SDD qualification for kaonic atoms measurements

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On behalf of SIDDHARTA-2 collaboration

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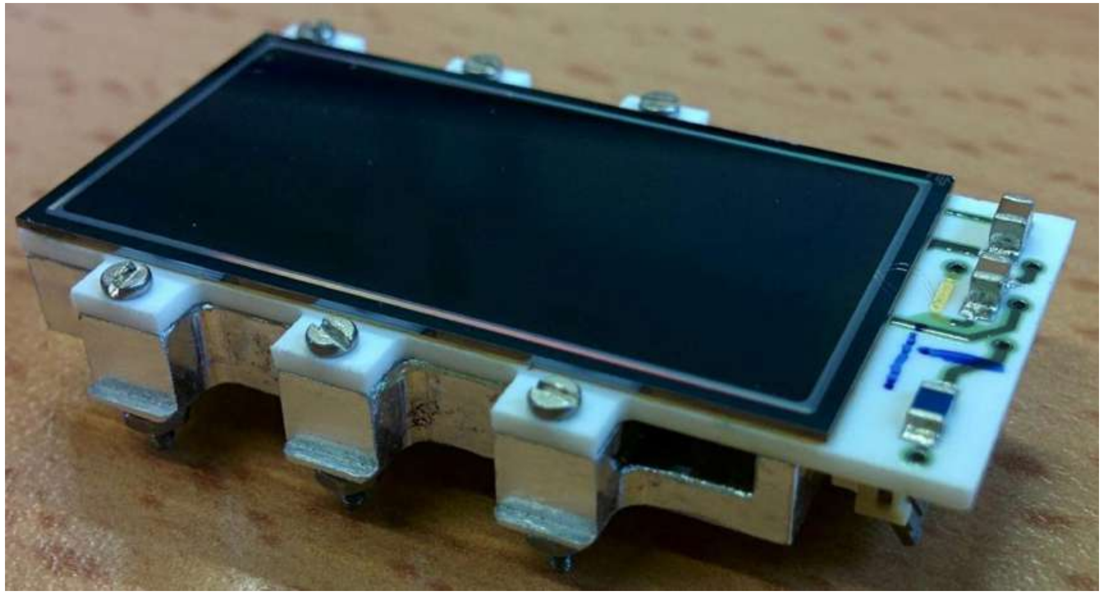
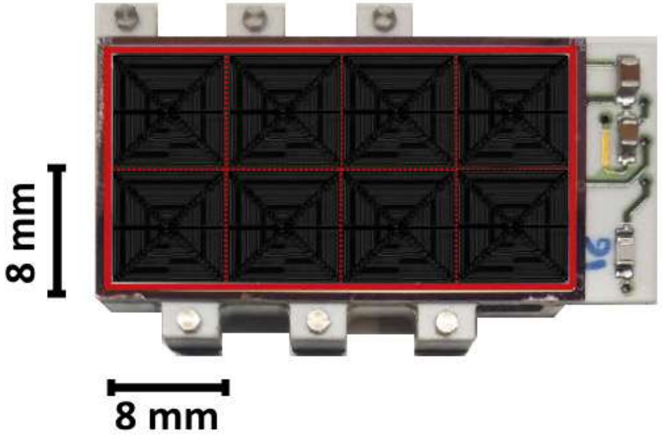
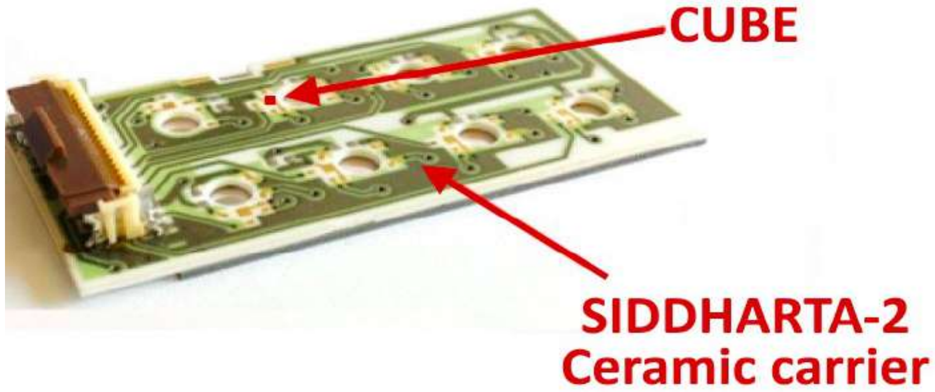
New Monolithic Silicon Drift Detectors for X-ray spectroscopy

