562         14308562         14308562         14308562         14308562         218538977         1287648         22487588         21857580         21867585         128537778         12874644         57215464         12570184         57231454         57231454         57231454         57231454         57231454         57231454         57231454         57231454         57231454         57231545         123710544         123710826         123705546         123701541         123701545         12370544         123710826         12370544         123710826         5732490         31031677         1373499         31145274         12370826         5732490         310311031         105110313         105110313         105110313         105110313         105110313         105110313         105110313 <td>SMS-KAN</td> <td>19q13.33</td> <td>57641156</td> <td>57395071</td> <td>57400799</td> <td>57395071</td> <td>57374324</td> <td></td> <td>57641156</td> <td>57395071</td> <td>57322747</td> <td>57395071</td> <td>57374324</td>	SMS-KAN	19q13.33	57641156	57395071	57400799	57395071	57374324		57641156	57395071	57322747	57395071	57374324
LAN-6         1q21.1         12266129         143070676         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         14379852         124556         124566         1249151         12449         12444         124710826         1241566         133114219         124379452         12371984         1245796         12471963         1131719         1449131         12371982         31145754         31145754         31145754         31145754         31145754 <td>LAN-6</td> <td>1p36.33</td> <td>21940846</td> <td>22438012</td> <td>22476248</td> <td>22476248</td> <td>22480144</td> <td></td> <td>22445846</td> <td>22438012</td> <td>22476248</td> <td>22476248</td> <td>22480144</td>	LAN-6	1p36.33	21940846	22438012	22476248	22476248	22480144		22445846	22438012	22476248	22476248	22480144
LAN-6         2p2.1         4205060         41405401         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4133143         4134143         5721456         22004536         22047530         22047530         22047530         22047530         22047530         22047530         22047530         22047530         21673143         1414143         1051241         10437178         21673043         12671086         21673043         12671086         21673047         21404344         12366359         2414394<	LAN-6	1q21.1	142661525	143607676	143798352	143887291	144106312		142661525	143607676	143798352	143798352	144106312
LAN-6         2436         22040639         220398375         220602890         22062890         220108300         22017330         220480390         220449807           LAN-6         3p14.3         5732405         57032227         57238434         5721650         57332405         5703227         57238434         5721650         57332405         5703227         57238434         5721650         5733247         57238434         5721650         5733247         57238434         5721650         5733247         57238434         5721650         5733247         57238434         5721650         5733247         57238443         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031         10511031 <t< td=""><td>LAN-6</td><td>2p22.1 2a36</td><td>42030809</td><td>41405461 218577787</td><td>218754682</td><td>41340562</td><td>41338977</td><td></td><td>42030809</td><td>41405461</td><td>41333143</td><td>41340562</td><td>41338977</td></t<>	LAN-6	2p22.1 2a36	42030809	41405461 218577787	218754682	41340562	41338977		42030809	41405461	41333143	41340562	41338977
LAN-6         3p14.3         5732493         57324834         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         57238434         5723833         5738333         5738333         5738333         5738333         5738333         57338434         5739737         573984         536339         536339         536339         536339	LAN-6	2436	220406369	220398375	220629809	220629809	220449867		220406369	220534849	220475305	220480390	220449867
LAN-6 $\dot{\mathbf{q}}_{12}$ 6802341680324168022411680234167036066809501568097504LAN-6 $\dot{\mathbf{q}}_{223}$ 10634419810509033410517743710511031310511599410527055110509033410511031310511031310511219LAN-6 $\dot{\mathbf{q}}_{223}$ 123703841237103741237108261237082612370834123708261237083412370826LAN-6 $\gamma_{11.21}$ 62170002449235248023592491933721784099311292231135783114574LAN-6 $\gamma_{11.21}$ 621710006234621630531663063166306337063993279637481636394091963063370LAN-6 $\gamma_{11.22}$ 69847573698352069807896983196069738283698352069831960LAN-6 $7_{11.22}$ 6984757369835206980789698552069831960697382836983552069831960LAN-6 $8_{22.1}$ 933461237834643106793779231338657433844443579281338674LAN-6 $8_{22.2}$ 93948619572831368567433944433579281338674LAN-6 $9_{22.2}$ 1245750116490751246097214609721460972146097LAN-6 $9_{22.2}$ 1245750124694612460972146097214609721460972146097LAN-6 $9_{22.2}$ 1245754124699721460972146097214609721460972146097 <td>LAN-6</td> <td>3p14.3</td> <td>57324905</td> <td>57032227</td> <td>57238434</td> <td>57238434</td> <td>57215650</td> <td></td> <td>57324905</td> <td>57032227</td> <td>57238434</td> <td>57238434</td> <td>57215650</td>	LAN-6	3p14.3	57324905	57032227	57238434	57238434	57215650		57324905	57032227	57238434	57238434	57215650
