ISAC Science Forum
^{37}K Beta Asymmetry

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Texas A&M University

SM PREDICTION OF A_β

SOURCES OF ERROR IN THE SM PREDICTION OF A_β

Branching Ratio

Half-life → Partial Half-life

Probability of Electron Capture

$$t = \ln 2\tau \left(\frac{1 + P_{\mathrm{EC}}}{\mathrm{BR}} \right)$$

N. Severijns, M. Tandecki, T. Phalet, and I. Towner. Ft values of the T=1/2 mirror β transitions. *Physical Review C*, 78(5):055501, November 2008.

SOURCES OF ERROR IN THE SM PREDICTION OF A_β

Branching Ratio

Half-life → Partial Half-life

Probability of Electron Capture

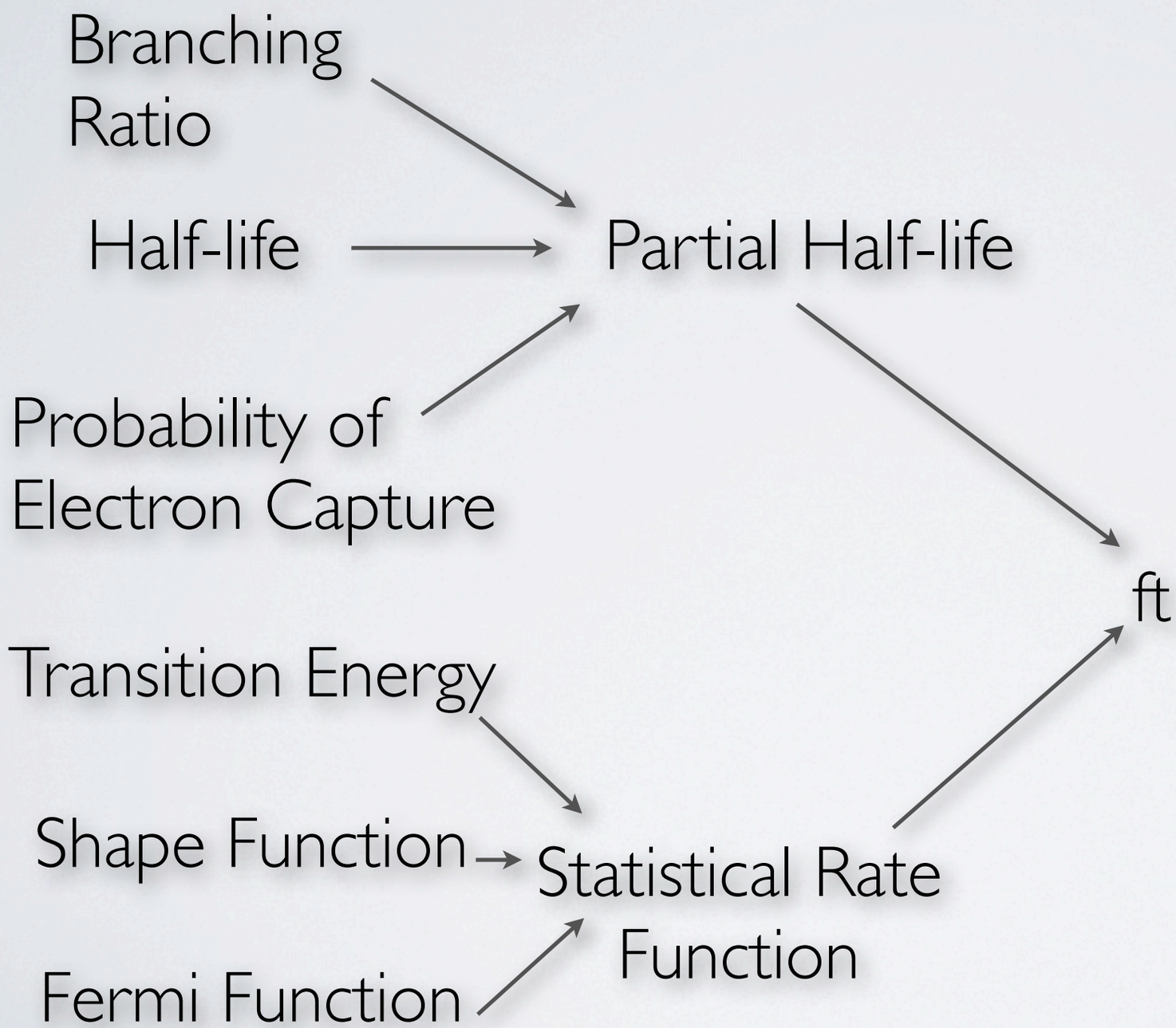
Transition Energy

$$f = \int F(\pm Z, W) S(\pm Z, W)(W - W_0)^2 p\, W\, dW$$

Shape Function → Statistical Rate Function

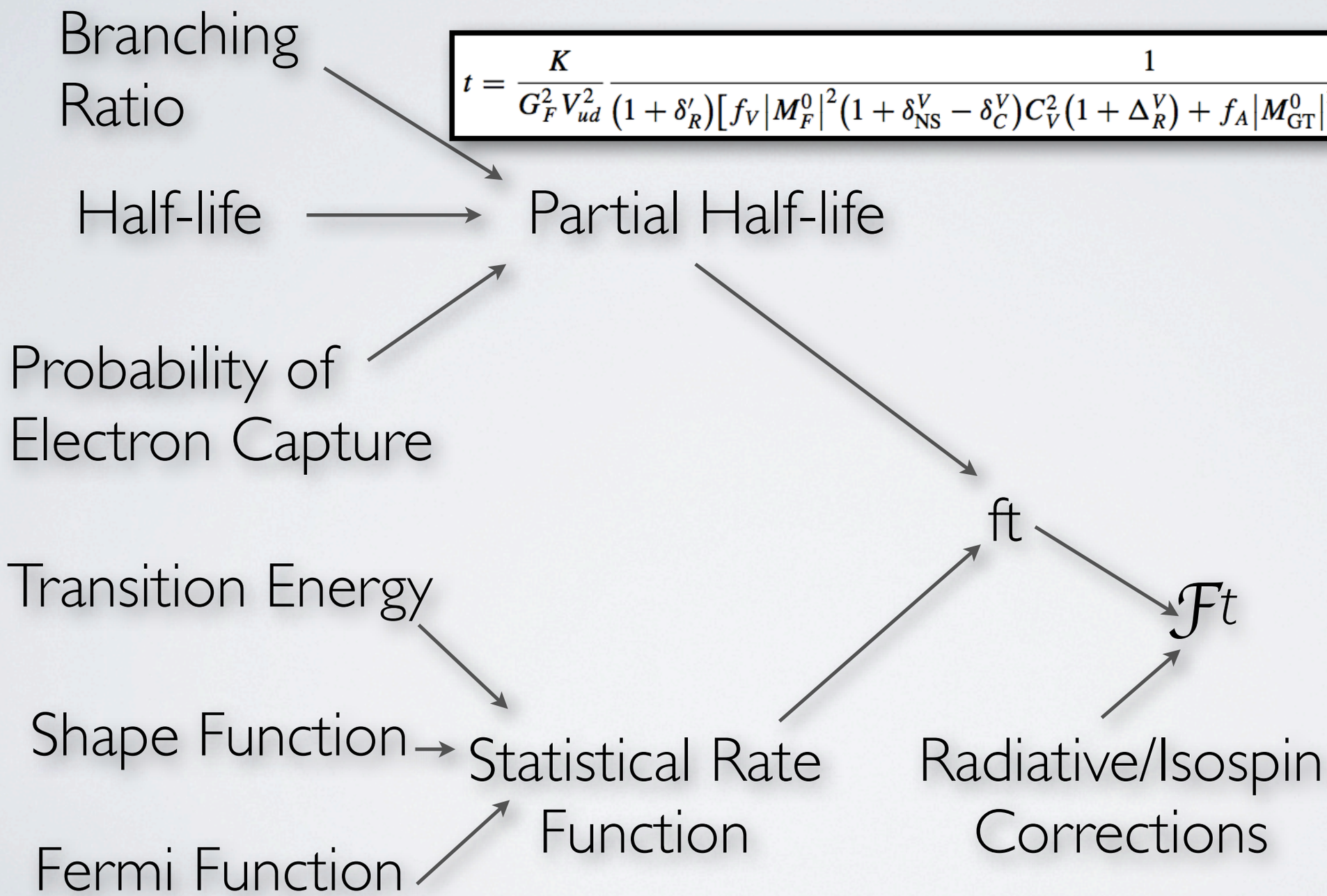
Fermi Function

SOURCES OF ERROR IN THE SM PREDICTION OF A_β



SOURCES OF ERROR IN THE SM PREDICTION OF A_β

$$t = \frac{K}{G_F^2 V_{ud}^2} \frac{1}{(1+\delta_R')\left[f_V |M_F^0|^2 (1+\delta_{NS}^V - \delta_C^V) C_V^2 (1+\Delta_R^V) + f_A |M_{GT}^0|^2 (1+\delta_{NS}^A - \delta_C^A) C_A^2 (1+\Delta_R^A)\right]}$$



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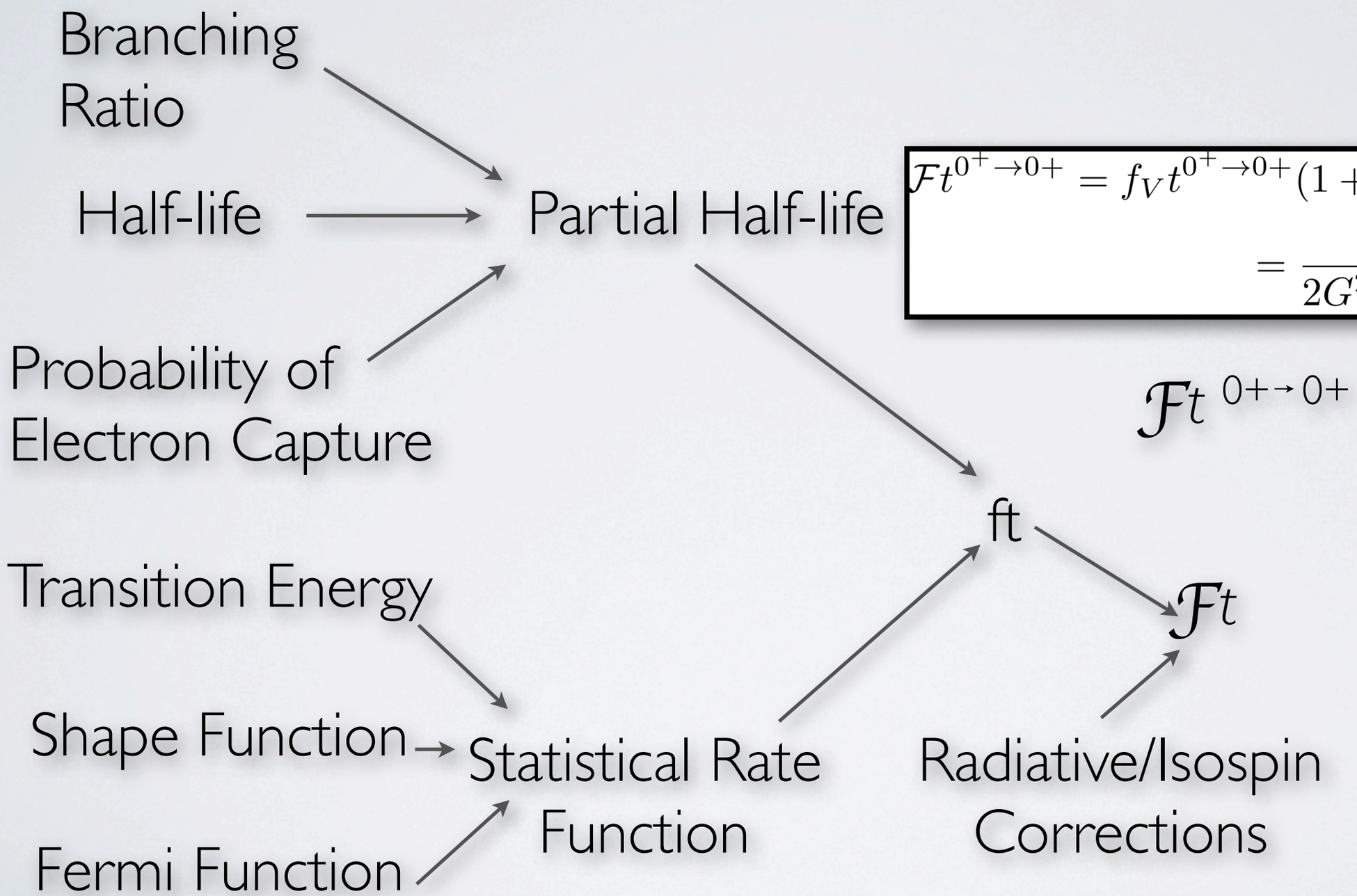
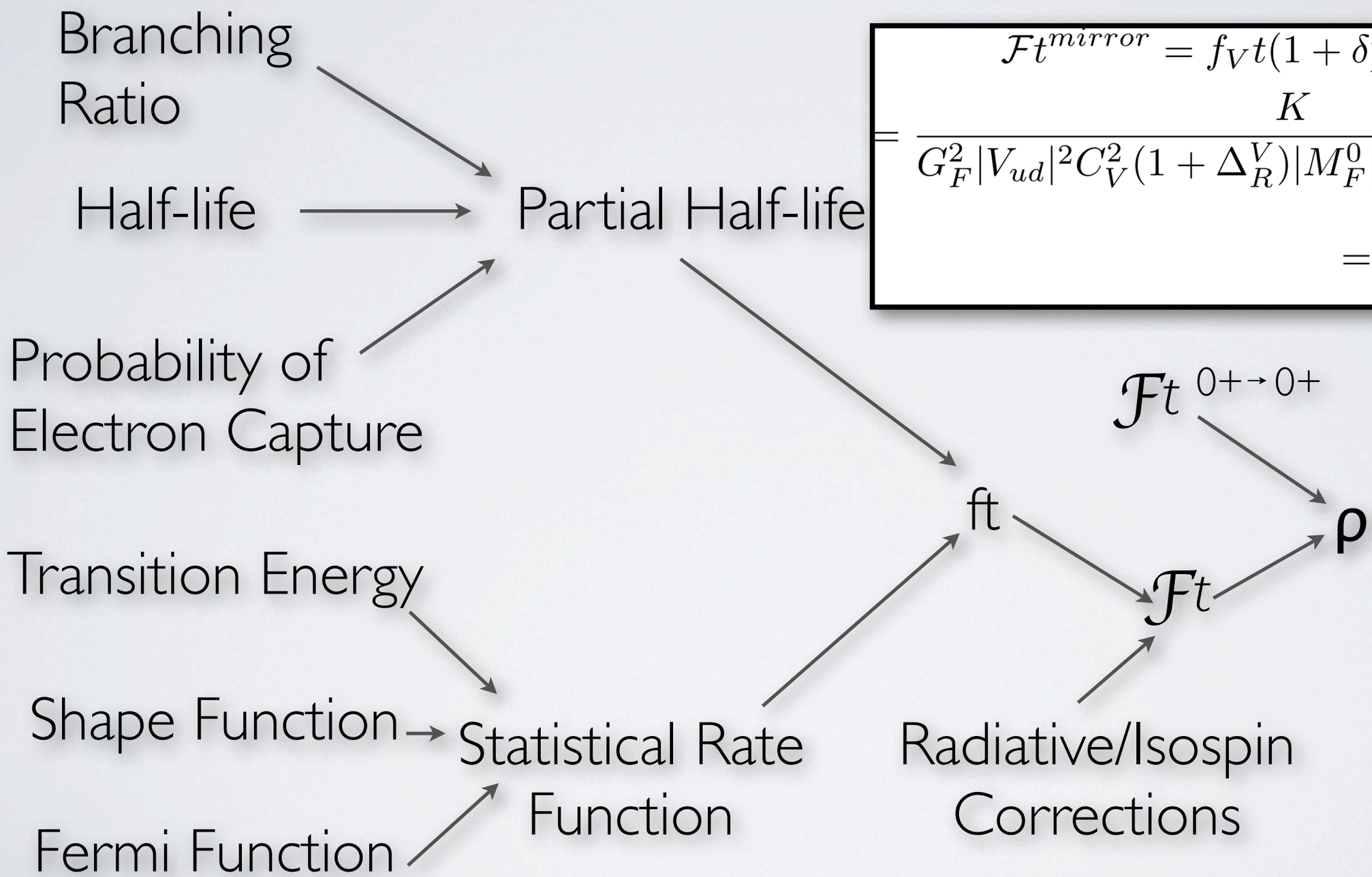


$$\mathcal{F}t^{0^+\to 0^+} = f_V t^{0^+\to 0^+}(1+\delta'_R)(1+\delta^V_{NS}-\delta^V_C) = \frac{K}{2G_F^2|V_{ud}|^2 C_V^2(1+\Delta^V_R)}$$

$\mathcal{F}t^{\,0+\to 0+}$

SOURCES OF ERROR IN THE SM PREDICTION OF A_β

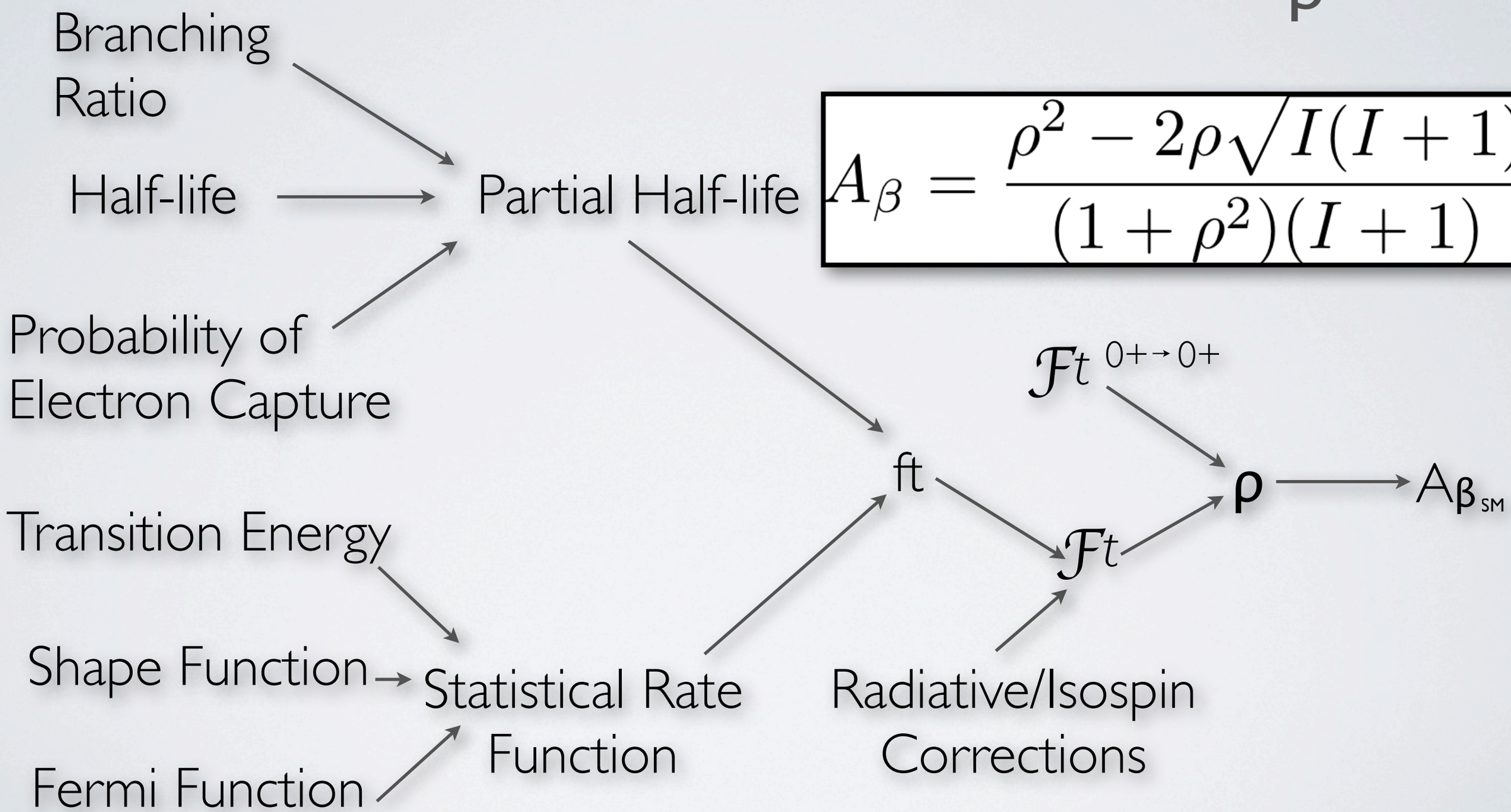


$$\mathcal{F}t^{mirror} = f_V t(1+\delta'_R)(1+\delta^V_{NS}-\delta^V_C)$$

$$= \frac{K}{G_F^2|V_{ud}|^2 C_V^2(1+\Delta^V_R)|M_F^0|^2[1+(f_A/f_V)\rho^2]}$$

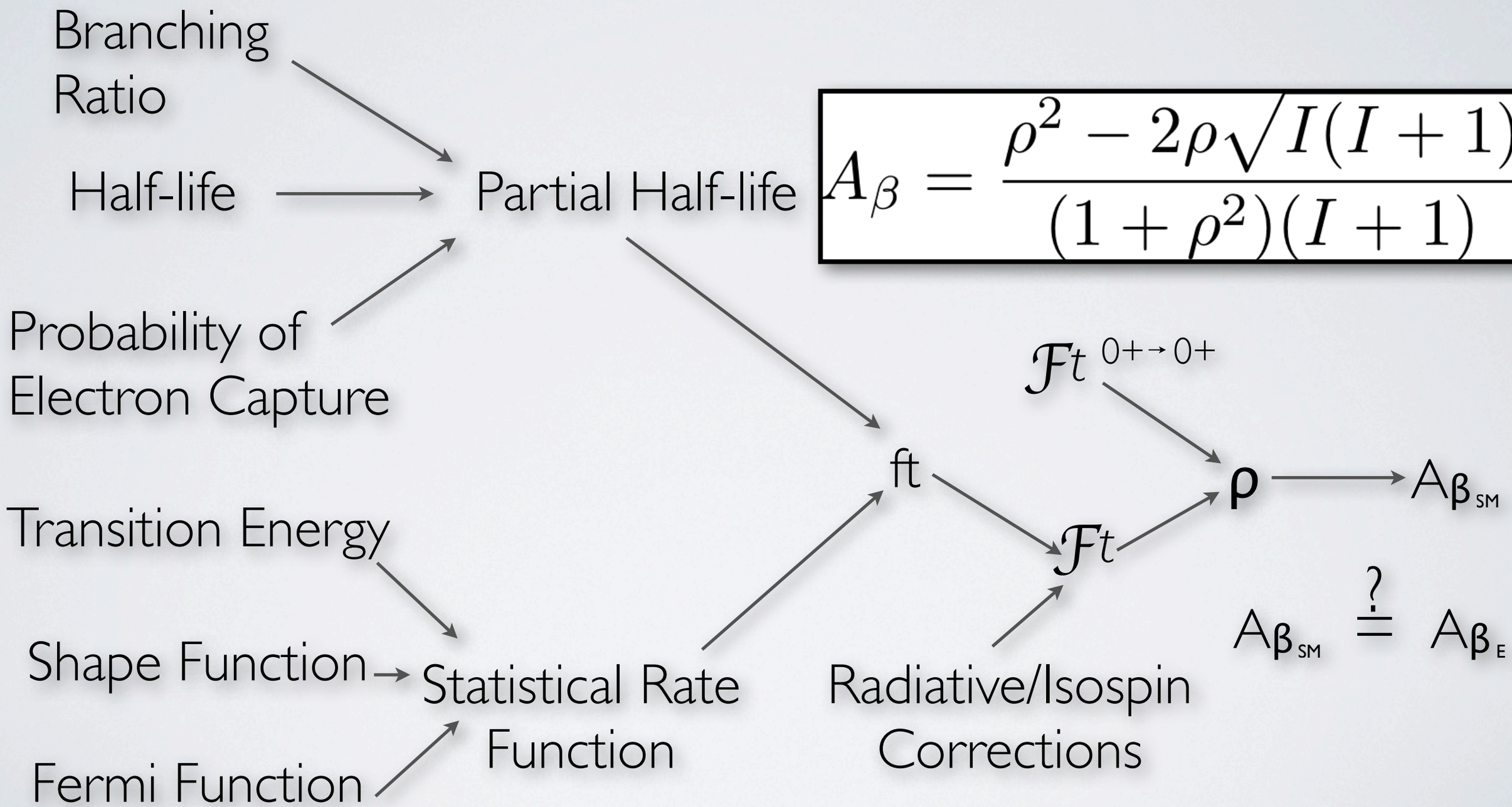
$$= \frac{2\mathcal{F}t^{0^+\to 0^+}}{(1+(f_A/f_V)\rho^2)}$$

