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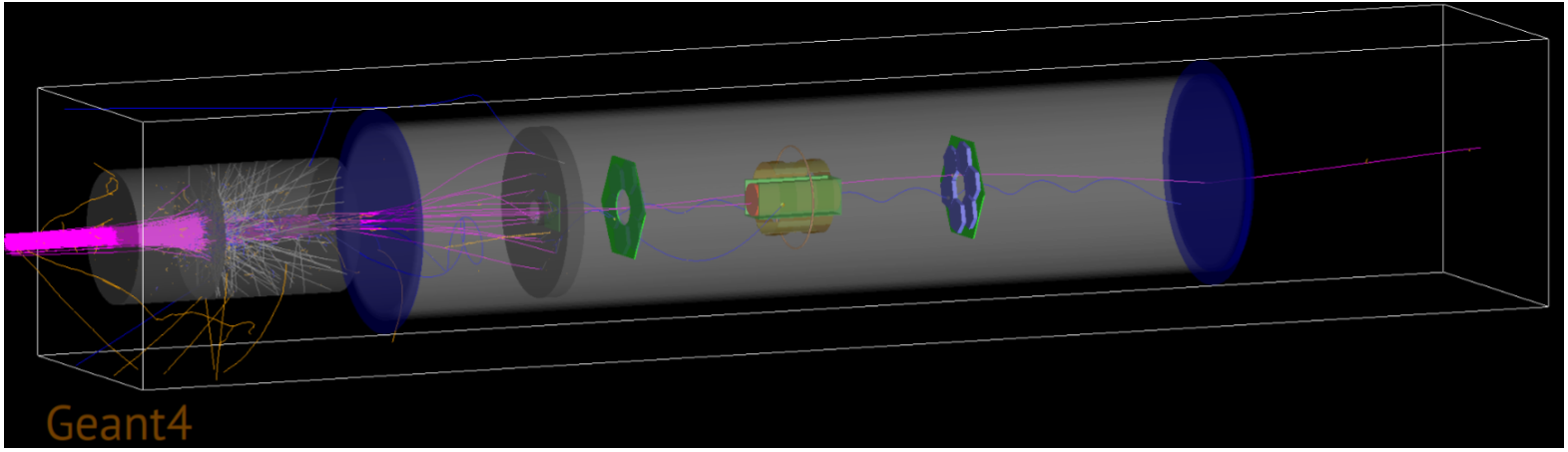
Chavdar Dutsov :: Paul Scherrer Institute

Preparation for the piM1 beamtime in September 2024

muEDM collaboration meeting – April 2024, Pisa (remote)

Beam time requests – piM1

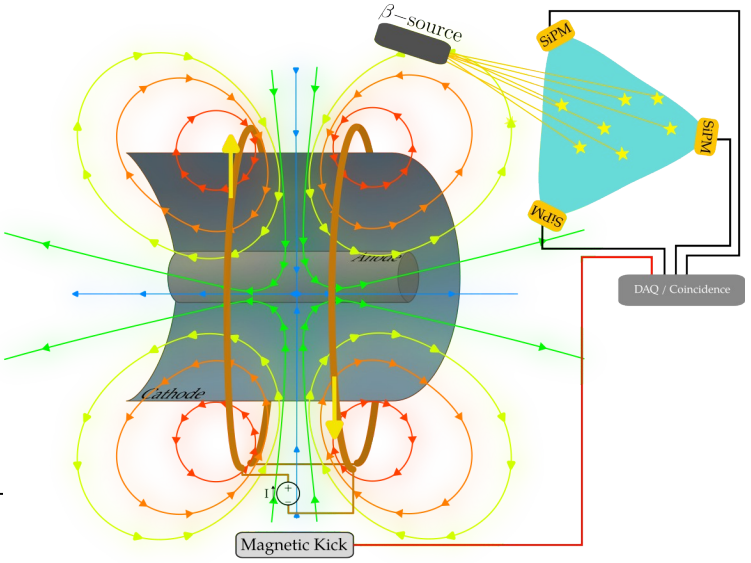
- *Possible systematic effect:* early-to-late change in the detection efficiency of the positron detection system that is correlated to the magnetic kick.
- **Goal:** Measure the positron decay asymmetry as a function of time post-magnetic kick using two detectors placed on the sides of a stopping target for 200 MeV/c pions inside the 3 T solenoid field.
- Source of uniformly distributed positrons → any asymmetry change correlated to the kick will be a sign of a systematic effect.



Development of a prototype detector system to test early-to-late stability

- With 3 SiPMs working in coincidence we can deduce the detection efficiency of a scintillation detector.
- The ratio of triple to double coincidences (T/D) between the photo-detectors will be monitored as a function of the time to the previous magnetic kick:

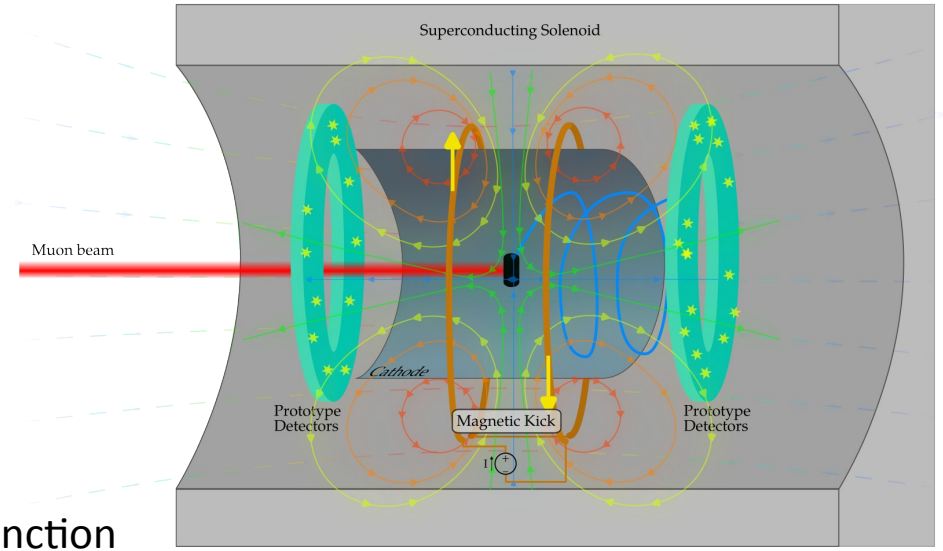
$$\frac{\phi_T}{\phi_D} = \frac{\int_0^{E_{max}} S(E)\left(1-e^{-\varphi E Q(E)/3}\right)^3 dE}{\int_0^{E_{max}} S(E)\left[3\left(1-e^{-\varphi E Q(E)/3}\right)^2 - 2\left(1-e^{-\varphi E Q(E)/3}\right)^3\right] dE} = \frac{T}{D}$$