LAN-66p16.310634119810590934105177437105110313105112319105110313105112319LAN-67p15.1227395546123703841237038412370384123708261232955461237038412370826LAN-67p14.3311260231129253113575831145724311260023112925206445824802359LAN-67p11.21639932796340919631305763400196363370639037063903796390491965784163639409196363370LAN-67p11.226994737369355069807089698755069807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856980738569807385698073856167777171167771647477716468751647777164747771646875LAN-69p23127417411264386126409721460972146097214689751269079 <td< td=""><td>LAN-6</td><td>6q12</td><td>68022441</td><td>68353881</td><td>68154792</td><td>68095015</td><td>68197504</td><td></td><td>68022441</td><td>68095015</td><td>67263660</td><td>68095015</td><td>68197504</td></td<>	LAN-6	6q12	68022441	68353881	68154792	68095015	68197504		68022441	68095015	67263660	68095015	68197504
LAN-6         6q2.31         12329546         12371034         12371074         123710826         12370834         12370826           LAN-6         7p15.1         2778409         2489235         2490337         2784090         31129225         25064458         2490337         24910337           LAN-6         7p14.3         31126002         31129325         31135758         31145758         31145784         3112602         51135758         3114574           LAN-6         7q11.21         62171000         62343621         63050316         6306370         63903270         63940191         6374633         63940319         6396370         16993270         63940191         6376373         3893520         69831500         6983523         6983550         6983552         6983552         6983523         169831960           LAN-6         8p212         93931612         3785440         3712319         330561         3766947         37458281         3783540         38093651         3766947         349434         3572281         3316679         3579281         3316679         3579281         3316679         3579281         3316679         3579281         3316679         3579281         316679         3164941         164472171         116472717         116472	LAN-6	6p16.3	106344198	105090334	105177437	105110313	105135994		105275051	105090334	105110313	105110313	105112419
LAN-6         7p16.1         27784099         24892359         2426367         2489239         24919337         27784099         31129225         24892359         24892359         24919337           LAN-6         7p11.21         6217000         62343621         63050316         63053316         62336389         62171000         6294328         6934208         62336389           LAN-6         7q11.21         69847573         69835520         69847507         63940919         63963370         63942919         63940919         63943520         6984758         6835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         69835520         6987385         6184344         37869447         73758281         37869447         73748281         73879441         14447614         1447717         11647717         11647717         11647717         116480735         116519714         116472717         116480735         11631974         316793         379281         338674         3394434	LAN-6	6q22.31	123295546	123710384	123731764	123710384	123710826		123295546	123710384	123605395	123710384	123710826
LAN-6       7p14.3       31126002       31125758       31135758       31145274       31126002       31125728       31135758       31145274         LAN-6       7q11.21       6393279       63940019       63130516       6335316       62336389       62171000       6291086       6238233       69335520       69807380       63963750         LAN-6       8p12       39331612       37835400       37102319       8393651       37869447       37452281       37835400       38093651       37809447         LAN-6       8p22.1       93948610       95445117       9524323       95445117       9574632       95445147       7147217       1164477471       116477717       116487735         LAN-6       8p22.2       3394434       3579281       3316679       3579281       3316679       3579281       3316679       3579281       3316679       3579281       336674         LAN-6       9p24.2       4947650       4639395       4685068       4648449       4647040       4947650       463827       464704         LAN-6       9p21.3       21461790       21460977       21469775       12764771       12643446       21460997       2146973       21497037       22197037       22197037       22197037	LAN-6	7p15.1	27784099	24892359	24256367	24892359	24919337		27784099	31129325	25064458	24892359	24919337