SOURCES OF ERROR IN THE SM PREDICTION OF A_β



$$A_\beta = \frac{\rho^2 - 2\rho\sqrt{I(I+1)}}{(1+\rho^2)(I+1)}$$

HERE IS THE HEART OF THE EXPERIMENT



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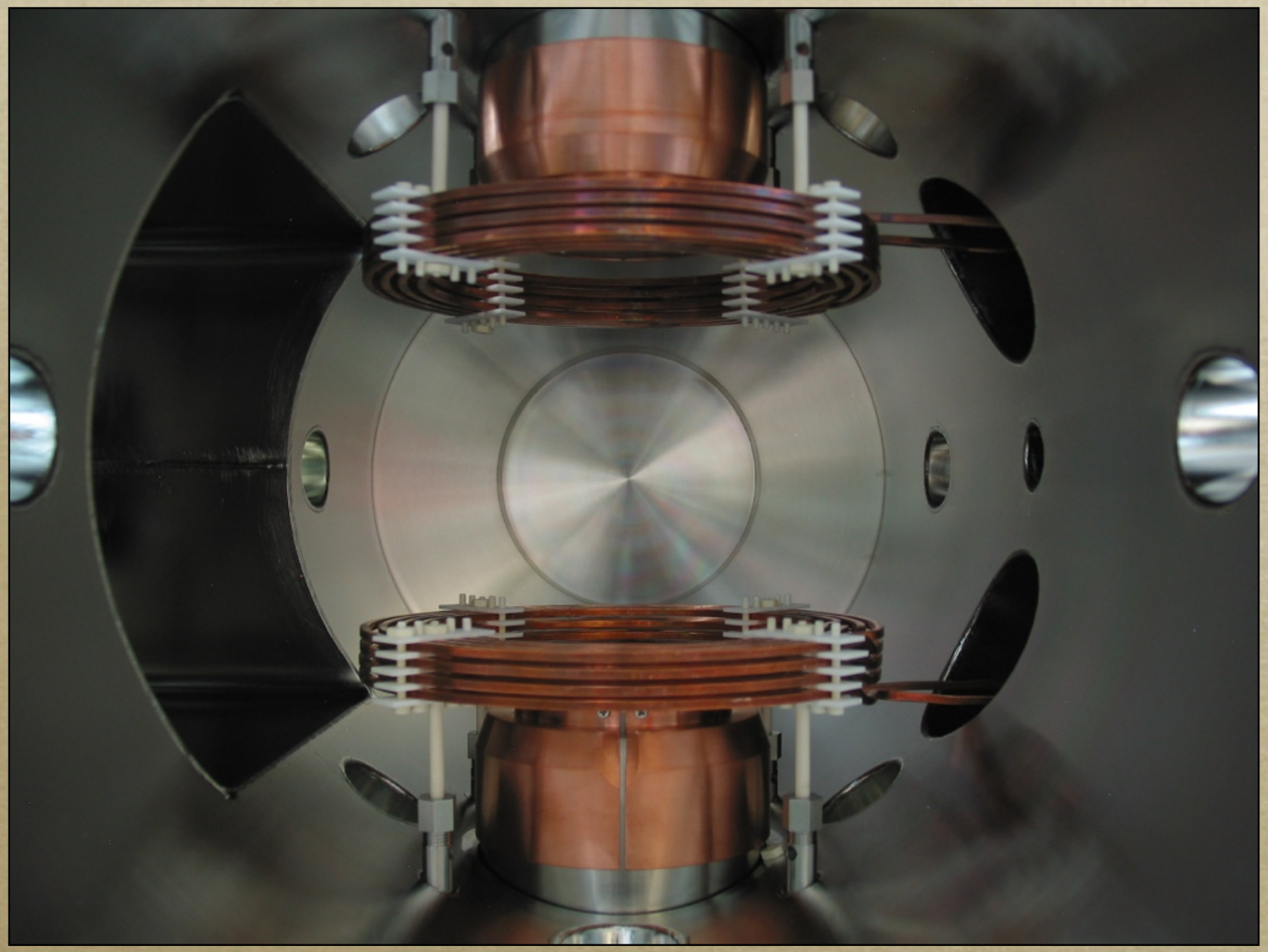
Overview of the Experiment



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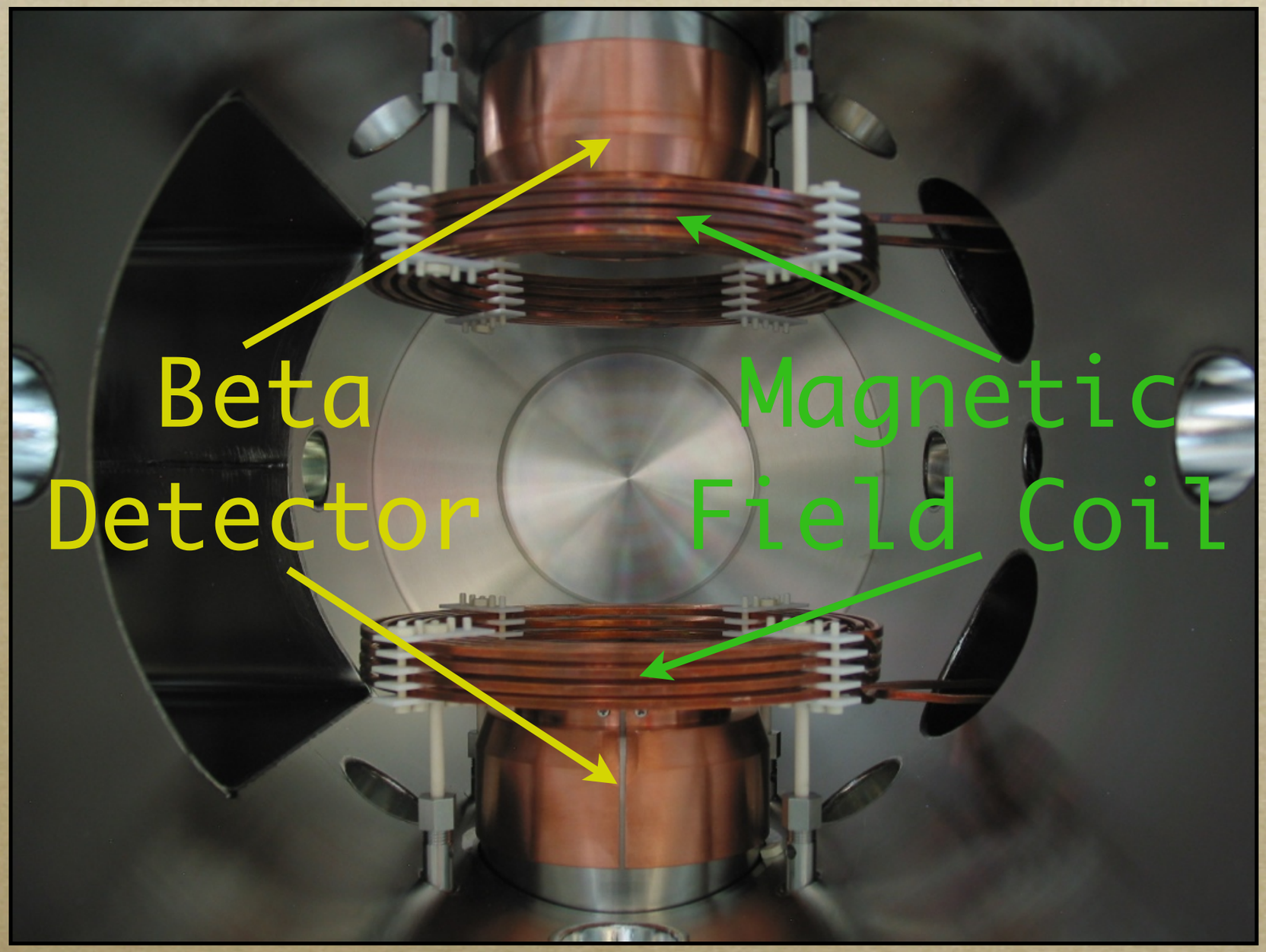

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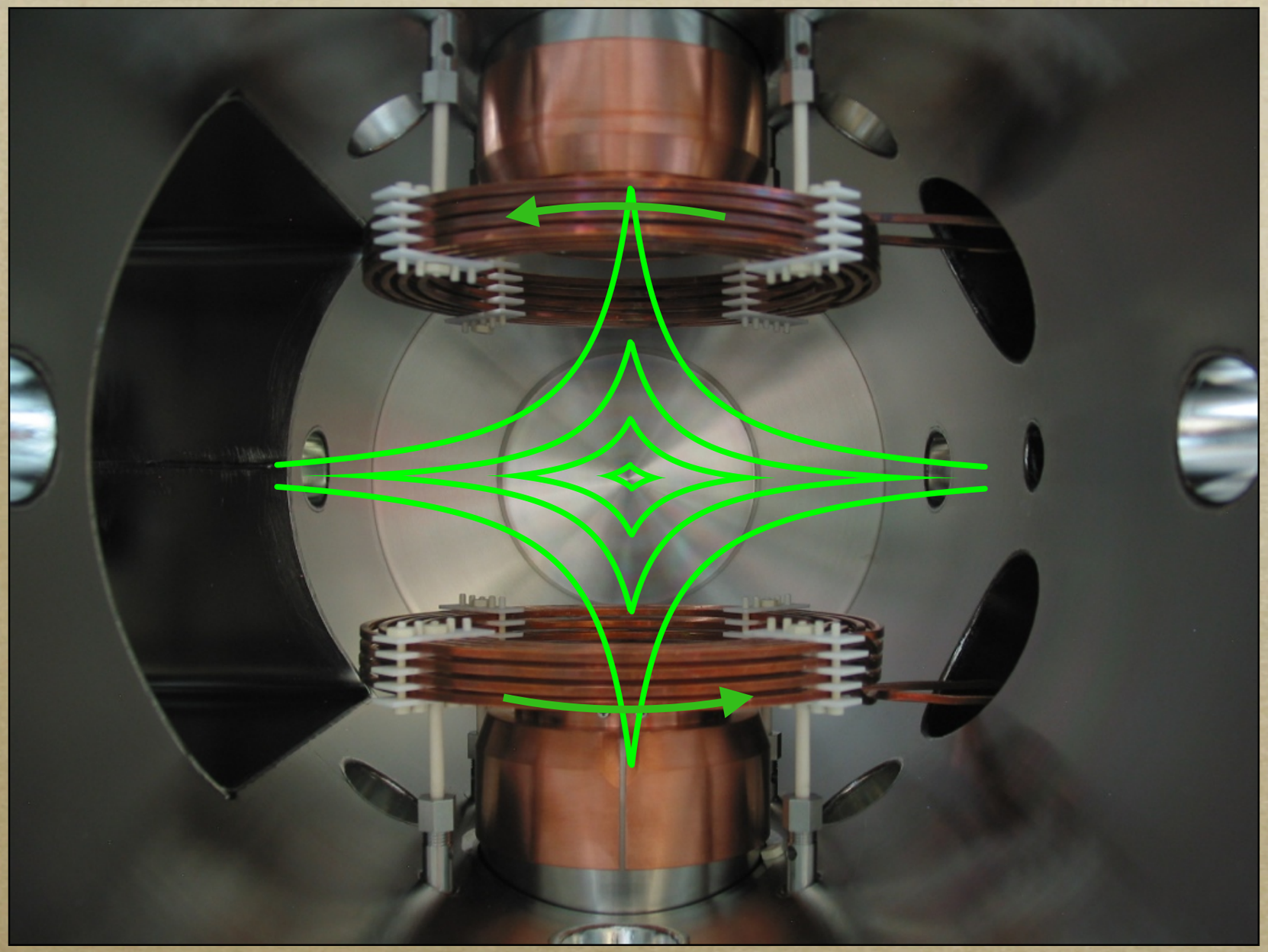

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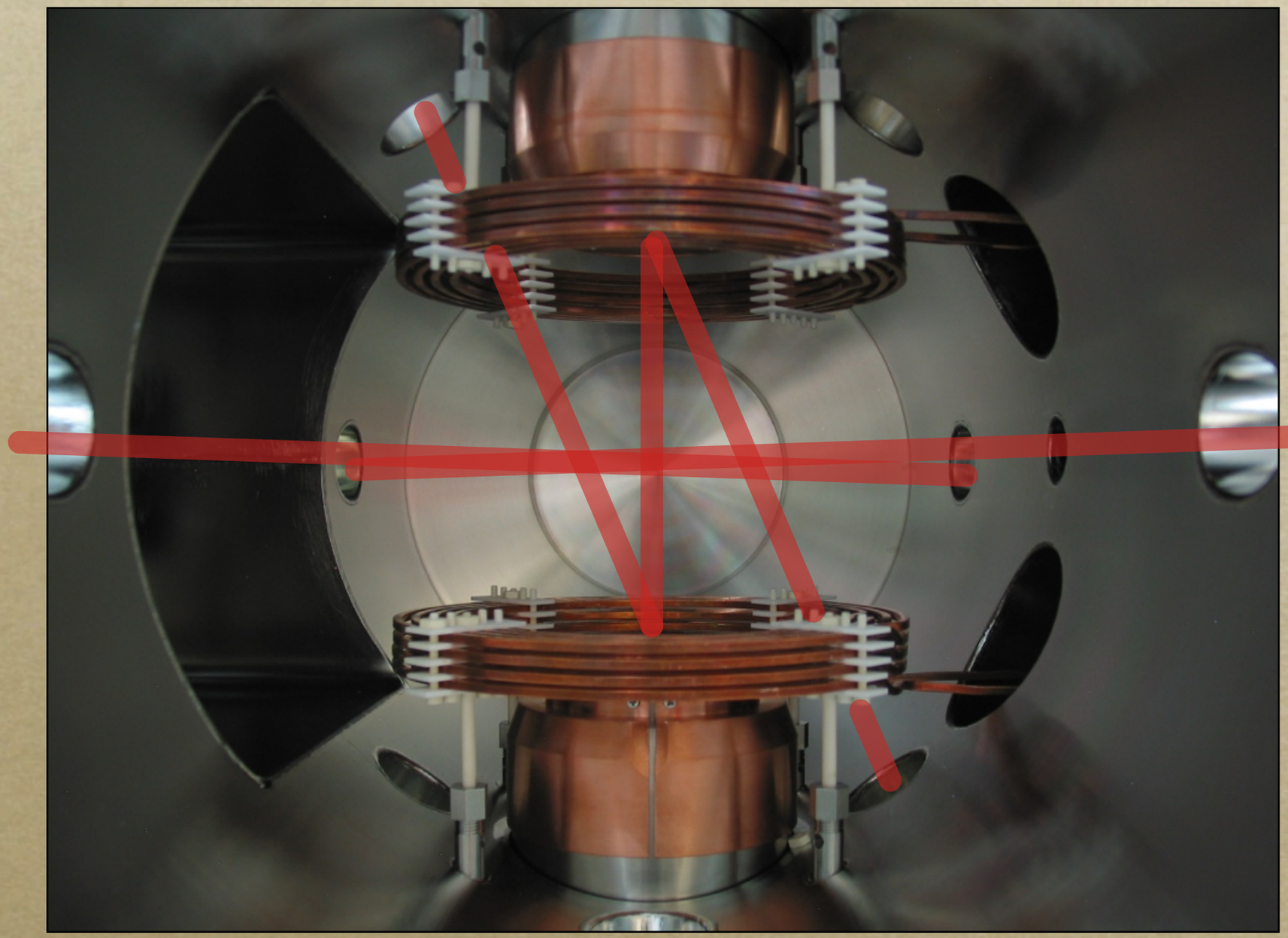

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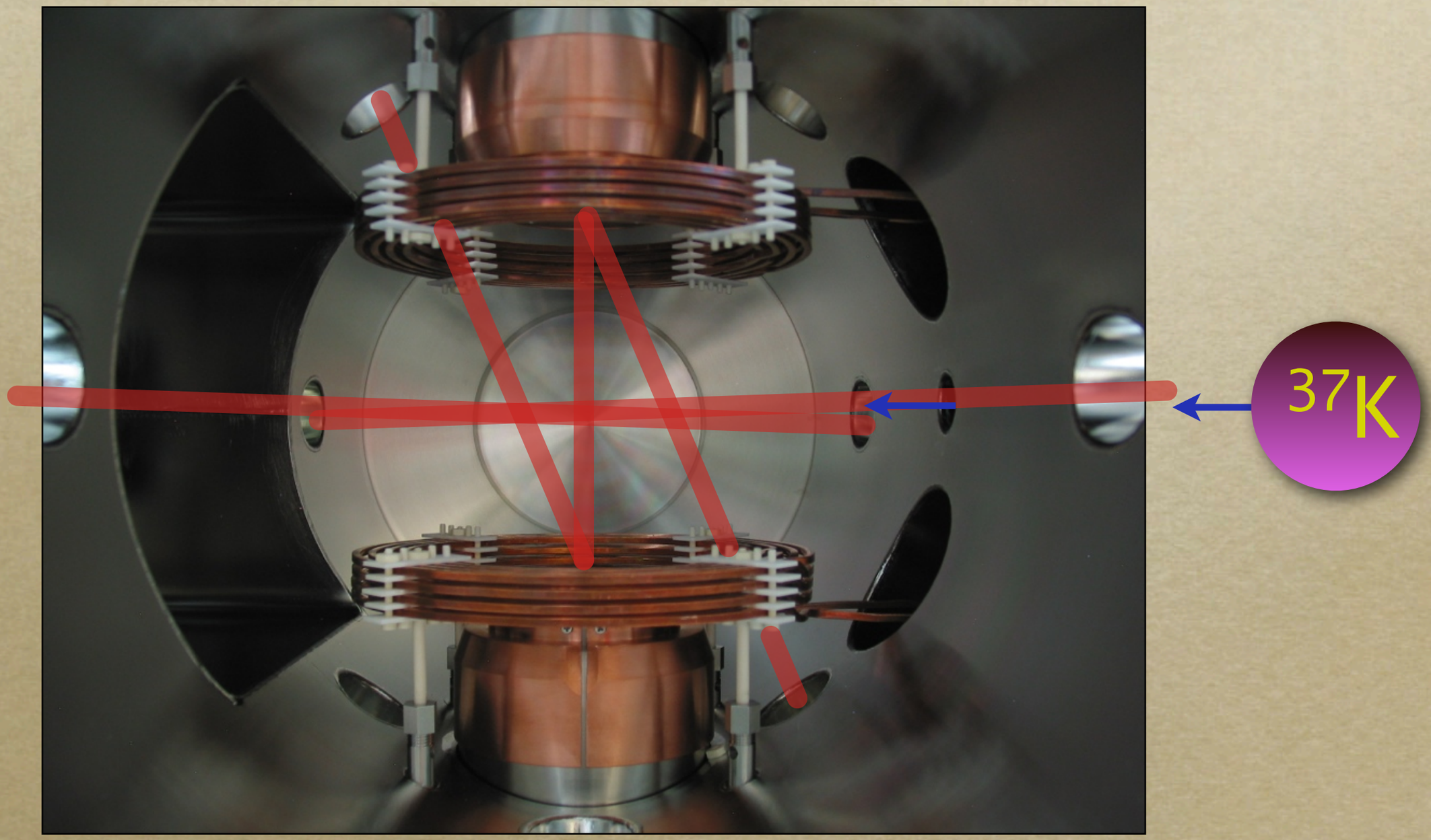

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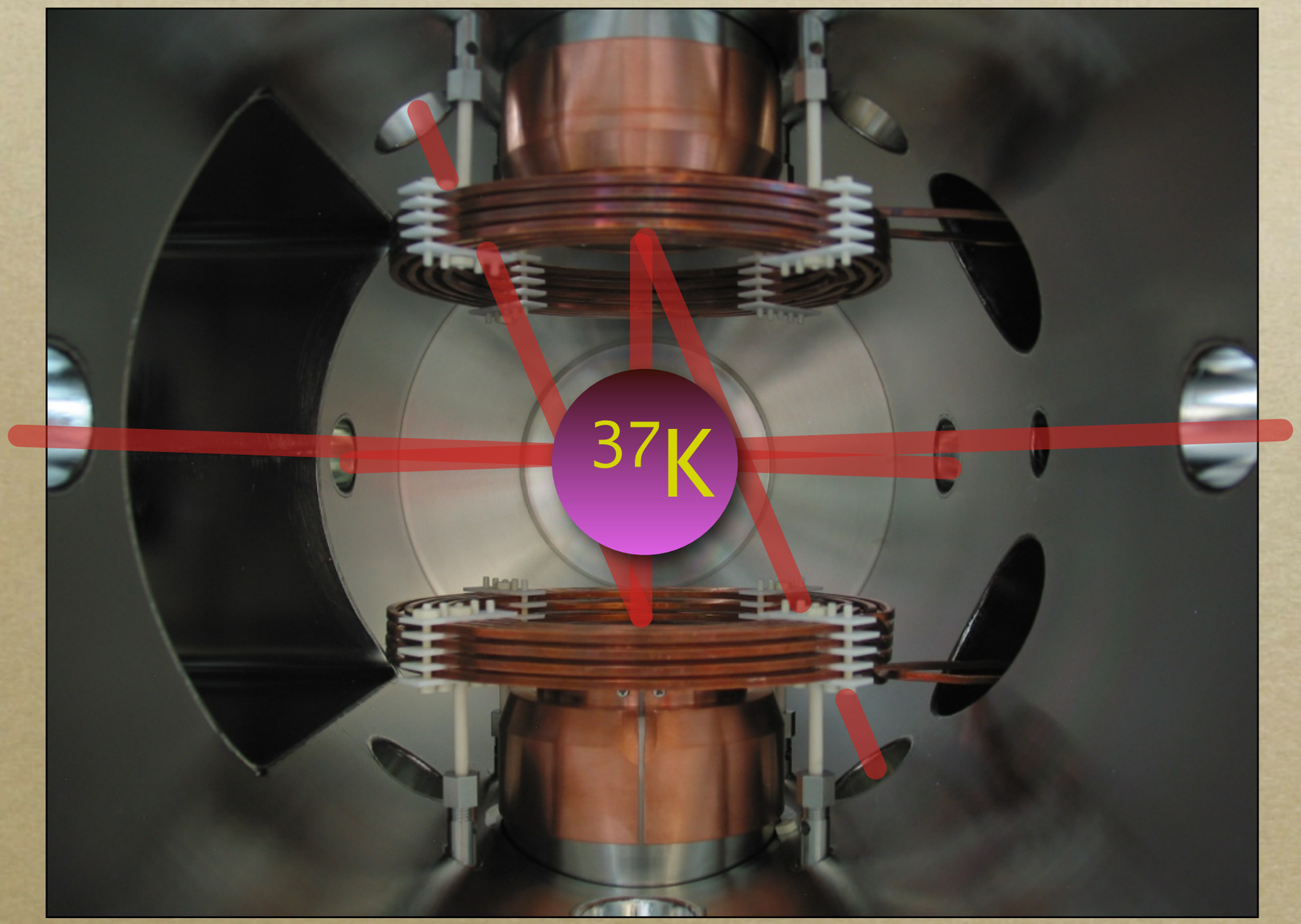

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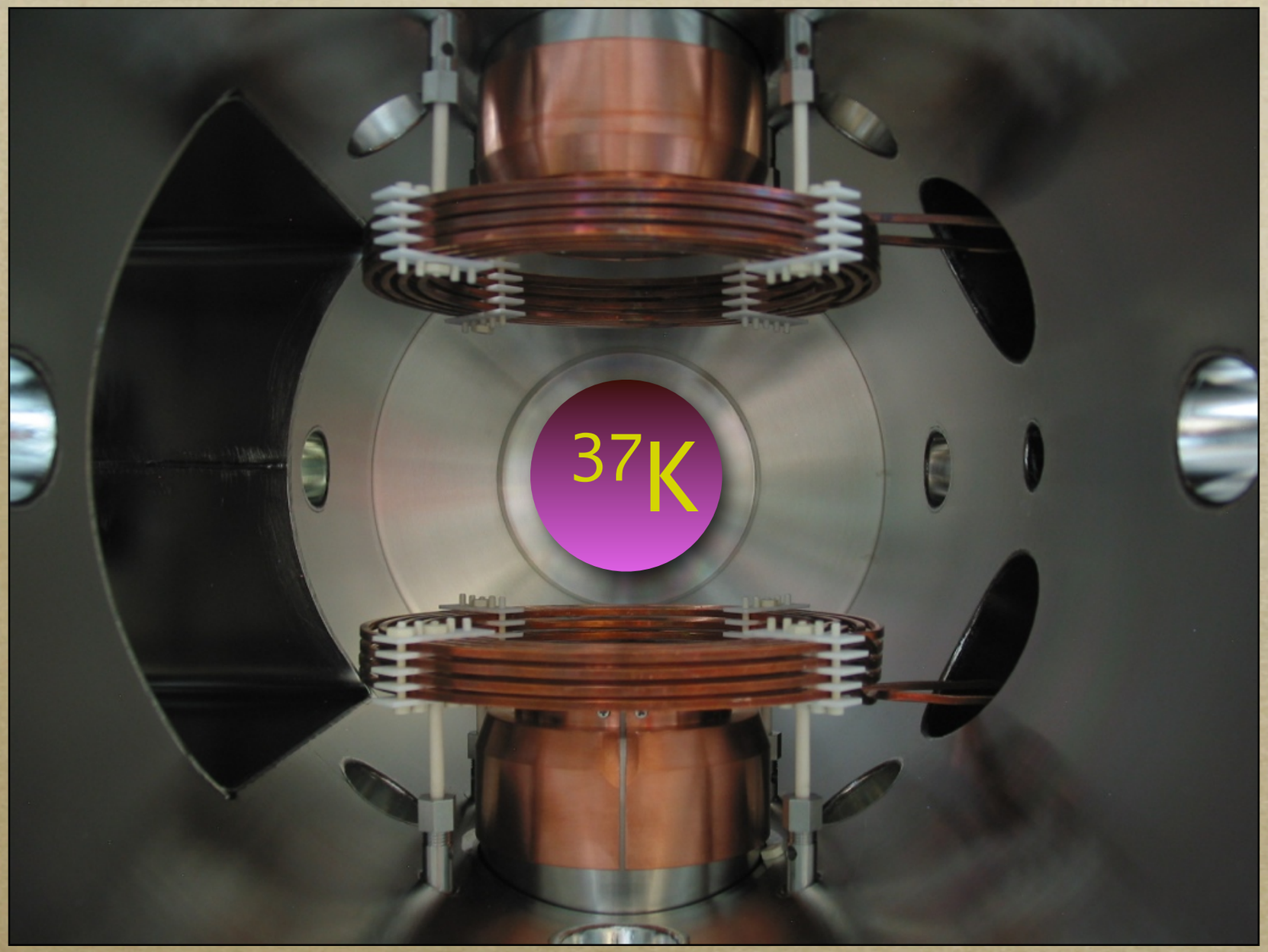

