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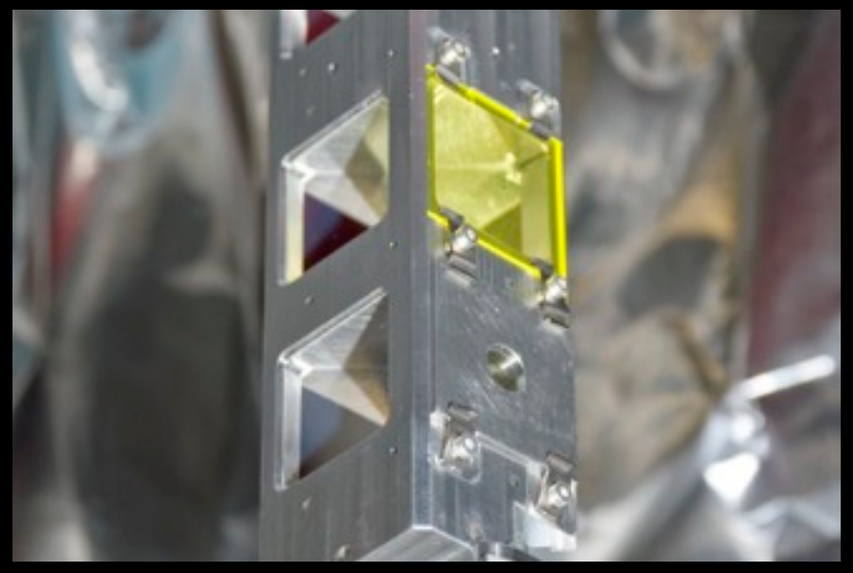
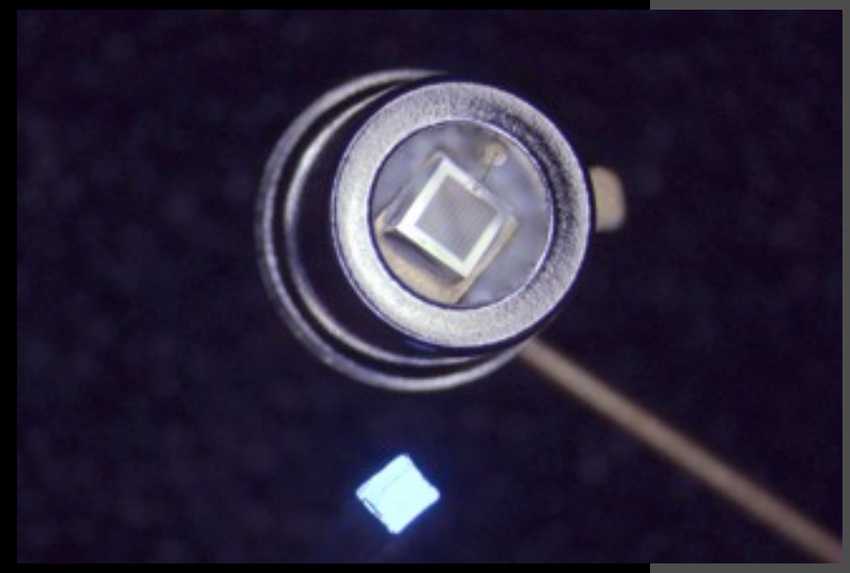




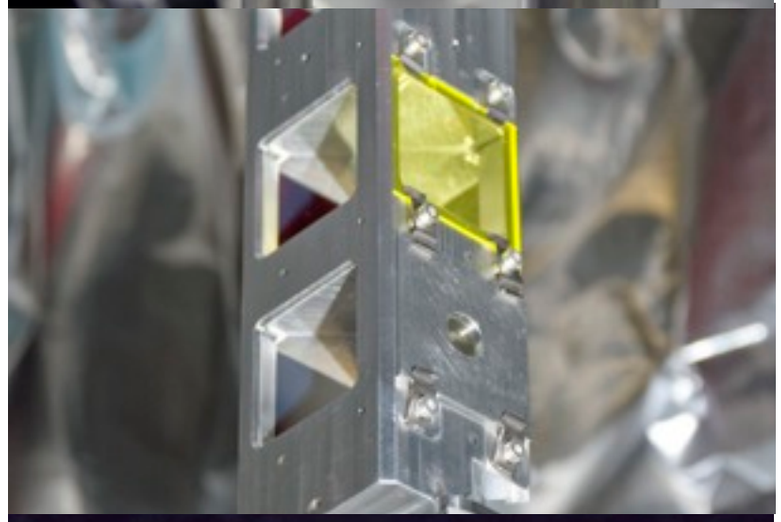
Scintillators for SwissFEL

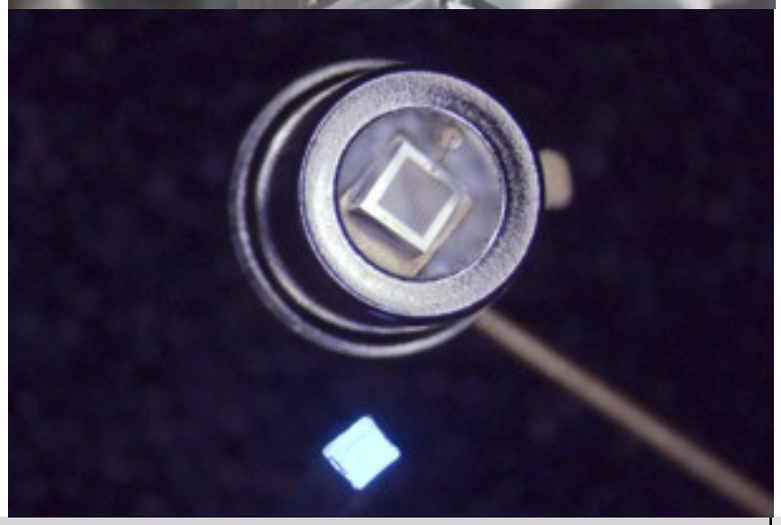
Usage of Scintillators at the SwissFEL Injector Test Facility

