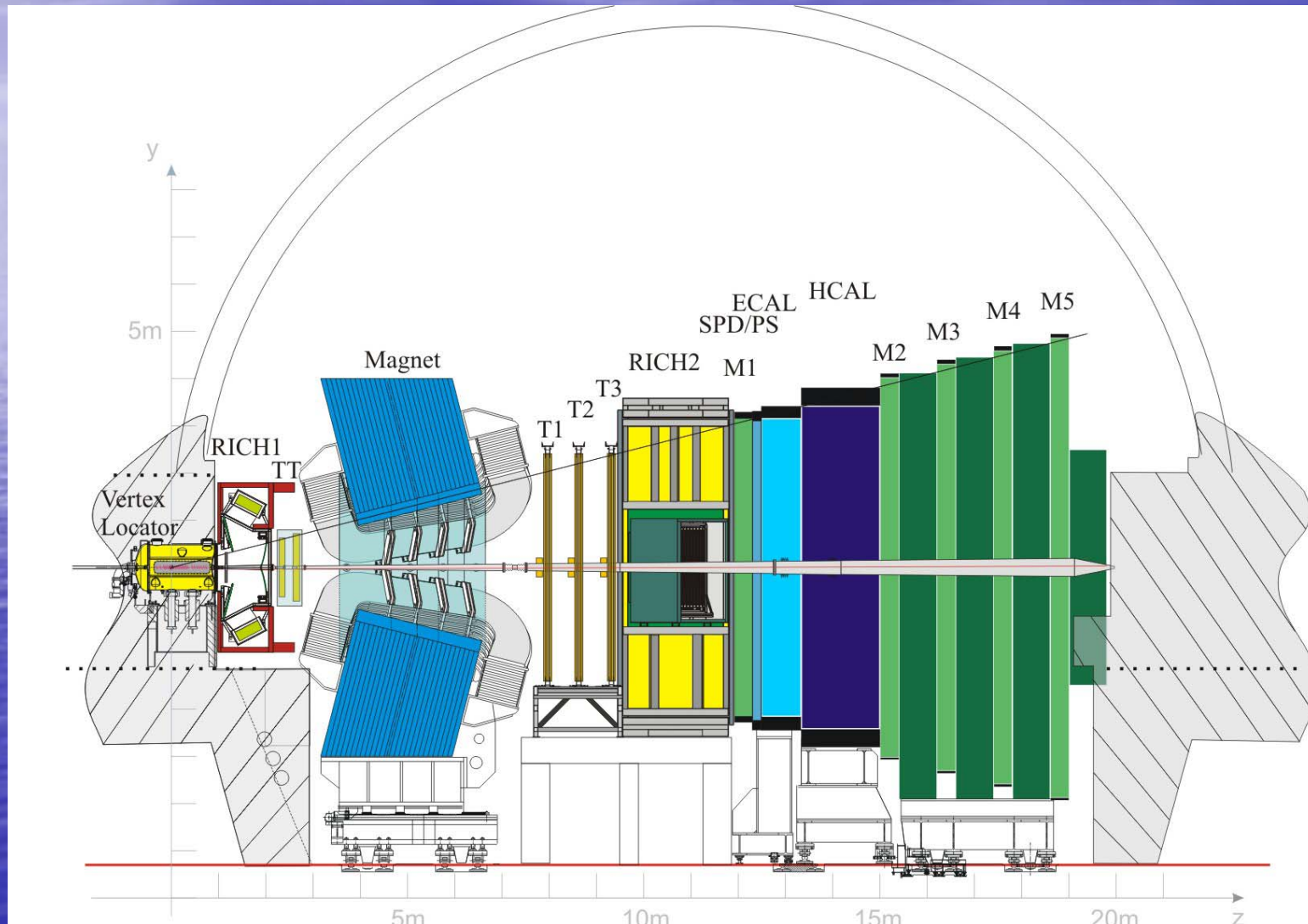


# Magnetic Distortion of HPD Images



Åsmund Skjæveland

# The LHCb experiment

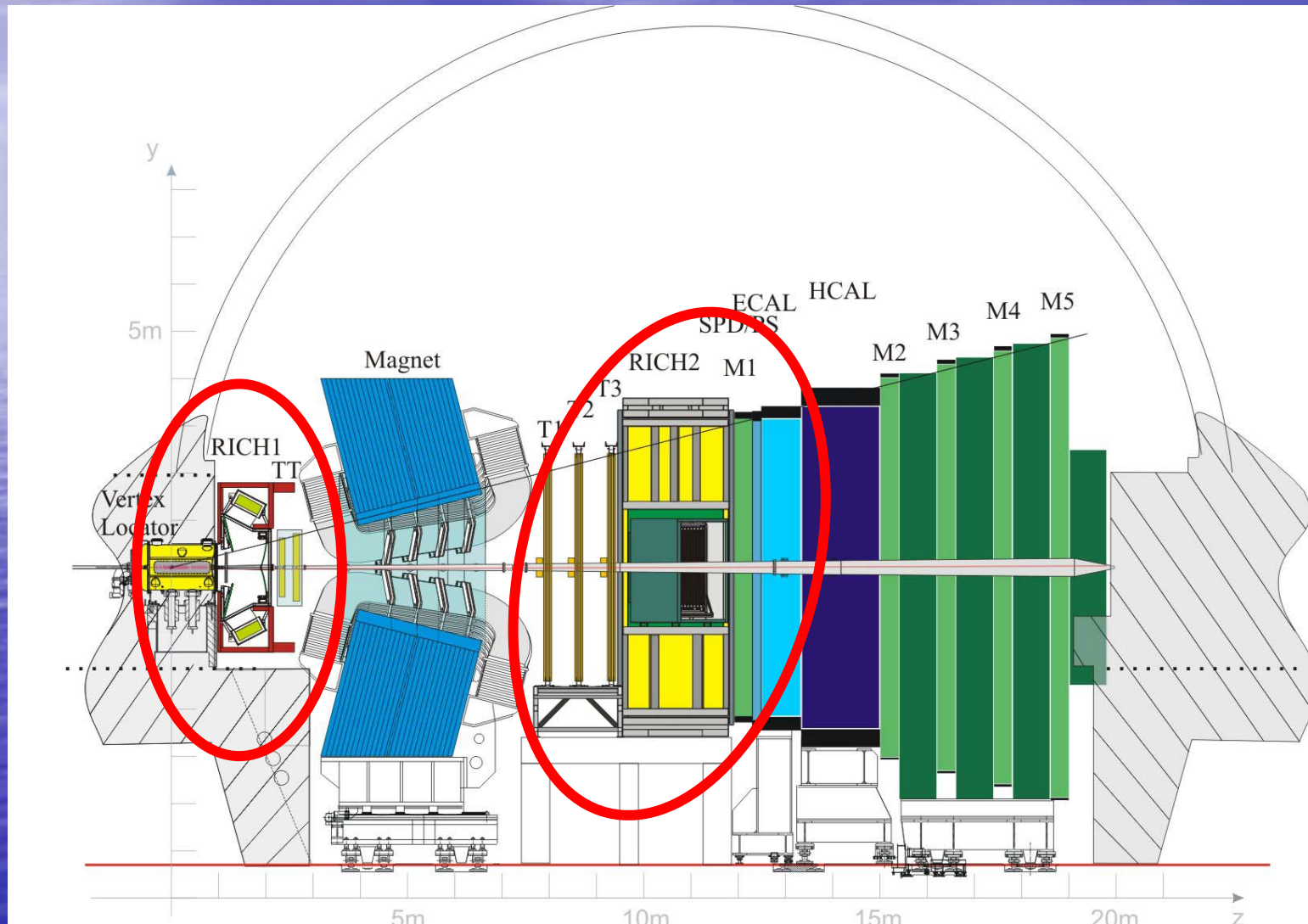


# The LHCb experiment

- Observe CP violation in decays of heavy hadrons produced in p-p collisions
  - Need accurate particle identification:
    - Tracking stations track particles with high precision
    - Magnet deflects track ➡ momentum and charge
    - RICH measure velocity ➡ combine with momentum to find mass



