Hall D Feedback

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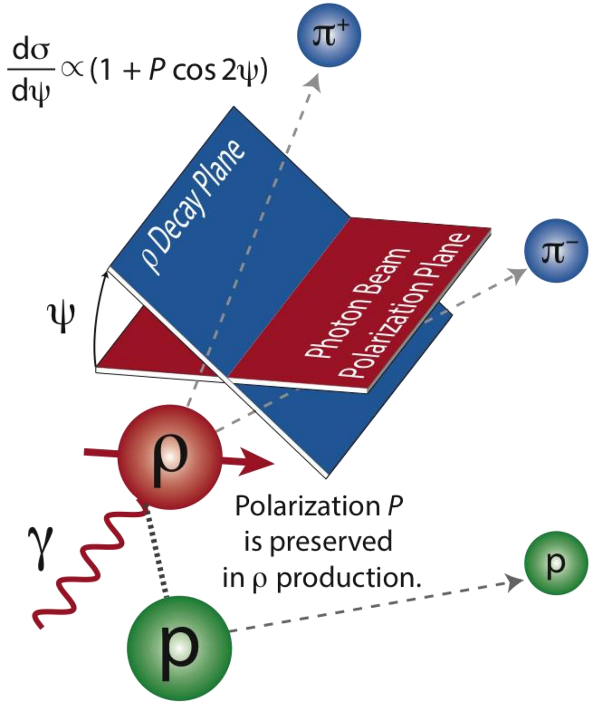
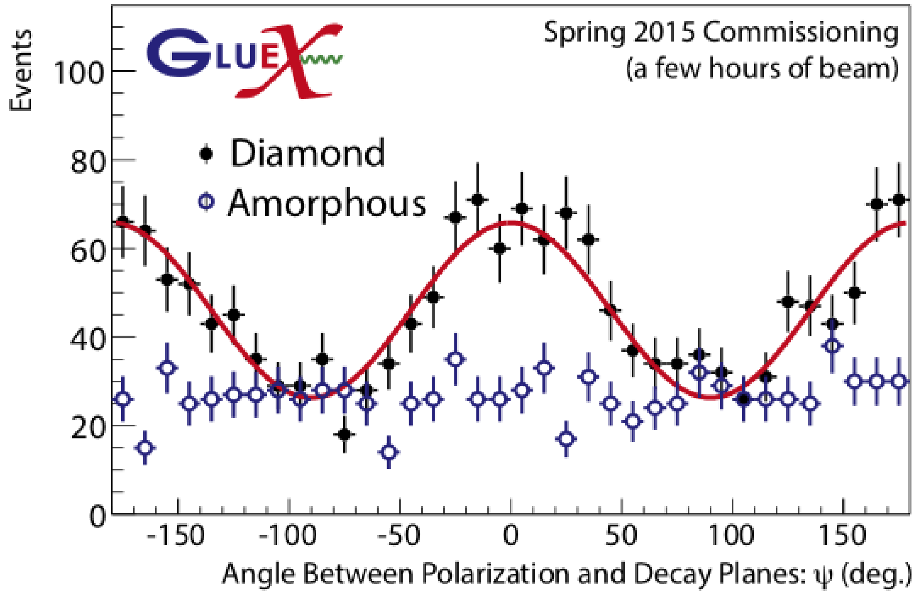
Overview

- Requirements for Hall D beam
- Hall D beamline equipment
- Experience from fall and spring running
- Expectation for the near future running
- Summary

