A Search for Right-Handed Currents in ^{37}K β-Decay

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The TRINAT Collaboration:

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[1] University of Manitoba
[2] TRIUMF
[3] Tel Aviv University
[4] Cyclotron Institute, Texas A&M University

The Decay Process

- Goal: Search for new physics.
  - Sensitive to right-handed currents, scalar/tensor currents, etc.

Isobaric analog decay minimizes nuclear structure corrections.

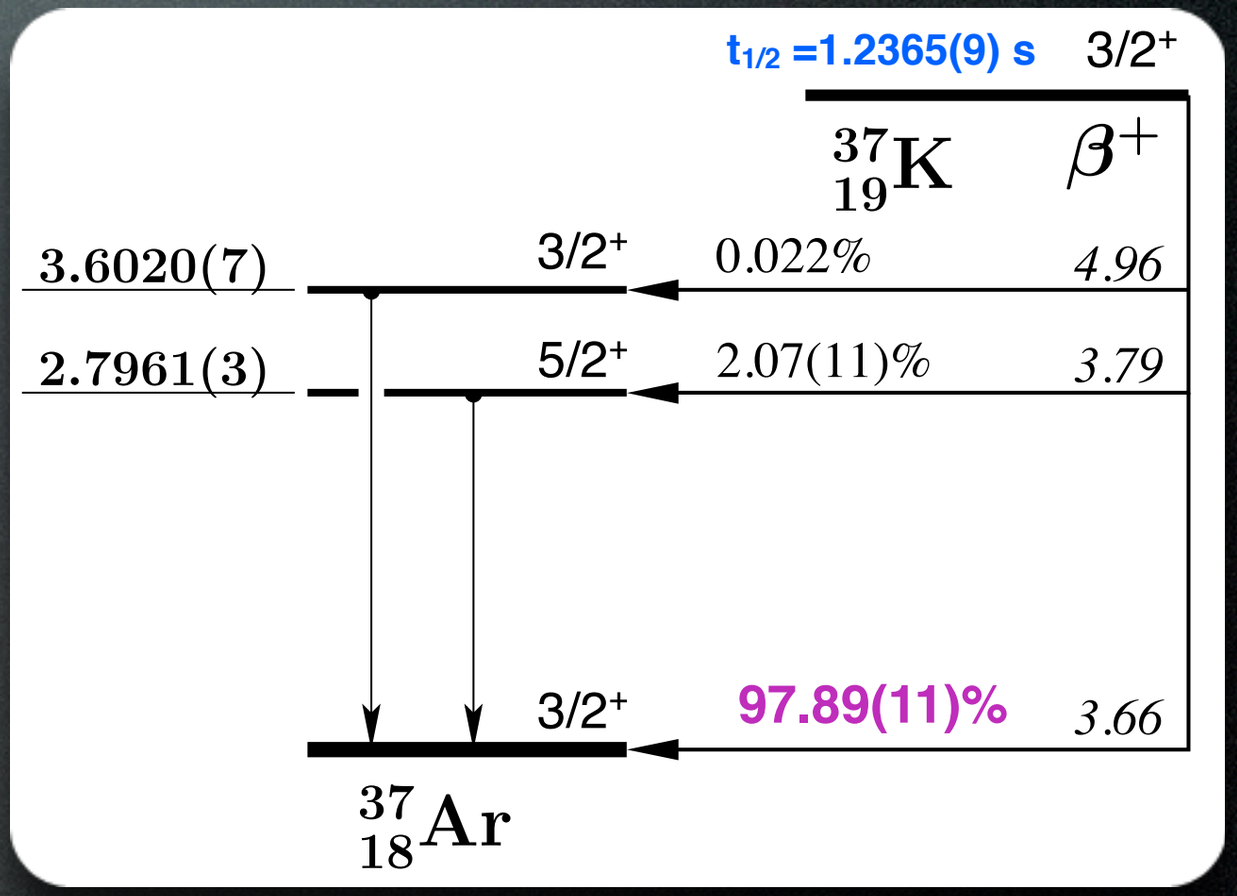


Diagram (mostly) courtesy of D. Melconian

- $^{37}K \rightarrow {}^{37}Ar + \beta^+ + \nu$
- 97.99(14)% branch:
  - $G_A M_{GT} / G_V M_F = 0.560^{+24}_{-29}$ [1]

[1] P. Shidling et. al, 2014

An Observable?

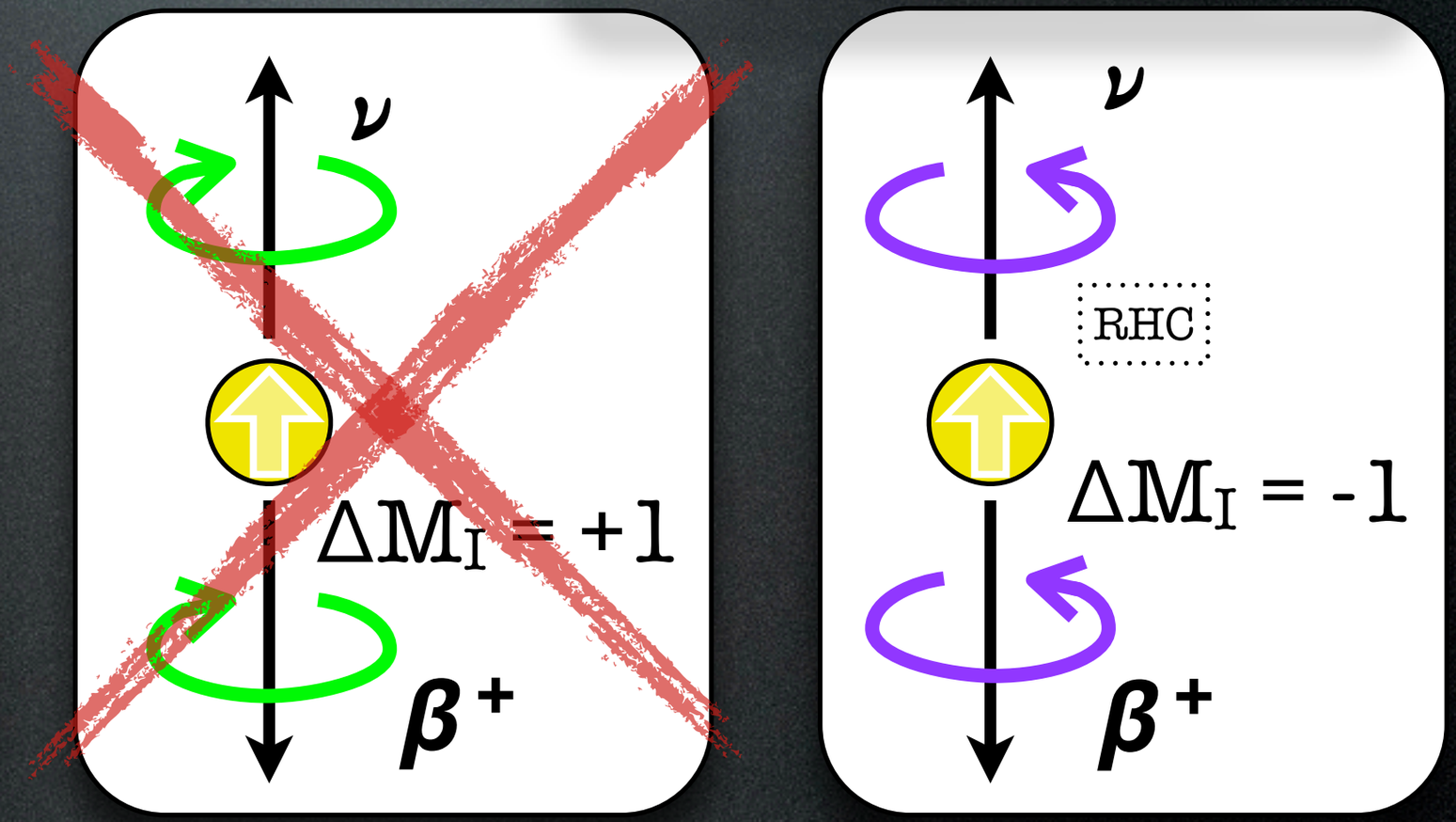
$$W(\theta_{\beta\nu}) \sim 1 + \left(\frac{a_{\beta\nu} + \langle P \rangle B_\nu - \frac{2}{3} T c_{\text{align}}}{1 + \langle P \rangle A_\beta + \frac{m}{E} b_{\text{Fierz}}} \right) \cos\theta_{\beta\nu}$$

