Measuring the muon beam in a magnetic field

James Lord
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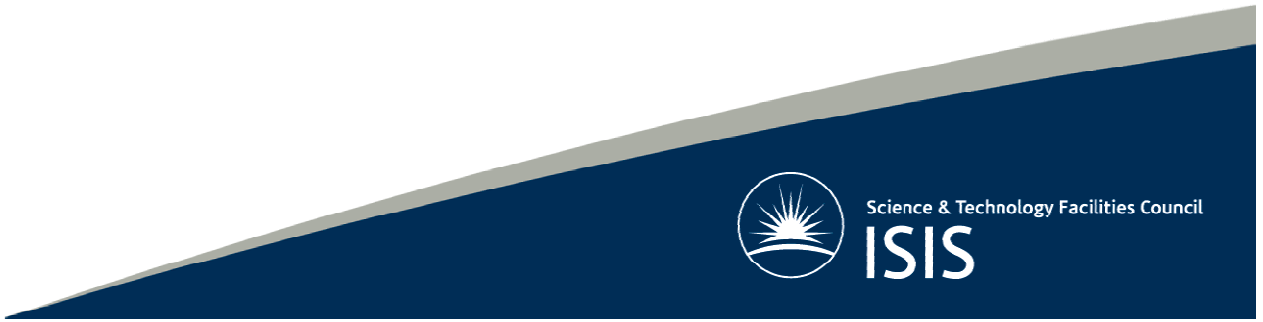
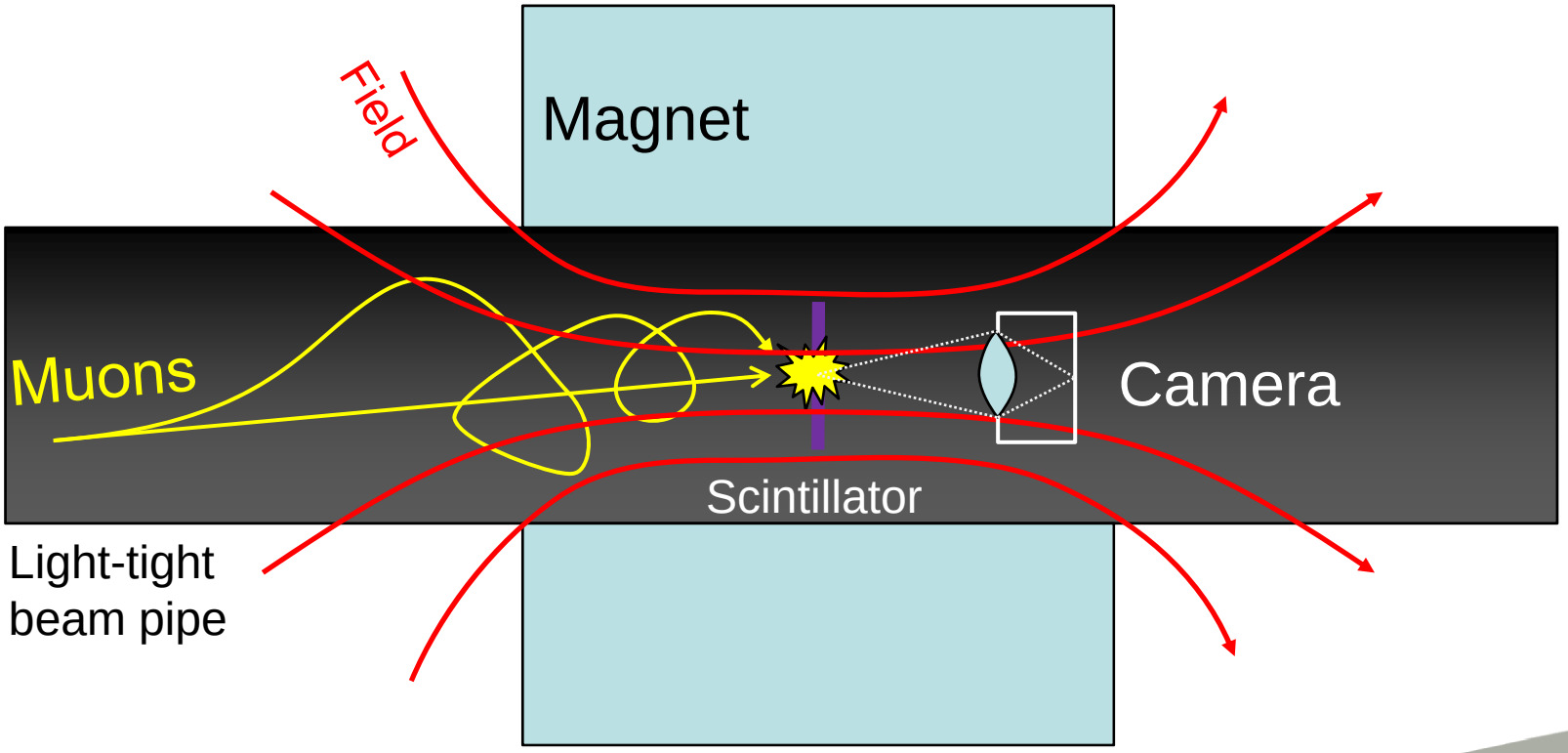


Beam camera principle



Beam imaging technology

- Photographic emulsion
  - traditional, slow to use (chemistry!)
- Microchannel plate
  - Used in vacuum
  - Resistive anode for imaging by particle counting (low count rates, continuous beam)
  - Phosphor screen and camera for higher intensity
- Scintillator and Image intensifier
  - good low light performance
  - **very** field sensitive (few G shifts image)
- Scintillator and CCD
  - must be cooled for low dark noise
  - not affected by field

Camera

Cooled CCD camera (as used for astronomy)

Wide aperture lens (f/0.95)

Long exposures (ms-minutes), 16 bit grey scale, USB readout.