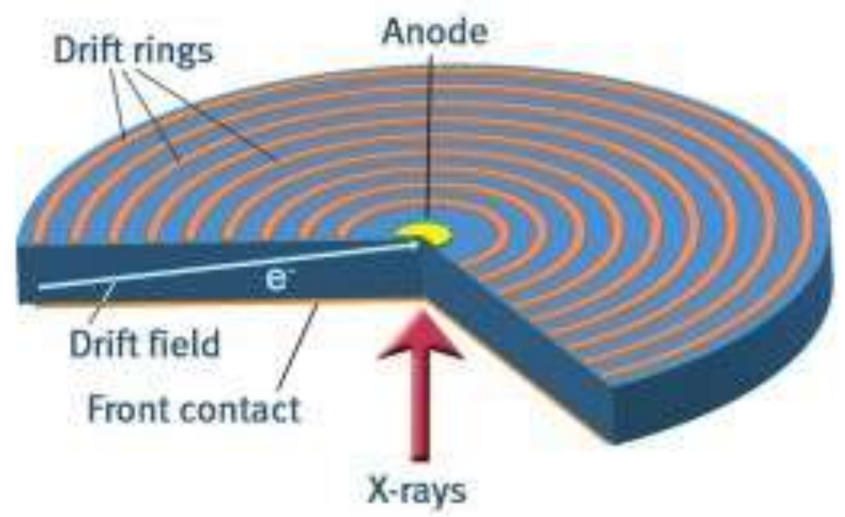




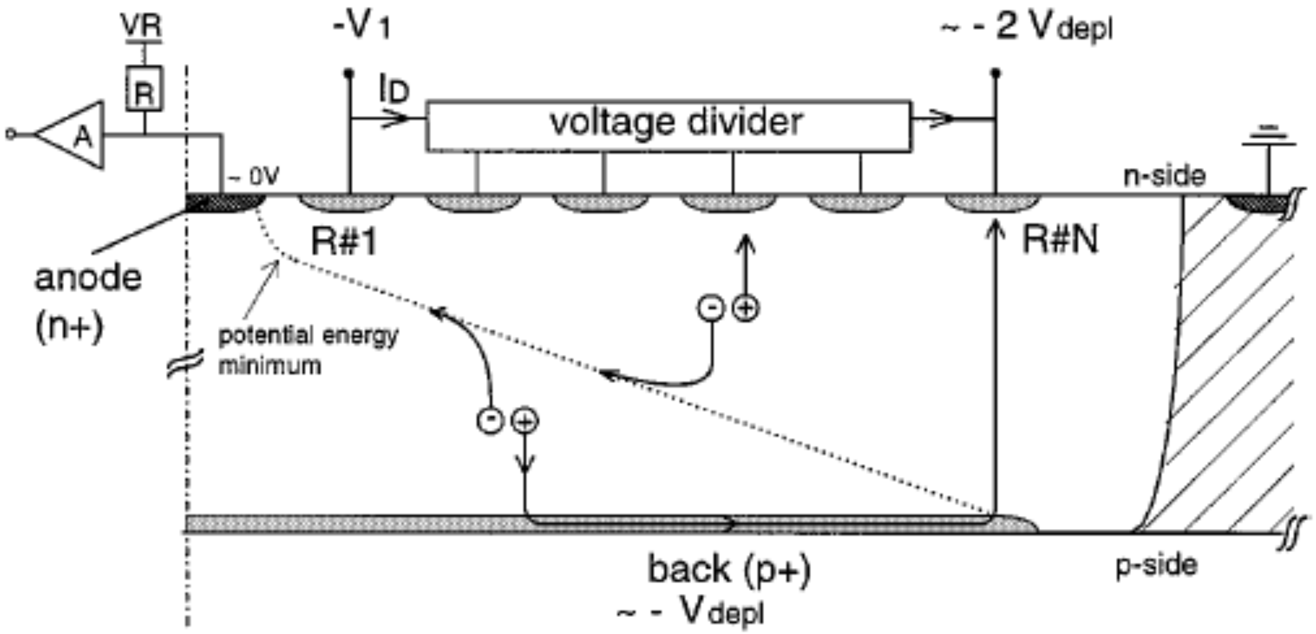


New Monolithic Silicon Drift Detectors for X-ray spectroscopy

SDD schematic picture



SDD cross section



SDD Energy Response

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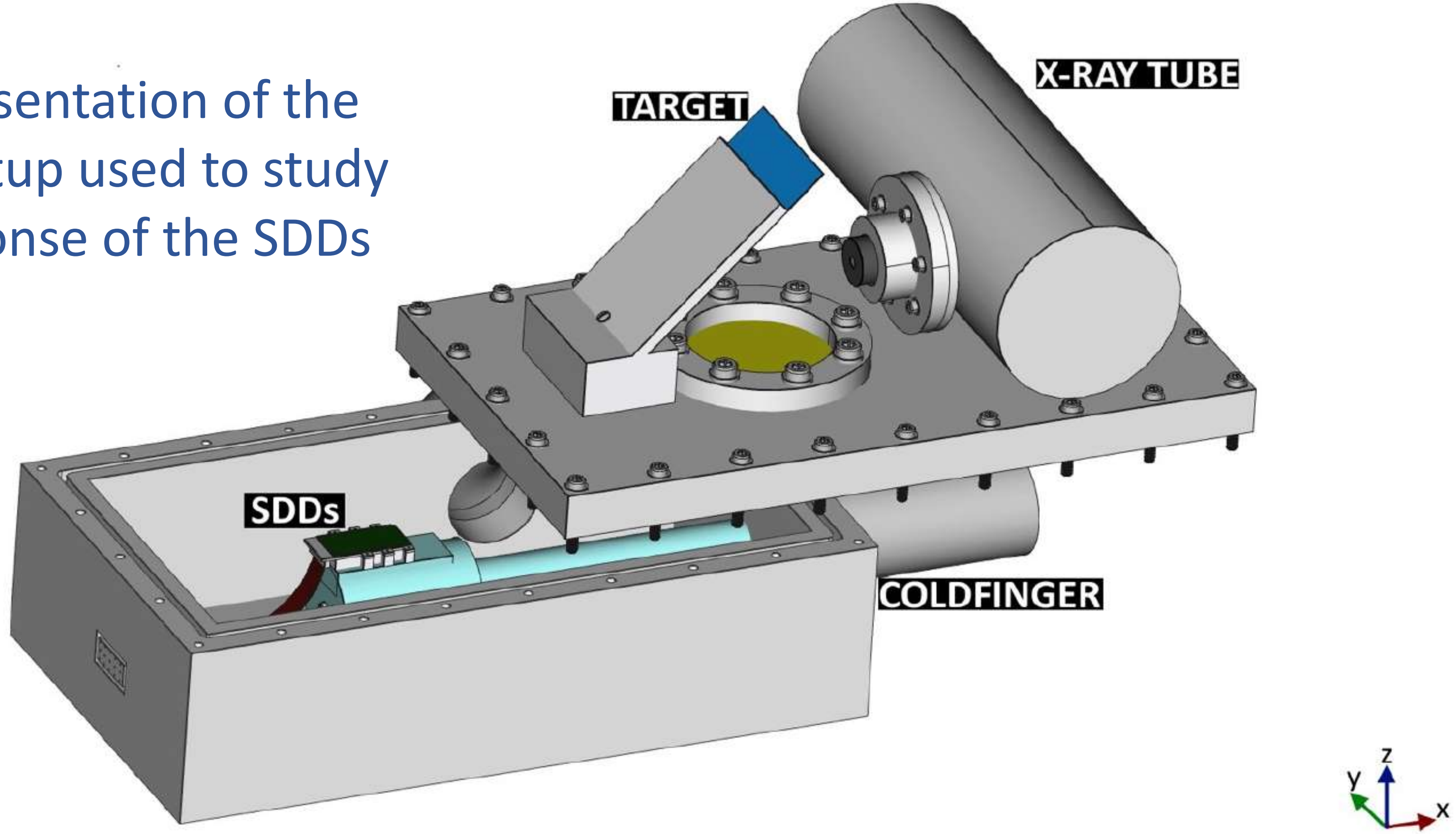
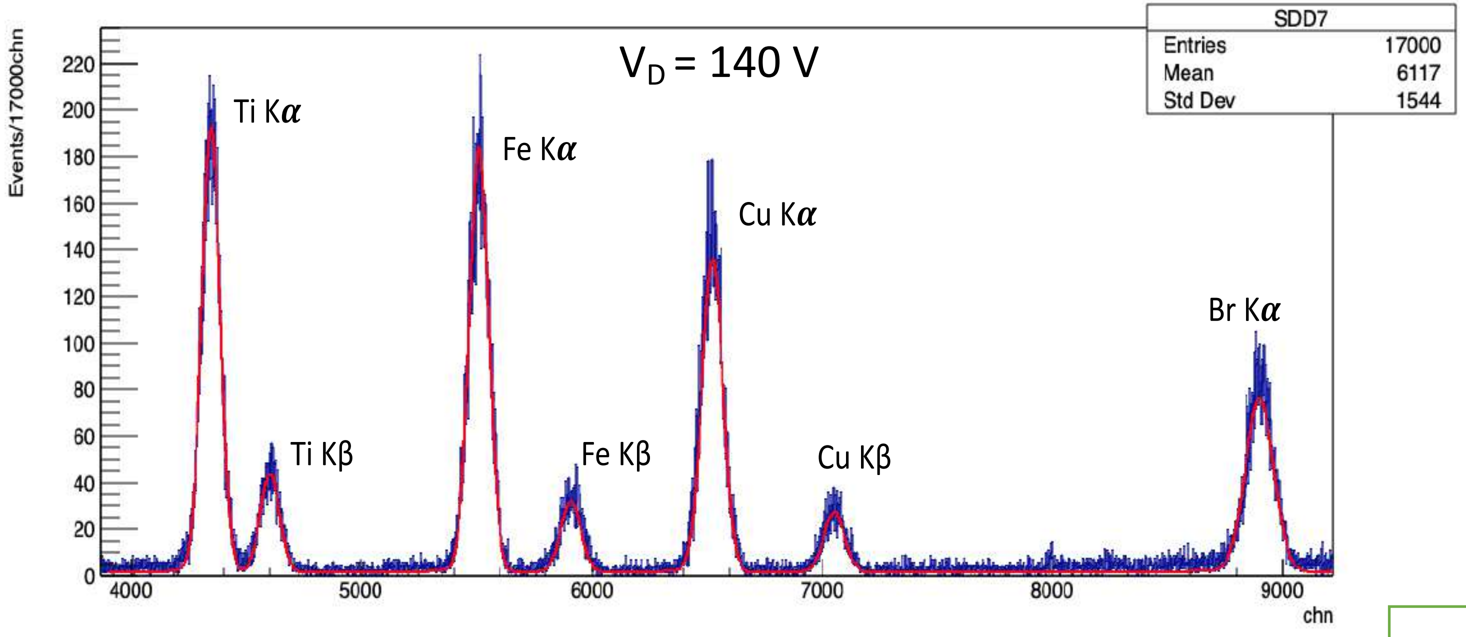
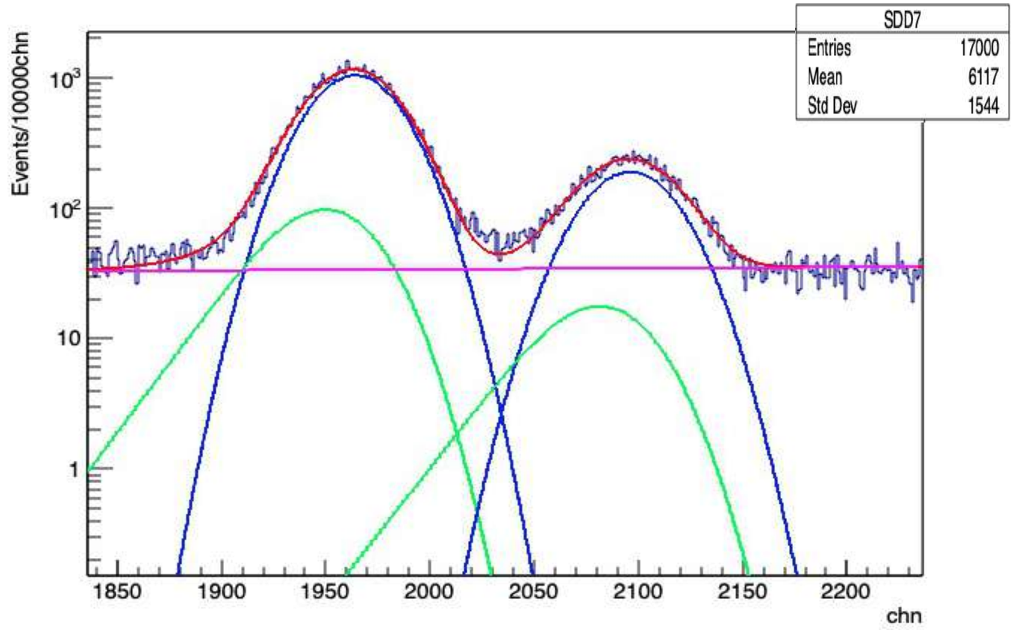
Schematic representation of the experimental setup used to study the energy response of the SDDs



SDD Energy Response

SDD Energy spectrum





$$G(x) = H_G \cdot e^{\frac{-(x-x_0)^2}{2\sigma^2}}$$

$$T(x) = H_T \cdot e^{\frac{x-x_0}{\beta\sigma}+\frac{1}{2\beta^2}} \cdot erfc\left(\frac{x-x_0}{\sqrt{2}\sigma}+\frac{1}{\sqrt{2}\beta}\right)$$

SDD Energy Response - Linearity

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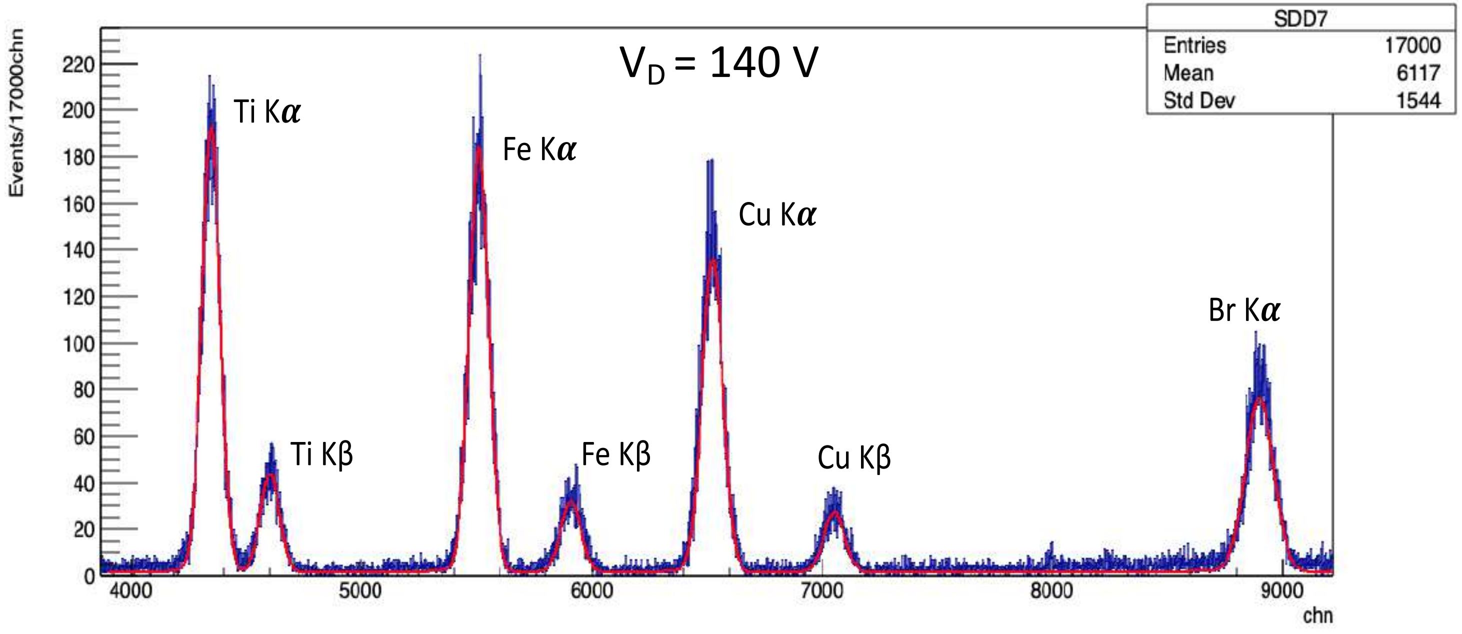
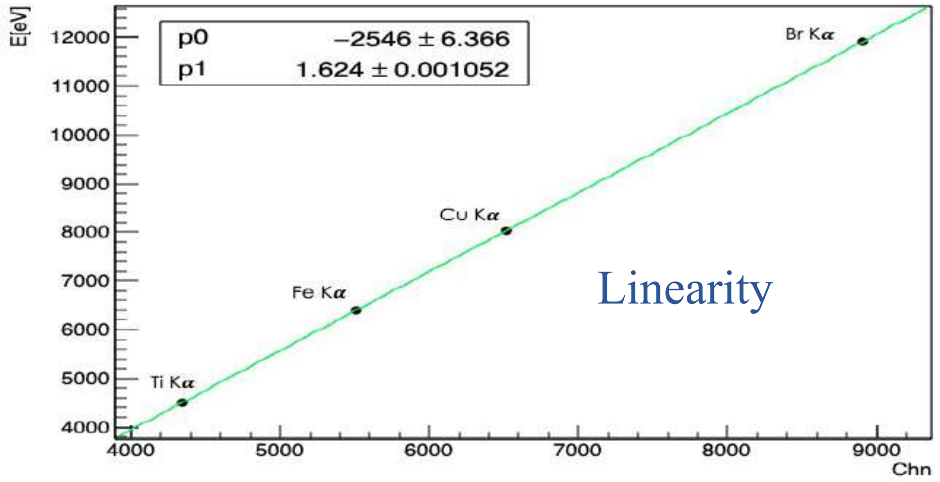
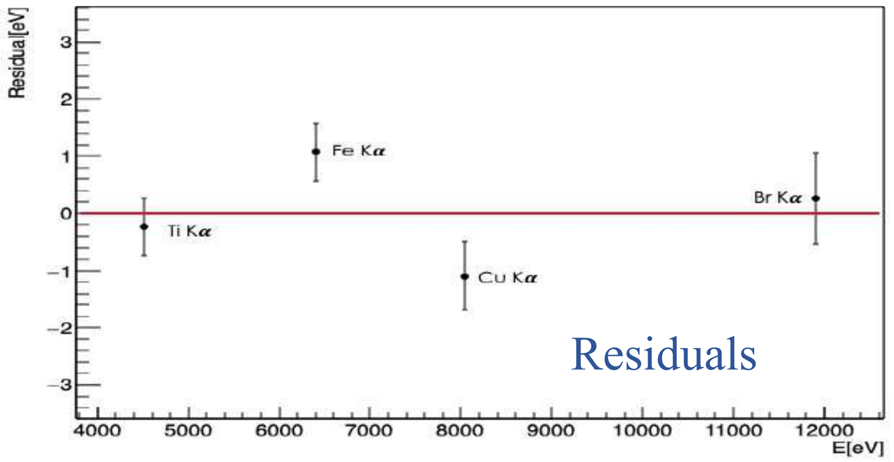
SDD Energy spectrum

