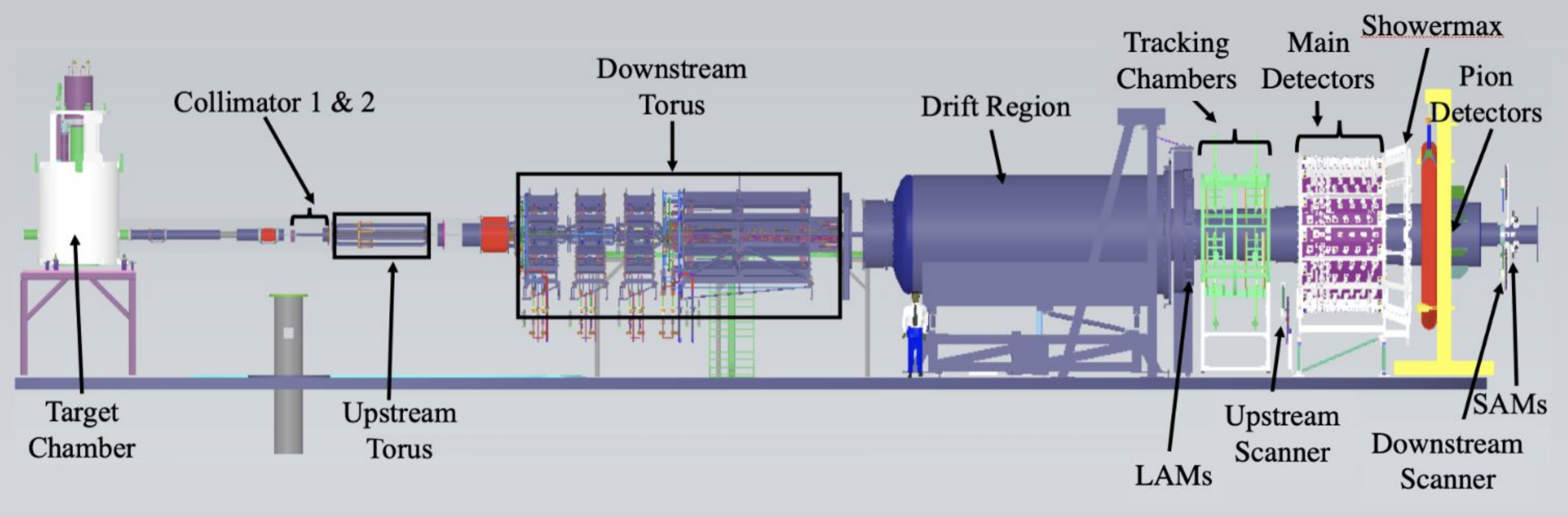
MOLLER Hardware Overview

James Shirk



Collimator 1 & 2
Downstream
Torus
Drift Region
Tracking
Chambers
Main
Detectors
Showermax
Pion
Detectors
Target
Chamber
Upstream
Torus
LAMs
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