

# Some ideas on irradiation studies of HV-MAPS sensors\*

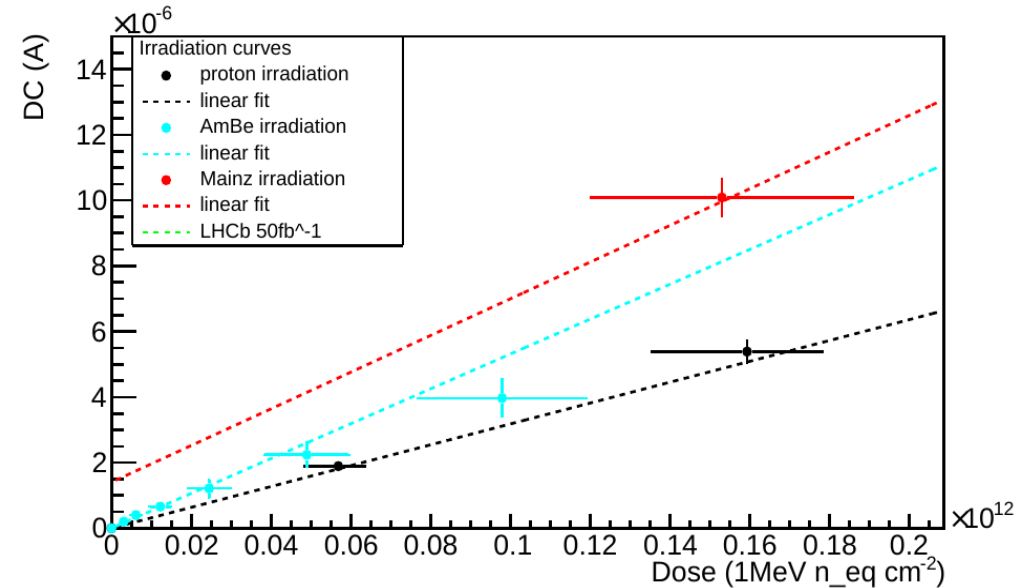
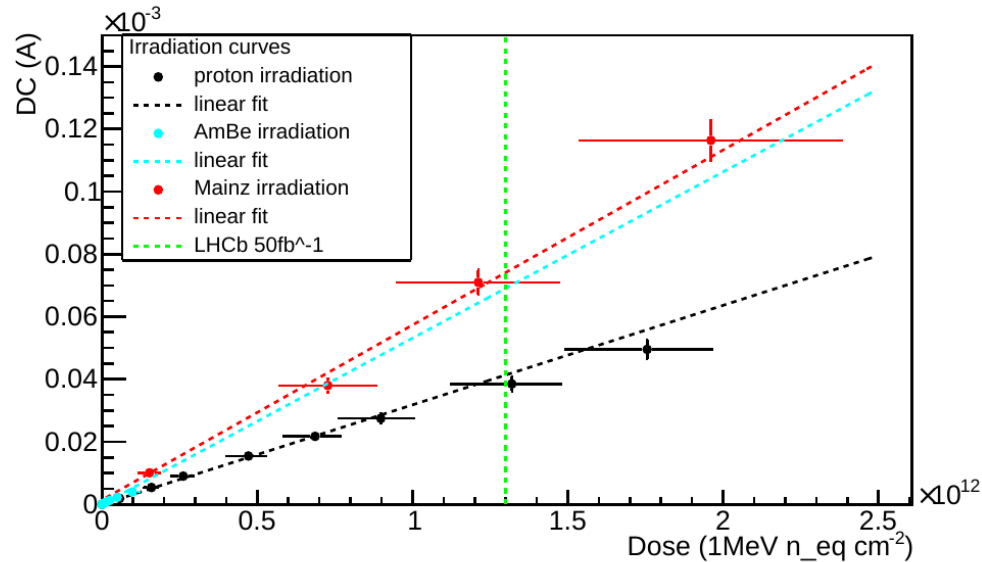
HV-MAPS meeting - 27.11.2021