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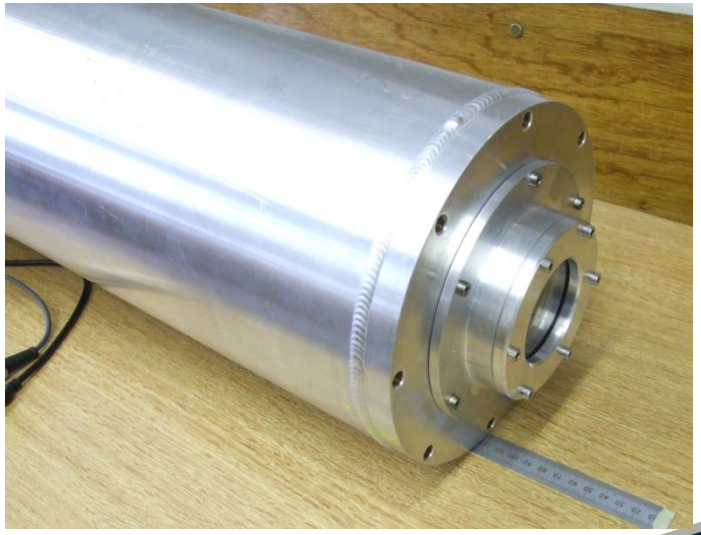
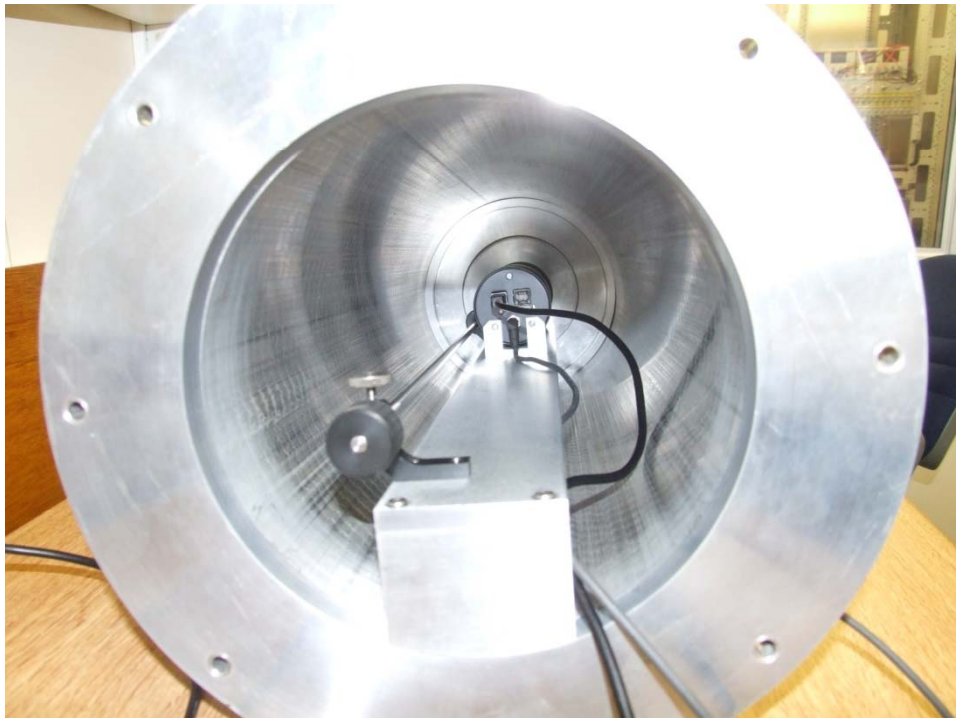
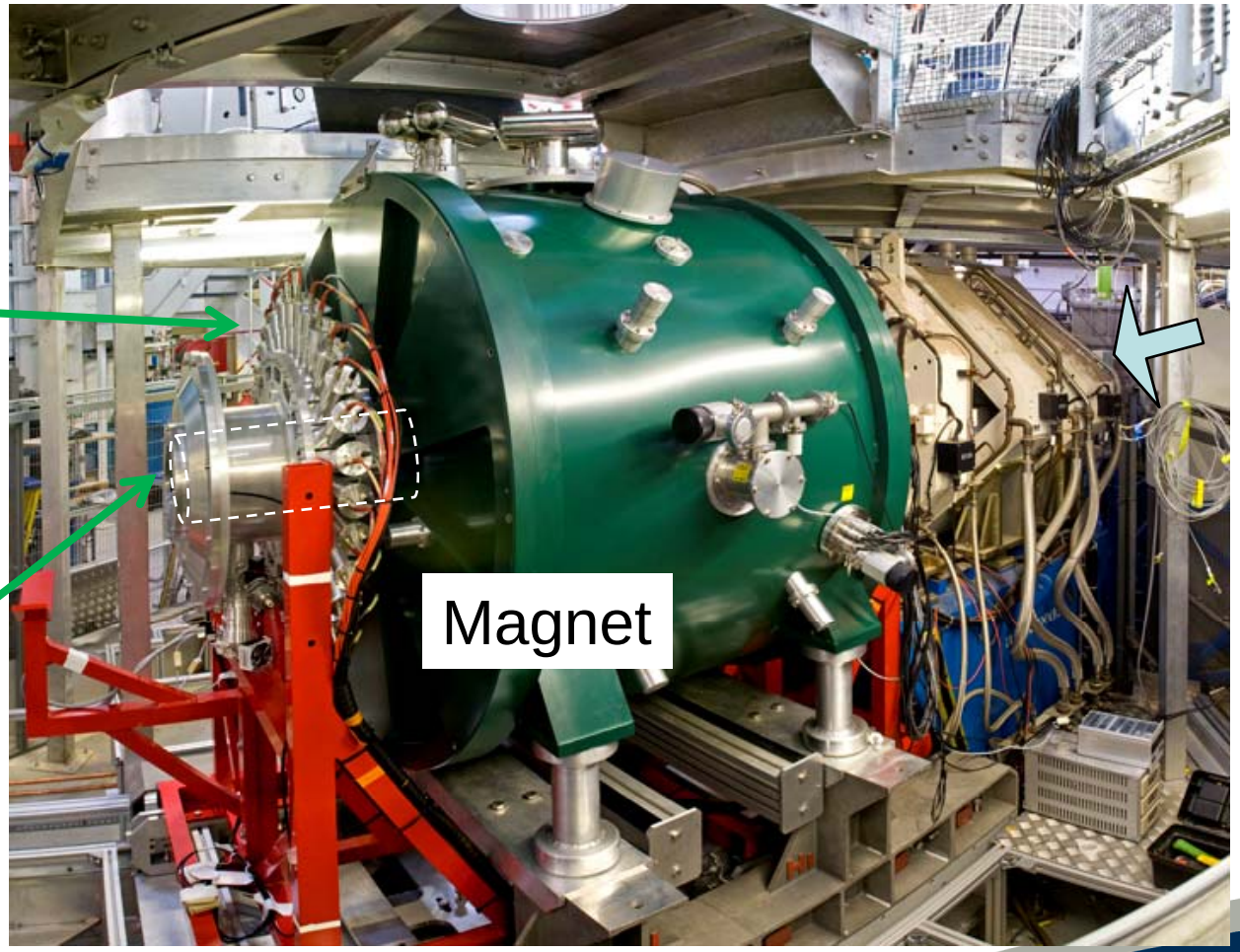
Mounting