$$T \equiv \frac{I(I+1) - 3\langle (\vec{I} \cdot \hat{I})^2 \rangle}{I(2I-1)}$$

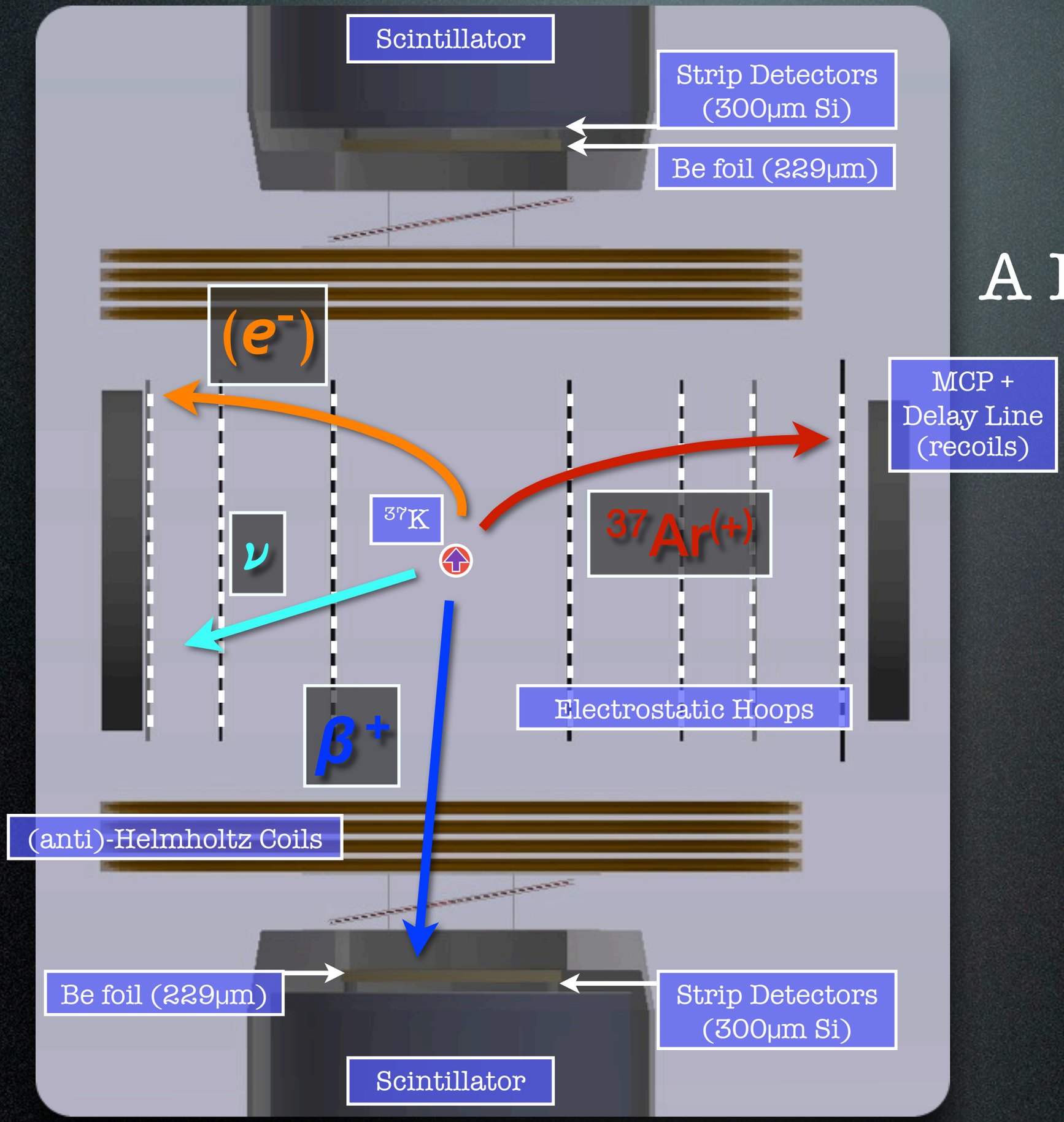
$$\langle P \rangle \equiv \frac{\langle I \rangle}{I}$$

In our geometry, the β momentum is very nearly parallel or antiparallel to the polarization direction.

