Beam Issues

Intro

PREX: highly sensitive to beam motion and 15ppb absolute error, transverse asymmetry much larger than A^{PV}

HAPPEX-III: less sensitive to beam motion, σ = 500 ppb but 0.6% linearity requirement

- Transverse Asymmetry
- Source optics configuration
  - clean up polarizer, cathode rotation
  - rapid flip switch
  - spot size
- Double Wien
- Beam intensity modulation system (source)
- Beam trajectory modulation system
- Compton backgrounds

Transverse polarization

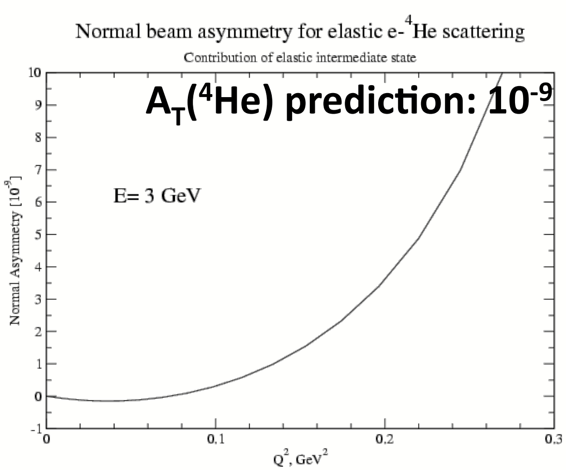
An allowed (non-parity-violating) asymmetry arises from transverse polarization. This may be an order-of-magnitude larger than A_{PV}, and present a significant challenge to the experimental accuracy.

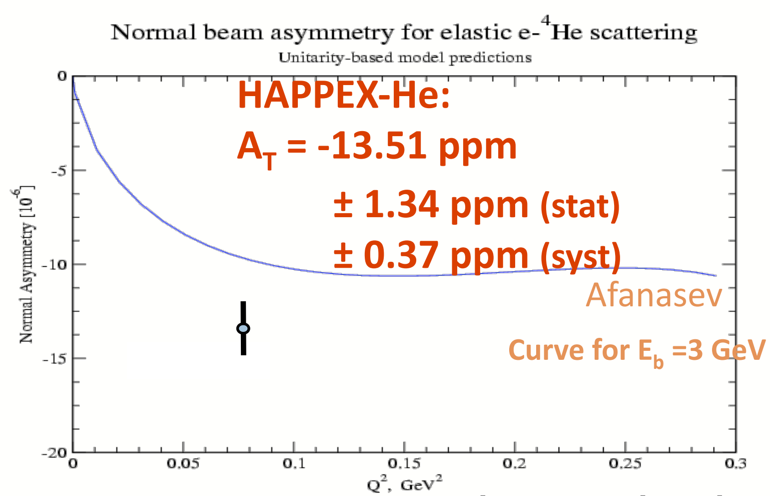
Vertical: Should be well controlled in injector. We aim for <1% vertical polarization... is this possible (and stable) using existing solenoids?

Accuracy in the Mott polarimeter will be critical!

Horizontal: Will require spin dance, and "A^T-hole" data will be transverse asymmetry monitor in Hall A. "Human-mediated feedback", on time-scale of ~week, may be necessary.

Goal: Vertical and horizontal transverse polarization <1%.





Dedicated measurement of PREX transverse asymmetry is required

Source/Helicity-Correlated Beam

High absolute precision requirement leads to tight requirements on HCBA

Rapid Helicity Flipping

- Studied at UVa and on beam (Riad)
- New switch in standard use
- 240 Hz looks very doable for PREX

Spot Size / Shape

- Studies from UVa presented tomorrow
- Conclusion: It is hard to do better than limit of 10^{-3} (but still possible)
- Cathode non-uniformity can exacerbate the problem
- Bottom line: double Wien is critical

Improved A_Q feedback

- Injector net?
- Otherwise, simply faster cycle on usual EPICS hook

Source Optics Improvement

- Clean-up polarizer
- Rotatable photocathode

Wien Slow Reversal

Goal: upgrade the Wien spin rotator to provide 180 degree spin rotation, relative to the optimized launch angle, with minimal beam optics change.

