# Status of the Double Scattering Polarimeter (DSP) for MESA

Matthias Molitor

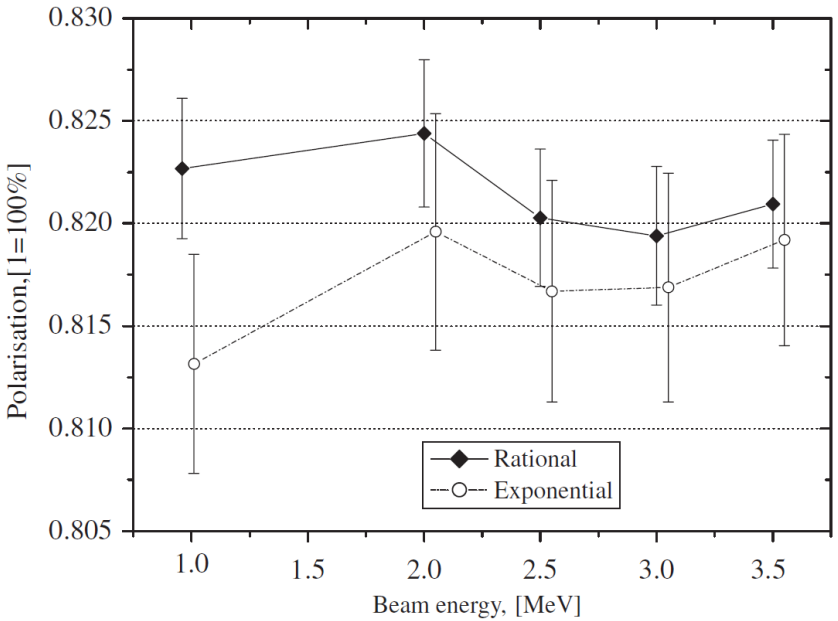
February 13, 2014


# Content

# Double or single scatter?

## single scatter

- extrapolated effective analysing power




Tioukine, Aulenbacher, Riehn: Rev. Sci. Instrum. 82, 033303 (2011)

# Double or single scatter?

## single scatter

- extrapolated effective analysing power
- Uncertainties:
  - extrapolation 3% $\rightarrow$ 1%
  - background 1% $\rightarrow <$ 1%
  - $S_0$ (theory) believed to be small

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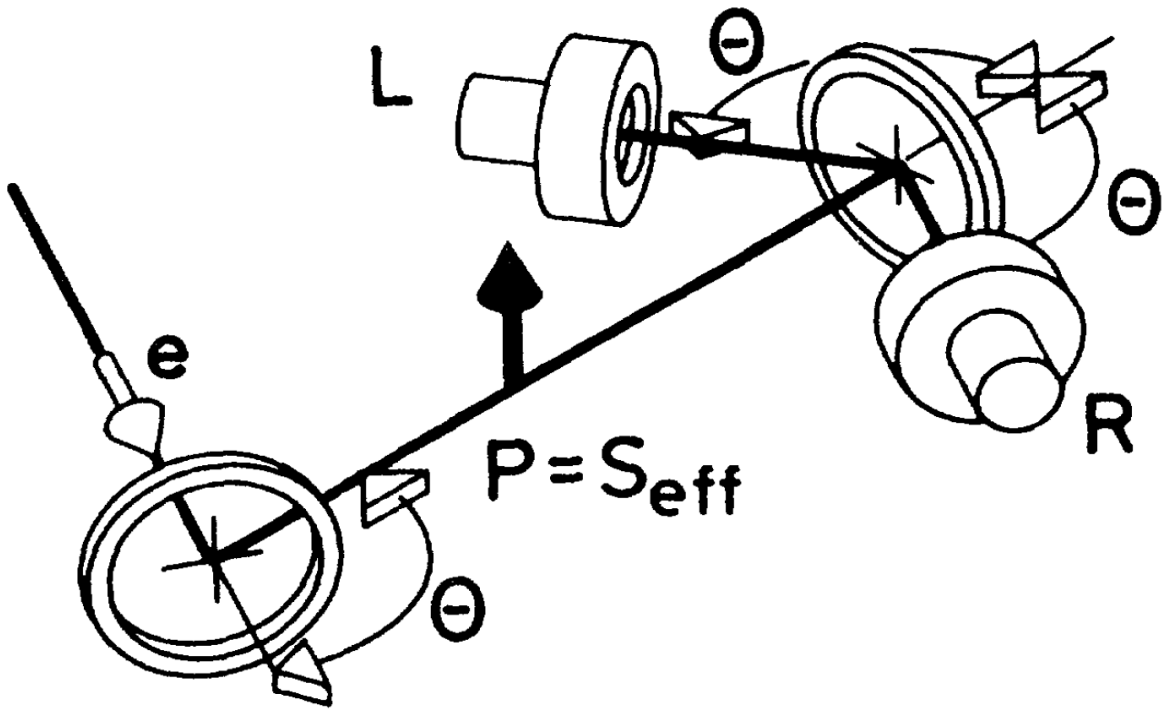
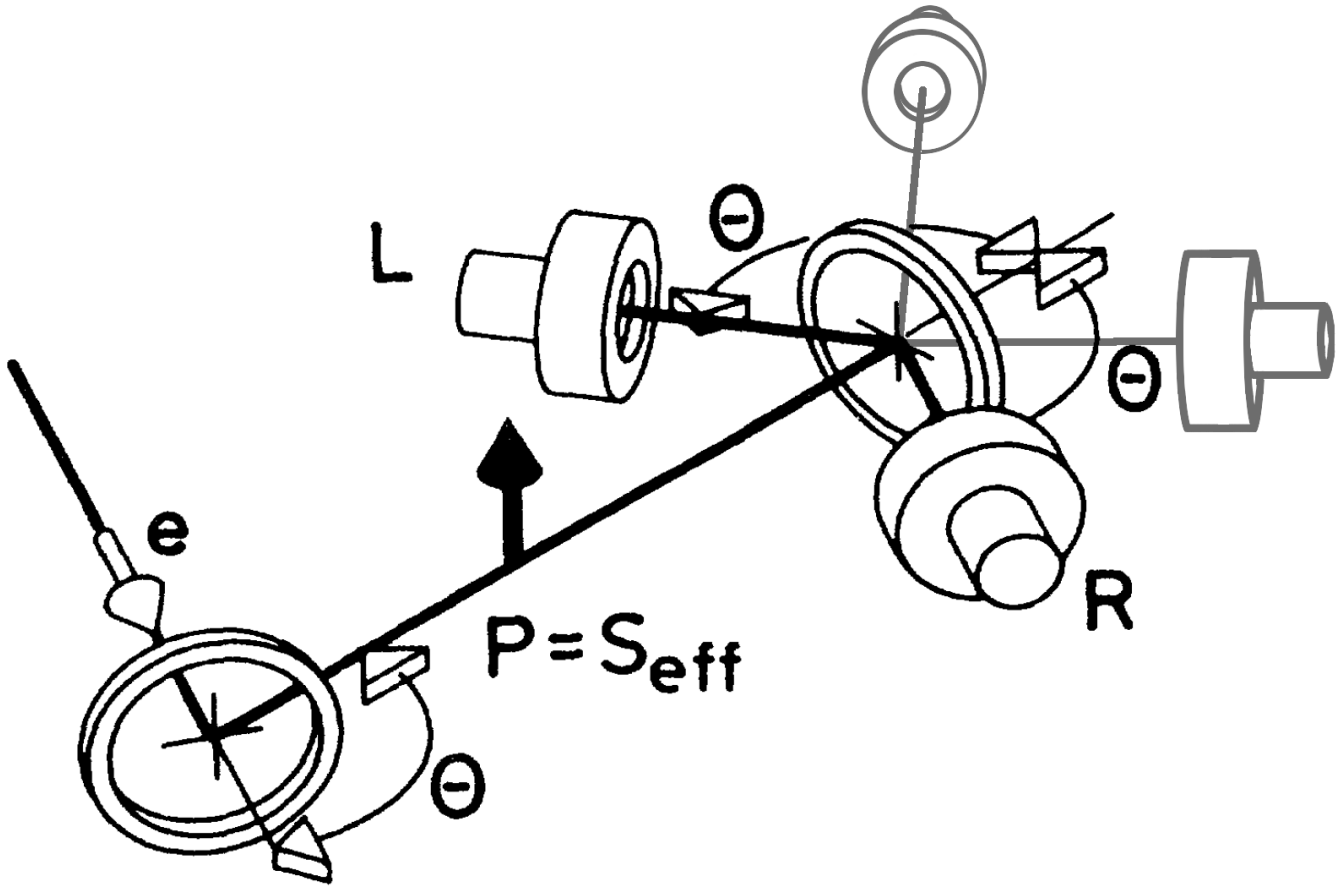
## double scatter

- effective analyzing power can be measured
- two identical targets preferable, but not necessary




Gellrich, Kessler: Phys. Rev. A 43, 204 (1991)