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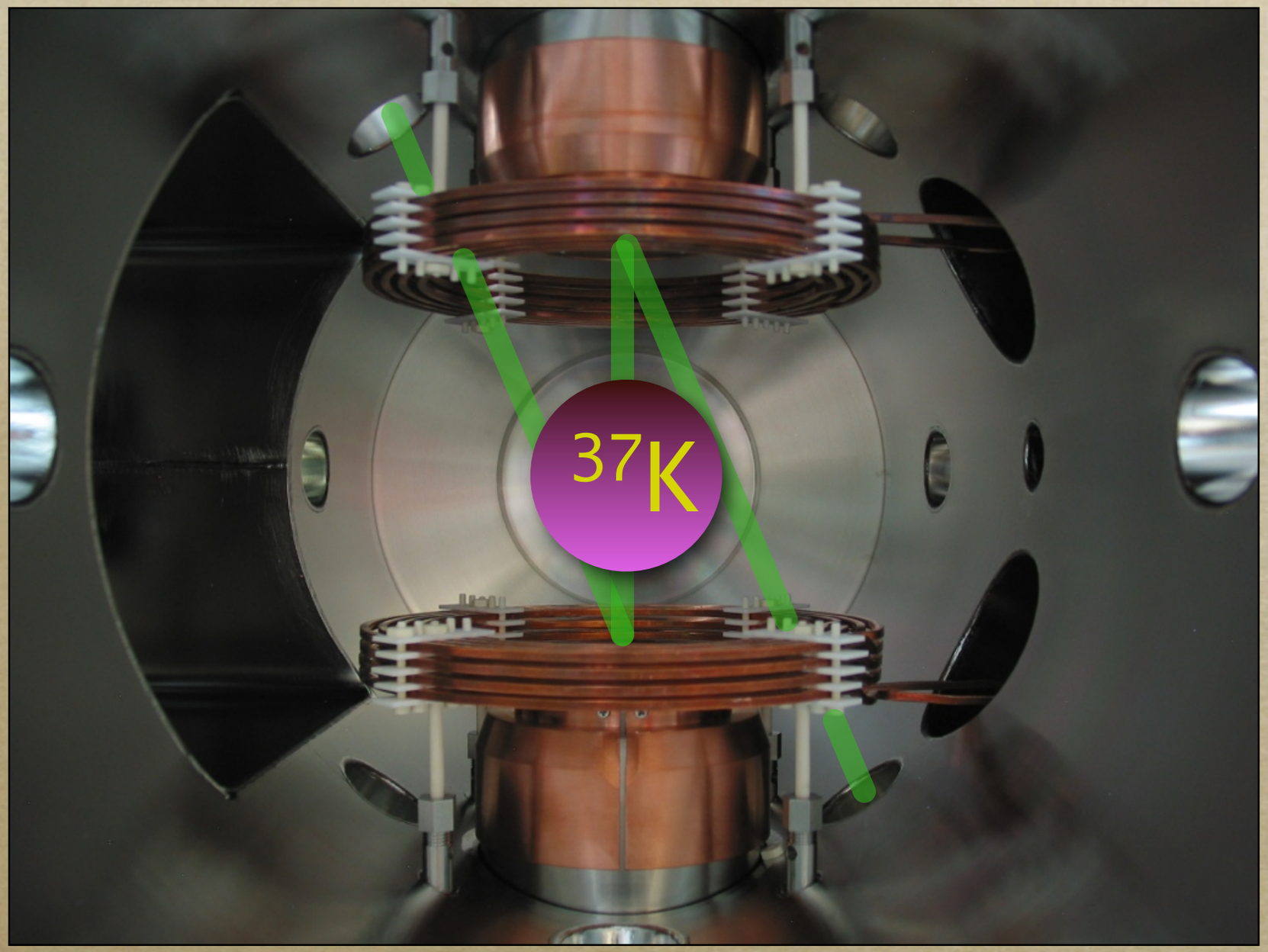

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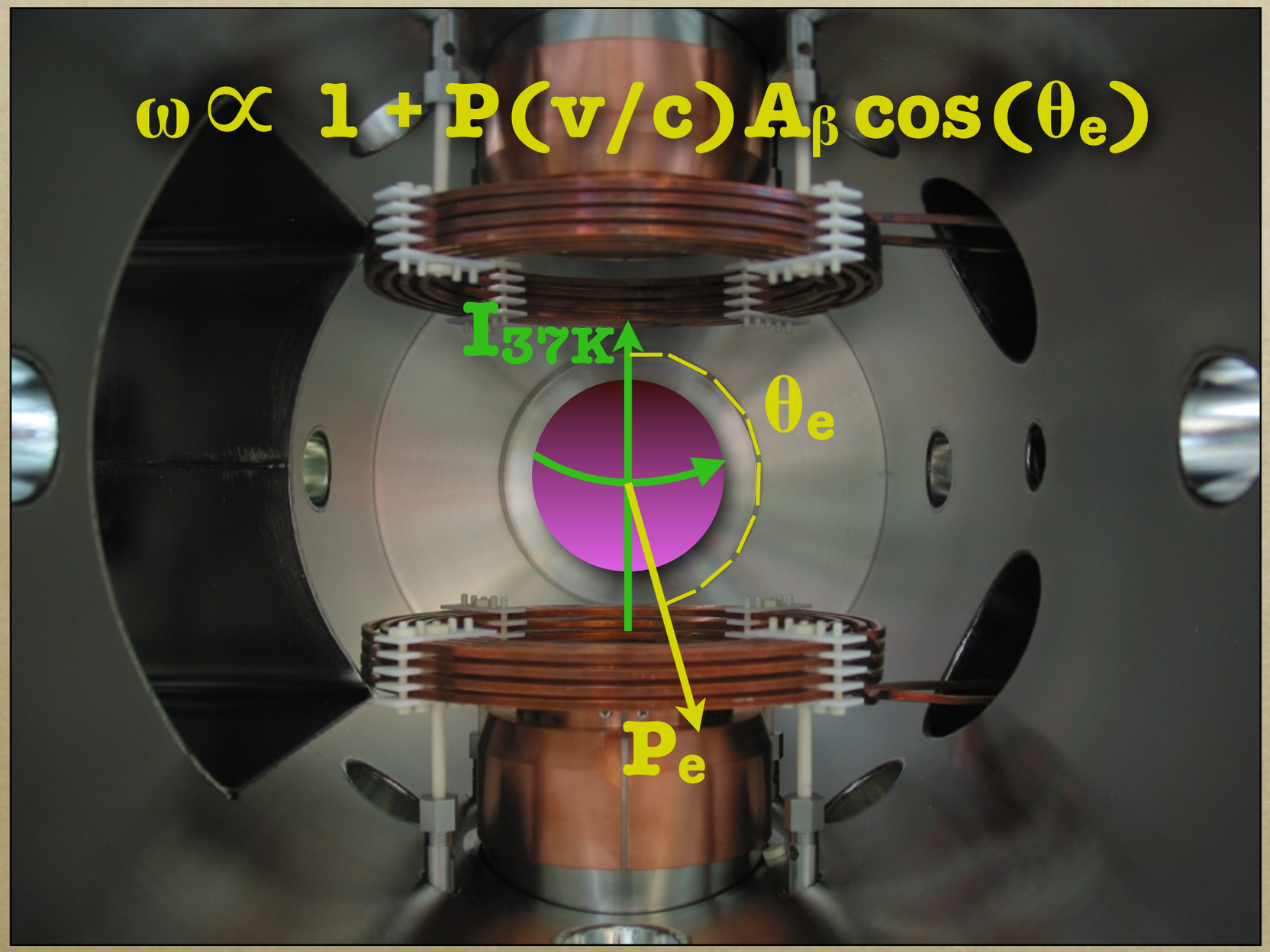
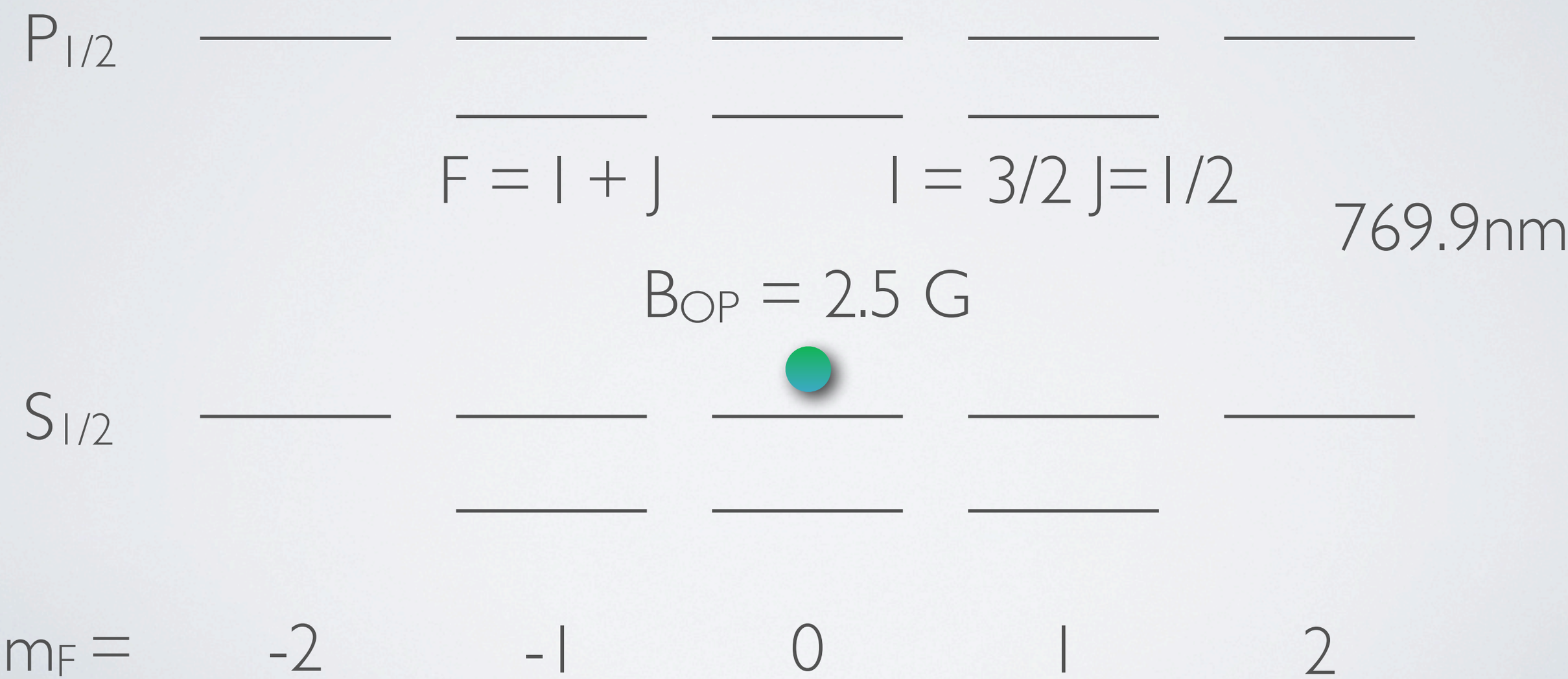


HOW ARE THE ^{37}K ATOMS POLARIZED?

HOW DOES OPTICAL PUMPING WORK?



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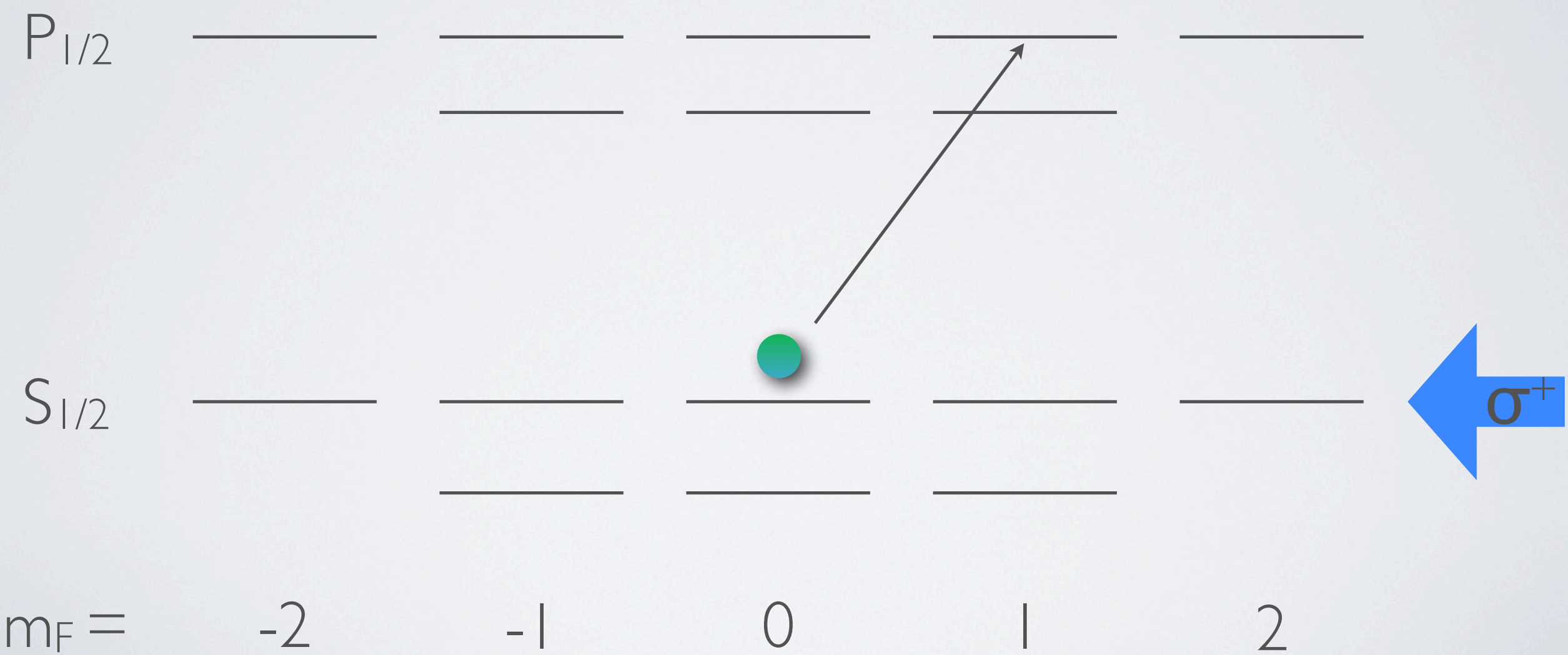

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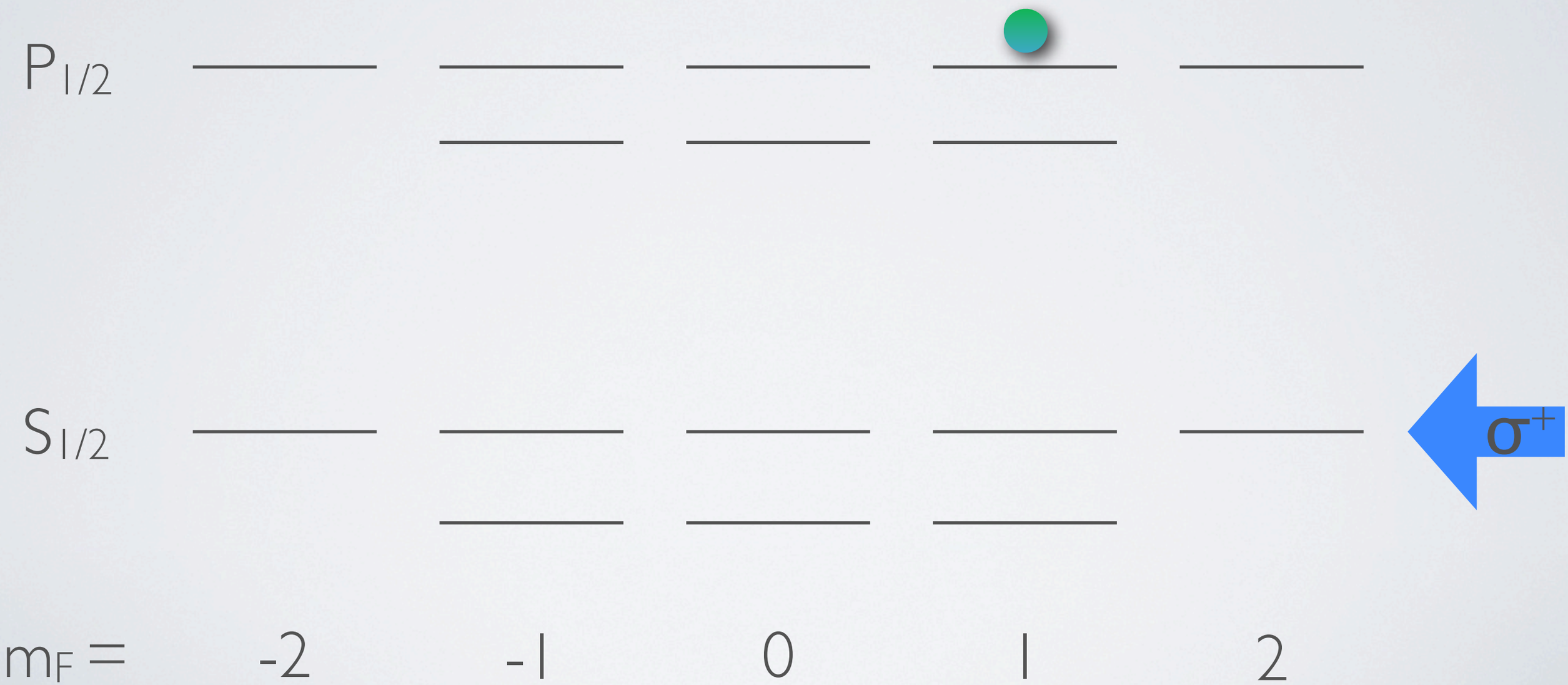

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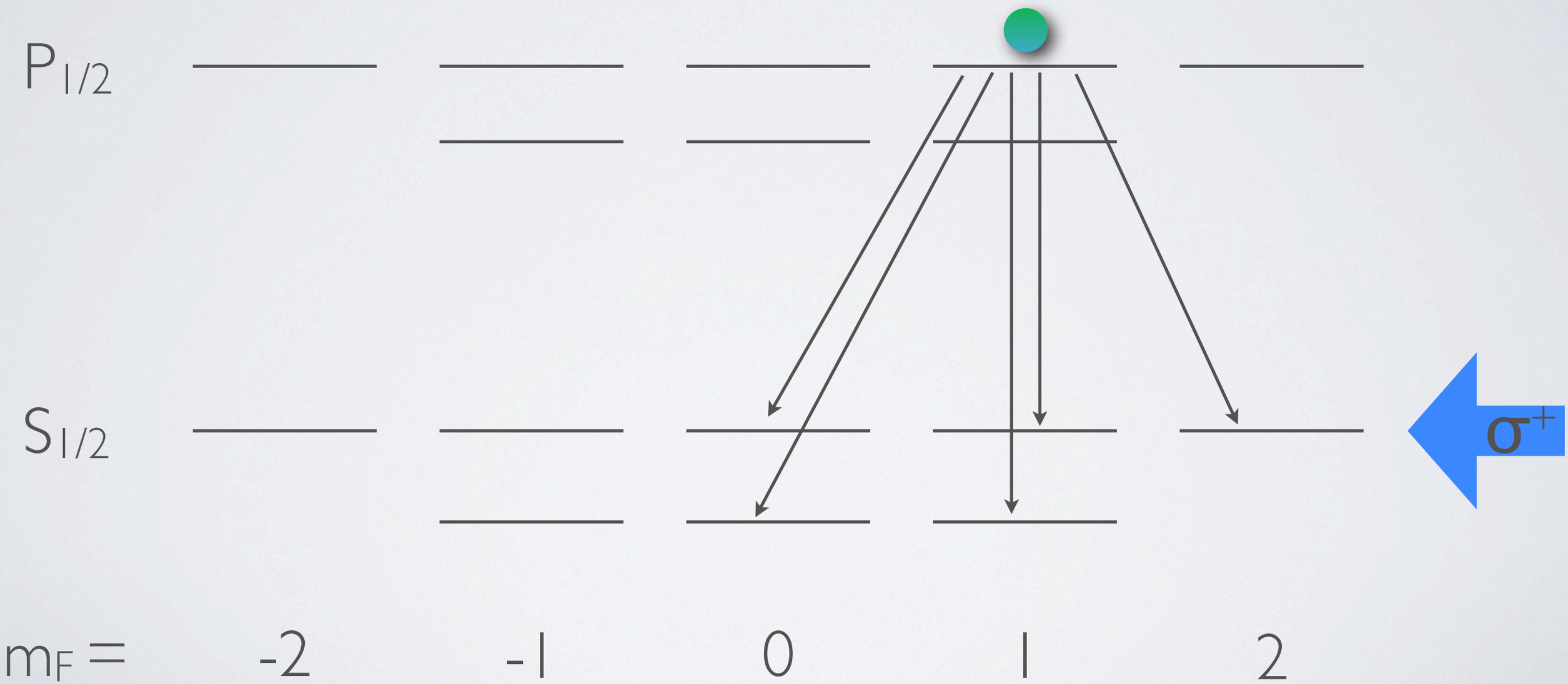
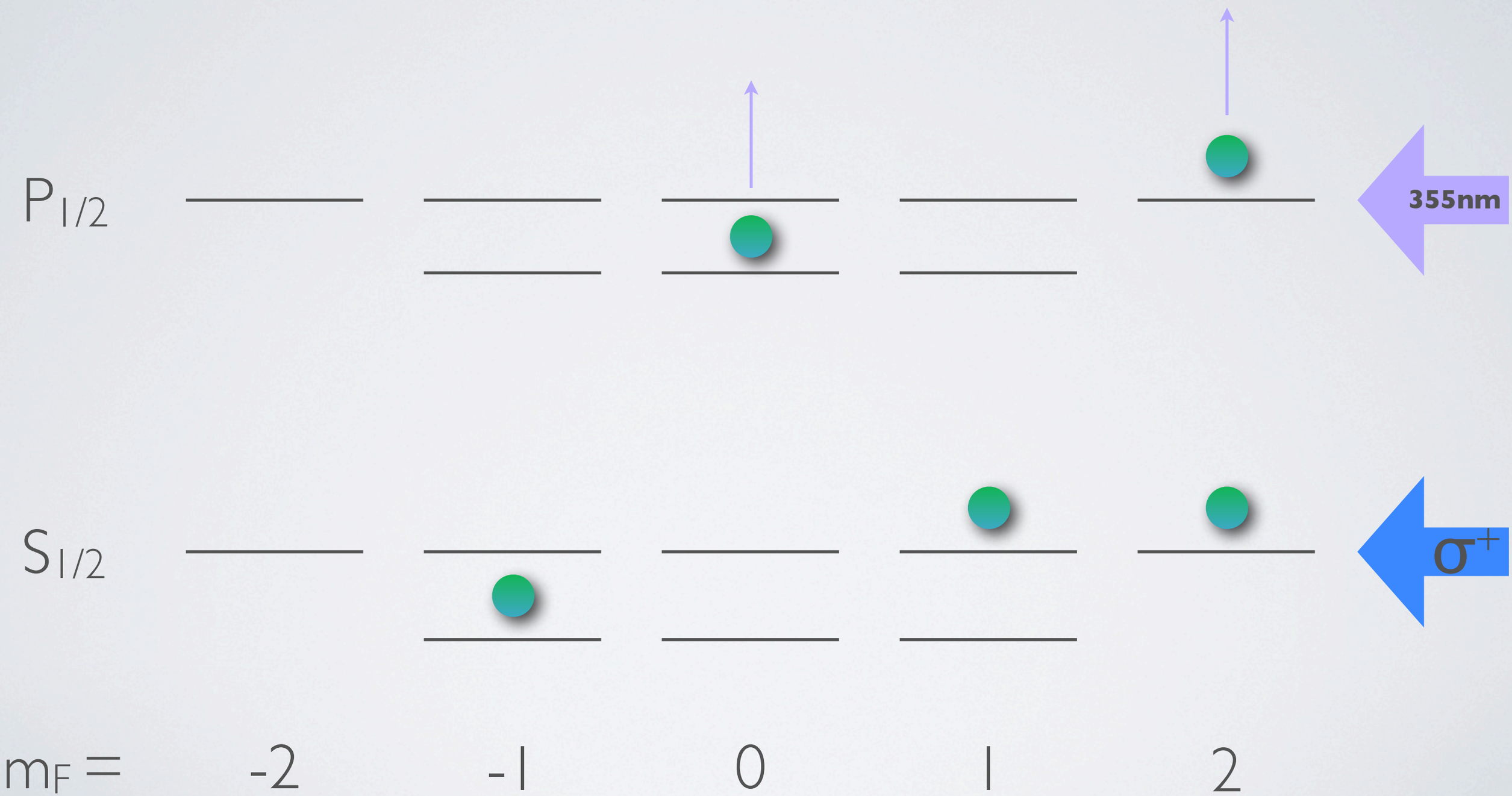


HOW DOES OPTICAL PUMPING WORK?