# The RICH detectors in LHCb



# RICH detectors

- Measures velocities via Čerenkov radiation
  - Uses Hybrid Photon Detectors ➡ high resolution
  - Combine images from many HPDs to find Čerenkov circles

# RICH detectors

- Measures velocities via Cherenkov radiation
  - Uses Hybrid Photon Detectors ➡ high resolution
  - Combine images from many HPDs to find Cherenkov circles

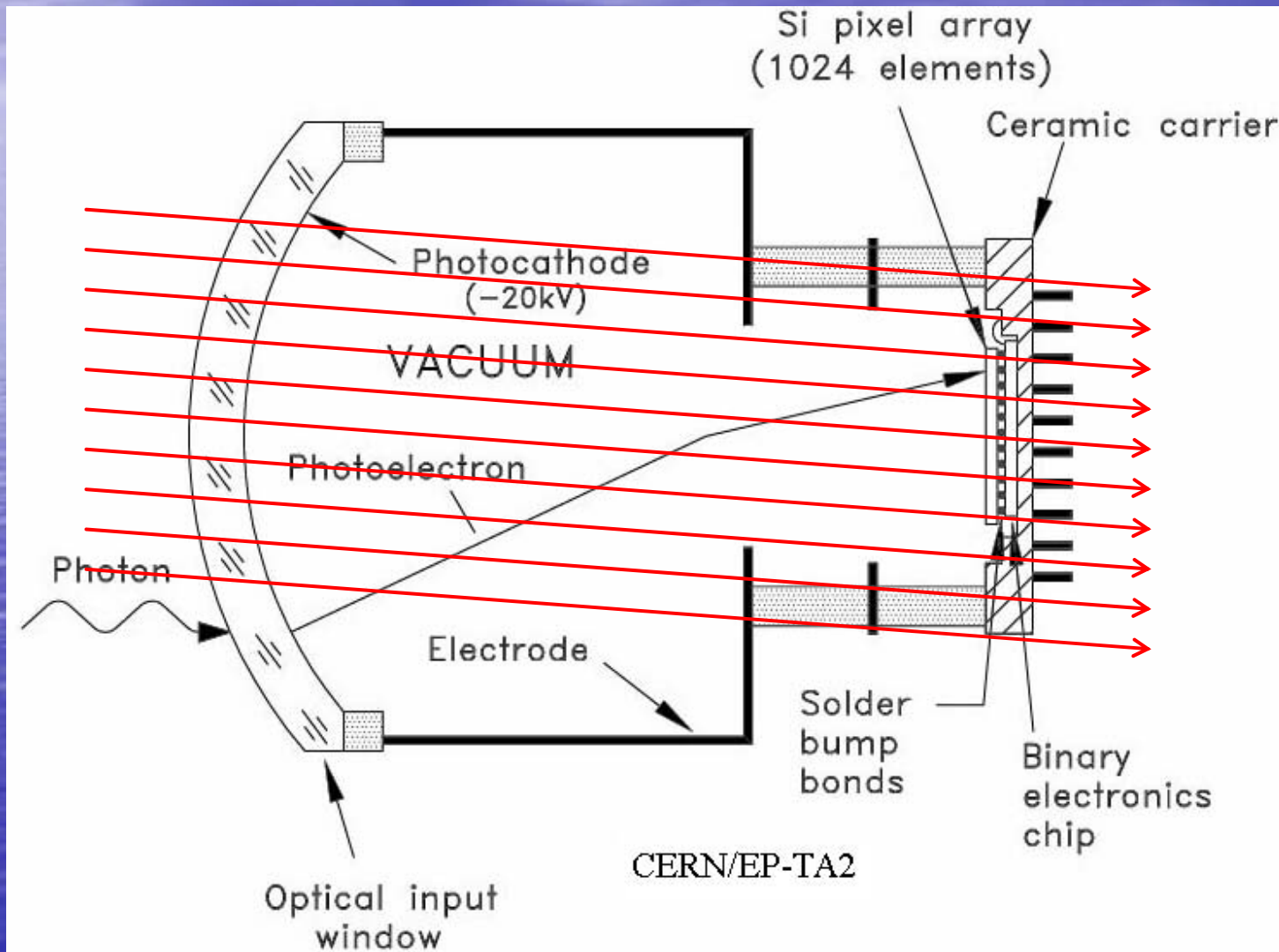


# Hybrid Photon Detector

- 37.5 mm radius
- 110 mm long
- Quartz optical window
- Resolution 256x32 pixels
- Photoelectron optics  
➔ sensitive to magnetic fields