Rasmus Ischebeck, for the PSI Diagnostics Group

Scintillators for SwissFEL

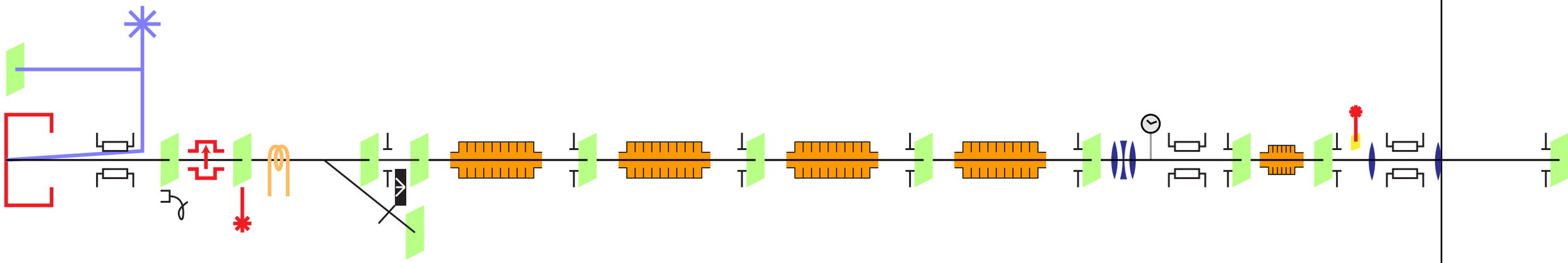
- Profile monitors for
  - Photocathode laser
  - Electron beam
- Loss monitors
  - Beam containment
  - Wire scanners