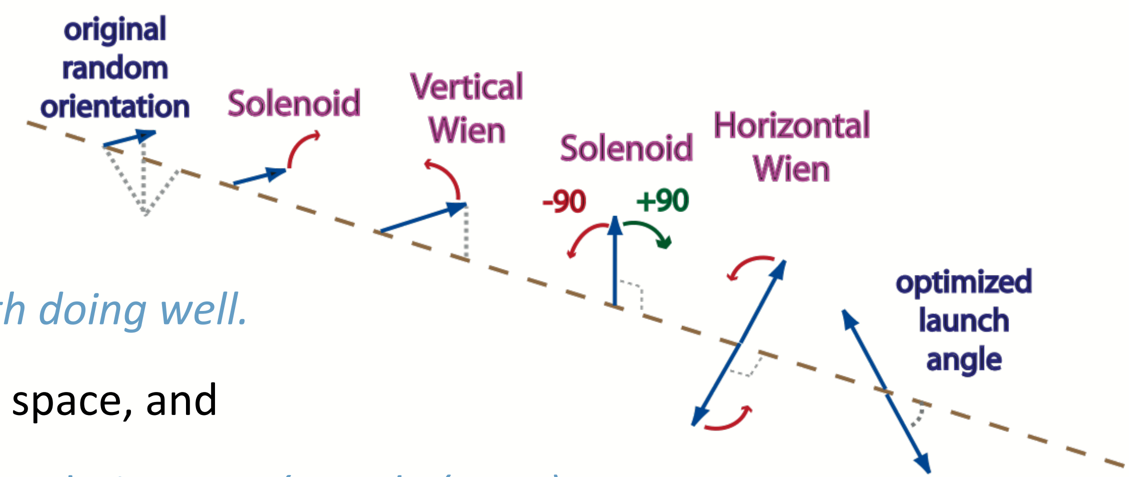
- This is crucial for cancelling possible higher-order helicity correlated beam asymmetries, such as spot size or vertical polarization moment distribution

Criteria:

- Transfer matrix mapping position motion from photocathode to position or angle at the Hall A target should change by <50%
- spin slip should not require a major retuning to restore design match

One *very* attractive concept:

Two Wien rotations, optimized once then held constant, with +/-90 degree solenoid rotation



Optically neutral (IDEAL!!!) and

If a job's worth doing, it's worth doing well.