LAN-6 7q11.21 62171000 62349021 6390310 633705 63940919 633705 63940919 637305 734163 63940919 633705 1 LAN-6 7q11.22 6947773 6983520 66907809 6983520 69831960 69738283 6983520 69807385 6983550 69831960 LAN-6 8q22.1 93931610 95445117 95274323 95445117 95414304 96630283 95445117 9507632 9349564 7957846 LAN-6 8q22.1 93948610 95445117 95274323 95445117 95414304 96630283 95445117 95372632 93495648 95414304 LAN-6 8q22.3 116469762 116142633 116478611 116140376 116480735 116519714 116472717 116471437 116472717 116480735 LAN-6 9p24.2 4947650 4635935 4685068 4648449 4647040 4947650 4430212 4624827 4624827 4647847 4647040 LAN-6 9p23 12741741 12643846 13524659 12649691 12706172 12741741 12643846 12164190 12754534 12716962 LAN-6 9p21.3 21451790 21460444 21400997 21468318 21451790 2146044 21400997 21488474 LAN-6 9p21.3 21451790 21460464 21400997 21466318 21451790 21450464 21400997 21488473 LAN-6 9p21.3 21451790 21460464 21400997 21468318 21451790 21450464 21400997 21488473 LAN-6 9p21.3 2185820 22158464 22197037 22197037 2249737 2249473 22585404 22197037 22197037 22197037 2249737 22498730 22158464 2197037 21497037 2197037 22197037 2249737 22497271 28850202 92885727 2885020 2885724 2872509 2885724 2872509 2885724 2872509 2885724 2872509 2885724 2872509 2885724 2872509 2885724 2872509 214503961 160386017 106074551 105993065 106086197 10622150 10609539 106074551 105993065 106086197 10622150 10609539 106074551 105993065 106086197 10622150 10609539 106074551 105993065 106086197 1062315 3659309 106074551 1248453 14479526 31825431 3656020 36393418 35294289 14AN-6 17q21.2 36319125 1356930 106045355 01585017 63787846 1245253 12456330 24836351 24865310 2457554 12456330 24836351 24865310 147555 11862430 5147595 51862430 5147595 51862430 5185691 130618719 5182430 5147595 51862430 51855691 14802100 CHLA-20 2q31.1 17472684 17470526 17493287 174717018 17477081 17470828 17470528 174717018 174717018 174710718 174730921 17472684 17457563 1145789569 174895669 174895669 174895669 174895669 174895669 174895669 174895669 174895669 174895669 17489	LAN-6	7p14.3	31126902	31129325	31135758	31135758	31145274		31126902	31129325	31135758	31135758	31145274
LAN-6         Tq11.21         6094175         6093190         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093219         6093210         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211         6093211	LAN-6	7q11.21 7a11.21	63993279	639/0019	63137057	630/0010	63963370		63993279	63940910	65748163	63940010	63963370
LAN-6         8p12         39331612         37835460         37192319         38093651         37869447         37458281         37835460         38093651         38093651         37869447           LAN-6         8q22.1         93948610         95445117         9557262         93495648         95414304           LAN-6         8q23.3         116467717         116142717         11647217         11647217         11647217         11647217         11647217         11647217         11647217         11647217         116480735           LAN-6         9p24.2         4394750         4635925         4685068         464449         4497400         497650         463212         4424827         4424871           LAN-6         9p21.3         21451790         21460464         21460997         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097         2146097 <td>LAN-6</td> <td>7q11.21</td> <td>69847573</td> <td>69835520</td> <td>68907809</td> <td>69835520</td> <td>69831960</td> <td></td> <td>69738283</td> <td>69835520</td> <td>69807385</td> <td>69835520</td> <td>69831960</td>	LAN-6	7q11.21	69847573	69835520	68907809	69835520	69831960		69738283	69835520	69807385	69835520	69831960
LAN-6         8q22.1         93948610         95445117         95274323         95445117         95414304         96630283         95445117         95372632         93495648         95414304           LAN-6         8q23.3         116466762         116142633         116478611         116140375         11619714         116471417         11647717         116480735           LAN-6         9p24.2         3394443         3379281         3338674         3339443         3579281         3316679           LAN-6         9p23.2         12741741         12643846         13524659         12649691         1270172         12741741         12643846         1216190         12754534         12716962           LAN-6         9p21.3         2218580         22158464         22197037         22197037         22404973         2218464         21467097         21882000         28844830           LAN-6         9p21.2         2880102         28929272         2882009         2857478         2875569         2885320         28742971         2882009         28844830           LAN-6         11403.4         71592372         7159242         71591974         71593774         71592477         71591974         7169174         7169174         7169174         7159174	LAN-6	8p12	39331612	37835460	37192319	38093651	37869447		37458281	37835460	38093651	38093651	37869447