# Pixel Hybrid Photon Detector



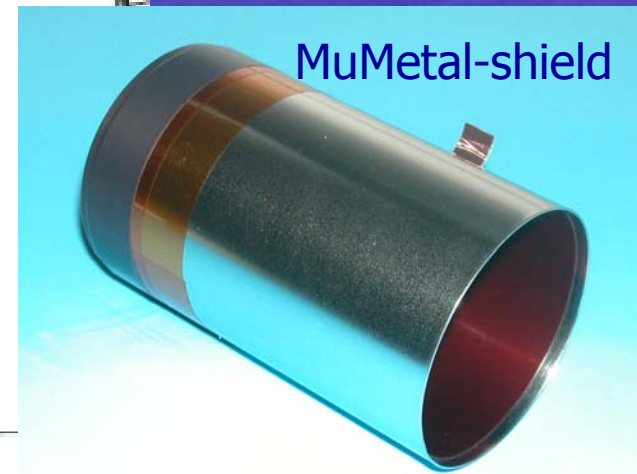
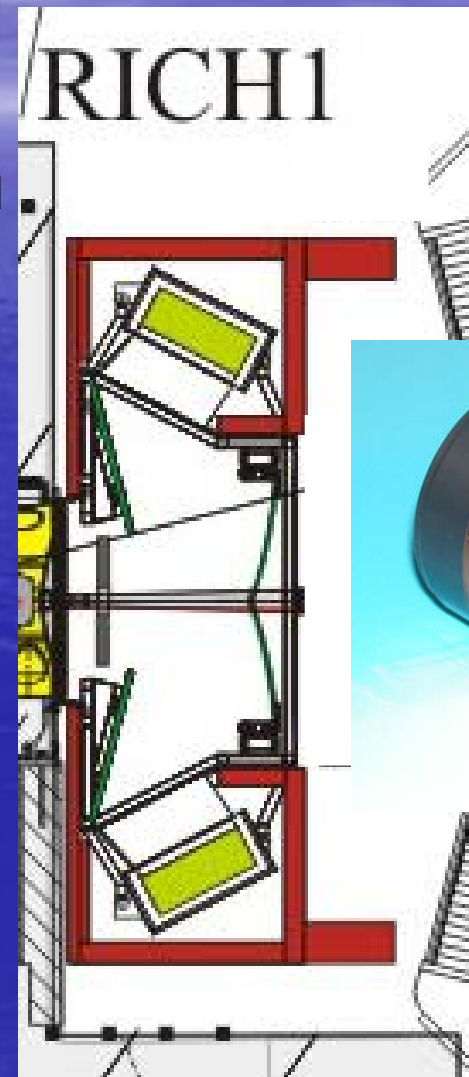


# Problem

- RICH1 is close to spectrometer magnet
- HPDs will be measurably affected by small magnetic fields ➡ image is distorted
  - Reconstruction of circle requires undisturbed images: Photon hits must be measured very accurately
  - If perturbation is large, data will be pushed off image chip ➡ uncorrectable data loss