$^{37}K \rightarrow {}^{37}Ar + \beta^+ + \nu$

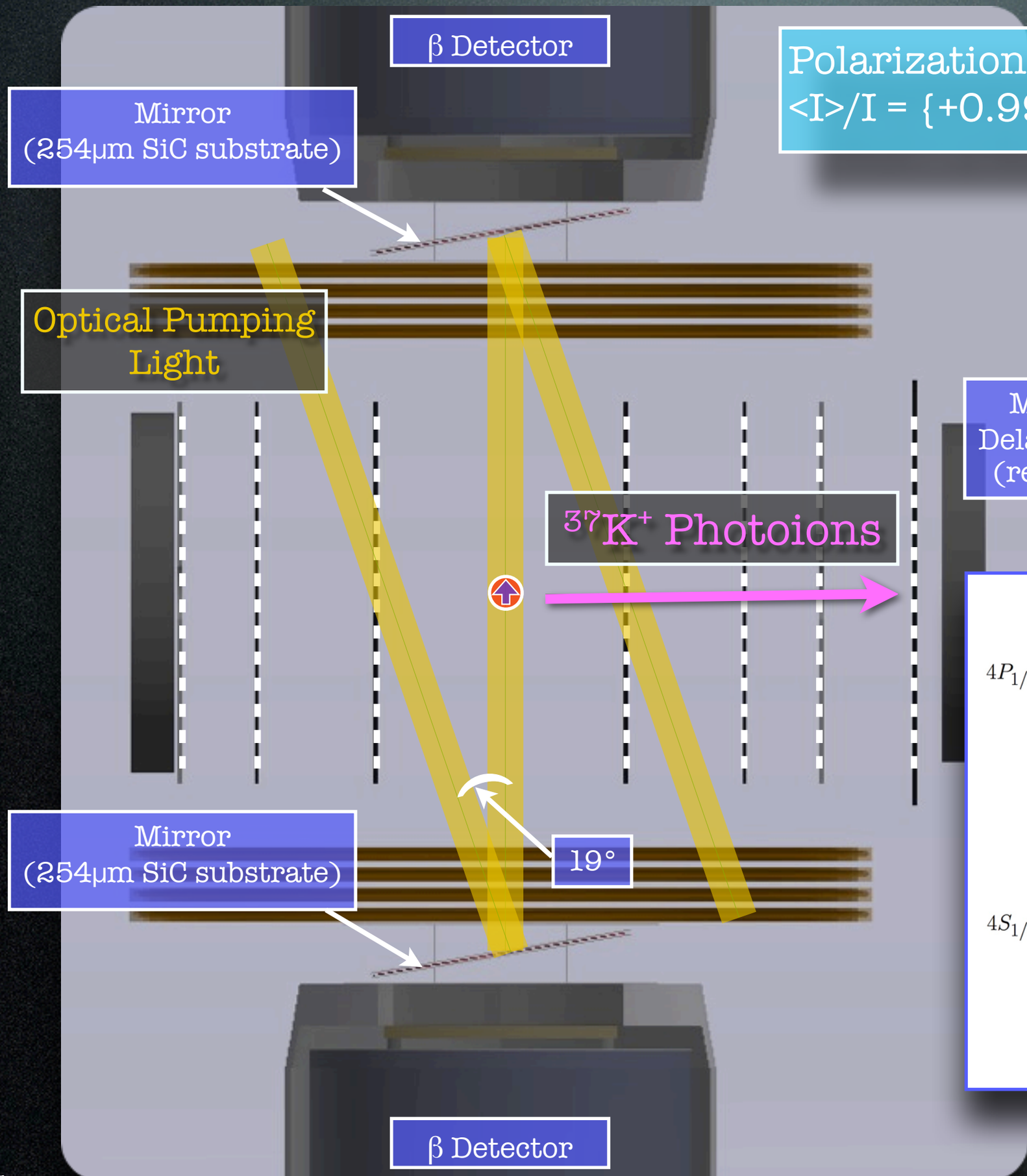


A Decay Event



Polarization

Polarization Achieved: [1][2]
$\langle I \rangle / I = \{+0.992(1), -0.992(1)\}$



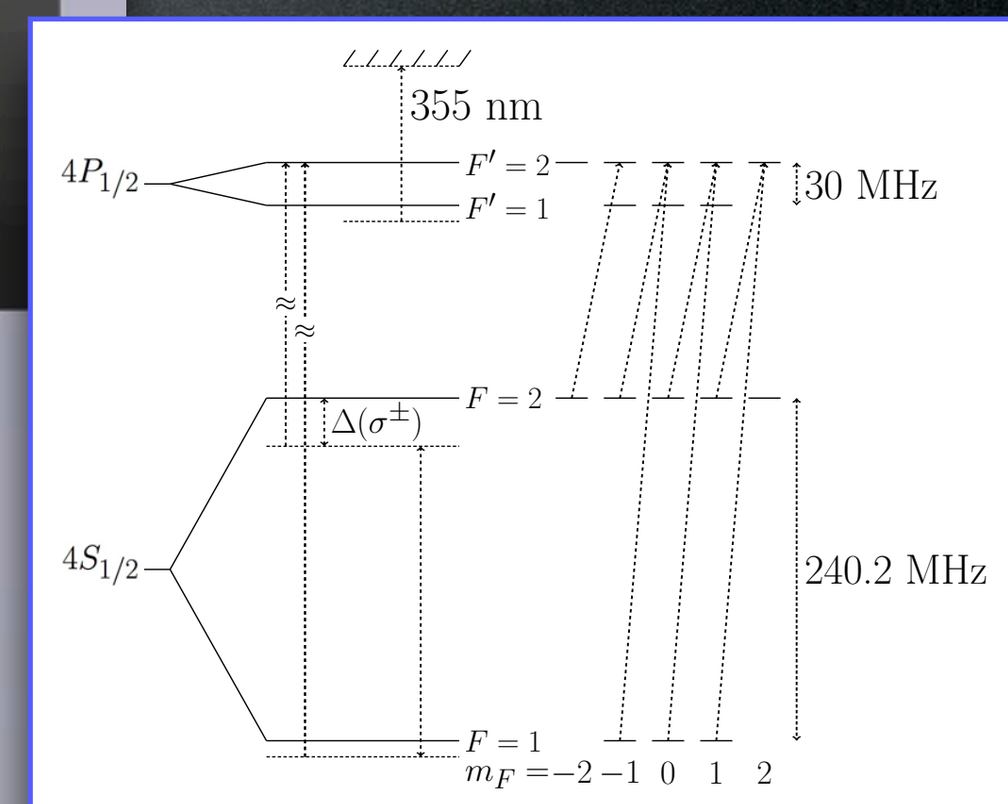
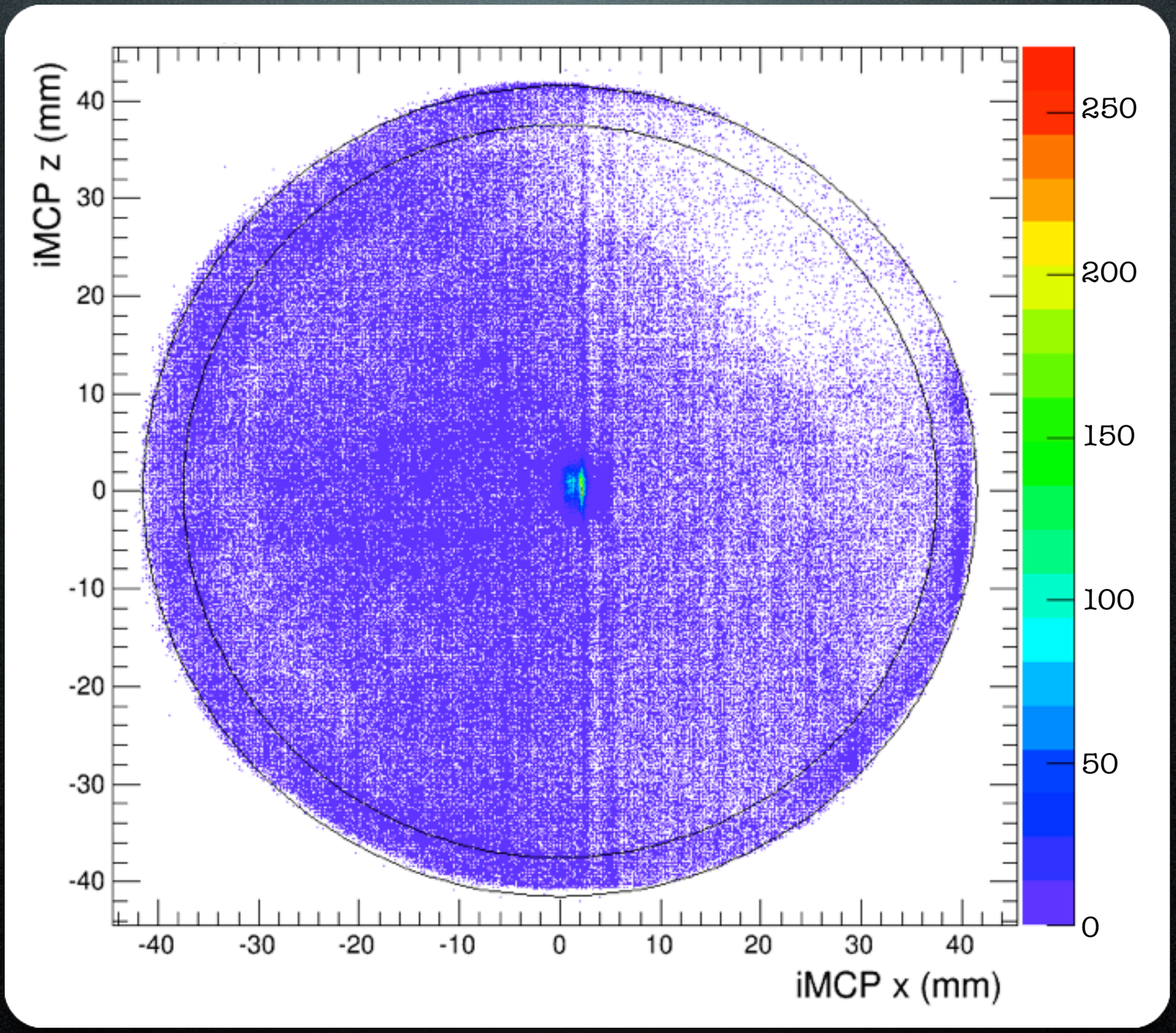


Diagram (mostly) courtesy of B. Fenker.

