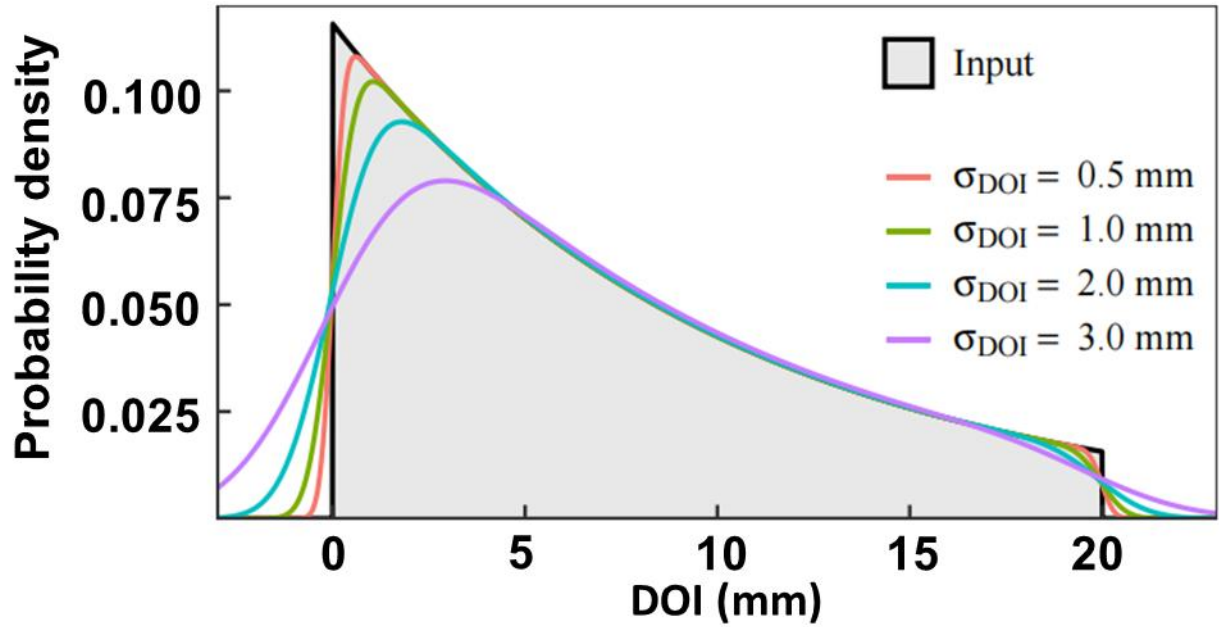**A**

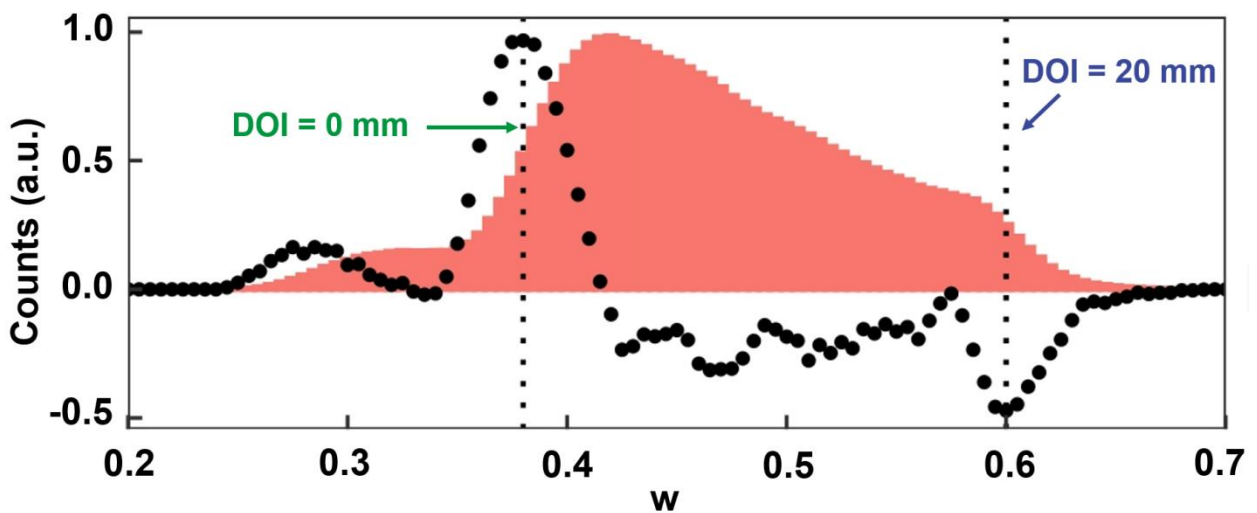$$f_{in}(z;\ \lambda, L) = \begin{cases} 0 & \text{for } z < 0 \\ A_0 e^{-z/L} & \text{for } 0 \le z \le L \\ 0 & \text{for } z > L \end{cases}$$

B

C

SUPPLEMENTAL FIGURE 1. (A) Input function f_{in} describes the interaction probability of absorbed photons along the depth z of the crystal according to the Beer-Lambert law, where L is the length of the crystal, λ is the effective attenuation length for 511 keV photons, and A_0 is the normalization constant. (B) DOI response at different DOI resolutions was modeled by convolving this input function (black) with a Gaussian blur (with standard deviation σ of 0.5 mm/red, 1.0 mm/green, 2.0 mm/blue, and 3.0 mm/purple). (C) Experimental w histogram for a representative detector module (red) and its derivative (black dotted line), showing two Gaussian distributions for the rise and tail of the decay. The Gaussian peaks correspond to the top (i.e., DOI = 0 mm) and bottom (i.e., DOI = 20 mm) of the crystal.