But it requires additional beamline space, and

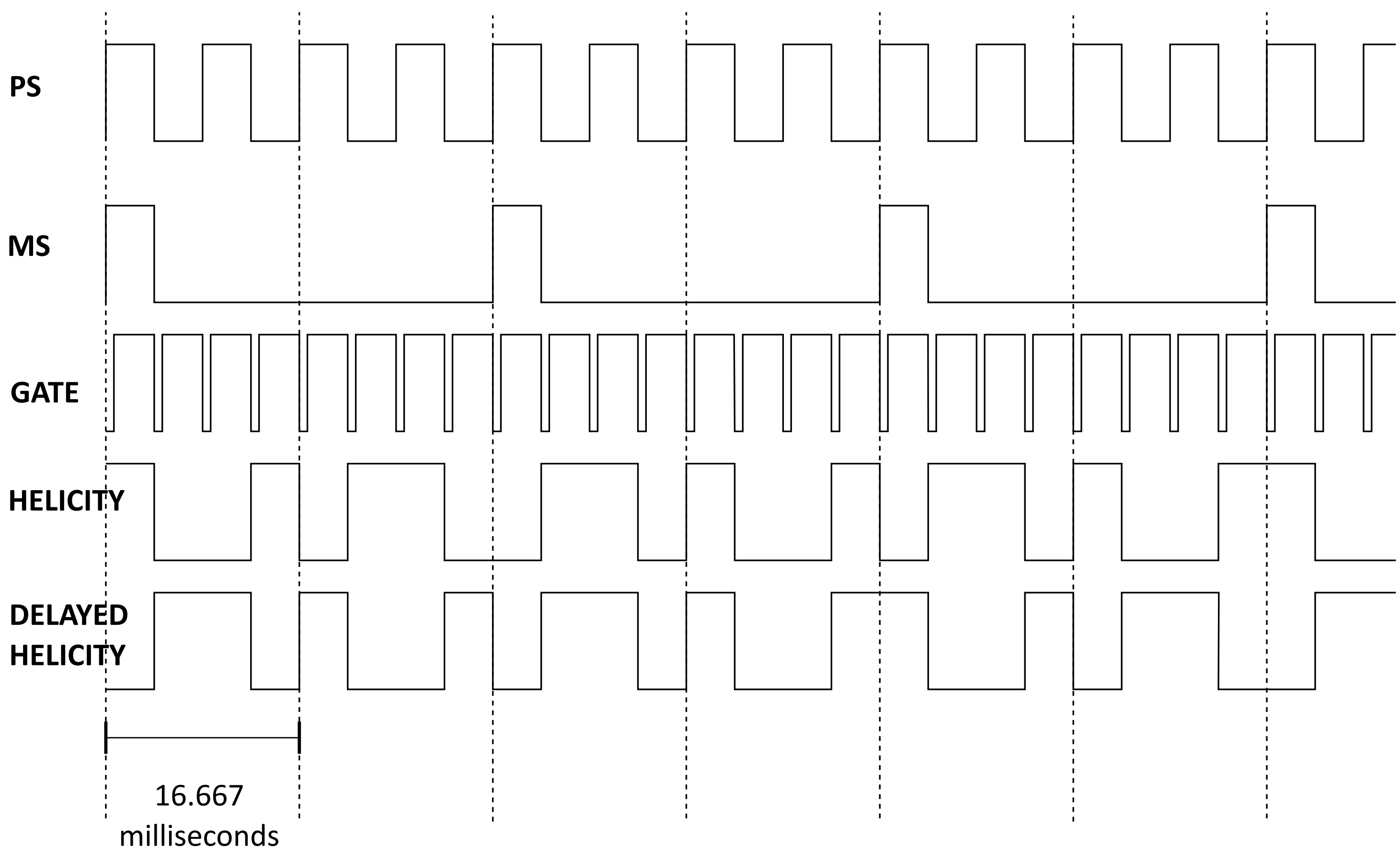
Le mieux est l'ennemi du bien. Voltaire, *La Bégueule (1772)*

Fast Flip and 60 Hz

New Helicity board in implement multiplet scheme for 120Hz, 240 Hz flipping

30 Hz pairs still available

Proposed helicity scheme for 240 Hz flipping



Expected Work in summer

Riad is planning a series of test studies on properties in injector, testing dependence on some source optics

August 2009 - configure for HAPPEX-III

- HAPPEX-II-style alignment, should take a couple of shifts in the tunnel after configuring DAQ.
- Not planning spot size measurements in tunnel
- Injector studies to fix waveplate angle
- If time allows, cathode rotation etc. would be valuable practice

Beam Intensity Modulation

Beam intensity modulation would study detector linearity response in situ, with cathode illumination spectrum and distribution under running conditions. (5-10%, few to 10 Hz?)

Tests would be infrequent, could be scheduled to minimize disruption to other halls.

IA type system, but “single ended” (shouldn’t require average intensity loss beyond surface insertion loss, unlike helicity-feedback system).

Driven by function generator + voltage supply, modest hardware/software work.

Does it interact badly with other feedback systems?

Beam Trajectory Modulation System

Modulation pattern

Option 1: revive old system of stepwise sawtooth pattern

Option 2: Avoid slow drifts with faster differential measurement

- VME function generators to drive sine waves
- Slower than DAQ readout frequency (i.e. 7.5 Hz?)
- FFB must still be disabled
- Uses standard Trim magnet P.S. cards
- phase readout in DAQ for cross-check (new cable?)