SwissFEL Injector Test Facility

- Test the generation of beams suitable for SwissFEL operation

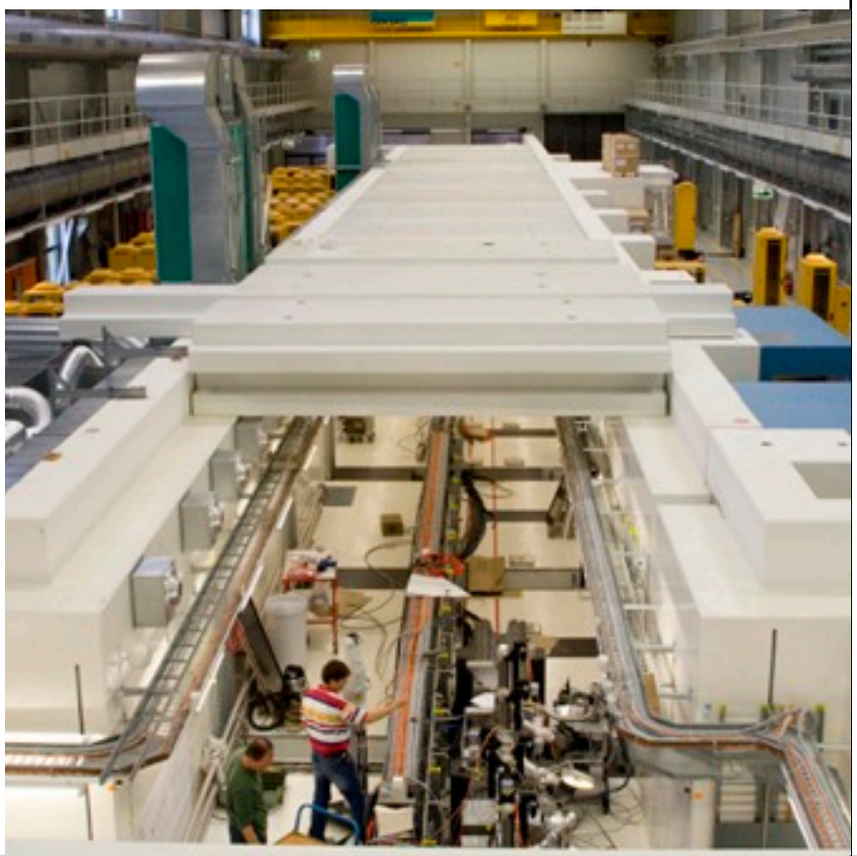


Accelerating Cavity

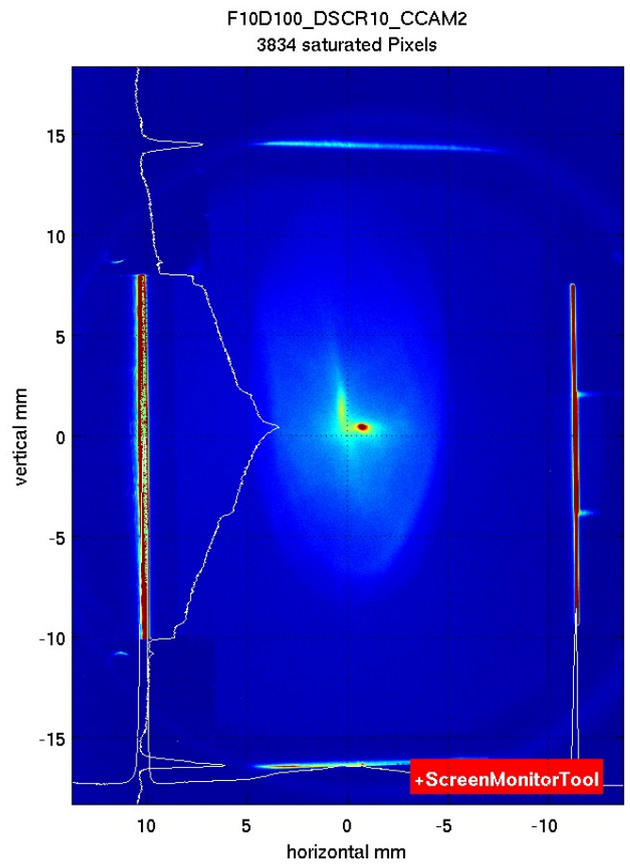
Quadrupole Magnets

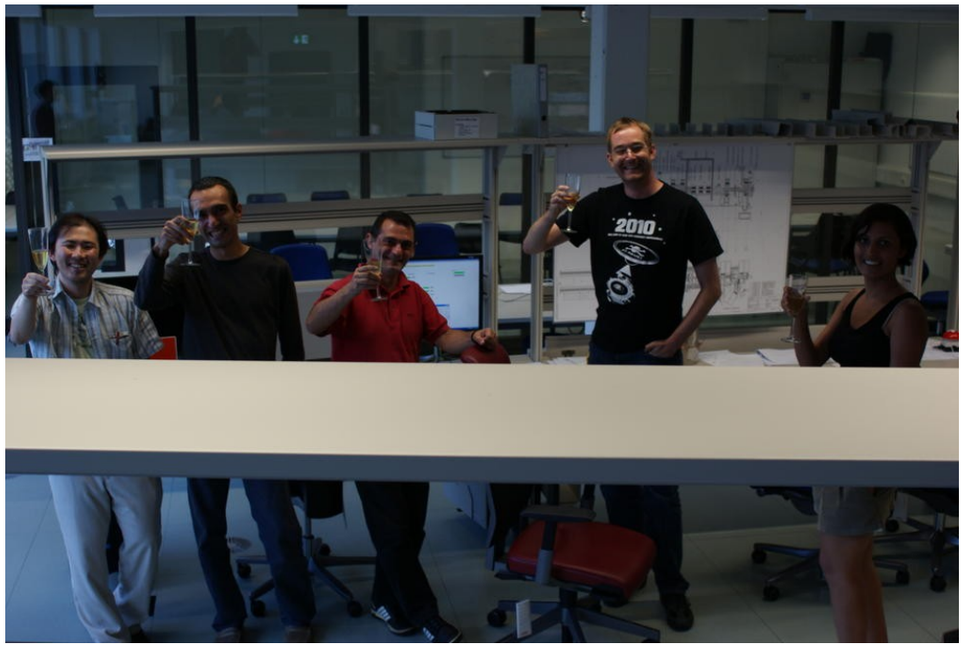
Beam Position Monitor

Profile Monitor



Inauguration readiness (9 August)





After that:

- Establishment of several primary and backup working points, using both or only one S-band structure (in case of failure).
- Also established working point with Ti:Sapph laser (primary laser for inauguration was Nd:YLF laser).
- Careful assessment of radiation issues.

24 August 2010

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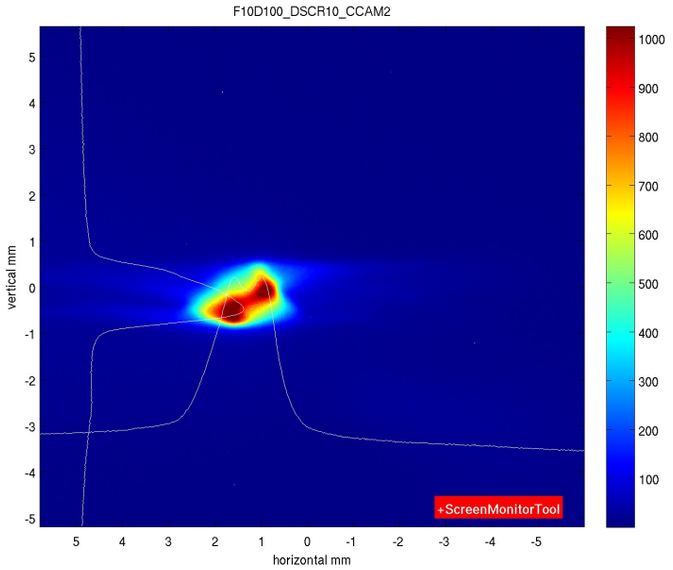
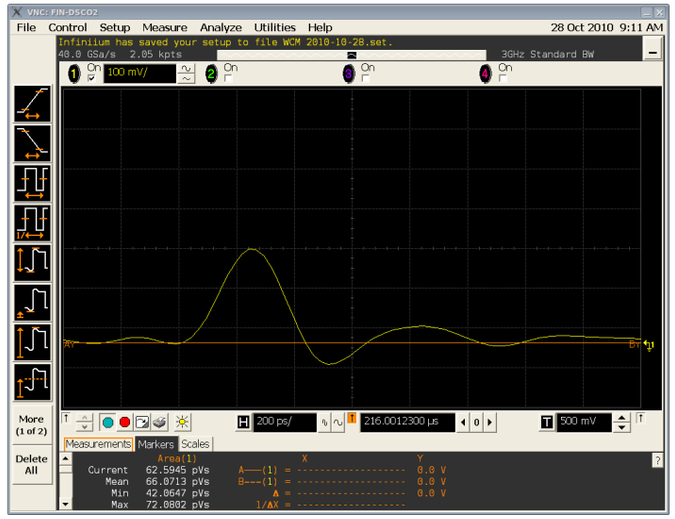
Keep it simple for the Federal Councillor: one button, two signals