[1] B. Fenker et. al., in preparation.
[2] B. Fenker., SSP 2015



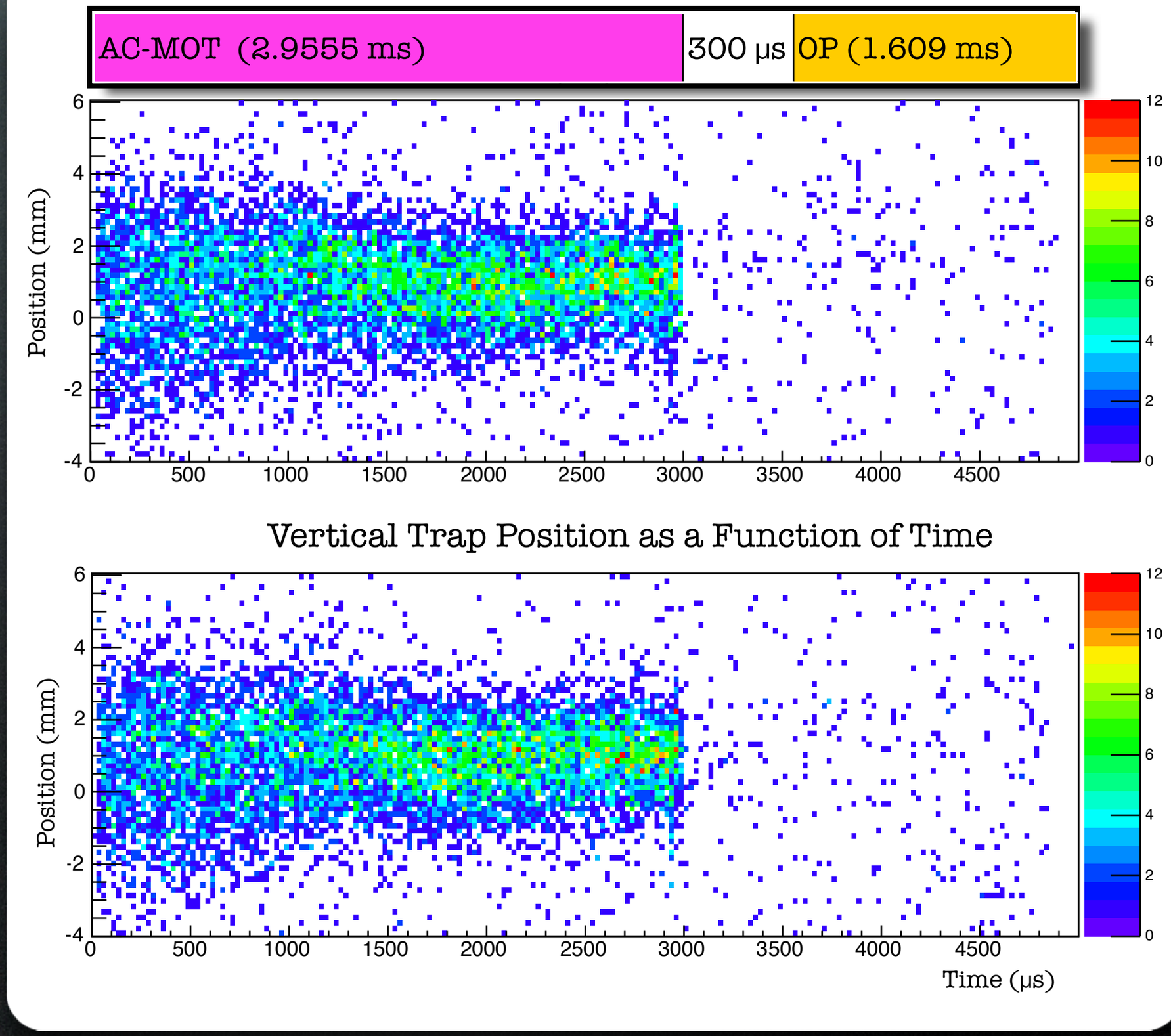
Calibrated Recoil Hit Position

Polarization State 1:

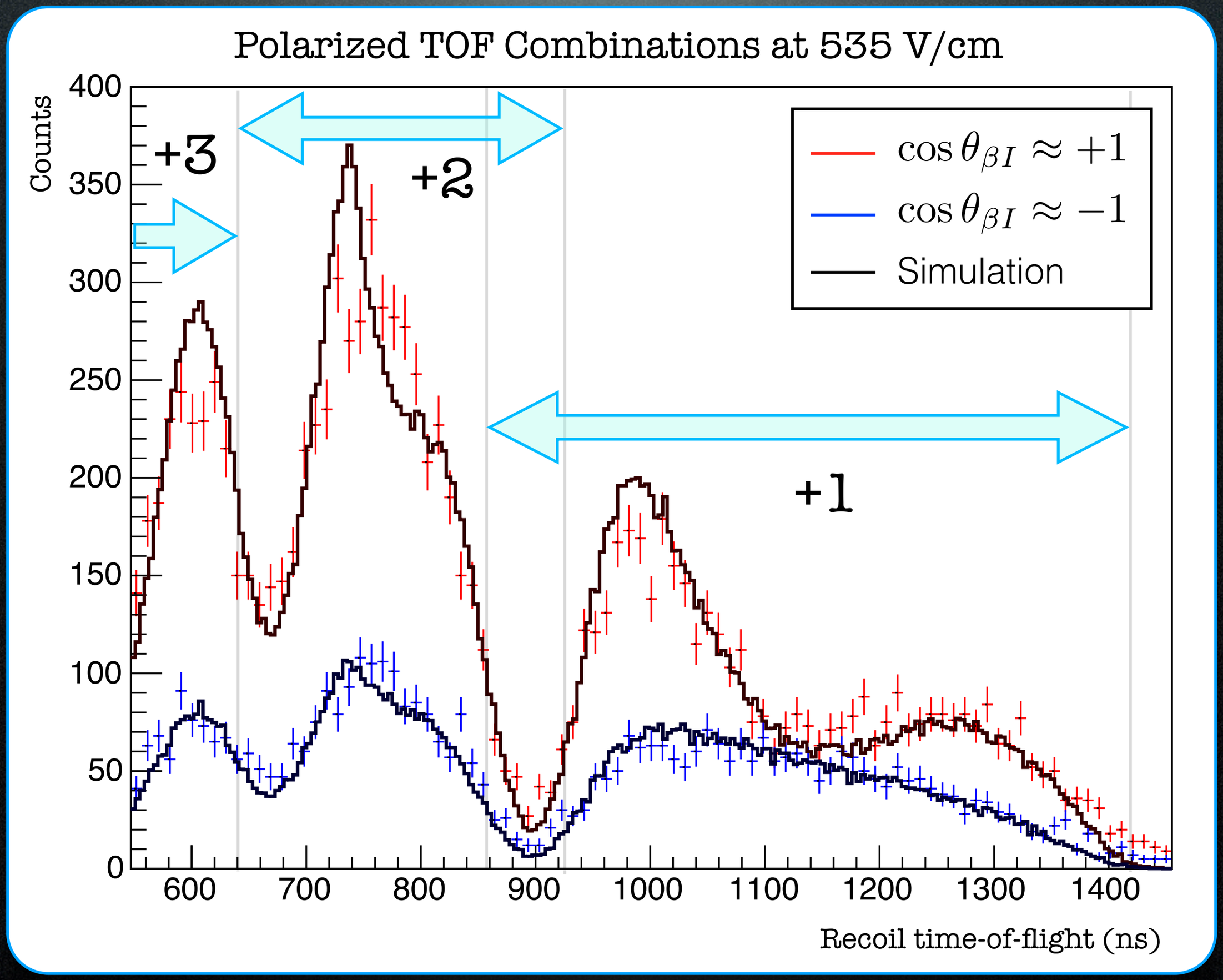
Centroid: 0.906 ± 0.013 mm
Width: 1.255 ± 0.012 mm