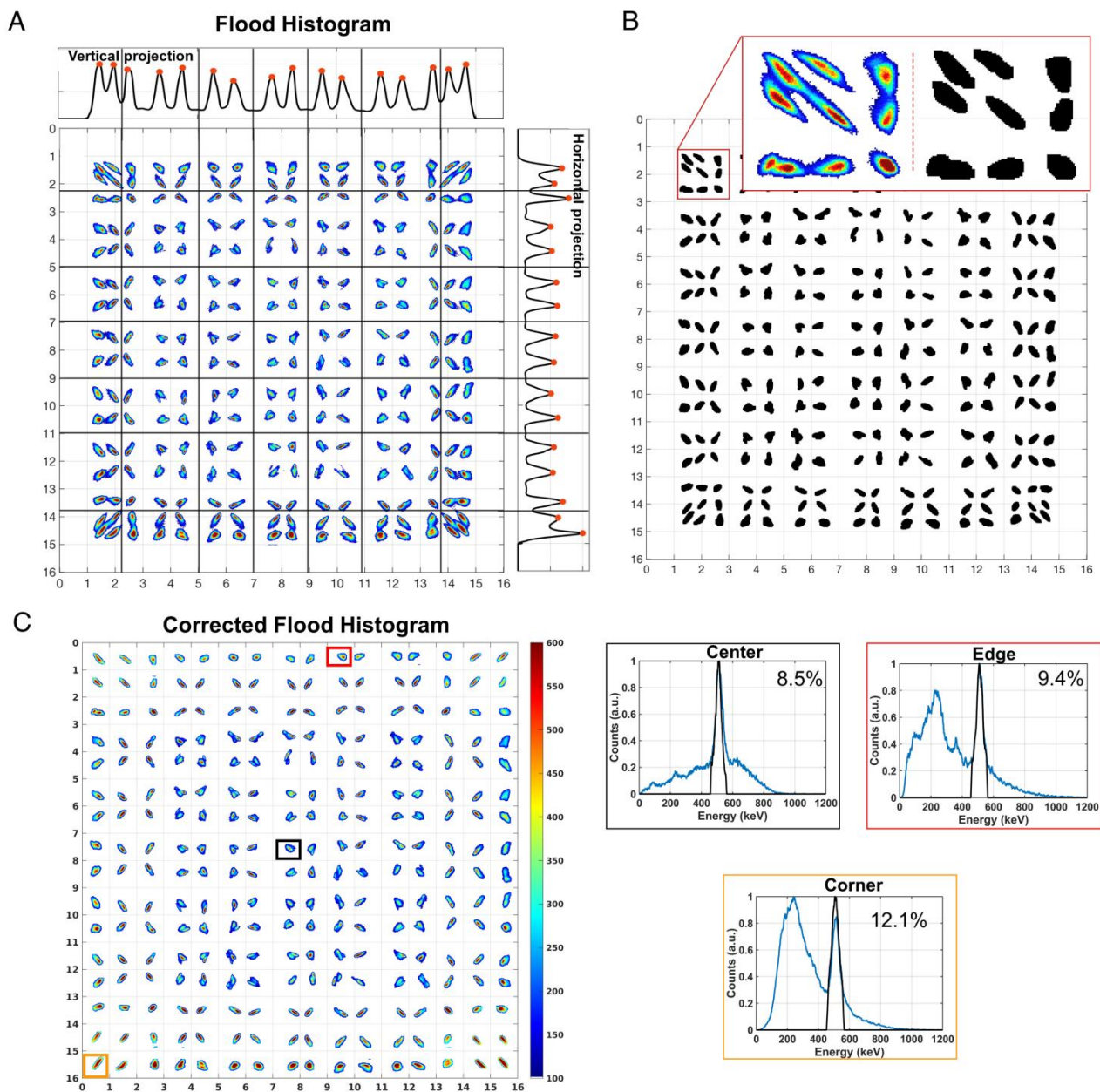
SUPPLEMENTAL FIGURE 2. (A) 2D flood histogram and its 1D horizontal and vertical projections for one detector module (solid circles show the peak of Gaussian distributions). (B) Segmented mask for all crystals obtained by k-means clustering. Inset shows a zoom-in comparison between flood histogram and mask for the crystals located at the top-left corner of the module. (C) Corrected flood histogram and energy spectra with (black) and without (blue) a 460-560 keV energy window and DOI correction. The DOI-corrected energy resolutions of the representative center, edge and corner crystals are 8.5%, 9.4% and 12.1%, respectively (Not corrected for saturation effects).
