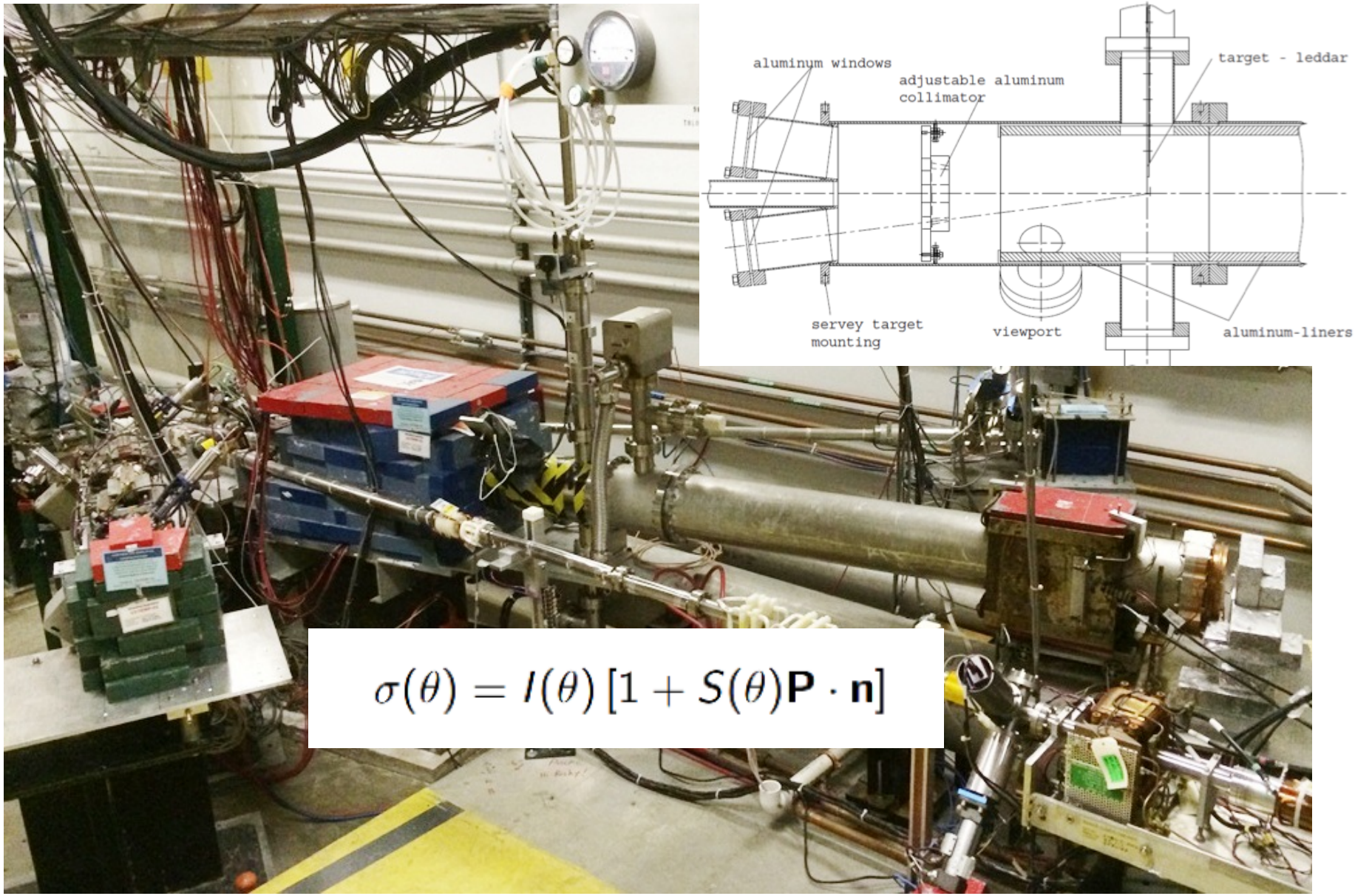