L
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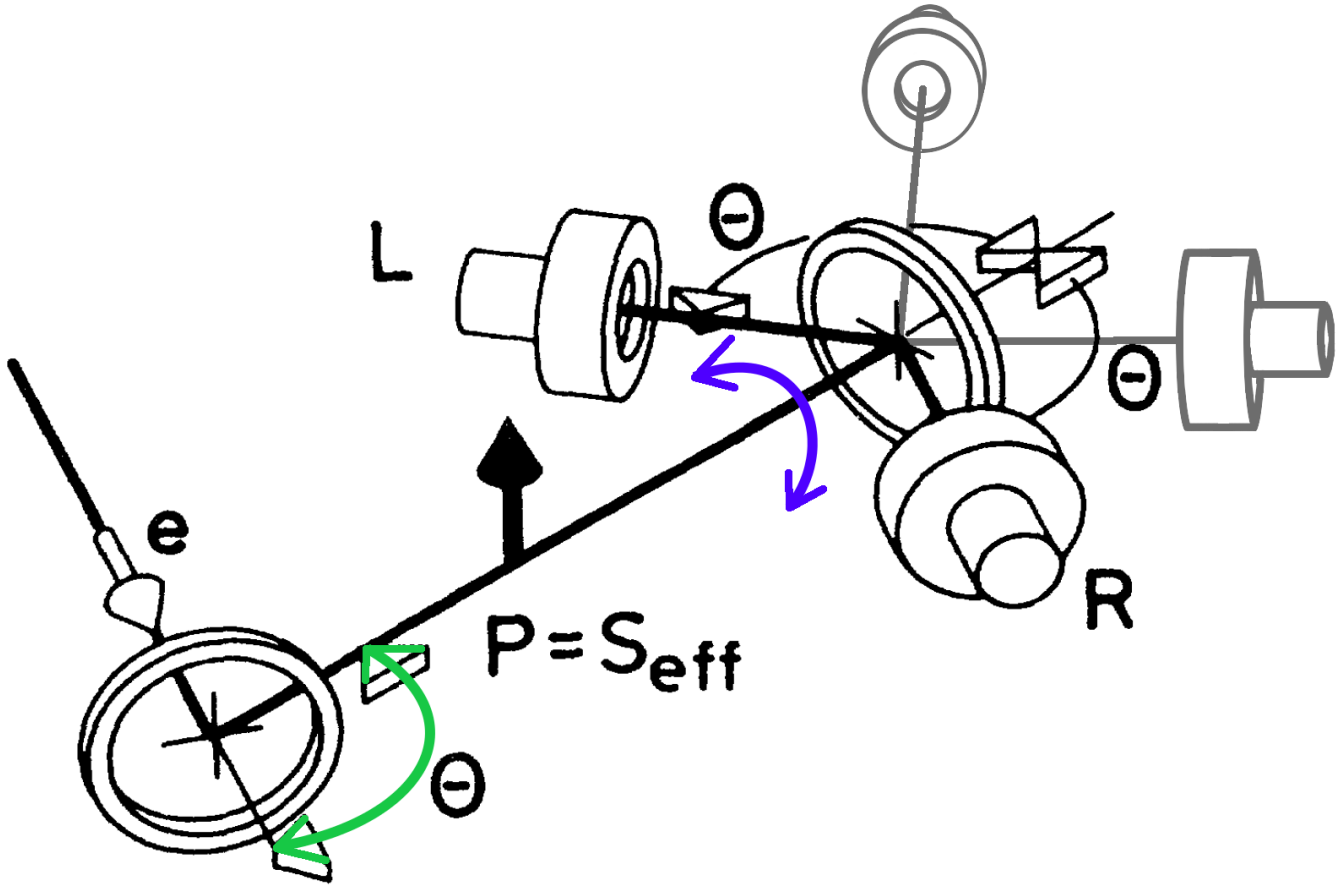
R
e
P=S_eff
Θ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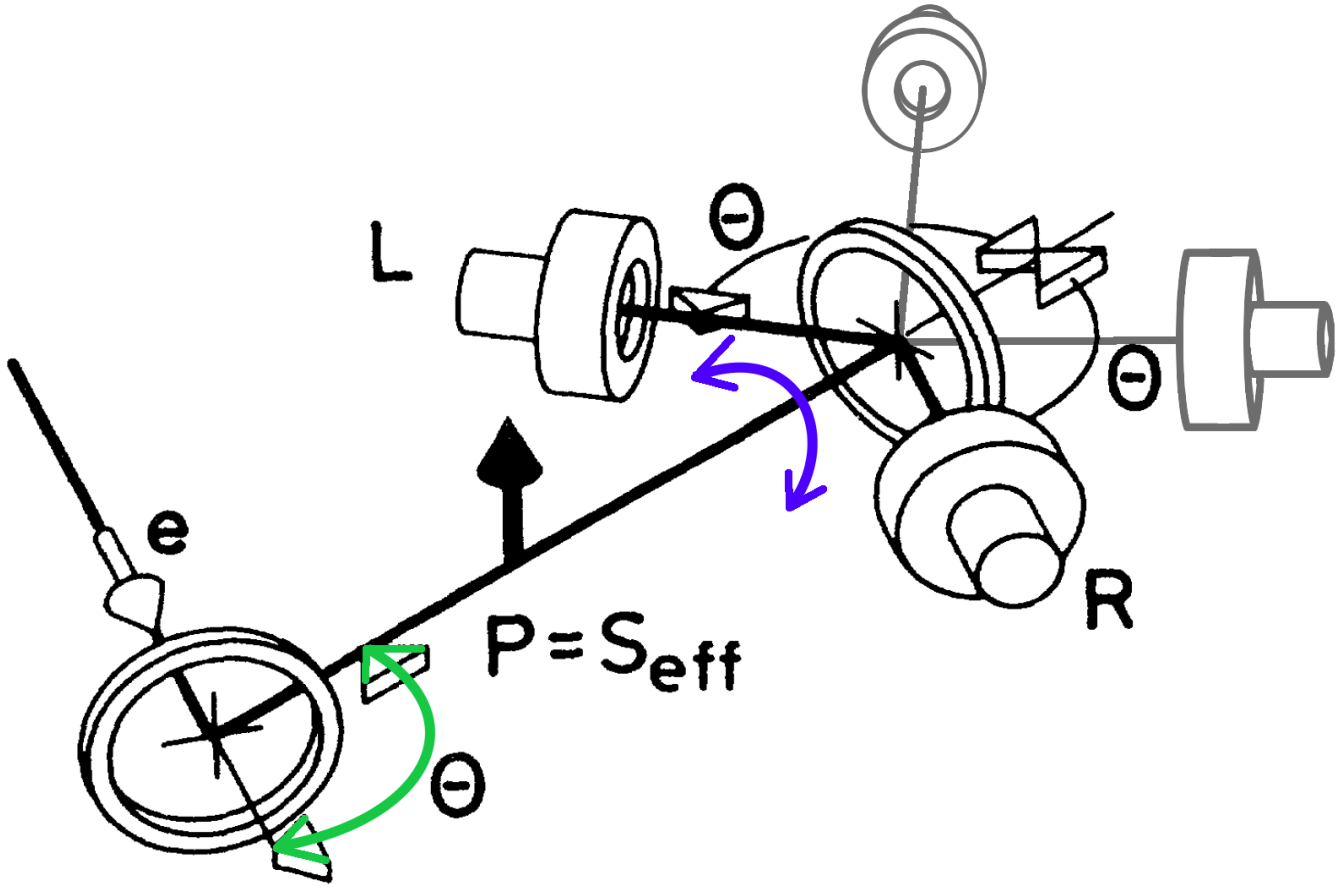
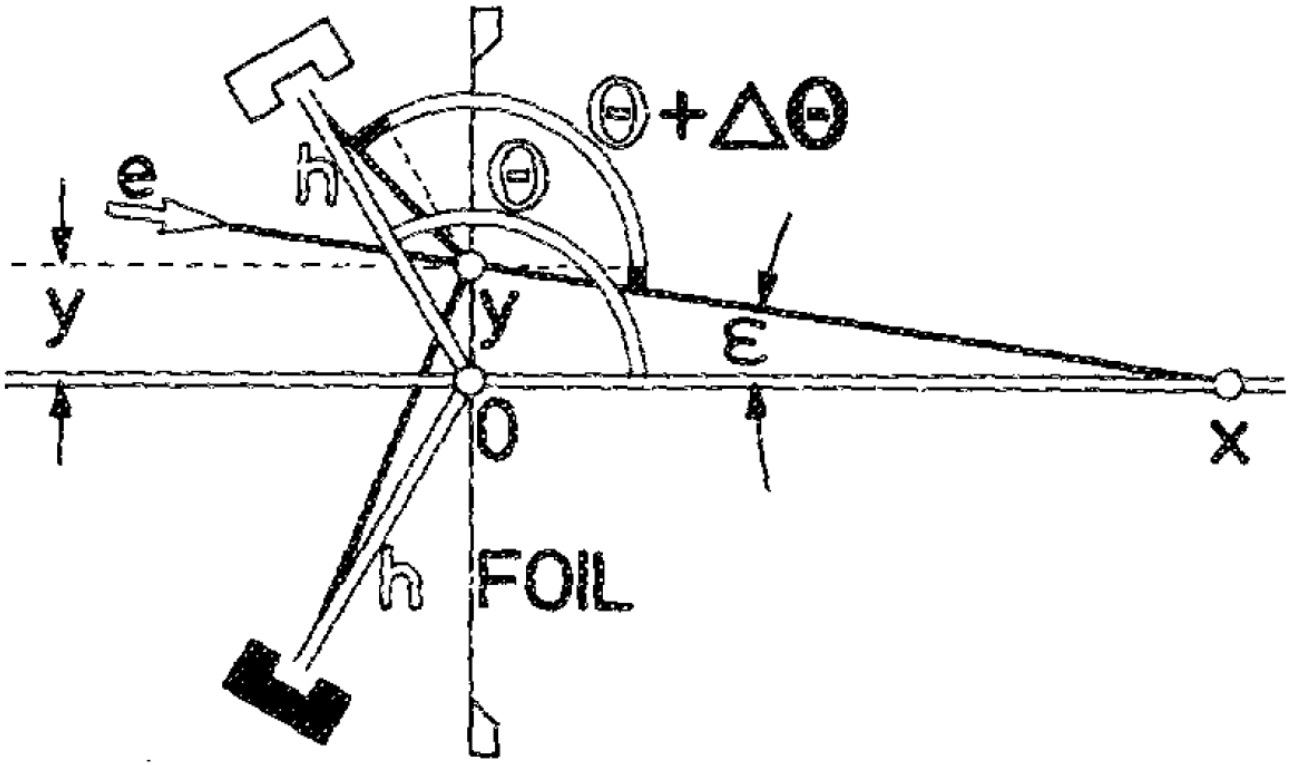
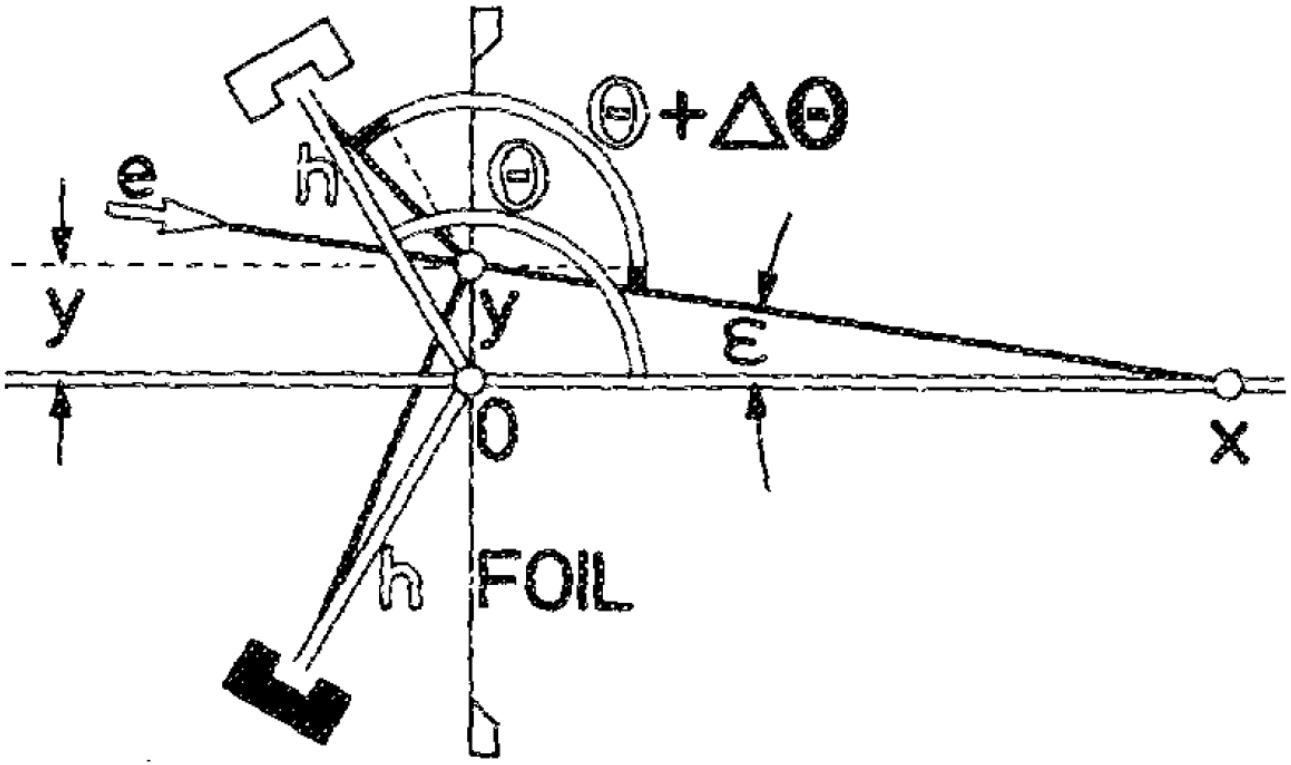



