

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see [Authors & Referees](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- A description of all covariates tested
- A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection

Labview 8.0, Labview 9.0 were used to synchronously control 3D translation stage movement and image record.

Data analysis

Matlab 2018a was used to process the original data obtained by the liquid-nitrogen-cooled InGaAs camera (2D-OMA V, Princeton Instruments).
ImageJ 1.51j8 was used to perform maximum intensity projections, 3D rendering and affine transform (shear, scaling and rotation) of the data obtained by oblique NIR light sheet microscopy.
Origin 9.0 was used to draw the curves and analyze the standard deviation.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The data that support the findings of this study are available from the corresponding author upon request

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

Life sciences Behavioural & social sciences Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	Sample sizes were chosen according to prior experience with similar models and determined by the reproducibility of molecular imaging. The sample sizes were specified in corresponding figure legends.
Data exclusions	No data were excluded from the analyses.
Replication	All attempts at replication were successful.
Randomization	No group was allocated, and any experiment involving comparison of imaging performance in different wavelength windows was done on the same animal or tissues.
Blinding	Not applicable, since no group was allocated.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Included in the study
<input type="checkbox"/>	<input checked="" type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology
<input type="checkbox"/>	<input checked="" type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Human research participants
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data

Methods

n/a	Included in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging

Antibodies

Antibodies used

- anti-mouse PD-1 (BioXCell; Cat. #: BE0146; Clone Name: RMP1-14; Lot. #: 659318AZ; Dilution: 150 ug/ 200 uL);
- anti-mouse/human-CD11b (BioXCell; Cat. #: BE0007; Clone Name: M1/70; Lot. #: 655017M2; Dilution: 150 ug/ 200 uL) ;
- anti-mouse-PD-L1 (Selleckchem; Cat. #. A2004; Clone Name: SP142; Lot. #: 02; Dilution: 150 ug/ 200 uL)

Validation

- anti-mouse PD-1 (BioXCell, clone RMP1-14):
Website: <https://bxc.com/product/invivomab-anti-m-pd-1/>
Relevant citations from website:
[1] Grasselly, C., et al. (2018). "The Antitumor Activity of Combinations of Cytotoxic Chemotherapy and Immune Checkpoint Inhibitors Is Model-Dependent." *Front Immunol* 9: 2100.
[2] Triplett, T. A., et al. (2018). "Reversal of indoleamine 2,3-dioxygenase-mediated cancer immune suppression by systemic kynurenine depletion with a therapeutic enzyme." *Nat Biotechnol* 36(8): 758-764.
[3] Moynihan, K. D., et al. (2016). "Eradication of large established tumors in mice by combination immunotherapy that engages innate and adaptive immune responses." *Nat Med*. doi: 10.1038/nm.4200.
- anti-mouse/human-CD11b (BioXCell; Cat. #: BE0007; Clone Name: M1/70)
Website: <https://bxc.com/product/m-cd11b/>
Relevant citations from website:
[1] Becker, A. M., et al. (2015). "ADAM17 limits the expression of CSF1R on murine hematopoietic progenitors." *Exp Hematol* 43(1): 44-52 e41-43.
[2] Liu, B., et al. (2015). "Collaborative interactions between type 2 innate lymphoid cells and antigen-specific CD4+ Th2 cells exacerbate murine allergic airway diseases with prominent eosinophilia." *J Immunol* 194(8): 3583-3593.
[3] Yokota, N., et al. (2014). "Contributions of thrombin targets to tissue factor-dependent metastasis in hyperthrombotic mice." *J Thromb Haemost* 12(1): 71-81.

3. anti-mouse-PD-L1 (Selleckchem; Cat. #. A2004; Clone Name: SP142):
 Website: https://www.selleckchem.com/products/Atezolizumab.html?gclid=EAlalQobChMIgbyP9M6E4AIVAcPkCh2nwgkEAAYASAAEgL5yvD_BwE
 Relevant citations from website:
 [1] Inman BA, et al. Clin Cancer Res. 2017, 23(8):1886-1890.
 [2] Deng R, et al. MAbs. 2016, 8(3):593-603.
 [3] Zheng Y, et al. Bioengineered. 2016, 18:1-7.
 [4] Herbst RS, et al. Nature. 2014, 515(7528):563-7.

Animals and other organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals	4-6-week-old C57BL/6 and BALB/c female mice were purchased from Charles River
Wild animals	This study did not involve wild animals.
Field-collected samples	This study did not involve samples collected from the field
Ethics oversight	Mouse handling was approved by Stanford University's administrative panel on Laboratory Animal Care. All experiments were performed according to the National Institutes of Health Guide for the Care and Use of Laboratory Animals.

Note that full information on the approval of the study protocol must also be provided in the manuscript.