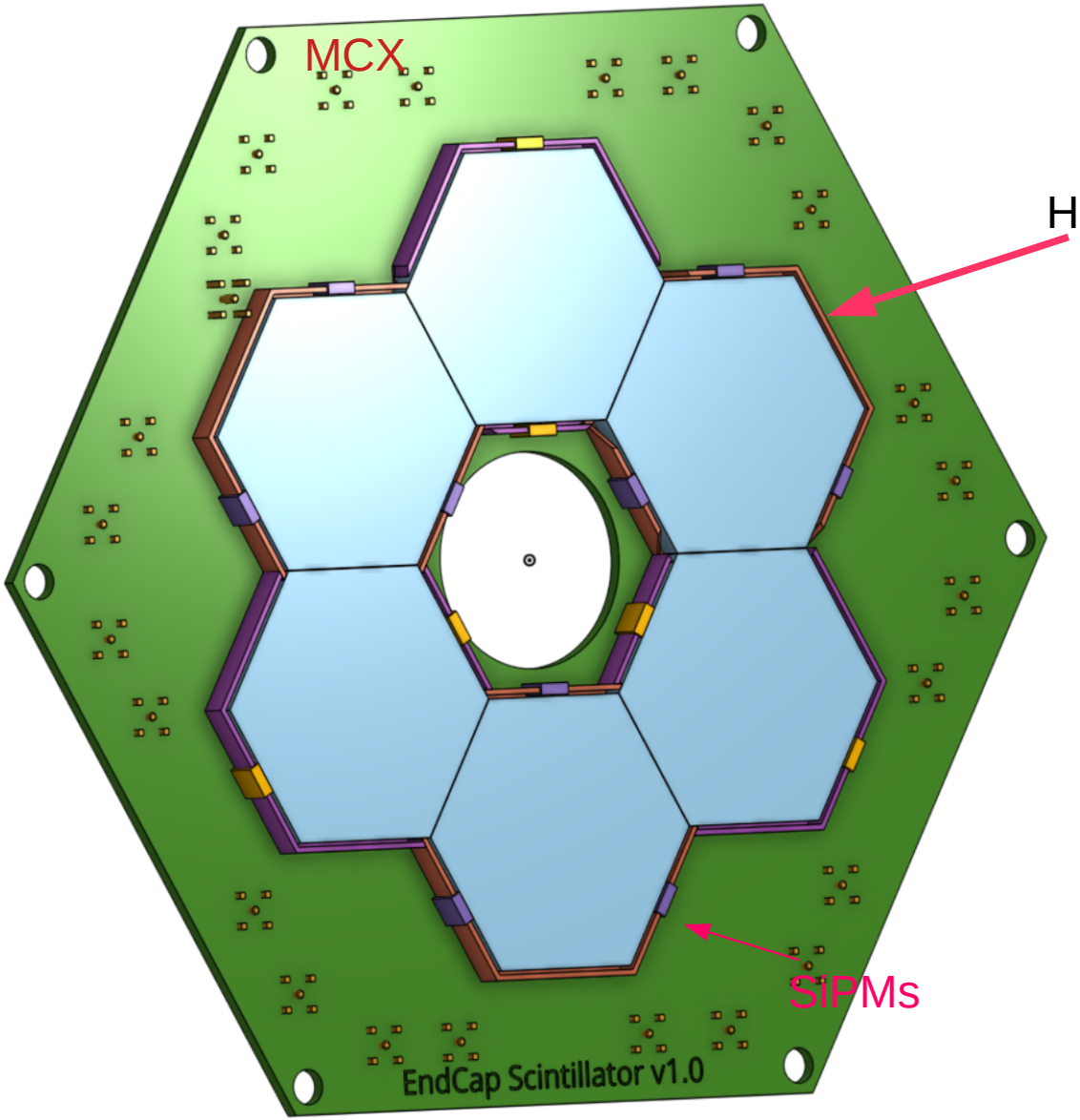
- We can relate the change in the ratio to a change in the overall detection efficiency with time.