The HiFi magnet

Scintillator on CCR (behind)



Beam

Camera in vacuum tube, in place of flypast tank

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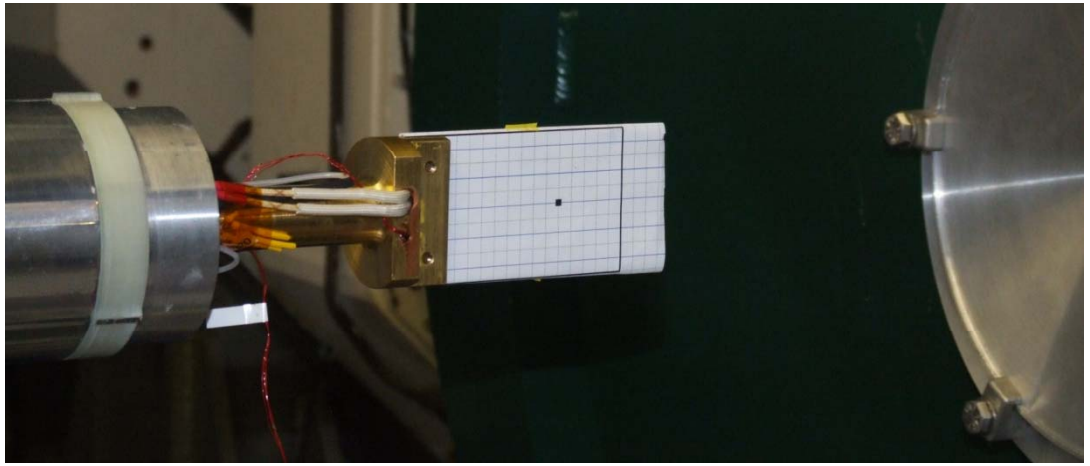
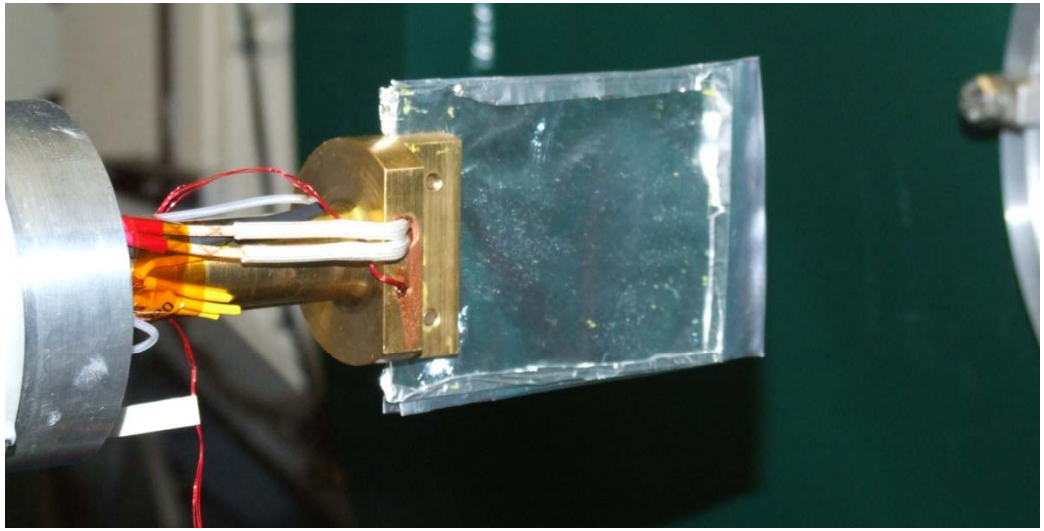
Scintillator – on CCR

Graph paper for alignment and focusing

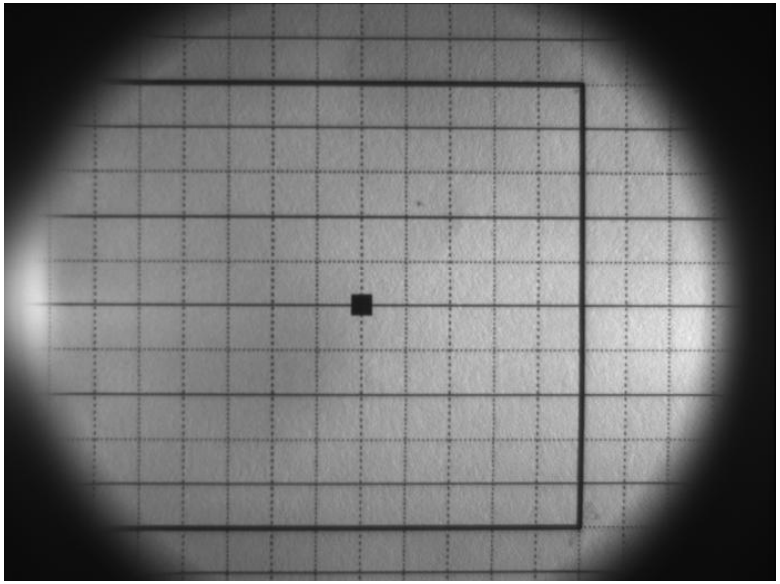


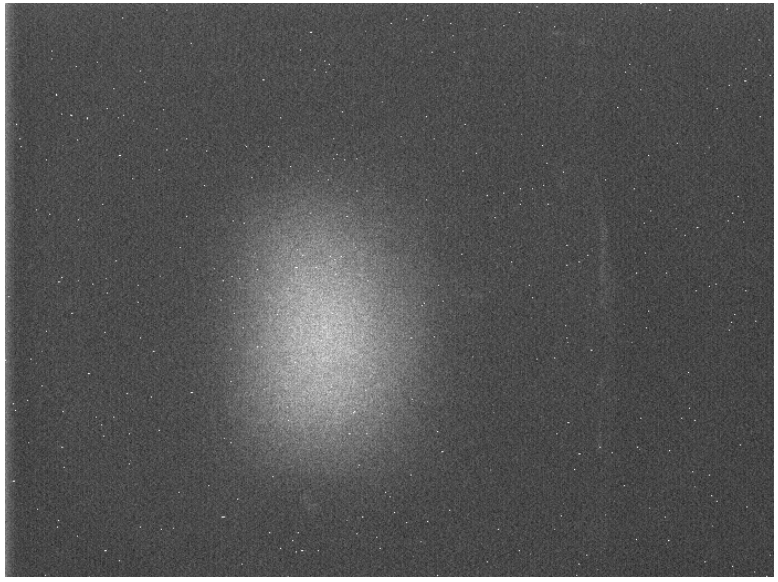


0.5mm plastic scintillator sheet with 0.25mm Al foil degrader

– as seen by camera

Graph paper, 5mm squares (with external illumination)





