

Assessment of the Imaging Performance of the CITIUS High-Resolution Detector for Heavy Charged Particles and Neutrons

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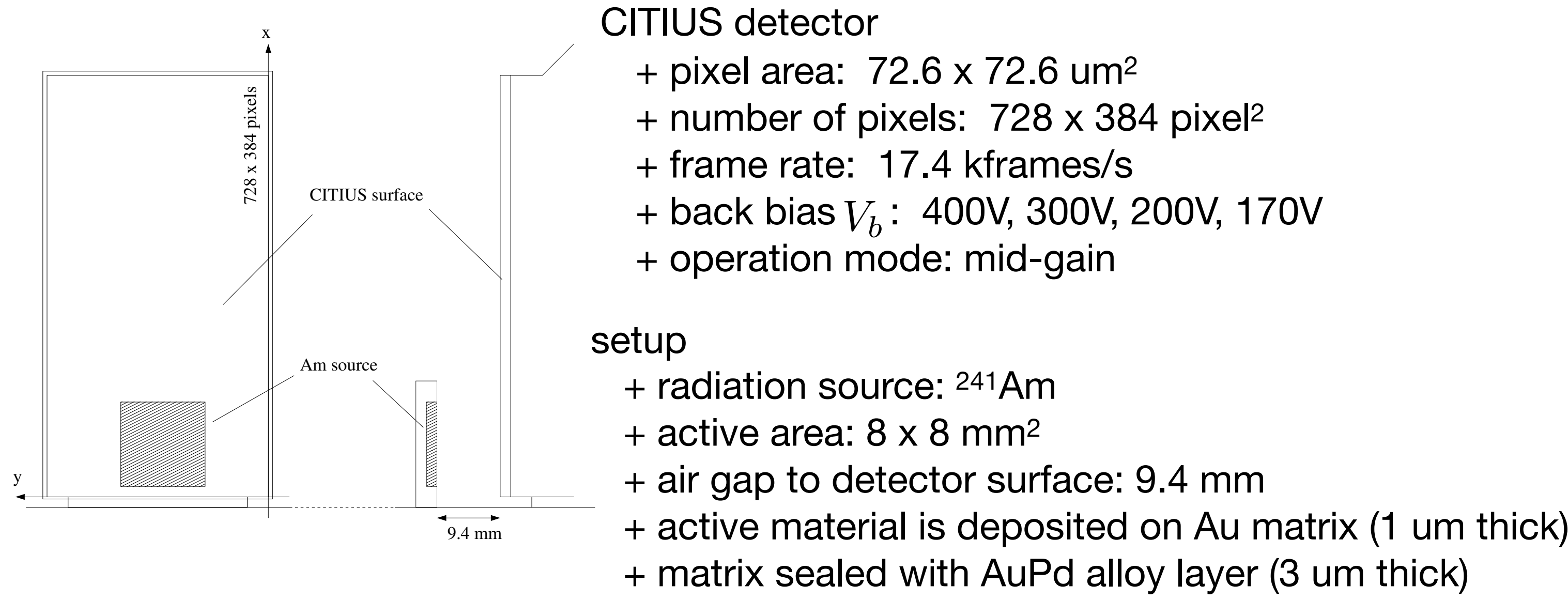
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(A) Abstract