LAN-68q23.311646976211614263311647861111614037611648073511651971411647271711671437116472717116472717116480735LAN-69p24.2339443435792813359281335928133943433394343331667935792813358674LAN-69p2312741741126438461352465912649691127061721274174112643846121641901275453412716962LAN-69p21.32218540222158444221907372219703722140444221970372219703722197037221970372219703722197037221970372219703721974474116422171164697221884643LAN-69p21.22841765728801622892927228820092885747828656092885320228742971288200928844830LAN-61123.310599306510608179106093993106074551105993055106808171063939110673551LAN-617q11.22575541247491292483323024836312475531248332302483635124865310LAN-617q21.250181719518694160393691603360160380176046835160436455603936916039369160386017LAN-617q21.2501817195186243051856911501871951862430518569115018719518624305185691LAN-617q21.250181719518624305185691150187195186243051856915	LAN-6	8q22.1	93948610	95445117	95274323	95445117	95414304		96630283	95445117	95372632	93495648	95414304
LAN-6         9p24.2         339443         3570281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         3370281         4467040           LAN-6         9p21.3         21451700         2146044         2146097         2140097         2197037         2240973         22187037         22197037         22404973         2218703         2197037         22197037         22197037         218404         2197037         218404         2197037         2187049         2187047         1883009         2884430           LAN-6         11q13.4         71592372         71549242         7159197         71634231         LAN-6         12q23.3         10086197         106095393         106074551         10607851         60436155         6033961         60336017	LAN-6	8q23.3	116469762	116142633	116478611	116140376	116480735		116519714	116472717	116471437	116472717	116480735
LAN-6         9p24.2         4947650         4633935         4683068         4648449         4647040         4947650         4630212         4624827         4624827         4647040           LAN-6         9p21.3         12741714         12643846         13254646         121641097         2146097         2146097         21470174         12643846         121641091         12754534         12710672           LAN-6         9p21.3         2218520         2218464         22197037         22197037         2218464         22197037         2218464         22197037         2218464         22197037         2218464         22197037         2218703         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         2197037         2197037         2197037         2187037         2187037         2187037         2187037         2187037         2187037         2187037         21	LAN-6	9p24.2	3394434	3579281	3316679	3579281	3585674		3394434	3579281	3316679	3579281	3585674
LAN-6         9p23         12/41/41         12043846         13524659         12049091         12/14/41         12043846         12164190         12/43243         12/16190         12/43243         12/16190         12/43243         12/16190         12/43243         12/16190         12/43243         12/16190         12/43243         12/41741         12/643846         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         12/64384         1	LAN-6	9p24.2	4947650	4635935	4685068	4648449	4647040		4947650	4630212	4624827	4624827	4647040
LAN-6         9p21.3         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21400791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         21100791         2110791         2	LAN-6	9p23	12/41/41	12643846	13524659	12649691	12/061/2		12/41/41 21/51700	12643846	12164190	12/54534	12/16962
LAN-6         9p21.2         28417657         28800162         28929272         2882009         28857478         28765609         28853202         28742971         2882009         28844830           LAN-6         11q13.4         71592372         71549242         71591974         71591974         71592372         71549242         71591974         71592372         71549242         71591974         71591974         71634231           LAN-6         11q23.3         105993065         106086197         106095399         106074551         105993065         106386197         10646855         60333691         603369161         60386017           LAN-6         17q21.2         50515719         518264341         36690164         3582756         35294289         50618719         51856209         36393487         35294289           LAN-6         17q21.2         50618719         51826931         5185691         50618719         5185630         51855630         5185630         51855630         5185691         5182430         51855630         5185631         2837256         51862430         51855630         5185631         5757846         5762314         5575864         14398352         143657867         14802010         CHLA-20         2q31.1         17472684	LAN-6	9p21.3 9p21.3	21431790	21400404	21400997	21400997	21408518		21431790	21460464	21400997	21400997	22197037