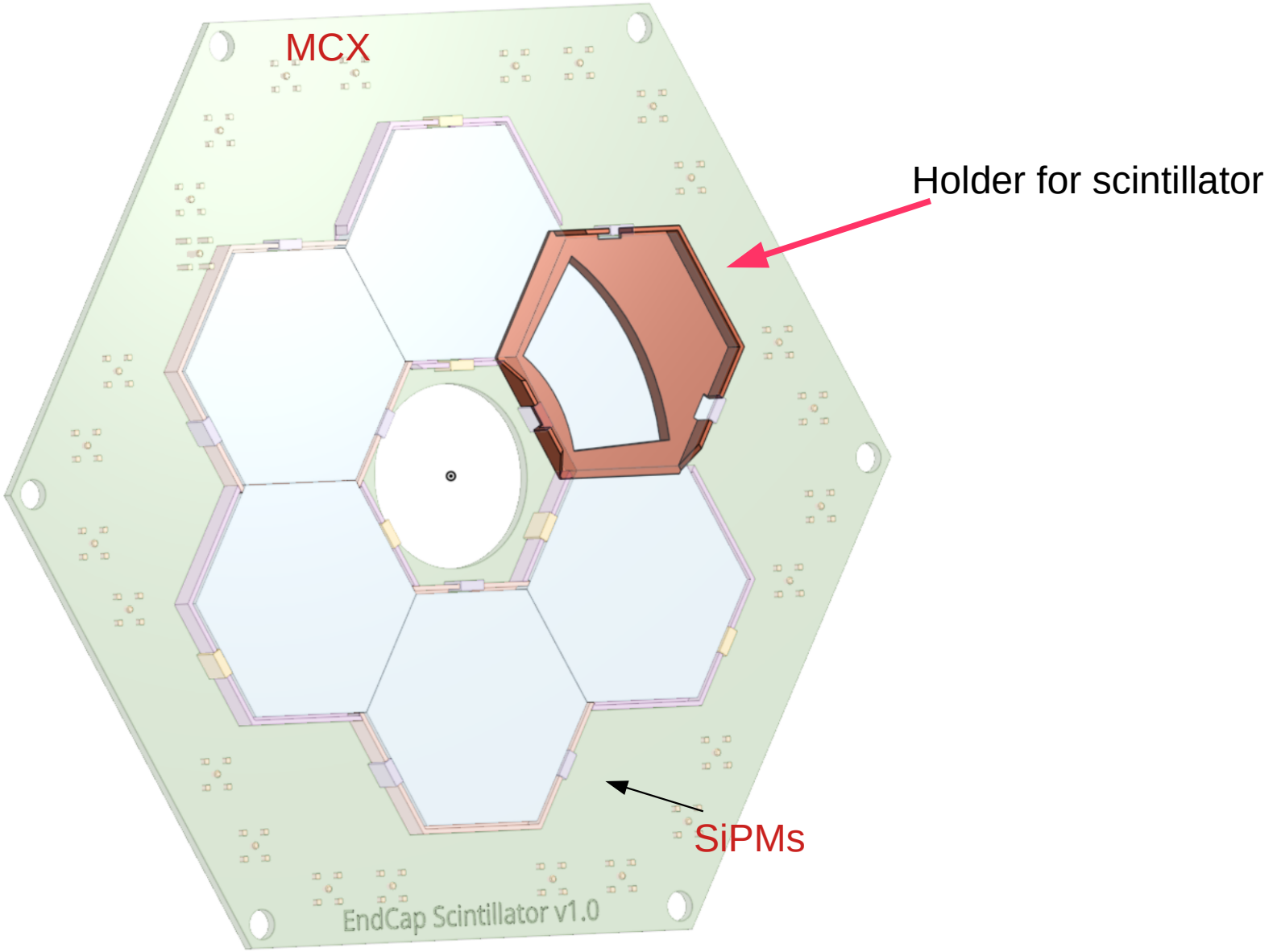
Experimental verification of detector performance

- Experimental setup:
  - Pion beam focused on a target.
  - Magnetic pulses at 2 kHz rate.
  - Study the observed asymmetry in up-down going decay positrons as a function of time to the last magnetic pulse.



- Study of other systematic effects (e.g. solid-angle coverage, accidental coincidences, correlated background, etc.).
- **Demonstration of time stability and resistance to the magnetic pulses.**


MCX
Holder for scintillator
SiPMs
EndCap Scintillator v1.0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Holder for scintillator
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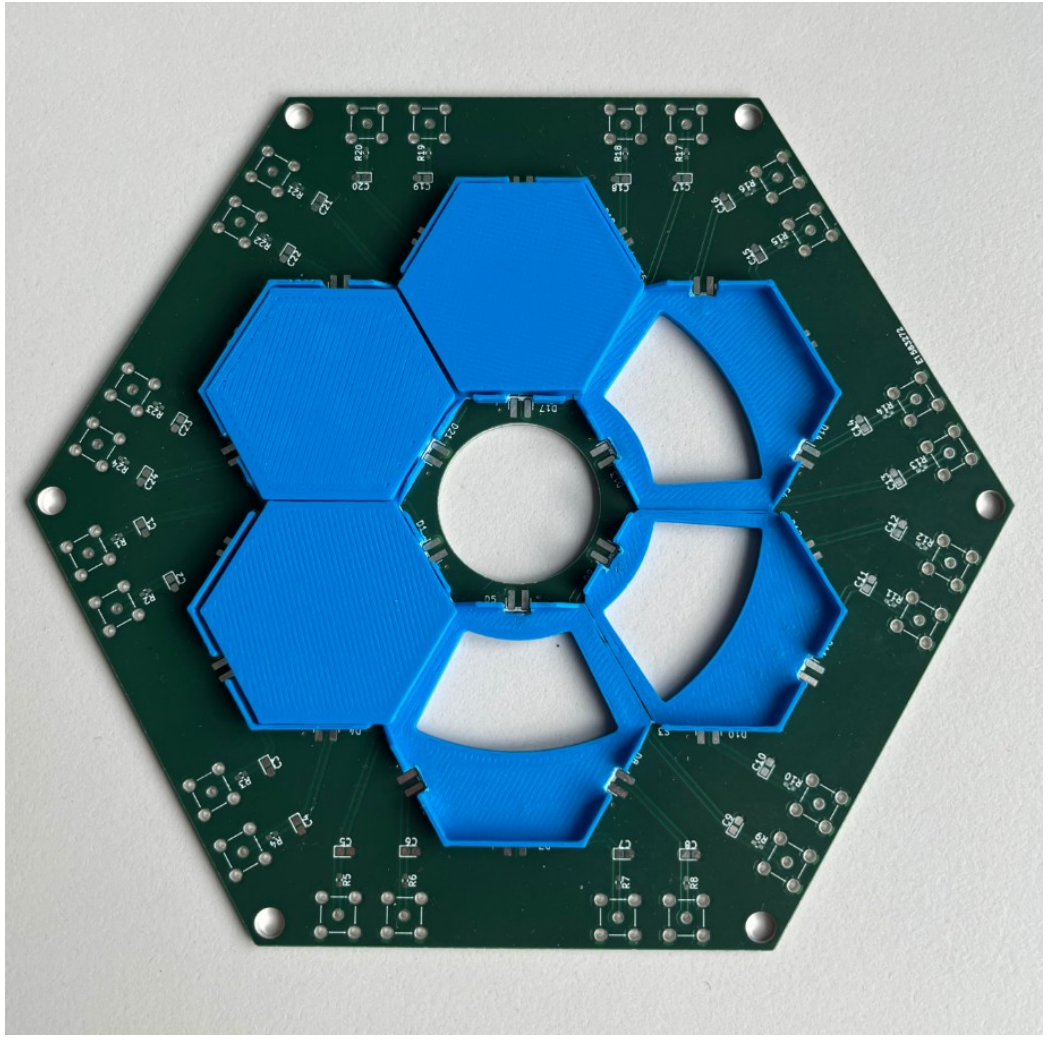