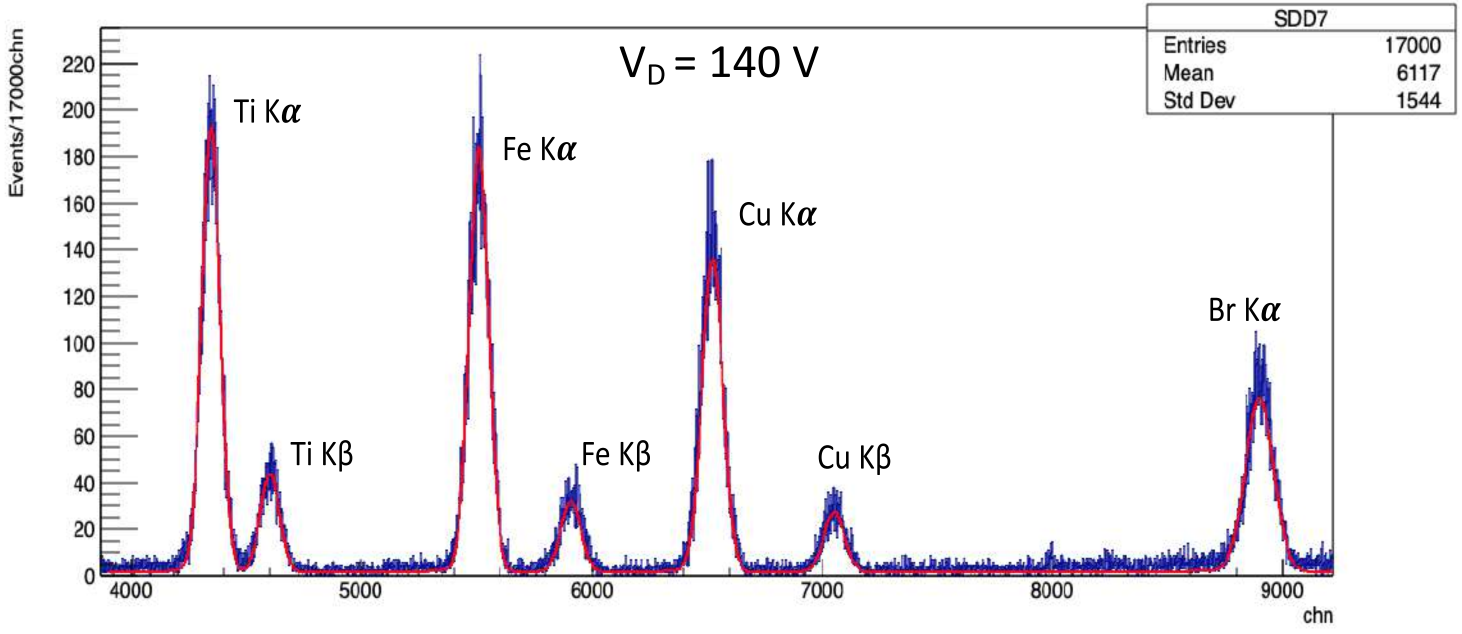


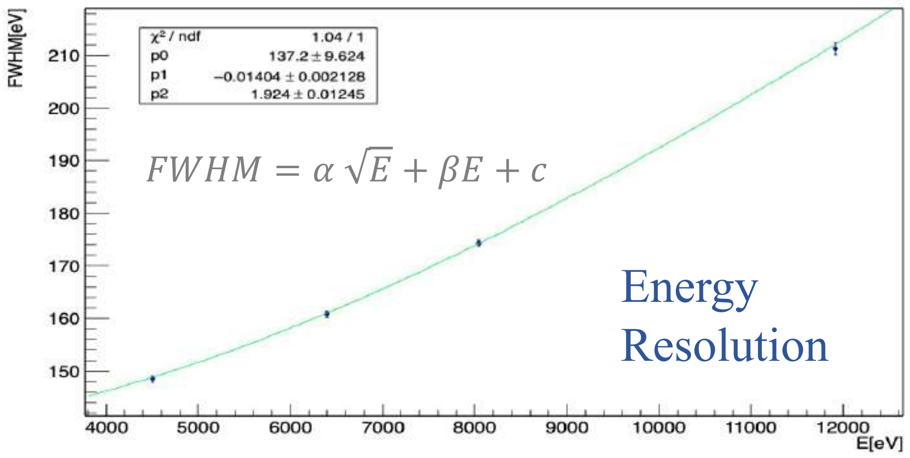




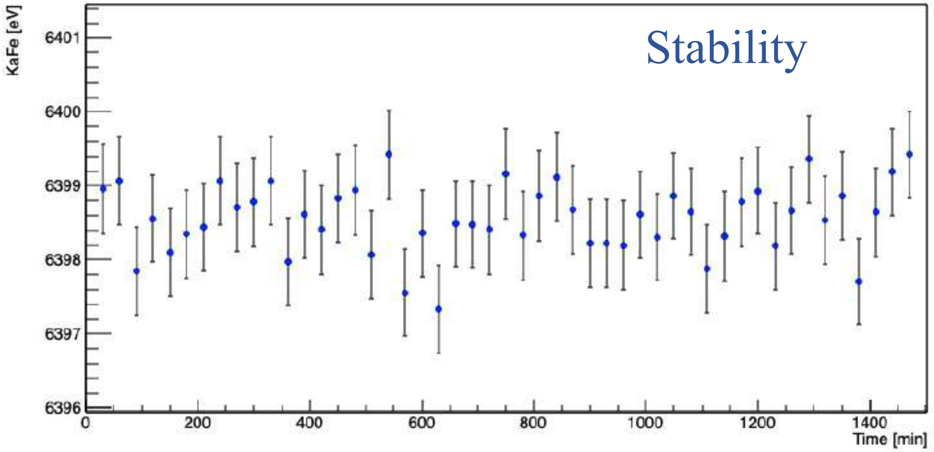
SDD Energy Response – Energy Resolution and Stability