Polarization State 2:

Centroid: 0.908 ± 0.013 mm
Width: 1.249 ± 0.018 mm



Polarization Flips


Polarized TOF Combinations at 535 V/cm
Counts
400
350
300
250
200
150
100
50
0
600
700
800
900
1000
1100
1200
1300
1400
Recoil time-of-flight (ns)
+3
+2
+1
$\cos\theta_{\beta I} \approx +1$
$\cos\theta_{\beta I} \approx -1$
Simulation

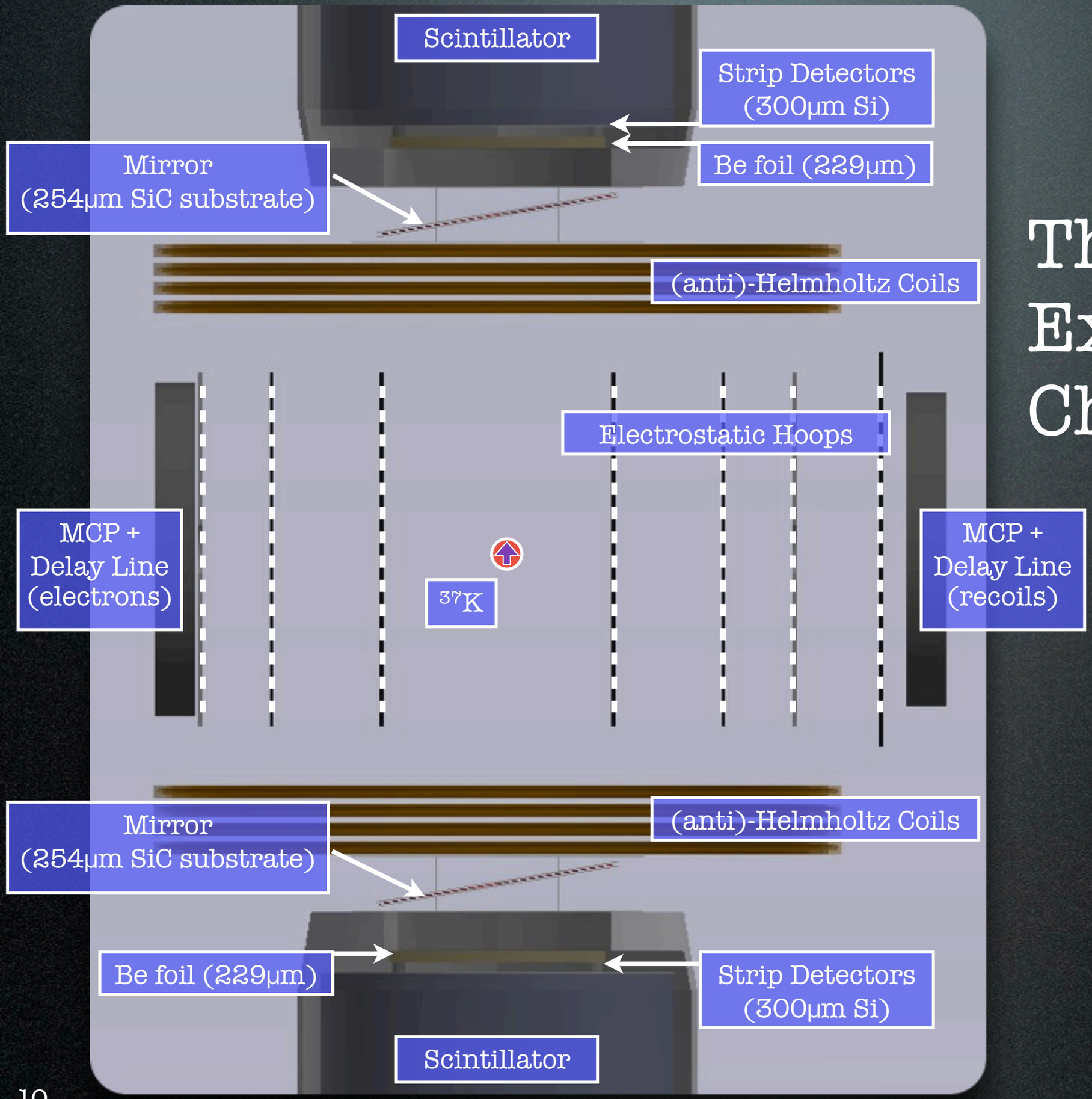
Conclusion

- Earlier: Polarized ^{37}K decay data has been collected at 3 different electric field values.
- Now: Data analysis is underway.
- Soon: Improved simulations with GEANT4, to include our non-uniform E-field, and BSM physics.
- Later: Fits to simulations to extract BSM parameters.

- From the Collaboration:
  - Polarization results to be published soon.[1]
  - Analysis for A_β is also in progress.

[1] B. Fenker et. al., in preparation.

