Hall A Møller Polarimeter Upgrade

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2. What we are going to do?

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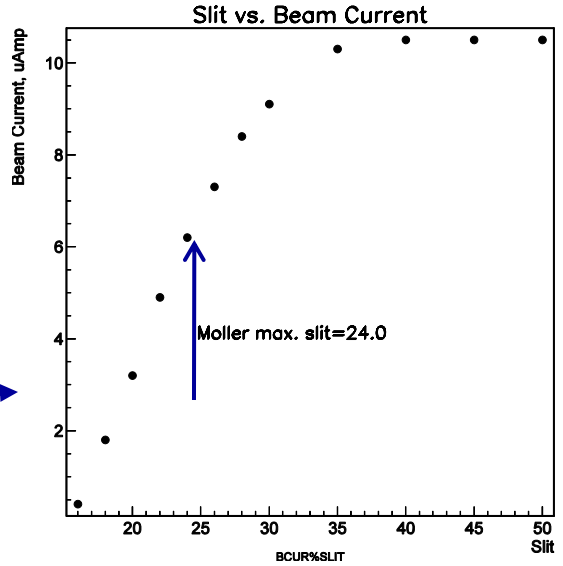
Why do we need upgrade?

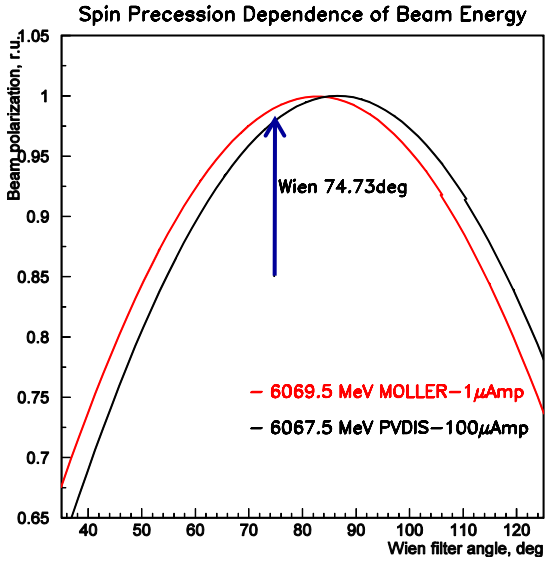
1. Improve the systematic error 2% ⇨ ~1.0%
   - PREX requirement

2. Meas. at high beam current 0.5μA ⇨ 50μA
   - no laser phase dependence
   - working energy fast-feedback
   - no bleed through effect