HOW DO WE MEASURE THE POLARITY OF THE ATOMS?



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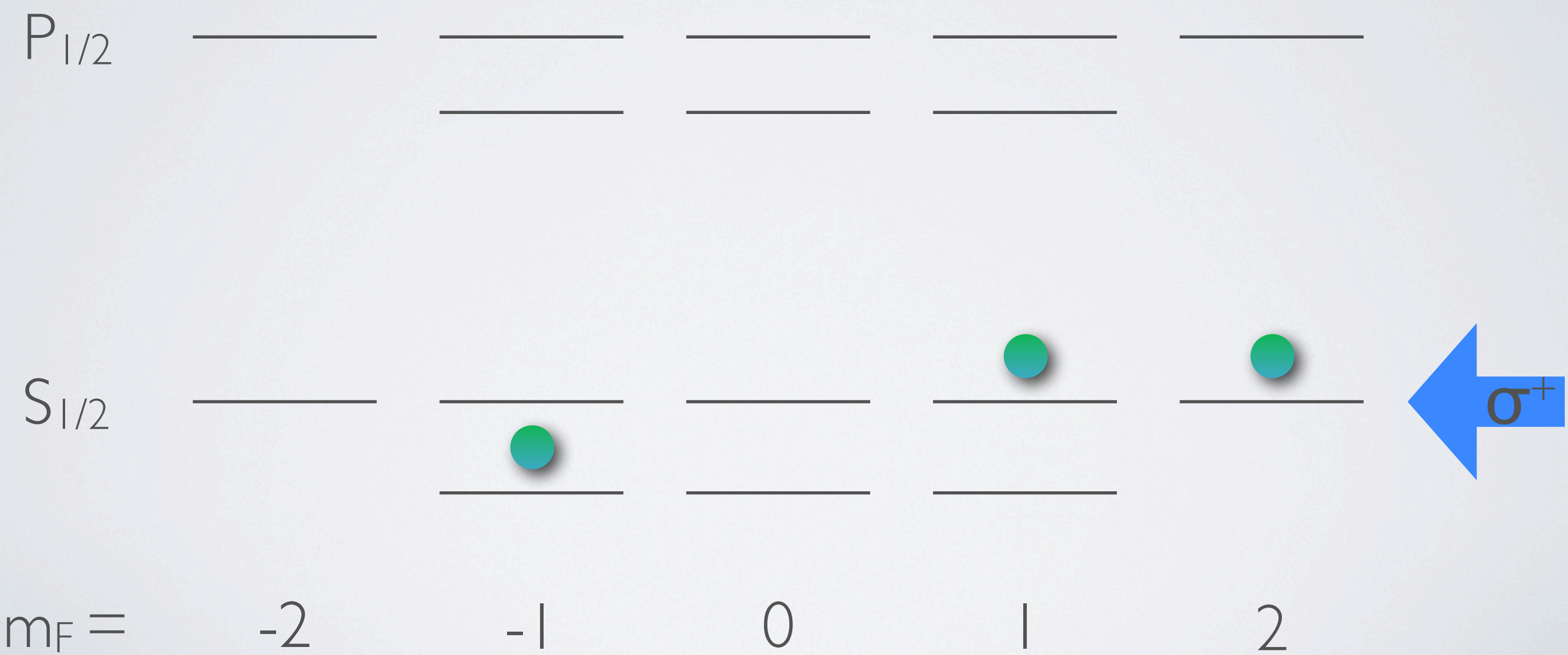

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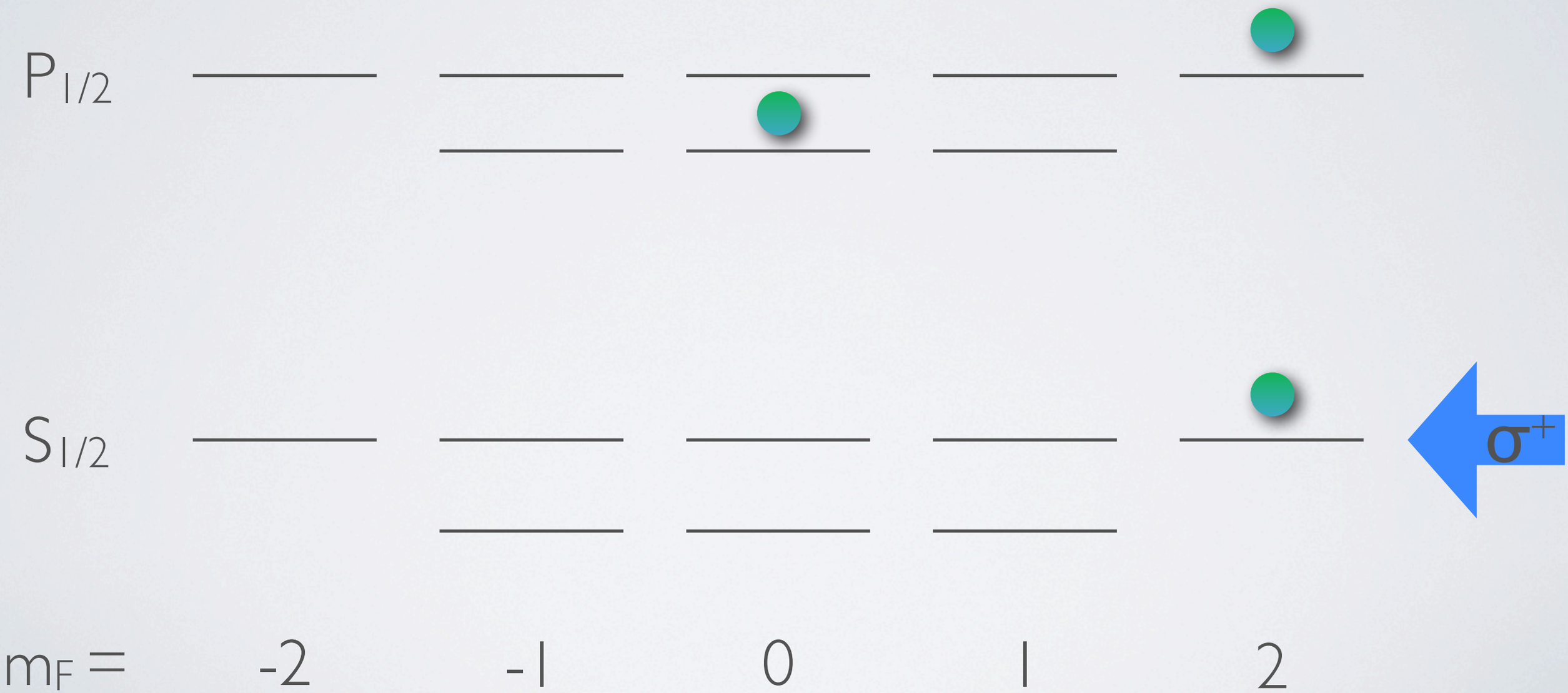

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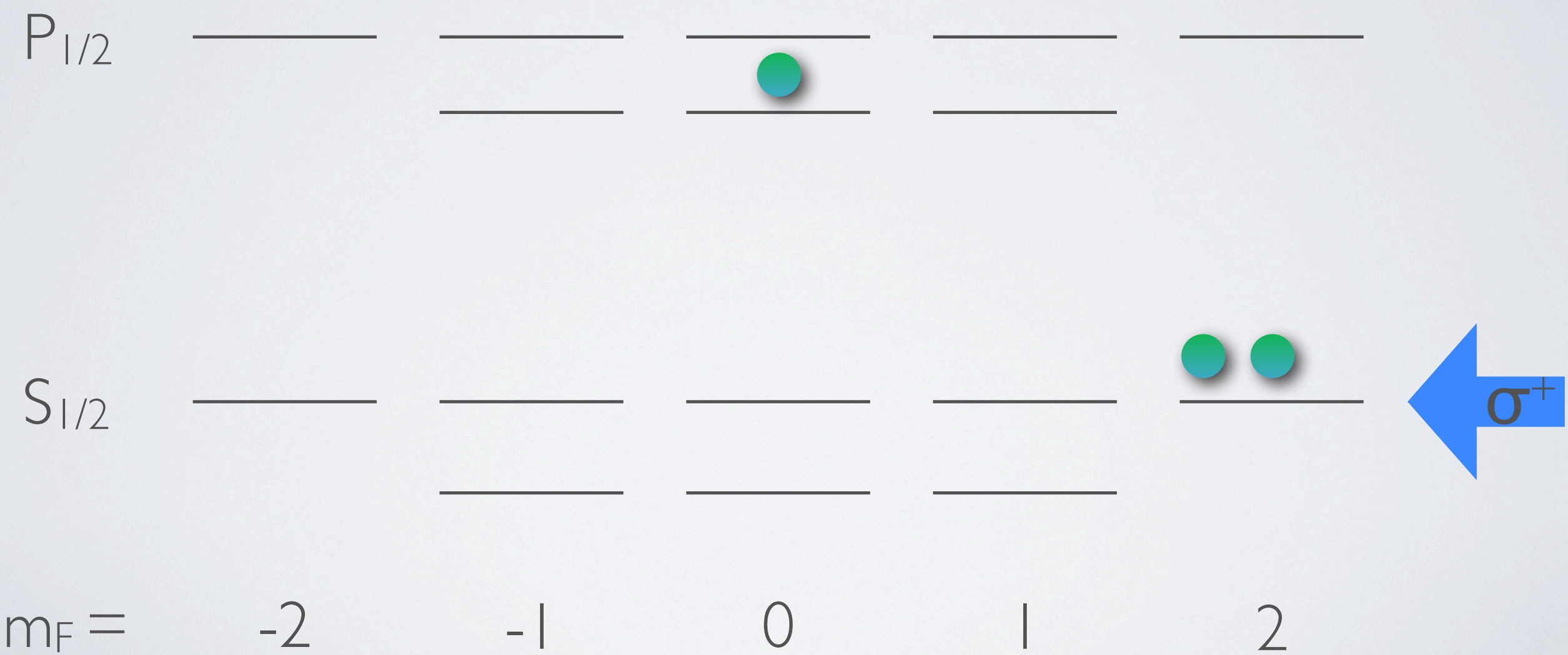

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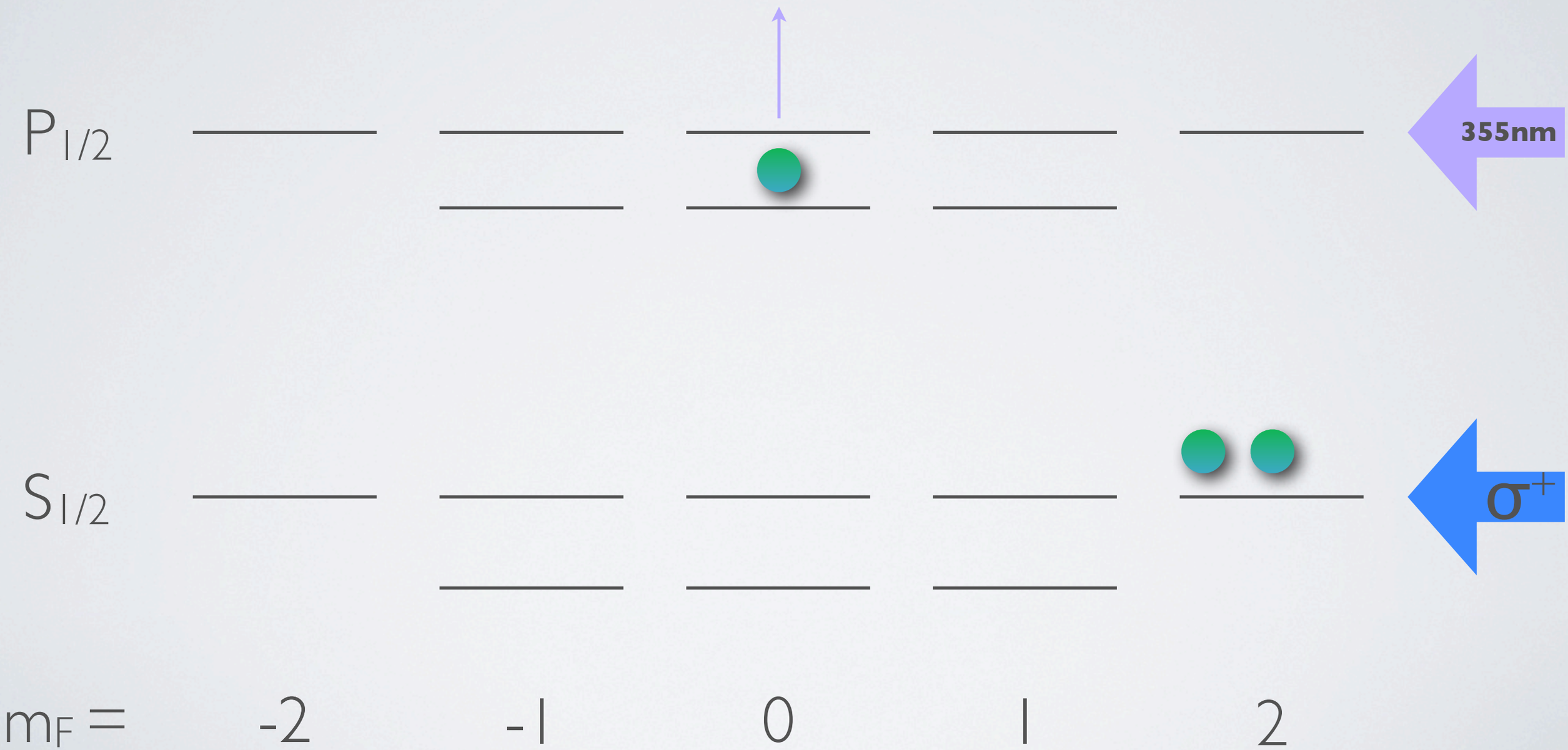
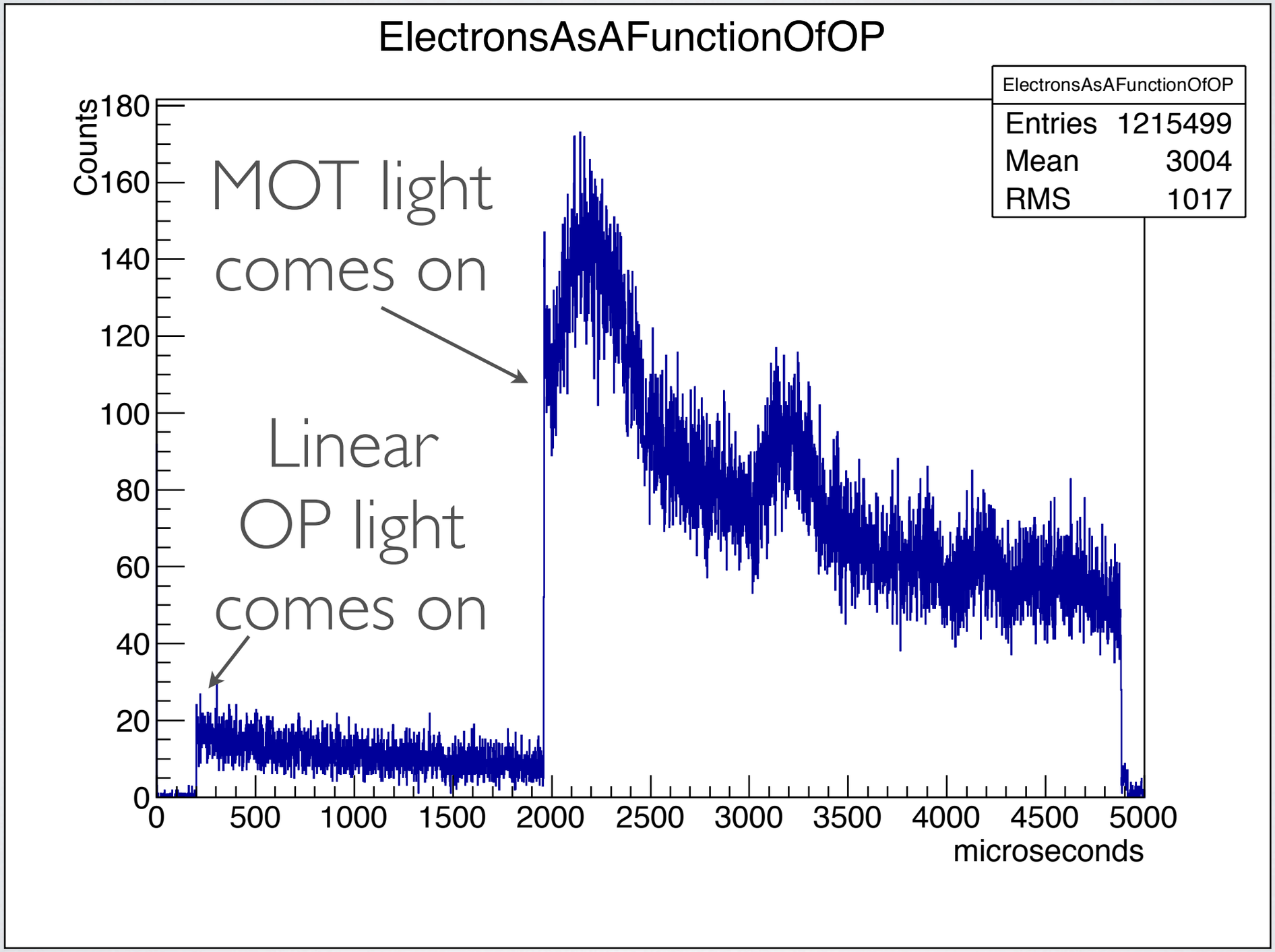


MEASURING THE POLARITY OF 41K ATOMS?



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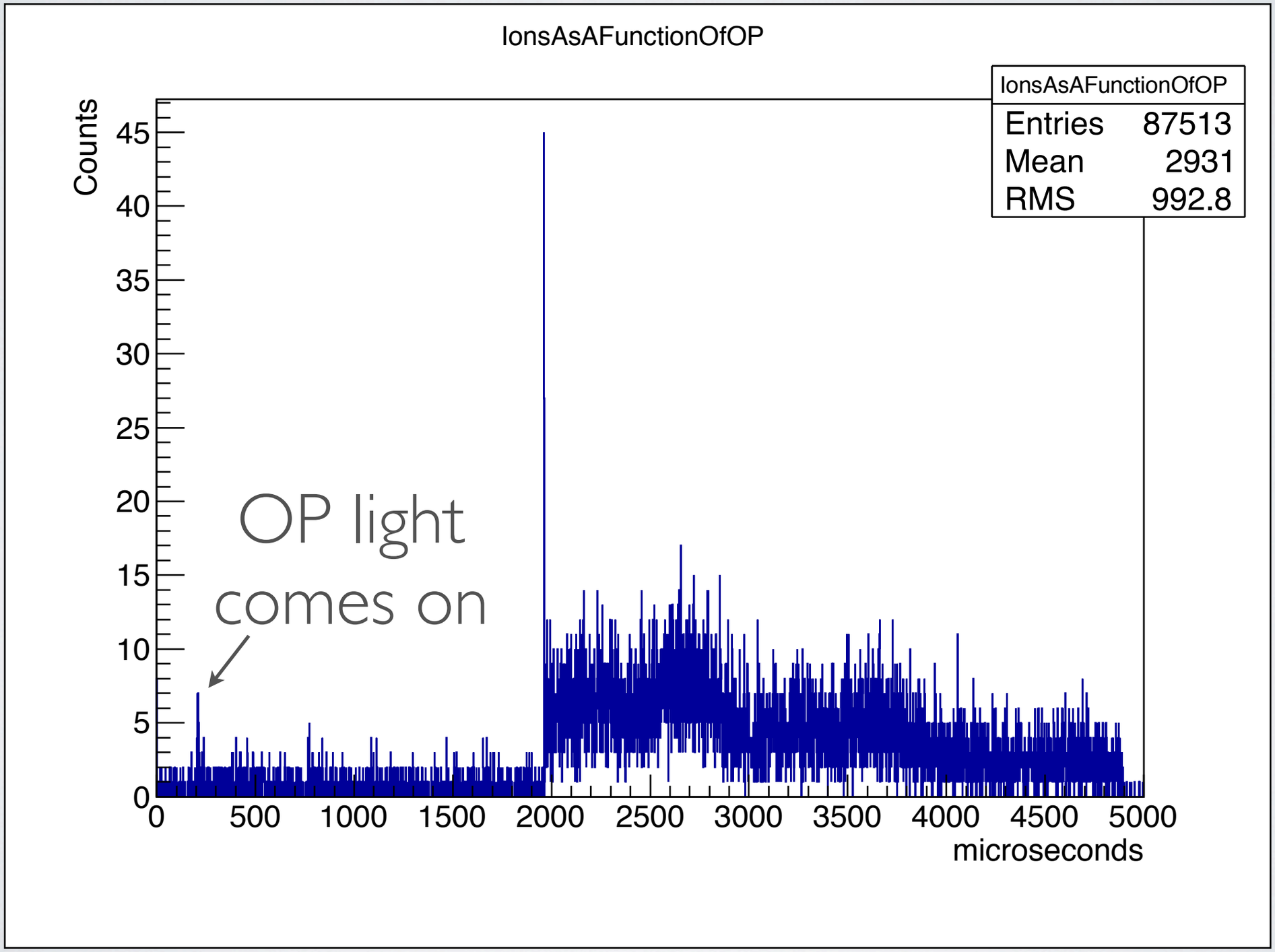