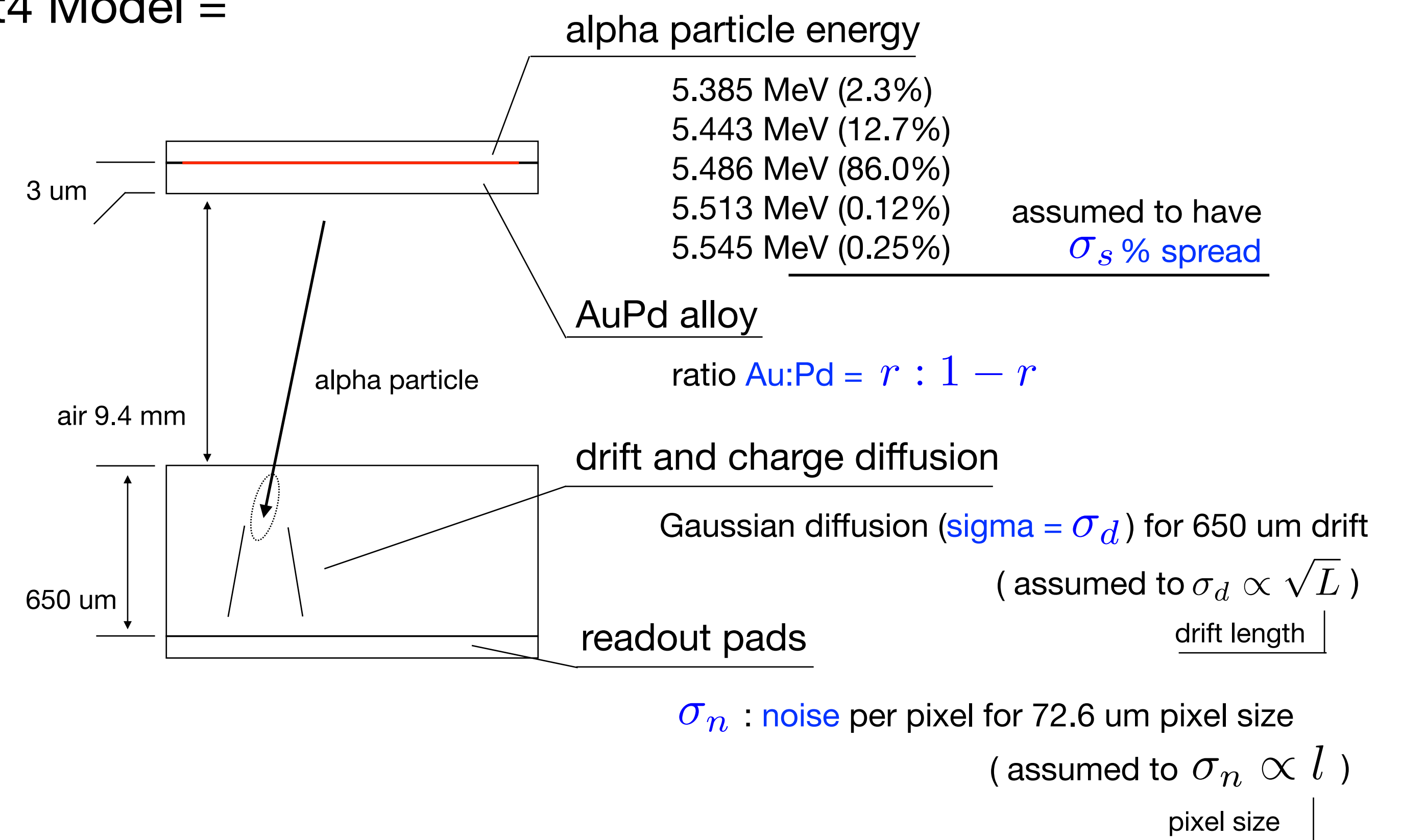
- + The response of the CITIUS high-speed, high-resolution detector to heavy charged particles was measured using alpha particles emitted from an ²⁴¹Am source.
- + Based on the measurement results, the degree of charge diffusion in the sensor and the noise level were evaluated by template fitting.
- + Geant4 Monte Carlo simulation model with the evaluated parameters was developed and performed to assess the position resolution for both alpha particles and neutrons.
- +++ To model neutron sensitivity, the detector surface was assumed to be coated with a ¹⁰B layer.