3. DAQ 12 years old
   - no spares
   - not fast enough for high current meas.

4. Segmented detector and no segmented aperture detector
   - aperture detector overloading at >1μA

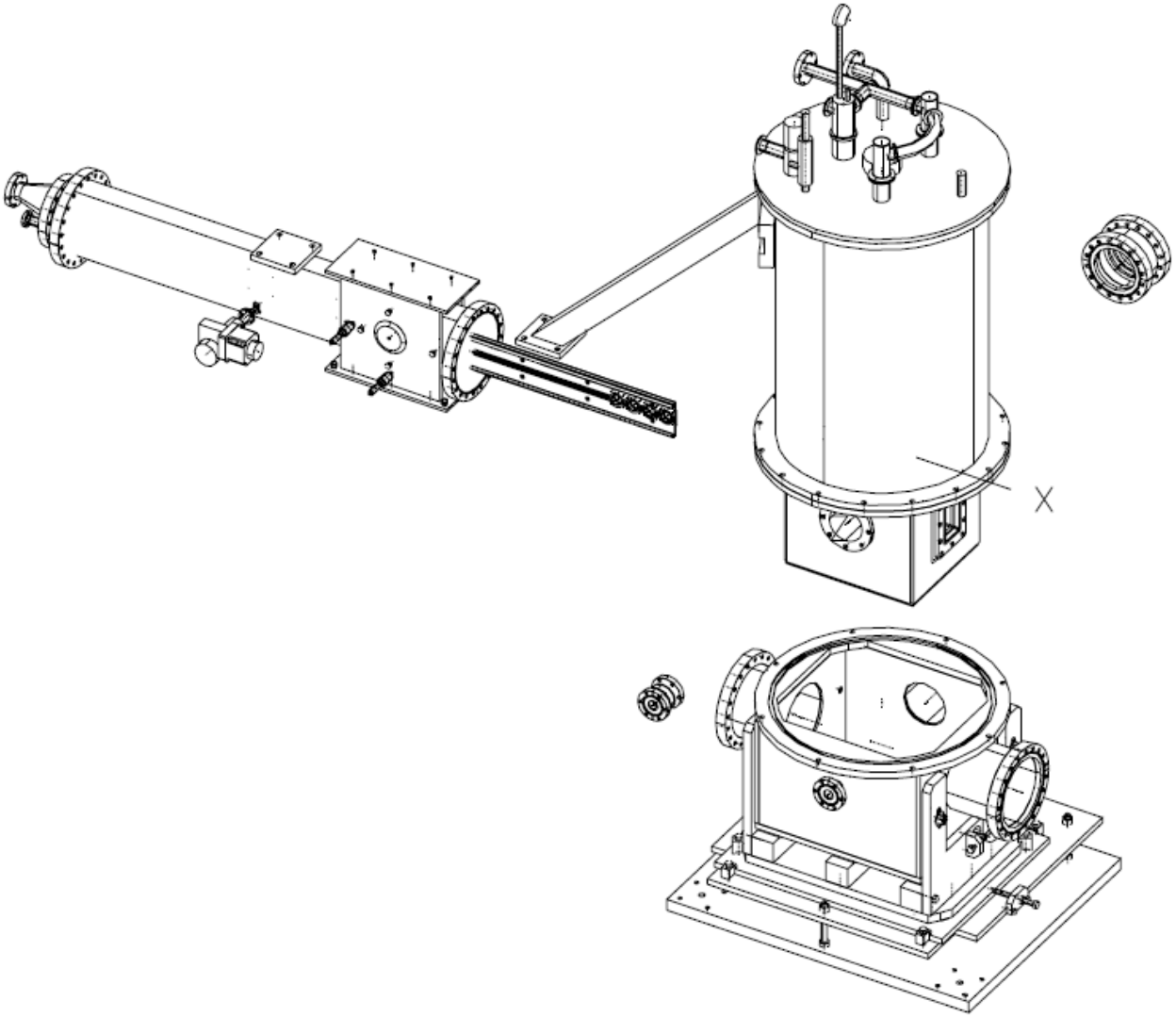




What has to be done?

1. Polarized electron target "brute force" 3T! (Hall C clone)
2. New fast DAQ based on FADC
3. Segmented aperture detector
4. Introduce a beam duty cycle (reduce heating)