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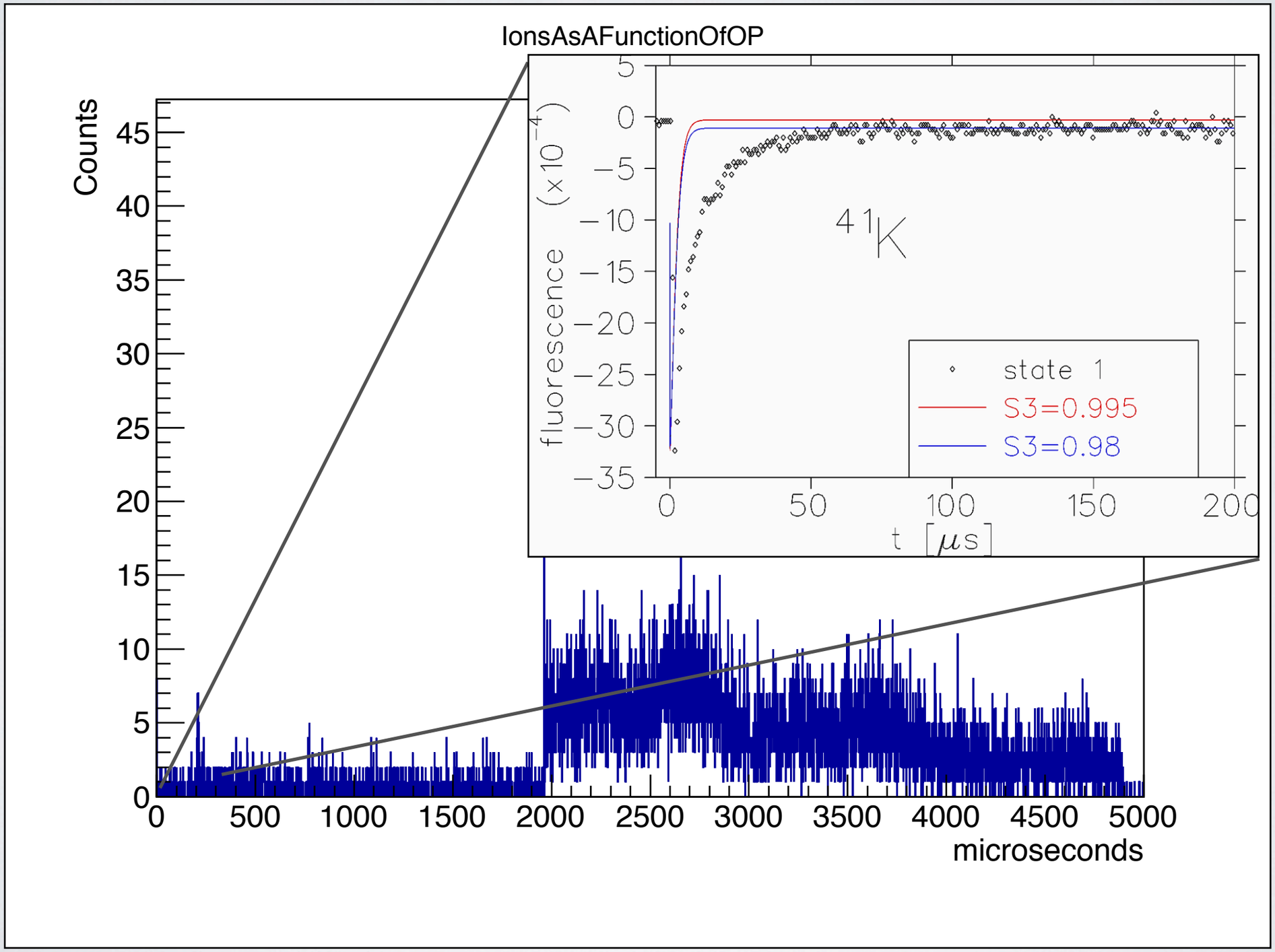
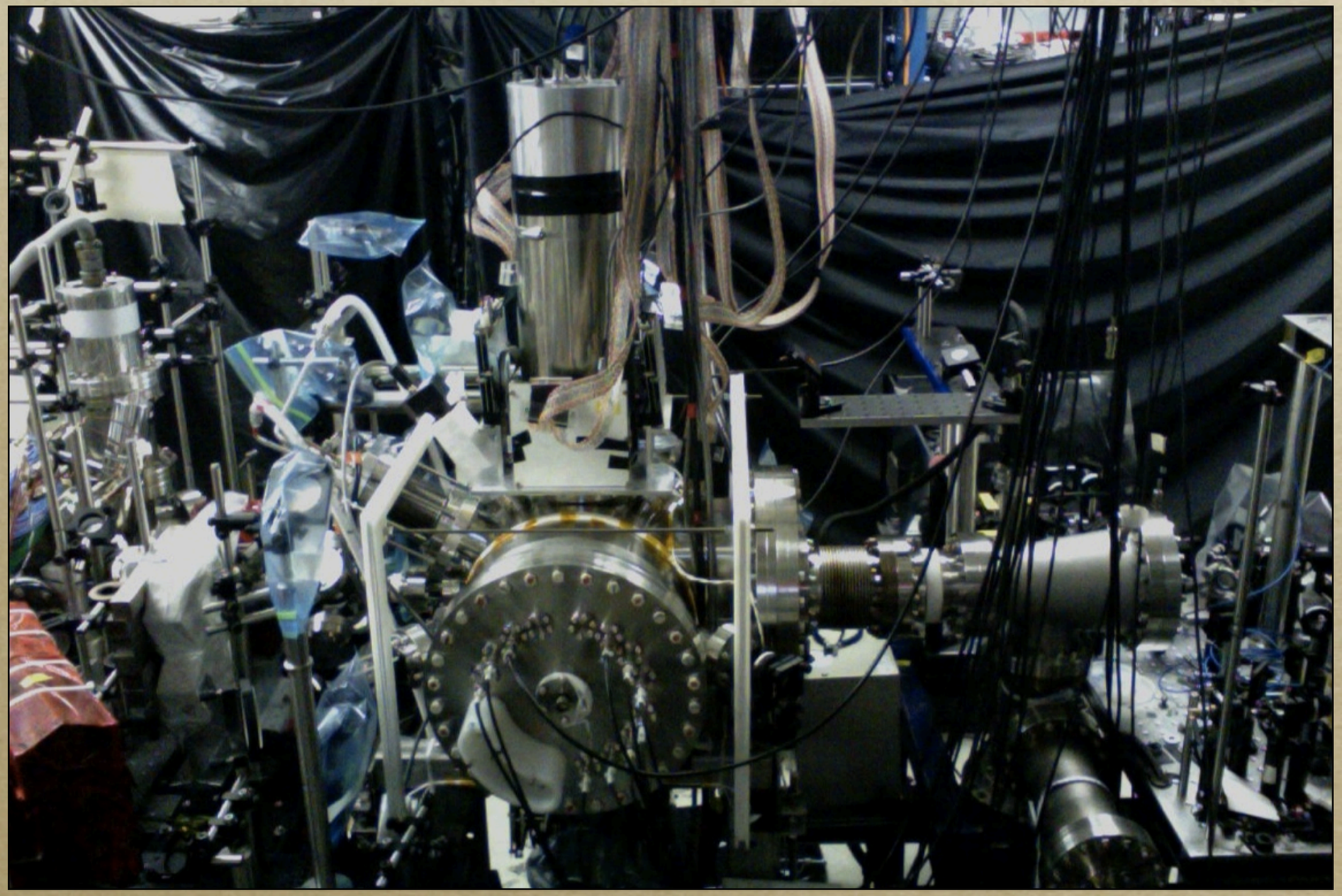


Everything Comes Together



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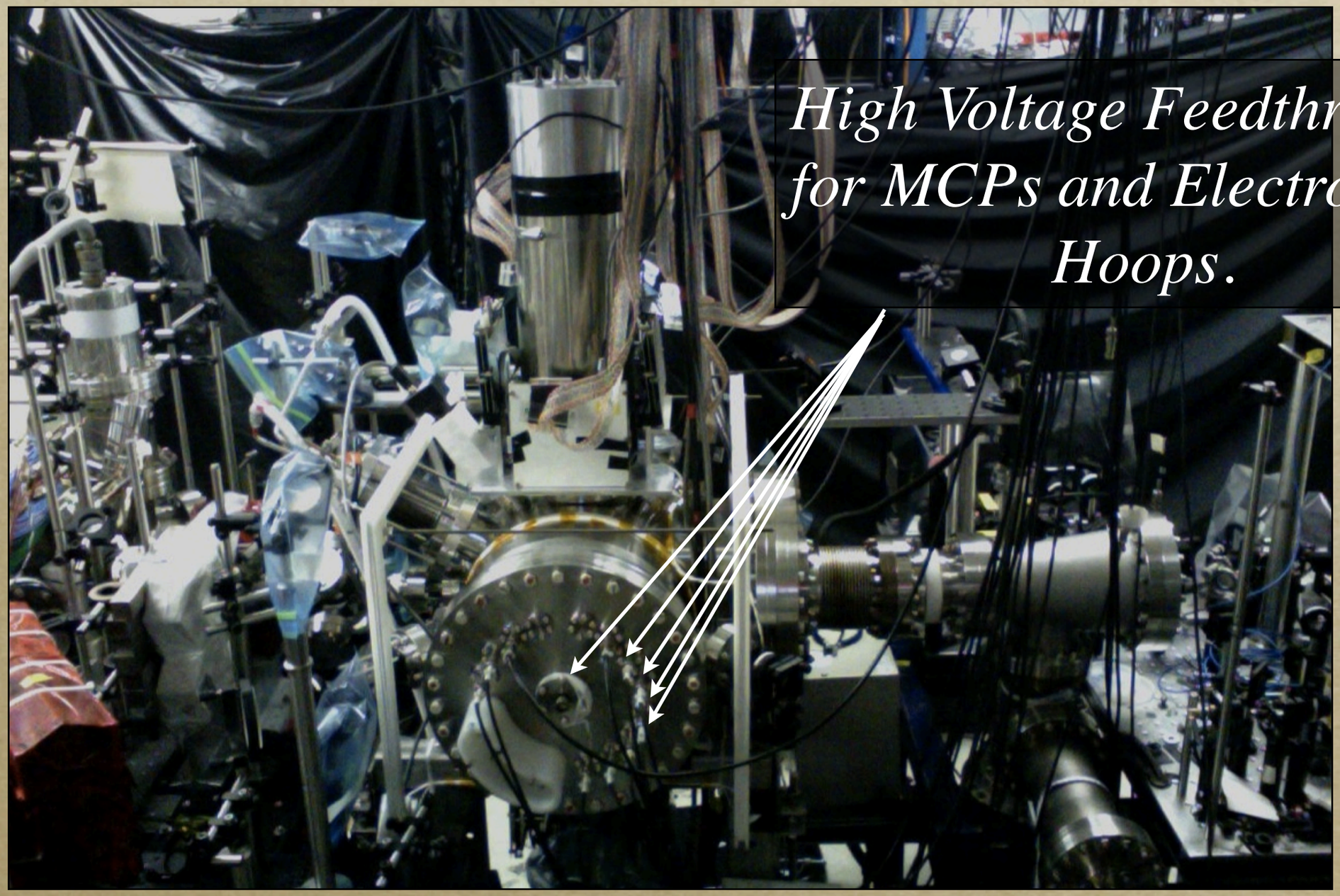

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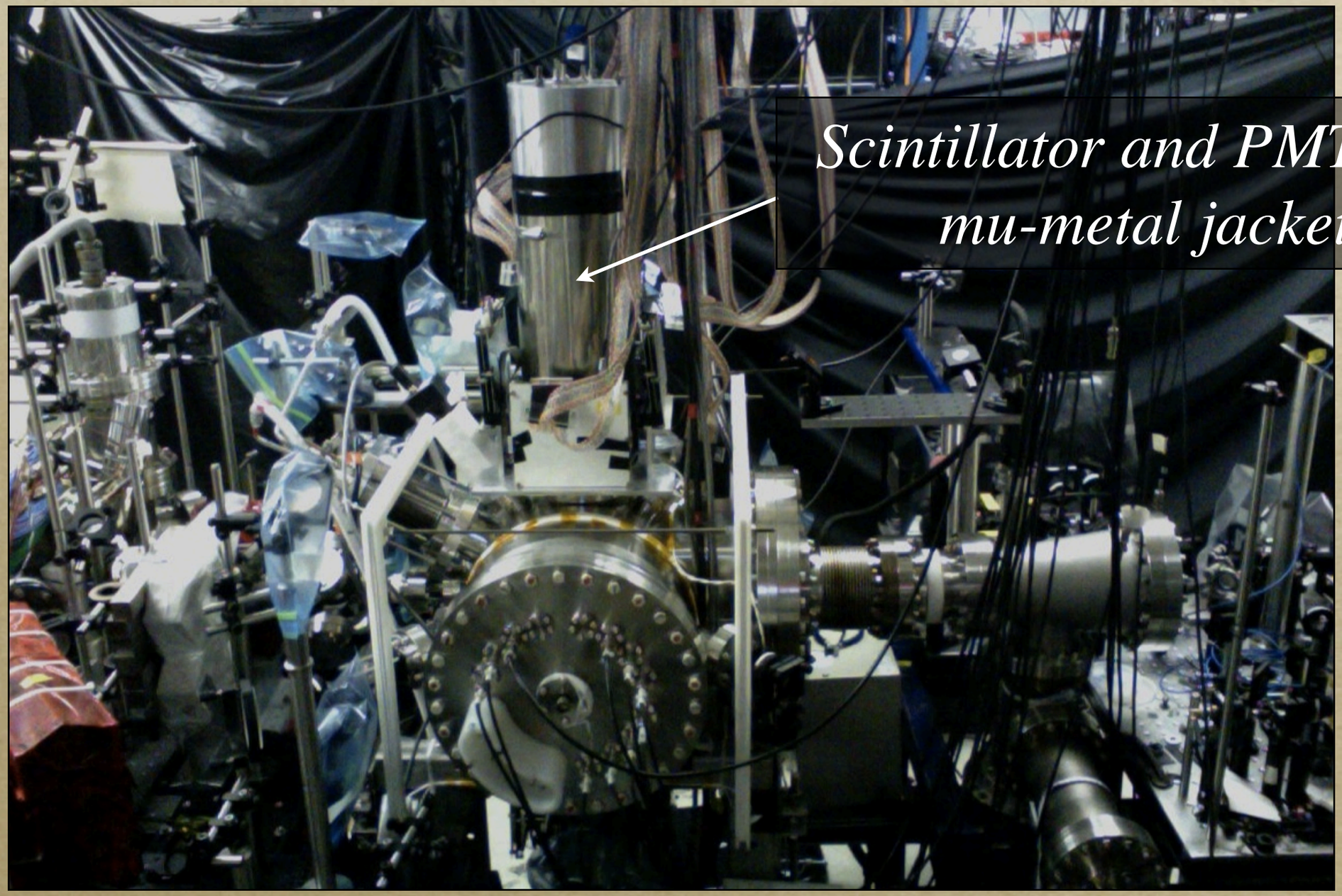

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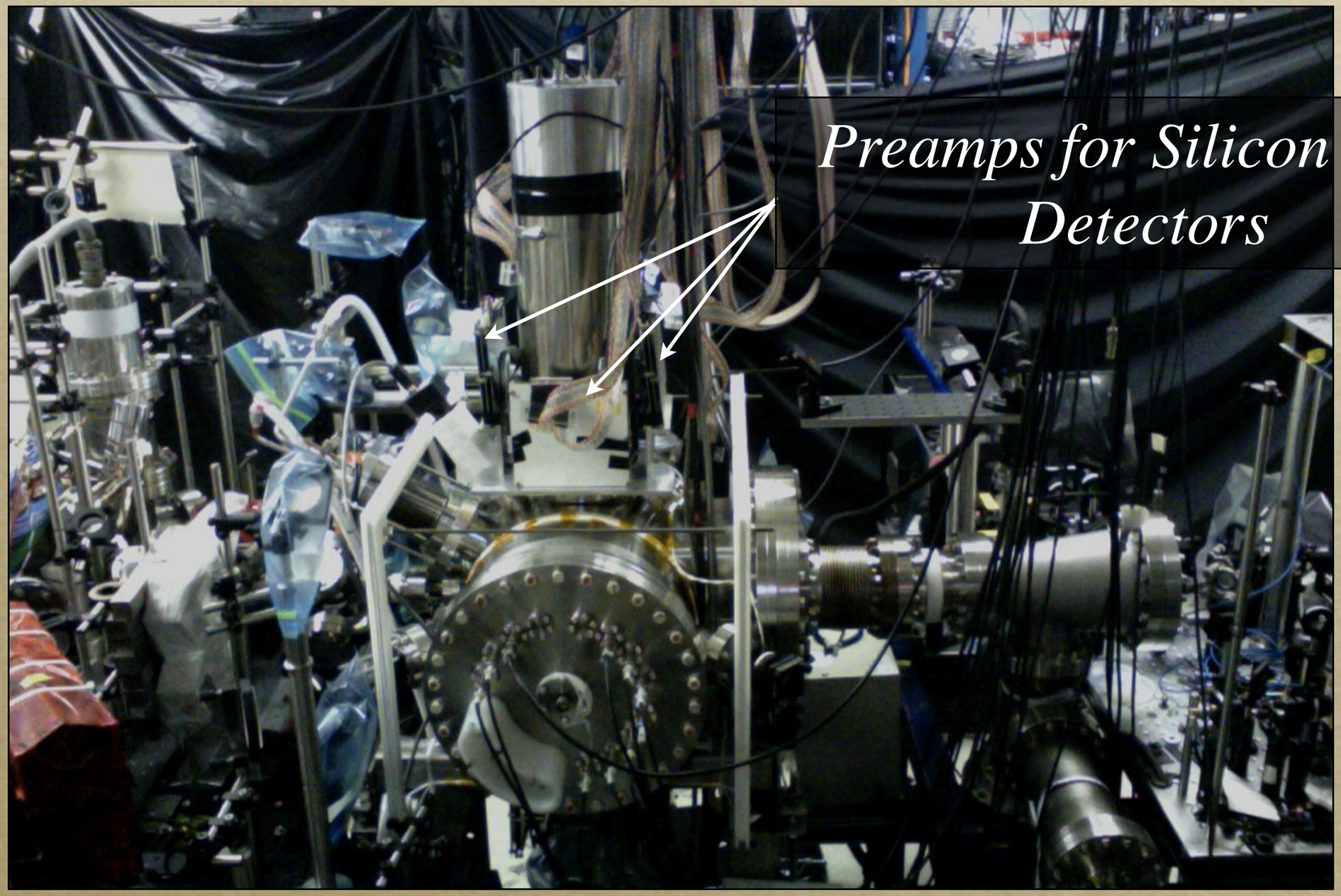

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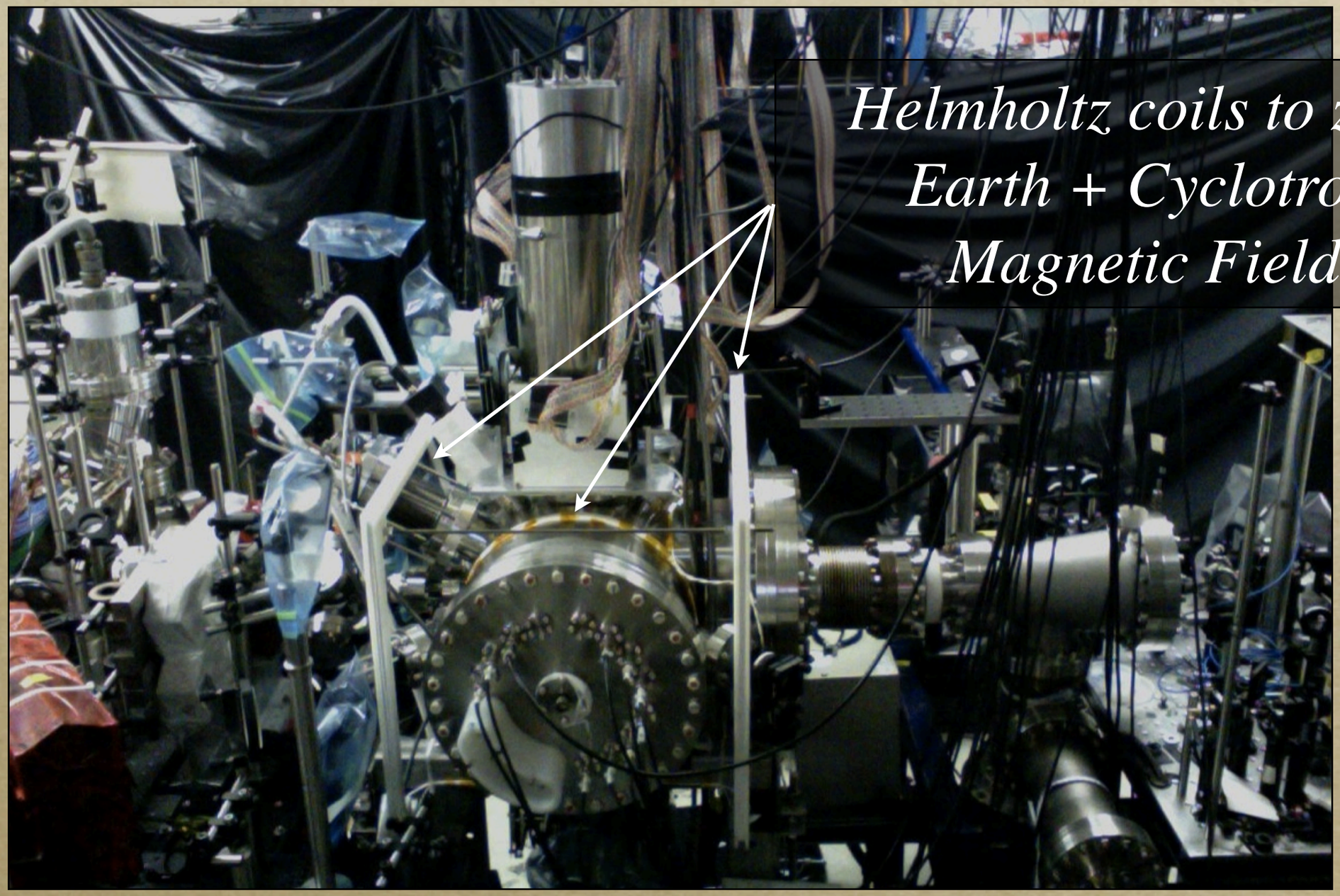

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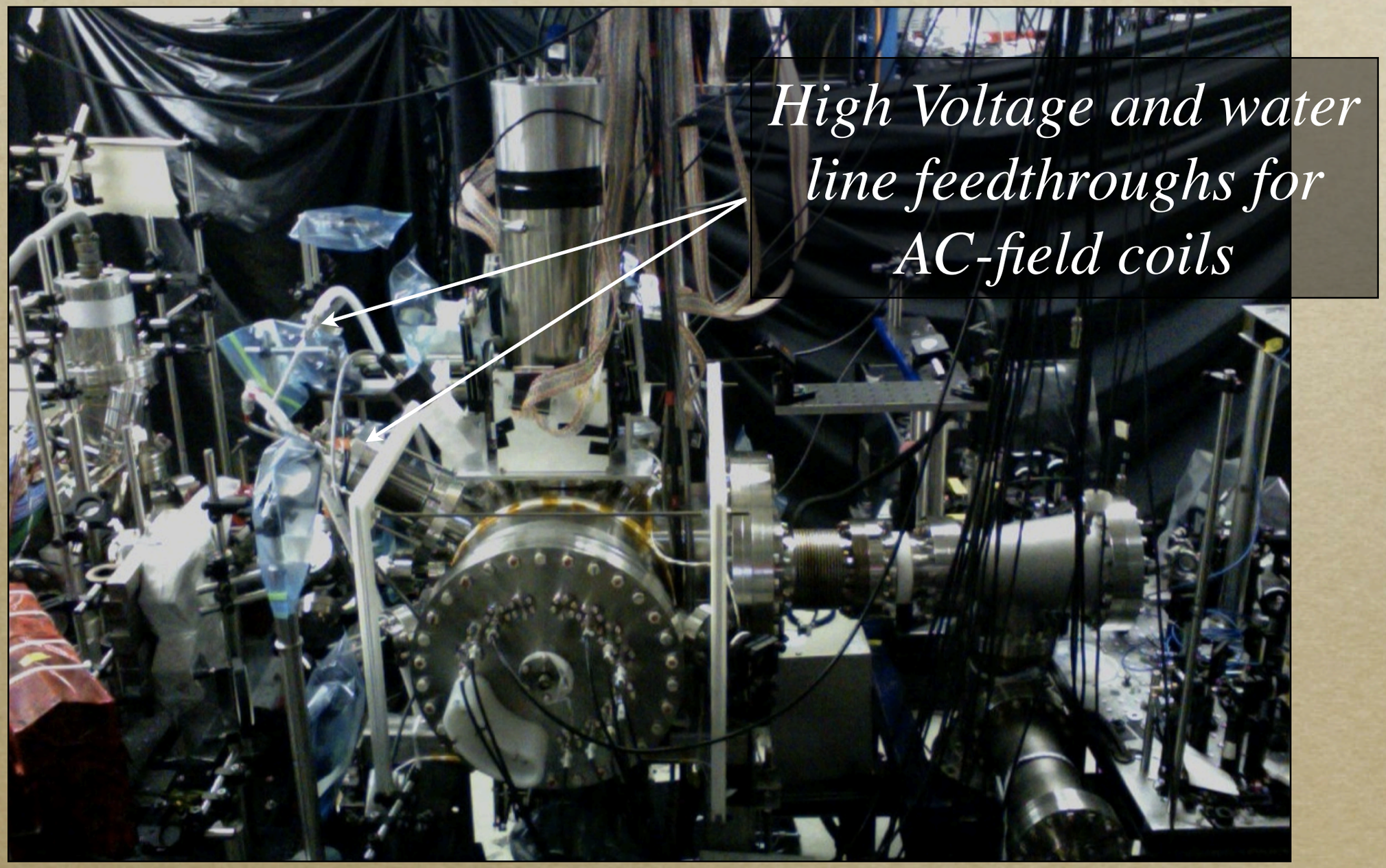
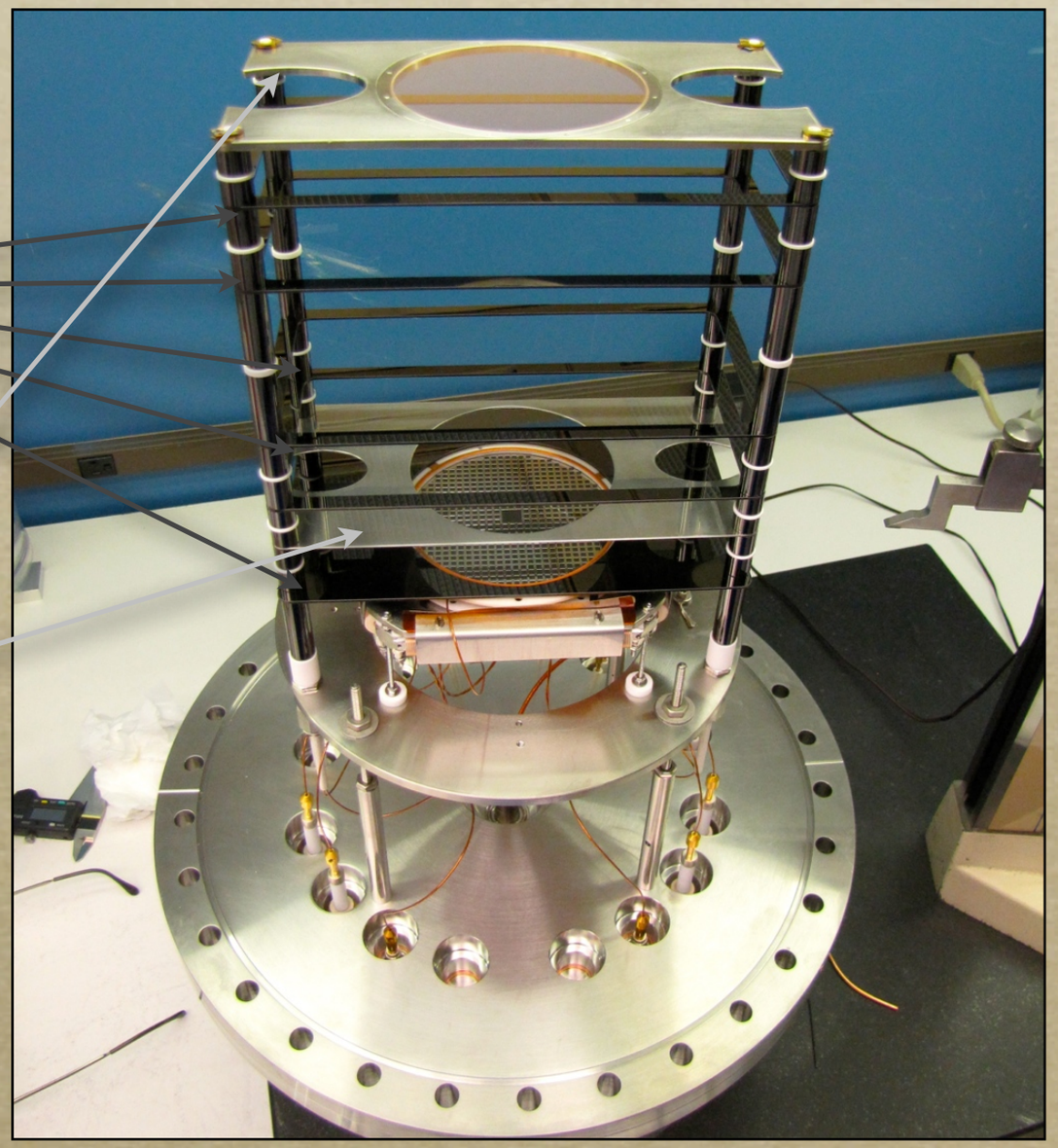