The TRINAT Experimental Chamber



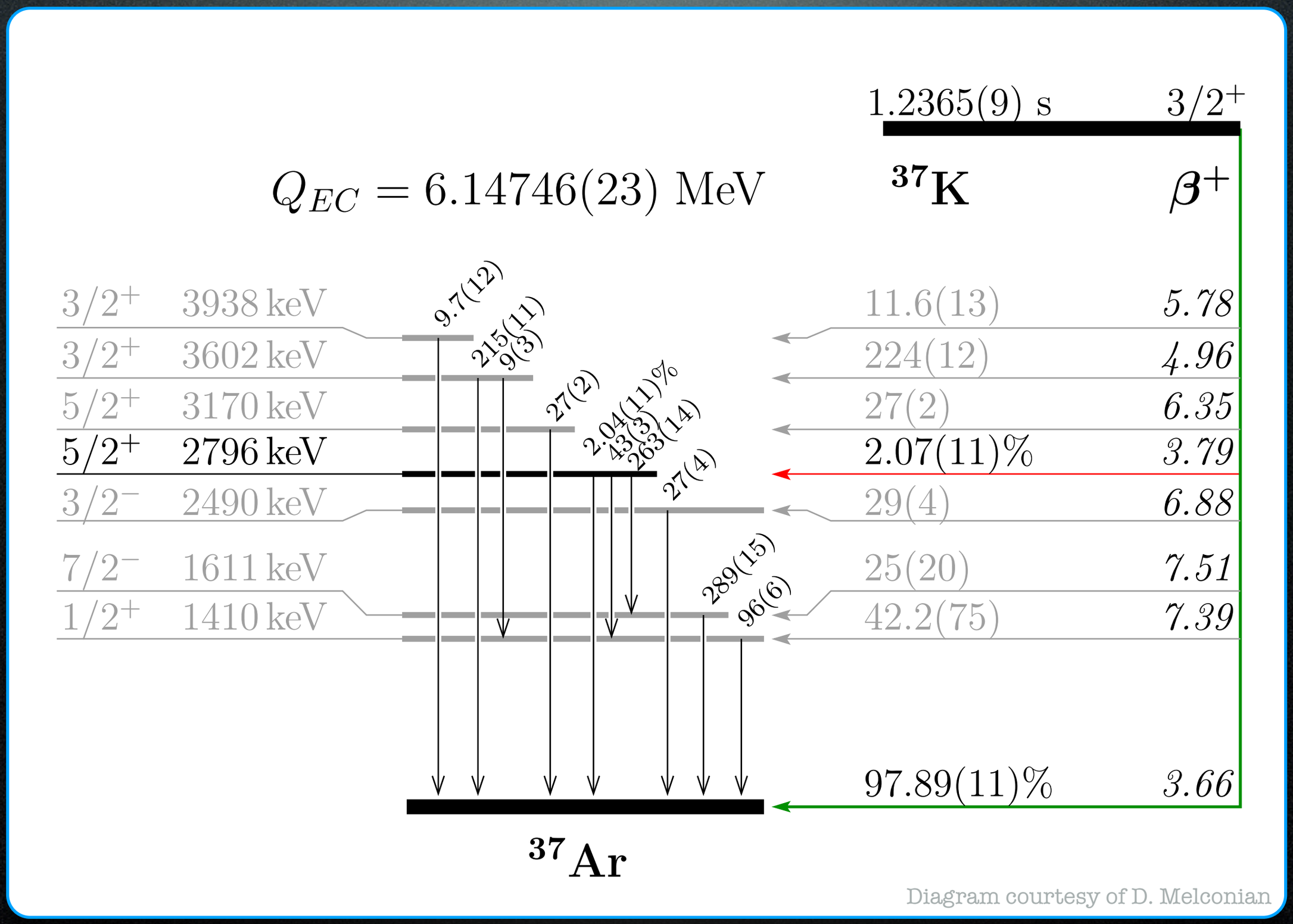
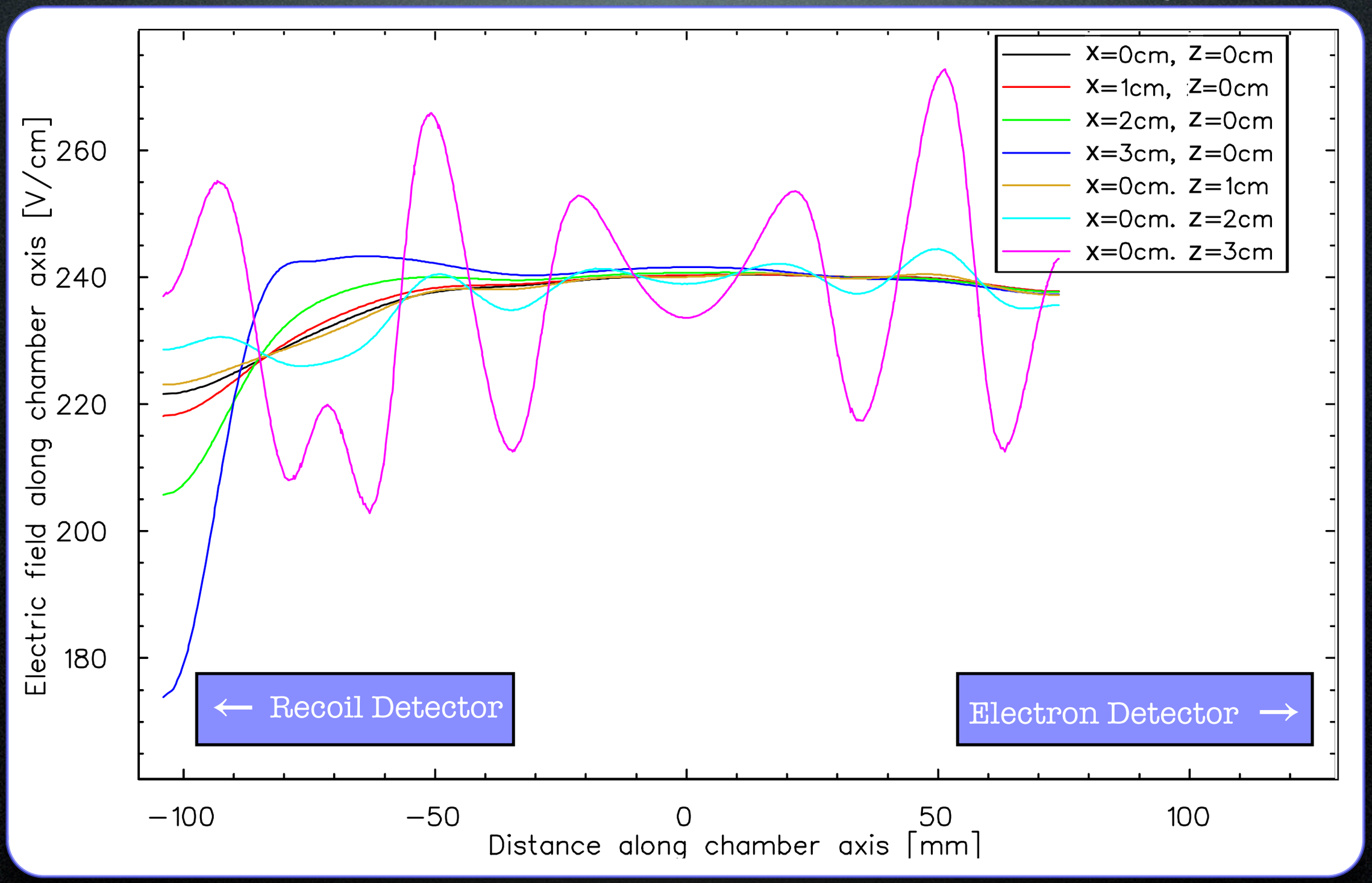