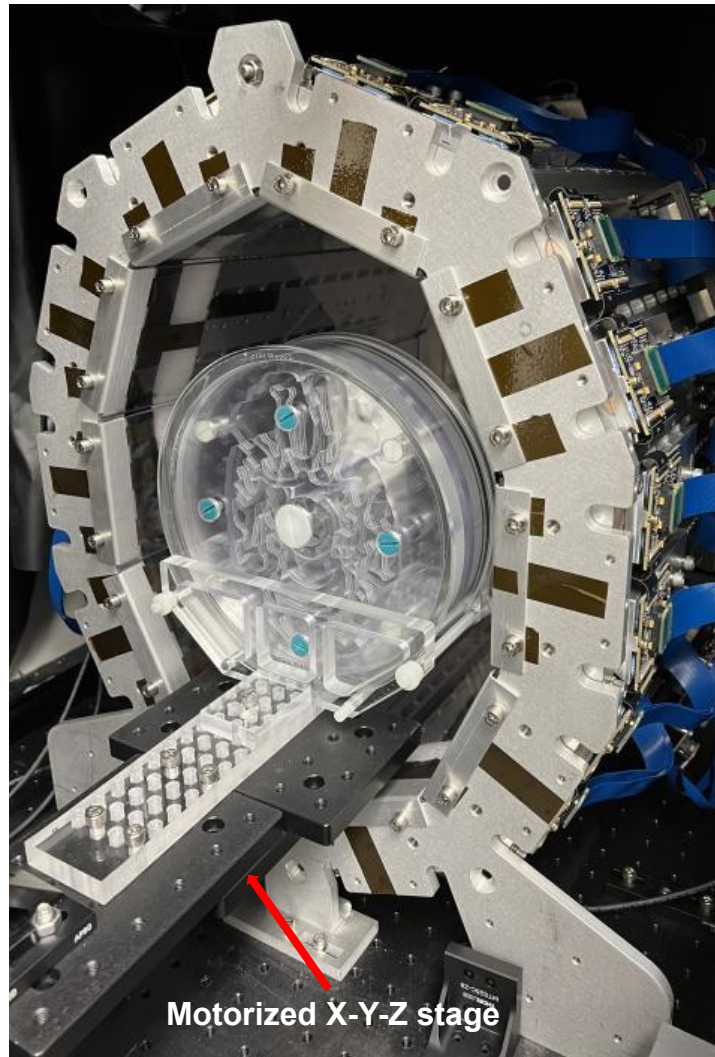
SUPPLEMENTAL FIGURE 3. Experimental setup for imaging the Hoffman brain phantom using the Prism-PET prototype scanner and a motorized X-Y-Z stage.