SDD Energy spectrum





Energy Resolution



Stability

SDD Energy Response – Charge Collection

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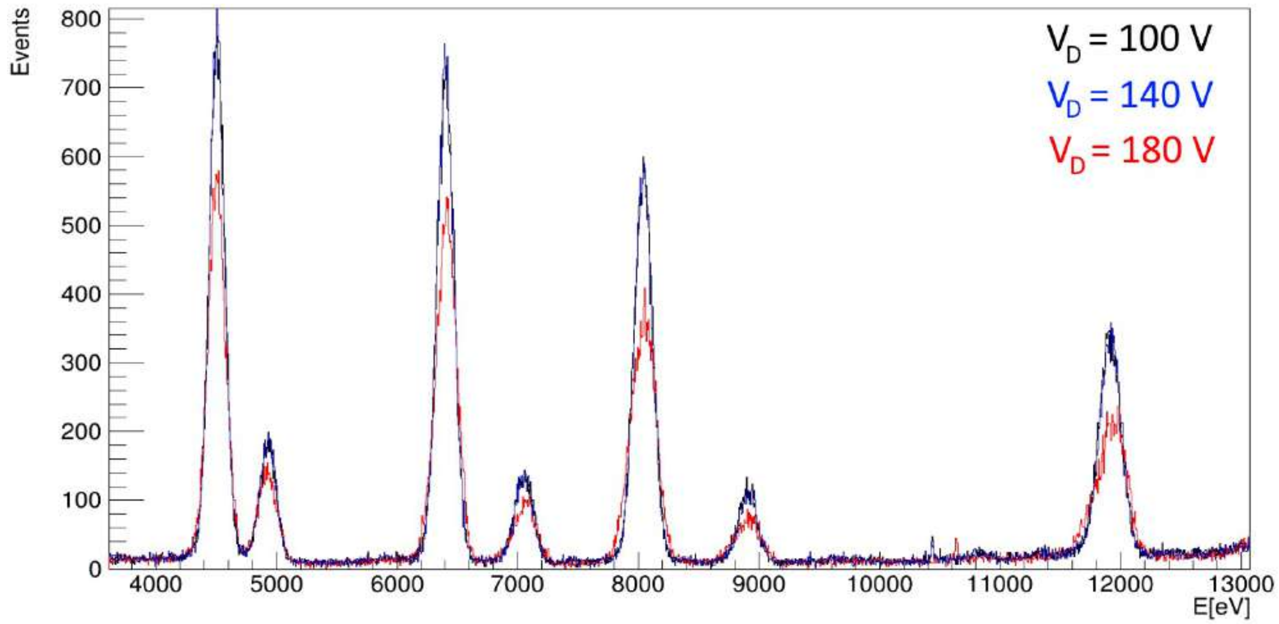
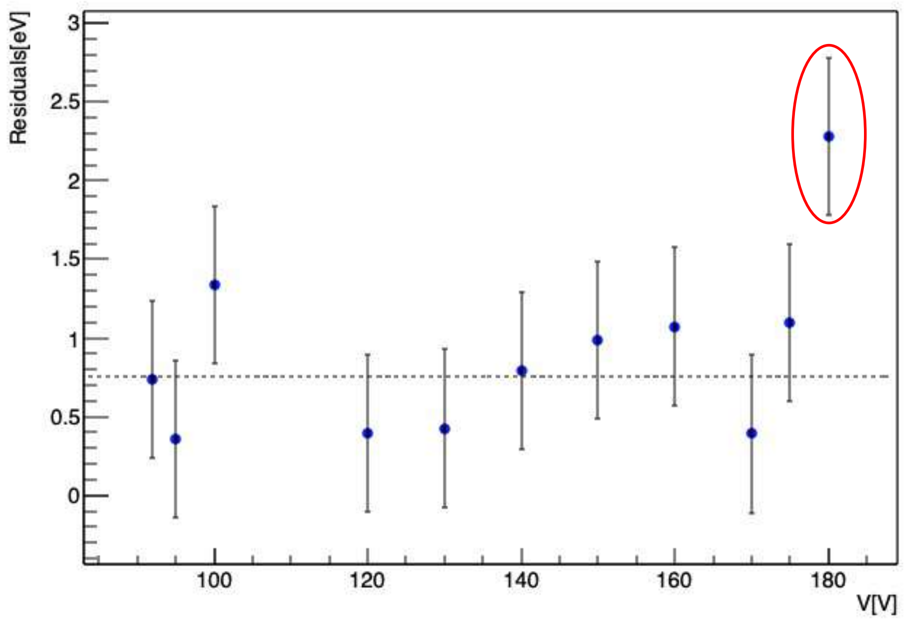
SDD Energy spectrum in function to the drift voltage