Button connected to laser shutter.



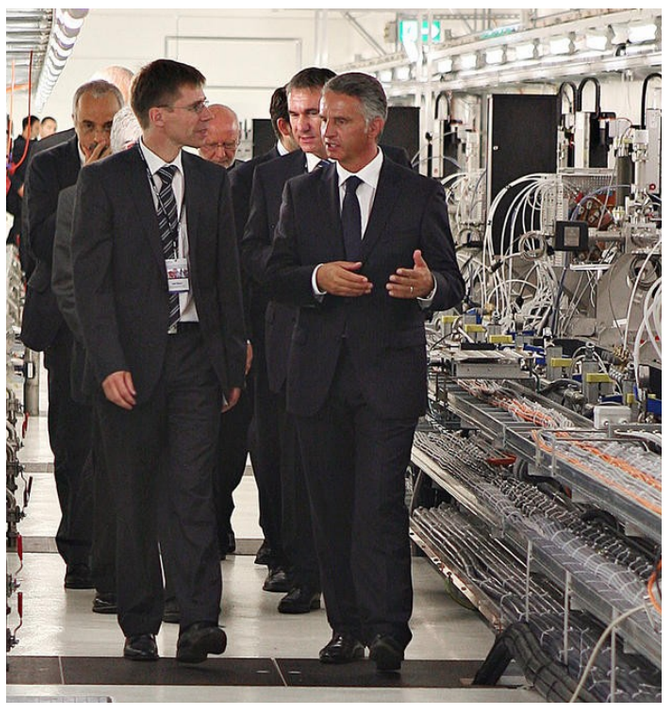
Beam on LuAG screen in front of beam dump.



Signal from Wall Current Monitor after the RF gun.

The Burkhalter beam:

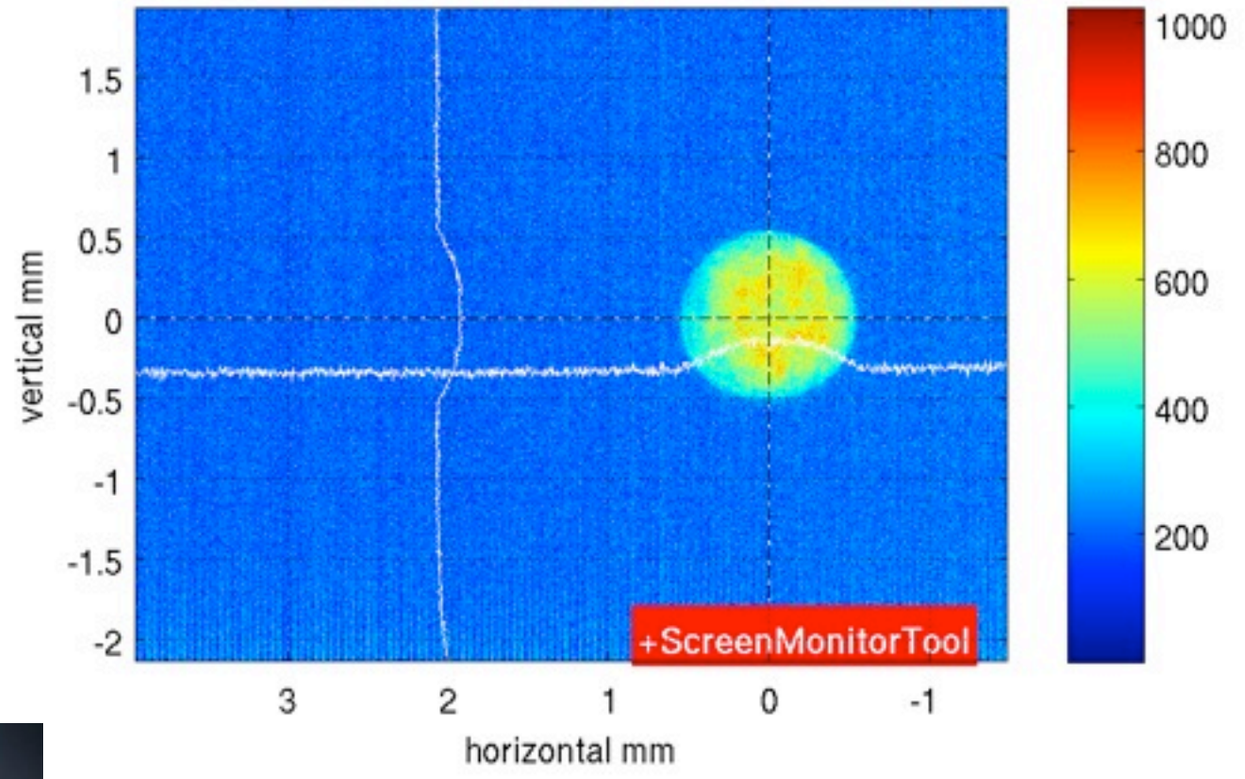
- ~35 pC charge
- ~160 MeV energy
- ~0.5 MeV energy spread



Visit to the injector tunnel.