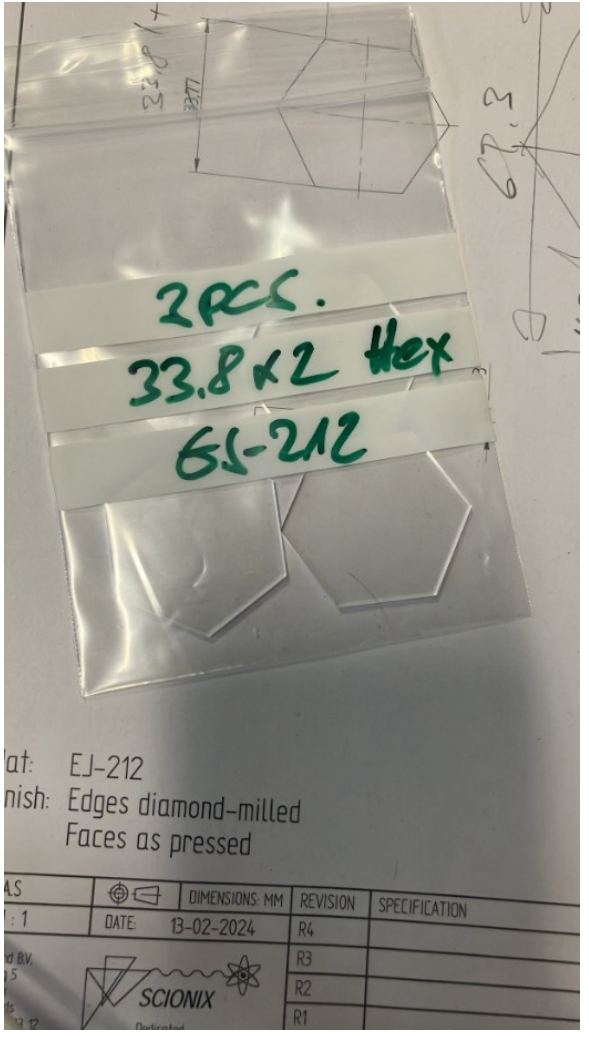
2 PCS.
33.8 x 2 Hex
EJ-212
EJ-212
Edges diamond-milled
Faces as pressed
DIMENSIONS: MM
REVISION
SPECIFICATION
DATE: 13-02-2024
R4
R3
R2
R1
SCIONIX