New Møller target design

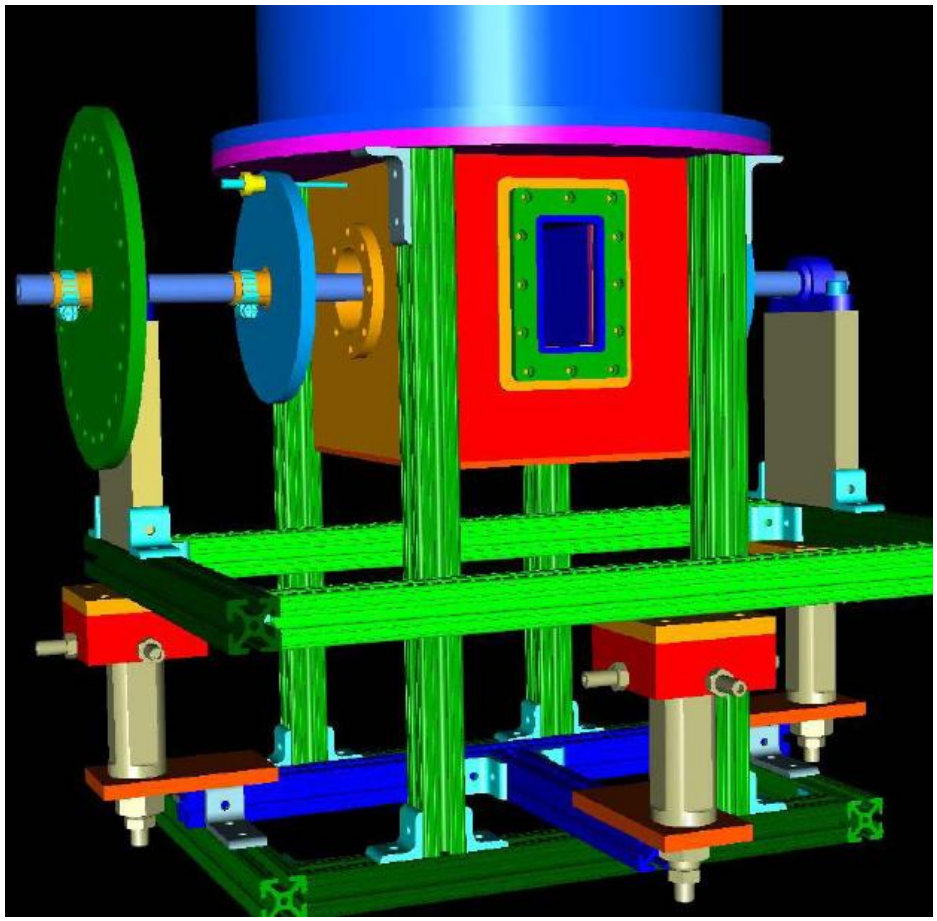


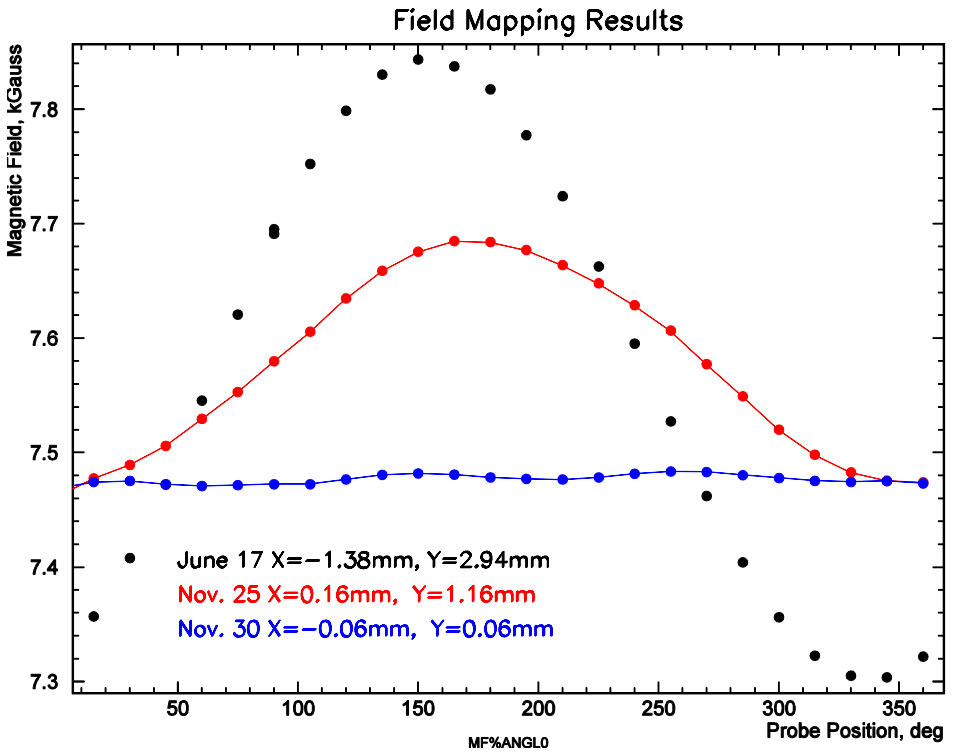
Superconducting magnet

After reconstruction:

