

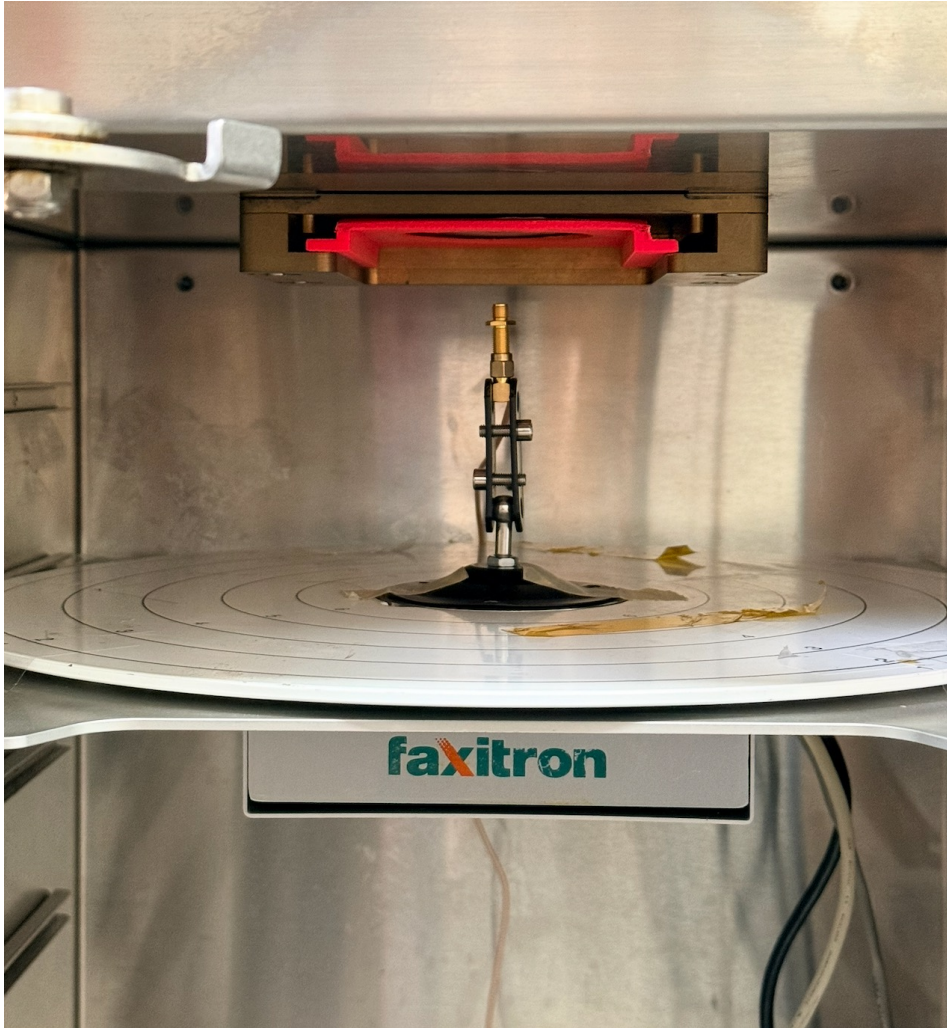
X-ray calibration for COFFEE3 TID experiment

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X-ray and calibration method



- **Faxitron MultiRad 160**
 - fully shielded
 - Measured dose rate (DR): 39.6 kRad/min with 150 μm Al Filter (40kV, 30 mA)
- **Radiation absorbed DR calibration via diode**
 - $DR = k_D \times ID$
 - $k_D = 51.8511 \text{ rad}/(\text{min} \cdot \text{nA})$: current-to-dose coefficient (provided by CERN)
 - ID: diode current
 - ***radiation* ~ X-ray current**
 - ***radiation* ~ $\frac{1}{\text{distance}^2}$**