Sebastian Bachmann

\*All informations and plots taken from

1. Master thesis by David Gerick
2. B.D. Leverington et al 2018 JINST 13 P05030

# Irradiation of SiPMs

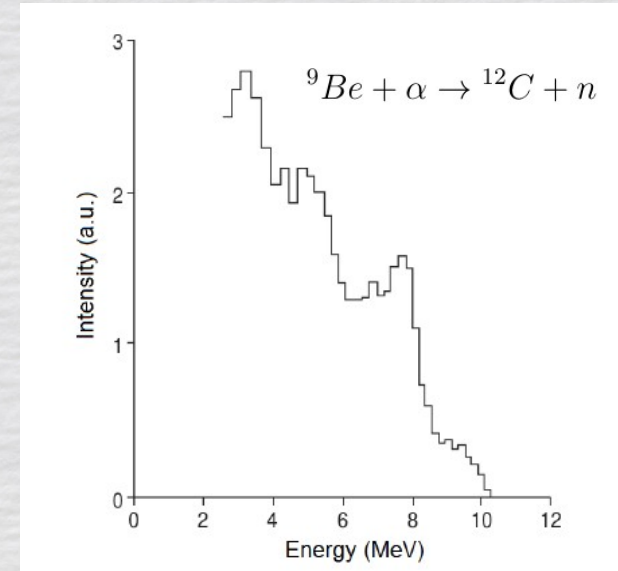
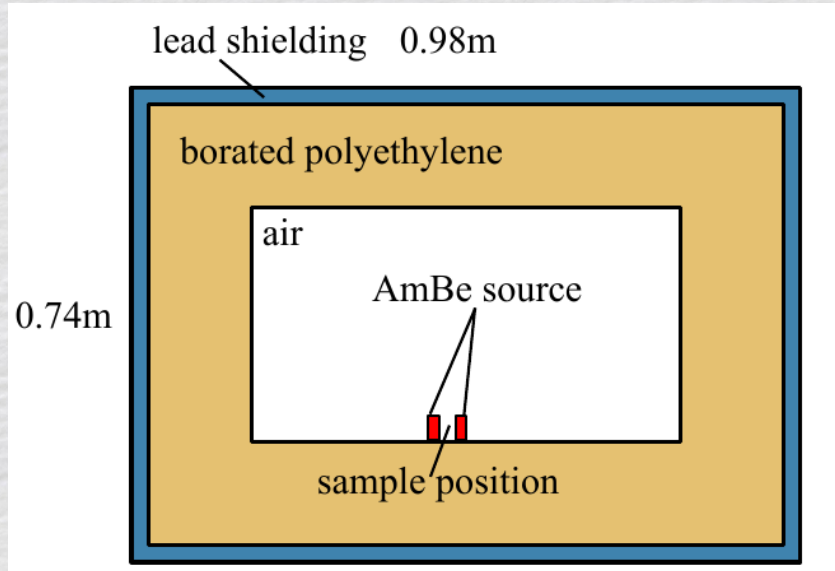


Dark current of SiPMs as a function of integrated flux

Rough estimate for 300fb<sup>-1</sup>@LHCb (Blake):

- Integrated flux 1E14 1 MeV n.eq./ cm<sup>2</sup>
- Ionising dose will be 210 kGy.

# Am<sup>241</sup>-Be<sup>9</sup> source (in house)



- 3 sources, 3.7GBq each
- flux measurement by means of neutron activation analysis using NaI - detectors

| Neutron source   | Flux [ $\text{cm}^{-2} \text{s}^{-1}$ ]           |
|------------------|---------------------------------------------------|
| AmBe-source 434  | $10697 \pm 425(\text{stat}) \pm 2300(\text{sys})$ |
| AmBe-source 4116 | $10977 \pm 431(\text{stat}) \pm 2360(\text{sys})$ |
| AmBe-source 4117 | $12908 \pm 467(\text{stat}) \pm 2776(\text{sys})$ |
| Total            | $34582 \pm 761(\text{stat}) \pm 7435(\text{sys})$ |

# TRIGA reactor@Mainz





# Measurement of Neutron Flux@Mainz

From Neutron Activation Analysis with a GeLi detector@100kW

$$\Phi_{eq}^{Mainz} = 5.15 \pm 0.15(stat) \pm 0.75(sys) \times 10^{11} \text{ cm}^{-2} \text{ s}^{-1}$$