- For $S_T = S_{eff}$ (unpolarized): $S_{eff}^2 = S_T S_{eff} = A = \frac{N_L - N_R}{N_L + N_R}$




Gellrich, Jost, Kessler: Rev. Sci. Instrum. 61, 3399 (1990)

- solid and scattering angle depend on beam position

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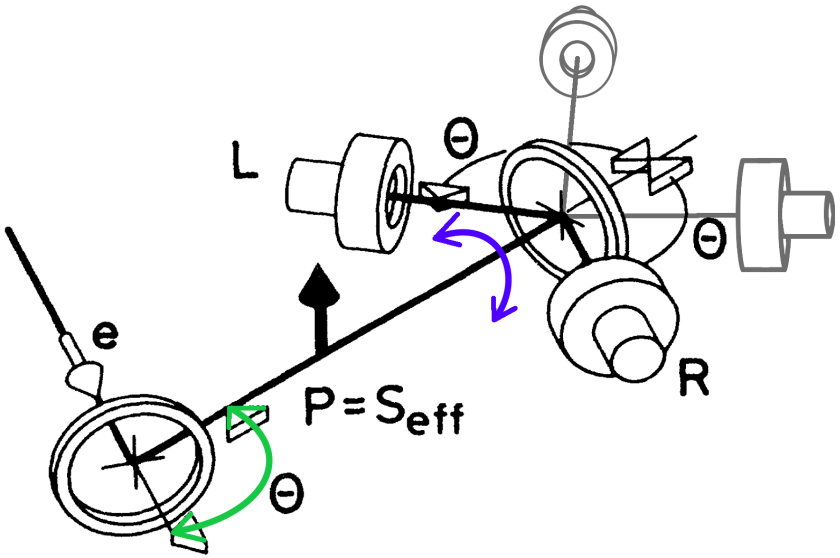
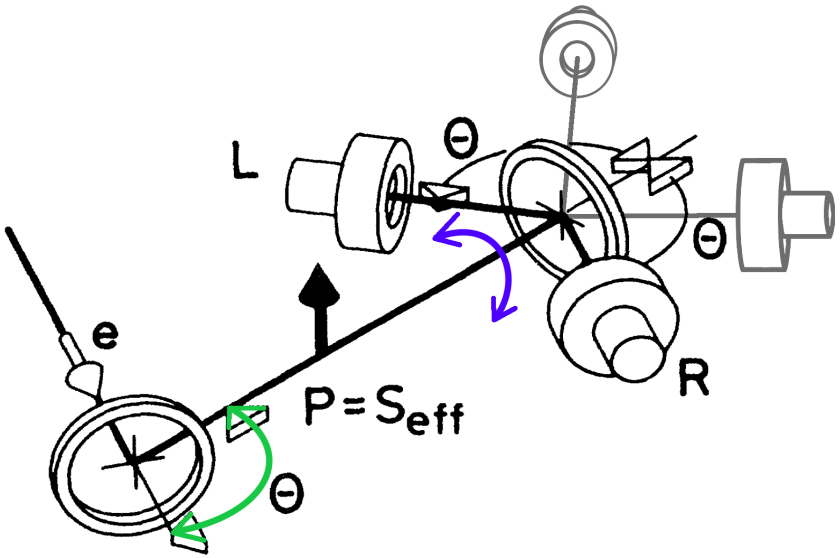
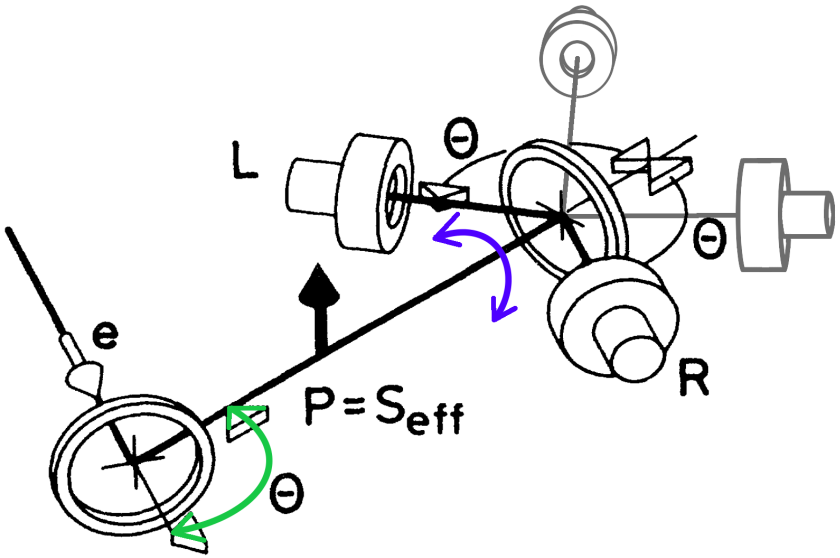
- solid and scattering angle depend on beam position
- different false asymmetries in counters




- single scattering of unpolarized electrons for monitor counter placement




- single scattering of unpolarized electrons for monitor counter placement
- double scattering with polarized beam for analyzing power measurement