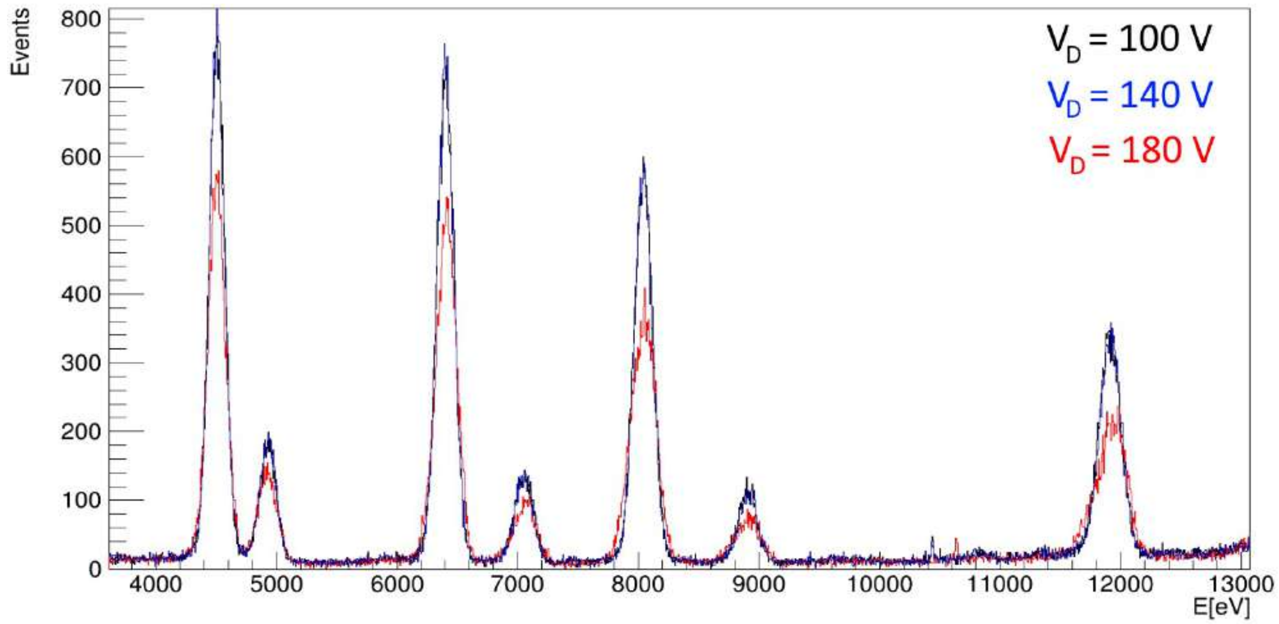


SDD linearity in function to the drift voltage

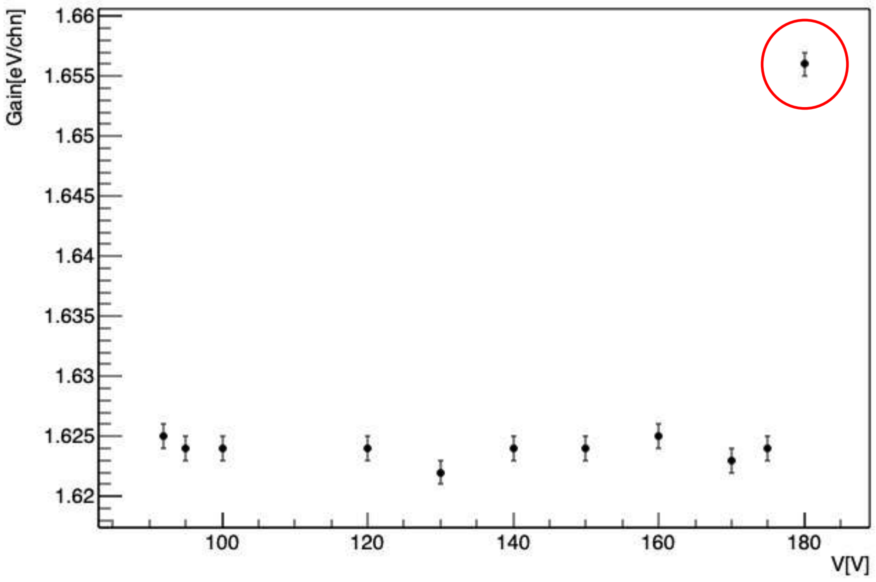


SDD Energy Response – Charge Collection

SDD Energy spectrum in function to the drift voltage

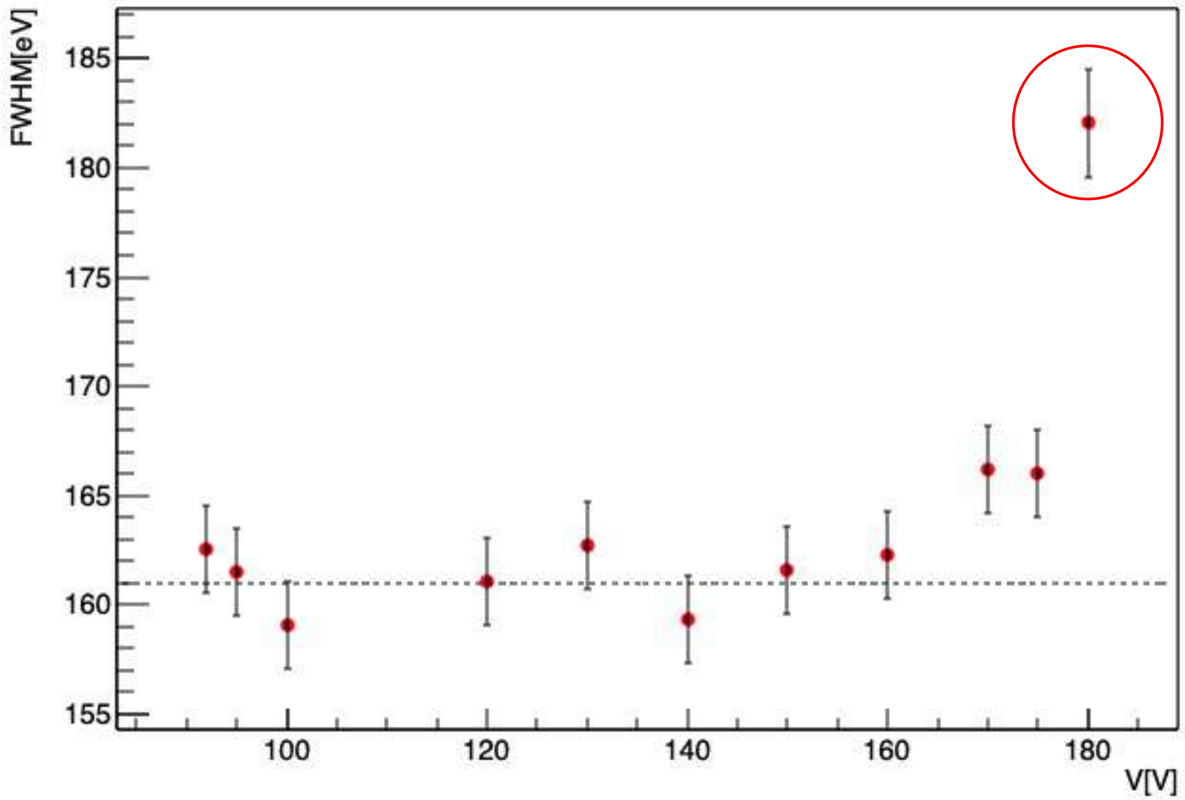


SDD gain in function to the drift voltage



SDD Energy Response – Charge Collection

Kα Fe FWHM



$$FWHM_{tot}^2 = FWHM_{intr}^2 + FWHM_{noise}^2 + FWHM_{c.c}^2$$

SDD Energy Response – Charge Collection