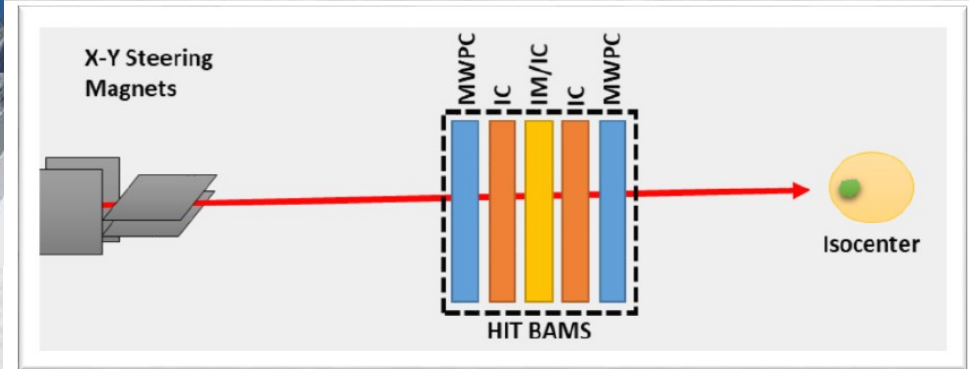
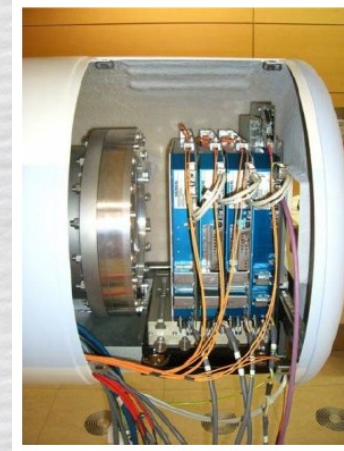
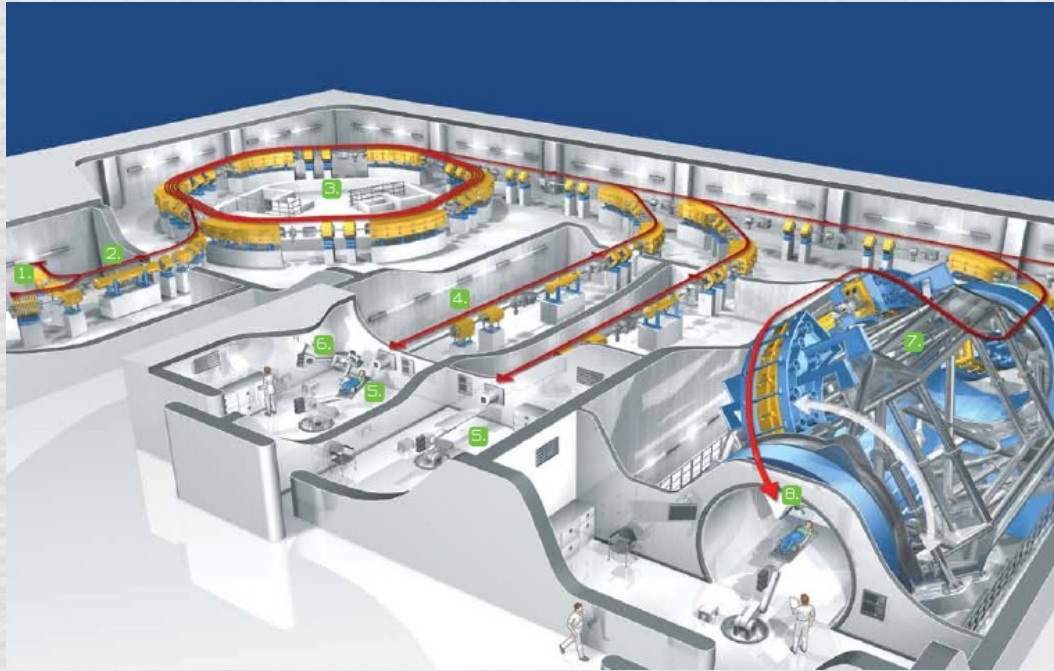
From calibrated PiN diodes @100kW

$$\Phi_{eq}(\text{BPW34F}) = 8.35 \pm 0.20(stat) \pm 1.25(sys) \times 10^{11} \text{ cm}^{-2} \text{ s}^{-1}$$

From calibrated PiN diodes @1kW

$$\Phi_{eq}(\text{LBSD Si-2}) = 6.12 \pm 1.37(sys) \times 10^9 \text{ cm}^{-2} \text{ s}^{-1}$$

# Heidelberg Ion beam Therapy center (HIT)



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**Table 1.** The energies and intensities available at the HIT Clinic. The energy range is divided into 255 possible settings, E1–E255. There are typically 10 different intensity settings available for use, I1–I10.