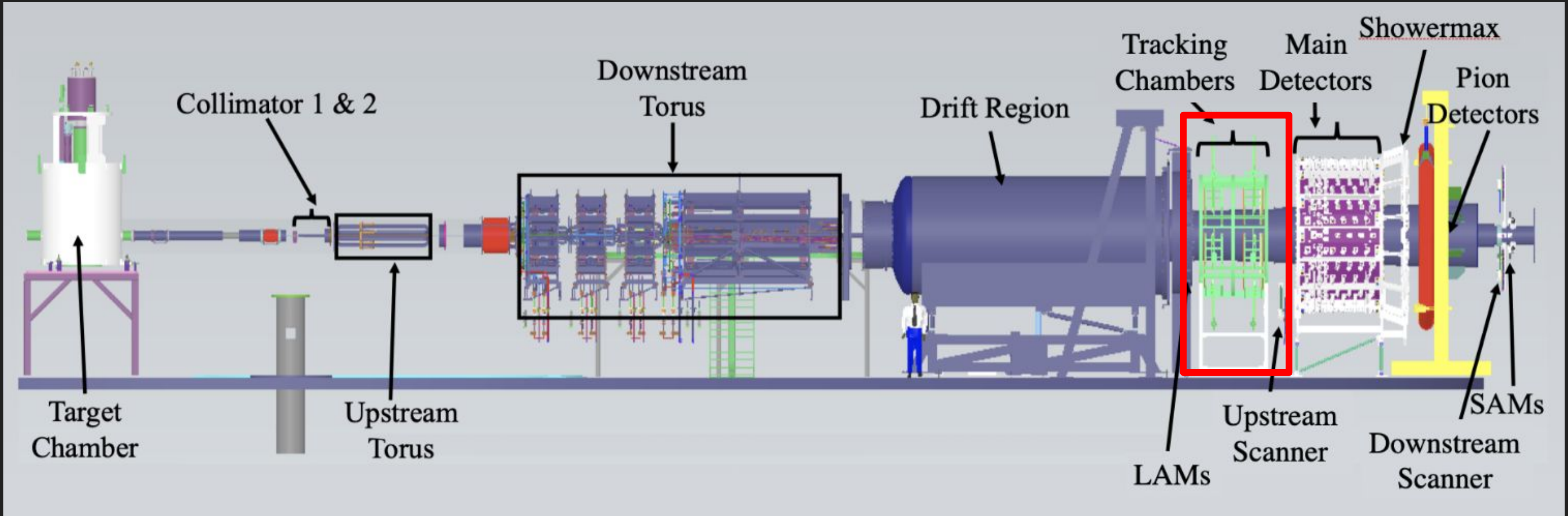
Scanner
Downstream
Scanner
SAMs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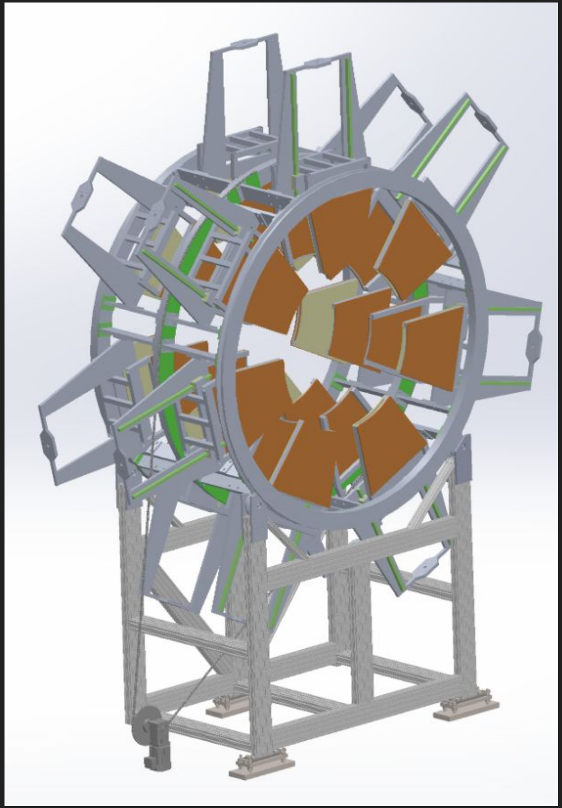
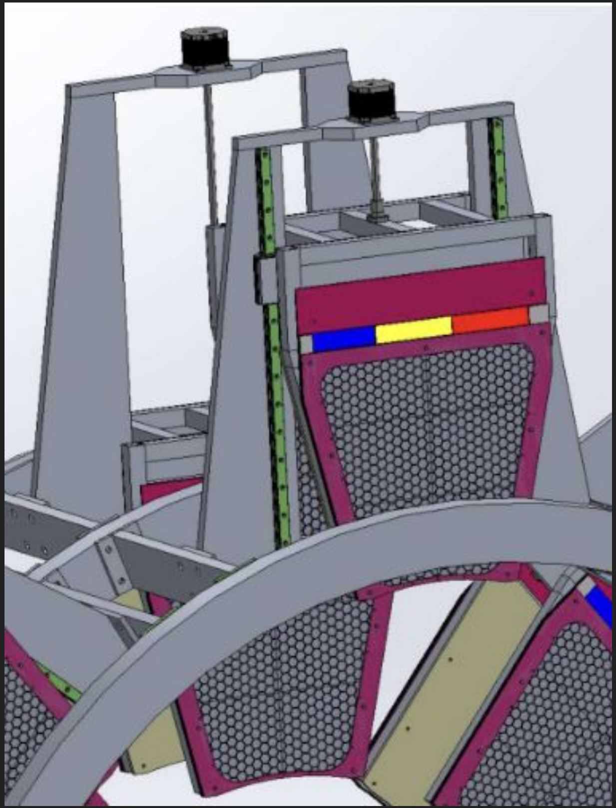
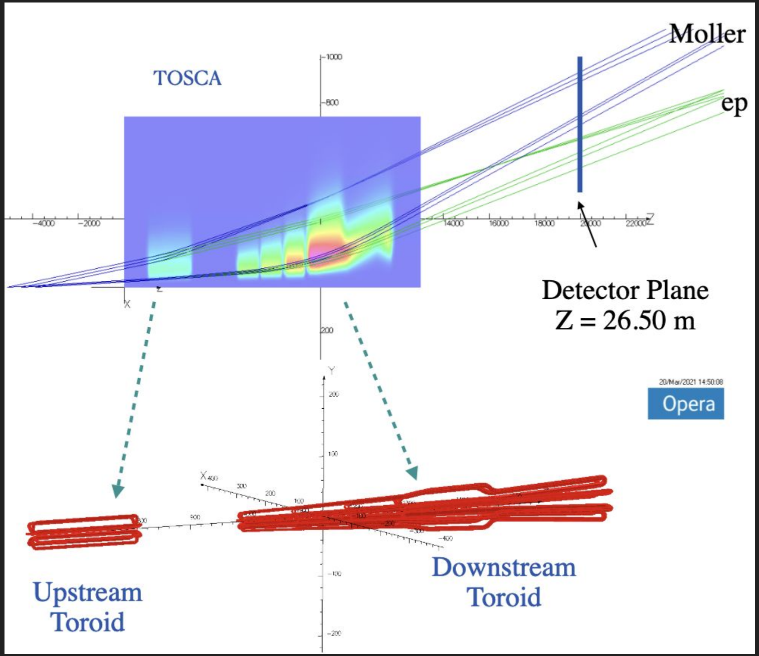
Tracking detector