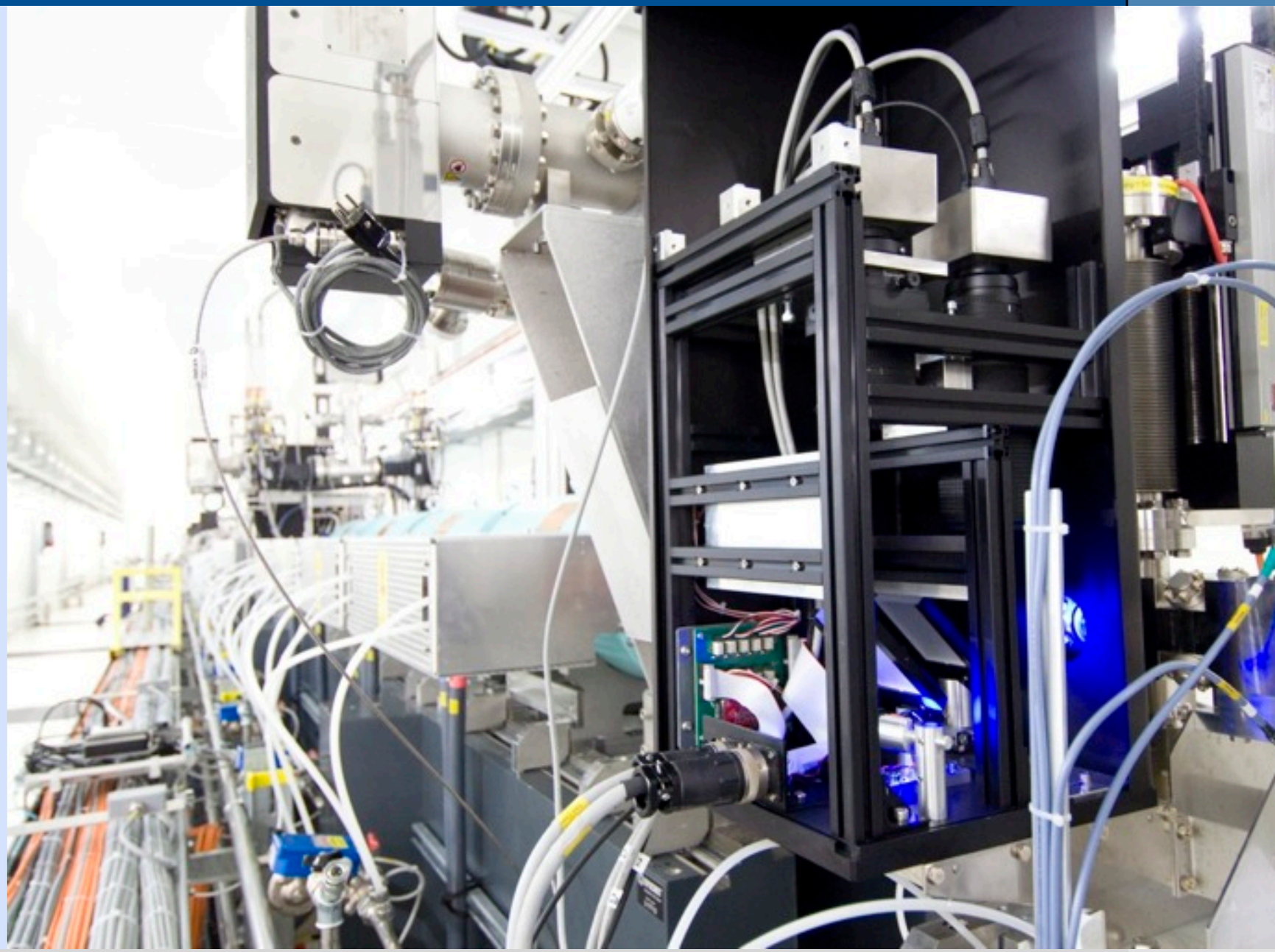
Profile Monitor for the Photocathode Laser

- Tb:glass scintillator
- Part of the photocathode laser is reflected onto the scintillator for on-line monitoring
- Imaged onto CCD detector