(B) Alpha-particle Irradiation Test

= Experimental Setup =

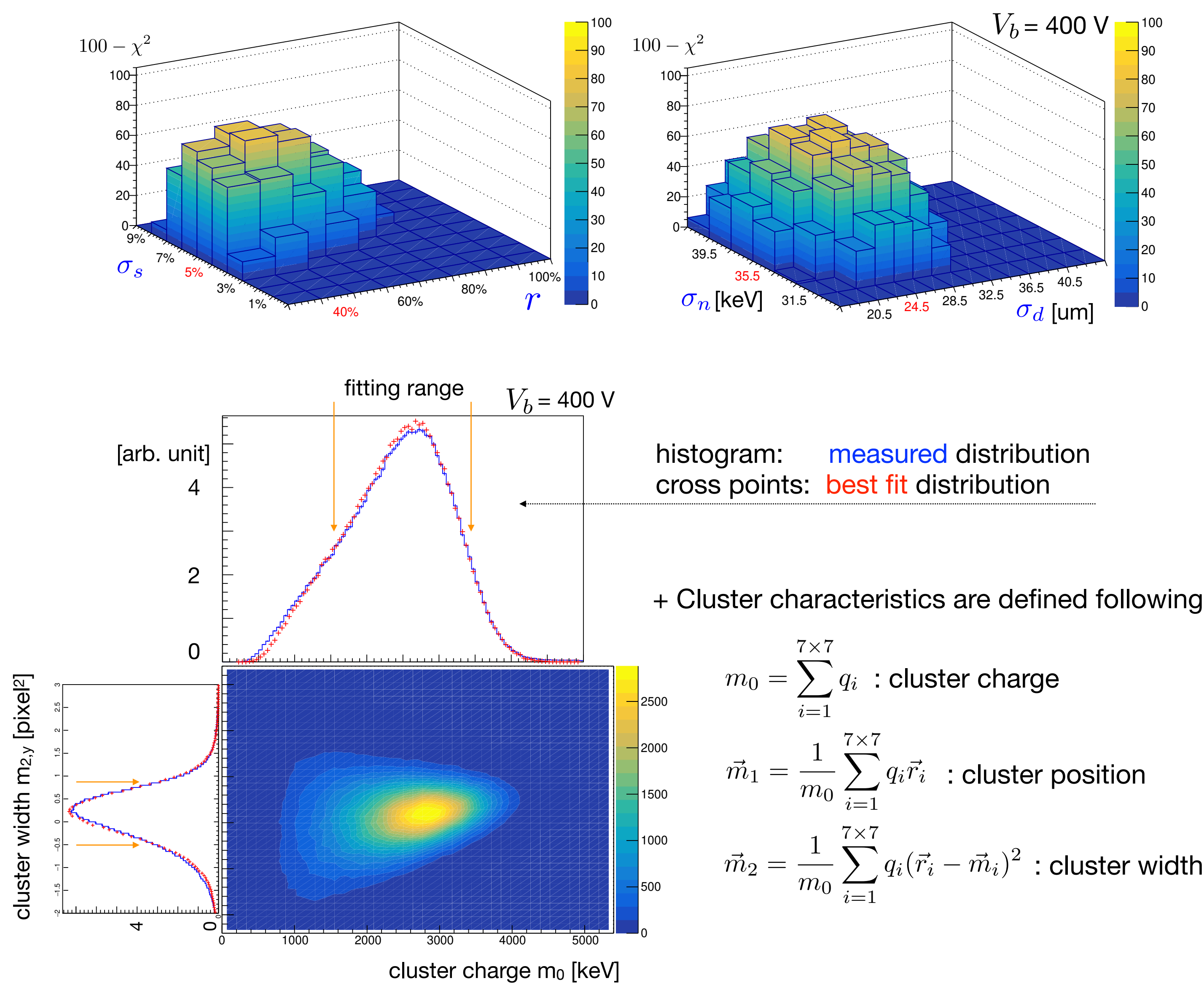


= Geant4 Model =