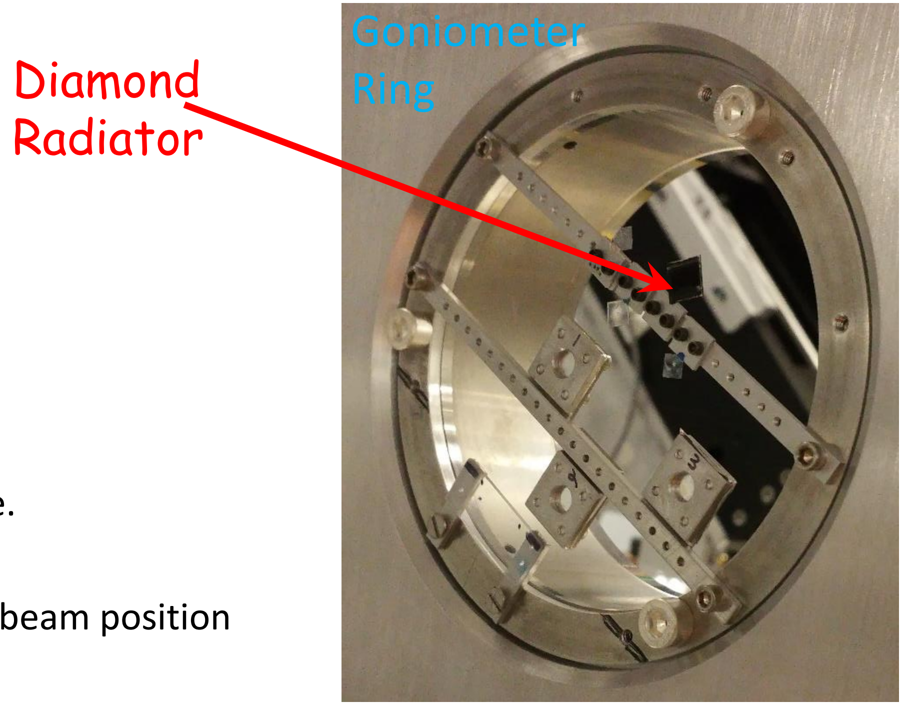




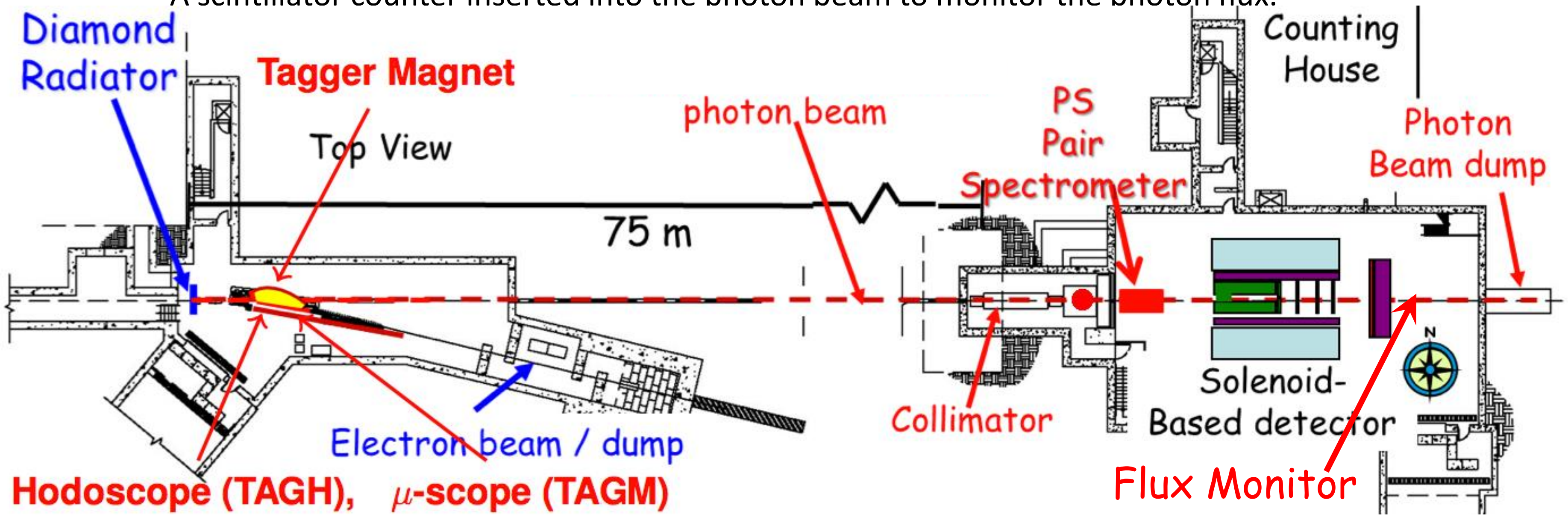
Beam Requirements

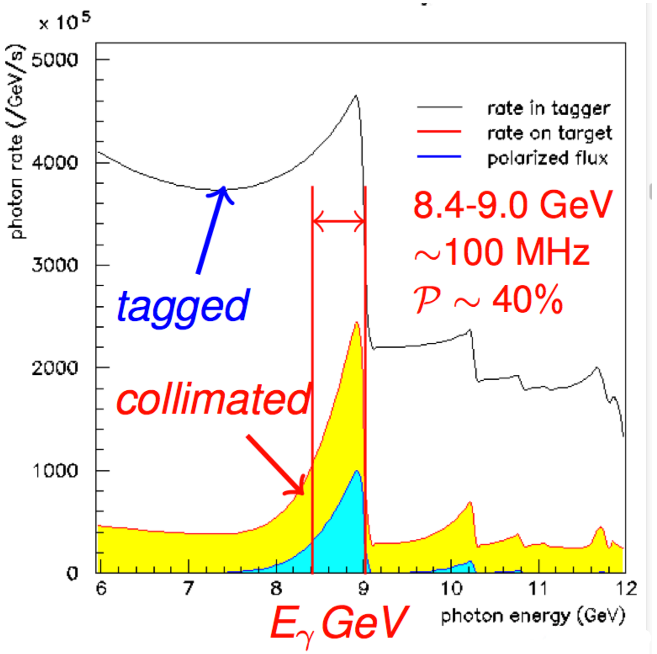
Electron beam parameters	First 6 months	6-12 months	Year 2
Minimum Energy	10 GeV	11 GeV	12 GeV
Maximum Current	3μA	3μA	3μA
Minimum Current	1nA	1nA	1nA
Maximum emittance	50 nm-rad	20 nm-rad	10 nm-rad
Maximum Energy Spread	< 0.5%	< 0.5%	< 0.1%
Maximum halo	10^{-4}	10^{-4}	10^{-4}
Virtual spot at collimator			
maximum x spot size at collimator	2 mm RMS	1 mm RMS	.5 mm RMS
maximum y spot size at collimator	2 mm RMS	1 mm RMS	.5 mm RMS
x and y position stability at collimator	1 mm RMS	0.5 mm RMS	0.2 mm RMS
position stabilization bandwidth @ 300 nA	1 Hz	60 Hz	1000 Hz
x and y range of motion of virtual spot at collimator	±25 mm	±25 mm	±25 mm