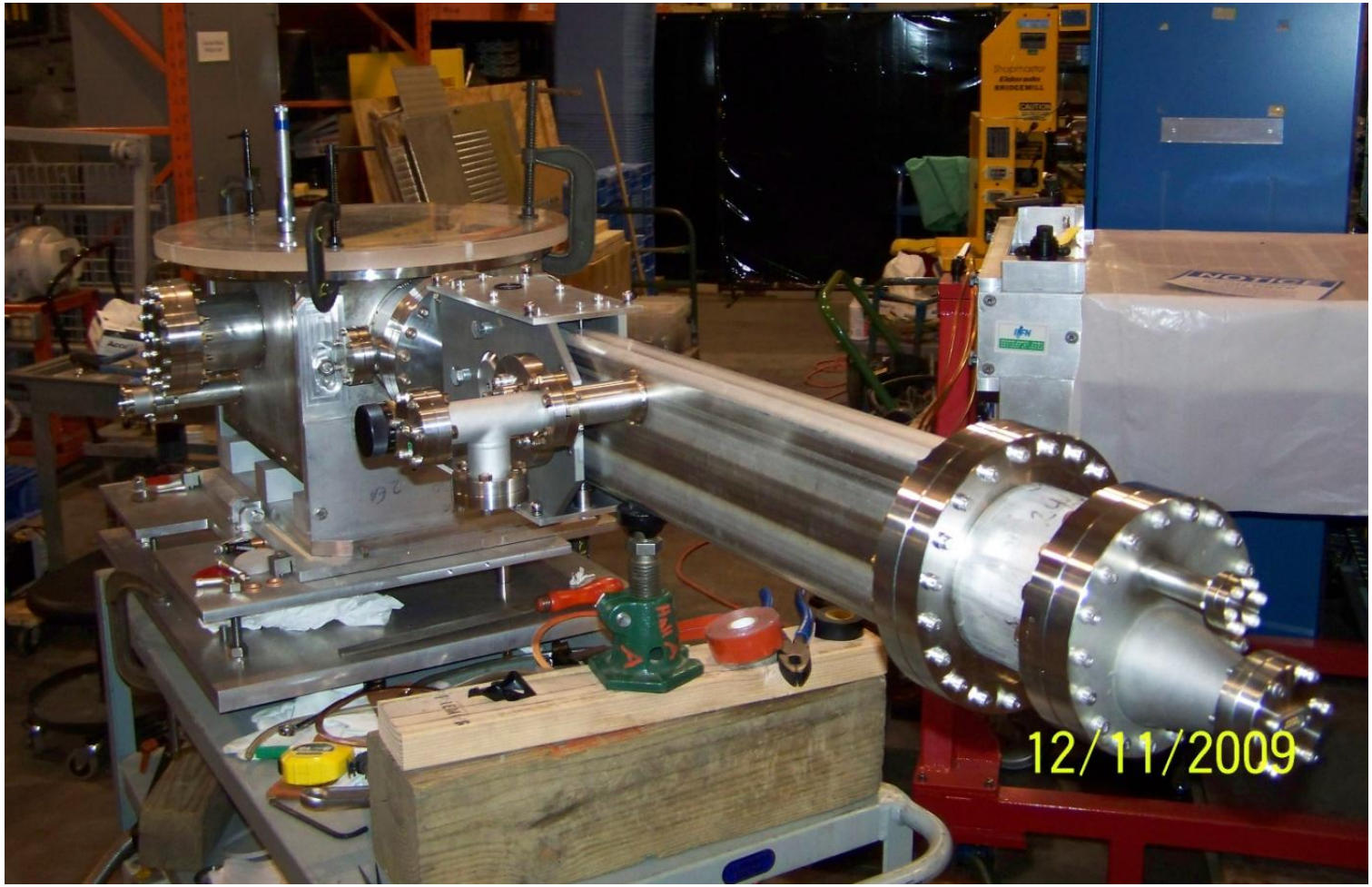
- Better alignment
- Lager N2 outlet diameter
- Better IR shield
- More N2 and He temper. sensors
- LHe and LN2 cryogenic lines ready in Hall A
- Vacuum and cooling tests are done