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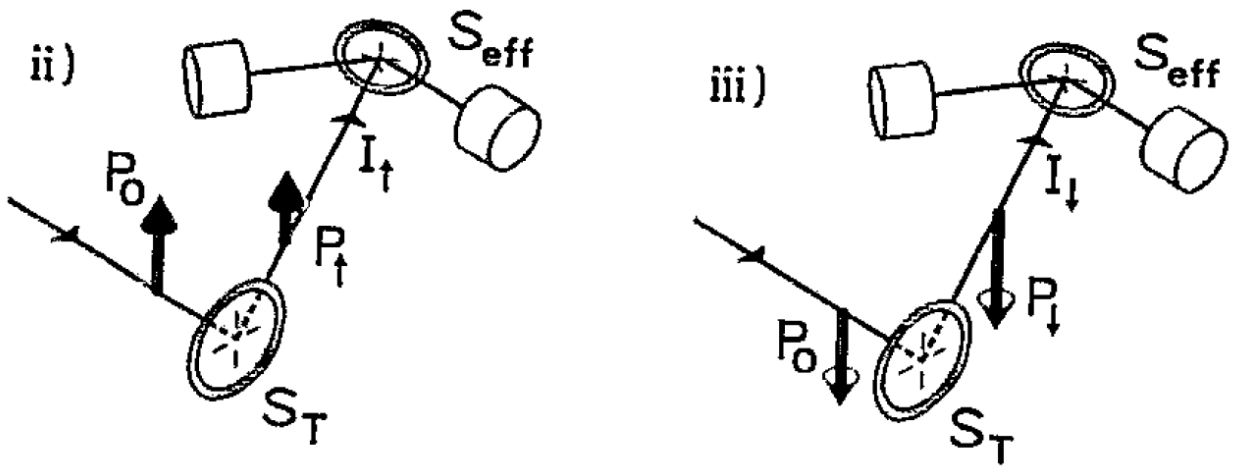
- double scattering with polarized beam for analyzing power measurement
- single scattering with polarized beam for polarization measurement

# Measurement of the Effective Analyzing Power ($S_{\text{eff}}$)




Mayer, Fischer, Blaschke, Kessler: Rev. Sci. Instrum. 64, 952 (1993)

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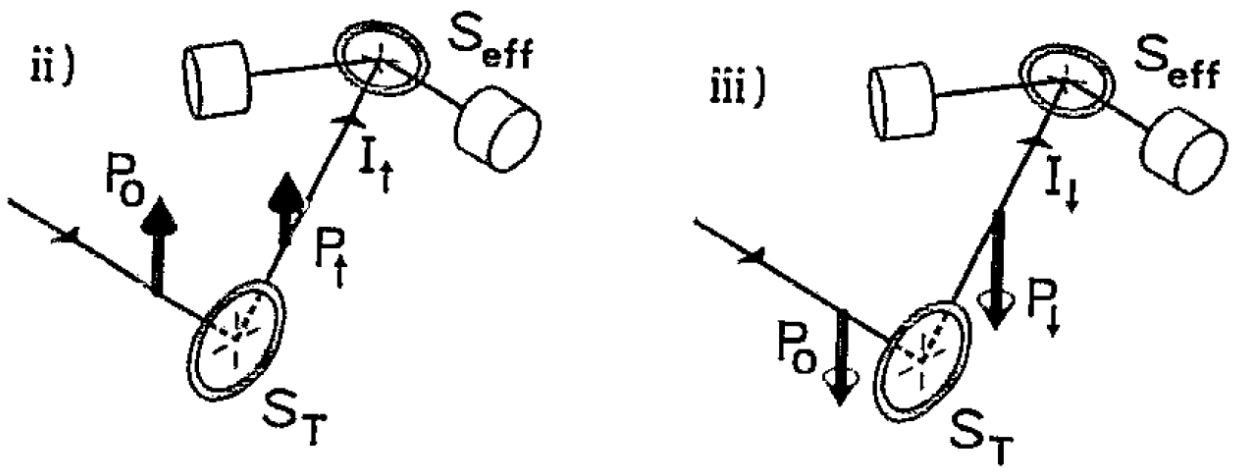


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- Measurements with $\uparrow/\downarrow$ polarized beam:

$$A_{\uparrow/\downarrow} = P_{\uparrow/\downarrow} S_{\text{eff}} = \frac{S_T \pm P_0}{1 \pm P_0 S_T} S_{\text{eff}}$$

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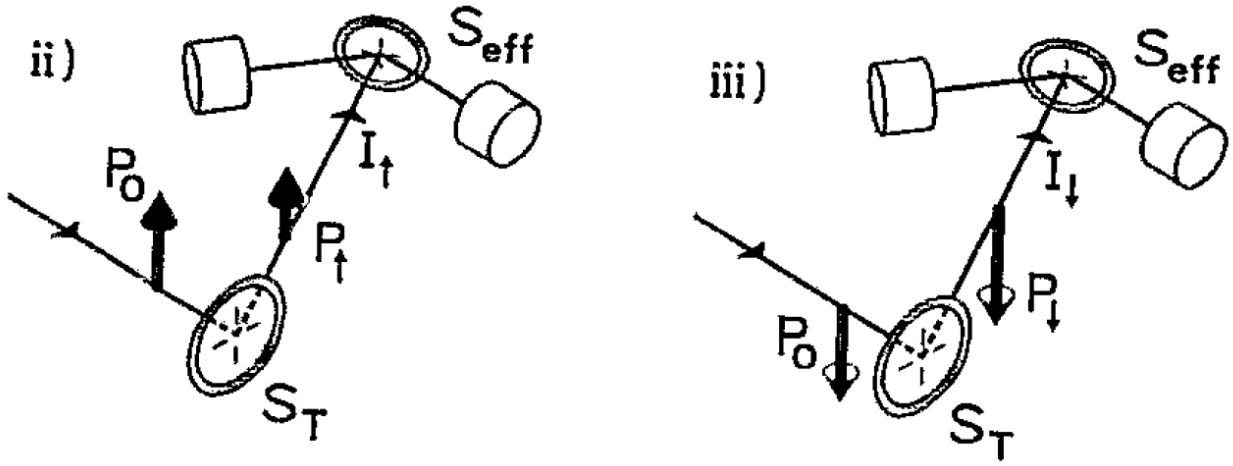


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- Calculation of $A_T$ from the currents $I_\uparrow$ and $I_\downarrow$

$$A_T = \frac{I_\uparrow - I_\downarrow}{I_\uparrow + I_\downarrow} = P_0 S_T$$

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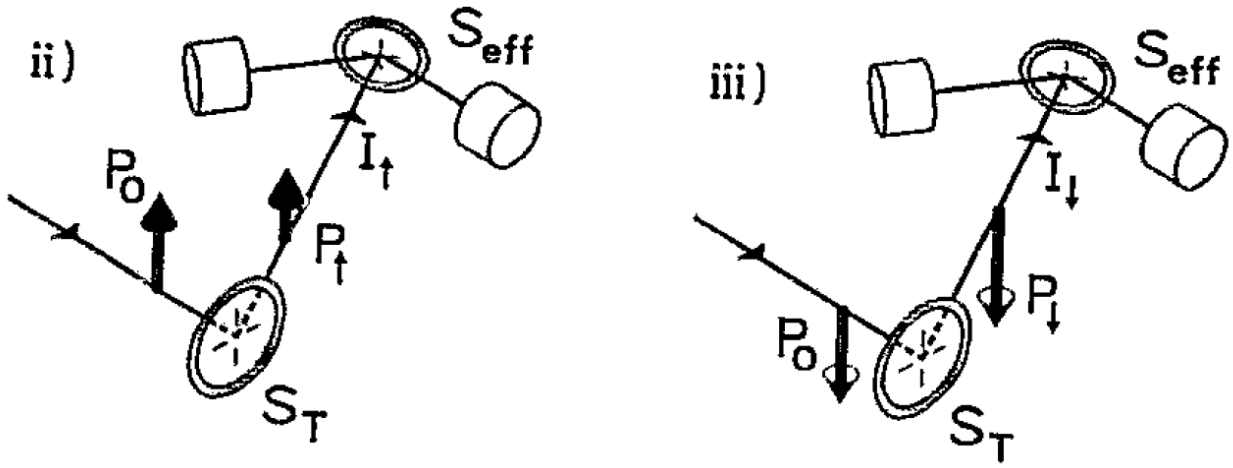