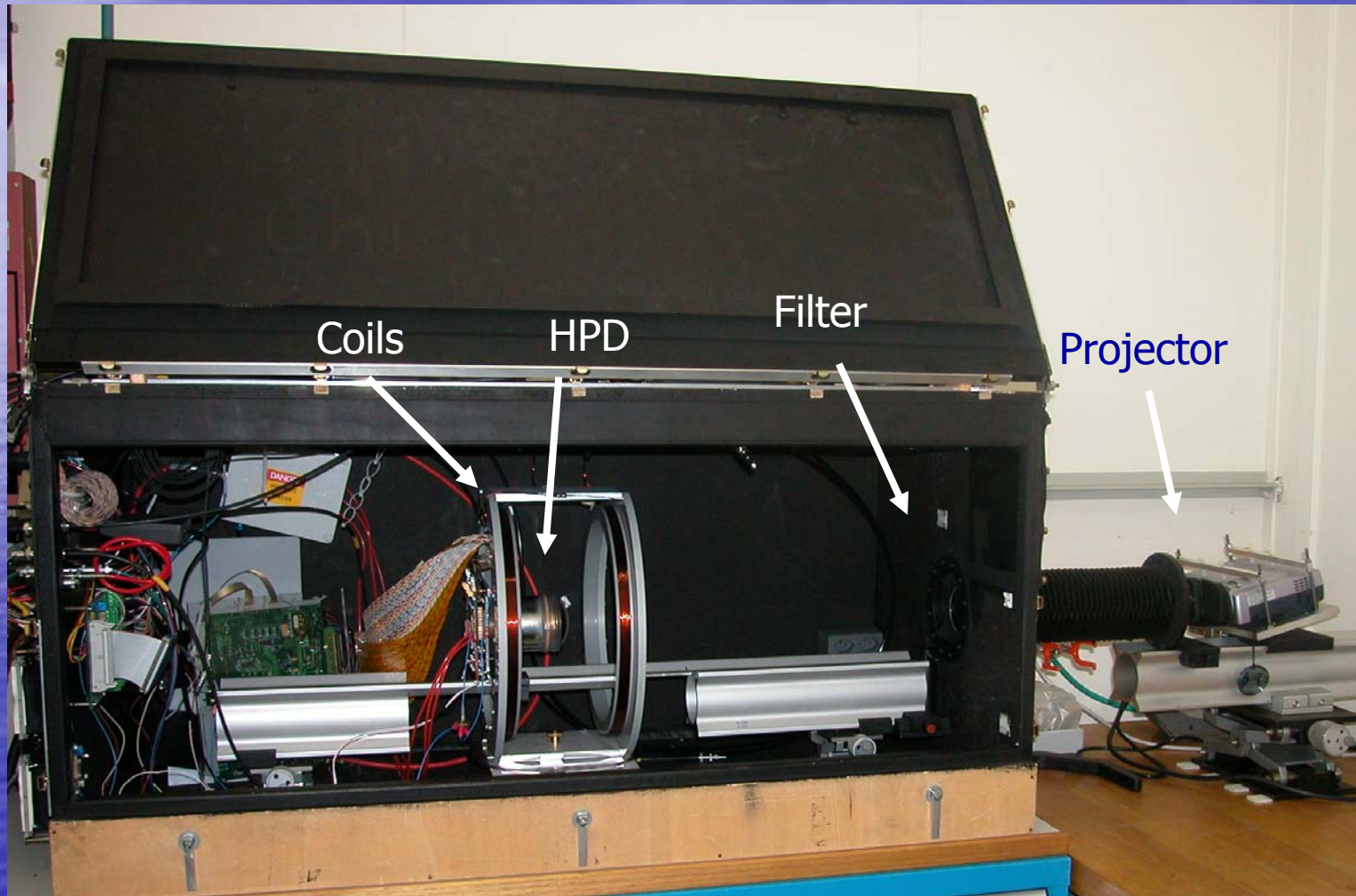
# Magnetic Shielding

- RICHes enclosed in iron box—internal field reduced to max. 25 G (RICH1) and 10 G (RICH2)
- MuMetal shield around each HPD further reduces magnetic field