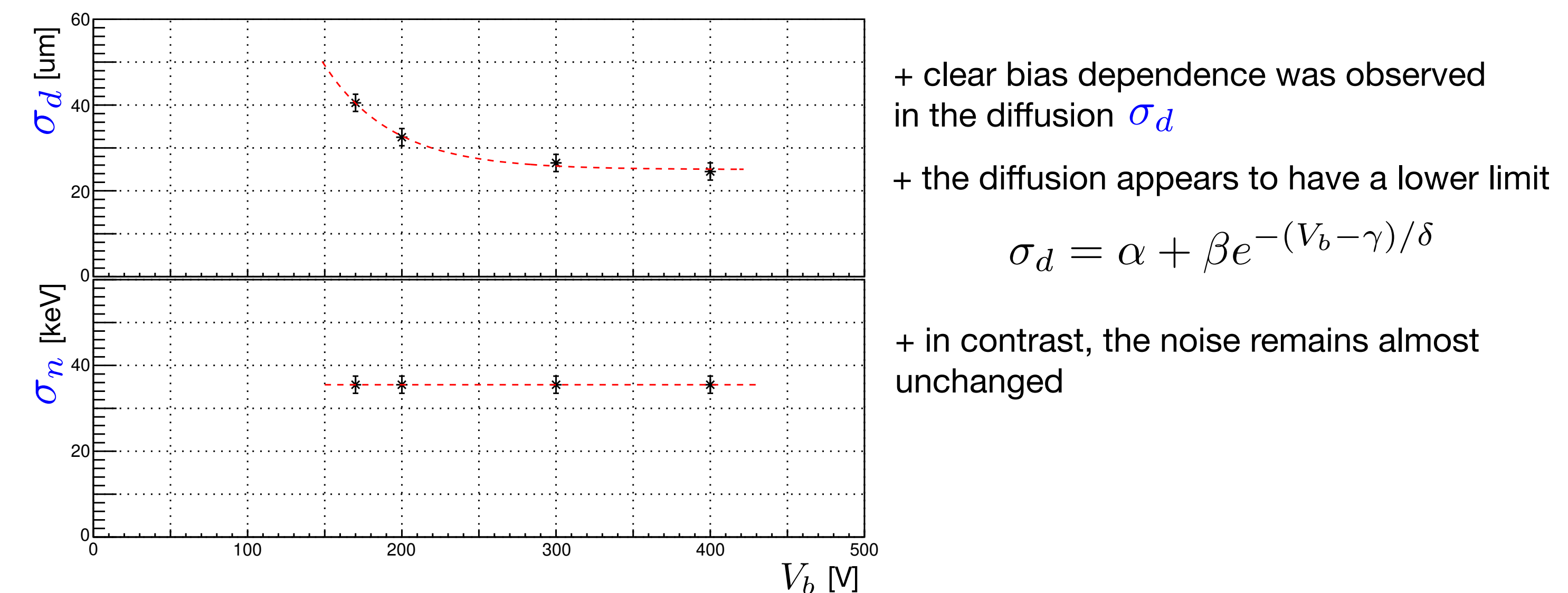


(C) Template Fitting

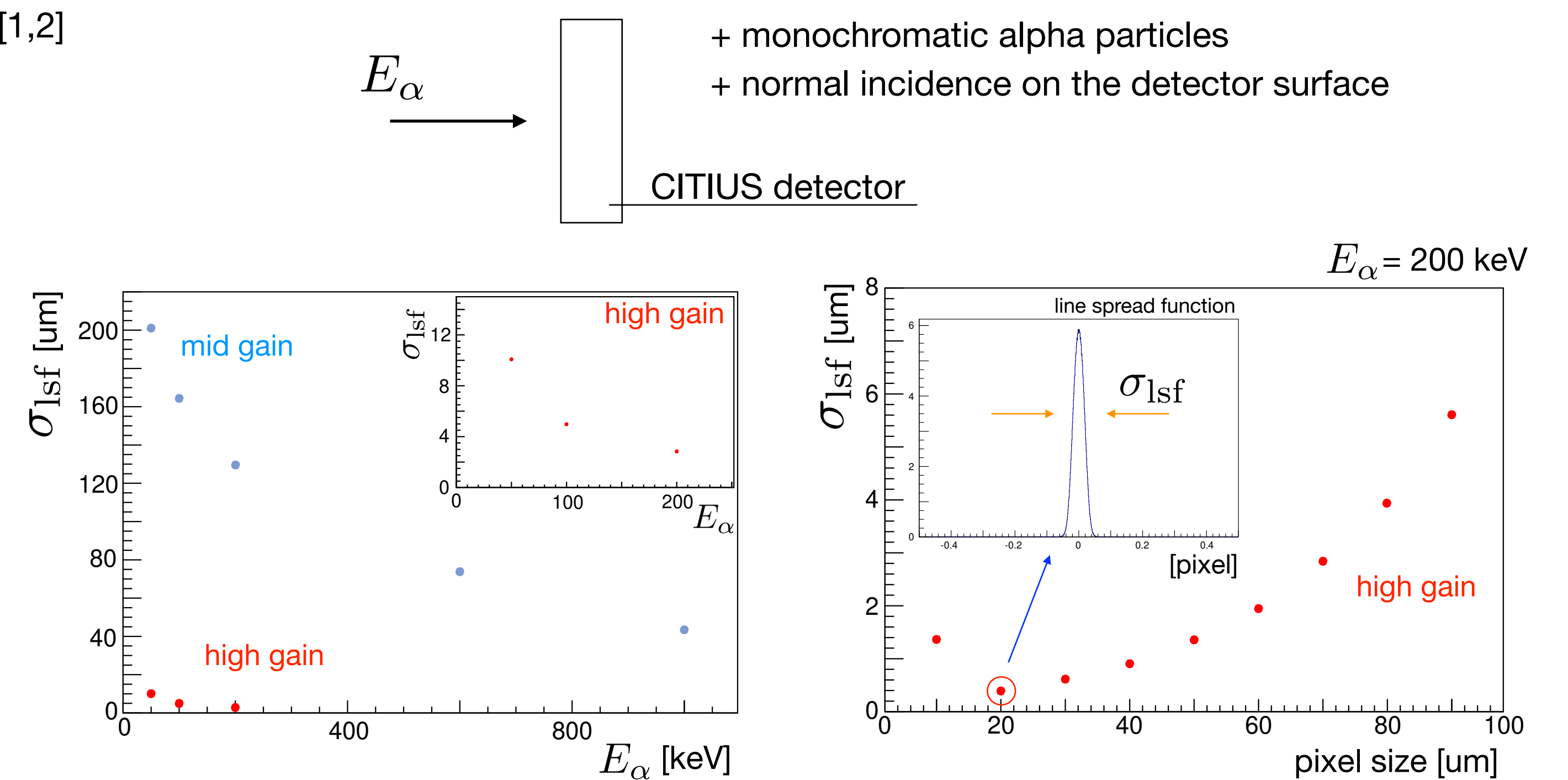
- + The four model parameters σ_s , r , σ_d , σ_n , were determined by template fitting for the source and for the detector