Muon beam spot on scintillator

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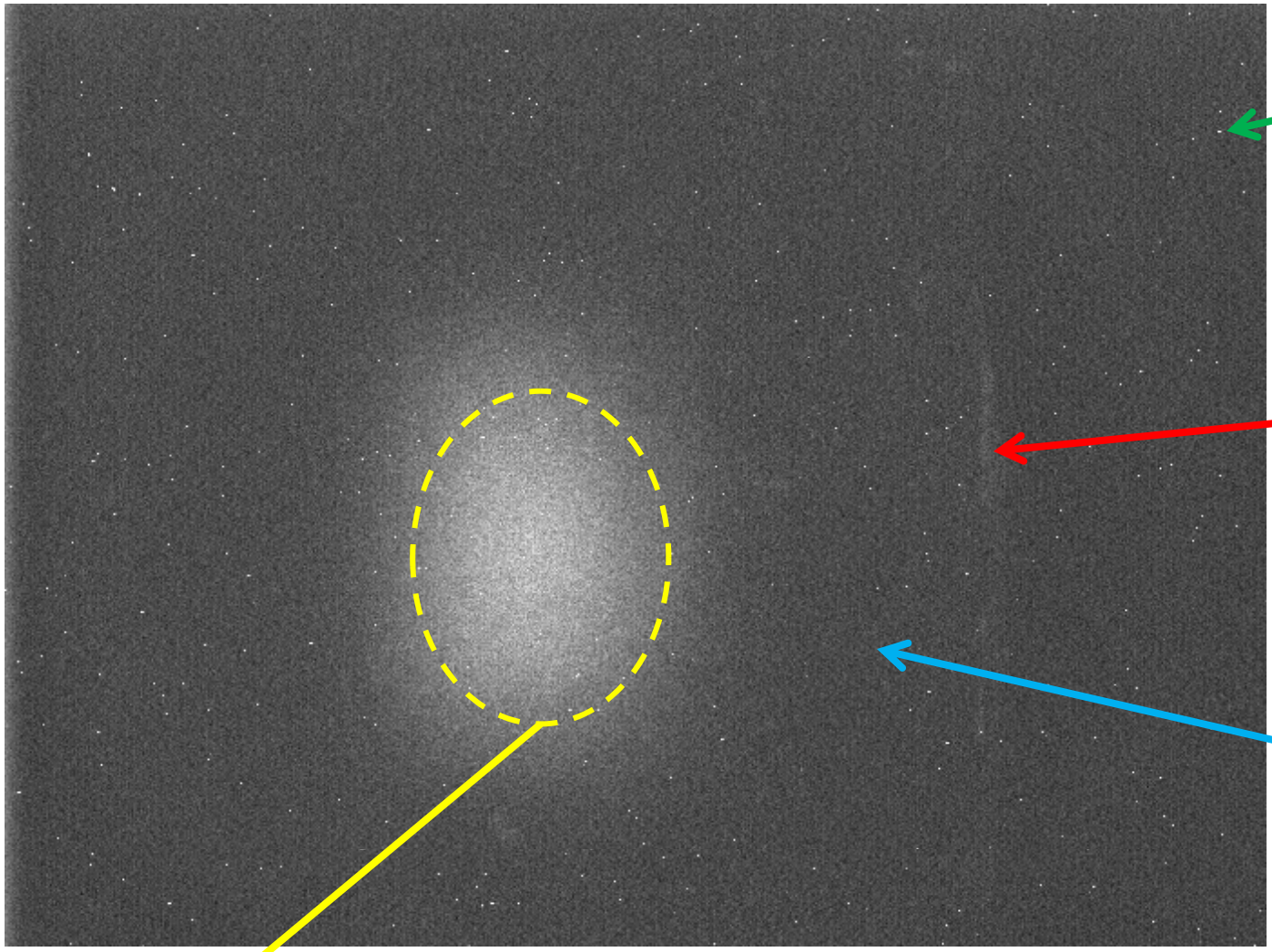
Spot picture



Bright spots: direct positron hits on CCD?

Edge of scintillator

Background noise (camera + photon counting statistics)

Beam Spot

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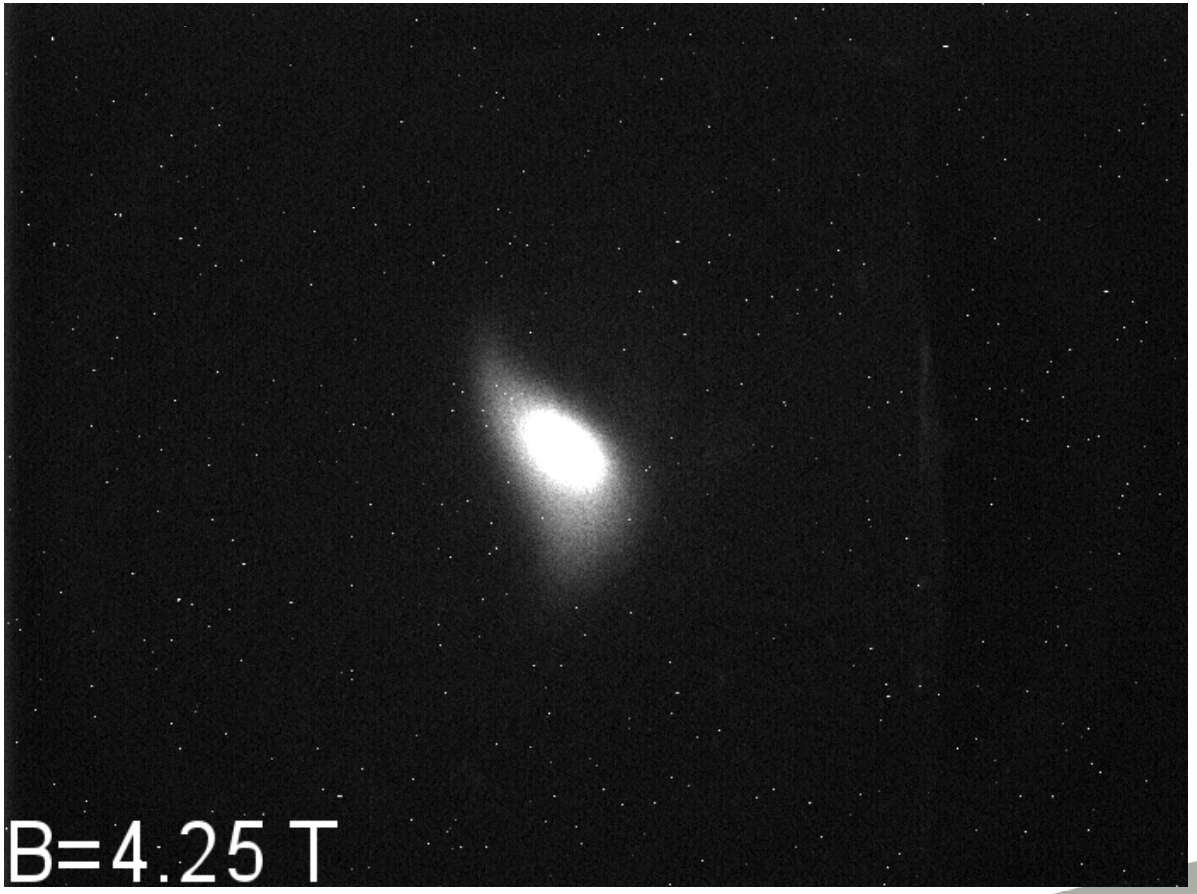
Apply fields…