Diagram courtesy of D. Melconian

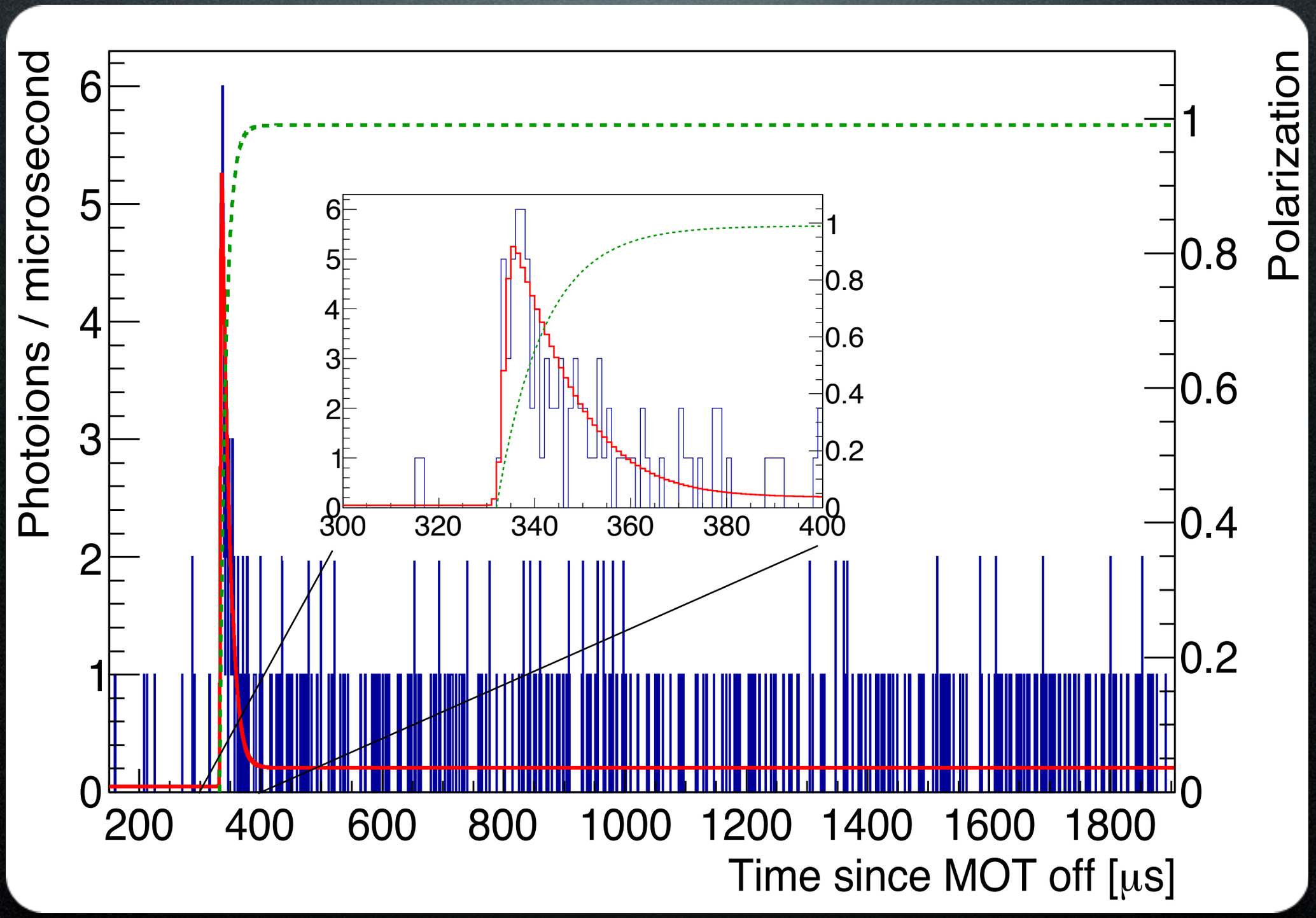
^{37}K Decay Scheme

Figure courtesy of A. Gorelov



Electric Field in the Chamber

Polarization Diagnostics



Preliminary Results: [1][2]
<I>/I = {+0.992(1), −0.992(1)}