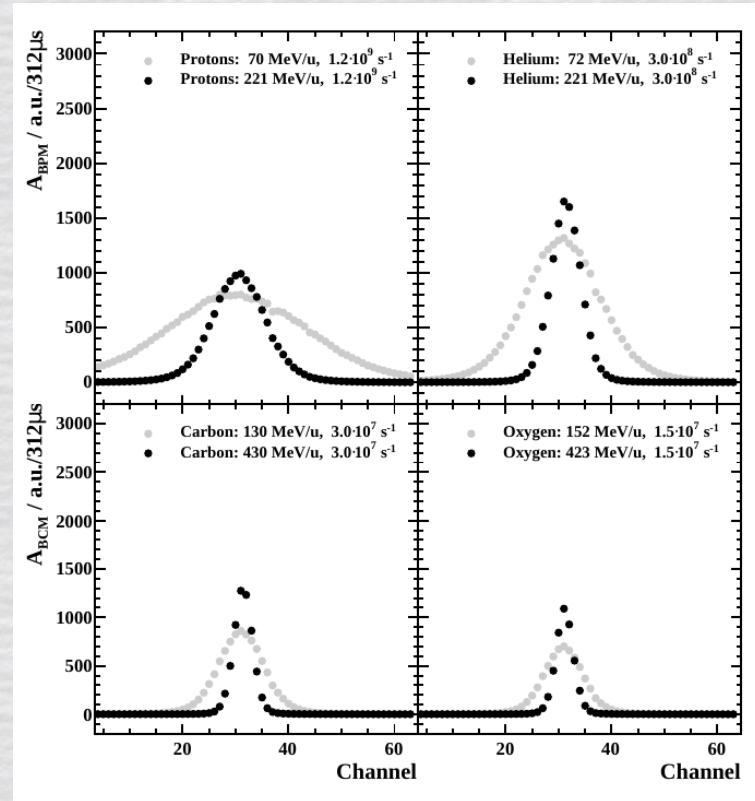
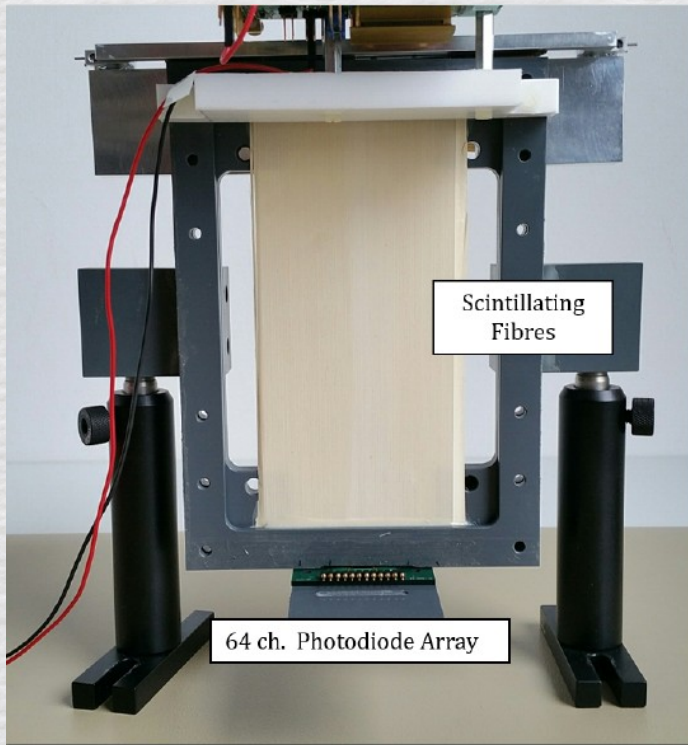
|                               | Protons                           | Helium                          | Carbon                          | Oxygen                          |
|-------------------------------|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Energy [MeV/u]                | 48–221                            | 51–221                          | 89–430                          | 104–515                         |
| Intensity [ $\text{s}^{-1}$ ] | $8 \cdot 10^7$ – $3.2 \cdot 10^9$ | $2 \cdot 10^7$ – $8 \cdot 10^8$ | $2 \cdot 10^6$ – $8 \cdot 10^7$ | $1 \cdot 10^6$ – $4 \cdot 10^7$ |

- spill length ~seconds, duty cycle 50%
- stopping power of Oxygen up to  $\sim 400 \text{ MeVg}^{-1}\text{cm}^{-2}$  (MIP:  $1\text{--}2 \text{ MeVg}^{-1}\text{cm}^{-2}$ )
- particle density for protons in the range of 2-50 particles per  $\text{cm}^{-2}$  every 25ns
- another rough estimate by Blake: during one night shift  $\sim 12\text{kGy}$  can be collected