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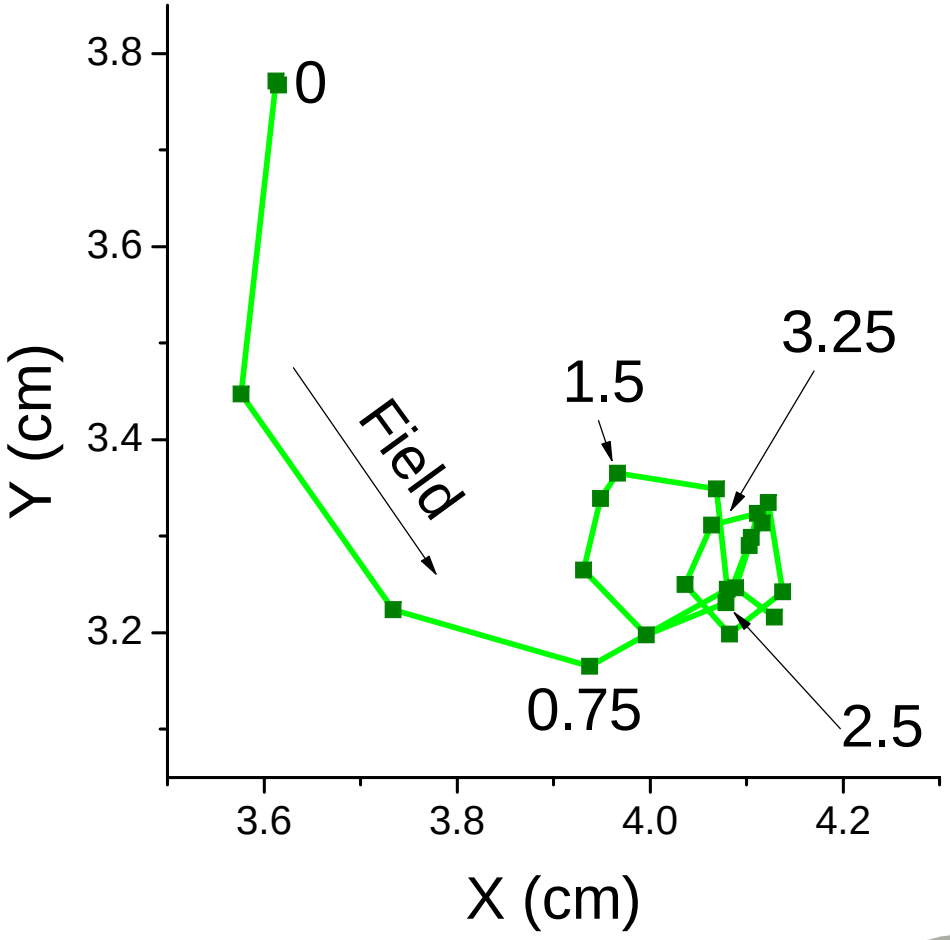
Beam spiralling