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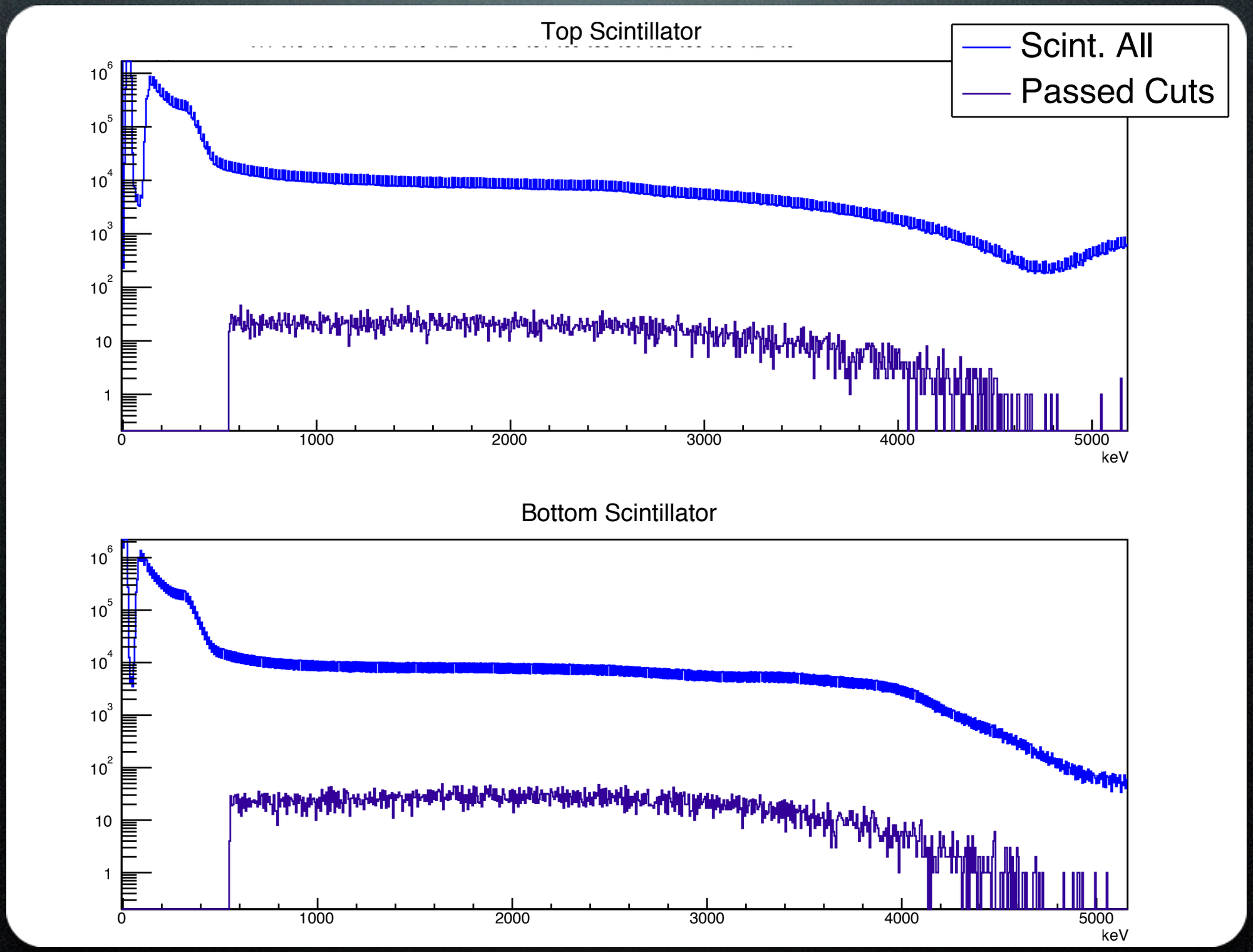
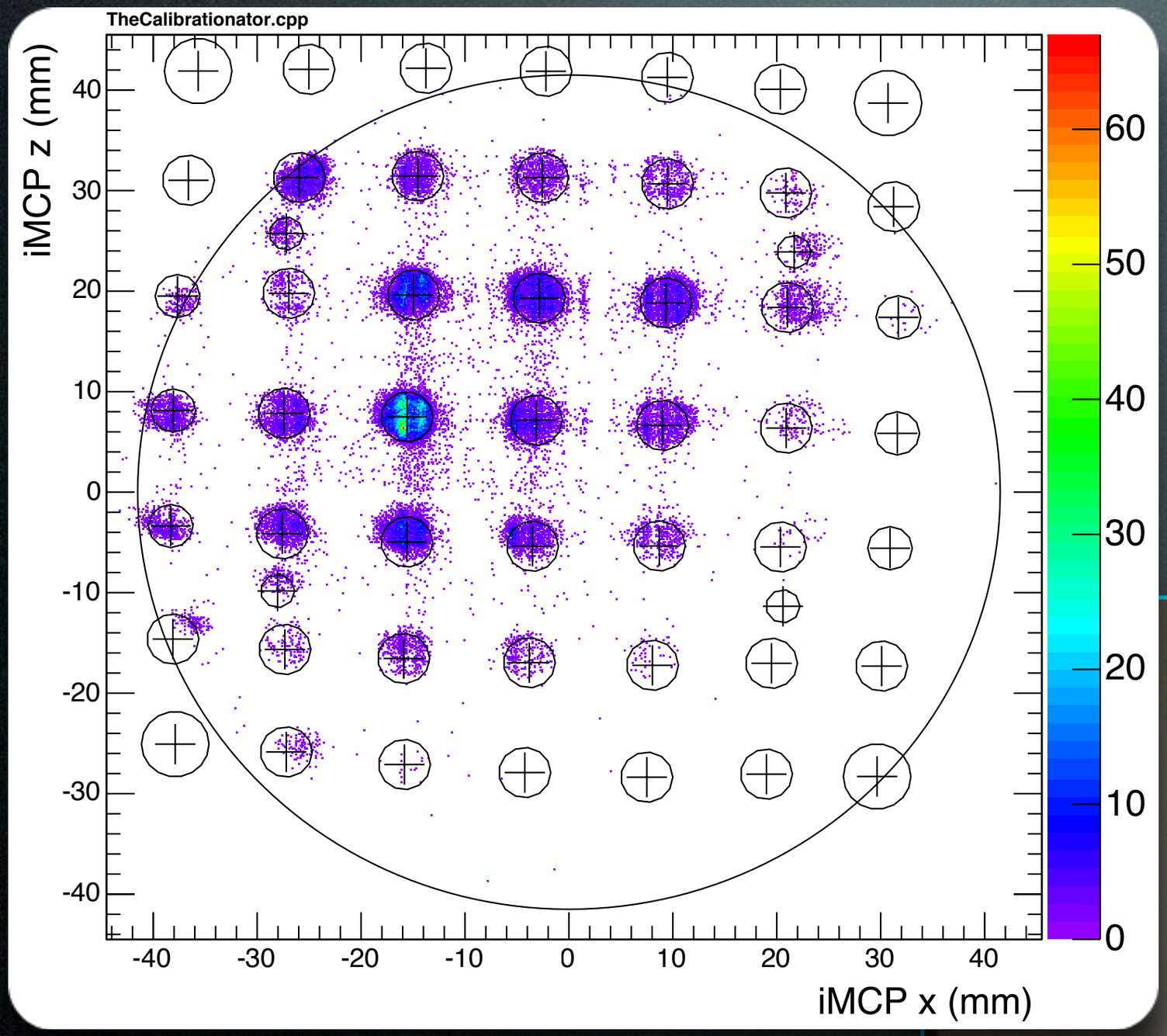
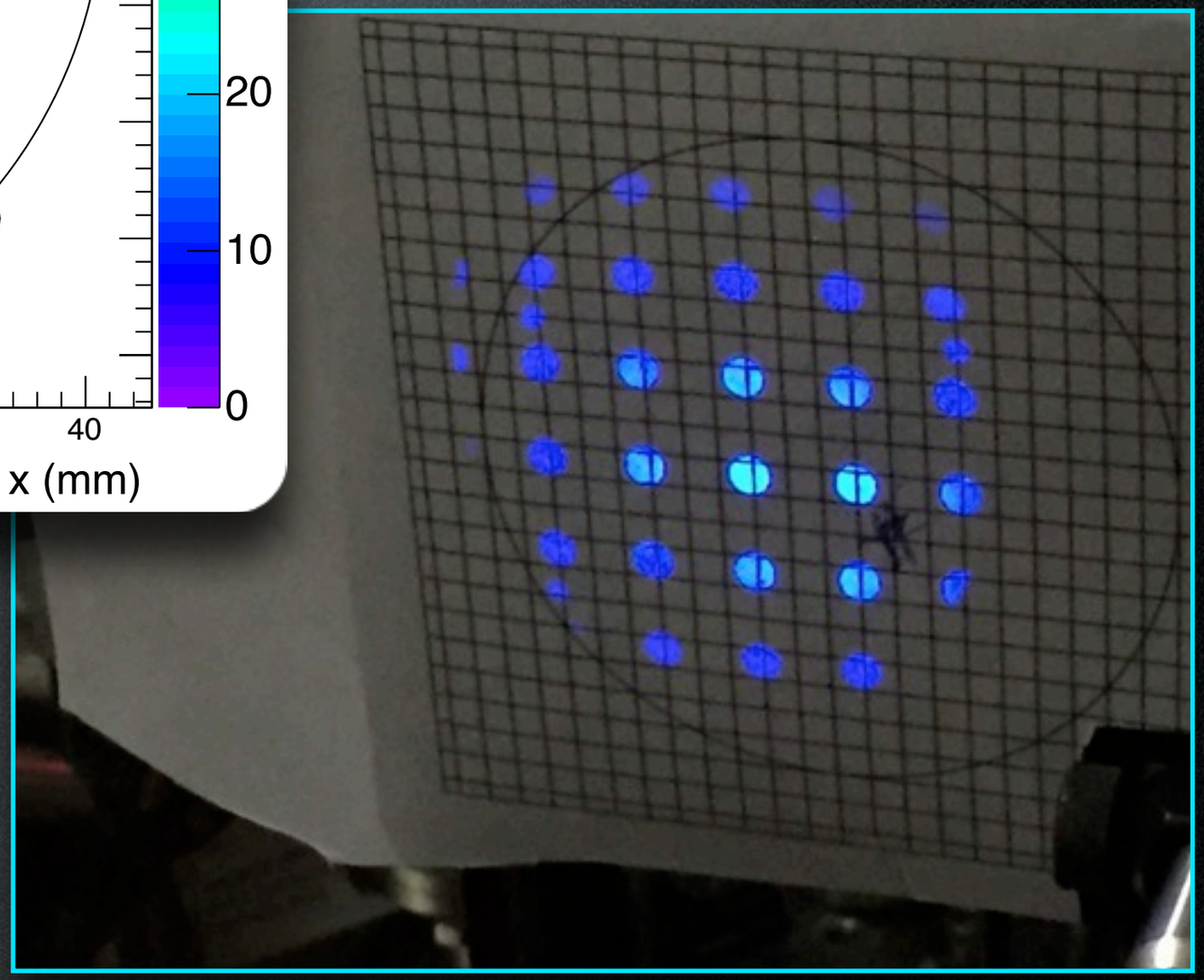
[2] B. Fenker., SSP 2015



Beta Energy Spectrum

Calibration via UV Laser