Electron Beam Profile Monitors

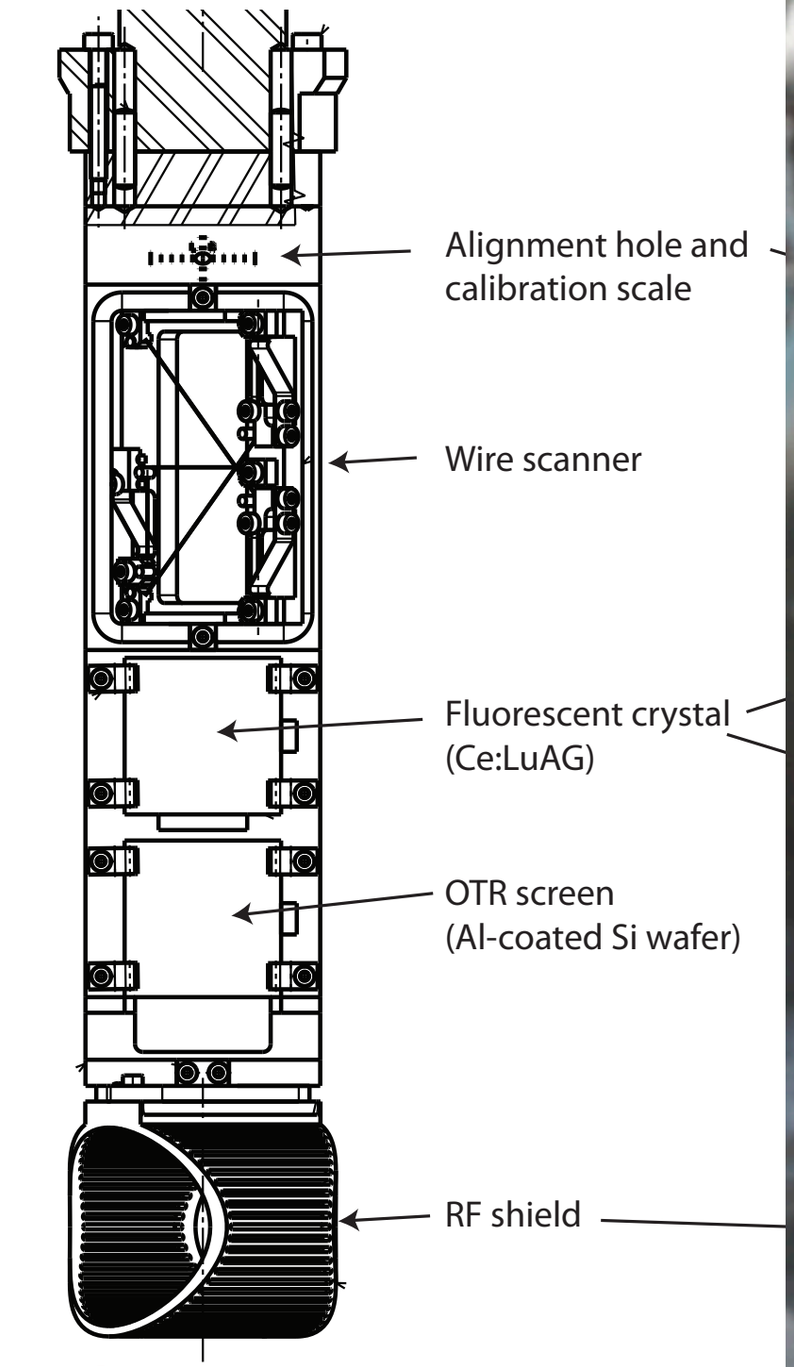
- Usage
  - Matching to design optics
  - Measure transverse phase space (phase space density, emittance)
  - Overlap electron beam with seed laser / laser heater
- With transverse deflecting structure: measure time-resolved parameters
  - Bunch length
  - Slice emittance
- In dispersive regions
  - Measure energy profile