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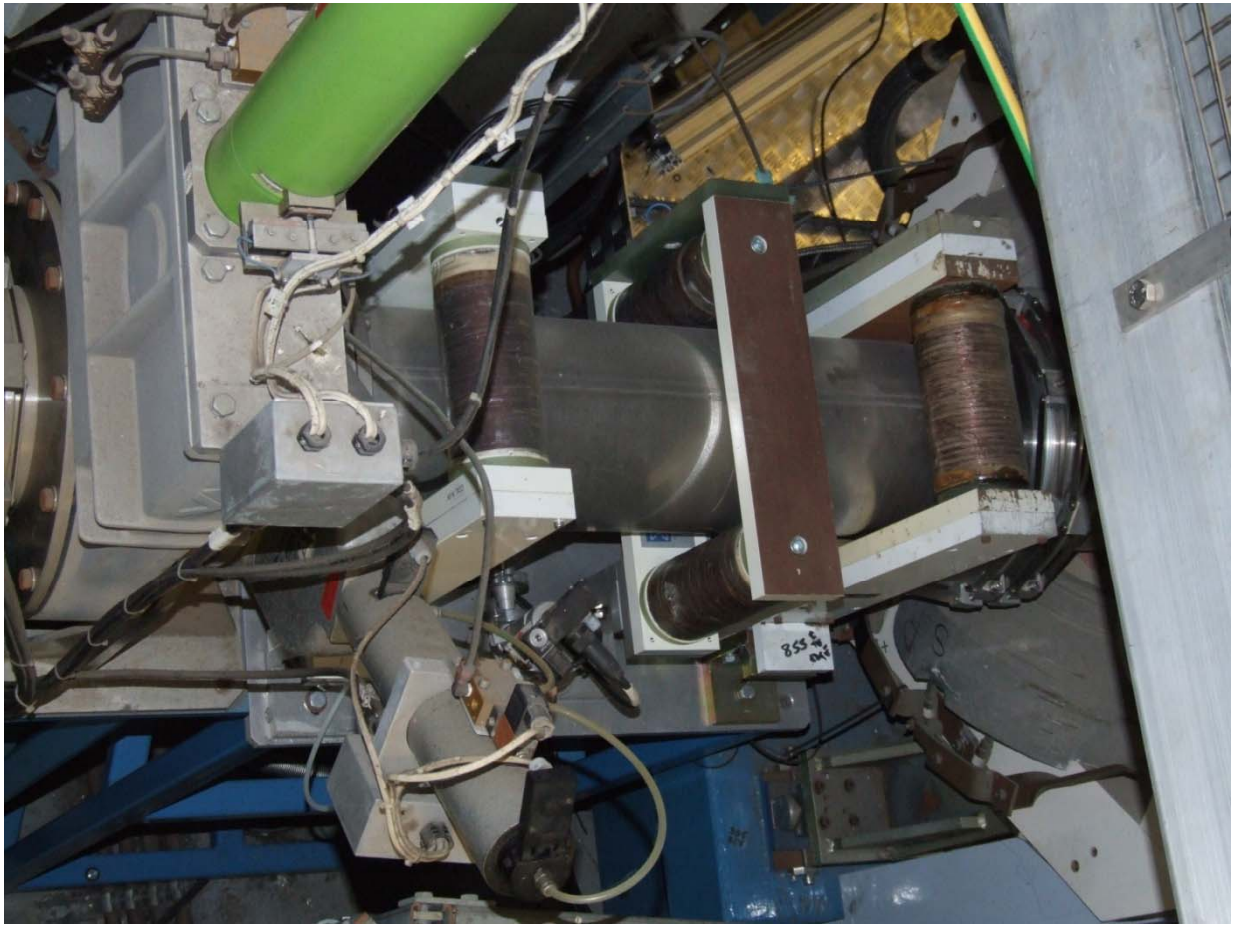
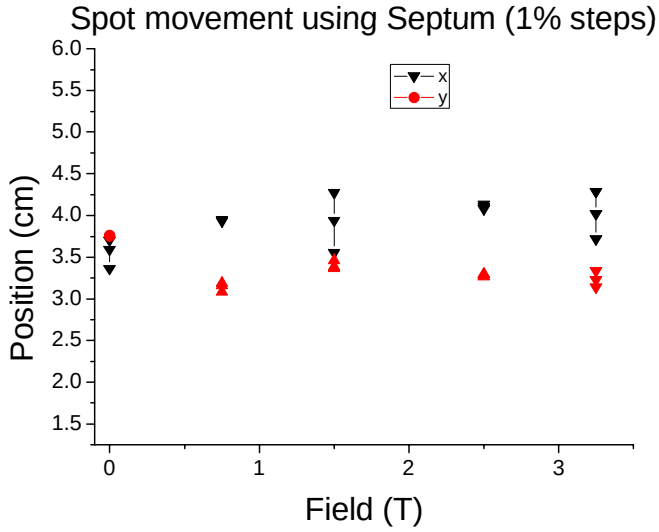
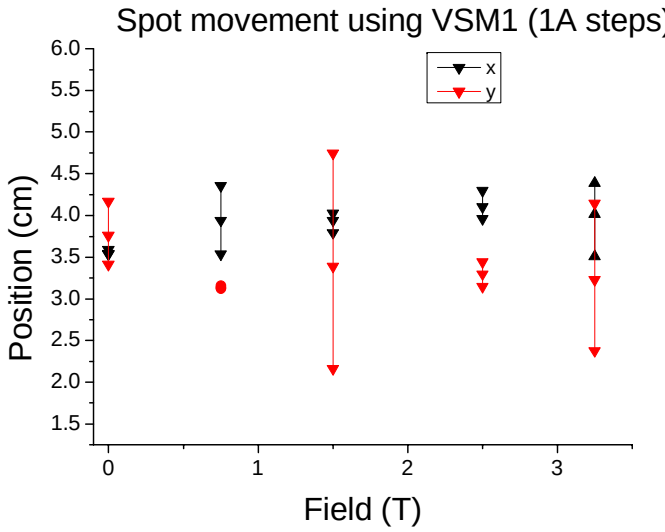
Beam steering

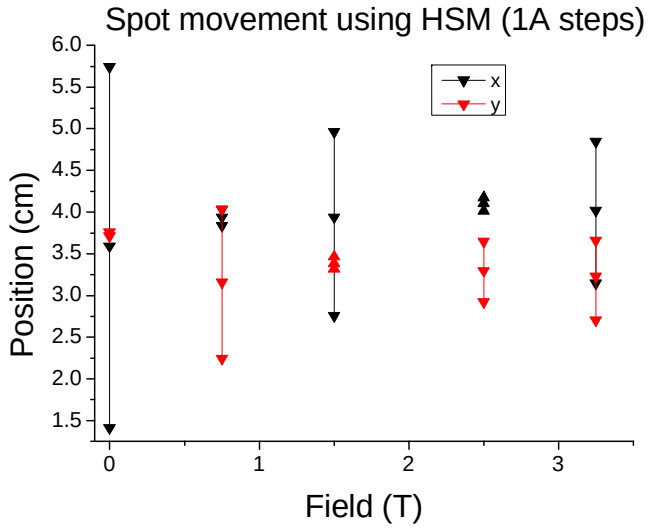


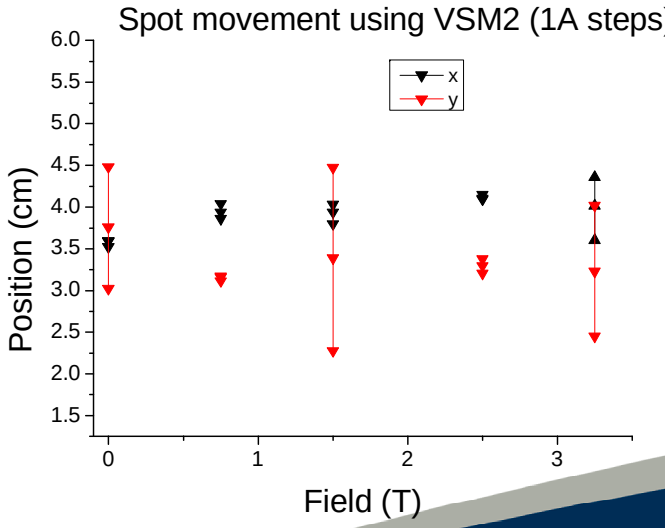
3 Steering magnets (plus Septum) giving full x, x', y, y' adjustment of beam