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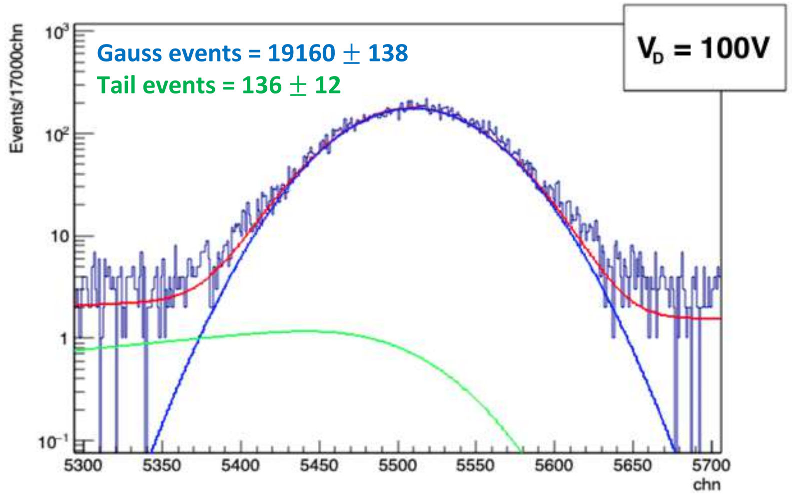
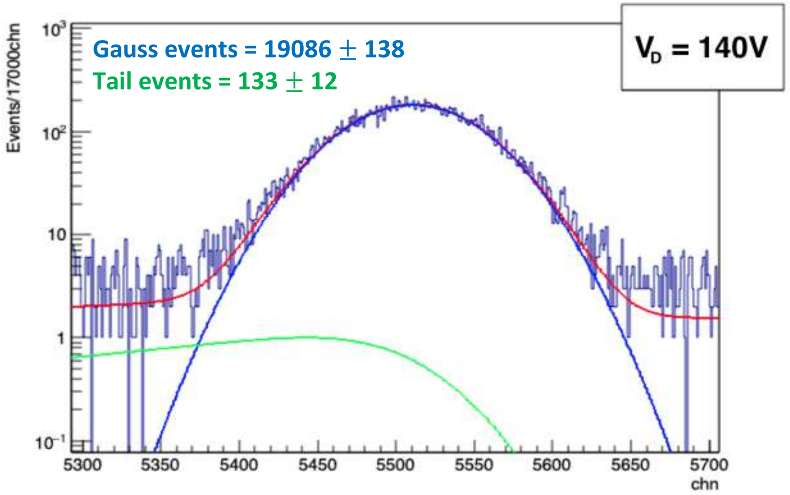
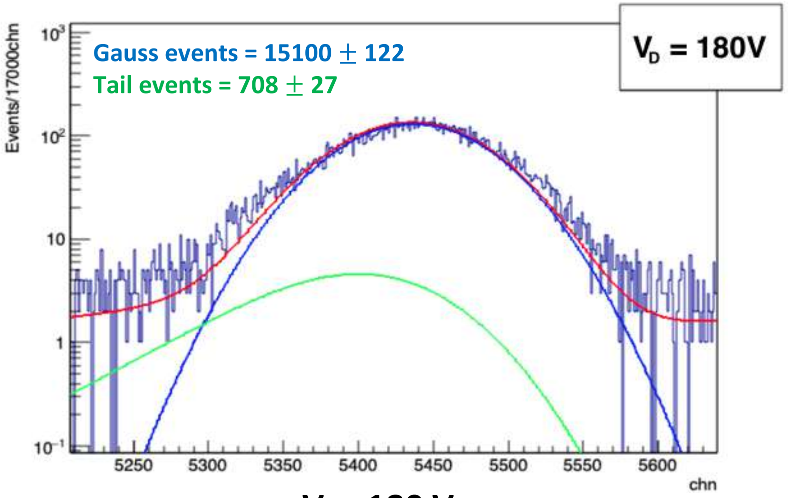


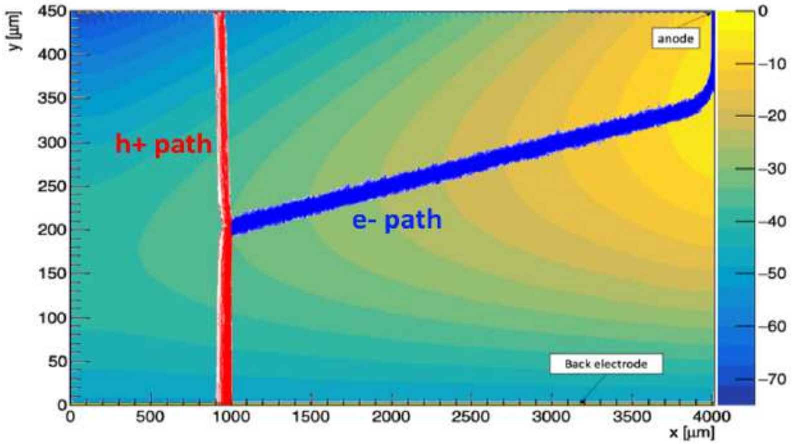


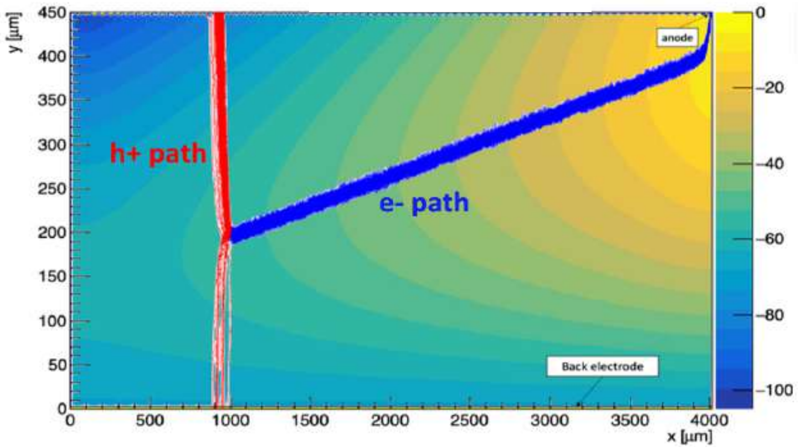


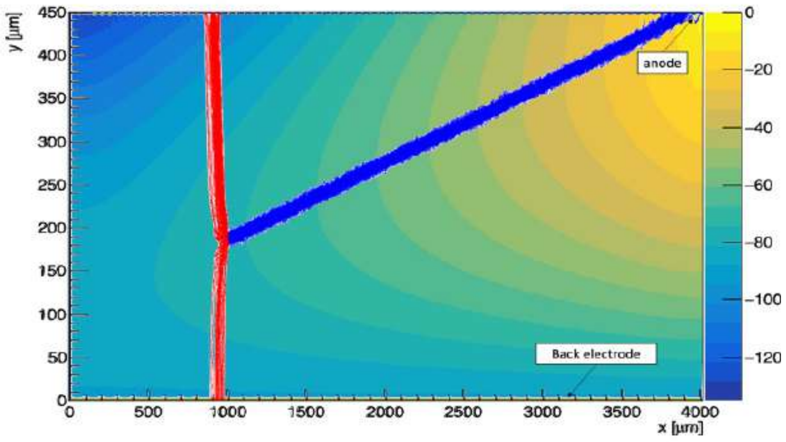
V_D= 100 V

V_D= 140 V

V_D= 180 V







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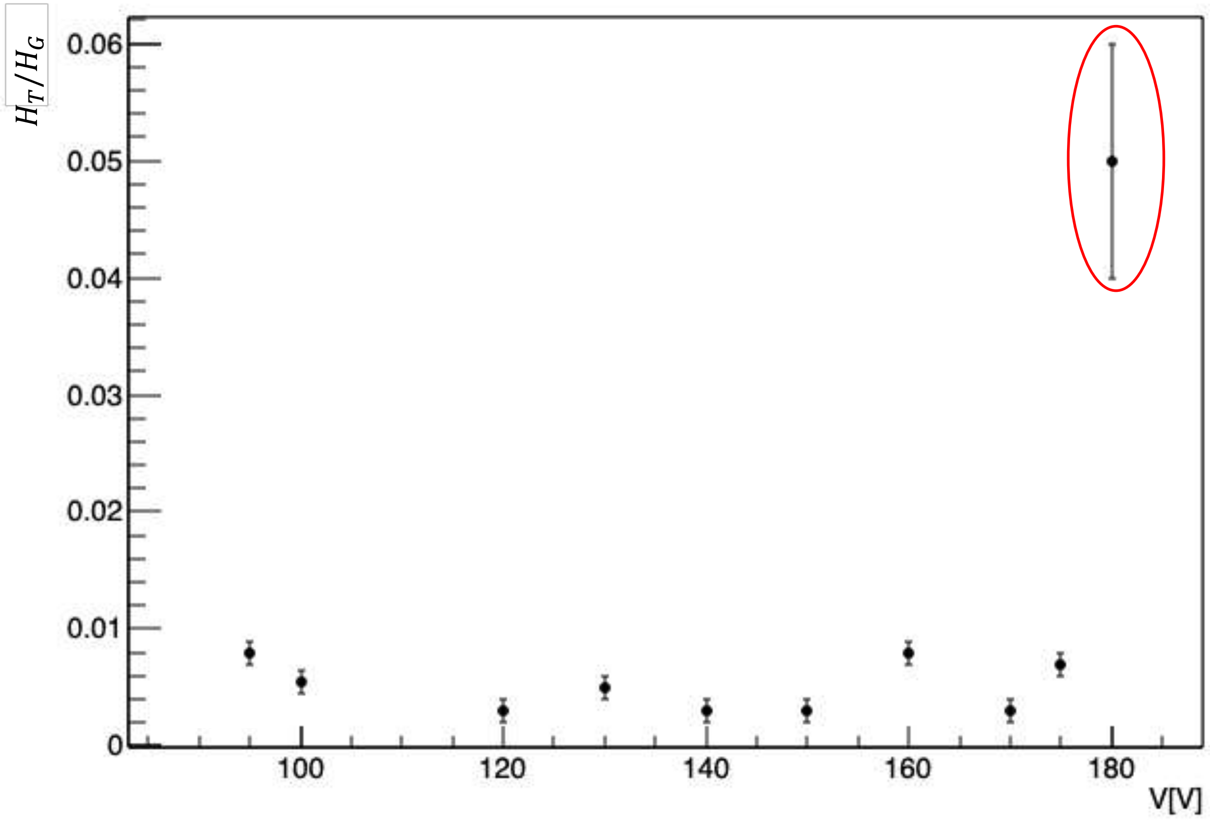
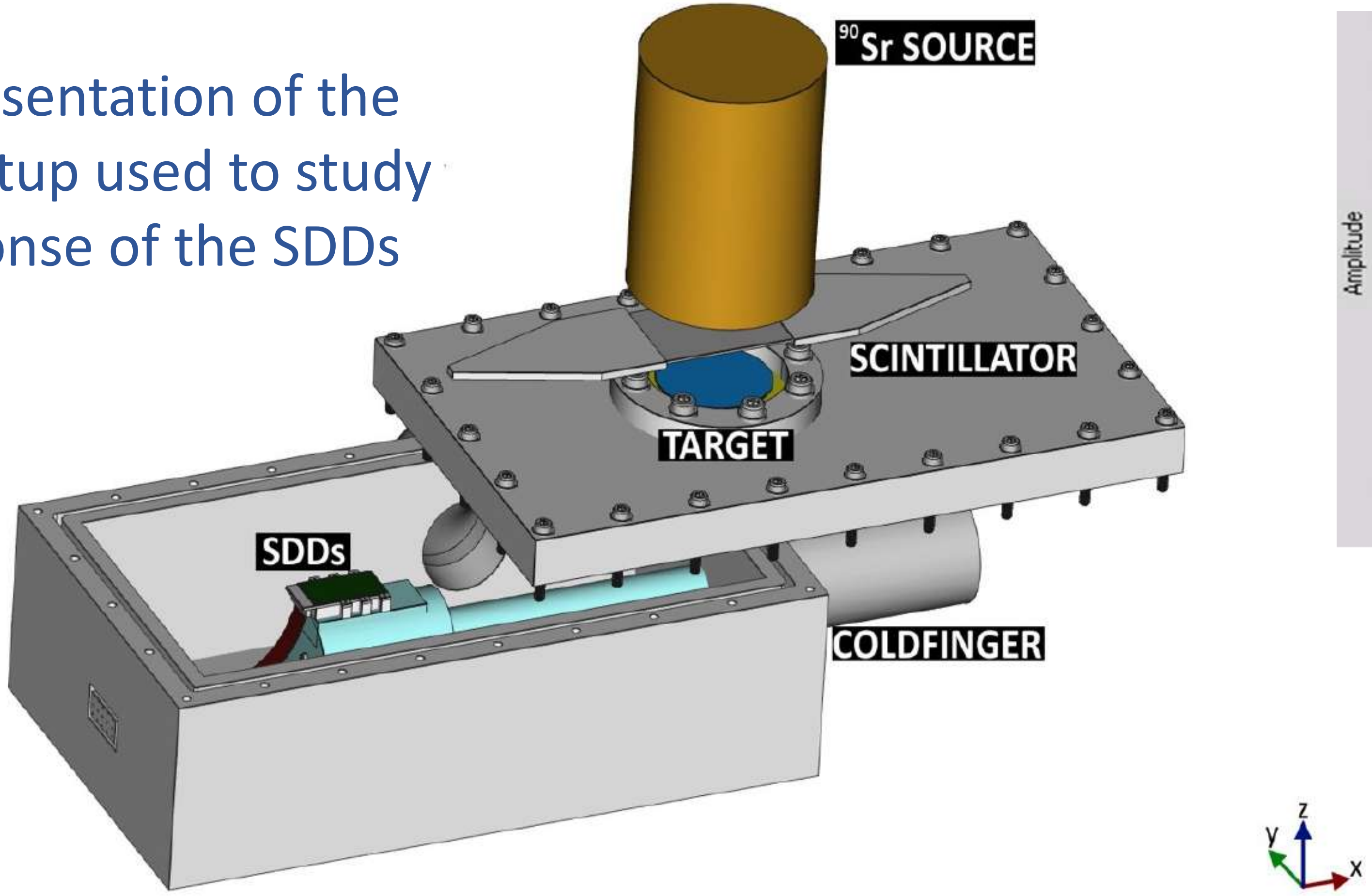
Tail-Gauss Events Ratio