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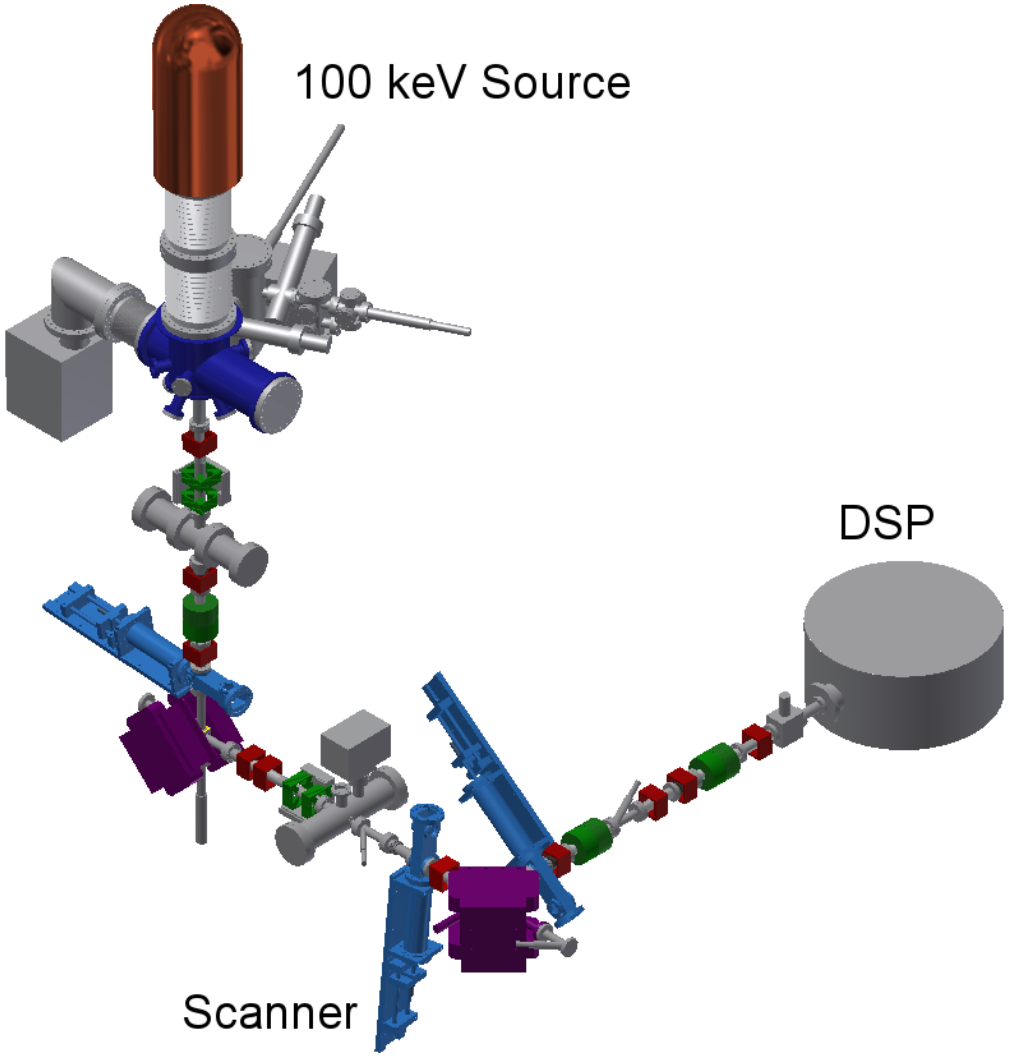
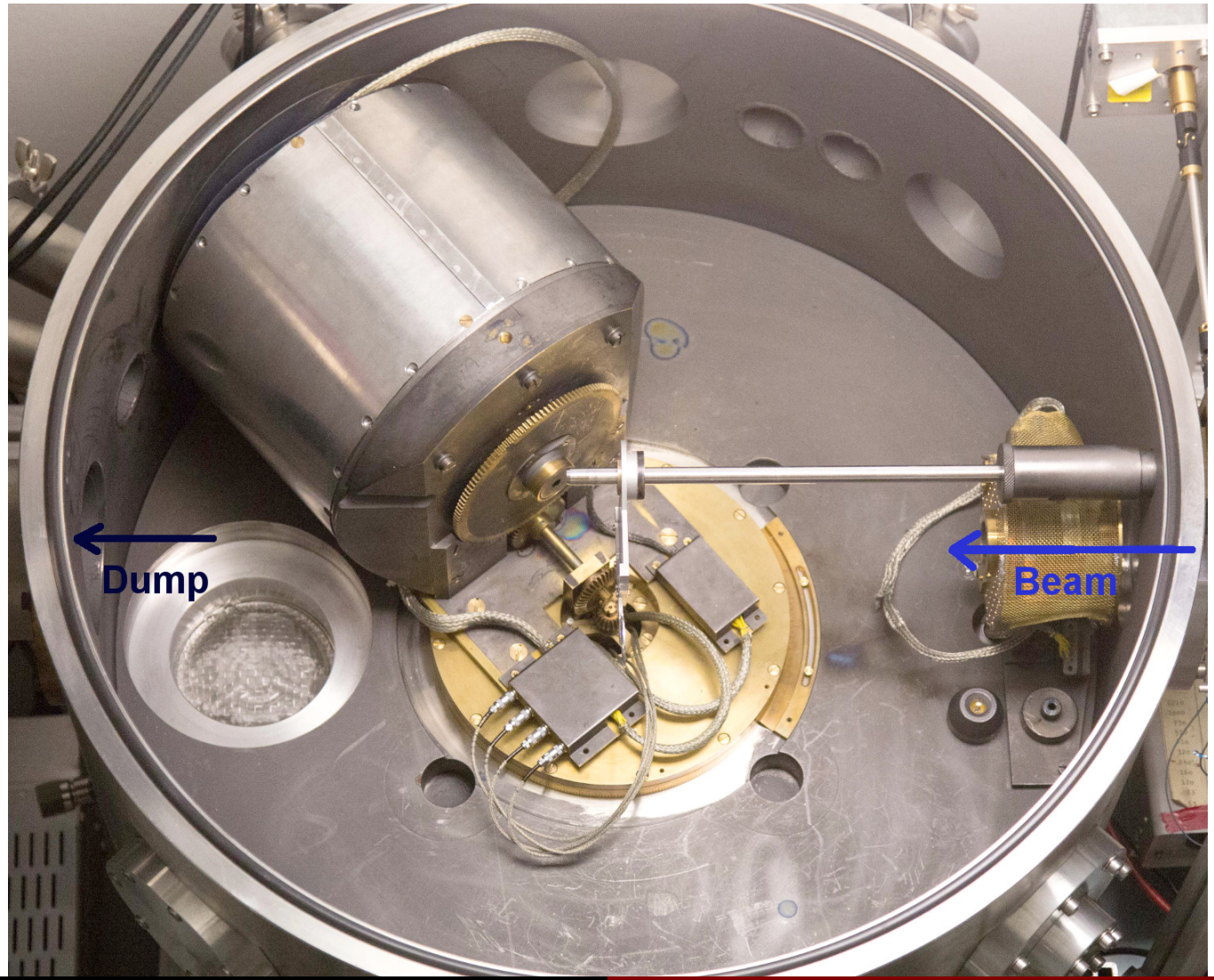
- Calculation of $S_{\text{eff}}$

$$S_{\text{eff}}^2 = \frac{1}{4A_T}\left\{[A_\uparrow(1+A_T)]^2 - [A_\downarrow(1-A_T)]^2\right\}$$

# DSP beamline



# DSP



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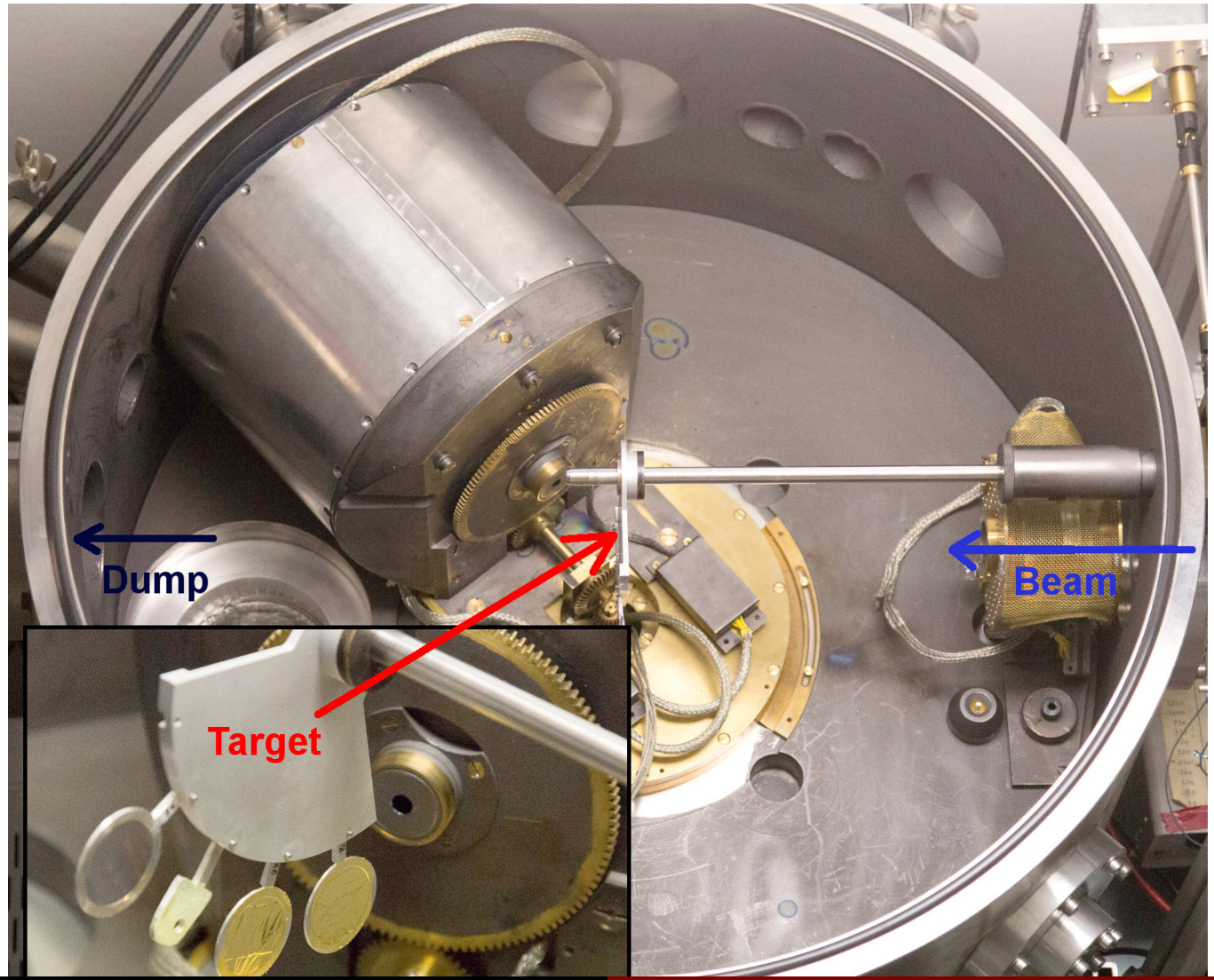