LAN-611q13.471592372715492427159197471591974716078557159237271549242715919747159197471634231LAN-612q23.310599306510608619710609593910607953110509306510608619710602531501005993065LAN-614q23.16046335160341801603936016603430106038601760468351643463516438635164346351LAN-617q11.225755541247912924833230248363512486531025755541248332302483635124865310LAN-617q21.236391251352643413669016435852756352942893009548735264341365562093339348735294289LAN-617q21.250161719518624345147595651862434518759651862434518759651862434CHLA-201q21.1120089986143607676120928505143872911433285361426612514275669614379835214365786714802010CHLA-202q31.11747208417470524174730921174720841747052417472084174705241747208417470524CHLA-202q32.2178610351788169917397795178714071787647717821492417857452017902874817857452017857647CHLA-204p16.1572237858421075913372584210757823465782346878320687832068783206CHLA-204q34.117518953174895669 <td>LAN-6</td> <td>9p21.2</td> <td>28417657</td> <td>28860162</td> <td>28929272</td> <td>28820009</td> <td>28857478</td> <td></td> <td>28765609</td> <td>28853202</td> <td>28742971</td> <td>28820009</td> <td>28844830</td>	LAN-6	9p21.2	28417657	28860162	28929272	28820009	28857478		28765609	28853202	28742971	28820009	28844830
LAN-6         12q23.3         105993065         106086197         106095939         106095939         106074551         105993065         106086197         106095939         106074551           LAN-6         14q23.1         60468351         60341891         60393691         60343301         6034301         60468351         60436455         60393691         6033301         6038017         60468351         60436455         60393691         6033361         24865310           LAN-6         17q1.2         2355541         24749122         2438332312         24836310         2575554         24893315         24863302         248363636           LAN-6         17q22         50618719         51862430         51475956         51862430         51862430         51862430         5185630           CHLA-20         1q21.1         120089986         143607676         120928505         143887291         143328561         142661525         14797566         14379852         14802010           CHLA-20         2q31.1         174726584         174705263         174717018         174730921         174726584         174701708         174730921           CHLA-20         2q32.2         17851430         17897520         17887047         178214924         178874520	LAN-6	11q13.4	71592372	71549242	71591974	71591974	71607855		71592372	71549242	71591974	71591974	71634231
LAN-6         14q23.1         60468351         60341891         60393691         60343301         60343301         60483351         60436455         60393691         60393691         60393691         60393691         60393691         60393691         60393691         60393691         60393691         60393691         60393691         24865310           LAN-6         17q21.2         36391251         33264341         36690164         3582756         35294289         36095477         33264341         365550209         36393487         35294289           LAN-6         17q22         50618719         51862430         5145756         35294289         36095477         35264341         365550209         36393487         35294289           LAN-6         17q22         50618719         51862430         5145756         51862430         51457696         14797852         143657867         14802010           CHLA-20         2p161         68885099         57662317         5762175         5762476         57662175         57624940         57662317         174717018         17477018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         1748714921         178574520 </td <td>LAN-6</td> <td>12q23.3</td> <td>105993065</td> <td>106086197</td> <td>106095939</td> <td>106095939</td> <td>106074551</td> <td></td> <td>105993065</td> <td>106086197</td> <td>106232150</td> <td>106095939</td> <td>106074551</td>	LAN-6	12q23.3	105993065	106086197	106095939	106095939	106074551		105993065	106086197	106232150	106095939	106074551
LAN-6         17q11.2         25755541         24749129         24830331         24830331         25755541         24830331         24830331         24830331           LAN-6         17q21.2         36391251         35264341         36690164         35852756         35294289         36095487         35264341         36556209         36393487         35294289           LAN-6         17q22         50018719         51862430         51475956         51820430         51856911         5018719         51862430         51855630           CHLA-20         1q21.1         12089986         14300767         120928505         14387291         143328536         142661525         142756696         143798352         143657867         14802010           CHLA-20         2q31.1         174726844         174702631         174730921         174726844         174705263         174717018         174730921           CHLA-20         2q32.2         17861035         178574520         178576047         178214924         178745203         17877647           CHLA-20         4p16.1         7572378         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         584210	LAN-6	14q23.1	60468351	60341891	60393691	60343301	60386017		60468351	60436455	60393691	60393691	60386017