Field mapping





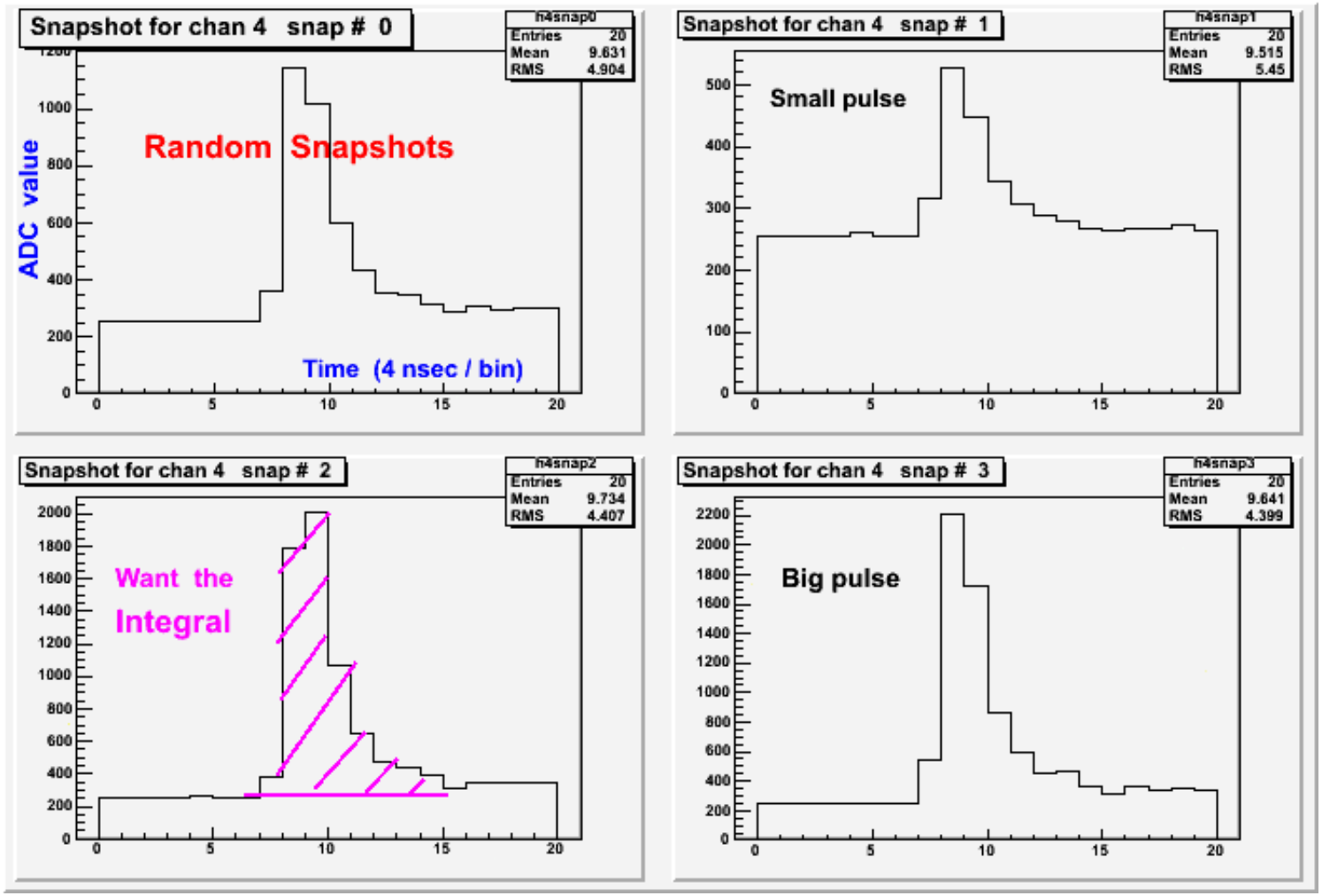
Møller target now



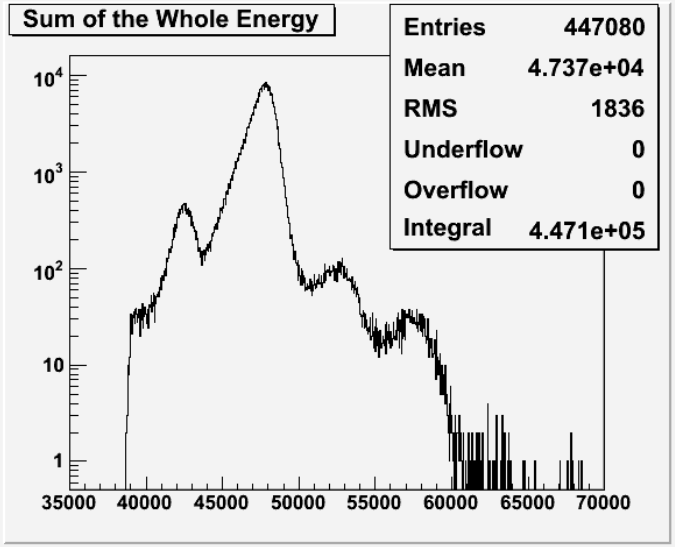
Targets: pure Fe foils 1μm, 1μm, 4μm, 10μm