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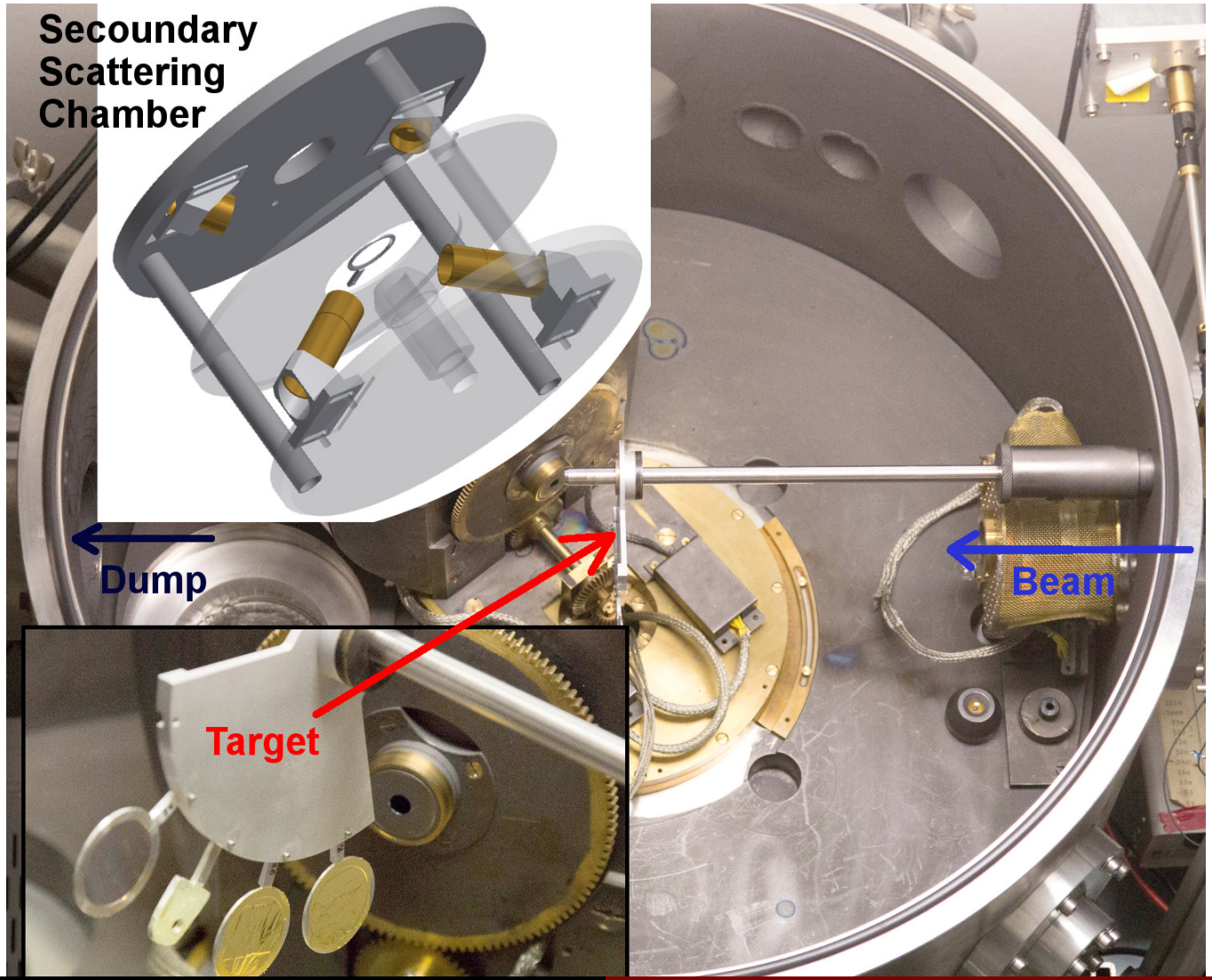

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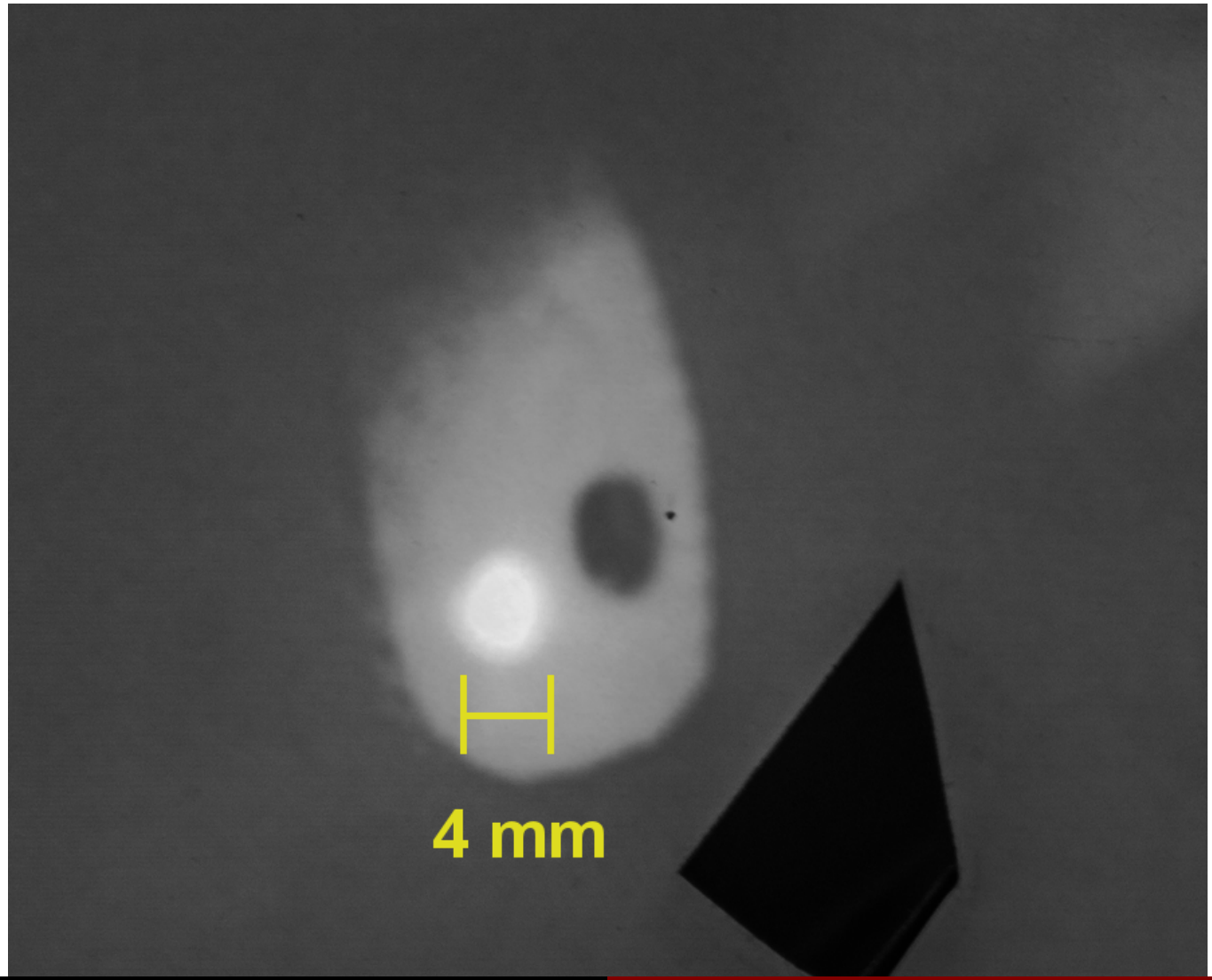
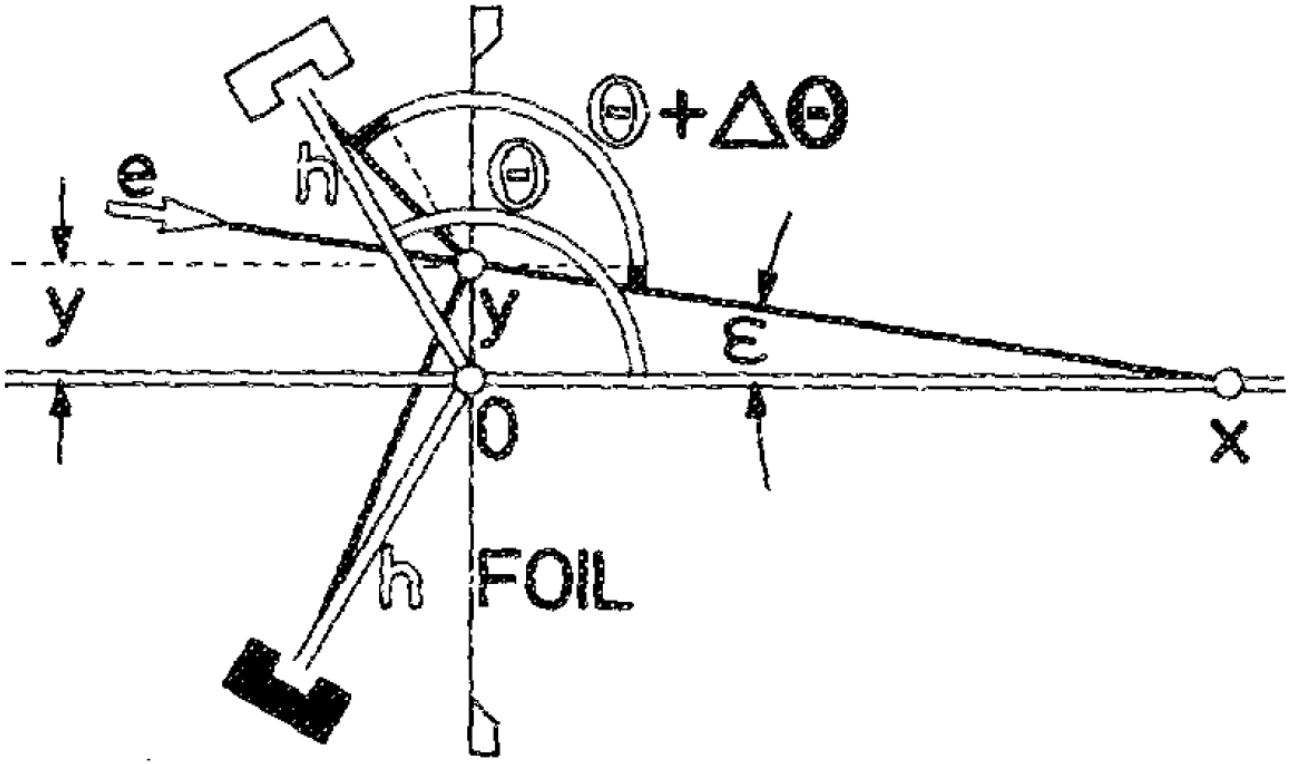