x and y centering of real spot at radiator	±1.0 mm	±0.5 mm	±0.5 mm

Hall D Beamline Equipment



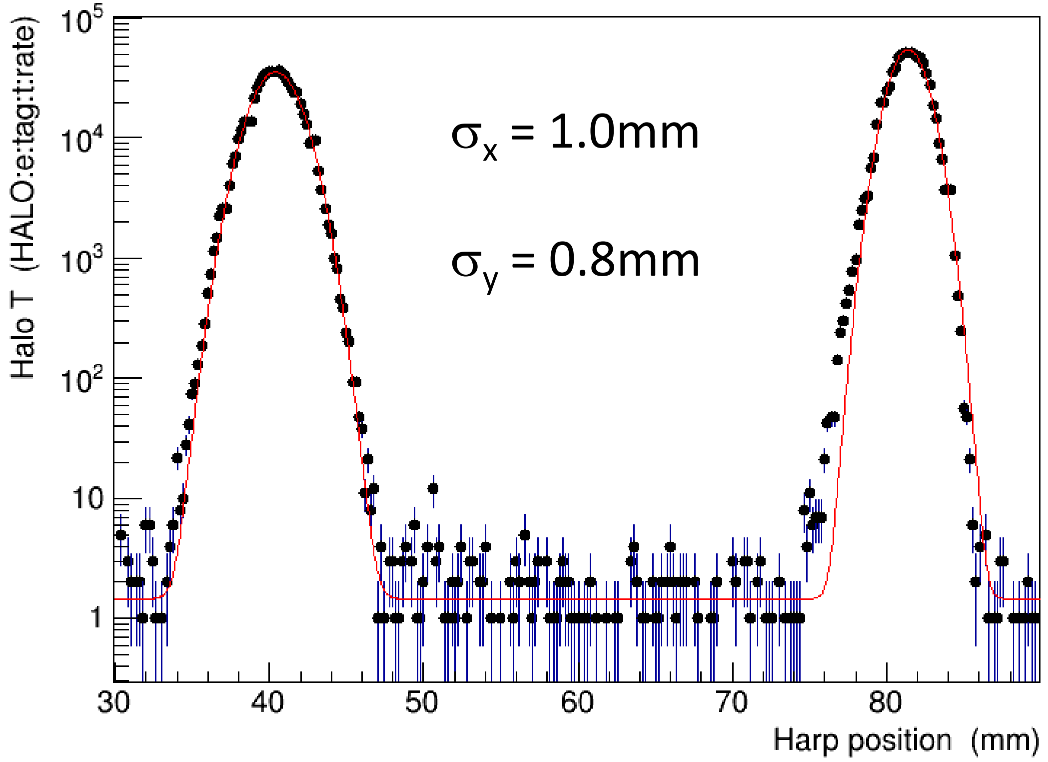
- Goniometer for diamond radiators
  - Each radiator has thin square area of ~5mmx5mm
- Amorphous radiator stick
  - Three targets with ~3cm diameter aluminum targets
  - 20mm tungsten wire for Hall-B style PMT-based harp scan
- Upstream beam profiler
  - Determines the beam profile just when the photon beam enters the collimator cave.
- Collimator with 5mm and 3.4mm holes
  - Active Collimator photon beam diagnostics mounted in front of it to determine the beam position
- Photon beam intensity monitor
  - A scintillator counter inserted into the photon beam to monitor the photon flux.