Why?

1. Verify acceptance of toroid magnets
2. Verify main (quartz) detector acceptance
3. Check if light output of quartz is position dependent
4. Study backgrounds



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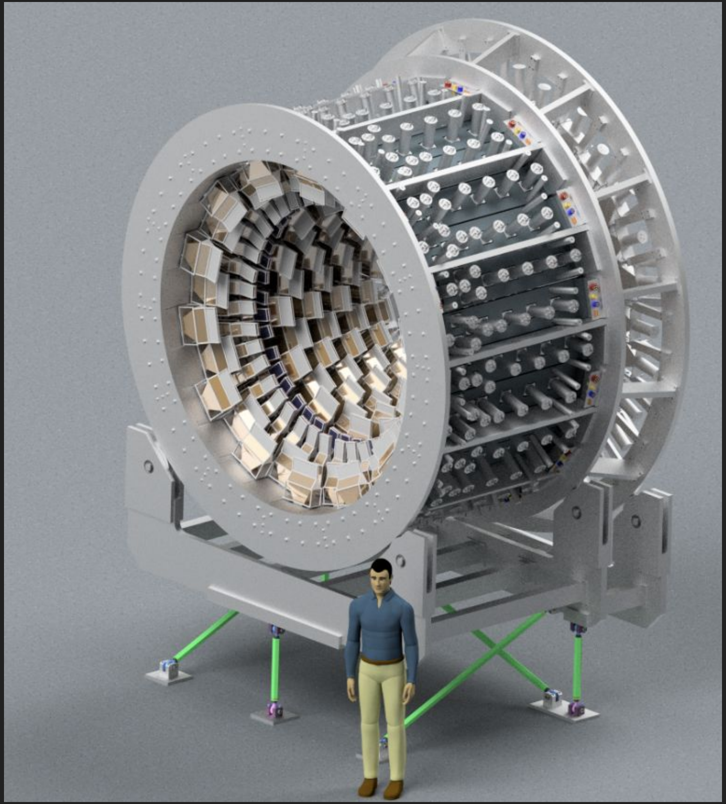