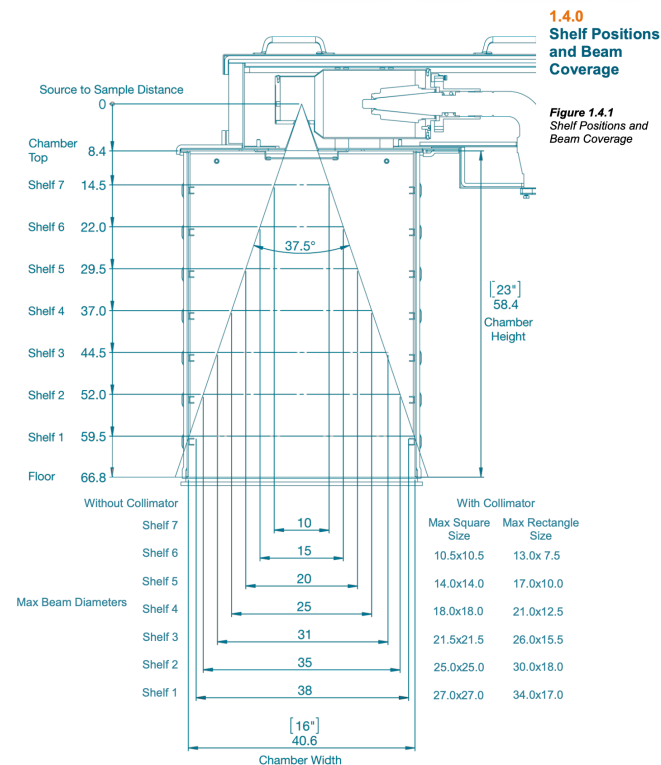
Note: k_D is a calibration constant, and its validity depends on the specific diode and irradiation conditions.