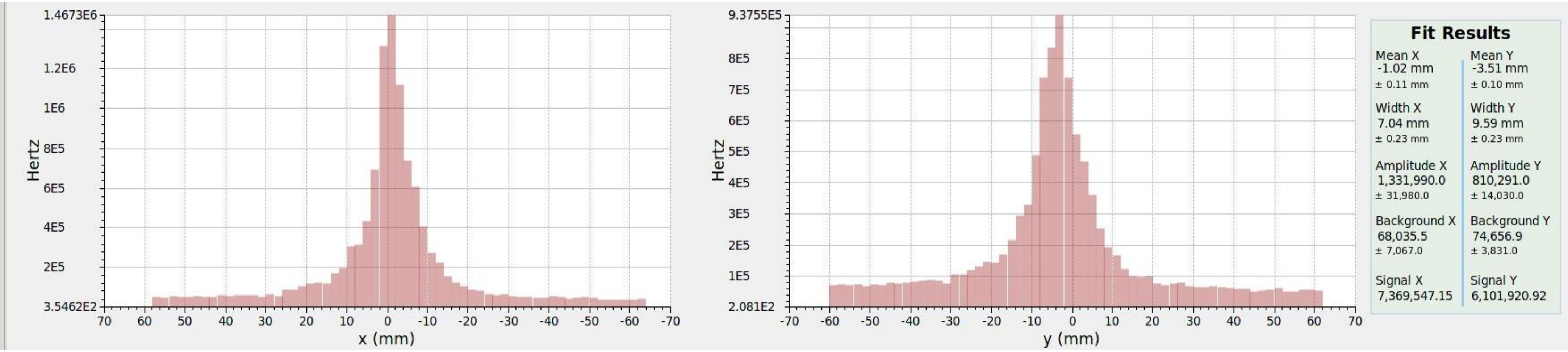


Beam in the Fall of 2014

- 19 (integrated) days 10.1 GeV beam available
  - Run from 50-200nA beam current.
  - Nice beam profile at radiator, expected spot size.
- Only amorphous radiator used during the fall running.
- Commissioned Hall D beamline components from the radiator to the photon dump.
  - Active Collimator has been commissioned.
  - Beam profiler used to calibrate Active Collimator.
  - Photon beam transfer verified through the target to the dump.
- Procedure for establishing the unpolarized photon beam was understood.