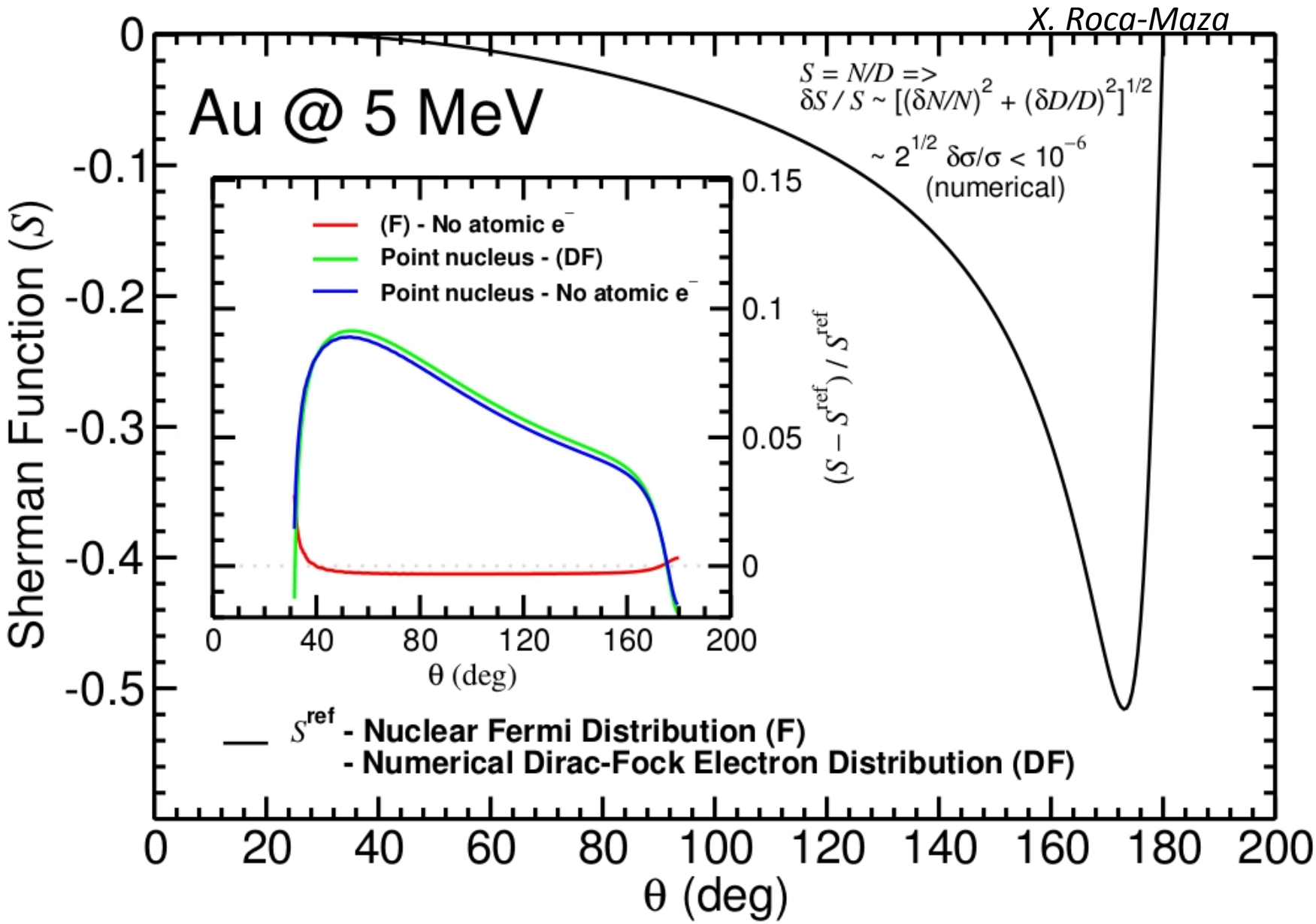
Mott Polarimeter at CEBAF