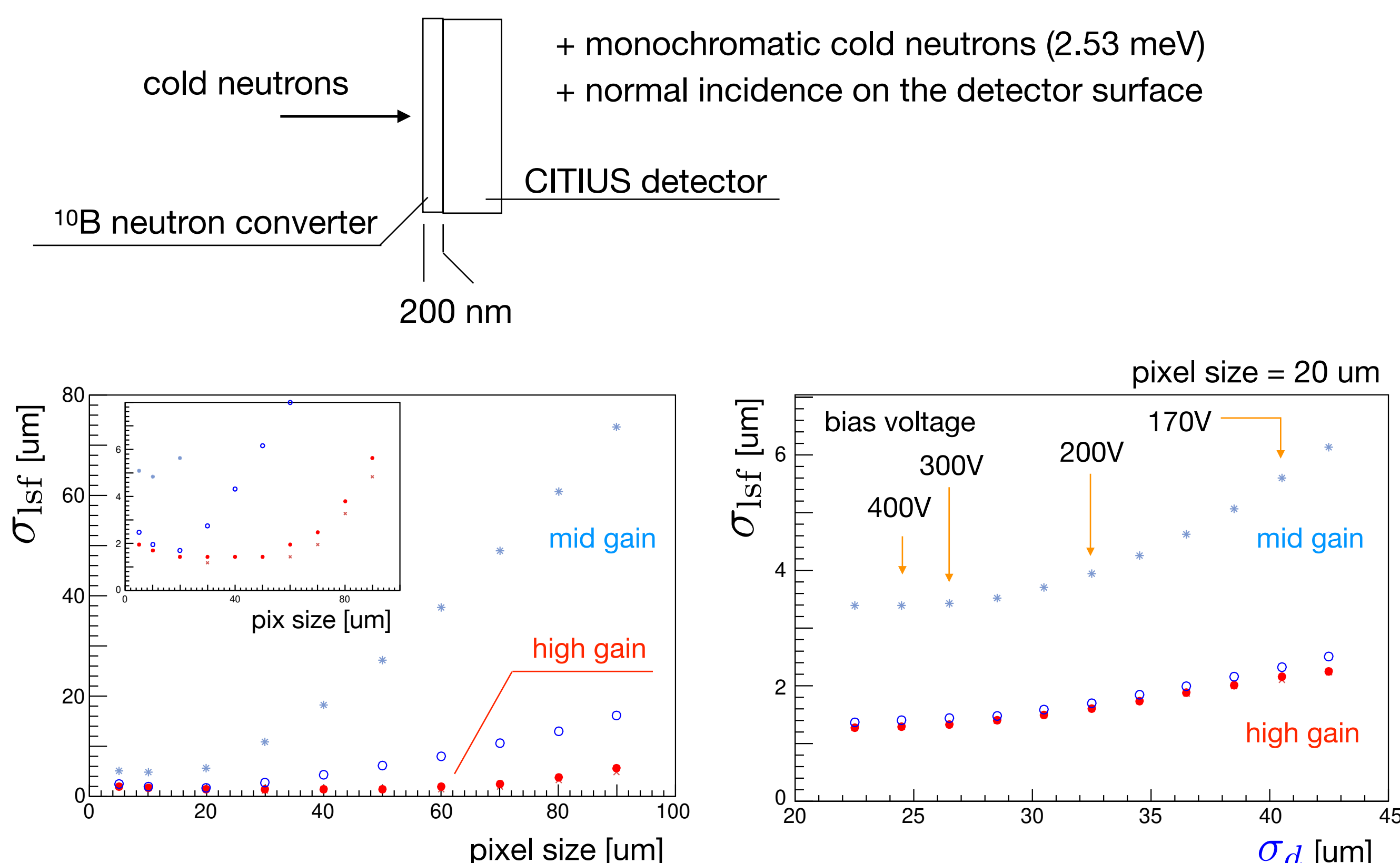
(D) Bias dependence of diffusion σ_d and noise σ_n



(E) Response for Alpha particles



(F) Response for Cold Neutrons



(G) Conclusion

- + From measurements using an alpha-particle source, we successfully quantified the charge diffusion and pixel-wise noise in the CITIUS detector at several bias voltages.
- + For alpha particles with energy below 200 keV - within the detector's dynamic range in high-gain mode - a spatial resolution of approximately 3 μm is expected.
- + By reducing the pixel size to about 20 μm , a spatial resolution better than 1 μm can be achieved.
- + For cold neutrons with a 200 nm ¹⁰B converter, the current system is expected to provide a spatial resolution of around 50 μm .
- + Pixel-by-pixel noise is considered to be the main factor degrading the spatial resolution.
- + By suppressing the noise, a spatial resolution of roughly 1 μm is expected when the pixel size is reduced to around 20 μm , similar to the response evaluated for alpha particles.

References

- [1] Y. Kamiya, R. Nishimura, S. Mitsui et al., NIMA 1064, 169390 (2024).
- [2] Y. Kamiya, T. Miyoshi, H. Iwase et al., NIMA 979, 164400 (2020).

Acknowledgements

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