X-ray calibration experiment

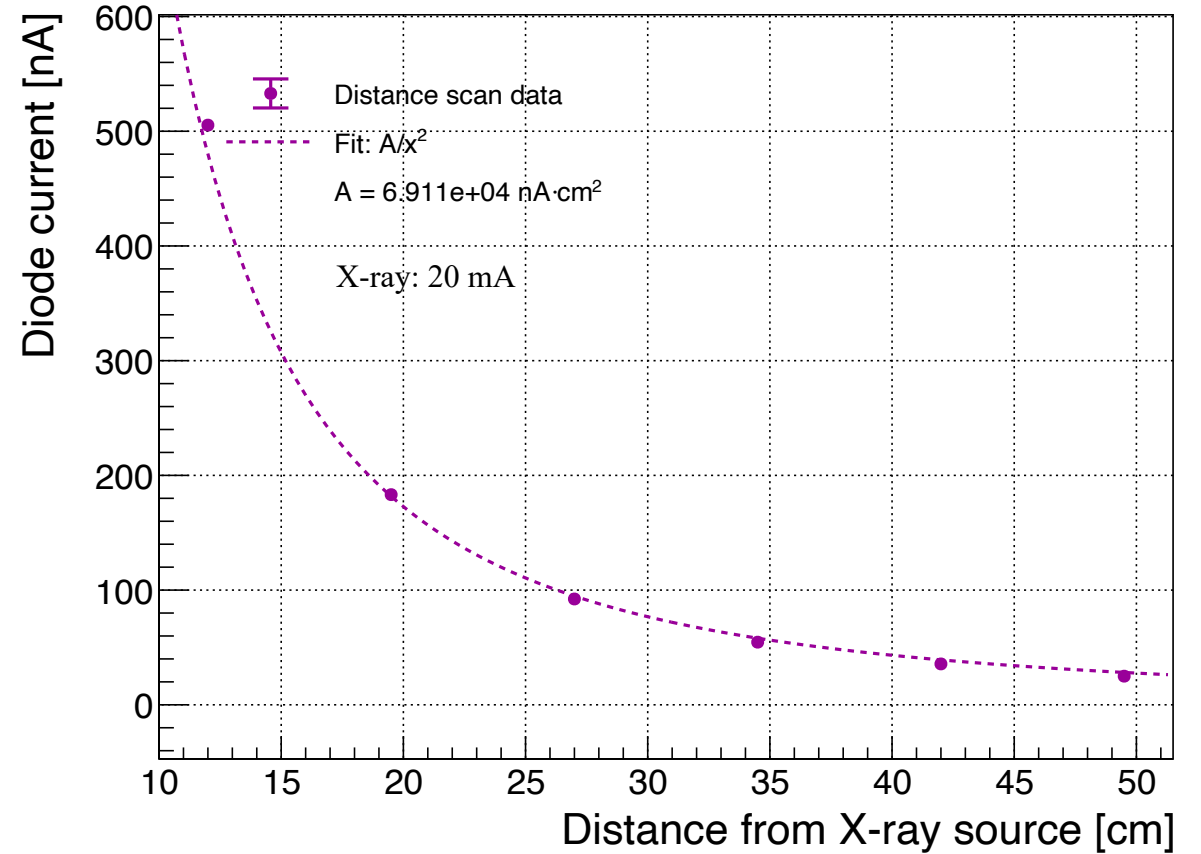
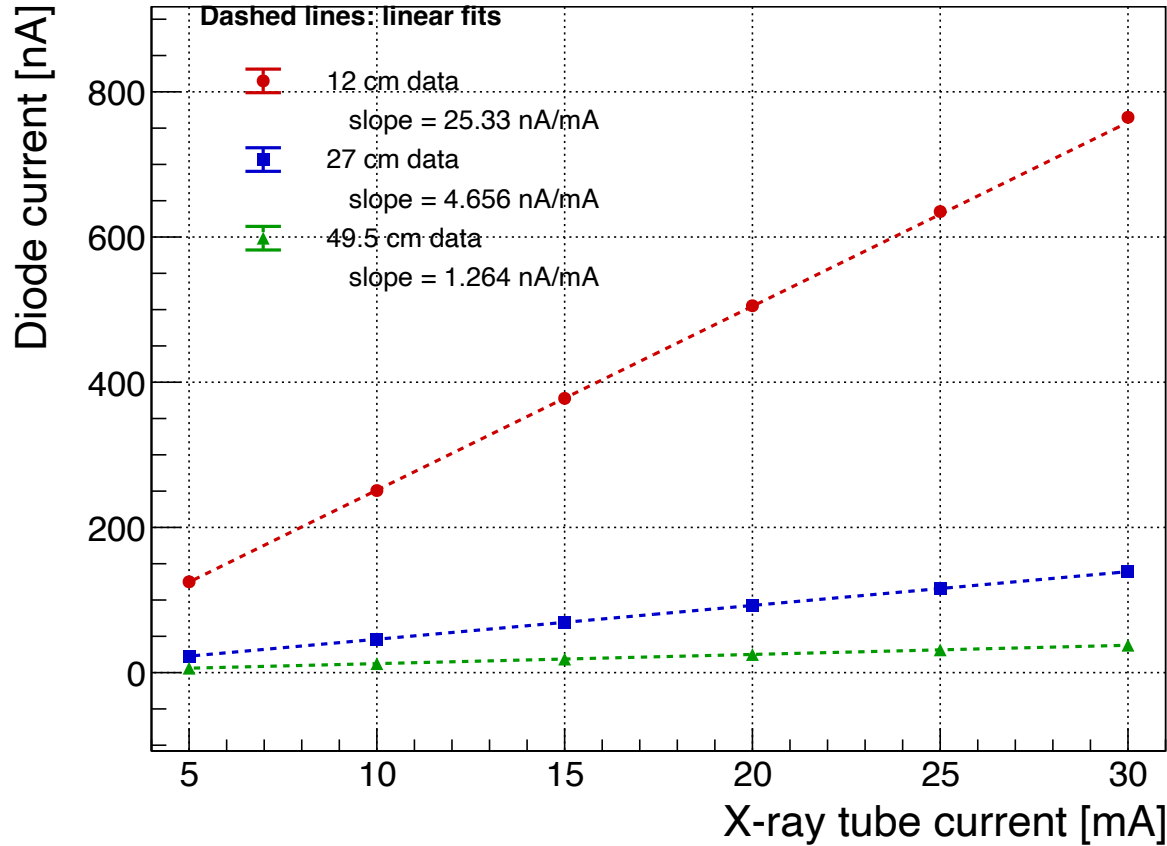
- The X-ray tube was operated at **40 kV** with a **150 μm** thick **Al filter**.
- The diode was operated at **-50 V**, the dark current was subtracted as background.
 - With the **diode position** fixed, scan the **diode current** as a function of the **X-ray current**.
 - With the **X-ray current** fixed, scan **the diode current** as a function of **position**.



The diode was biased using a Keithley 2410, which also measured the current.



Diode current response



Measured at room temperature.