LAN-6         17q21.2         36391231         35264341         36690164         35852756         35294289         30095487         35264341         36556209         36393487         35294289           LAN-6         17q22.2         50618719         51862434         5147595         51862434         5147595         51862434         5018717         51862434         5147595         51862434         5147595         51862434         5147595         51862434         51475956         51862434         51475956         51862434         51475956         51862434         51475956         51862434         51475956         51862434         514759566         143798352         143657867         14802010           CHLA-20         2q31.1         174726844         174705241         17472587         174717184         174730921         17472684         17470523         17471718         174717084         17471718         174717084         17470571         178214924         178574520         17857647         178214924         178574520         17857647         178214924         178574520         17857647         178214924         178574520         17857647         178214924         178574520         17857647         178214924         178574520         178576477         178214924         178574520         17	LAN-6	17q11.2	25755541	24749129	24833230	24836351	24865310		25755541	24836351	24833230	24836351	24865310
LAK-6         11422         30016119         31802430         3147350         3147350         3147350         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         31802430         3180	LAN-6	17q21.2	36391251	35264341	36690164	35852756	35294289		36095487	35264341	36556209	36393487	35294289
CHLA-20         2p1.1         16089590         957662314         55736316         657662175         57621905         174270836         174717018         174730921           CHLA-20         2q31.1         174726584         174705263         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018         174717018	CHLA 20	1/q22	120080086	51802450 142607676	214/2920	51802430 142887201	21820911		50618/19	51802430 142756606	514/5950 1/2708252	51802430	14802010
CHLA-20         2q32.1         17472684         174705263         17473927         174717018         17473021         17472684         174705263         17473021           CHLA-20         2q32.2         17851050         17473021         17472684         174705263         17473021           CHLA-20         2q32.2         17851050         178871620         178874520         178874520         178874520         178717018         17471081         174710921           CHLA-20         4p16.1         5722378         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         12300938         12391099         12321237         12300938         12391799         12321237         12300938         12391799         12321237         12300938         12391799         12321237         12300938         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         1748956	CHLA-20	2n16.1	68885099	57662314	55736176	57577846	57662175		57629406	57662314	58097954	57625311	57583694
CHLA-20         2q32.2         17851035         178581699         179377095         178574520         178576047         178214924         178574520         179028748         178574520         178576047           CHLA-20         4p16.1         5722378         5842107         5913372         5842107         5913372         5842107         572378         5842107         5913372         5842107         5842107         572378         5842107         5913372         12300938           CHLA-20         4p15.33         12551237         12310275         12310278         12351237         12310278         12351237         12300938         1239179         1232127         12300938           CHLA-20         4q34.1         171518953         174895669         17507390         174895669         174897540         175185953         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         17489	CHLA-20	2q31.1	174726584	174705263	174793287	174717018	174730921		174726584	174705263	174717018	174717018	174730921
CHLA-20         4p16.1         5722378         5842107         5913372         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107         5842107 <th< td=""><td>CHLA-20</td><td>2q32.2</td><td>178651035</td><td>178581699</td><td>179377095</td><td>178574520</td><td>178576047</td><td></td><td>178214924</td><td>178574520</td><td>179028748</td><td>178574520</td><td>178576047</td></th<>	CHLA-20	2q32.2	178651035	178581699	179377095	178574520	178576047		178214924	178574520	179028748	178574520	178576047