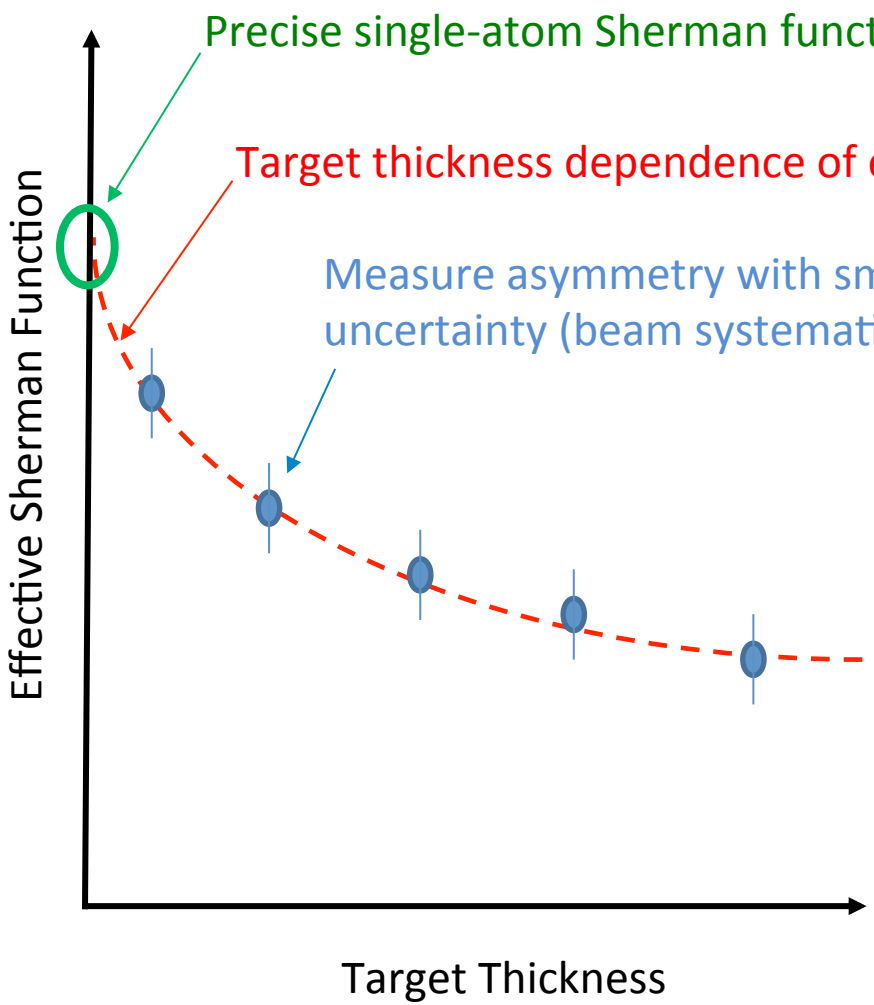
$$\sigma(\theta) = I(\theta)\,[1 + S(\theta)\mathbf{P}\cdot\mathbf{n}]$$