Project the 6-dimensional phase space on 1 or 2 dimensions

Reconstruct the phase space by numerical methods

Electron Beam Profile Monitors
Scintillators, OTR Screens & Wire Scanners



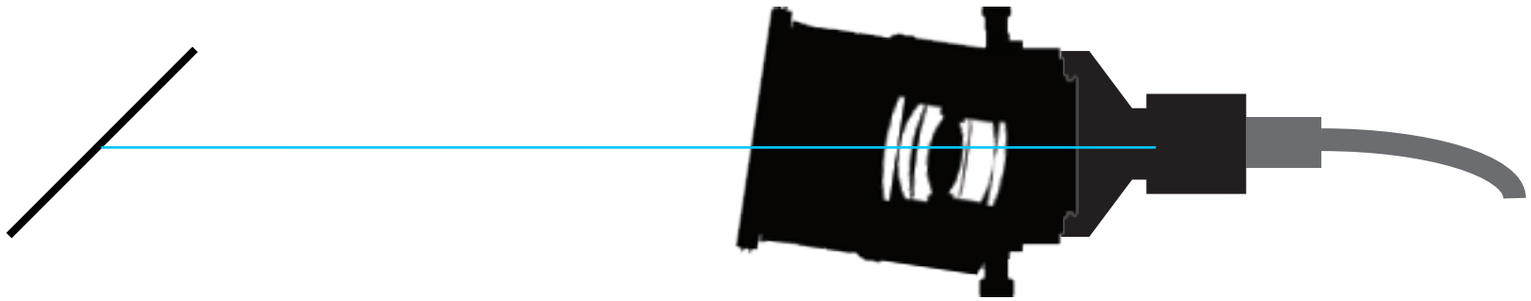
High Energy Screen

Installed scintillators

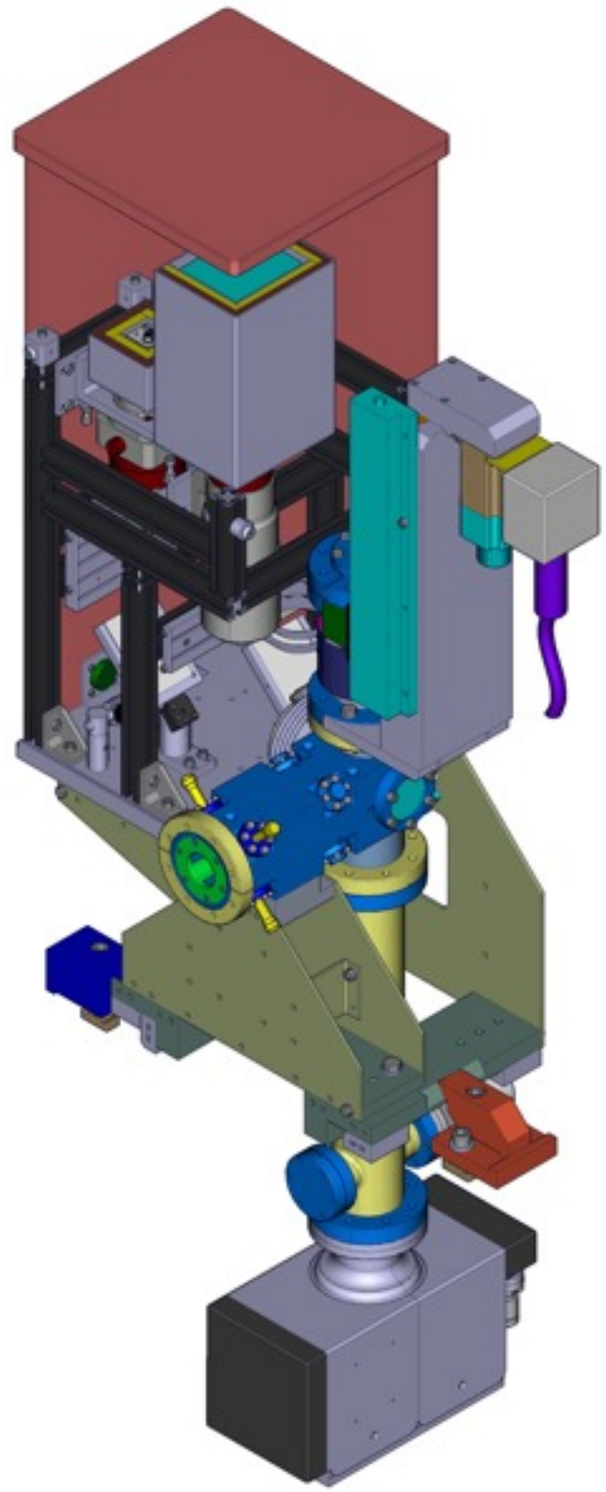
- Ce:YAG
  - 5 µm
  - 20 µm
  - 200 µm
- Ce:LuAG
  - 200 µm

Electron Beam Profile Monitors
Visual Light Optics

- OTR screen / scintillator is at an angle of 45º to the optical axis
- For overview camera (1:5.3 demagnification)
  - Use Scheimpflug criterion to correct image plane orientation