CHLA-20         4p15.33         12551237         12300938         12392275         12316278         12316278         12300938         12391799         12321237         12300938           CHLA-20         4q34.1         17518953         174895669         175097390         174895669         175097390         174895669         175097390         174895669         175097390         174895669         17594384         175185953         174895669         174895669         174895669         17594384         8763427         87640754         87583206         87594384         87688742         87640368         87583206         87594384         617583206         87594384         90366715         90138115         90473794         90376886         90366715         90138115         90372039         904073794         90368911         99803560         99817691         99940387         9964387         99638911         99803560         99817691         99940387         99638911         99803561         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387         99940387	CHLA-20	4p16.1	5722378	5842107	5913372	5842107	5844271		5722378	5842107	5913372	5842107	5842107
CHLA-20         4q34.1         175185953         174895669         175097390         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174895669         174	CHLA-20	4p15.33	12551237	12300938	12392275	12321237	12316278		12551237	12300938	12391799	12321237	12300938
CHLA-20         8q21.5         87/2412/         87/6407.68         87583206         87583206         87583206         87583206         87594384           CHLA-20         8q21.3         90473708         90367018         9036715         91038118         90473708         90366715         91038115         903708         958686         9366715           CHLA-20         8q21.2         100574413         99817691         99940387         99638911         99803560         99817691         99940387         99638911           CHLA-20         8q24.1         127917518         128902498         128922998         128922998         128912903         127917518         128902498         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128922998         128913003         1271673         1844844	CHLA-20	4q34.1	175185953	174895669	175097390	174895669	174897540		175185953	174895669	174890618	174895669	174895669
CHLA-20         8q2.1.5         90473708         90300811         9040734         9040734         9040734         90138115         90370233         9040734         90306715         90138115         90370233         9040734         903560         903703         9036715         9033560         90933761         90940387         909638911         909638911         90940387         909638911         909803560         90917631         128022998         128913903           CHLA-20         8q24.1         12797518         1280922998         128923998         128913903         127917518         1280922998         12892393         128913903           CHLA-20         18p11.23         8617957         8510927         820848         8510927         8392640         8617957         8393289         8309751         844844         8392640           CHLA-20         19q12         33171613         32761177         23876259         32690406         24095263         33171613         32761177         24165666         32690406         24053526	CHLA-20	8q21.3	8/234127	8/640754	87583206	8/583206	8/594384		8/858742	8/640368	8/583206	8/583206	8/594384
CHLA-20         8q24.1         127917518         128903451         128922998         128913903         127917518         128902998         128913903           CHLA-20         18p11.23         8617957         8510927         8200488         8510927         8392640         8617957         8393289         8300751         844844         8392640           CHLA-20         19q12         33171613         32761177         23876259         32690406         24095263         33171613         32761177         24165666         32690406         24095263	CHLA-20 CHLA-20	8q21.5	904/3/08 100574413	90380811	90407394 99940387	90407394 99940387	99638911		99803560	905/2039 99817691	90407394 99940387	905/0880 99940387	90500/15
CHLA-20         18p11.23         8617957         8510927         8200848         8510927         8392640         8617957         8393289         8309751         844848         8392640           CHLA-20         19q12         33171613         32761177         23876259         32690406         24095263         33171613         32761177         24165666         32690406         24095326	CHLA-20	8q24.1	127917518	128903451	128922998	128922998	128913903		127917518	128903451	128922998	128922998	128913903
CHLA-20         19q12         33171613         32761177         23876259         32690406         24095263         33171613         32761177         24165666         32690406         24055356	CHLA-20	18p11.23	8617957	8510927	8200848	8510927	8392640		8617957	8393289	8309751	8448484	8392640
	CHLA-20	19q12	33171613	32761177	23876259	32690406	24095263		33171613	32761177	24165666	32690406	24053526

Table listing the locations for the copy number breakpoints detected by GADA and CBS on the four neuroblastoma cell-lines (SK-N-BE2, SMS-KAN, LAN-6, CHLA-20) that have also been found on all array platforms (Xba, Nsp, Sty, Nsp+Sty, Illumina).

