Introduction and overview

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Mu2e-II Snowmass21 Calorimeter Workshop

22 September 2020

Why a Calorimeter ?

- Let's summarize the calorimeter scope in Mu2e/Mu2e-II experiment:

1. work as an independent trigger for the experiment:
   - a good energy resolution is needed → lower than 10% from 50 MeV

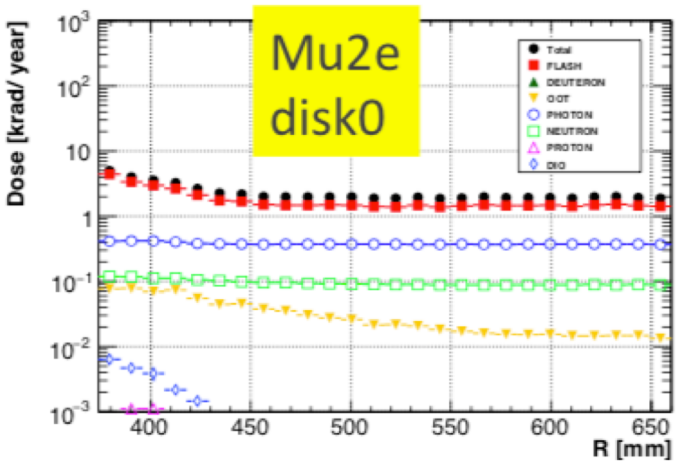
2. Seed for the tracker reconstruction and provide a good T0
   - good time resolution is needed → lower than 500 ps from 50 MeV

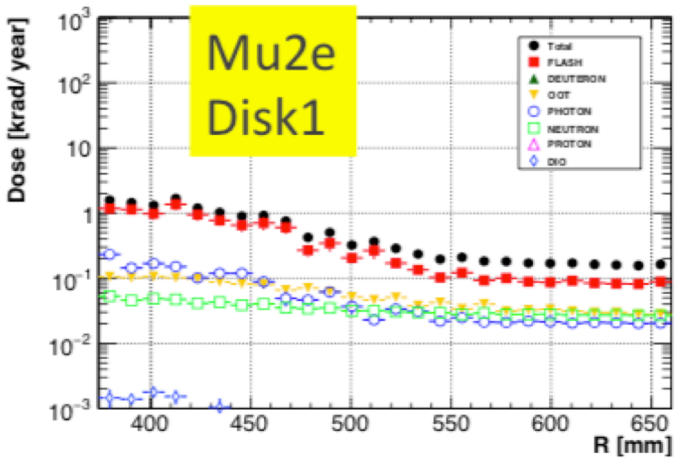
3. PID
   - Good energy and time resolutions (10% and 500 ps)

4. Provide independent (from STM) muon stop normalization
   - With dedicated LYSO or LaBr crystals

Example of Dose distribution in crystals

From Miscetti's talk at Mu2e-II workshop @ NorthWestern University





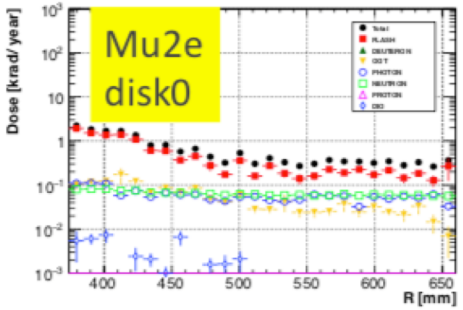
X 10 Factor →

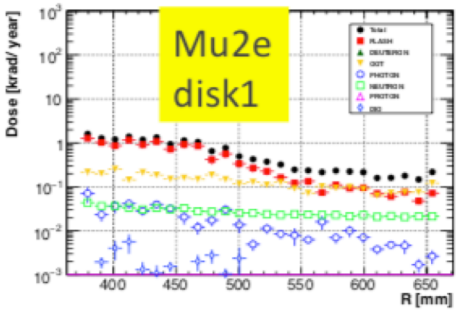
Disk1:
Inner:(60x 5 x 3 → 900 krad
Outer:((15x5x3) → 180 krad

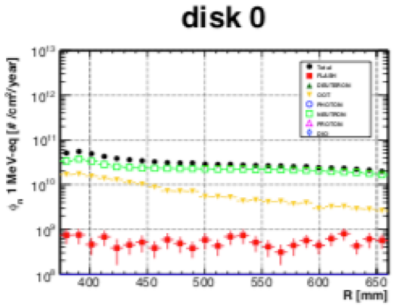
Disk2:
Inner: (10x 5 x 3) → 150krad
Outer:(5x5x3) → 75 krad

Example of Dose/neutrons distribution in SiPM

From Miscetti's talk at Mu2e-II workshop @ NorthWestern University







X 10 Factor →

Disk1: Inner:
(10x2x 5 x 3) → 300 krad
Outer: (10x0.5x5x3) → 75 krad

Disk2:
Inner: (10x1x 5 x 3) → 150 krad
Outer = (10x0.5x5x3) → 75 krad

Latest SiPM Dose test indicated no hints of deterioration up to 80 krad

X 10 Factor

Disk 1 = $10 \times 6 \times 10^{10} \times 5 \times 3 = 900 \times 10^{10} = 9 \times 10^{12}$

Neutron fluence up to 10^{13} n_1MeV/cm^2 → -40 C

R&D considerations ... and infrastructures ..

- List of R&D tests for whatever proposed solution
  1. Crystals → measure rad-hardness to dose (RIN and TID)
  2. Photosensors → measure rad-hardness to neutrons up to 10^{13} n_1MeV/cm^2
  3. Mechanics → Control behavior at low temperatures
  4. Electronics → rad-hardness and speed

- List of engineering details:
  1. Qualify MTTF of all components
  2. Work on improving Cooling system and cooling distribution
  3. Improve/change electronics

R&D phases is already started
and we will have six dedicated talks in this workshop for
Crystals, photosensors and electronics

Ren-Yuan
Yuri

David
Steve
Nikolay

Franco

Goal and considerations..

- High pileup → we need a faster crystal
- High dose → we need a rad hard crystal up to 1 Mrad
- High radiation environment and magnetic field → we need a rad hard photosensor fast, with high gain and high quantum efficiency
- **As we will see, the baseline solution is to use BaF2 crystals + enhanced SiPM**
- But I want to close with an exercise / question:
  "can be 7 cm of LYSO + 10 um pixel size SiPM (at -40 C) an alternative solution?"
  Stefano and I are personally looking also to this option

SPARES