$$\mathcal{A} \equiv \frac{mG_F}{\sqrt{2}\pi\alpha} \frac{4E\sin^2\theta}{(3+\cos^2\theta)^2}$$

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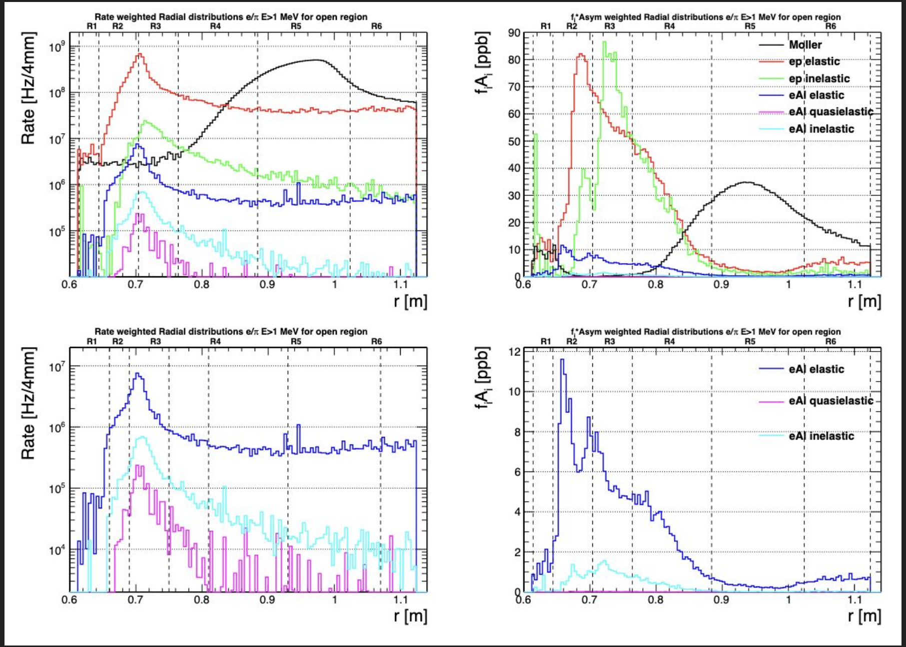

Two modes of operation

Counting Mode

- Can discern individual PMT 'counts' in the quartz detector
- Calibration mode
- Beam current O(10 nA)
- A portion will run with thin carbon targets instead of LH2
  - Verify vertex reconstruction
- GEM trackers used

Integration Mode

- Rate is high enough that PMT pulses overlap, measure 'integrated' voltage instead
- Data mode
- Beam current O(10 μA)
- GEM trackers will be taken out of acceptance