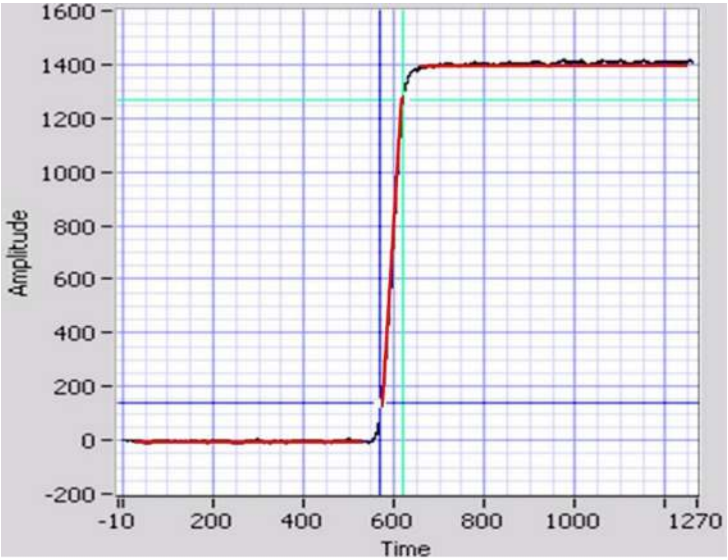


paper in preparation

SDD Timing response

Schematic representation of the experimental setup used to study the timing response of the SDDs



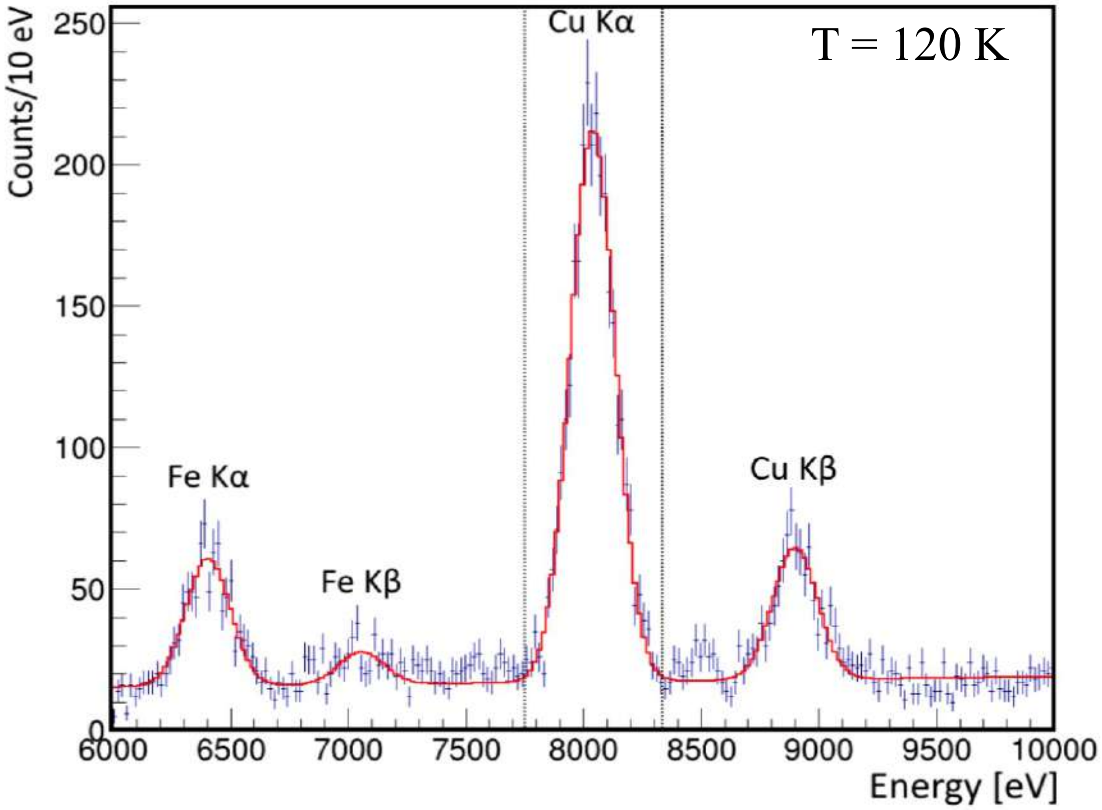


Event signal on the leakage ramp of the SDD

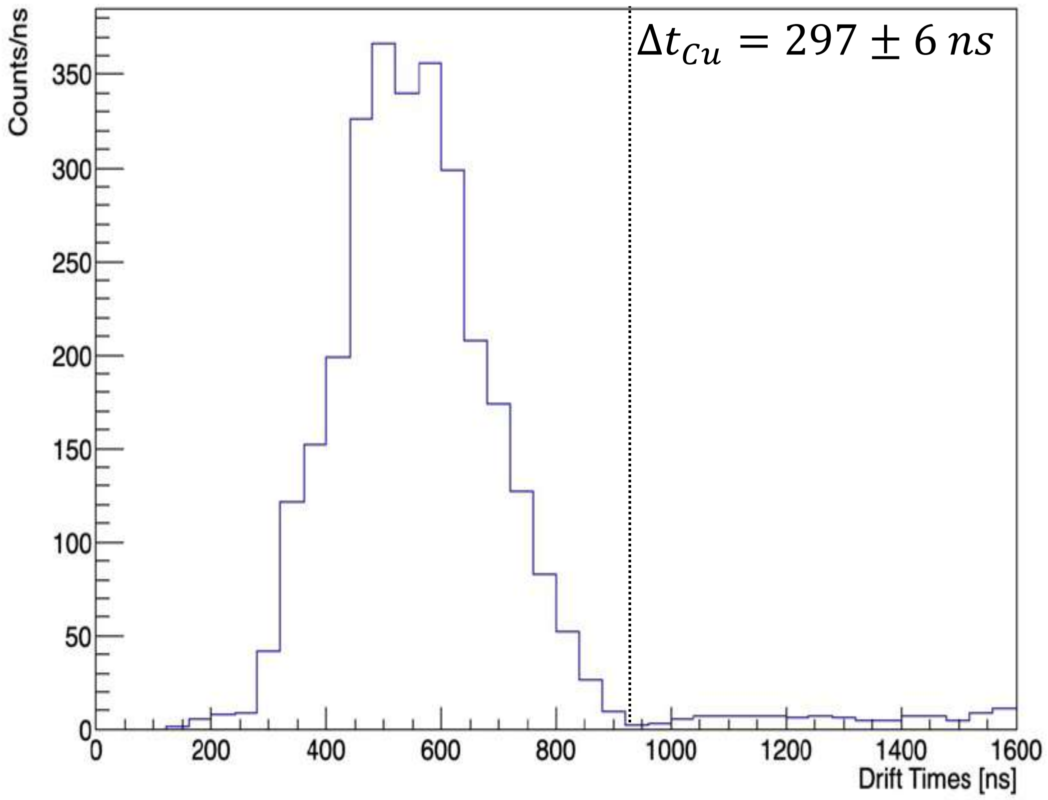
Iliescu M. et al. 2021, Reducing the MIPs Charge-Sharing Background in X-Ray Spectroscopic SDD Arrays **IEEE Trans. Instrum. Meas. 70** 9507807.