Steering sensitivity vs. Field









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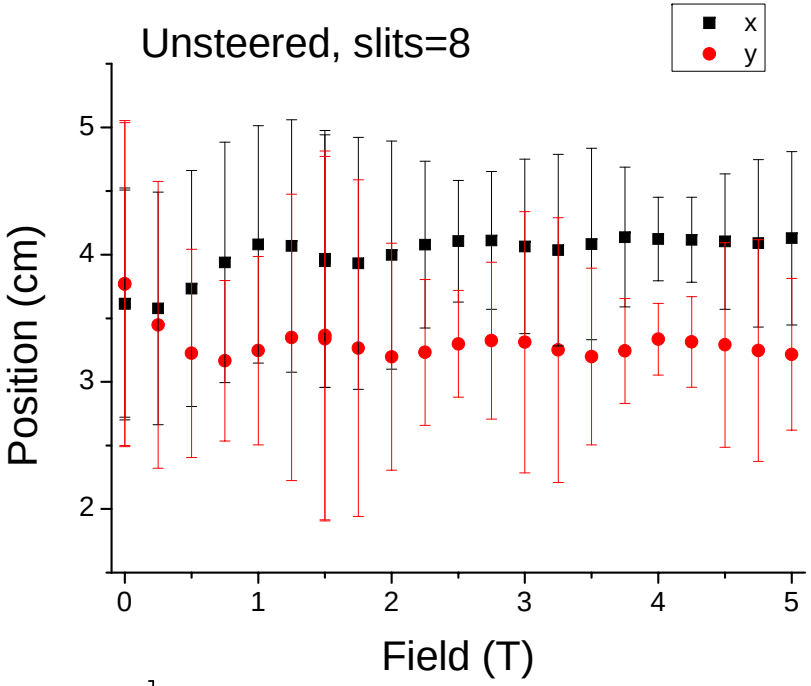
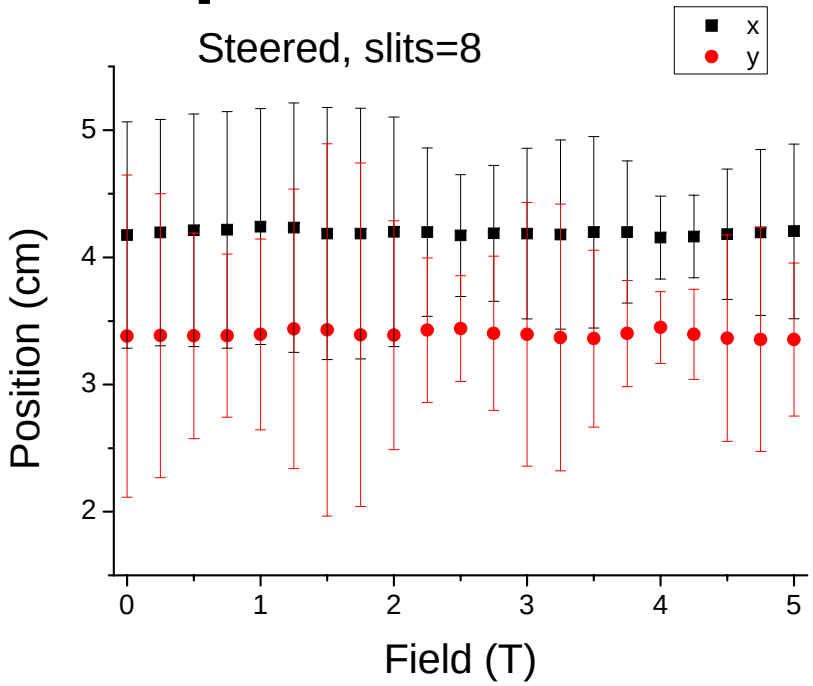
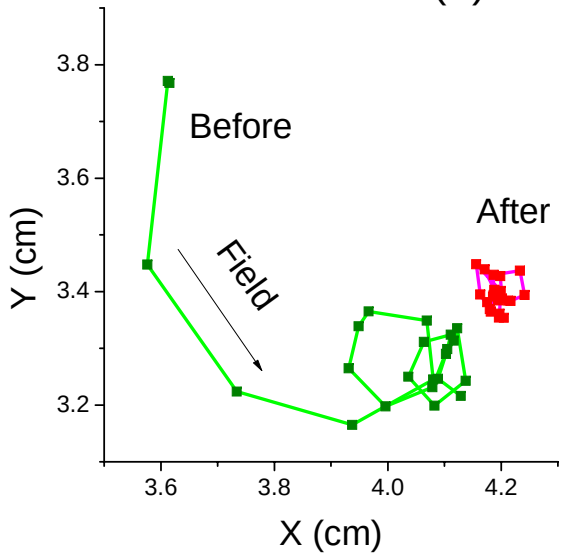
Beam alignment

- Choose constant steering settings to minimise movement between test fields
- Optimum spot at magnetic centre, defined by symmetry of fringing fields
- Adjust sample to beam, not beam to sample
- Dynamic steering would be possible
- Dynamic (de-)focusing?

Steered beam position







Static spot possible at magnetic centre: should be close to mechanical centre of magnet