Installation of MCPs

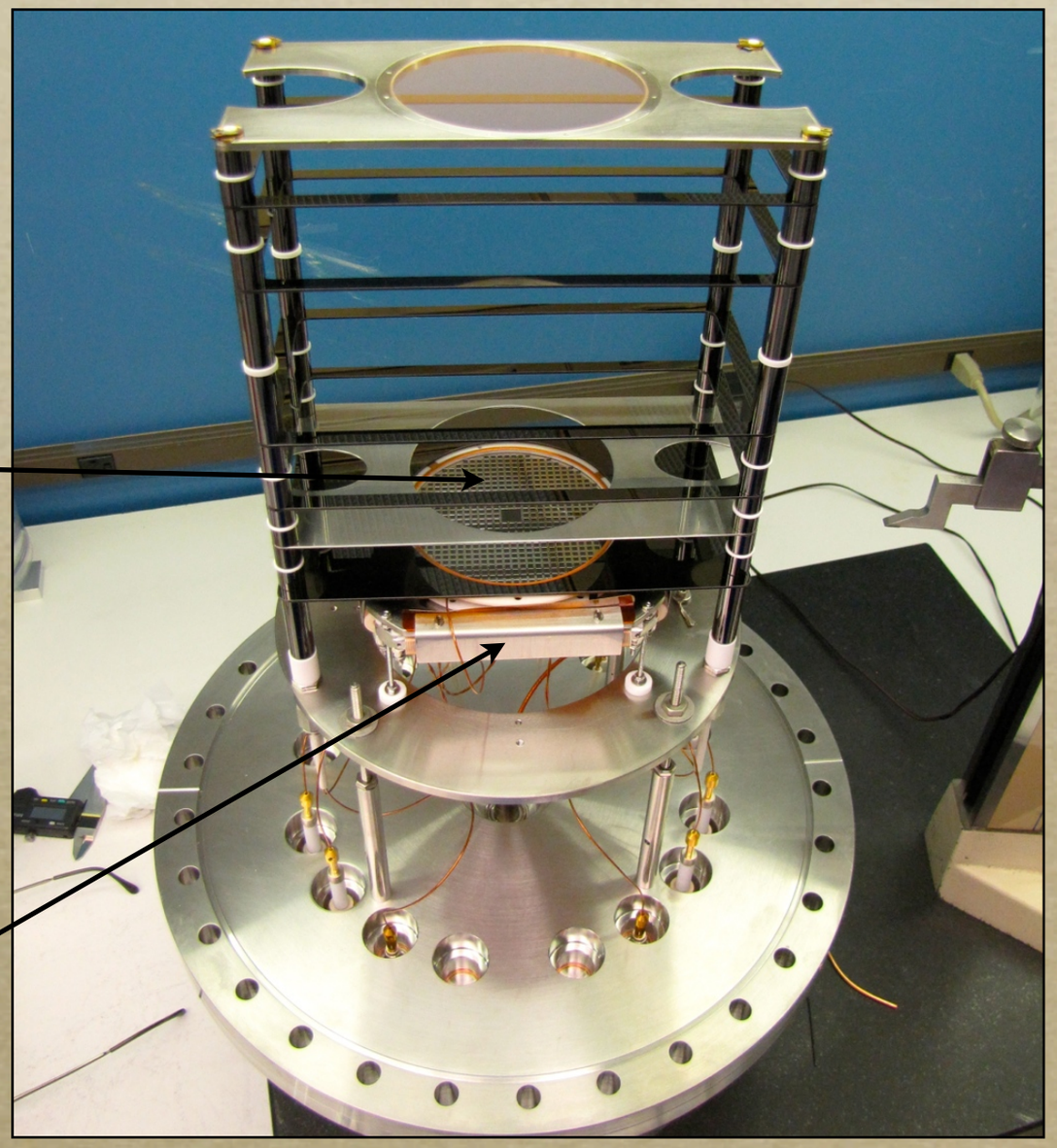
Glassy Carbon Electrostatic Hoops

Grade 4 Titanium, hand polished, to replace broken glassy carbon hoops



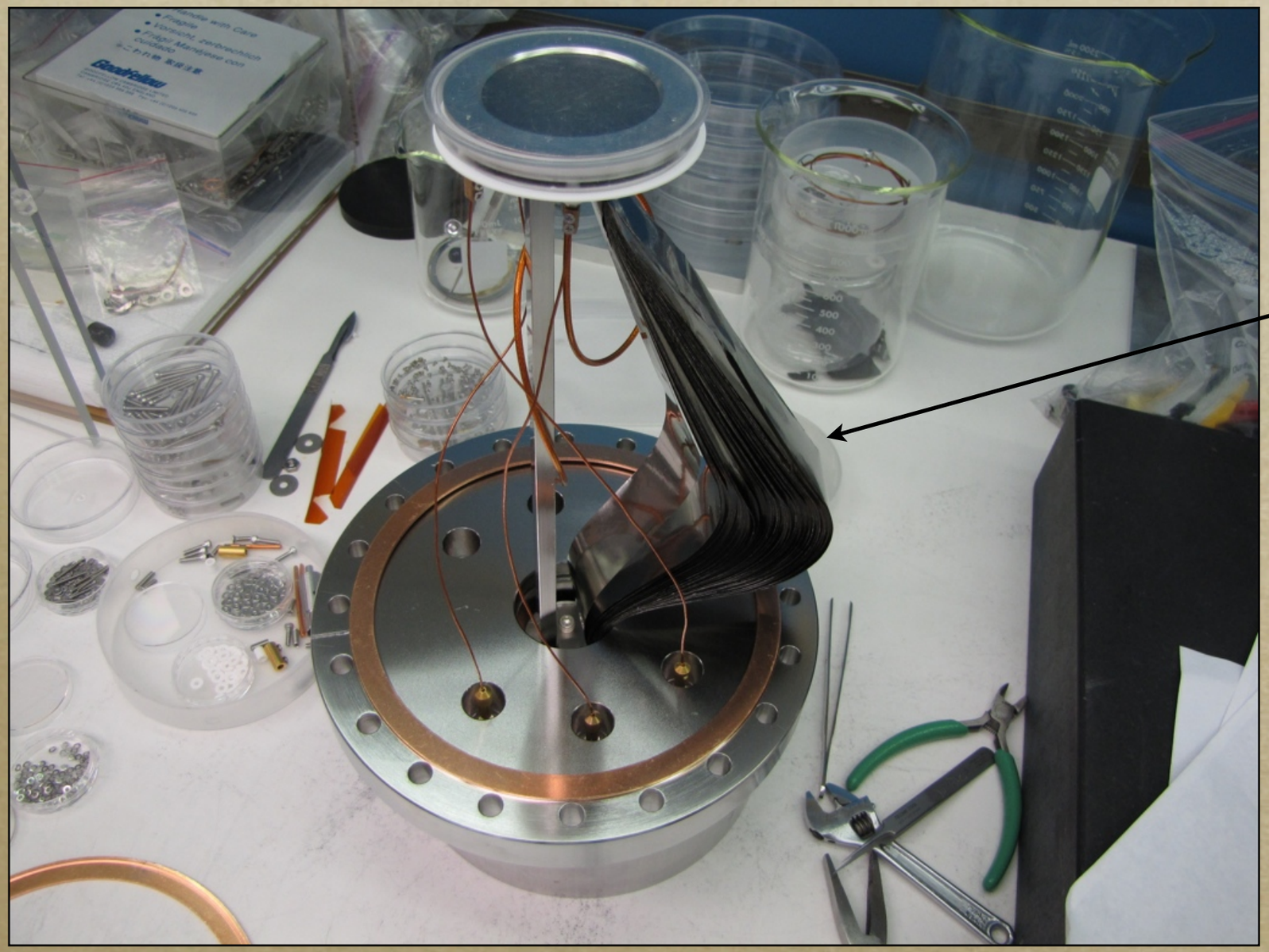
Installation of MCPs

Calibration Mask. 4/9ths open. Large open area in center to image trap.



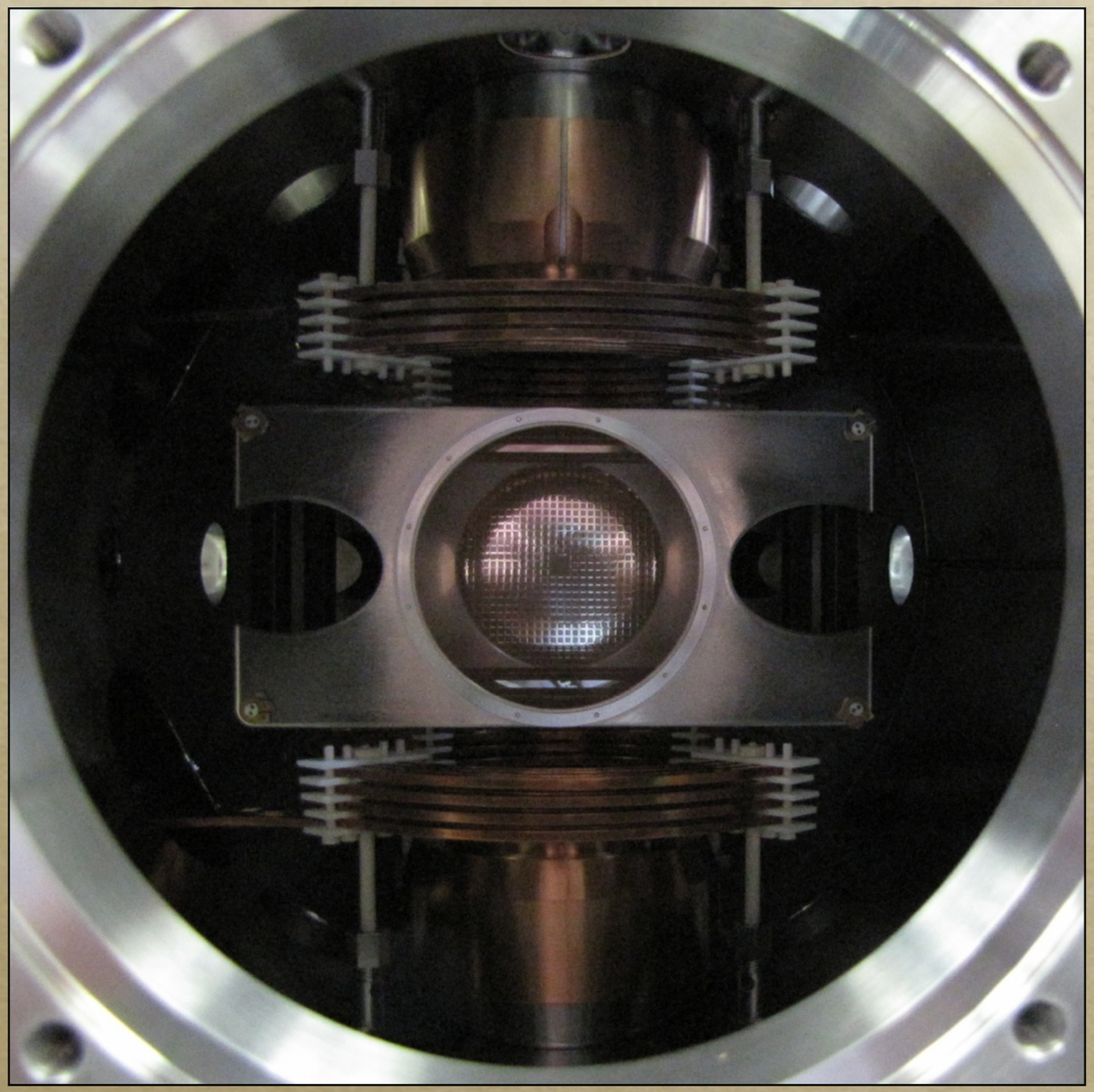
Delay Line Anode for position sensitive readout

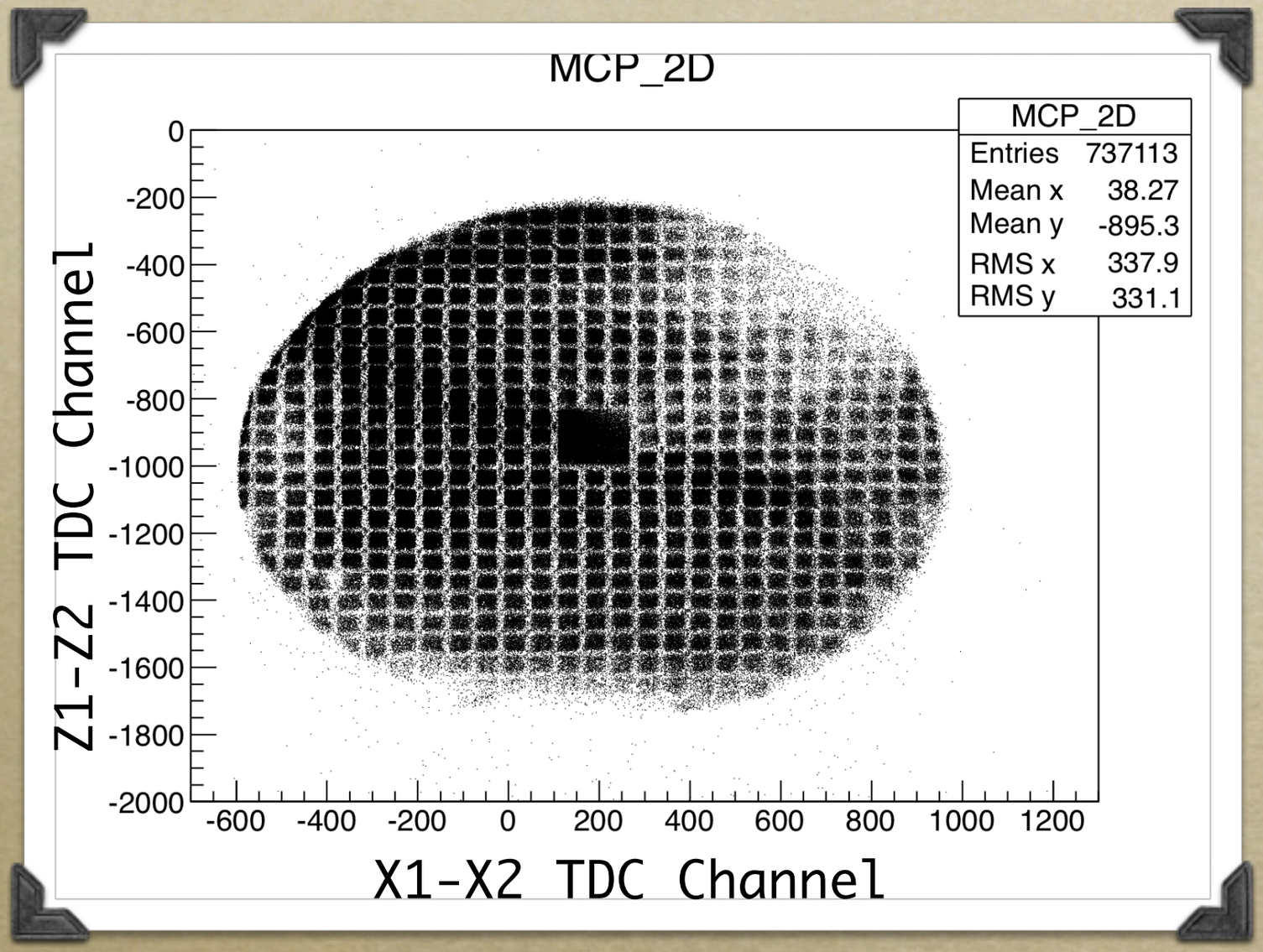
The Shake-off-electron MCP



Low Inductance Ground. 50 Titanium foils 20um x 1.2”x12”

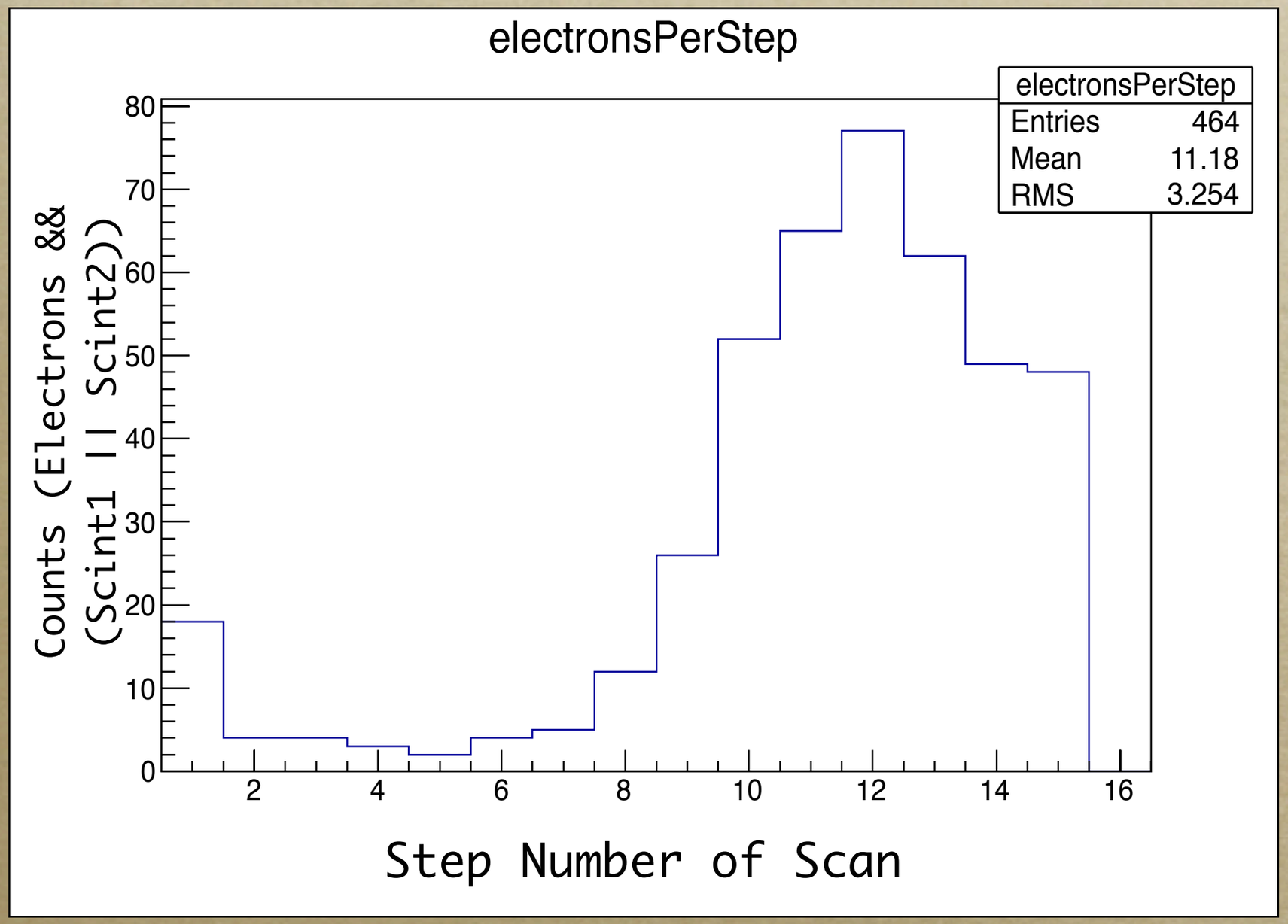
Installation of the Hoops

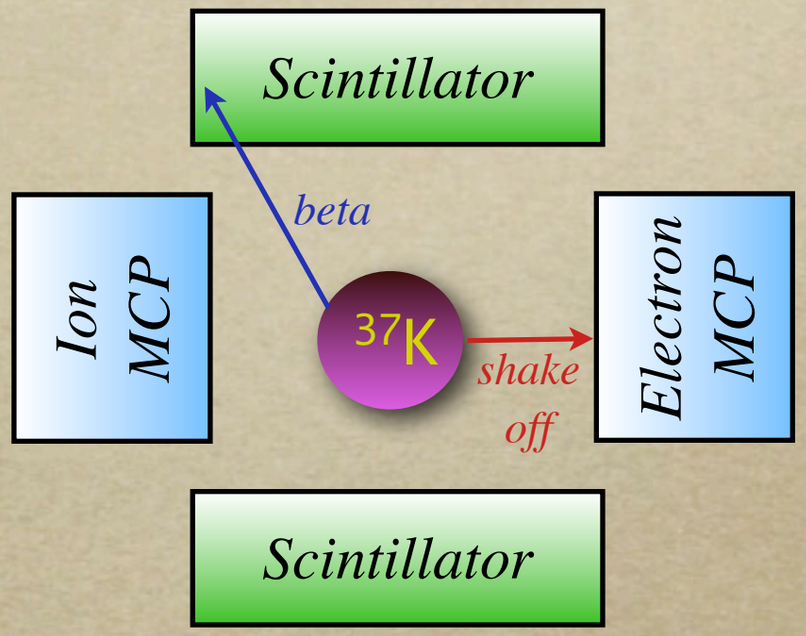




The Beam Time

Finding The Trap





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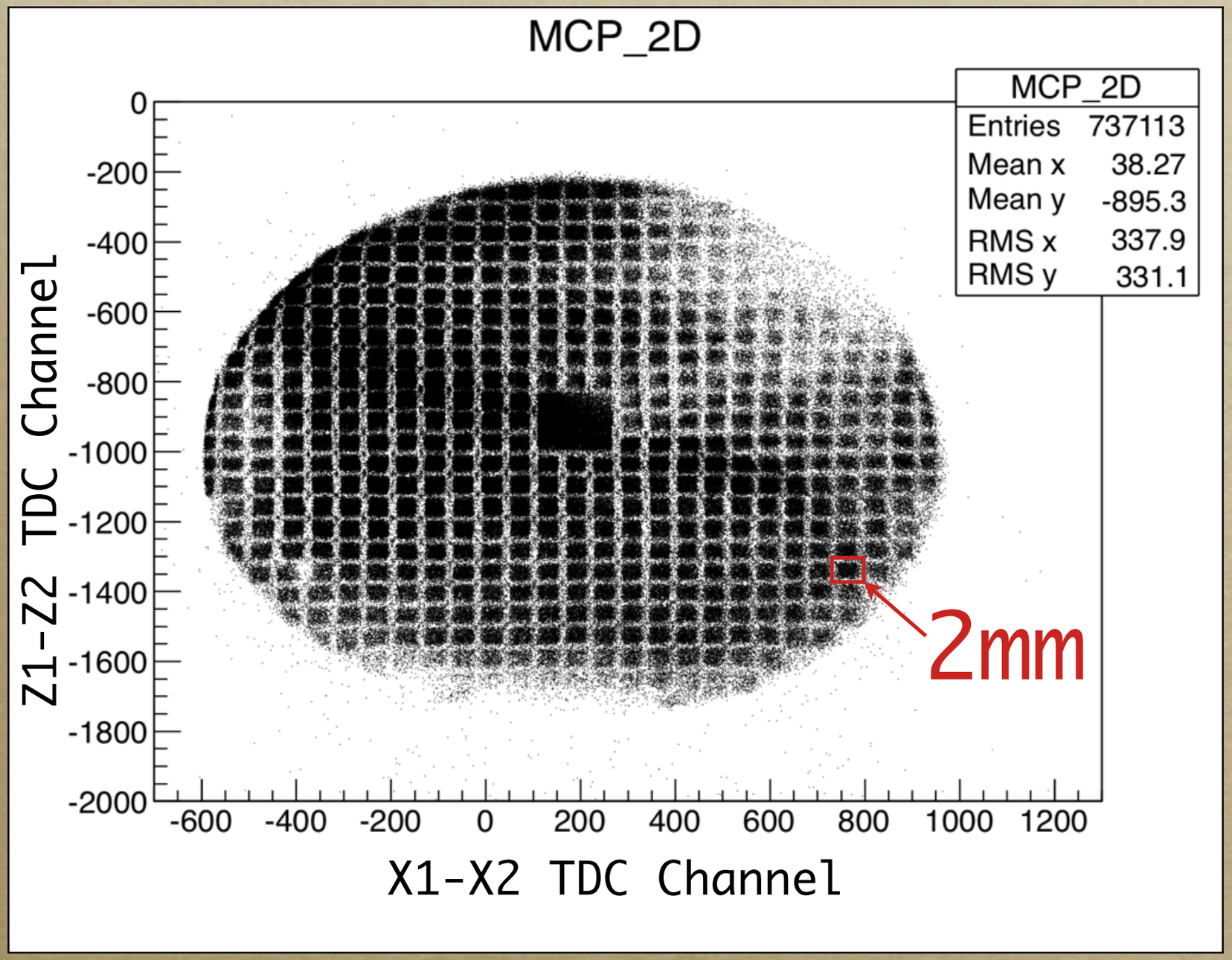