SDD Timing Response

Energy spectrum

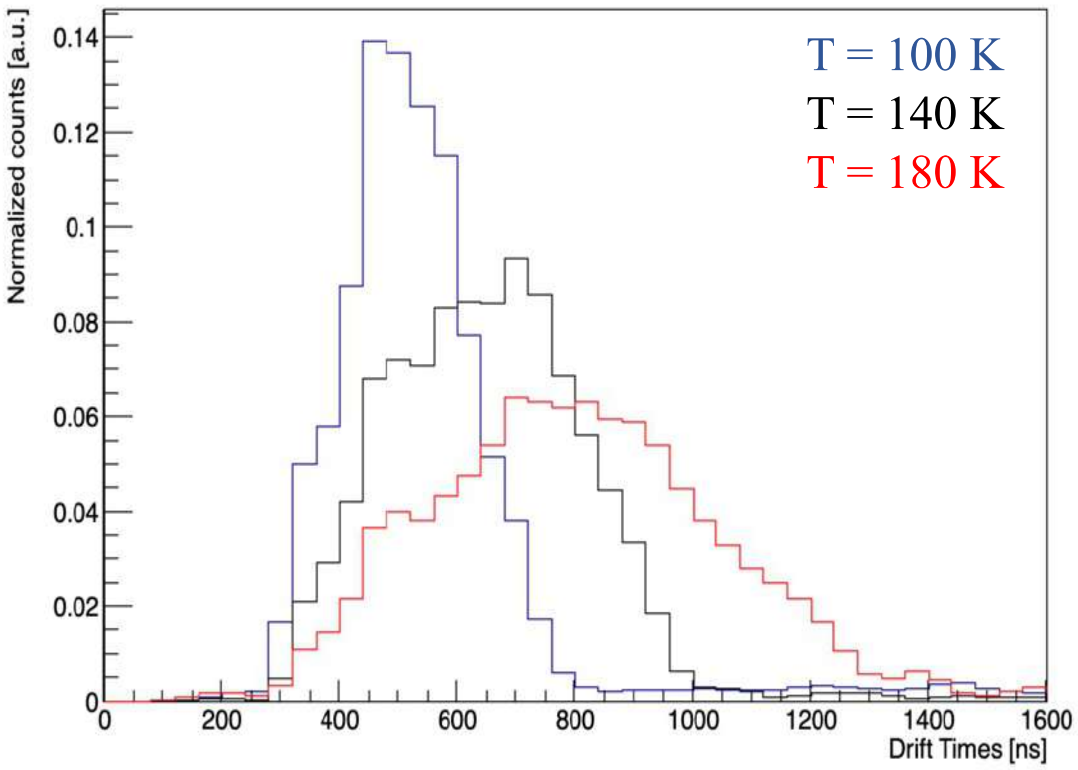


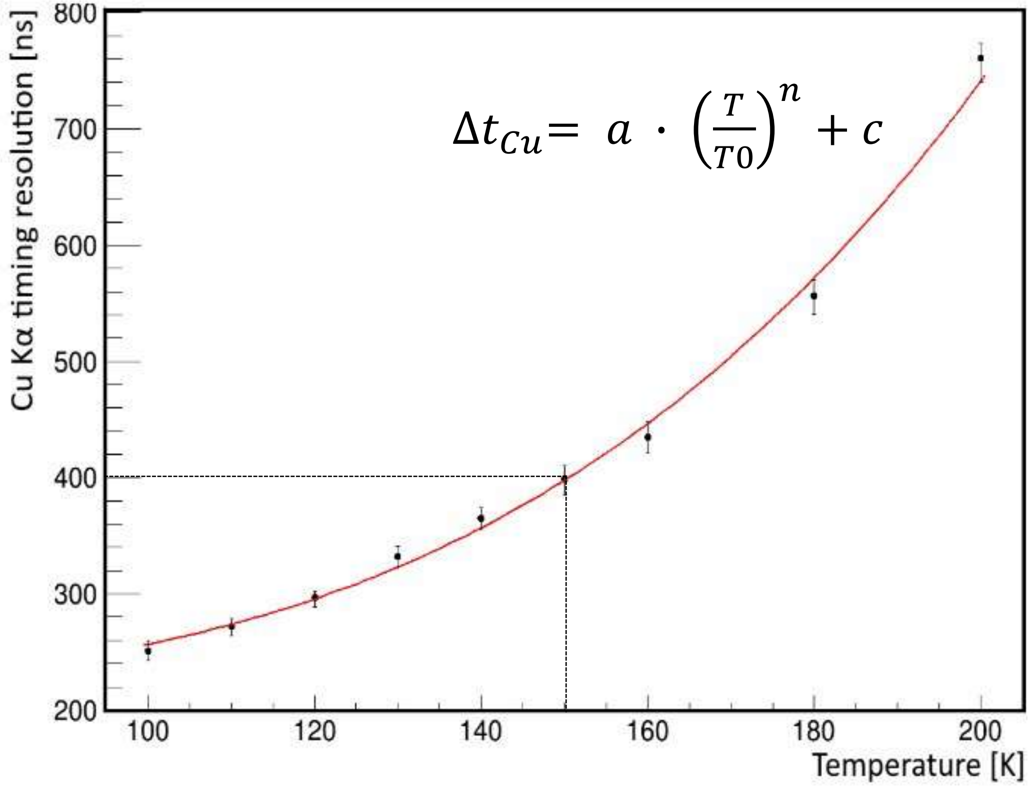
SDD Timing response



SDD Timing response

SDD timing response in function to the temperature





paper in preparation

SDD Characterization for SIDDHARTA-2

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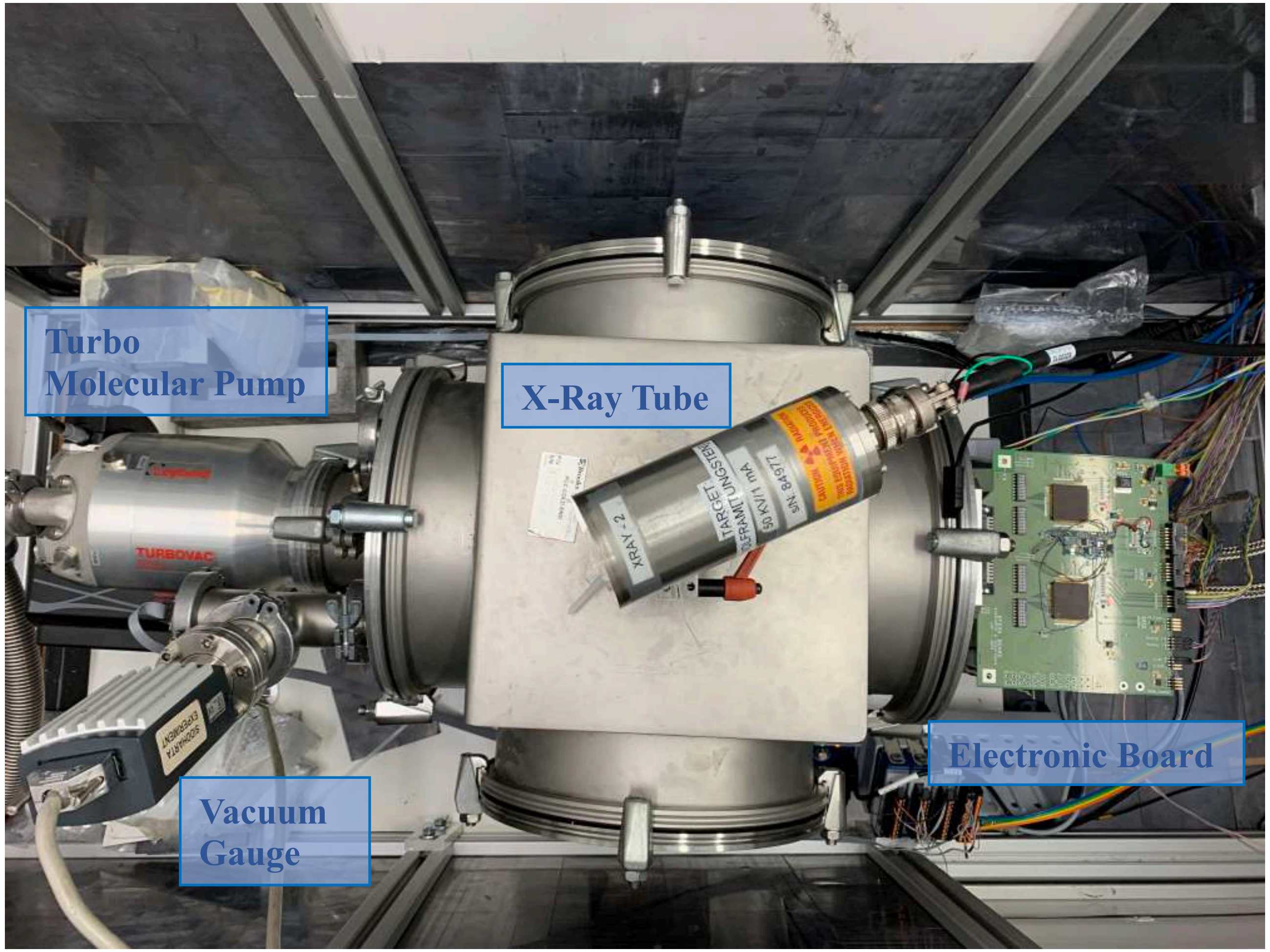
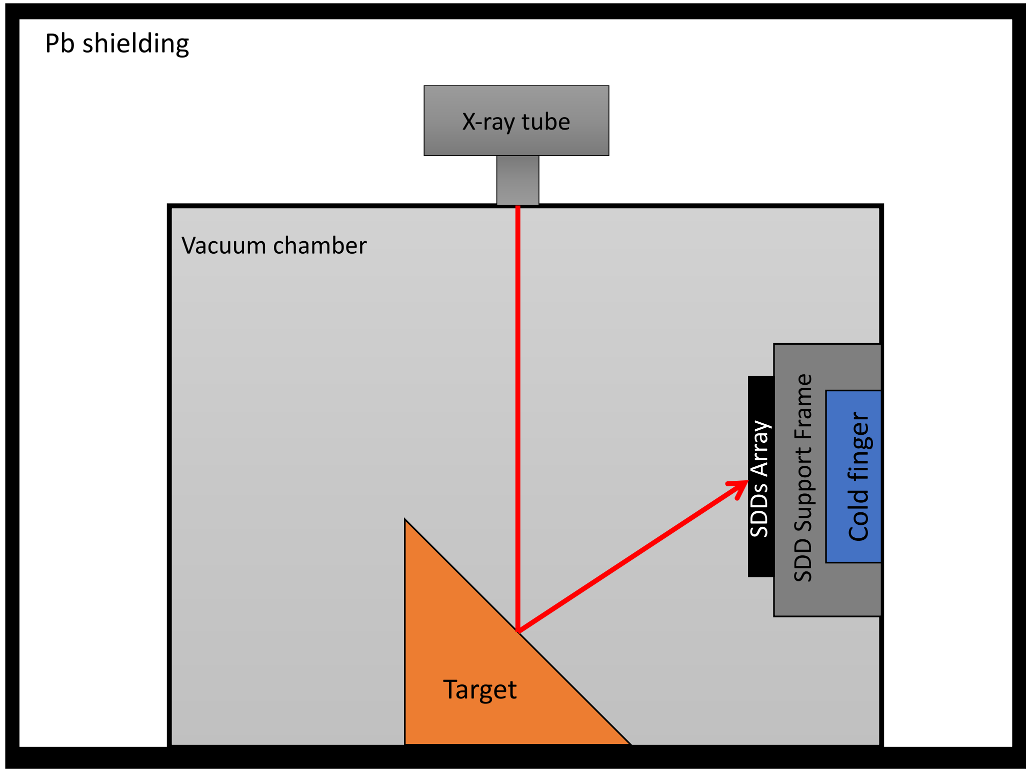
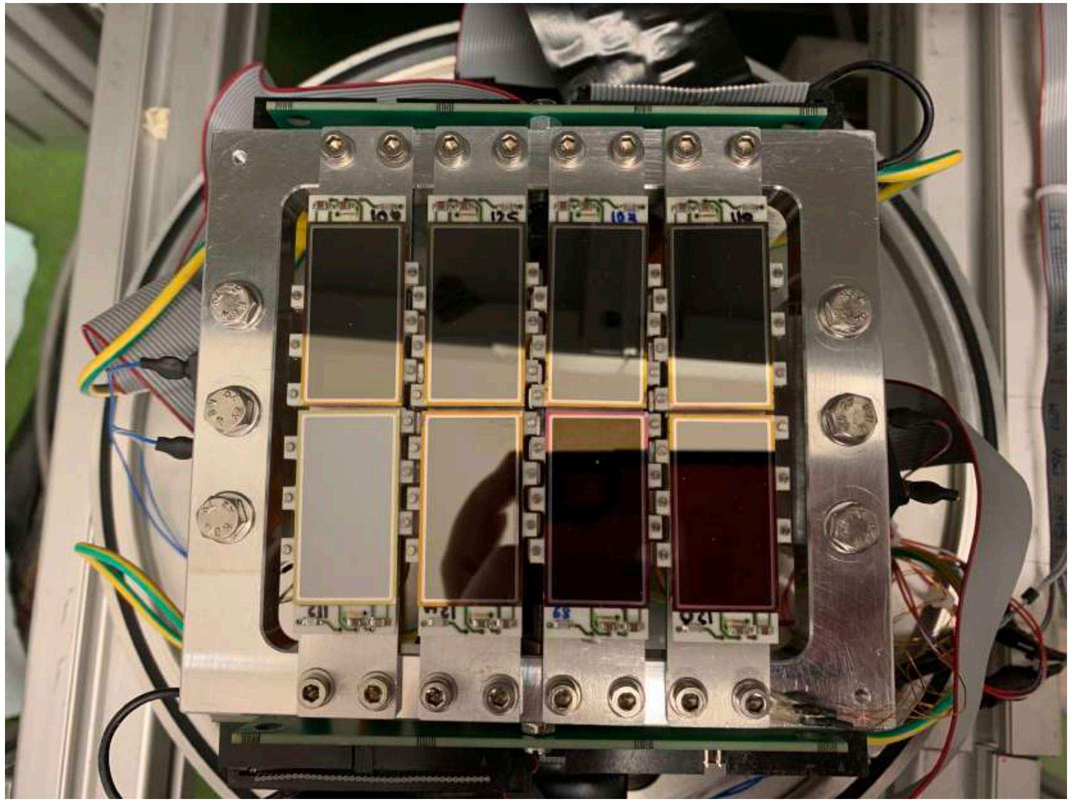
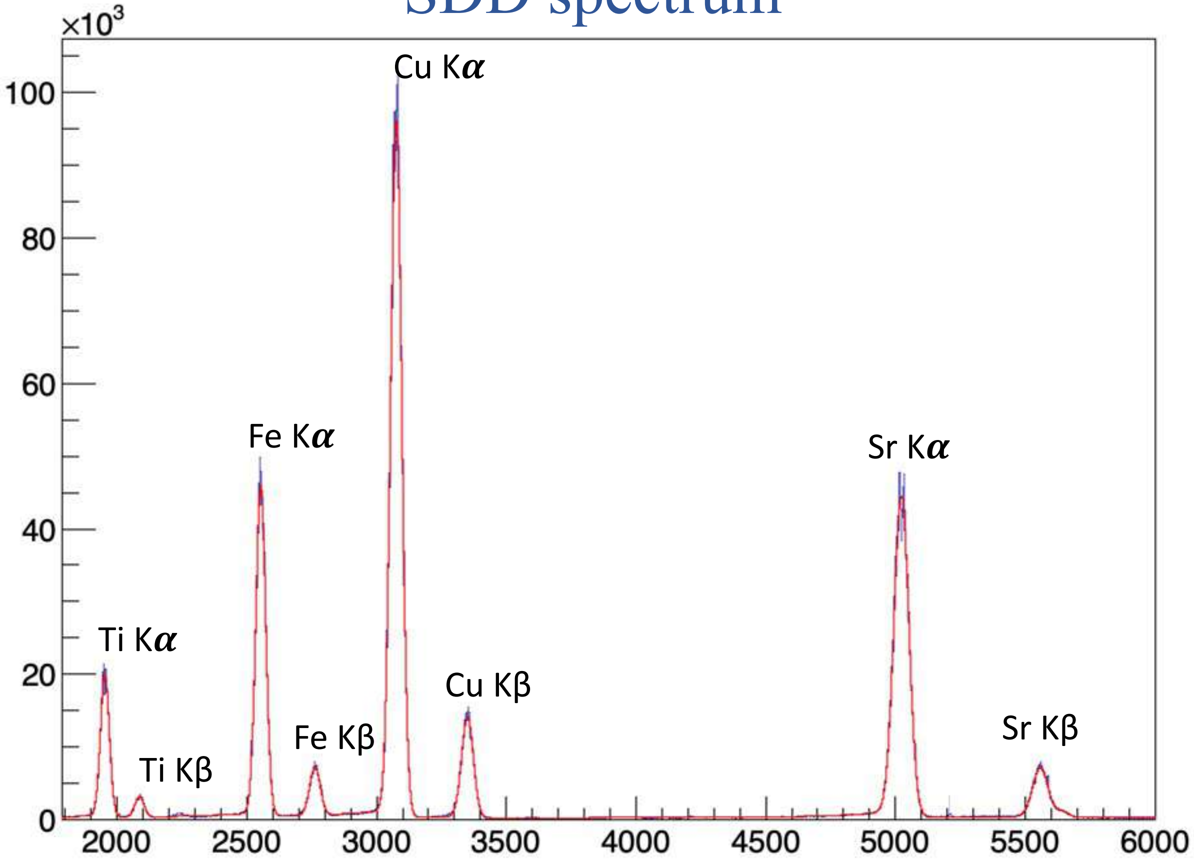




SDD Characterization for SIDDHARTA-2



SDD spectrum



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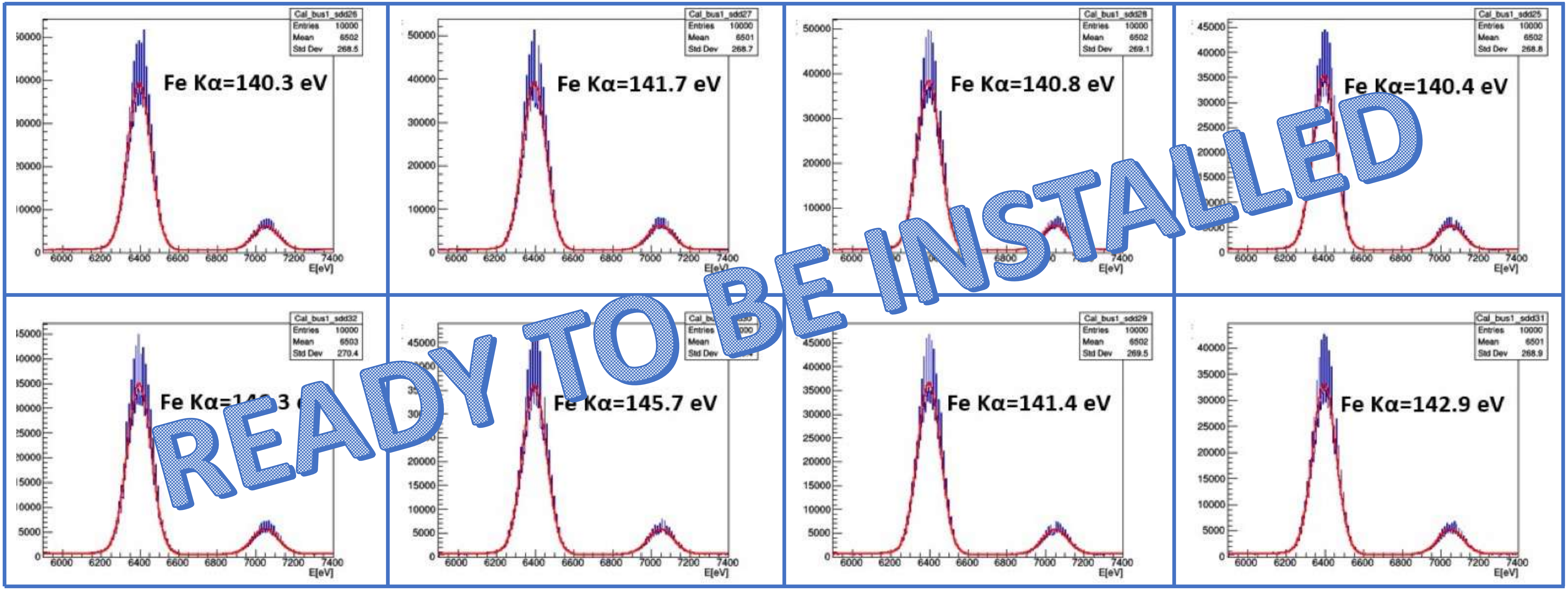

SDD Characterization for SIDDHARTA-2

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Conclusions

- **Accurate qualification of the new monolithic Silicon Drift Detectors**

  - **Energy Response:** Identified the SDD working range 90 V $\leq V_D \leq$ 170 V within:
    - The energy response is linear within 3 eV (energy range 4 keV – 12 keV), Consequently, the systematic error due to SDD calibration is about 3 eV
    - The energy resolution for $K\alpha$ Fe is about 150 eV FWHM
    - Verified the stability

  - **Timing Response:** study of the drift time in function to the temperature and definition of the ideal working temperature for the SIDDHARTA-2 experiment. The drift time (400 ns) is a factor two better than the SDDs of SIDDHARTA: better background rejection

THANK YOU