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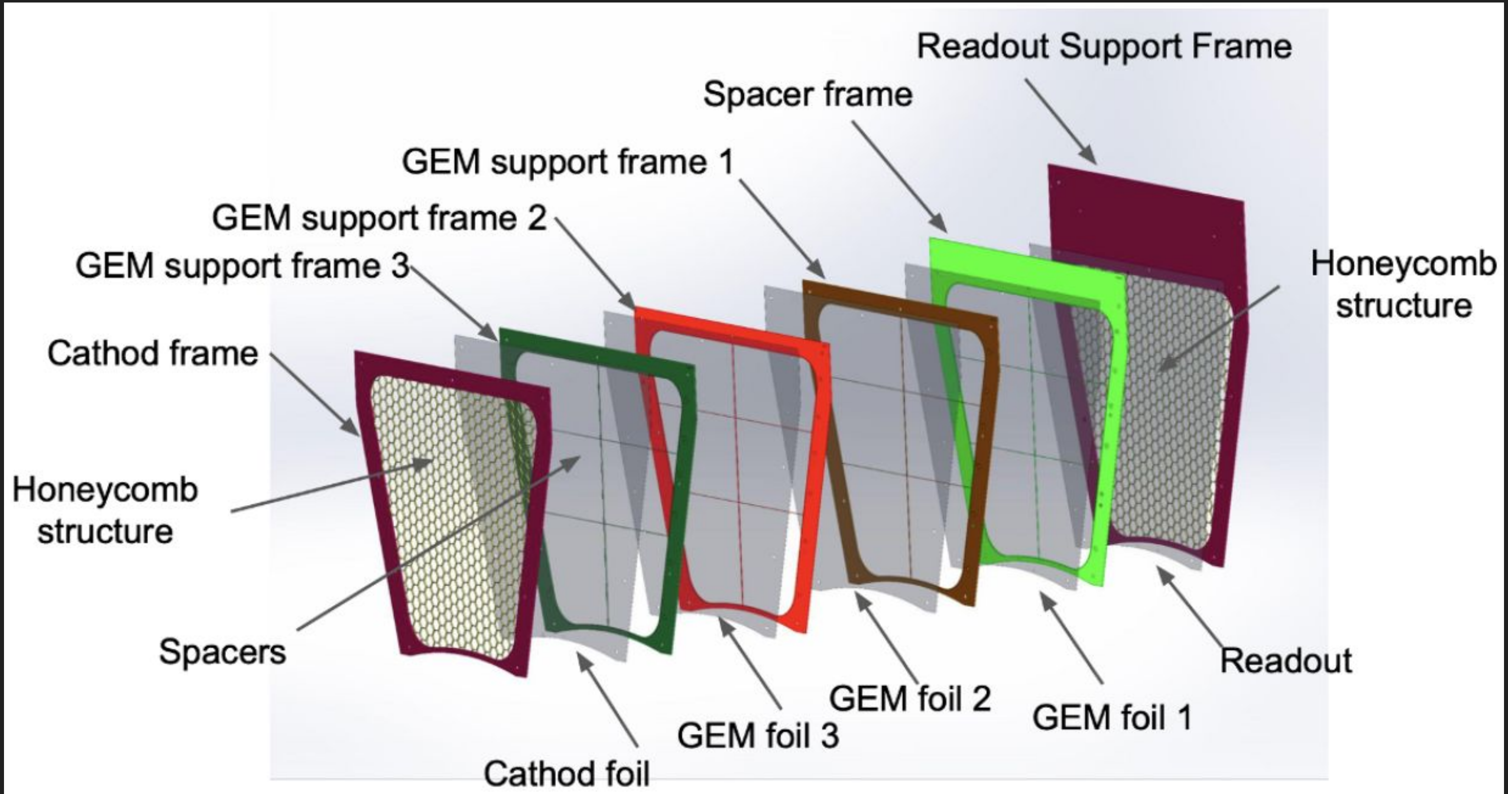
GEM CAD blowout



Run Several Tests

Leakage current

1. Do GEM foils have adequate resistance?
2. Does this resistance change over time?
3. How often do they discharge?

Gain Analysis

1. How does the gain vary over the position of the detector?
2. Are any areas in our detector likely to be inefficient?
3. How does the gain change with voltage?

Efficiency

1. Is our detector sensitive to ionizing particles?
2. What is the probability that an ionizing particle will pass through and be detected?