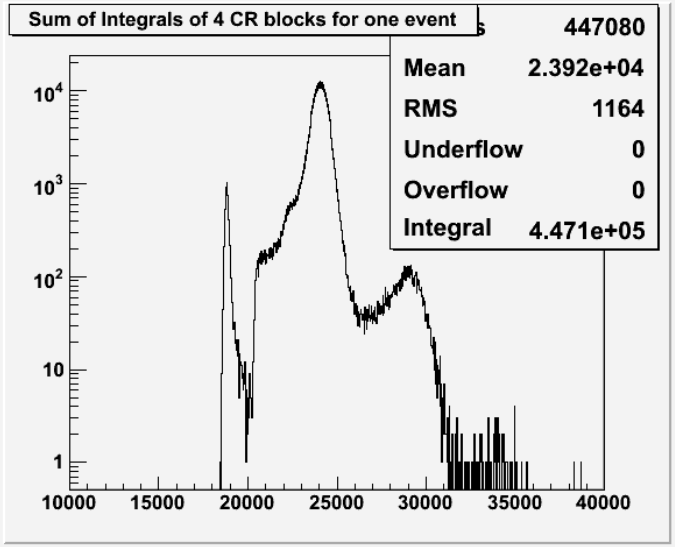
FADC: Snapshots of data above pedestal

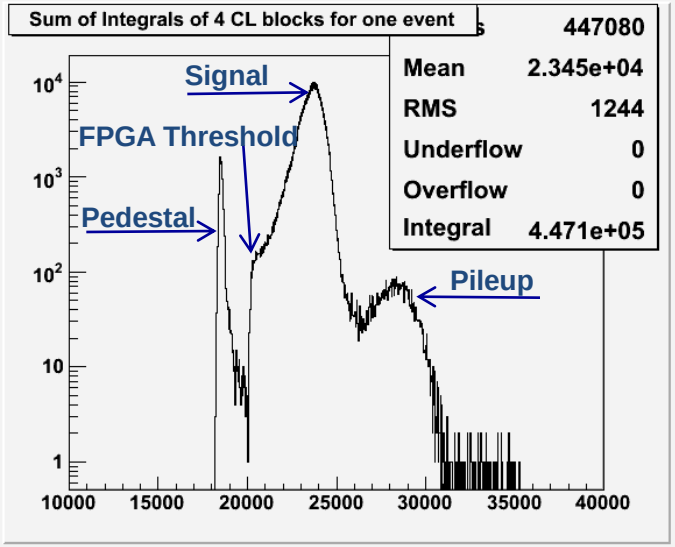
ADC vs. Time



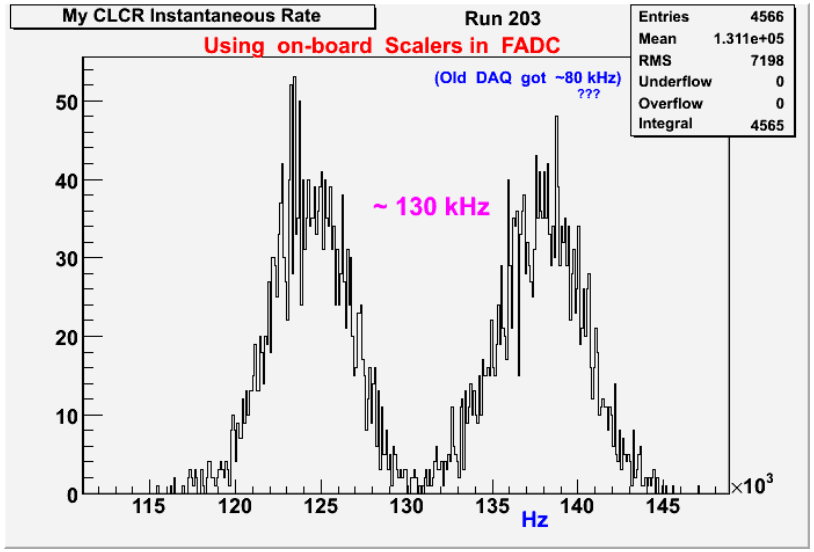
FADC: Energy Spectra

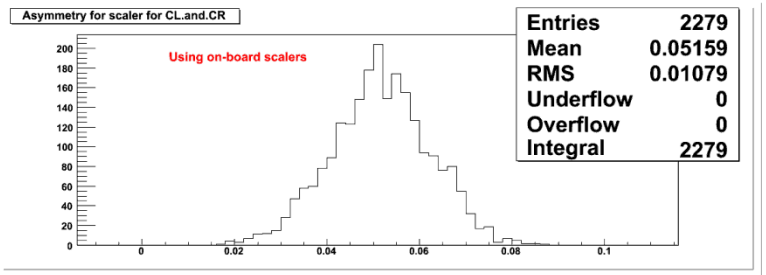


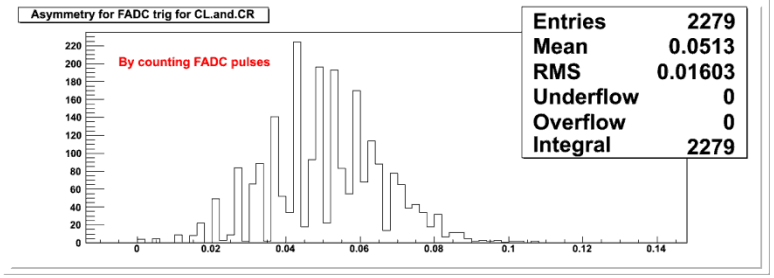


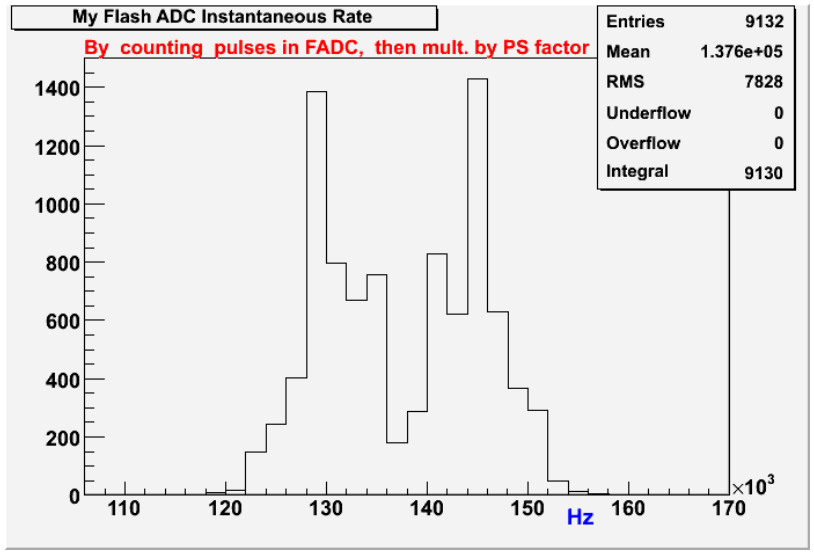


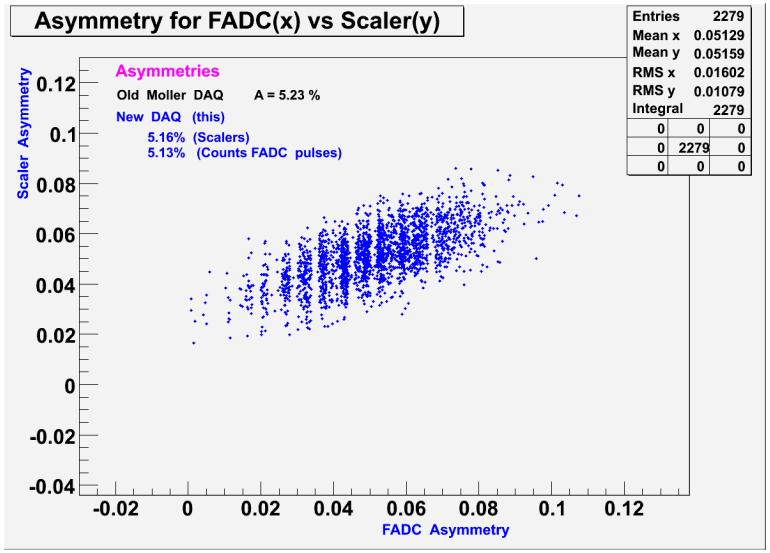
FADC: Rates and Asymmetries











Segmented aperture detector

High current measurements

1. Target heating by 50 μA:
   - Fast raster 1.4×1.4mm², 25×24kHz
   - In pulse ΔT_{max} ~12 K
   - Total ΔT_{max} ~ 24 K - acceptable!
   - For PREX 1.5×0.5mm² available!
2. Beam structure:
   - Beam repetition rate 500MHz/4=125MHz
   - "Tune beam" Δt=4ms (of 30ms) pulses ~K×30Hz
3. Present foil: 10μm at 20° ⇨ 30μm eff. thick.
   - New foil: 1μm at 90° ⇨ 1μm eff. thickness
   - Rate factor 0.03