# Beam Monitoring@HIT

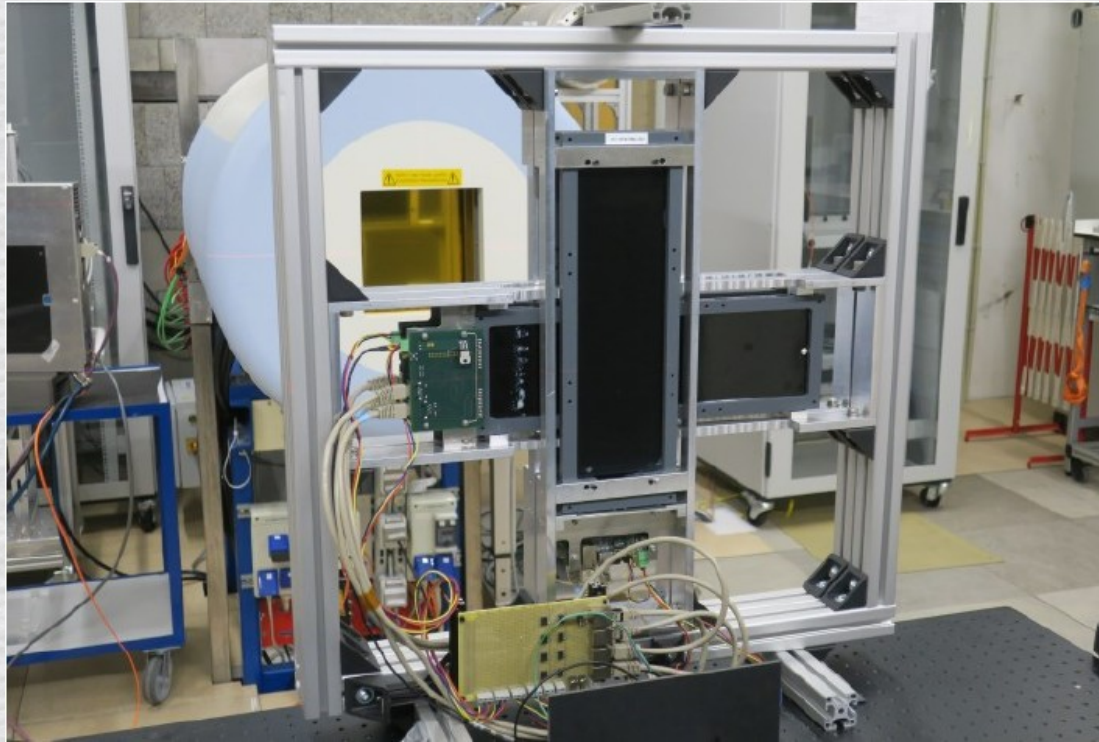
(Blake Leverington)



1 channel = 0.8mm; integration time = 312 $\mu\text{s}$



# Beam Monitoring@HIT: New detector (Blake Leverington)



# Pharmazeutischer Gefrierschrank (Elcold®) -45°C 384L - Horizontale Gefrie



**998** €99 (o. MwSt.)

## Strong points

Scharnierdeckel-Gefrierschränke / -45°C

Tiefkühltruhe mit extra niedriger Temperatur  
Kontinuierlich - 45°C

Anzeige und Einstellung: digitale Temperatur  
Wiederverschließbar

Ausgestattet mit: Standard-Batterie-Alarmsystem  
Temperaturbereich: -10/ -45°C

Klimaklasse: 4

Modell: EL41LT

Außen: 1505 x 655 x 850 mm

Fassungsvermögen: 384 Liter

Leistung: 210 W

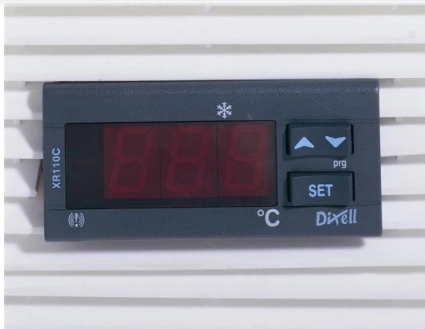
Gewicht: 78 kg

Kältemittel: R404a

Auftauen: manuell

Kalt: statisch

Verbrauch: 4,8 kWh



Inner volume:  
1100x450x650 mm

Different sizes available  
from 130l to 416l