Cell-line	Chr &	Chr & GADA Position [BP] CBS Position [BP]				[BP]					
name	Cytoband	Xba	Nsp	Sty	Nsp+Sty	Illumina	Xba	Nsp	Sty	Nsp+Sty	Illumina
SMS-KAN	2q22.1	141962960	142006622		142006622	141996840	141962960	141991258		141991258	141996840
SMS-KAN	2q22.1	142284086	142419855		142419855	142418322	142284086	142419855		142386408	142418322
SMS-KAN	2q23.3	152928225	152959722		152945591	152947104	152928225	152959722			
SMS-KAN	2q23.3	153172826	153233532		153356905	153182040	153172826	153231102			
SMS-KAN	4q22.3	98081595	97971534		97971534	97946136	98081595	97971534		97971534	97946136
SMS-KAN	4q22.3	98389453	98794422		98492192	98515047	98389453	98489669		98489669	98515047
LAN-6	4q35.1		187001741	187043679	187043679	187037031		187001741	187248120	186997226	187037031
LAN-6	4q35.2		189693227	189400592	189537964	189715209		189693227	189400592	189693227	189715209
LAN-6	5q35.3		178389593	178435944	178439675	178388353		178389593	178435944	178439675	178388353
LAN-6	6q26		162768919	162672040	162783990	162769931		162768919	162770133	162770133	162769931
LAN-6	6q26		163042210	162863051	163042210	163069487		163073363	162948280	163042210	163069487
LAN-6	7p21.1	17042942	17048506		17048506	17079506					17079506
LAN-6	7p21.1	17194089	17293268		17293268	17187461					17194647
LAN-6	9p13.3		35932406		35934224	35923323					35923323
LAN-6	9p13.3		36095264		36117196	36036596					36036596
LAN-6	11q25		134393784		134408260	134410991					134410991
LAN-6	12q24.32		125117158		125475975	125319087		125257058	124609076	125131448	125319087
LAN-6	12q24.33		127723245	127722879	127723245	127723245		127723245	127835197	127723245	127723245
LAN-6	13q31.1				82988642	82996585					82996585
LAN-6	13q31.1				83045936	83063672					83055928
LAN-6	14q31.3	88300117	88381272		88443831	88310402	88300117	88381272		88443831	
LAN-6	14q31.3	88499809	88623396		88625132	88647502	88499809	88623396		88634883	
LAN-6	16p13.3		5755300	5775884	5775884	5679682		5669239	5775884	5802165	6023611
LAN-6	16q23.3			82340991	82342624	82374996		86364648	82340991	82342624	82502789
LAN-6	17		19109505		19117656	19120783				19117656	19120783
LAN-6	17		19175068		19175068	19145456				19175068	19145456
CHLA-20	2q37.2		236702079	236768287	236768287	236738515		236702079	236844697	236768287	236765691
CHLA-20	4p14		38741486		38741486	38758076		38741486		38741486	38752396
CHLA-20	4p14		38996761		38996761	39068335		38996761		38996761	39006763
CHLA-20	5q11.2		50870182		50824363	50850389		50824363		50824363	50850389
CHLA-20	5q11.2		51529692		51532772	51532772		51529692		51532772	51532772
CHLA-20	7q33		132875721		132875721	132884795		132875721		132875721	132875949
CHLA-20	7q33		133004505		133004505	132996066		133004505		133004505	132996066
CHLA-20	11q14.1		78683236	78694008	78694008	78691521			78694008	78694008	78691521
CHLA-20	11q14.1		78805883	78801531	78801531	78814667			78801531	78801531	78818346
CHLA-20	11q22.1	99371373	99366936		99366936	99378927	99371373	99240362		99366485	99378927
CHLA-20	11q22.1	100243669	100322922		100322922	100299086	100243669	100319819		100322922	100299086

Table 7. Copy number breakpoints found by at least two platforms

Table listing the locations for the copy number breakpoints detected by GADA and CBS on the four neuroblastoma cell-lines (SK-N-BE2, SMS-KAN, LAN-6, CHLA-20) that have also been found on at two of the array platforms analyzed (Xba, Nsp, Sty, Nsp+Sty, Illumina).