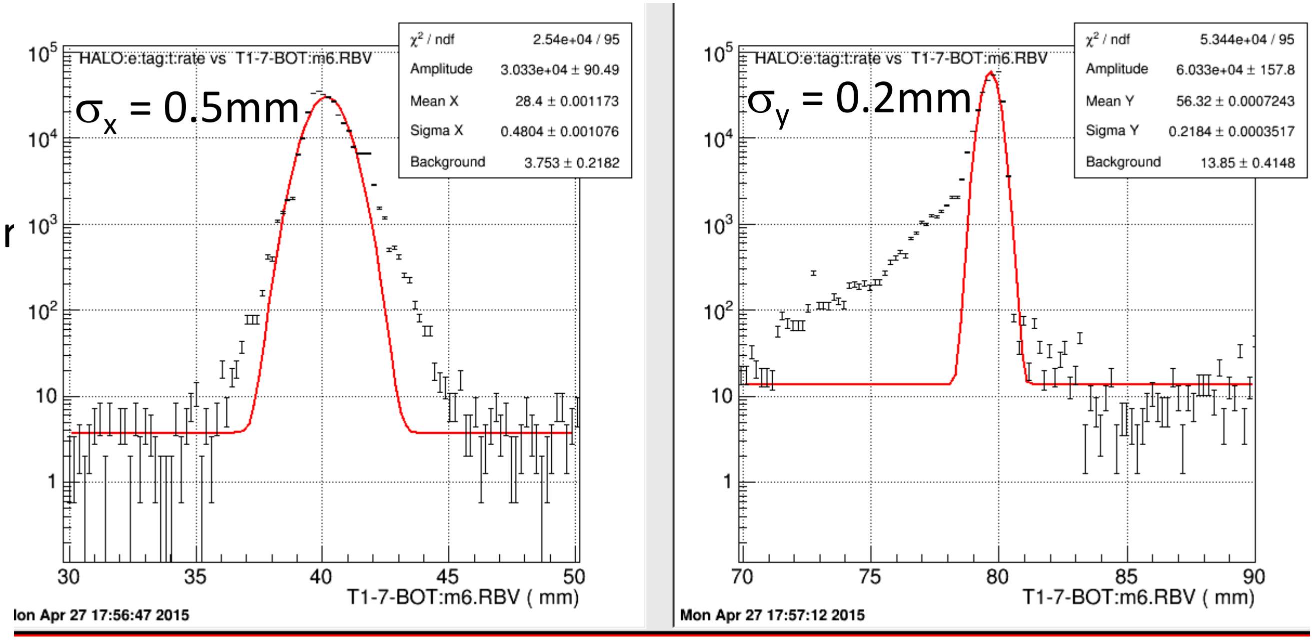


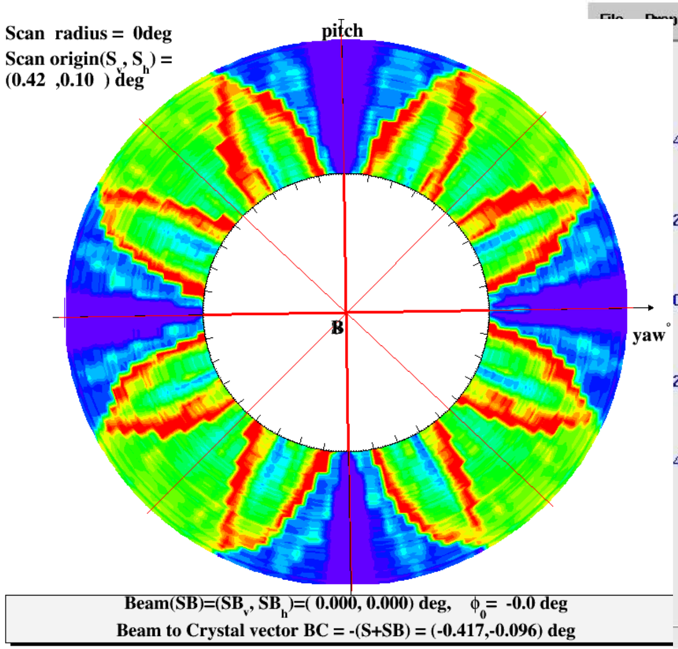
Photon Beam Profile from BPU



Beam in Spring of 2015

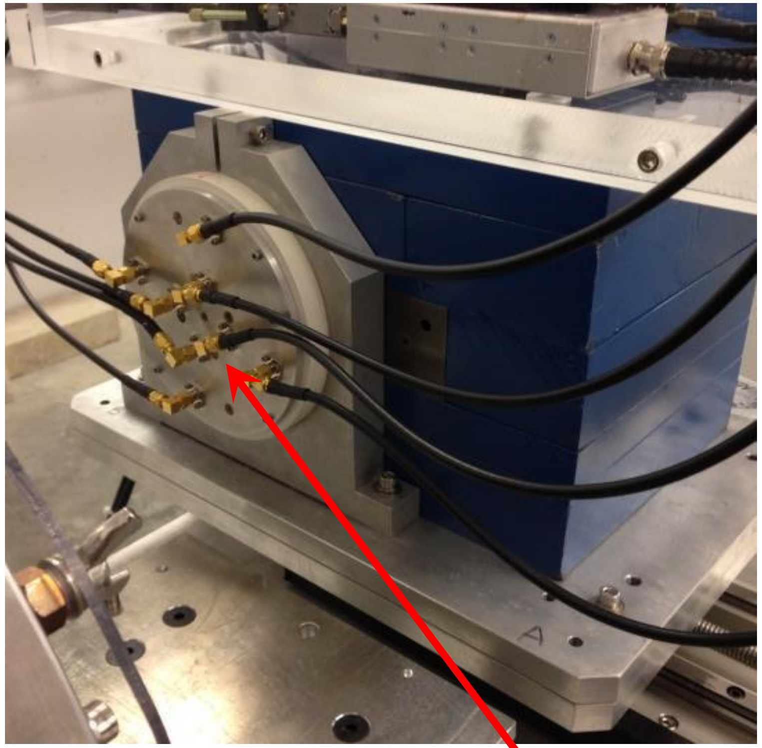
- About a week of running with 5.5 GeV beam, 5mm collimator
  - Beam current 5-200nA on amorphous and diamond radiators.
  - Narrow beam profile at radiator with shoulders.
- Partially commissioned goniometer
  - Issues with beam position stability
  - Need to commission with 12GeV beam where the electron deflection angles are smaller.
- Beam stability at the radiator was a problem
  - Needed for running with diamond radiators.