# $\frac{\partial I}{\partial \Theta} > 0$ Measurements

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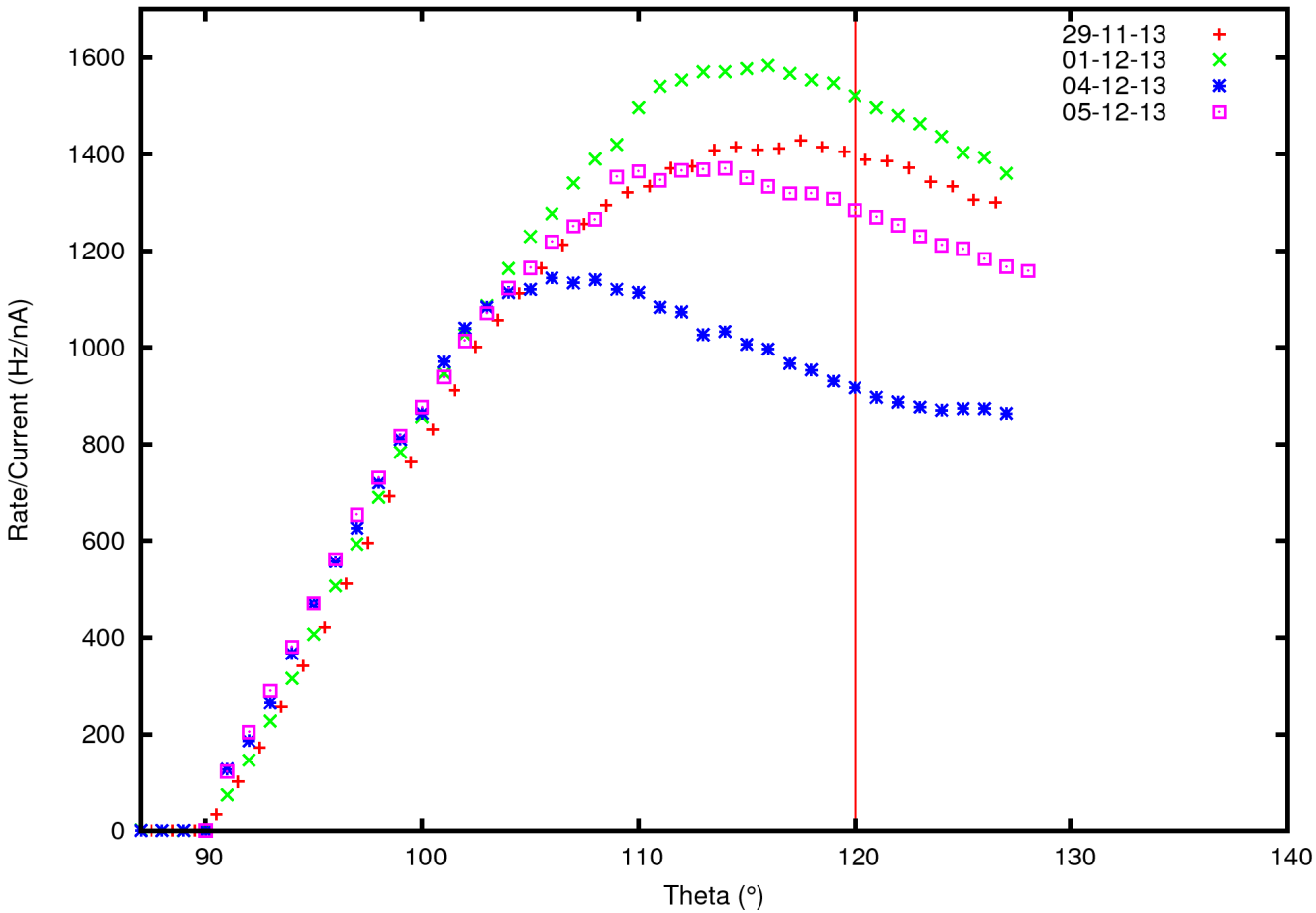
- measuring the $\Theta$-dependend rate of (back-)scattered electrons
- $h_\mathrm{m}/h_\mathrm{p}$: ratio of distances from target for monitor and polarization counters

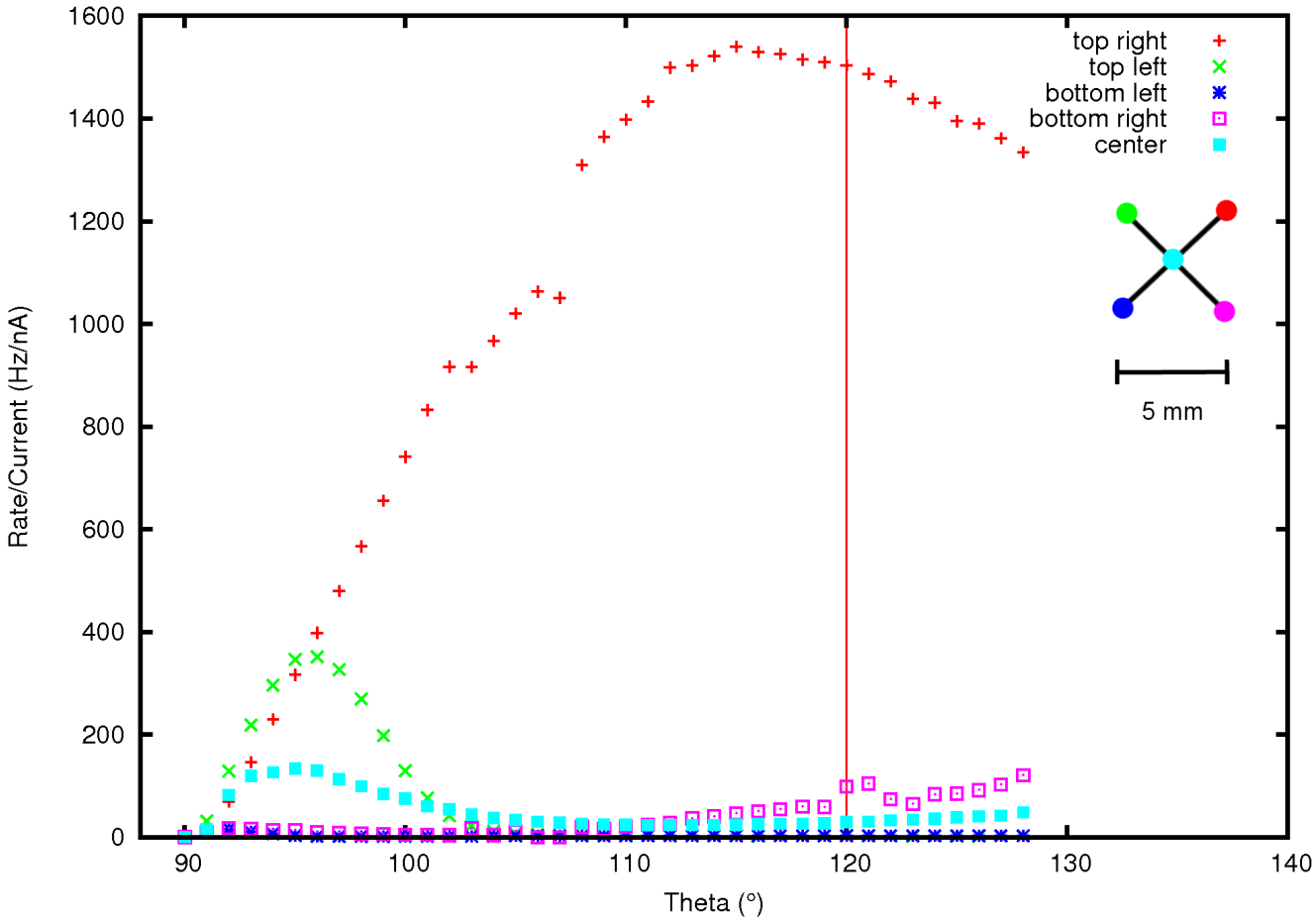
$$\frac{h_\mathrm{m}}{h_\mathrm{p}} = \frac{\cos\Theta_\mathrm{m} - 2\left[E(\Theta_\mathrm{m})\right]^{-1}\sin\Theta_\mathrm{m}}{\cos\Theta_\mathrm{p} - 2\left[E(\Theta_\mathrm{p})\right]^{-1}\sin\Theta_\mathrm{p}}$$