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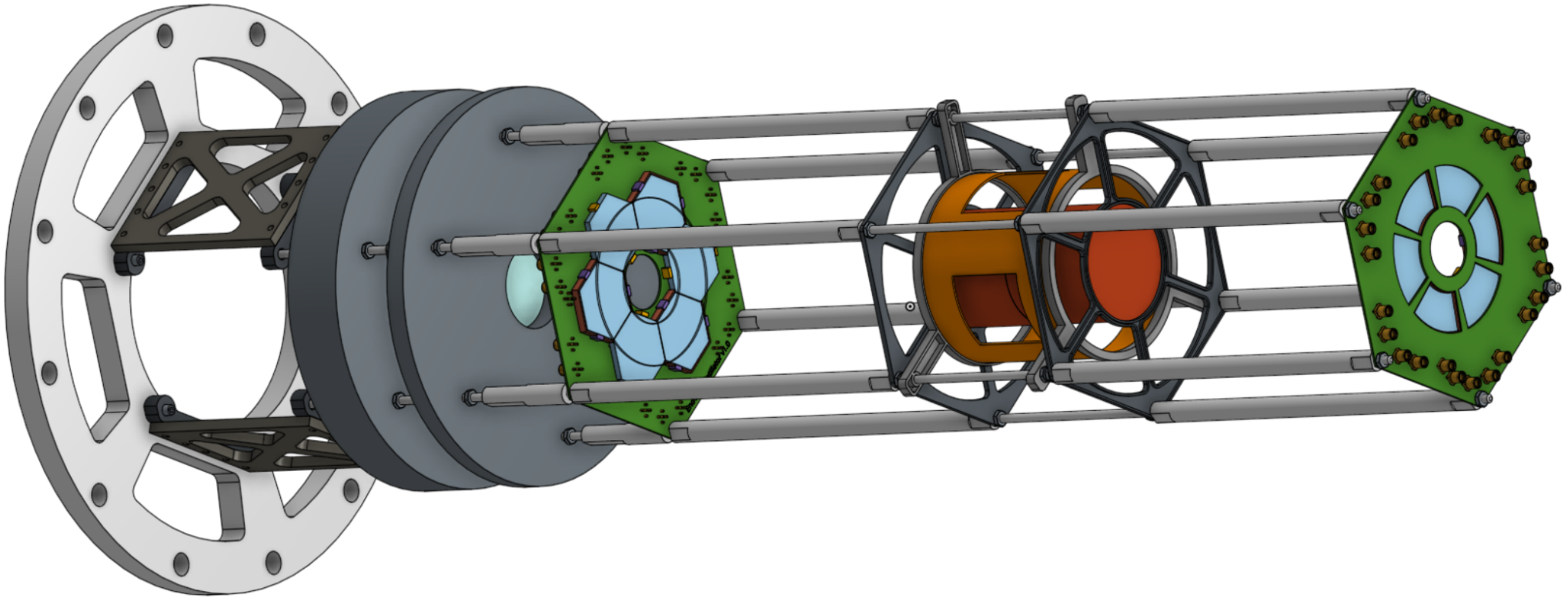
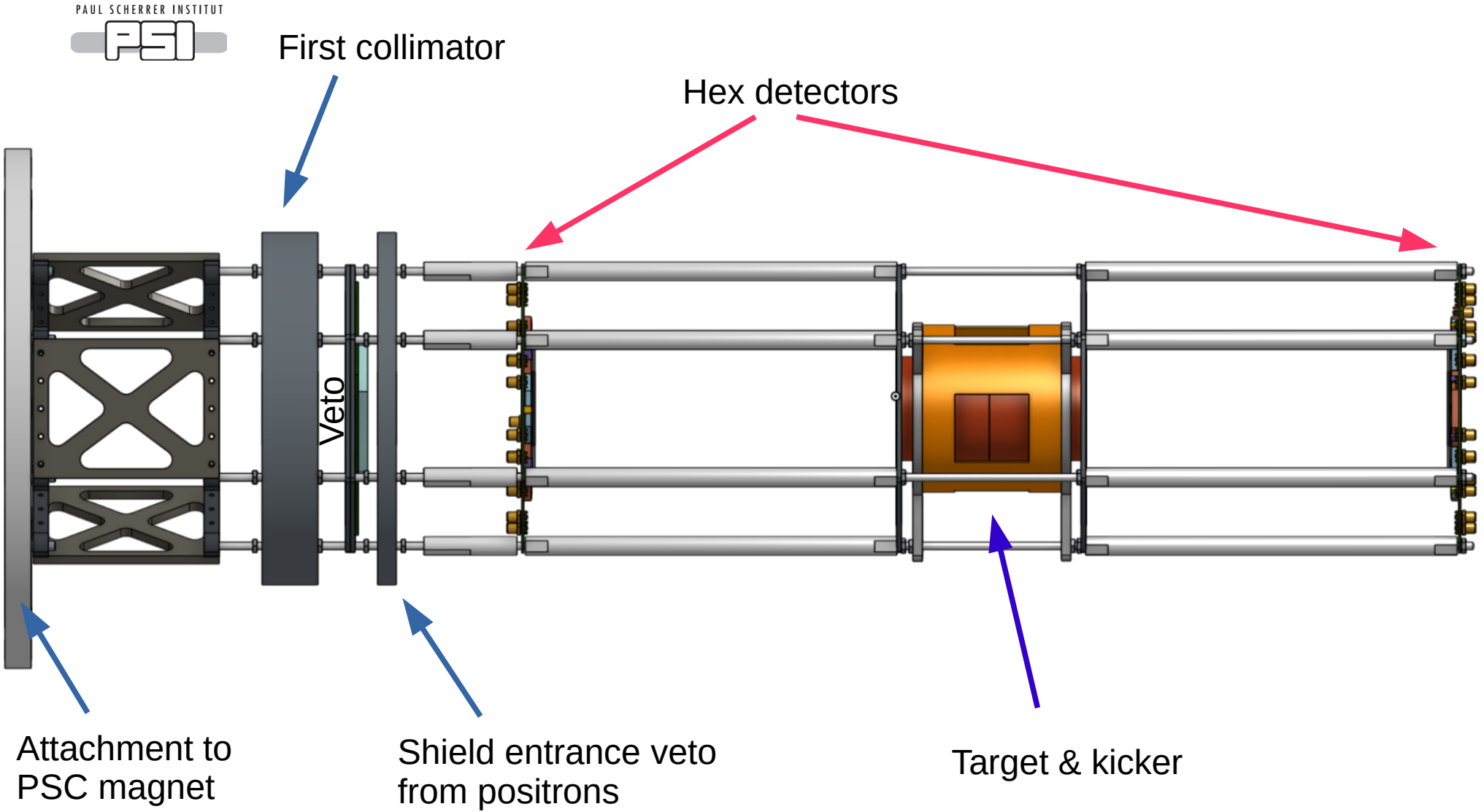