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How Tests are Run

Leakage current

1. Put GEM in N2
2. Apply voltage between top and bottom
3. Measure current on picoammeter

Gain Analysis

1. Put GEM in X-Ray box
2. Bring GEM to voltage
3. Vary X-Ray position or detector and take measurements

Efficiency

1. Use three scintillators to trigger detector
2. Measure how many of the scintillator counts correspond to hit in detector

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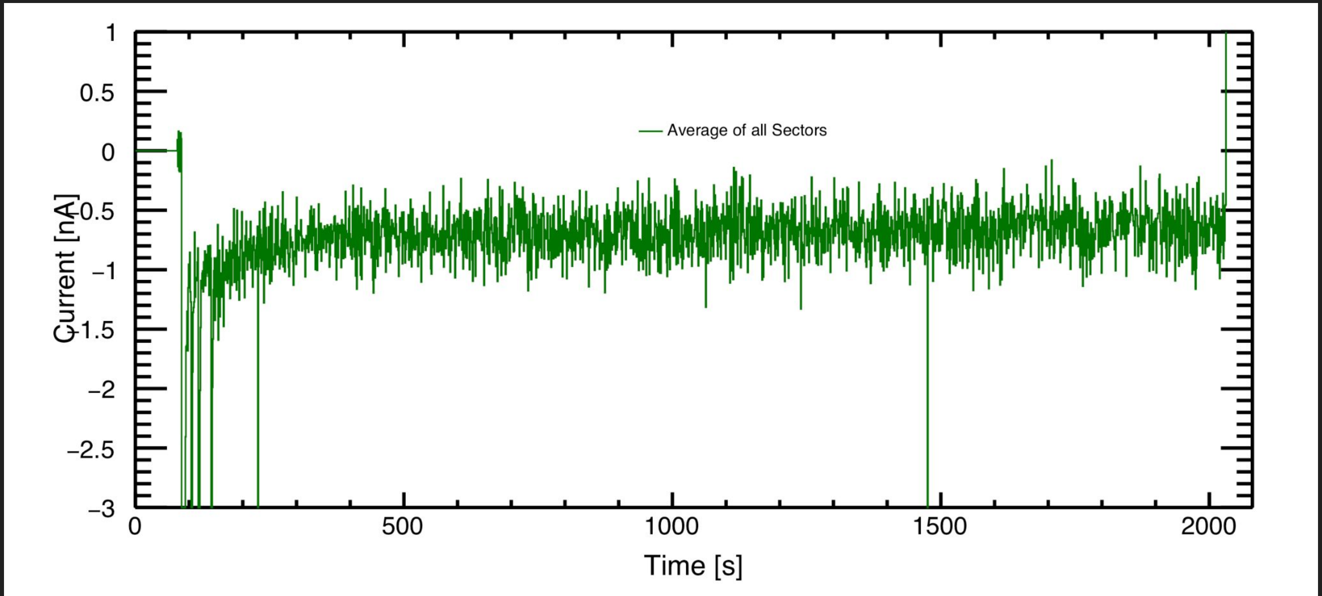

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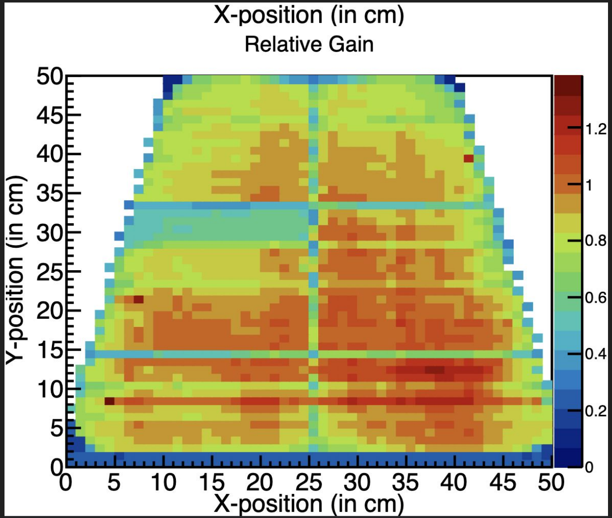