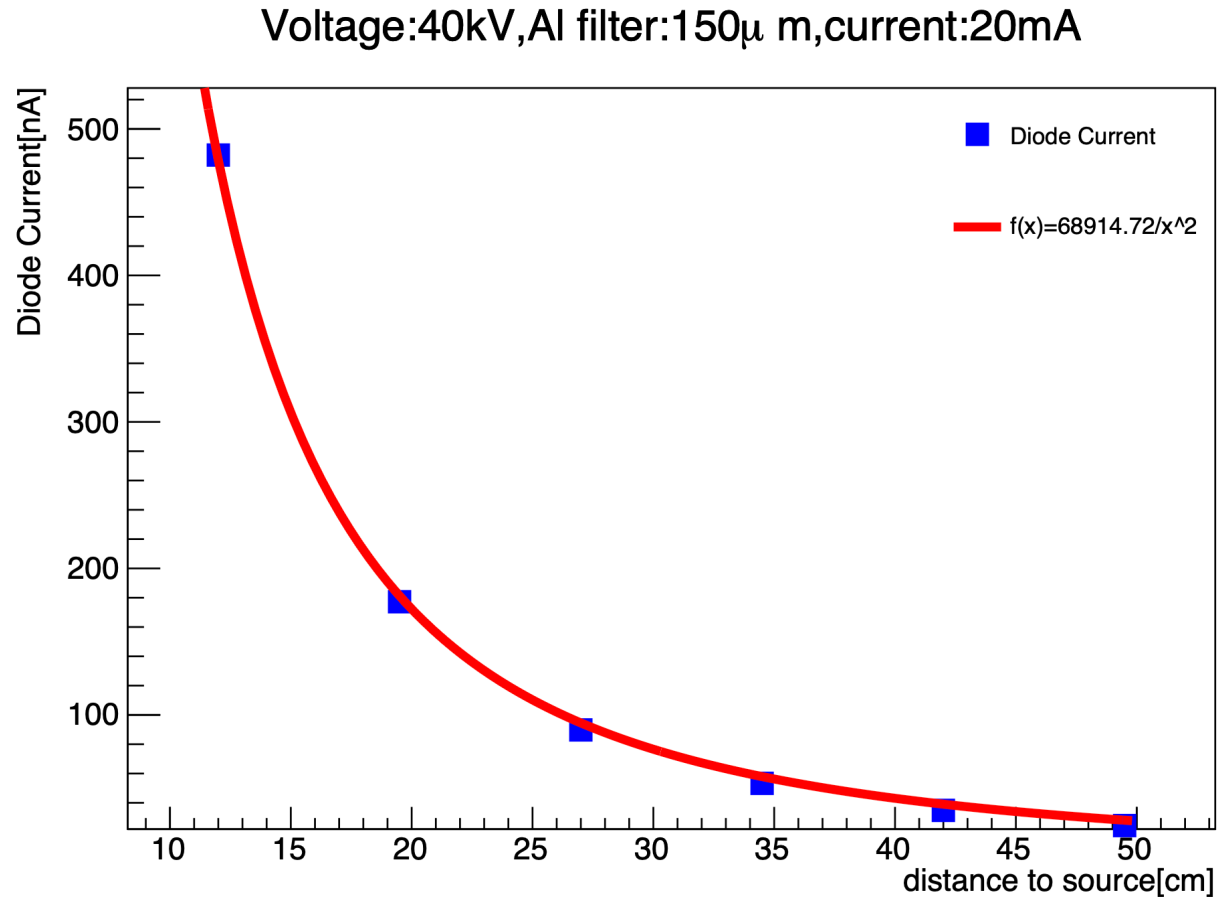
- The measured diode current shows a good linear relationship with the X-ray current.
- The inverse-square dependence of the diode current on position is consistent with the 2023 calibration results (see backup).

Summary

- Estimated dose rate: **~39.6 kRad/min** at (X-ray: 40 kV, 30 mA; distance: 12 cm, with 150 μm Al filter).
- For the COFFEE3 TID test, the total dose is aiming for 62.5–187.5 MRad.
- Estimated irradiation time: **~26 hours for 62.5 MRad** and **~79 hours for 187.5 MRad**.
(Considering that the X-ray system cannot be operated at 30 mA continuously for a long period, the actual irradiation time will be longer.)