$$E(\Theta) = \frac{1}{I(\Theta)}\frac{\partial I}{\partial \Theta}$$

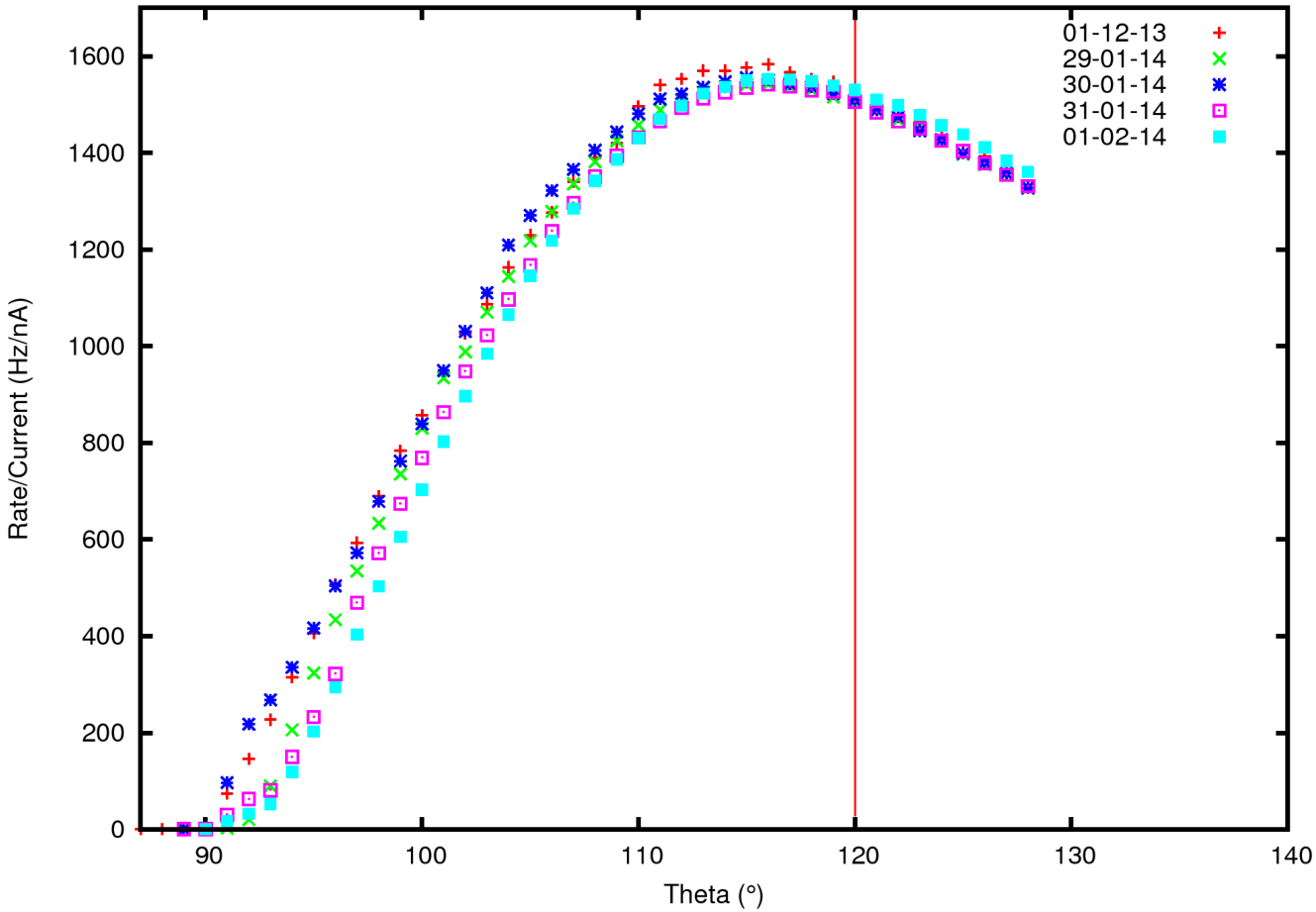
# $\frac{\partial I}{\partial \Theta} > 0$ Measurements: First data



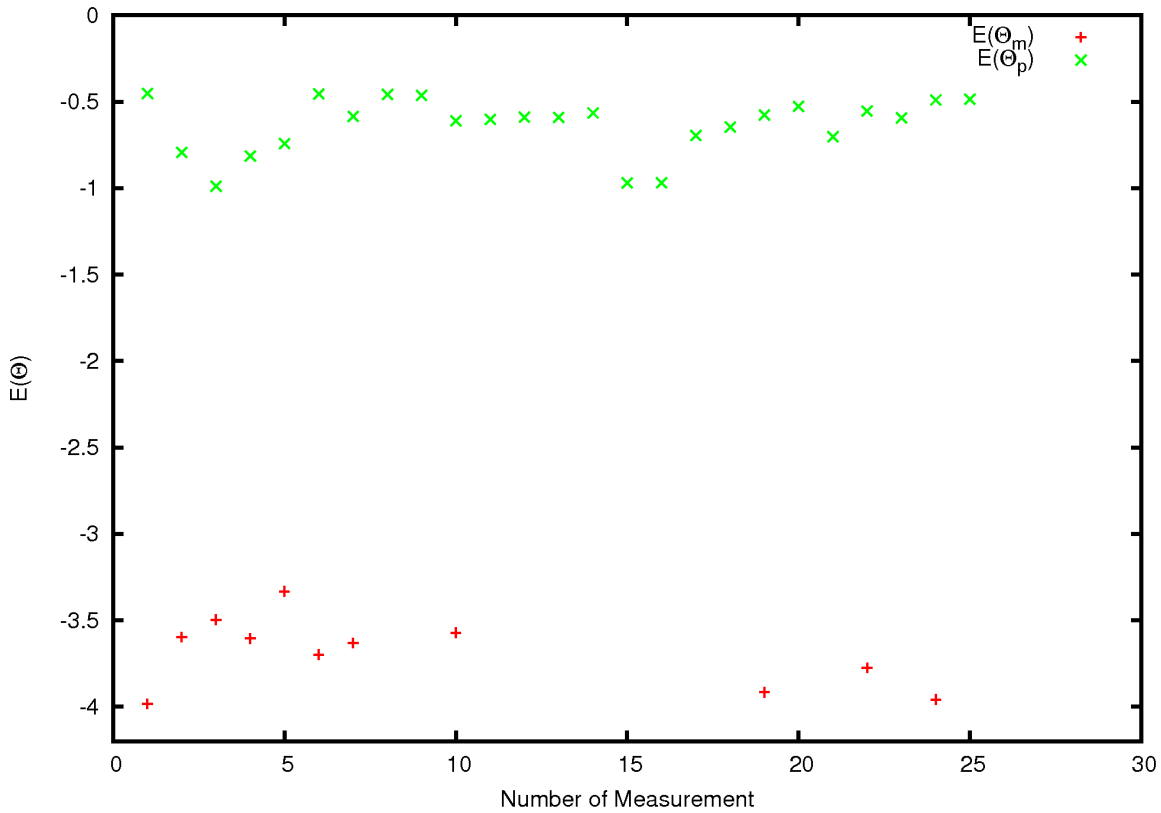
# $\frac{\partial I}{\partial \Theta} > 0$ Measurements: Beam position dependence



# $\frac{\partial I}{\partial \Theta} > 0$ Measurements: continued data taking



# $E(\Theta_m)$, $(\Theta_p)$ calculation




- $\frac{\Delta E(\Theta_m)}{E(\Theta_m)} = 6\%$
- $\frac{\Delta E(\Theta_p)}{E(\Theta_p)} = 26\%$

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  - more precise measurements of $E(\Theta)$
  - installation of Spin rotator
  - begin experiments with double scattering

# Thank you for your attention