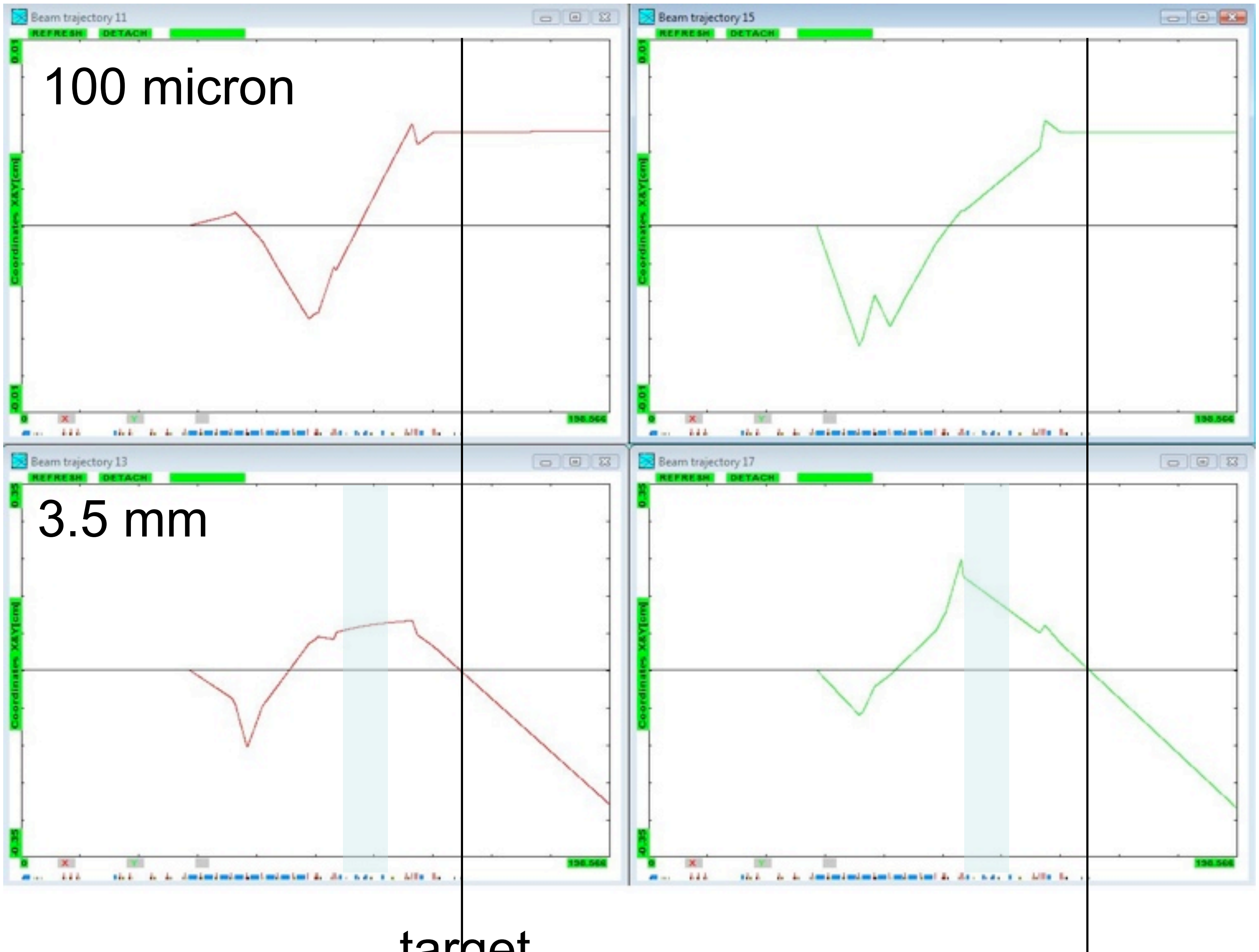
Coil location

Coils can be located in arc, which allows use of 1C01-1C08 girders to restore design input specification

There will be effect from upstream mis-match on magnet slopes!