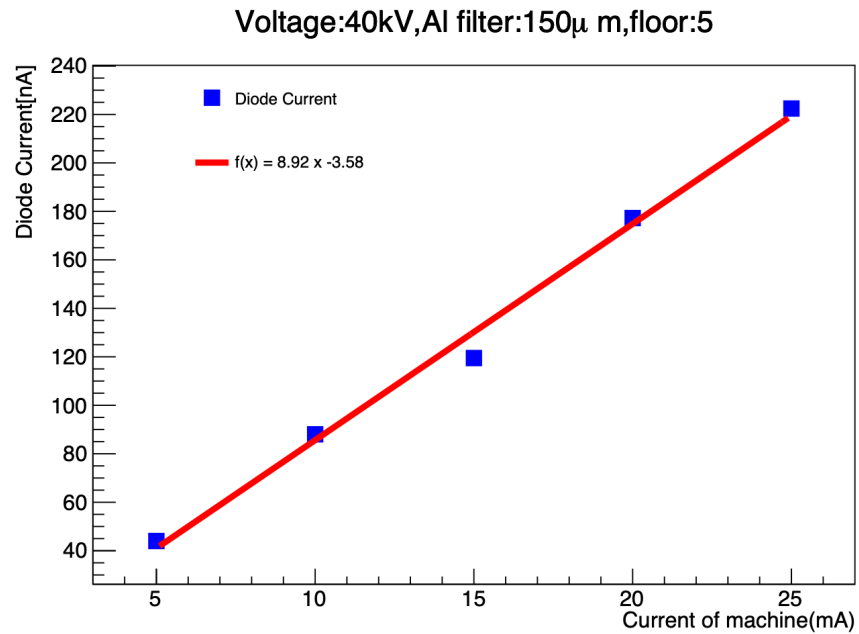
Backup

2023 calibration results

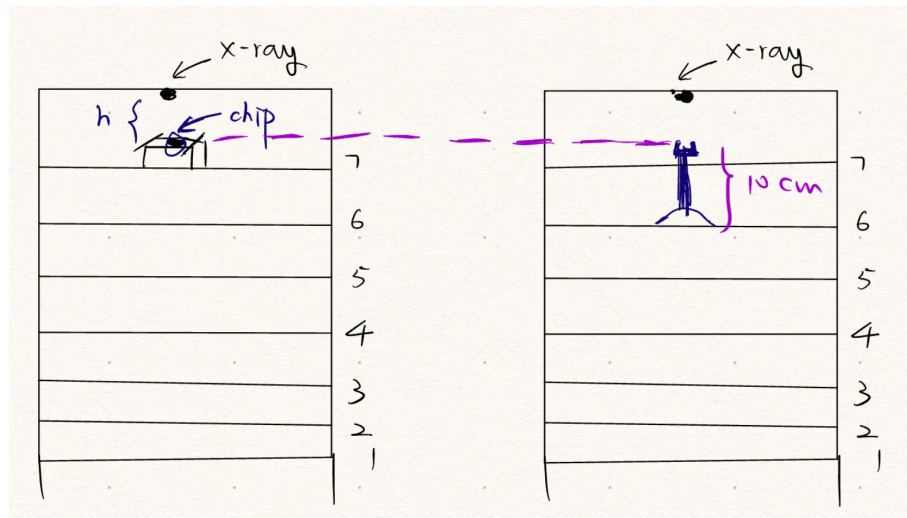


- Working condition of X-ray
 - 40kV
 - 20mA
 - Al filter: 150 μ m
- The dose rate satisfy the inverse square attenuation, but we cannot expect the coefficient is universal for any filter.

2023 calibration results



- Working condition of X-ray
 - 40kV
 - 5th floor($d = 29.5 - 10$ cm)
 - Al filter: 150 μ m
- The dose rate is proportional to the current, but we cannot expect the coefficients is universal for any filter.



Provided by Mingming Xia and Weiguo Lu

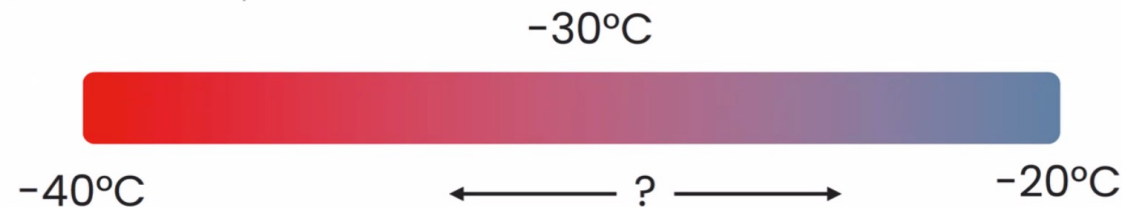
Pending questions



- Lower temperature to operate the sensor (T at sensor level)
 - Currently specification -20°C → based on previous measurements, never done for UP irradiation environments

NIEL	$1 \times 10^{15} n_{\text{eq}}/\text{cm}^2$	3	$3 \times 10^{15} n_{\text{eq}}/\text{cm}^2$
TID	62.5 MRad	3	187.5 MRad

- Issue if afterward we ask -30°C
- The low temperature is to minimize the noise → keep the S/N after irradiation (= less signal, more noise)
- Operating point is technology dependent :
 - HV-MAPS : Good hints from LF-monopix/RD50-MPW4 in LF, MP and COFFEE but not clear answer before next generation prototypes
 - Velo (400 Mrad, up to $8 \times 10^{15} n_{\text{eq}}/\text{cm}^2$) → -40°C



Work in progress