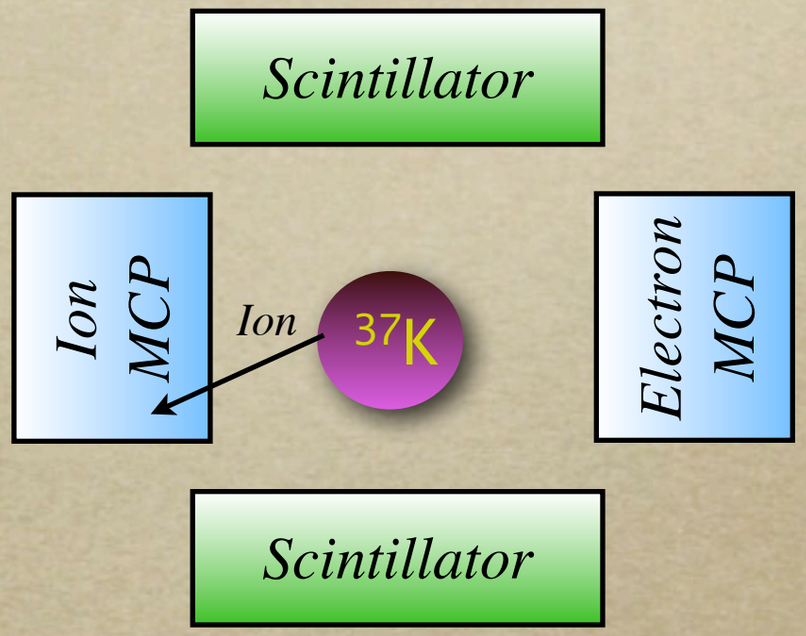

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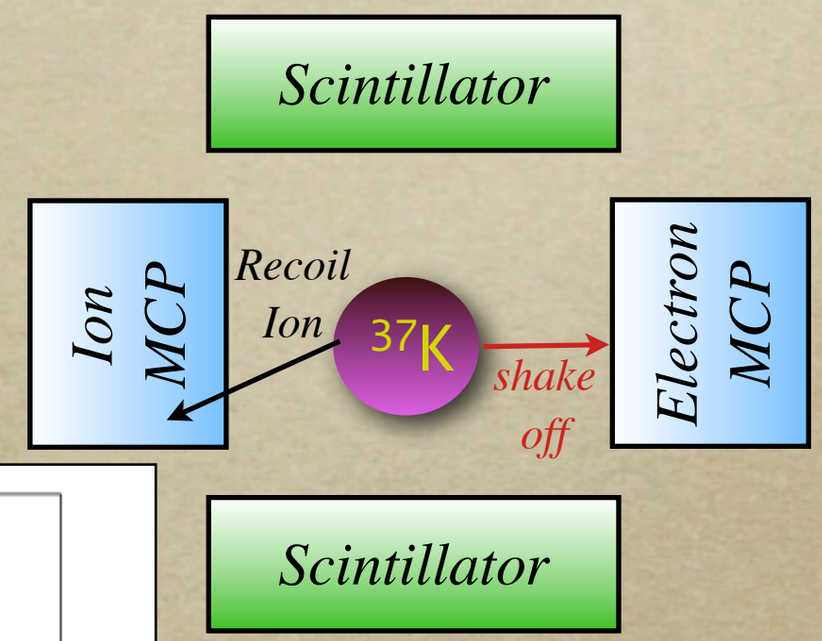

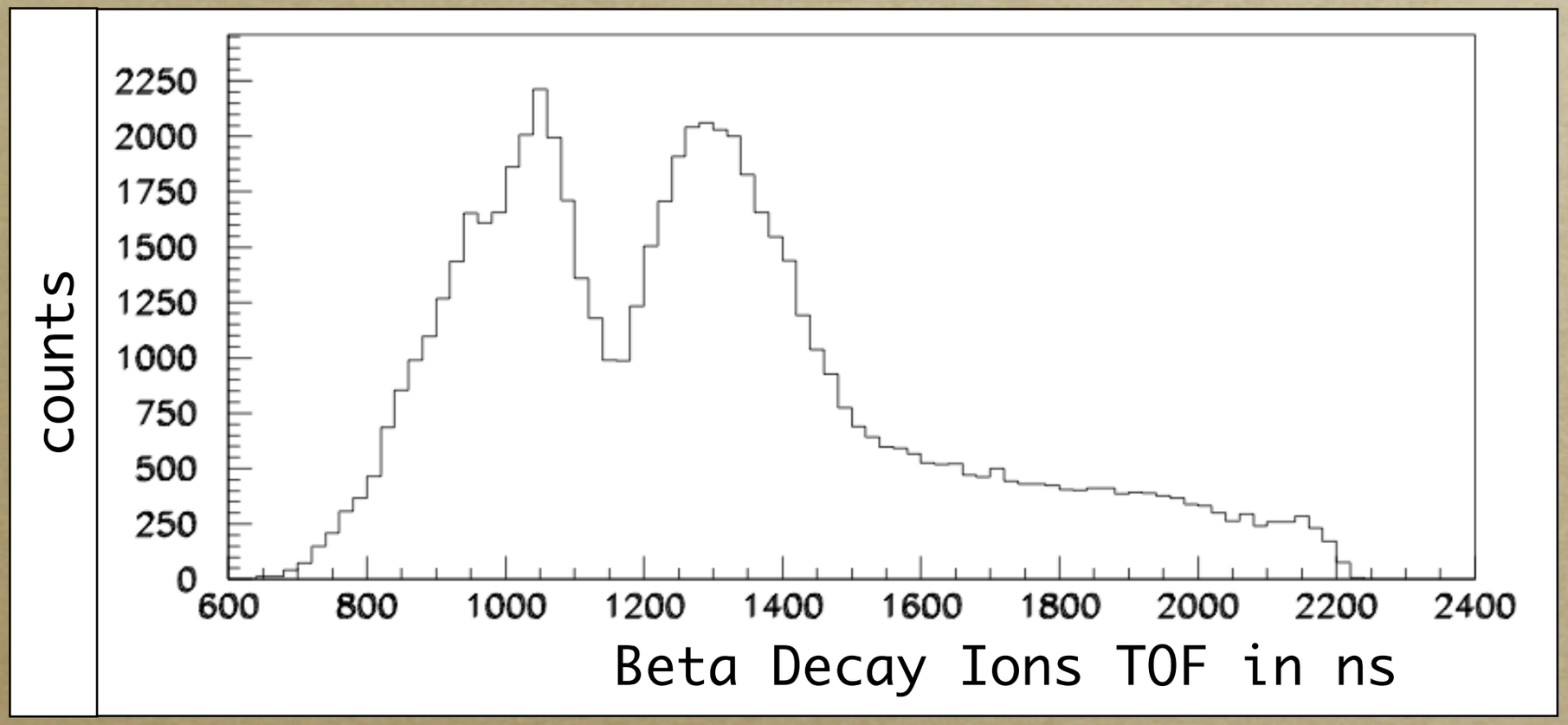

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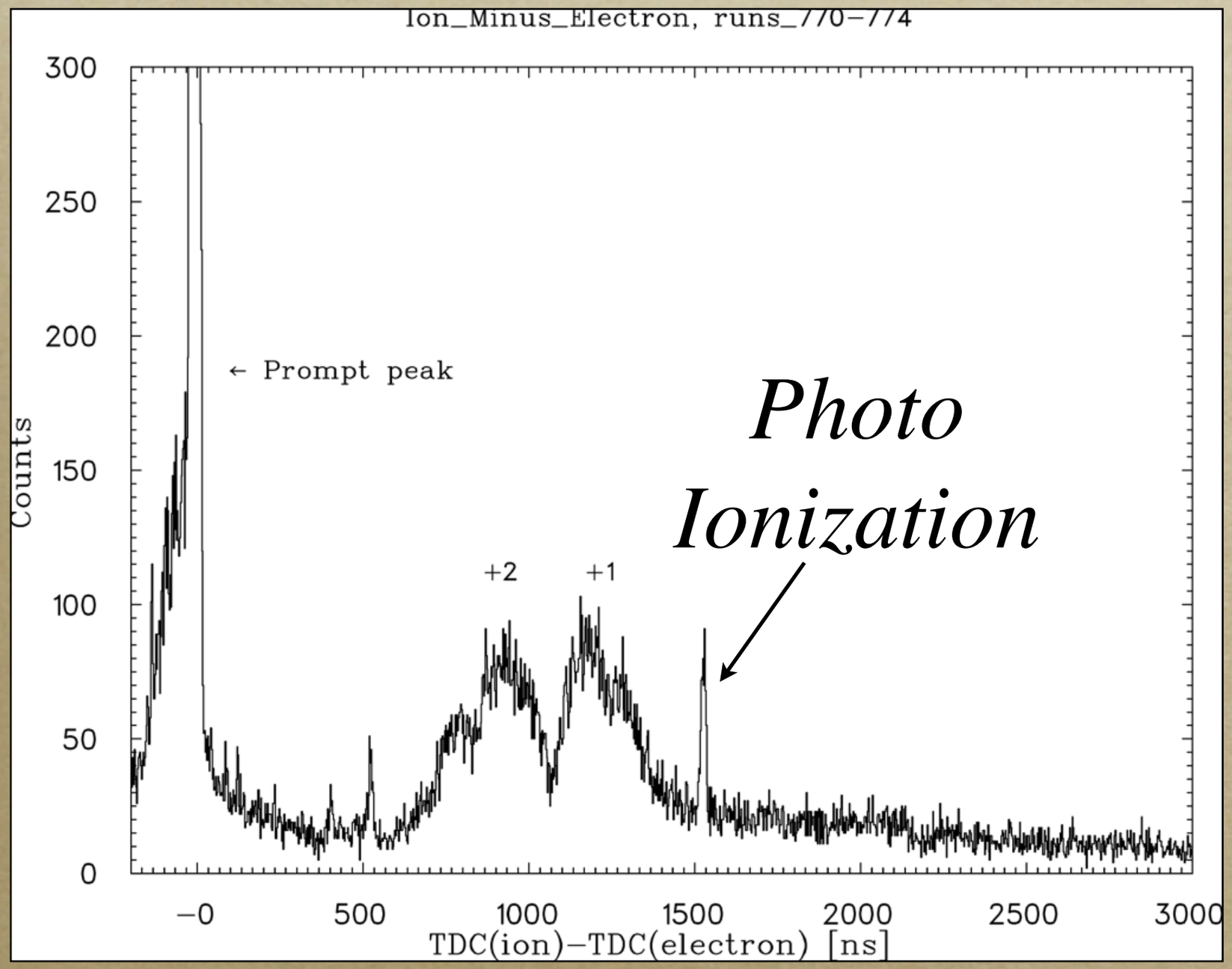

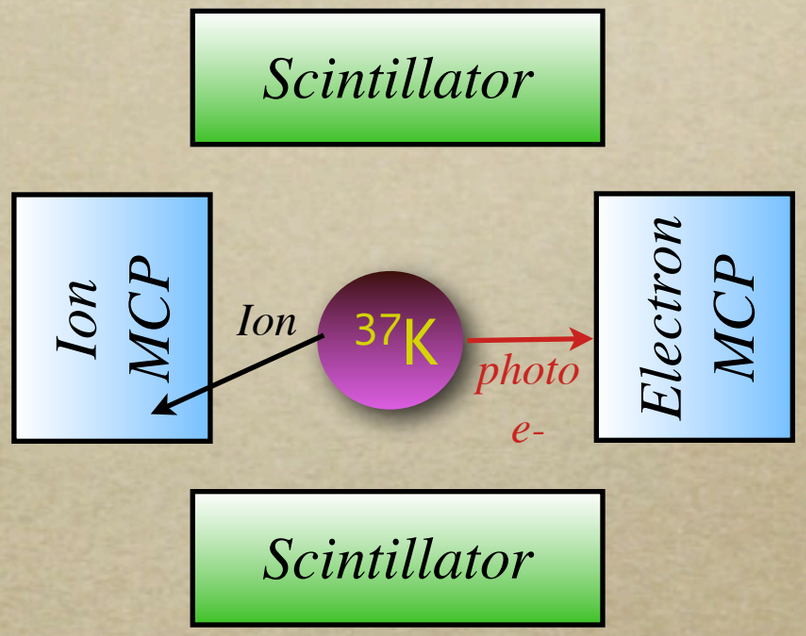

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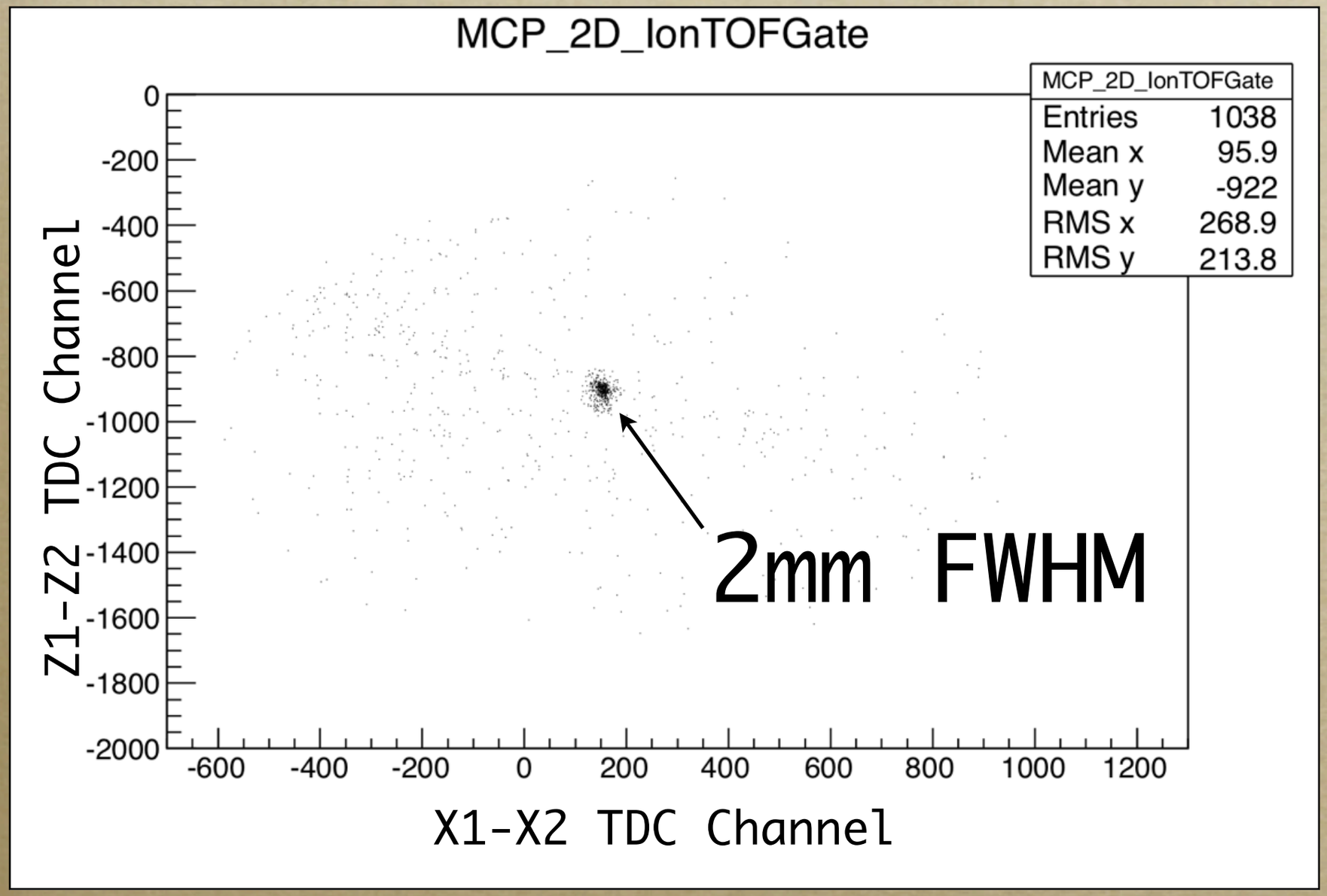
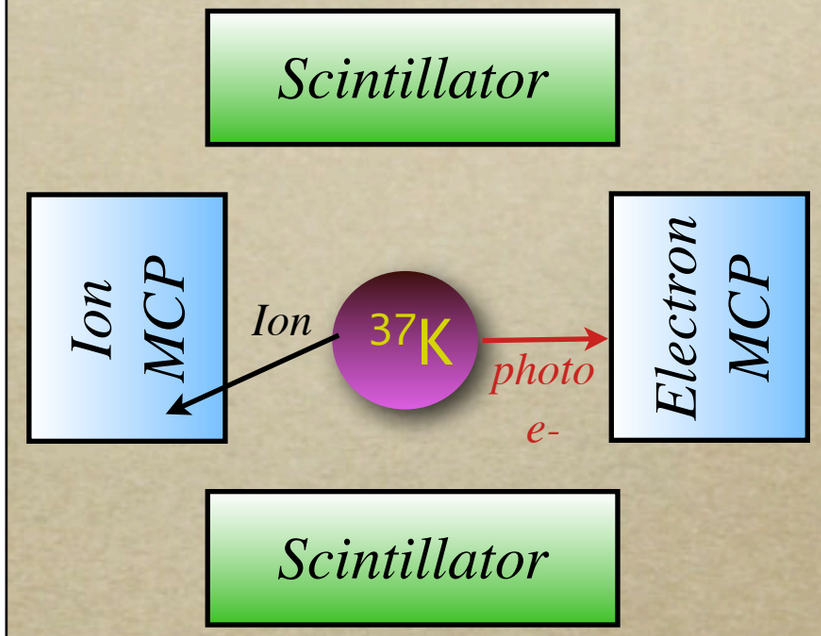
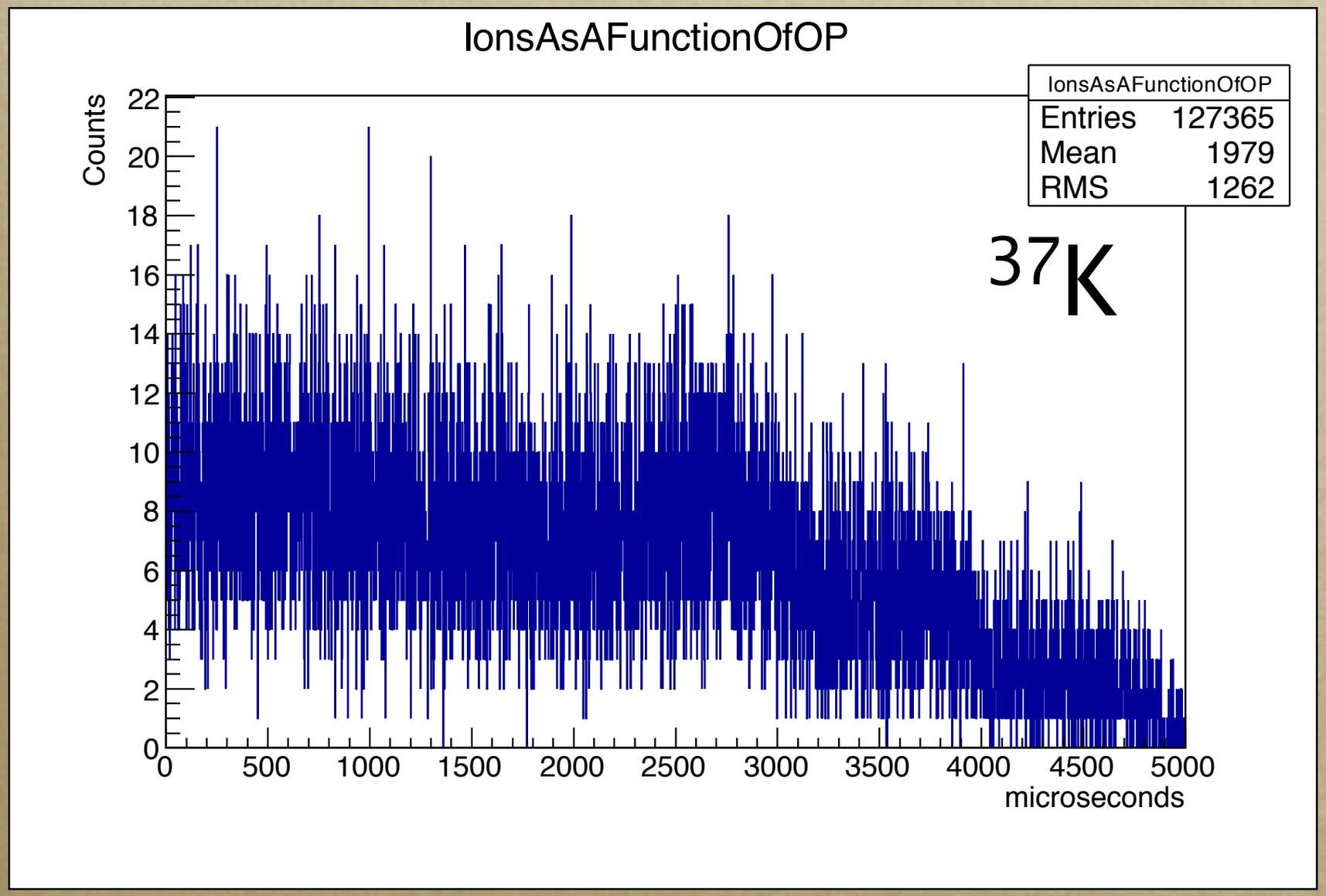
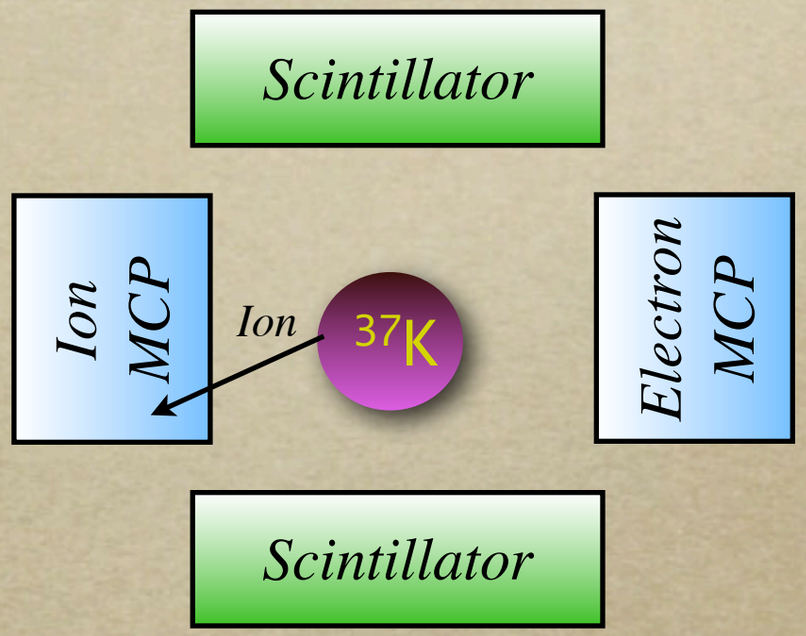
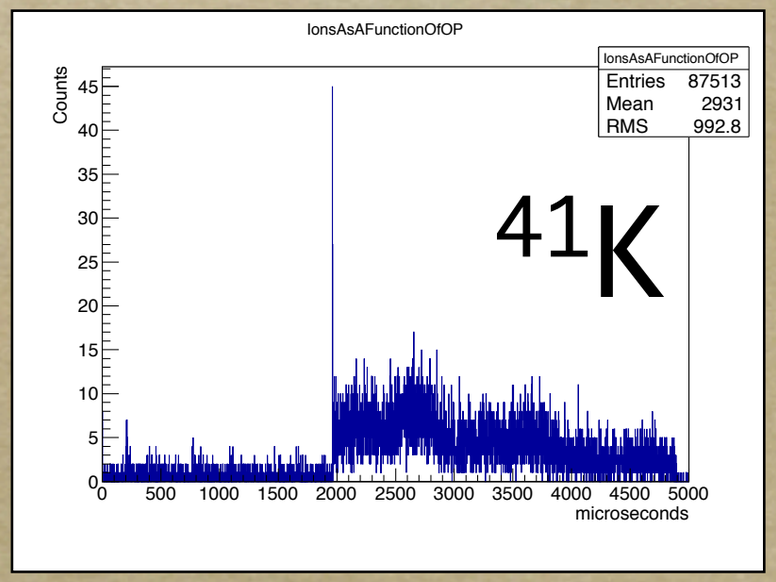