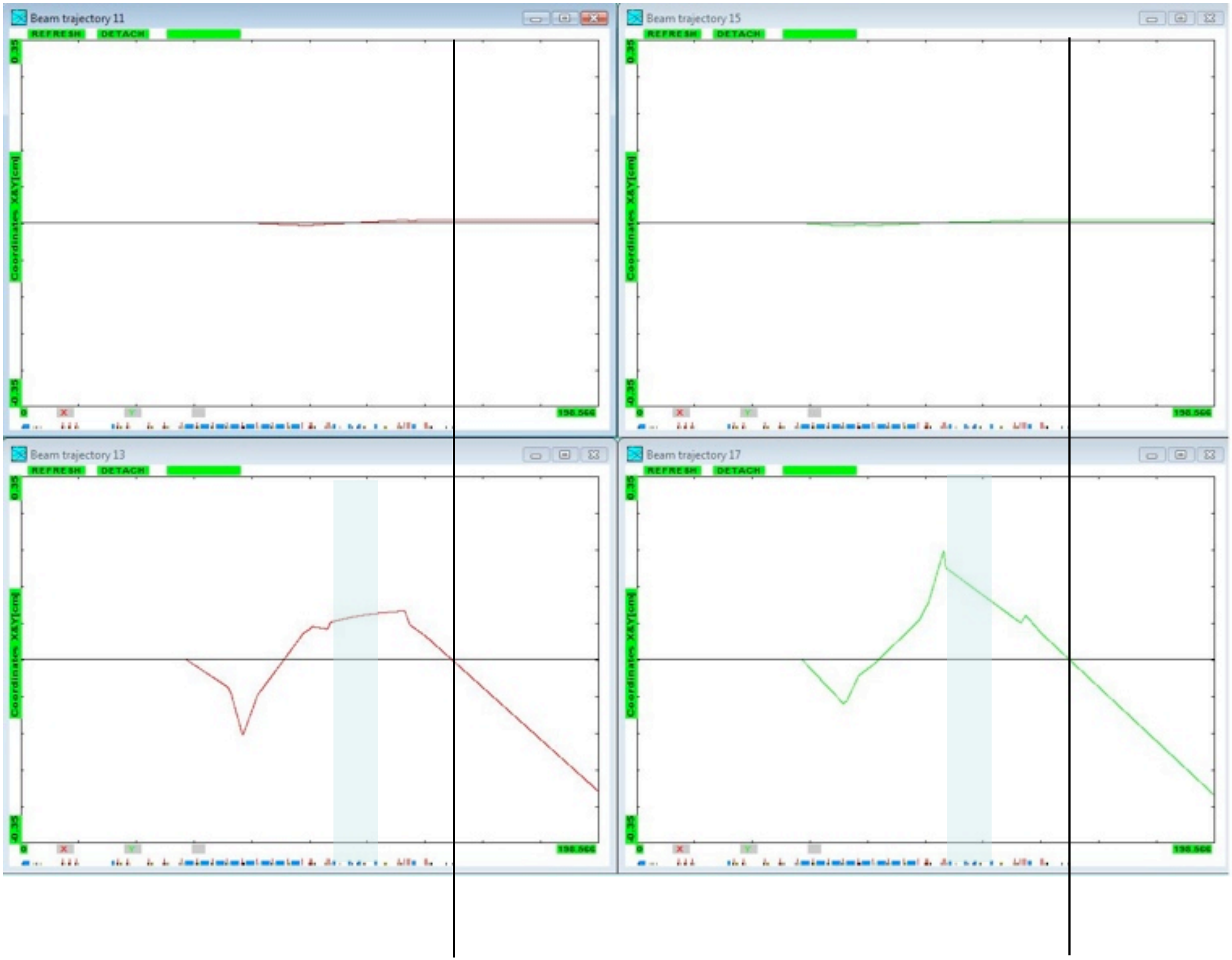
Beam Trajectory Modulation System

Work by Nuruzzaman, D. Mack, with OPTIM deck from Jay

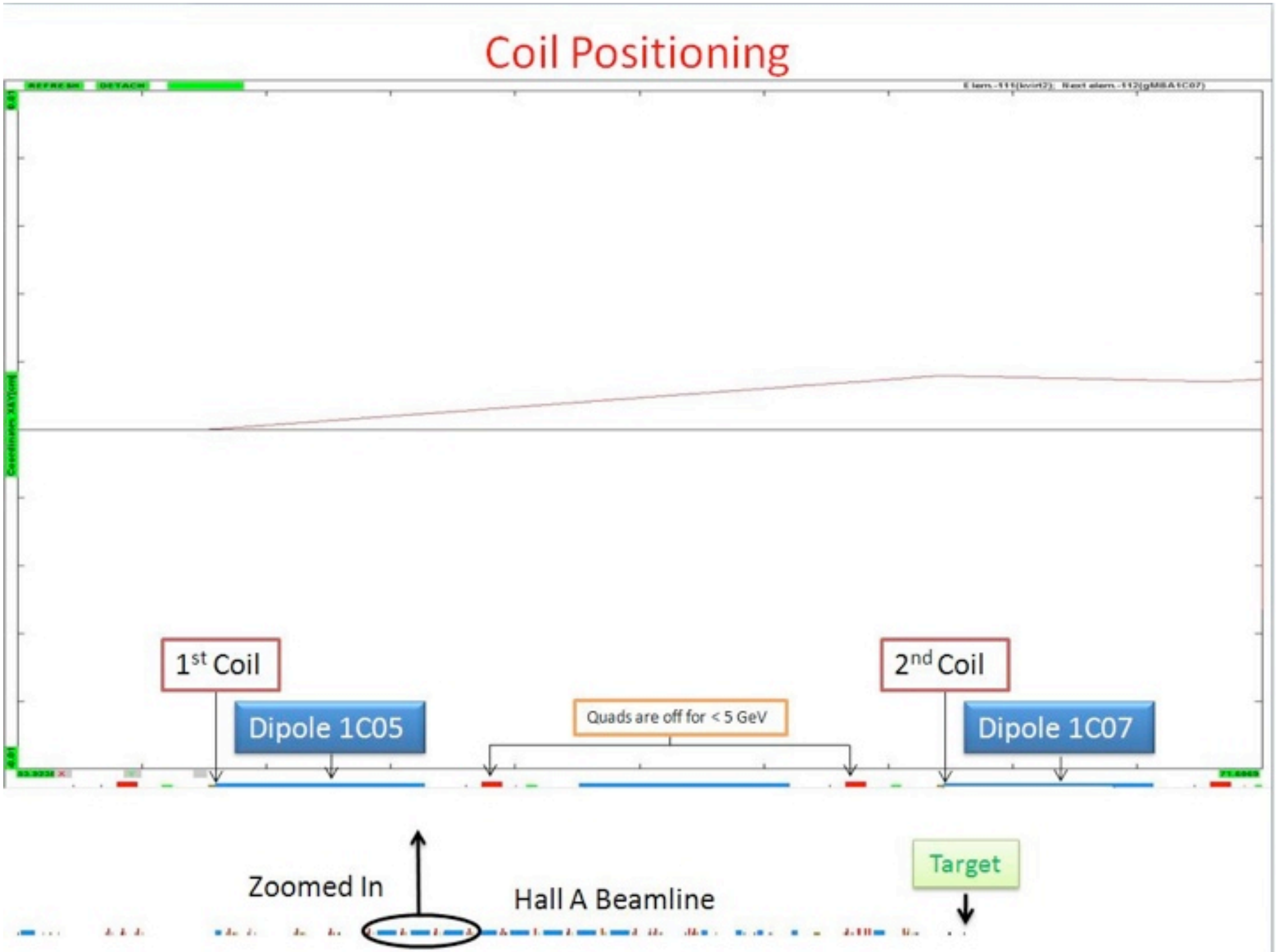


target

Beam Modulation System