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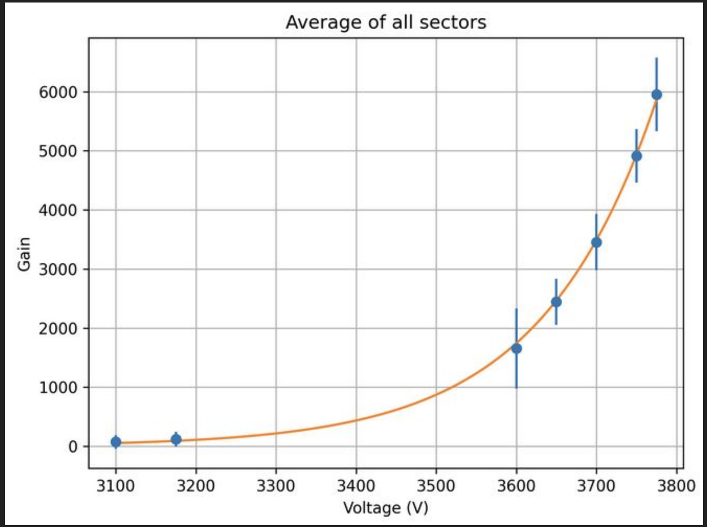

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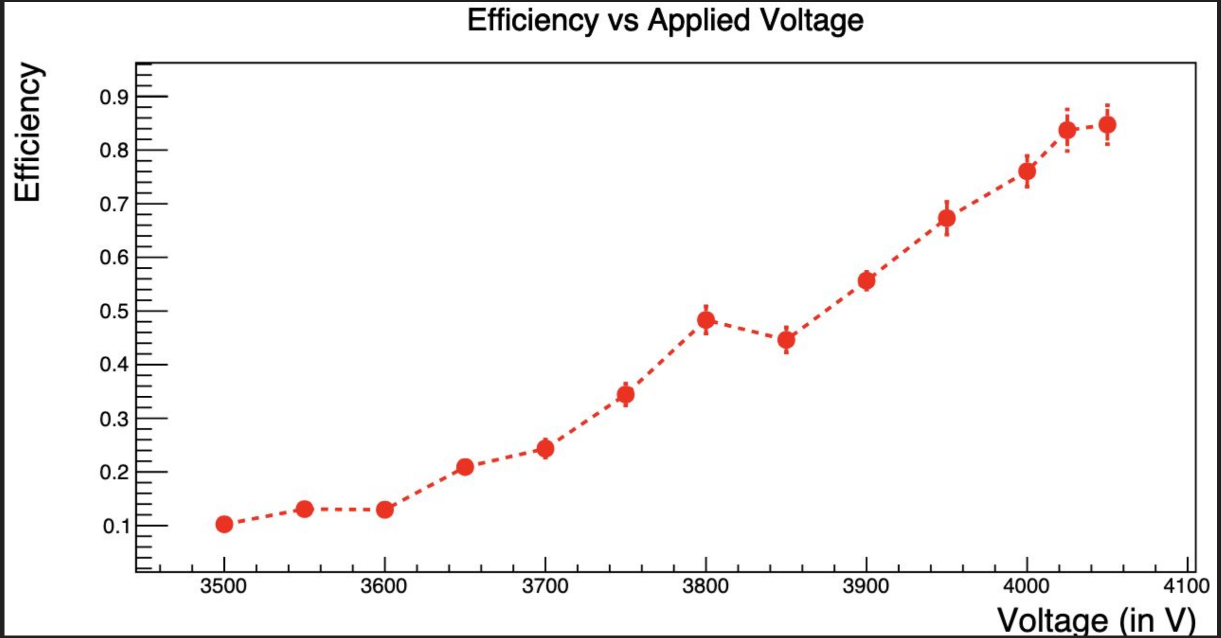