# Experiment setup





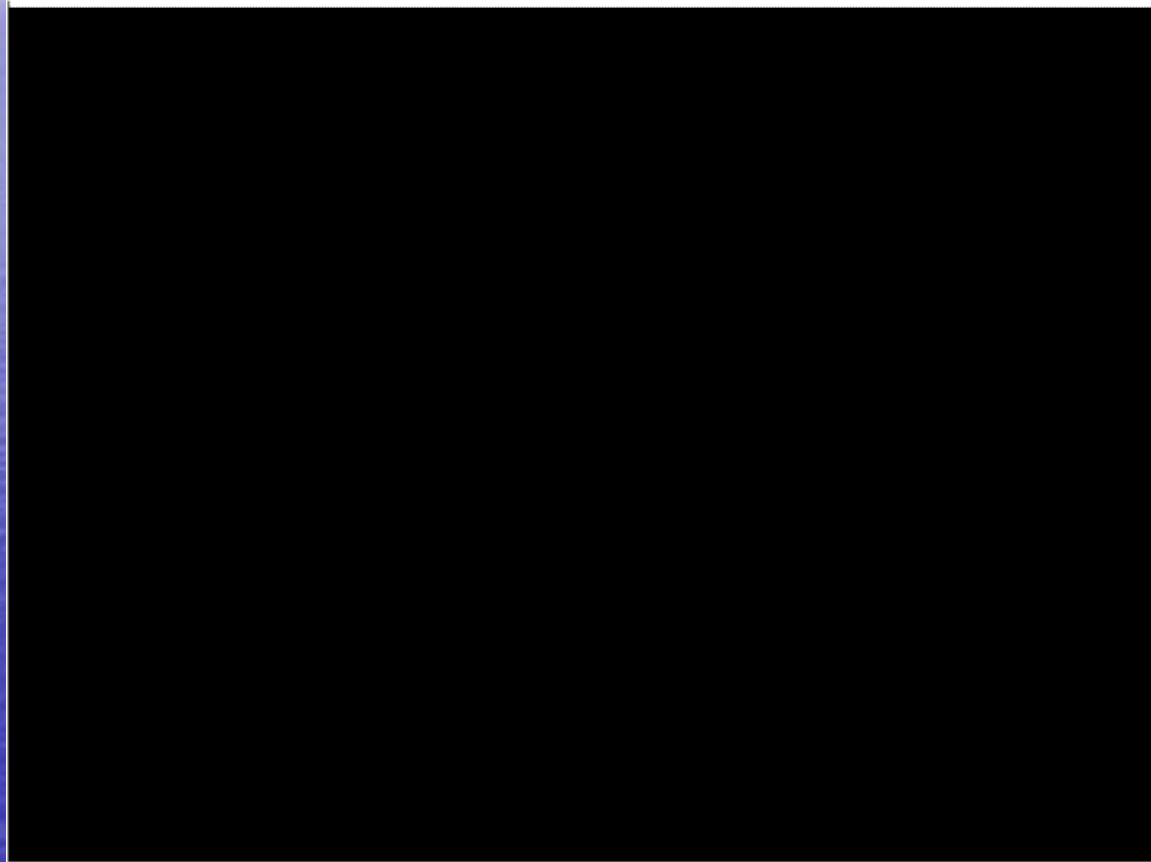
# Setup

- Standard projector connected to laptop
- Dense optical filters
- HPD tube
- Read-out electronics

# Calibration

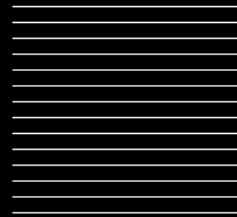
- Projected image much larger than HPD
- Find HPD by sweeping horizontal and vertical lines across the screen
- Fine-tune with line patterns