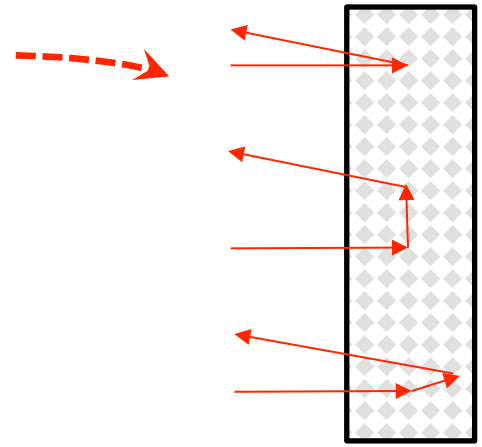
Exploring gold at KE=5.0MeV



Accurate Test of MeV Mott ($\Delta P/P$)

$$P = \frac{A}{S_{eff}}$$





Expected Range of Uncertainty	
Theory	0.5 – 1.0%
Target Thickness	0.2 – 0.5%
Instrumental	0.2 – 0.3%
BUDGET	0.6 – 1.2%

January 2015 - Run 1

Polarimeter design optimized for KE=5.0 MeV

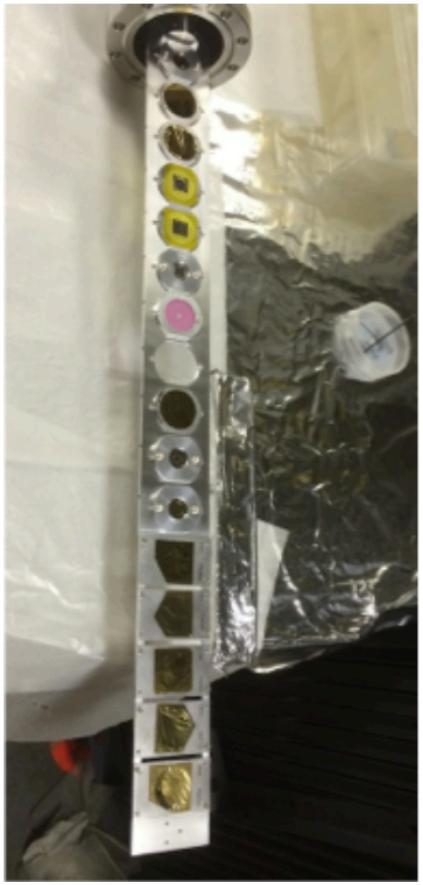
Studied systematics of measured asymmetry vs …

- Beam position
- Beam size
- Beam energy spread
- Dump background
- DAQ dead time
- Detector rate

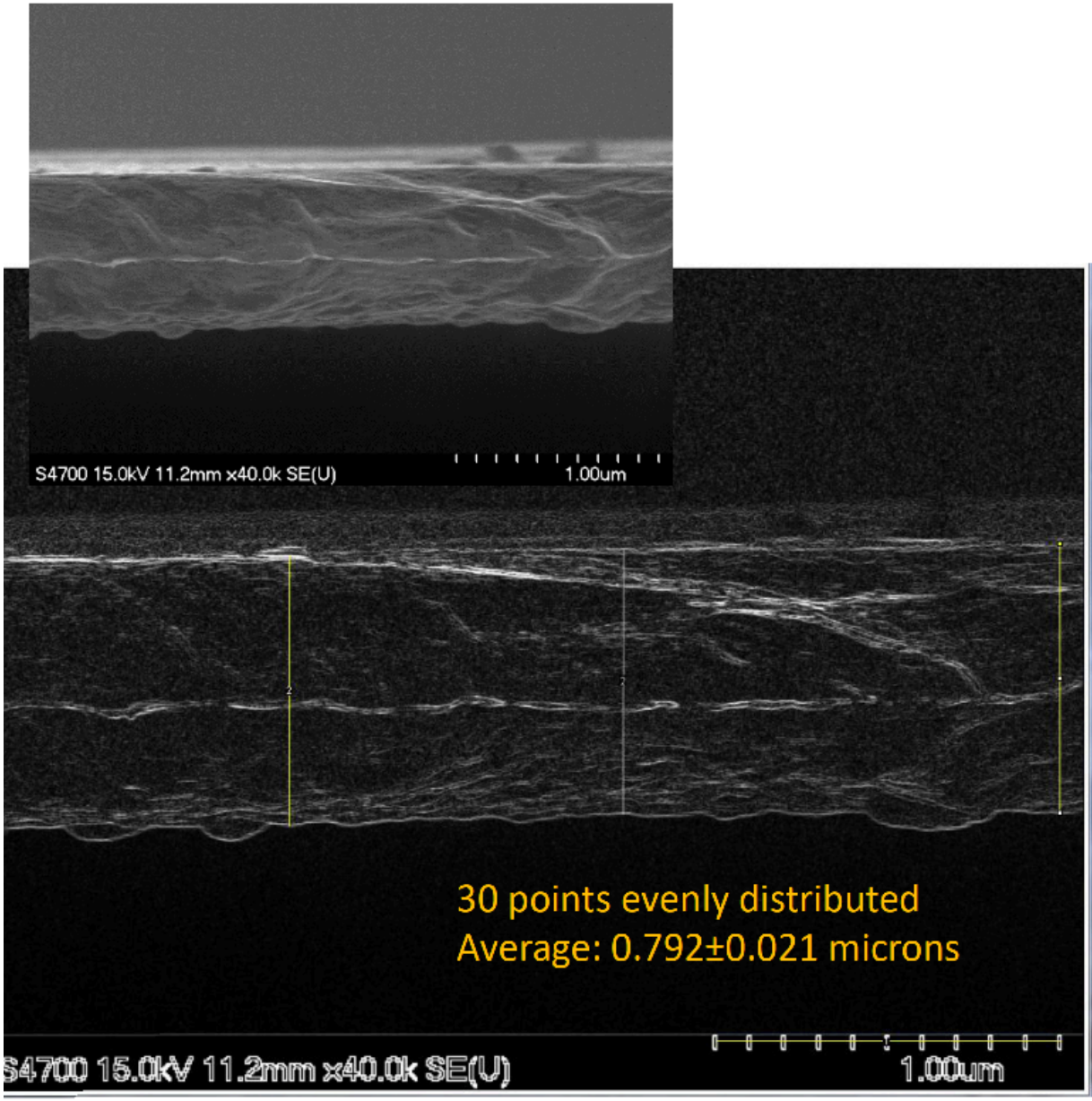
Measured asymmetry vs. targets of gold …