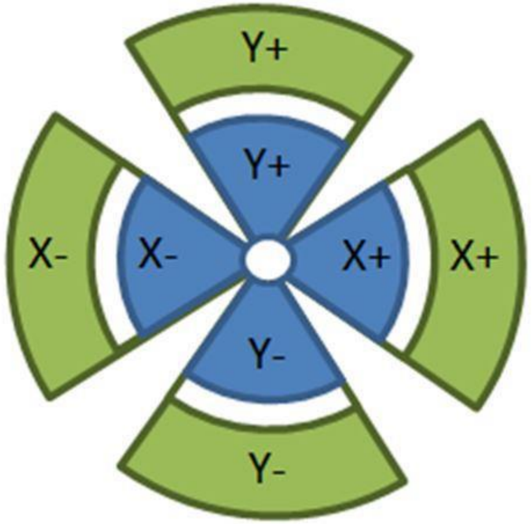


Active Collimator Readings

- Active Collimator (AC) is physically attached to one of the collimator holes (either 3.4mm hole or 5.0mm hole).
- Active collimator signals were calibrated to provide the position relative to the center of the AC center.
  - Calibration requires moving the beam in Y and scanning the motor in X.
  - AC center is aligned with one of the collimator holes.
  - We usually use the inner ring of the active collimator.
- When collimator to which the active collimator is attached is out of beam (for instance collimator is in blocking position) the active collimator reading is invalid.
  - The beam should not be steered when AC is not in the right position.
- Active collimator readings work properly only there is actual photon beam reaching it. Otherwise they are just noise or fake positions.
  - When there is no radiator there is not photon beam.
  - The AC positions should not be used with retracted radiators.
- EPICS record is provided to indicate if the active collimator positions should be considered valid for beam tuning.
  - In the spring only collimator position was in the calculation.