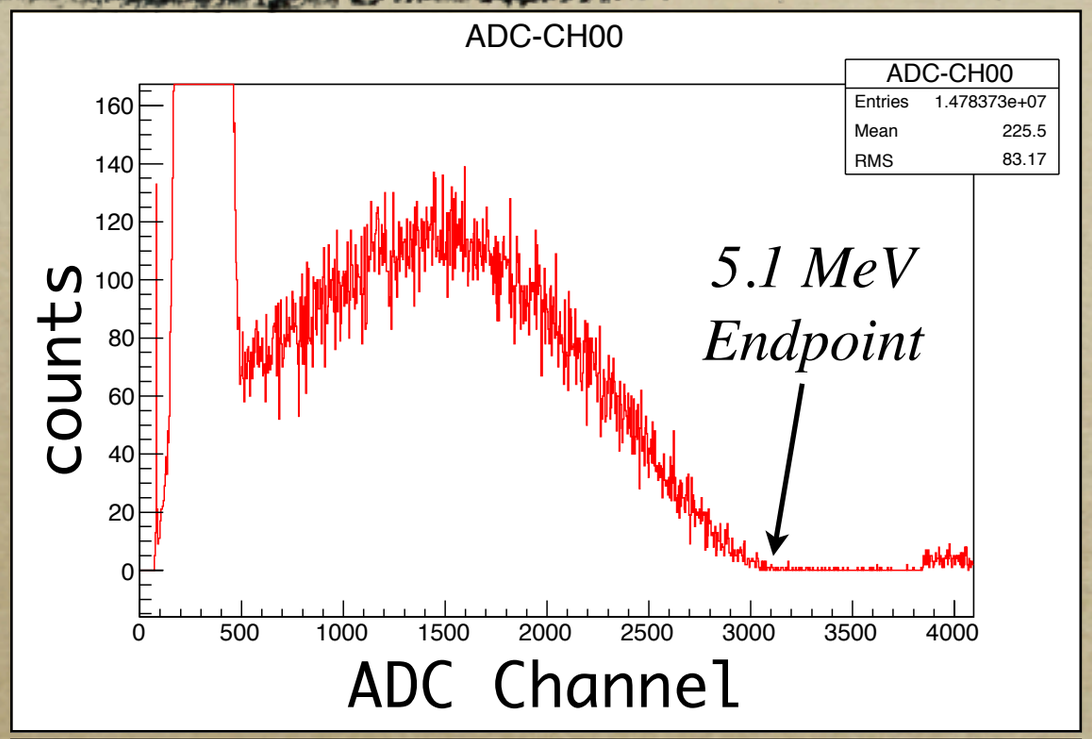
Measuring the Polarization

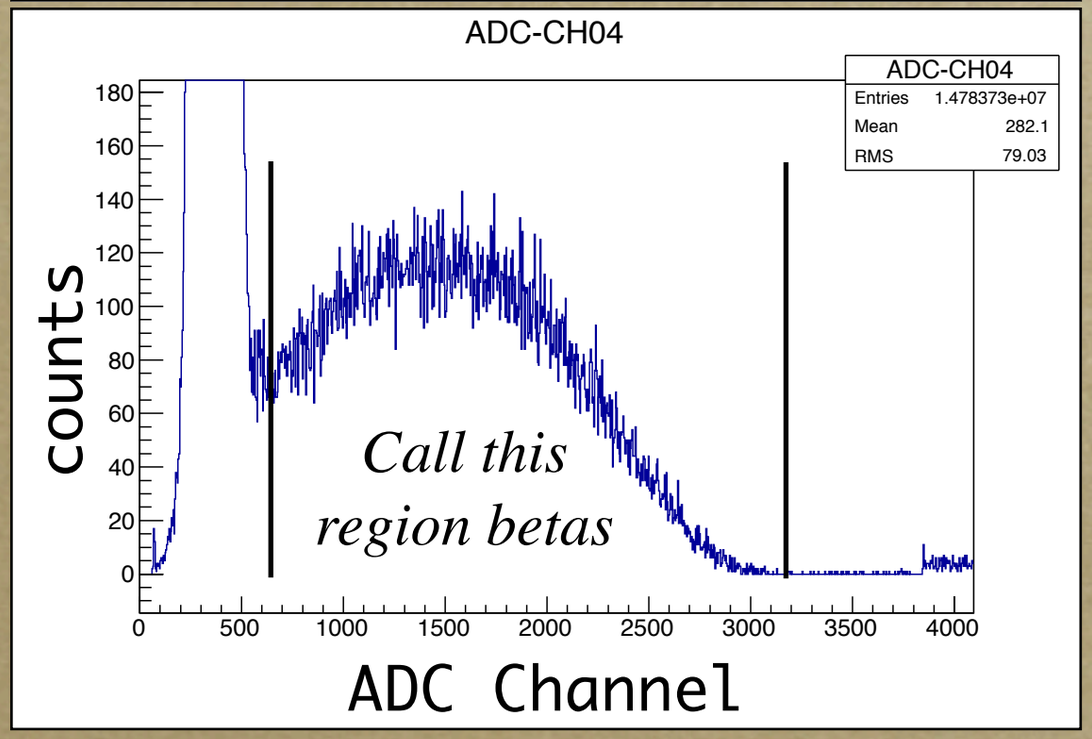


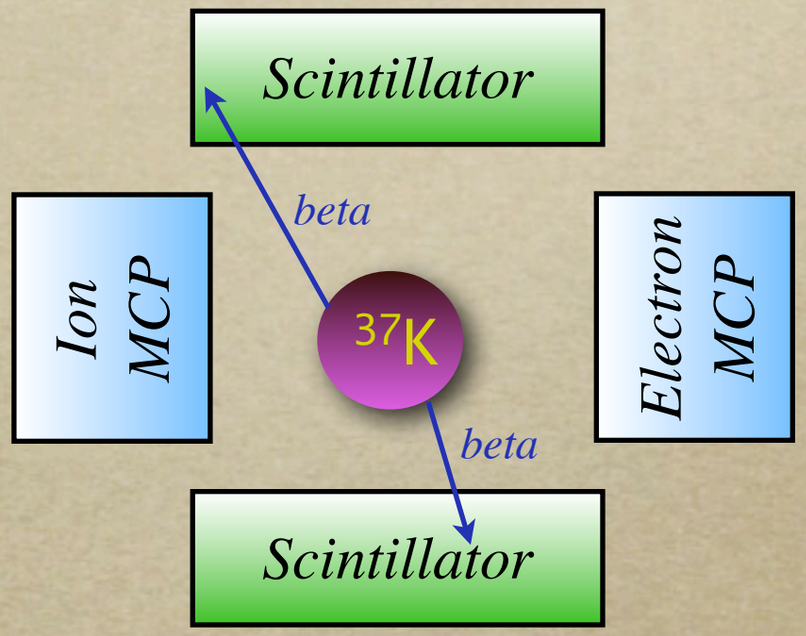




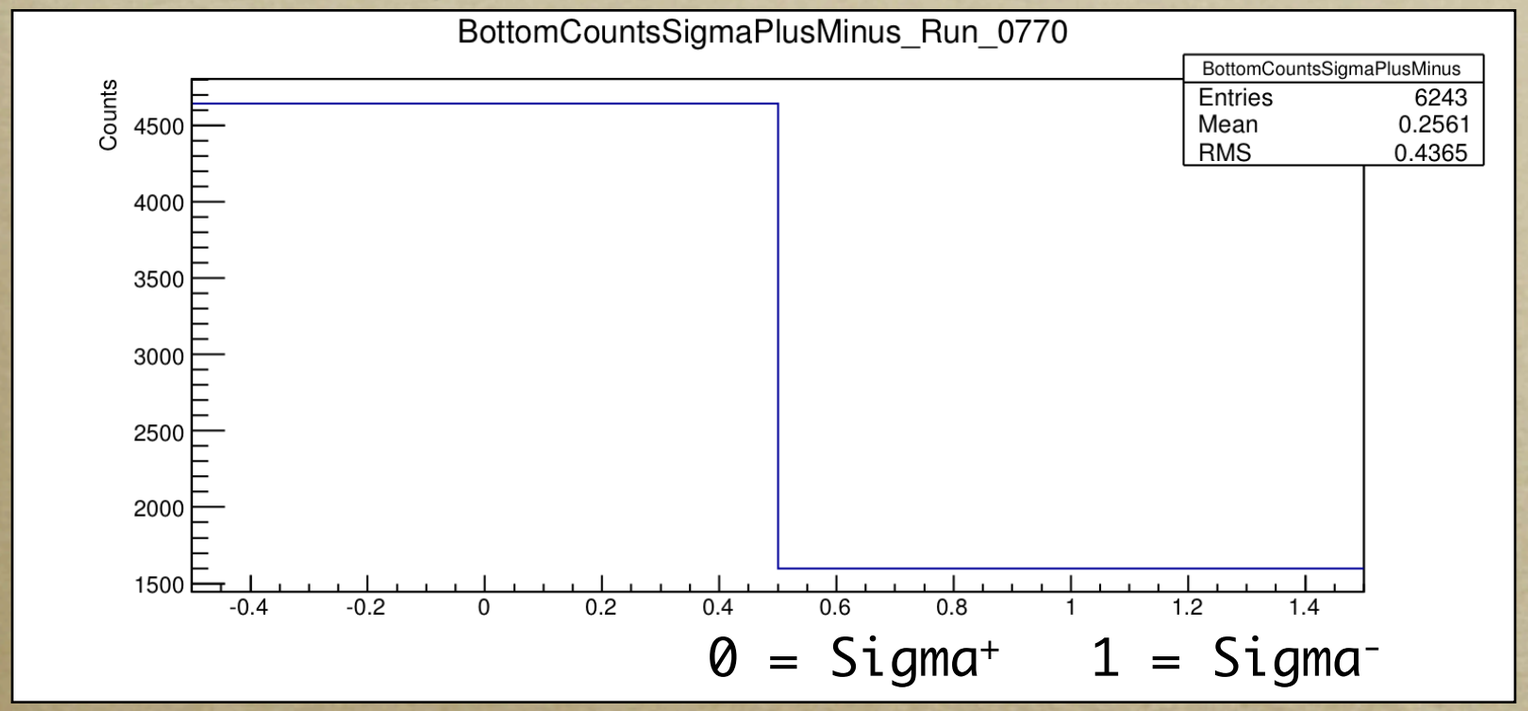
Measuring the Asymmetry

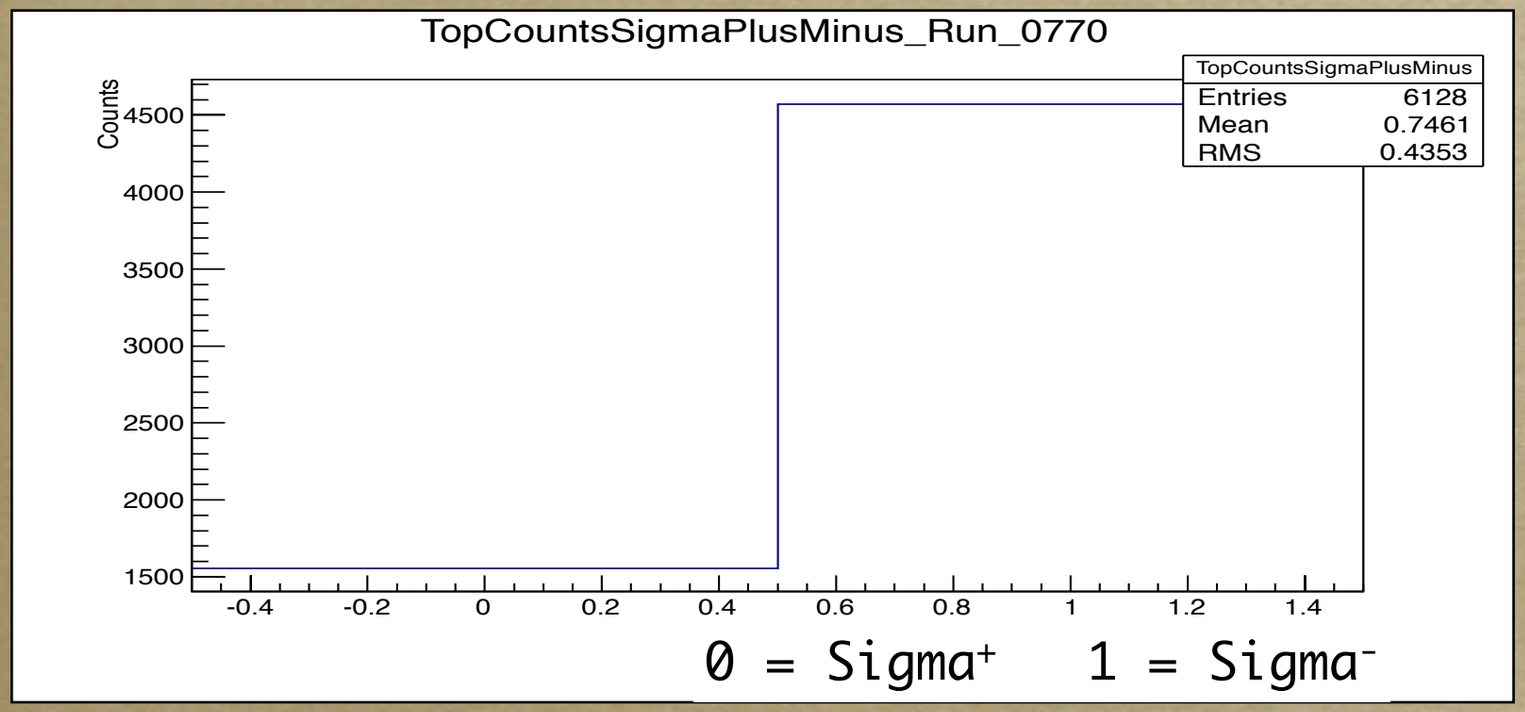


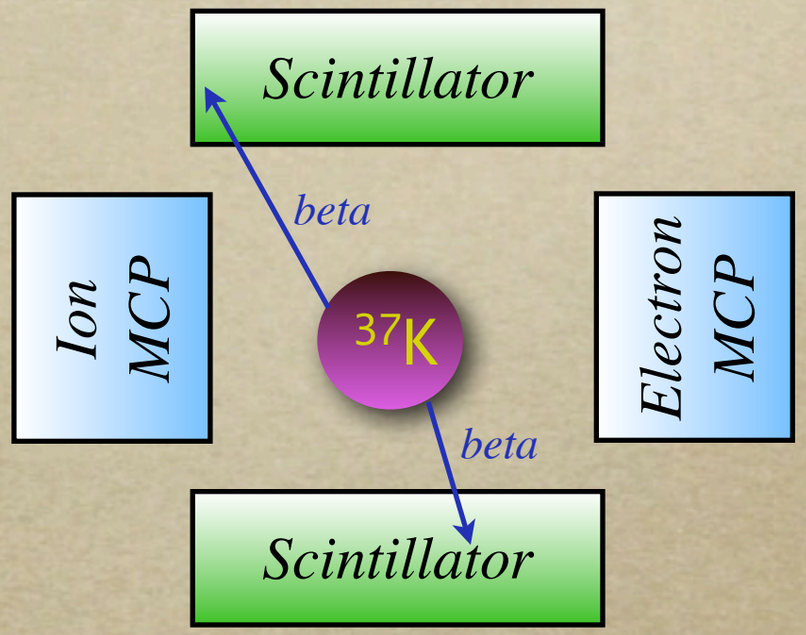




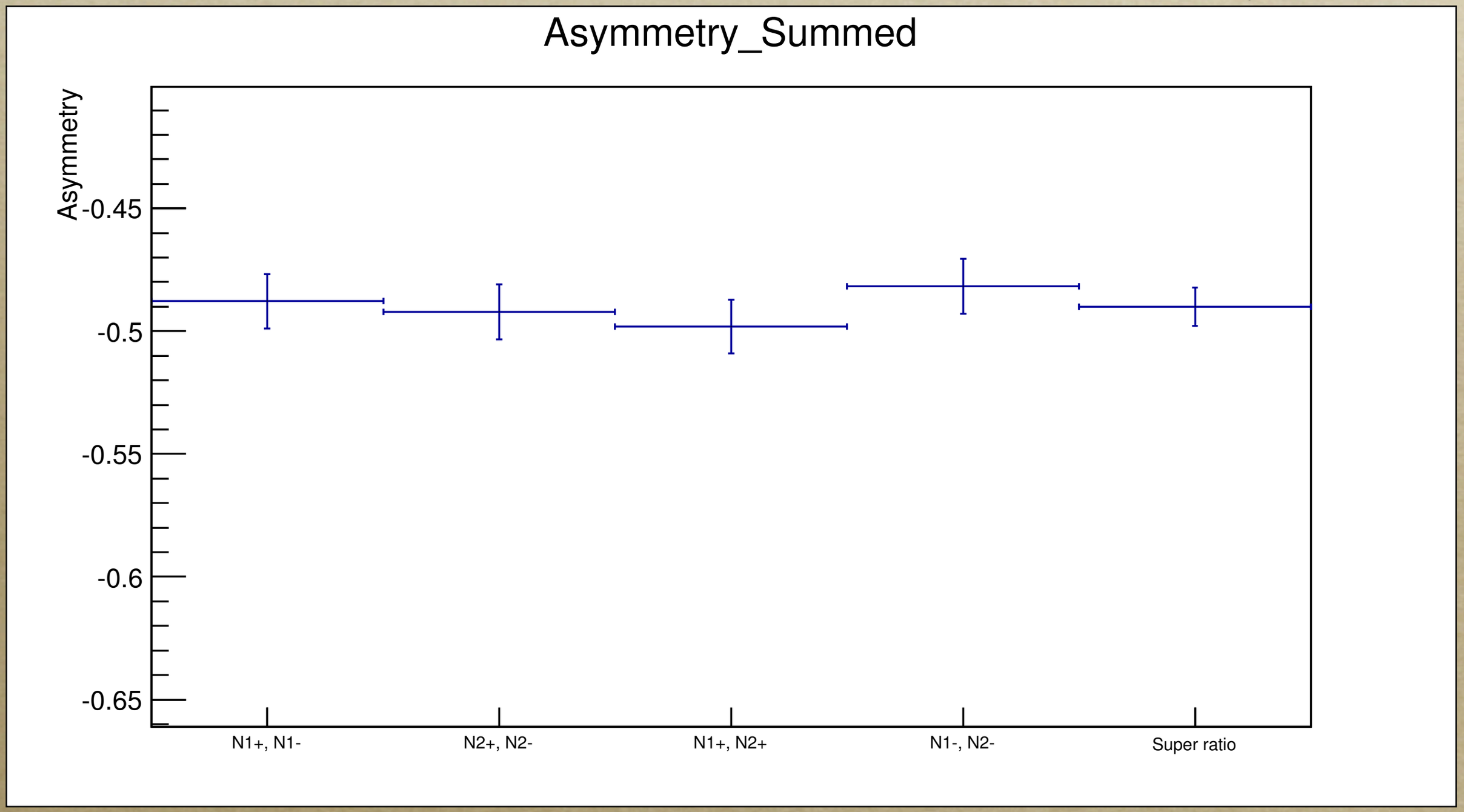
Measuring the Asymmetry







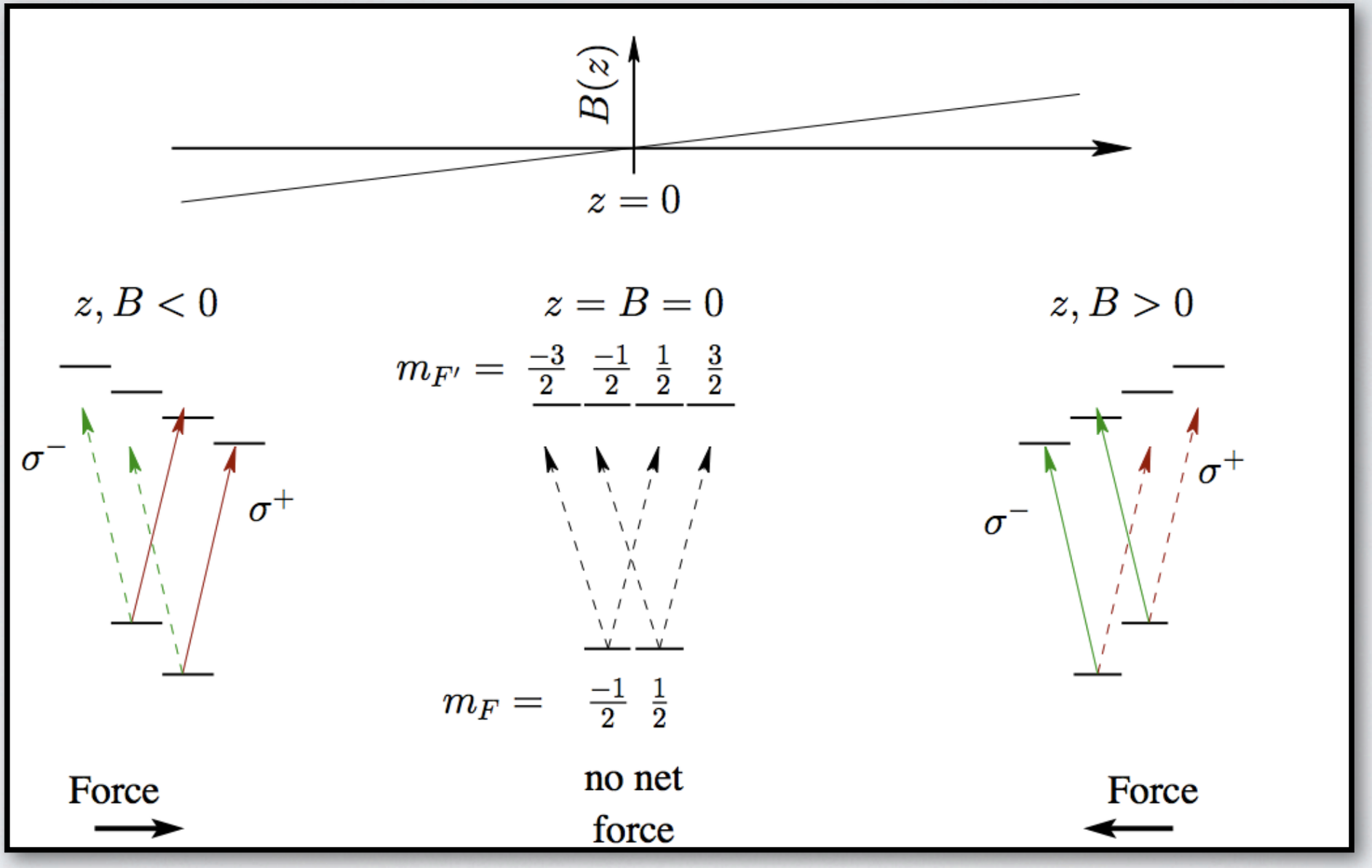
Measuring the Asymmetry



Things left to do

1. Improve silicon detectors for higher temperature operation.
2. Apply some reasonable cuts to improve polarization measurements.
3. Improve the trap size.
4. Improve trap loading.
5. Take more data.

THE ZEEMAN SPLITTING IS ADVANTAGEOUS.



σ^+

σ^-