# Calibration

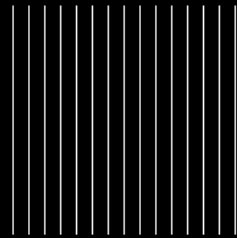




# Calibration

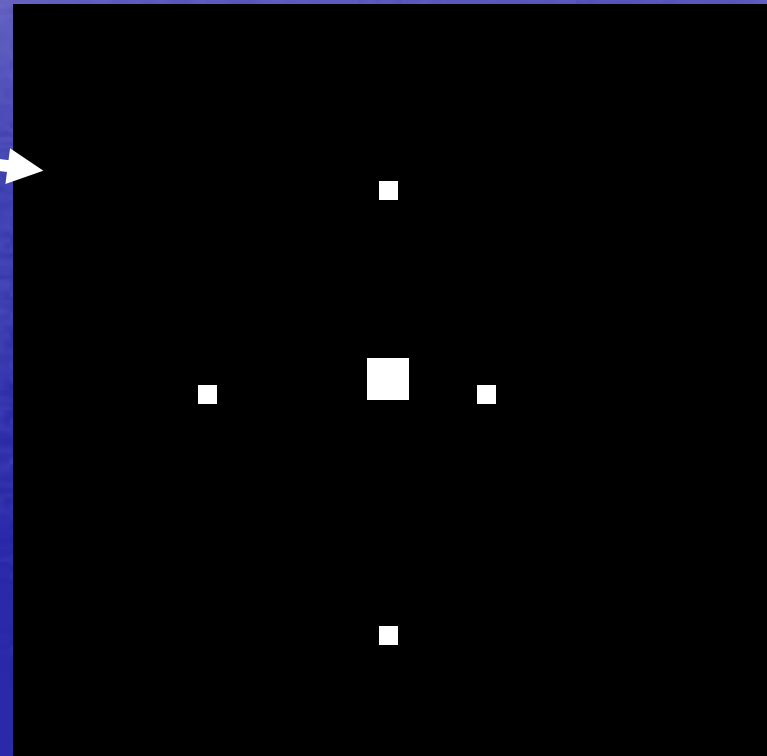


# Calibration



# Data taking

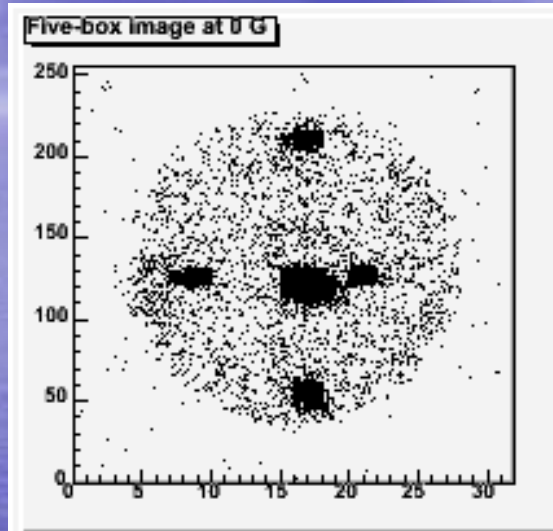
- Illuminate HPD with a defined pattern
- Vary magnetic field
- Record HPD image