Beam Modulation System

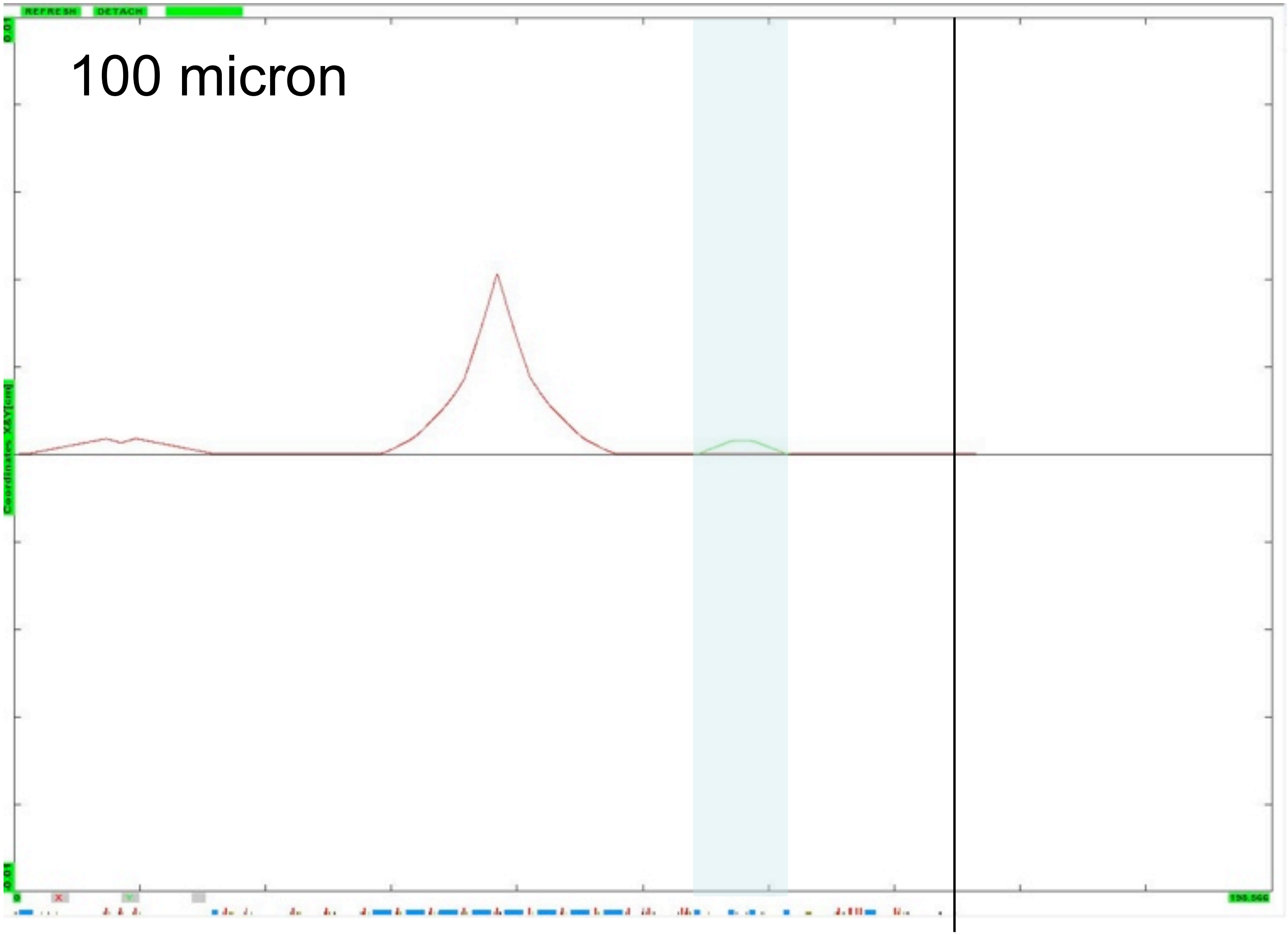


Beam Modulation System

Beam Modulation Calibration Constant for Hall-A HAPPEx III

Beam Parameter	Modulation Amplitude	BdL_1 (G-cm)	Calibration Constant (BdL_2 / BdL_1)
X	50 μm	I_1 = 17.7	-1.2768
X′	50 μrad	I_1 = 325.0	-7.1667
Y	50 μm	I_1 =-54.0	-0.5741
Y′	50 μrad	I_1 =200.0	0.3235

Beam Modulation System



Energy kick by 0.001%: $1e^{-5} * 4m = 40$ micron