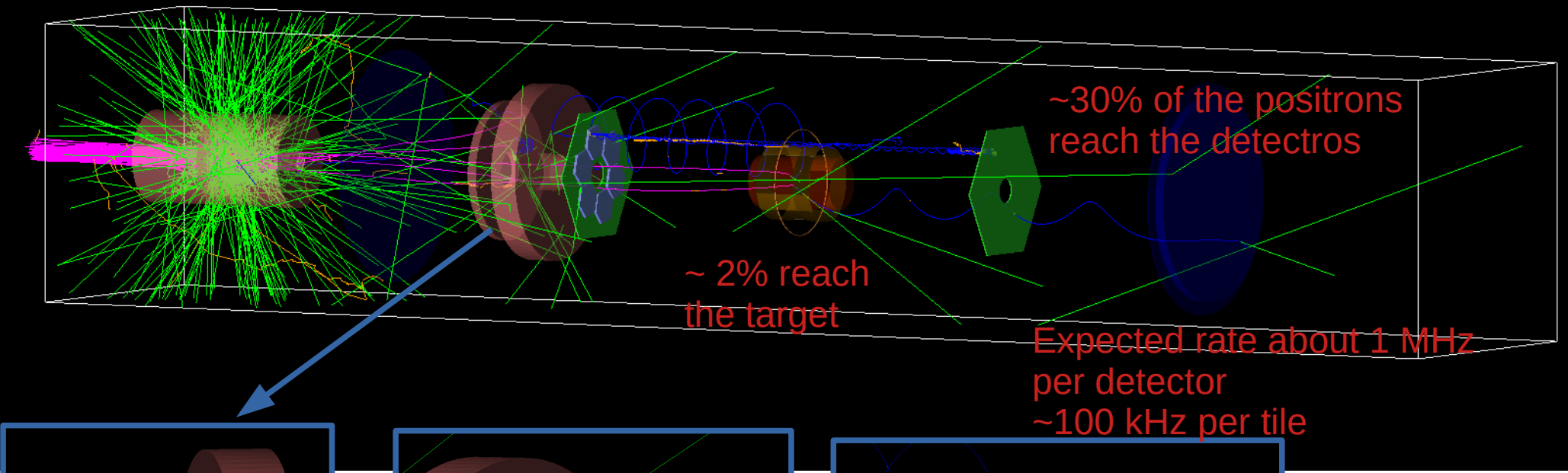
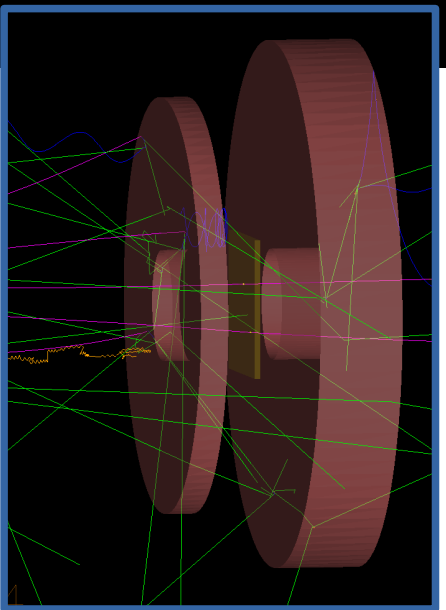
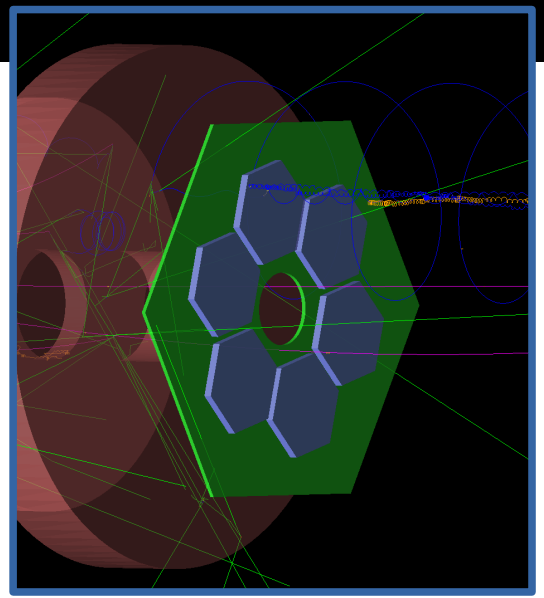
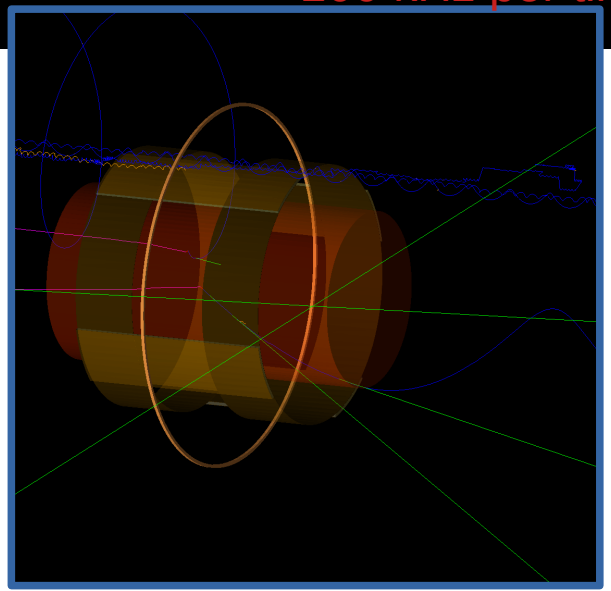