- 11 foils from 0.05 to 1 micron thick
- High <0.25% statistical precision (1-3 hours/foil)

Measure target thickness “off-line”



FESEM of “0.75 micron” gold target

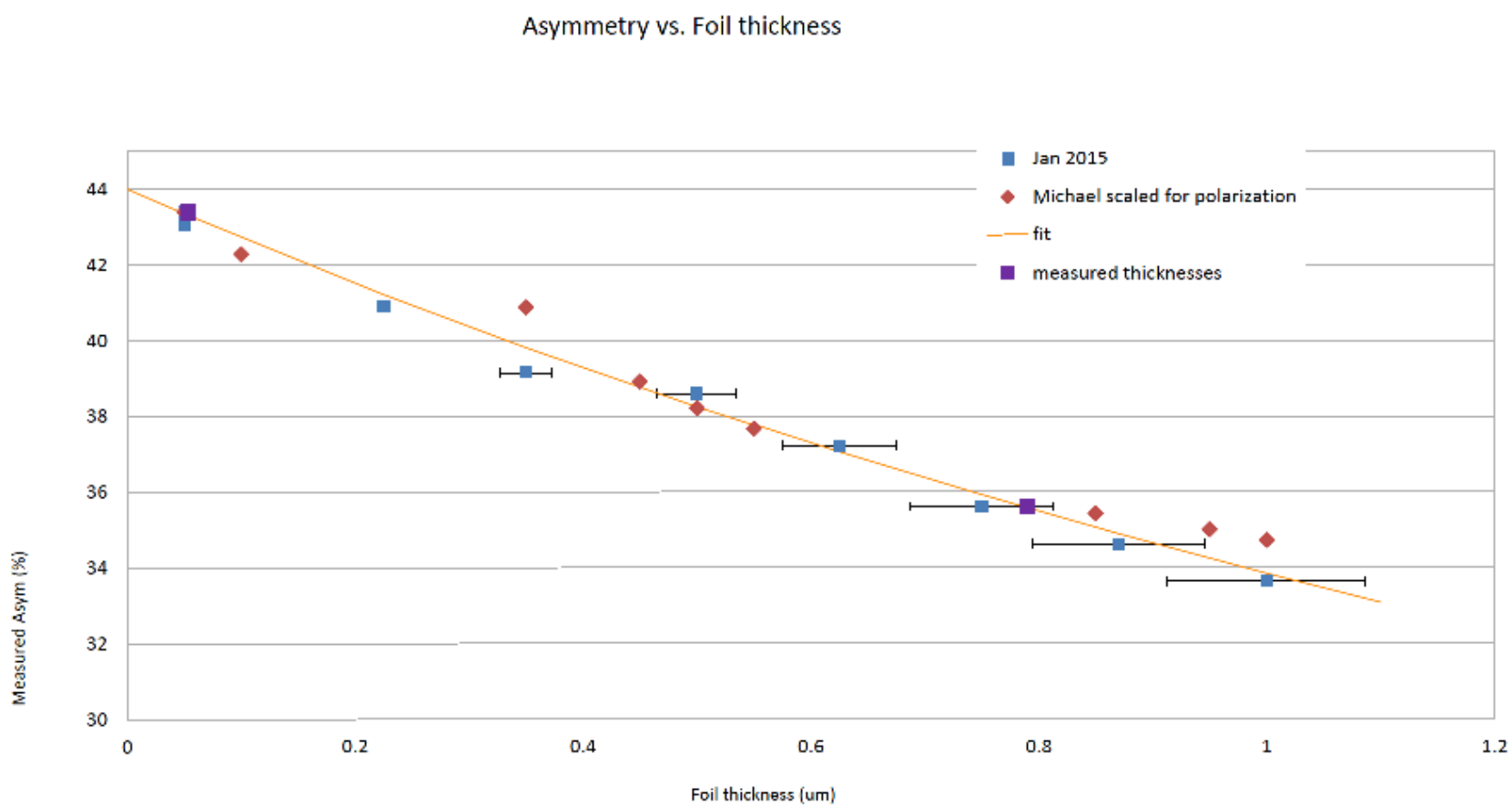


Results

File Edit Font Results

	Label	Area	Perim.	Angle	Length
10		0.002	0.772	-89.816	0.772
11		0.002	0.781	-90	0.781
12		0.002	0.788	-90	0.788
13		0.002	0.778	-90	0.778
14		0.002	0.778	-90	0.778
15		0.002	0.775	-90	0.775
16		0.002	0.788	-90	0.788
17		0.002	0.788	-90	0.788
18		0.002	0.778	-90	0.778
19		0.002	0.772	-90	0.772
20		0.002	0.778	-90	0.778
21		0.002	0.778	-90	0.778
22		0.002	0.795	-90	0.795
23		0.002	0.765	-90	0.765
24		0.002	0.785	-90	0.785
25		0.002	0.785	-89.819	0.785
26		0.002	0.828	-90	0.828
27		0.002	0.838	-90	0.838
28		0.002	0.838	-90	0.838
29		0.002	0.801	-89.823	0.801
30		0.002	0.781	-89.818	0.781
31	Mean	0.002	0.792	-89.958	0.792
32	SD	5.066E-6	0.021	0.114	0.021
33	Min	0.002	0.765	-90.182	0.765
34	Max	0.002	0.838	-89.628	0.838

Preliminary on-line analysis of target thickness extrapolation



High Level Summary

The "Mott experiment" is coming at the end of a two year effort for a precision test of the polarimeter…

- Form collaboration with theorists to improve and assess Sherman function
- Building fast 250 MHz DAQ to record energy and time of all events
- Install a new Be+Cu dump for reduced background and higher current (70uA)
- Tested different methods to produce 31 MHz e- beam
- Re-build higher energy resolution detectors
- "Opening" polarimeter for internal survey of critical components
- Develop a Geant4 model of detectors response and single/double scattering
- Build improved target ladder+controls
- Better tools for operational use

Run 1 provided a basis to study systematics of upgraded polarimeter and test precision of Geant4 model to reproduce target thickness extrapolation.

Run 2 will measure the <u>same polarized beam</u> using three beam energies (KE= 3, 5, 8 MeV) to test the precision of the polarimeter and the accuracy of the theory.

Precision Test of Mott Polarimetry in the MeV Energy Range

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