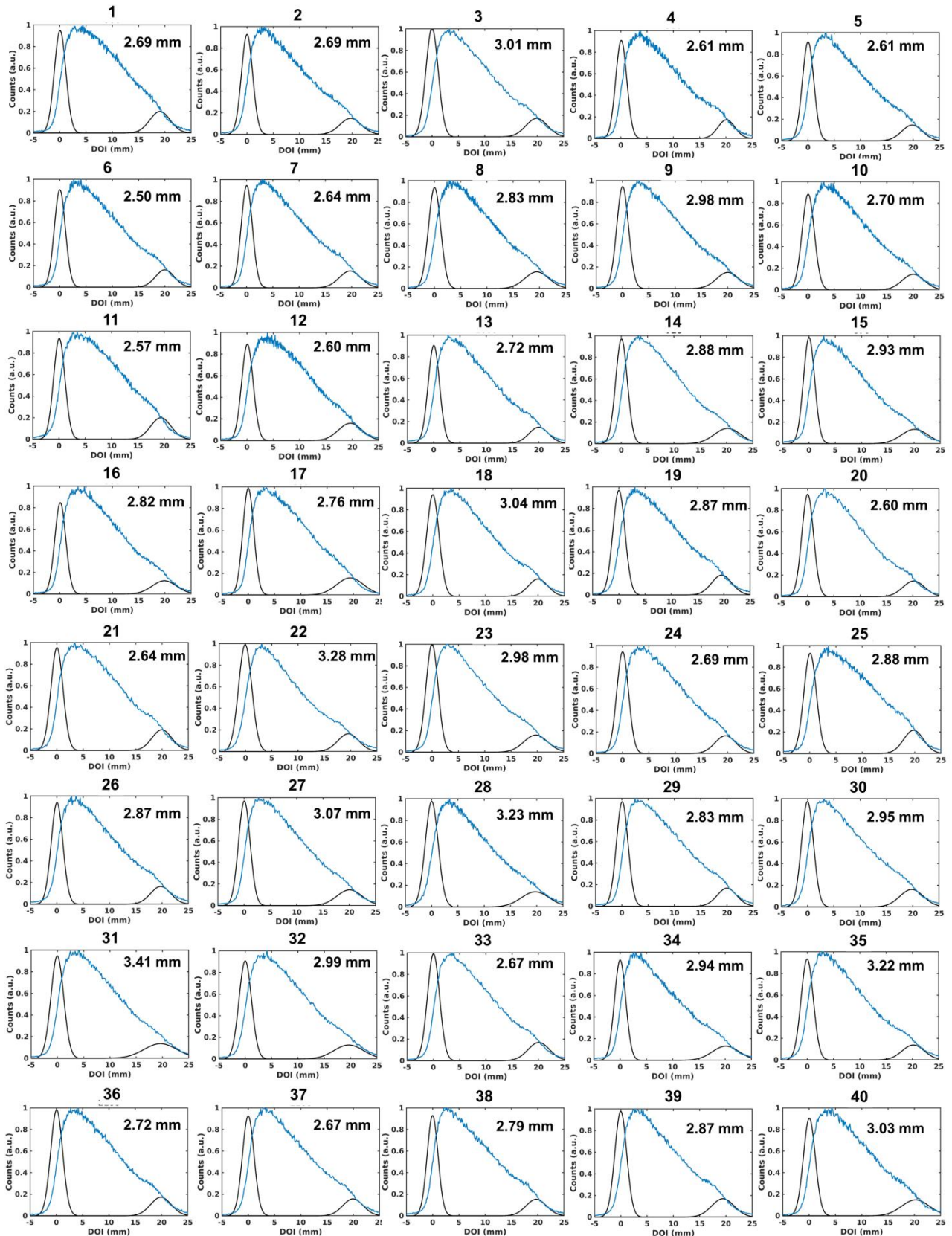
SUPPLEMENTAL FIGURE 4. DOI histograms (blue) and the derivatives of their rising and falling edges (black) for all 40 detector modules. The average DOI resolution across all crystals is 2.85 mm FWHM.
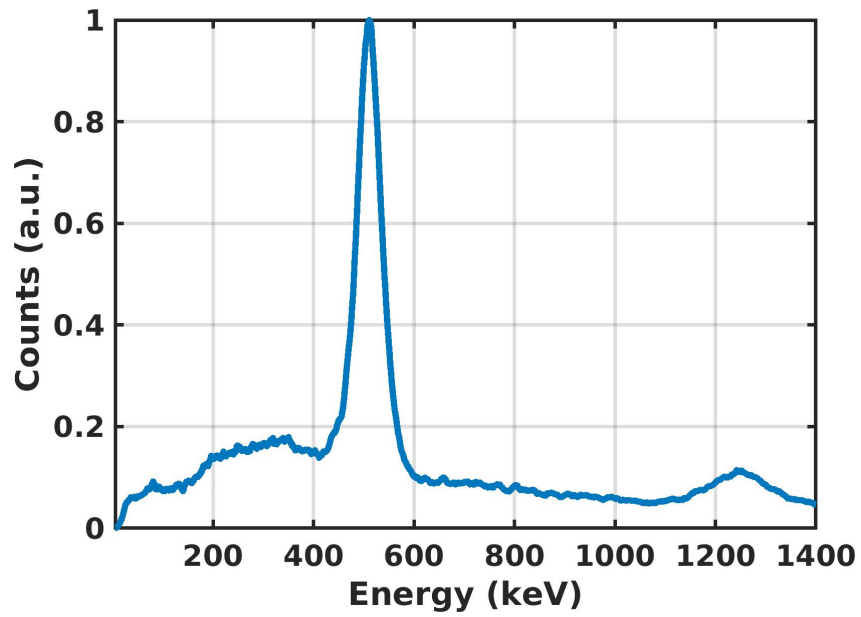
SUPPLEMENTAL FIGURE 5. A representative crystal's energy spectrum using ^{22}Na point source, which achieved an energy resolution of 11.9% at the 511 keV peak.