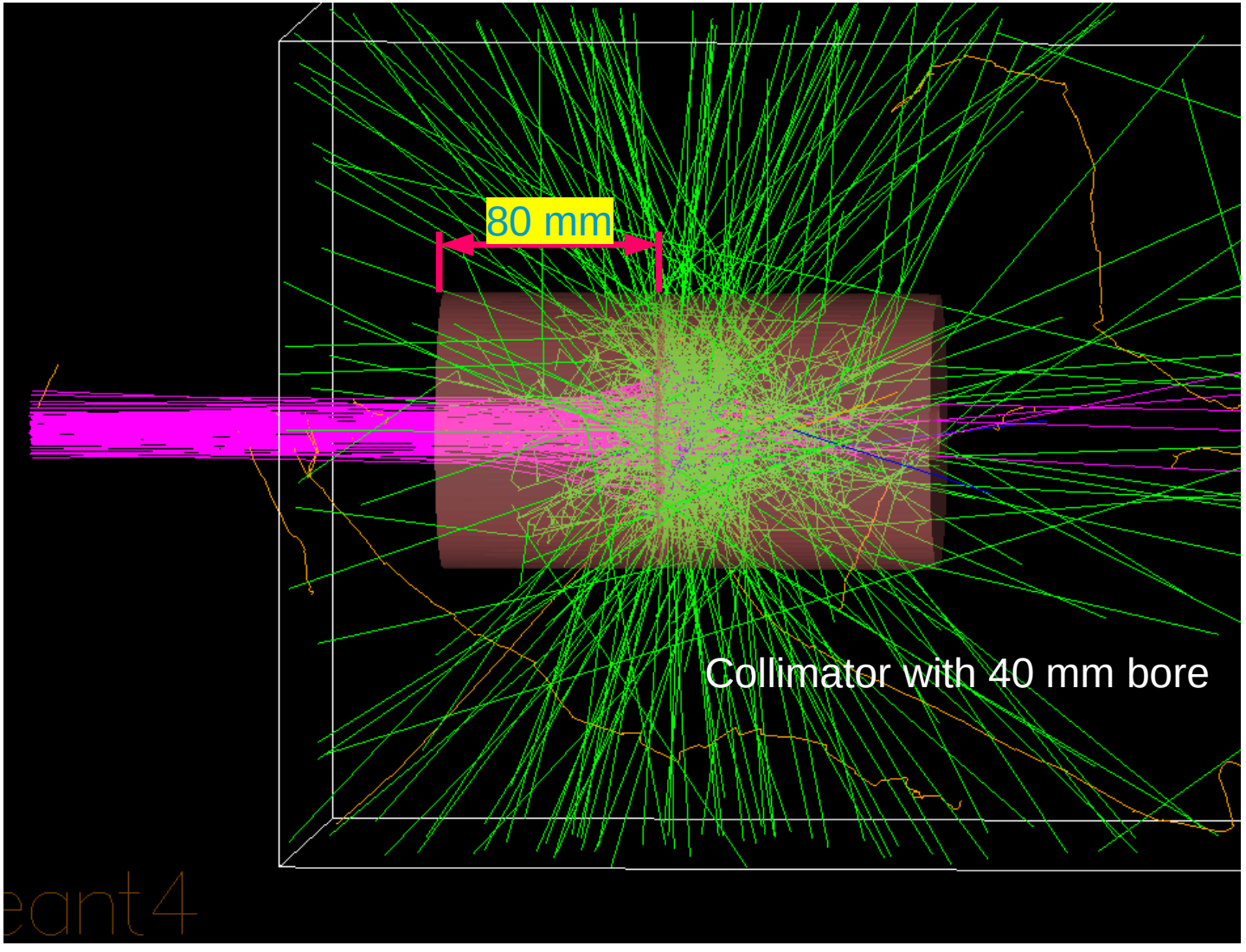

First collimator
Hex detectors
Veto
Attachment to
PSC magnet
Shield entrance veto
from positrons
Target & kicker


~30% of the positrons
reach the detectros
~ 2% reach
the target
Expected rate about 1 MHz
per detector
~100 kHz per tile








80 mm
Collimator with 40 mm bore

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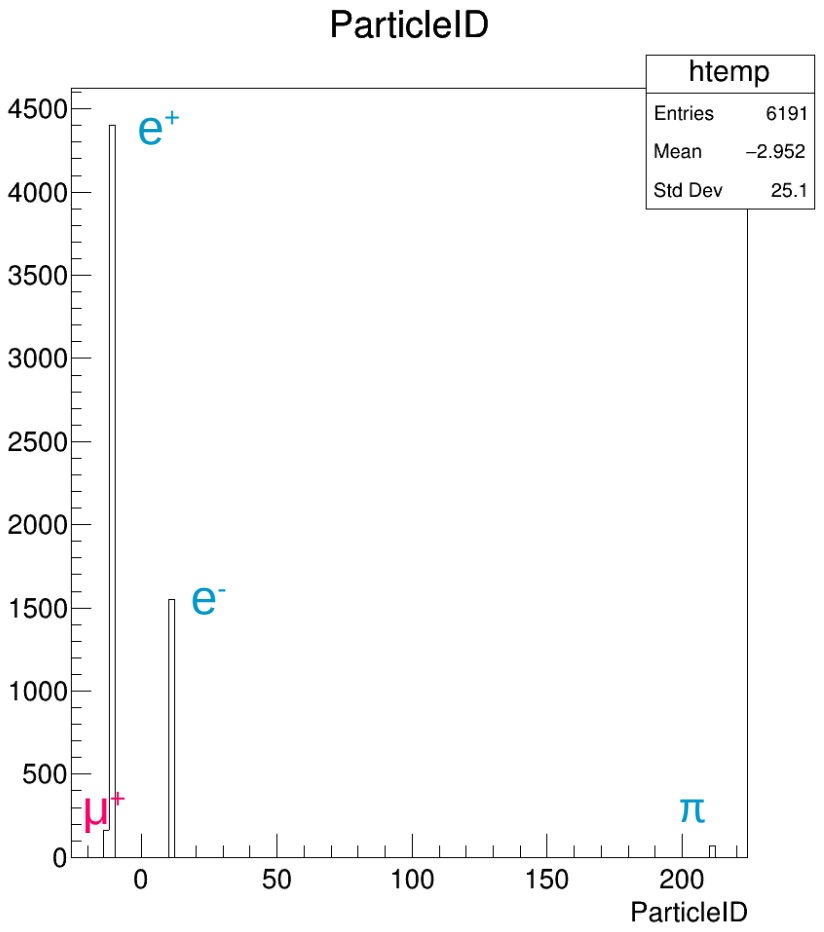
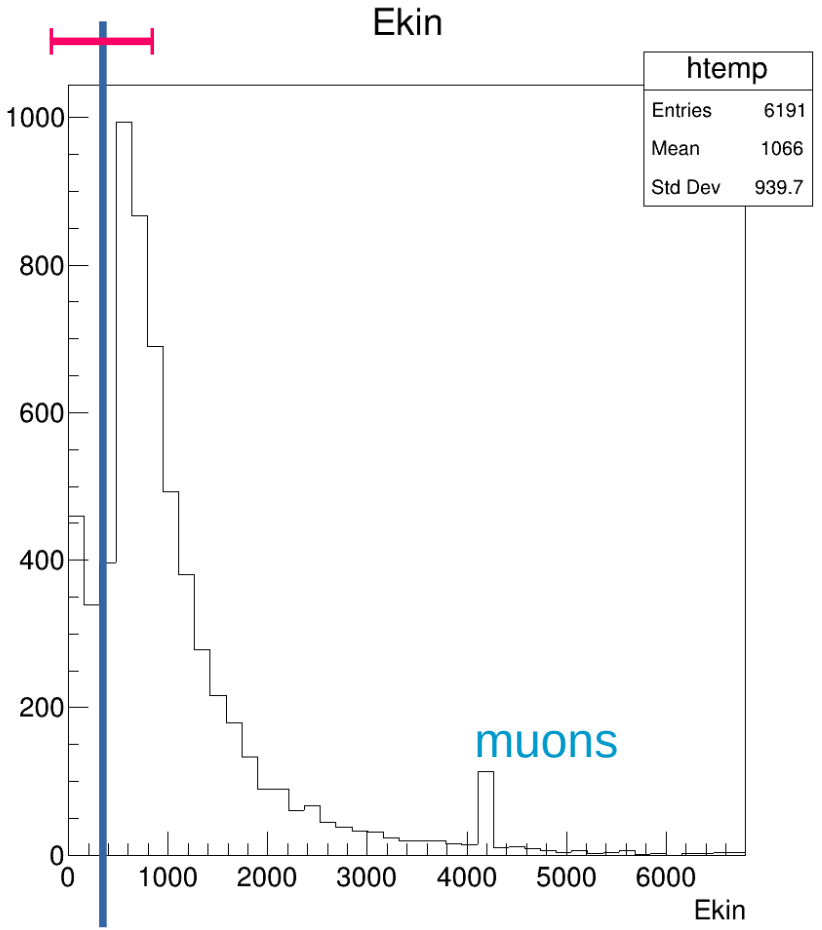
Particles hitting the detectos after veto:



Variation of the thresholds we place might be an issue that can be tested in the beamtime



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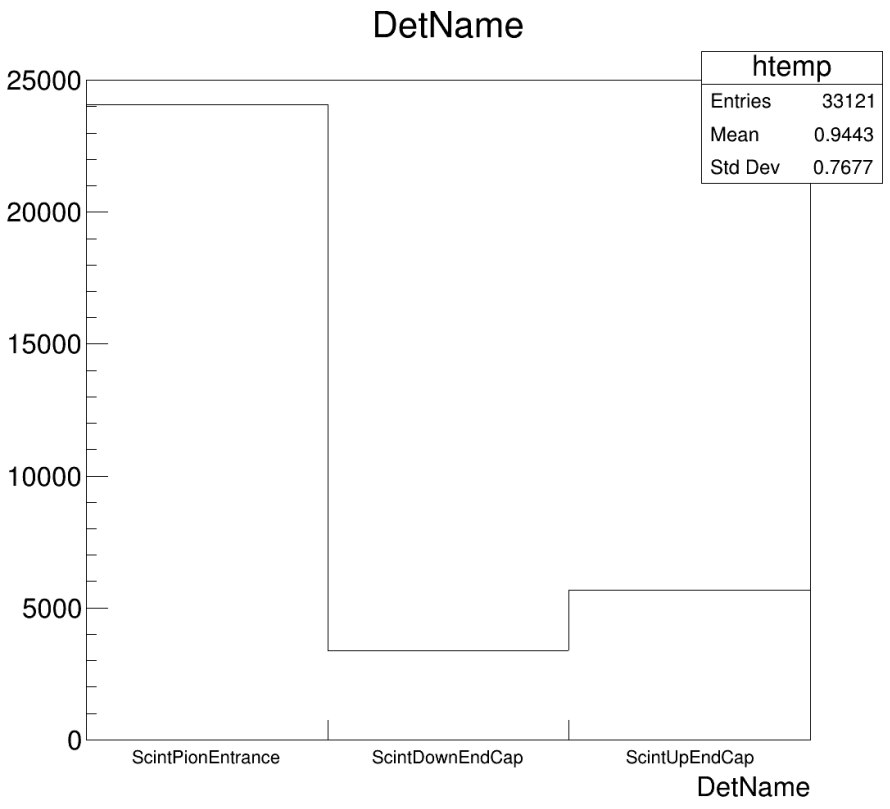
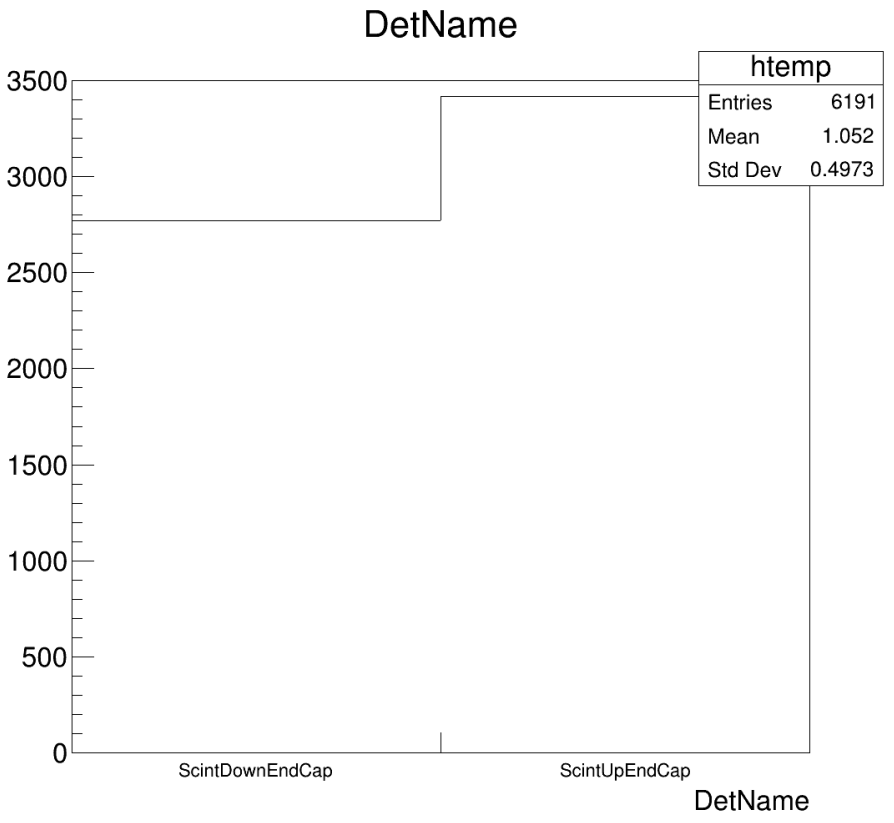
Without Veto



With Veto



- From 1e6 pions we get 3000 positrons per detector.
- This is about 0.3% efficiency.
- About 1.2 MHz rate per detector or 200 kHz per scintillation tile.
- **Short term plans:**
  - ~~Optimize veto/collimators to improve symmetry between up/down stream detectors.~~
  - Test the PCB board with WaveDream and tiles that are already cut.
  - Start with procurement of mechanical construction