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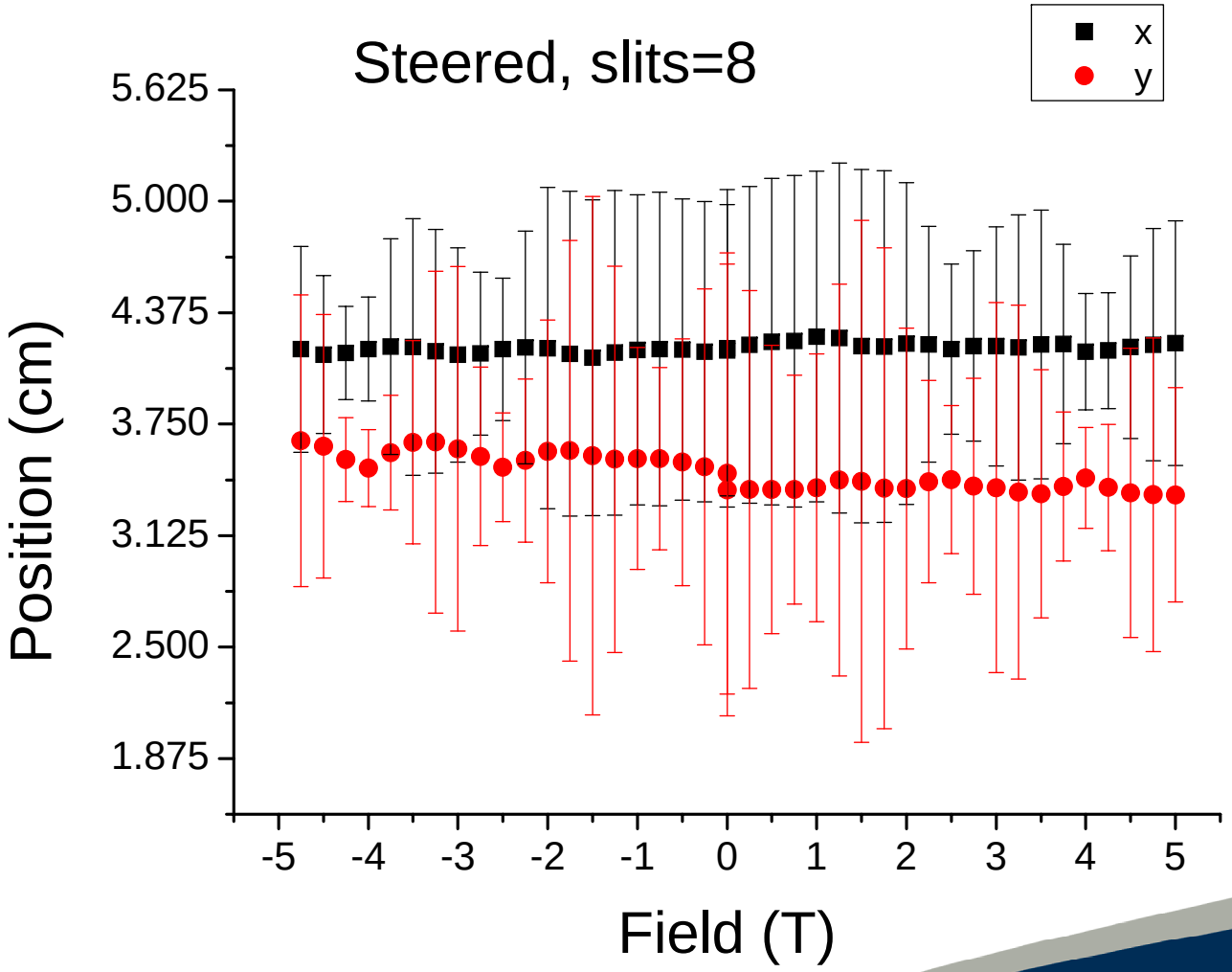
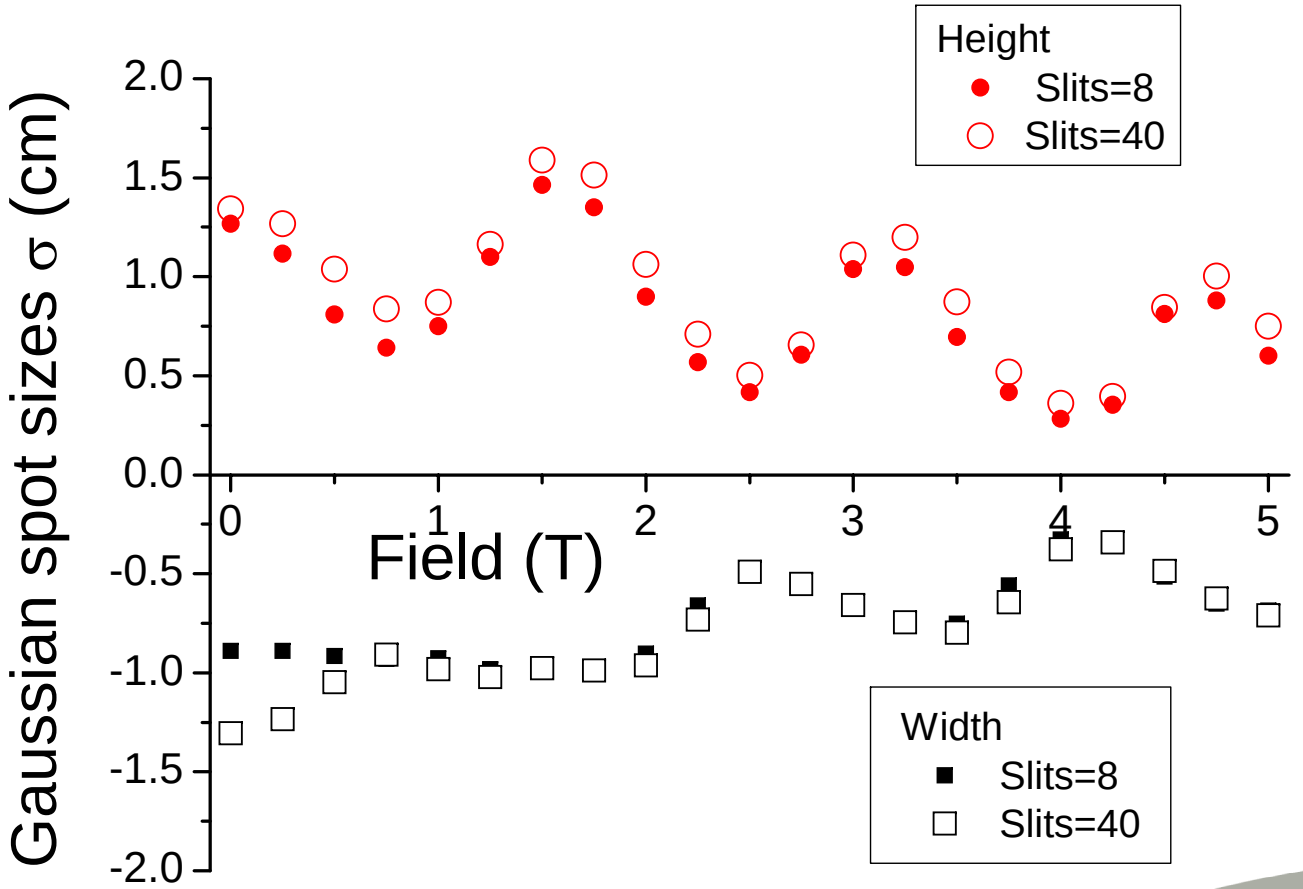
Negative fields too…



Spot size variation



Thanks

ISIS Muon Group

- Zaher Salman
- Richard Tingle
- Iain McKenzie

Project Engineering

- Jim Nightingale
- Brian Holsman