Active
Collimator

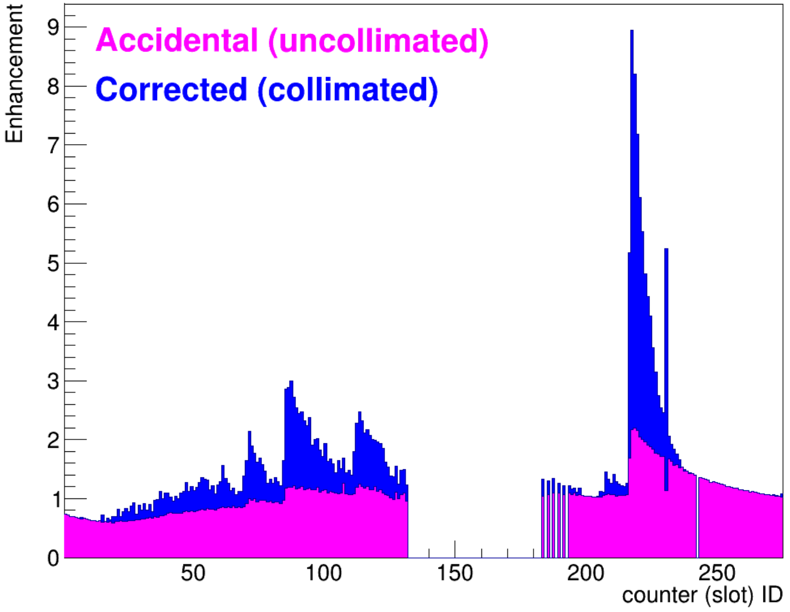


Beam Setup Procedures

- Initial photon beam tuning
  - Verify that the photon beam profile on the upstream beam profilers is reasonable.
  - Move the beam in x- and y- direction and find the beam-profiler positions where the photon beam-intensity monitor and pair spectrometer rates are maximized.
- Active Collimator calibration procedure
  - MCC operator moves the y-positions at some fixed x-positions (preferable one that found above)
  - At the fixed y-position an automated scan in x-direction is performed by moving the primary collimator stage
  - The data is written into files and analyzed offline to extract the calibration constants for determining the photon beam position in mm.
- Procedure for establishing the coherent bremsstrahlung.
  - Establish the beam to the LH2 target in Hall D using amorphous radiator (see above).
  - Fixing the BPM (slow orbit locks), determine the GONI motor positions for the diamonds in the established beam.
  - The plan is to use Fast Feedback from AC to keep the photon beam centered at the center of the primary collimator.

Fast and Slow Feedback Requirements

- Photon beam in Hall D is collimated by a 3.4mm (or 5.0mm) collimator to increase the degree of linear polarization of the beam reaching the LH2 target.
  - Motion of the photon beam centroid at the collimator position will deteriorate the linear polarization of the beam.
- Trent A., Bryan B. and company have been working on a FFB system using Hall D AC and BPMs.
  - Stripline BPMs and air-core magnet tested, 60Hz suppression tested.
  - Stripline BPMs can provide 0.3mm FFB signal at 1KHz bandwidth starting from 330nA beam current.
    - Unlikely to be able to have 0.5mm precision with 5nA and 1KHz bandwidth from BPMs.
  - AC can provide FFB signal ~0.2mm precision at 1KHz bandwidth starting from 5nA beam current and 10^{-4} RL.
- The only requirement from Hall D requiring FFB is that the coordinate at the active collimator be within 200mm (RMS) with 1KHz (720Hz) bandwidth for beam currents from 5nA to 2mA.
  - Beam position at the radiator needs to be stable with 0.5mm with <1Hz bandwidth.
  - Current arrangement of the air-core magnets in Hall D beamline may not be optimal for decoupling of the photon beam position stability at the active collimator and the electron beam position at the radiator.
  - Need feedback from CASA physicist (Todd S.).



Impact of collimation

FSD and Software Interlocks

- We need to prevent the electron beam with I_B>100nA incident on any thick structure in the radiator system.
- Standard ion chamber FSD-s have been implemented in the tagger hall.
  - Calibrated before each run for each target.
  - Sometimes we may need to disable or to increase the trip level when aligning the diamond radiators.
- We implemented beam FSD for amorphous radiator stick motion
  - Simple linear motion allows for simple hardware-based system.
  - "Forbidden" ranges of the motorized stage trigger FSD.
- Goniometer contains two translation stages (x,y) and three rotational stages (yaw, pitch, roll).
  - Nearly impossible to implement a hardware FSD.
  - Ion chambers already protect against high rates from radiator.
  - We plan to provide a binary EPICS variable that would be available to MCC for automatic shutdown of the beam.
    - Should be masked when tuning the beam on the goniometer.

Summary

- The Hall D photon beamline has been commissioned and beam tuning procedures understood.
  - No formal write-up for procedures at this time.
- Active Collimator commissioned
  - Calibration procedure understood.
  - Needs to be integrated into FFB in the fall to be used for physics beam to cancel 60Hz motion of the photon beam.
- Goniometer has been commissioned with 5.5GeV beam, coherent bremsstrahlung beam produced and observed.
  - Physics data analyzed to verify the polarization of the beam.
  - Setup for 12GeV will probably be more difficult.
- BPMs and magnets were tested for FFB capabilities
  - Low beam currents might be an issue for FFB from BPMs.
  - Locations of the air-core magnets may need to be revisited.
- Master Oscillator signal is delivered to the tagger hall and Hall D
  - Drifts and jitters are being understood
- EPICS signals need to be produce for
  - Automated beam shutdown to Hall D
  - Usage of AC readout for steering the electron beam
- KPP achieved, data is being used to calibrate the GlueX detectors.
  - We would like more good beam data in upcoming runs.

Thanks for the Beam

FFB Component Locations