   - Thickness for cooling = Thickness for heating
4. Statistical accuracy 1% in ~20min

Møller systematic errors

Variable	Hall C	Hall A	
		Present	Upgrade
Target polarization	0.25%	1.8%	0.5%
Target angle	0.0%	0.5%	0.0%
Analyzing power	0.24%	0.3%	0.3%
Levchuk effect	0.3%	0.2%	0.3%
Target temperature	0.05%	0.0%	0.02%
Dead time	?	0.3%	0.3%
Background	?	0.3%	0.3%
Others	0.1%	0.3%	0.5%
Total	0.47%	2.0%	~1.0%

To do list

Target :

- Target loader, can and magnet assembly and alignment
- Target loader welding and final assembly
- Target installation in the Hall
- Target tests: motion, control, FSD etc.

Detector:

- aperture detector test
- aperture detector installation and alignment

Present DAQ:

- adaptation to new target configuration and aperture detector

Fast DAQ:

- finish data analysis code

COMMISSIONING

Beam polarization measurement

CONCLUSION

A lot of job is successfully done

A lot of job has to be done in a limited time

We have to work hard

We need a good luck

Møller polarimetry

Polarized electron targets: magnetized ferromagnetic foils
- Iron: polarized d-shell (6 positions occupied out of 10)
- Pe not calculable: derived from measured magnetization
- Spin-orbital corrections (5%) - measured in bulk material
- Magnetizing field is along the beam

Field 20 mT, foil at 20°

- Magnetization along the foil
- Magnetization can be measured
- Polarization differ. along the foil
- A few % from saturation
- Sensitive to annealing, history
- Polarization accuracy ~2%

Field 3 T, foil at 90°

- Magnetization perp. to the foil
- Magnetization - from world data
- Polarization constant along the foil
- Foil saturated
- Polarization is robust
- Polarization accuracy ~0.5%

INVASIVE!