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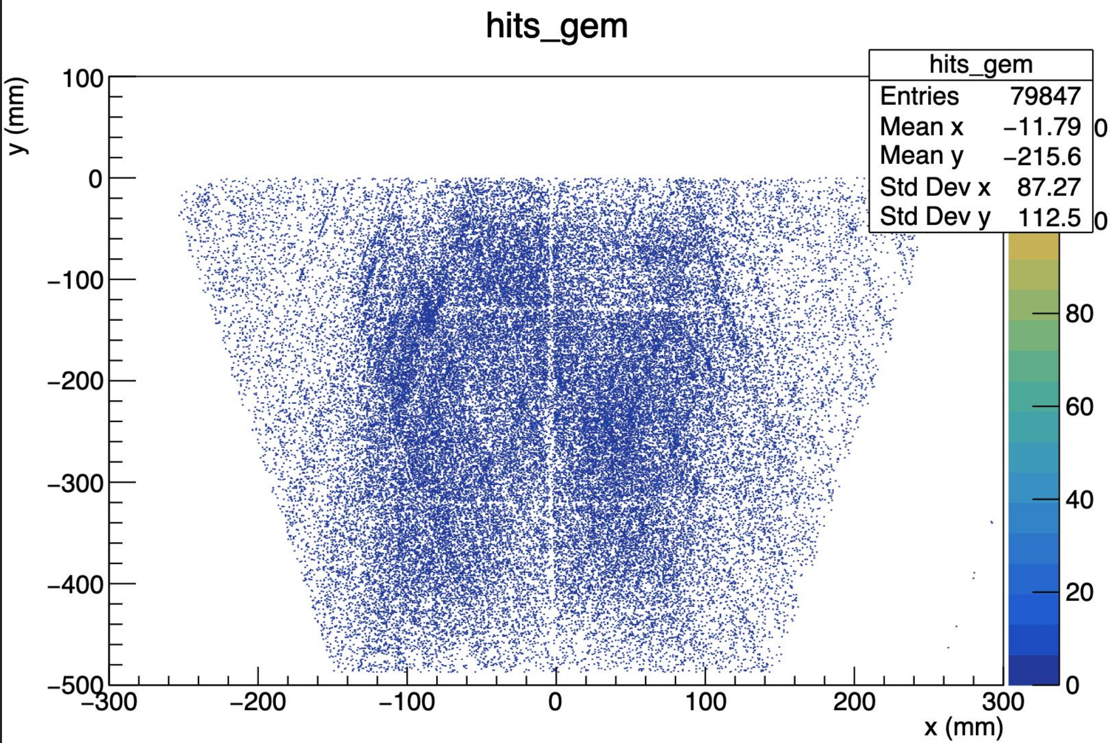

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Parameters of the Standard Model [hide]

#	Symbol	Description	Renormalization scheme (point)	Value
1	m_e	Electron mass		0.511 MeV
2	m_μ	Muon mass		105.7 MeV
3	m_τ	Tau mass		1.78 GeV
4	m_u	Up quark mass	$\mu_{\overline{MS}} = 2$ GeV	1.9 MeV
5	m_d	Down quark mass	$\mu_{\overline{MS}} = 2$ GeV	4.4 MeV
6	m_s	Strange quark mass	$\mu_{\overline{MS}} = 2$ GeV	87 MeV
7	m_c	Charm quark mass	$\mu_{\overline{MS}} = m_c$	1.32 GeV
8	m_b	Bottom quark mass	$\mu_{\overline{MS}} = m_b$	4.24 GeV
9	m_t	Top quark mass	On shell scheme	173.5 GeV
10	θ_{12}	CKM 12-mixing angle		13.1°
11	θ_{23}	CKM 23-mixing angle		2.4°
12	θ_{13}	CKM 13-mixing angle		0.2°
13	δ	CKM CP violation Phase		0.995
14	g_1 or g'	U(1) gauge coupling	$\mu_{\overline{MS}} = m_Z$	0.357
15	g_2 or g	SU(2) gauge coupling	$\mu_{\overline{MS}} = m_Z$	0.652
16	g_3 or g_s	SU(3) gauge coupling	$\mu_{\overline{MS}} = m_Z$	1.221
17	θ_{QCD}	QCD vacuum angle		~0
18	v	Higgs vacuum expectation value		246 GeV
19	m_H	Higgs mass		125.09 ±0.24 GeV