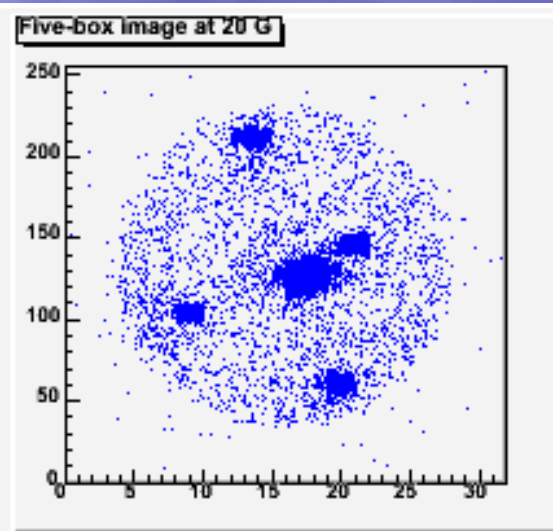


# Observations for axial fields

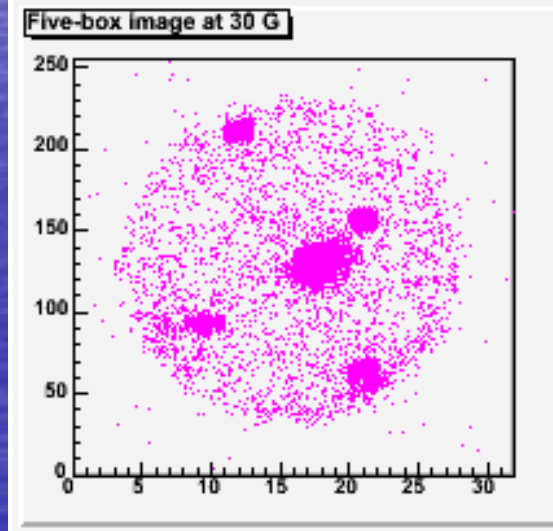
0 G



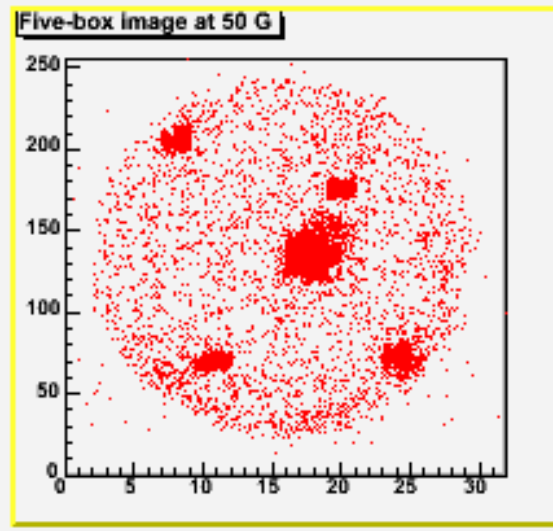
20 G



30 G

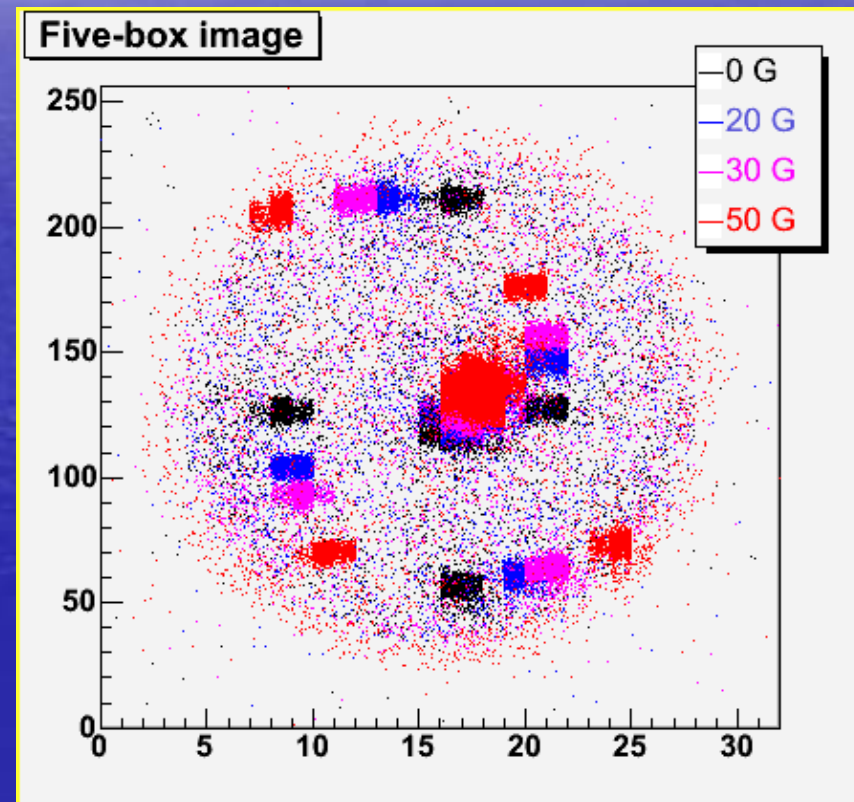


50 G



# Observations

- Small but clear background
  - thermal electrons
  - ion feedback
- Image is rotated
- Image is enlarged
- Image center is slightly displaced



# Conclusion

- Entire image on chip: **No data loss**
  - Reconstruction of undisturbed image probably possible



# To Be Done

- Make and test other test patterns
- Measure other field configurations
- Make and test image correction algorithm
- Publish
- Have a beer