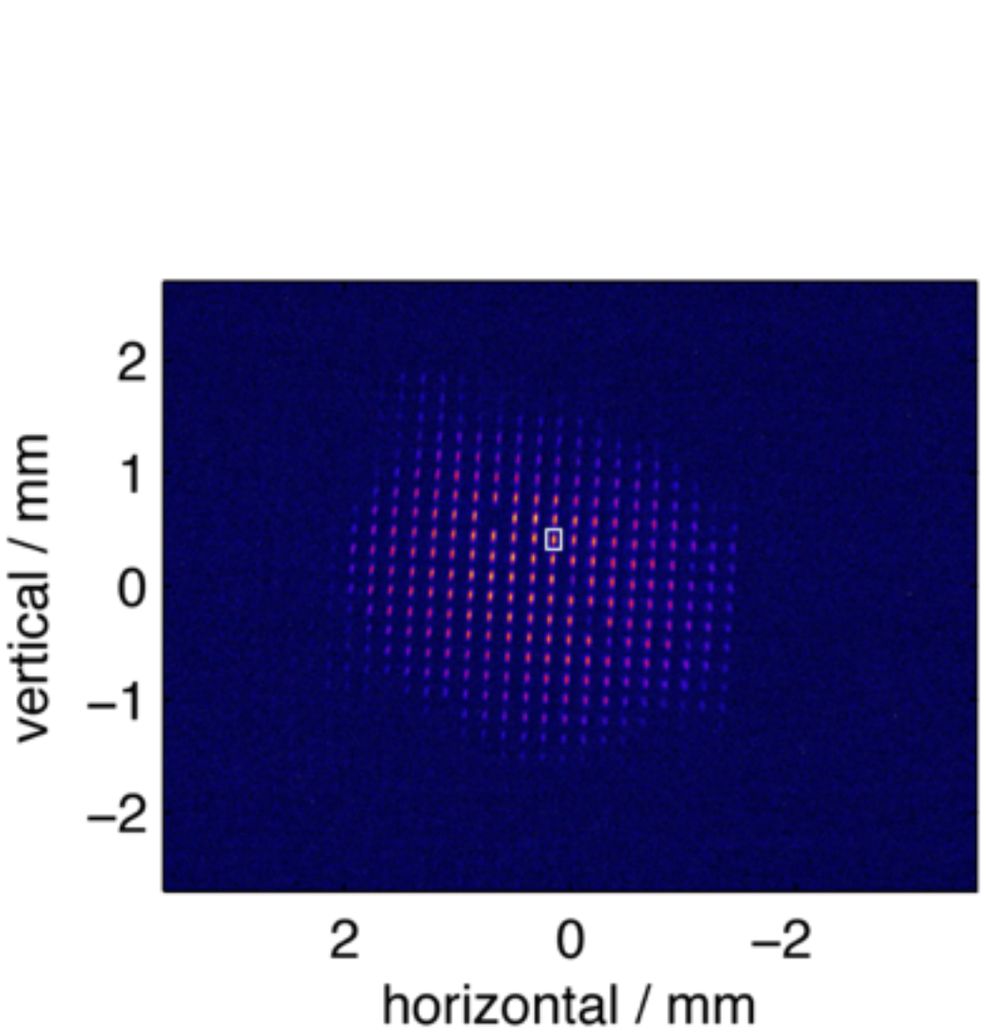
Projected pixel size: 23 µm

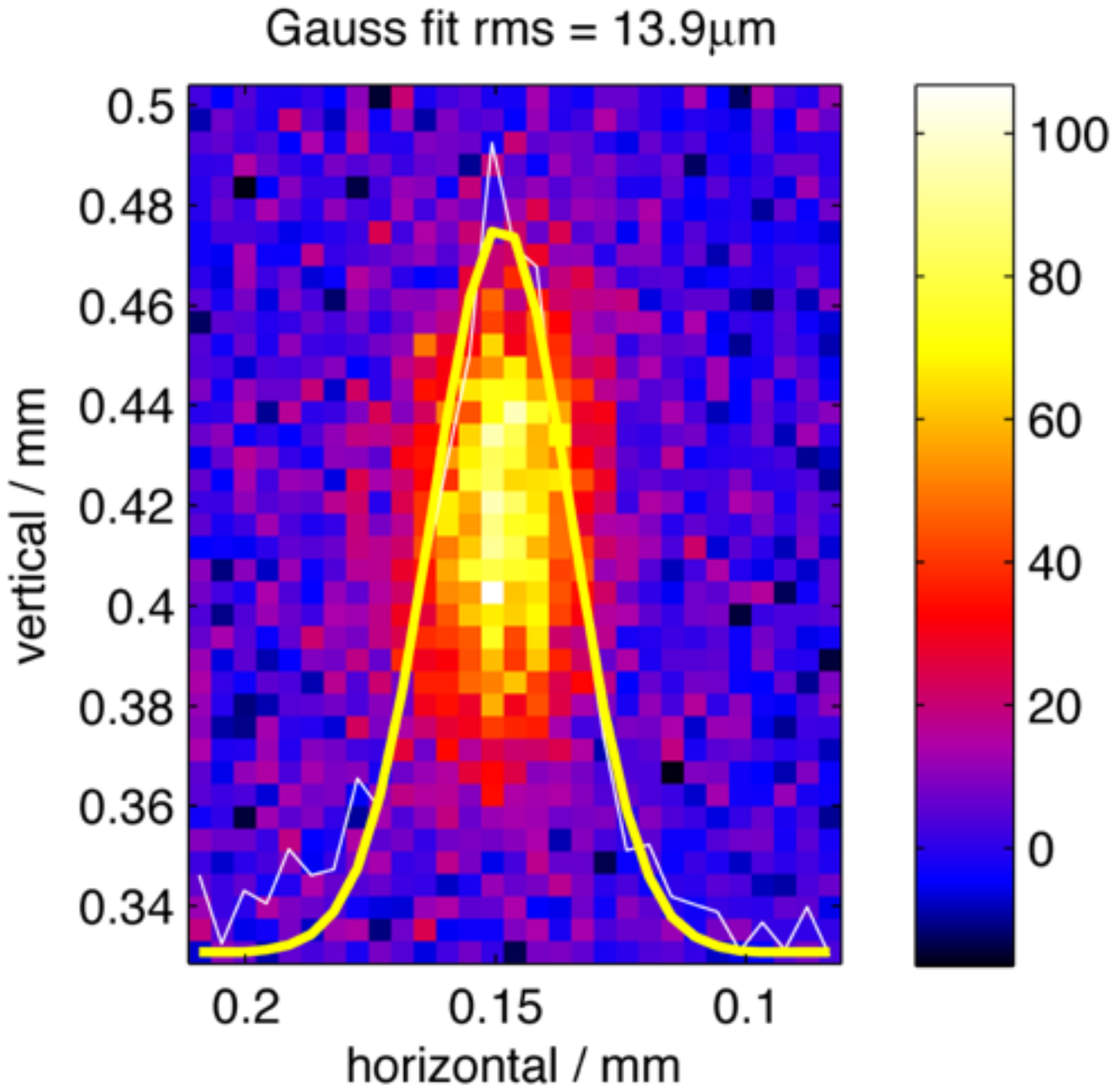


- For 1:1 imaging
  - Perspective control lens is not available commercially
  - Only central part (~1...2 mm) of the screen can be imaged within depth of field

Measurement at 7 MeV

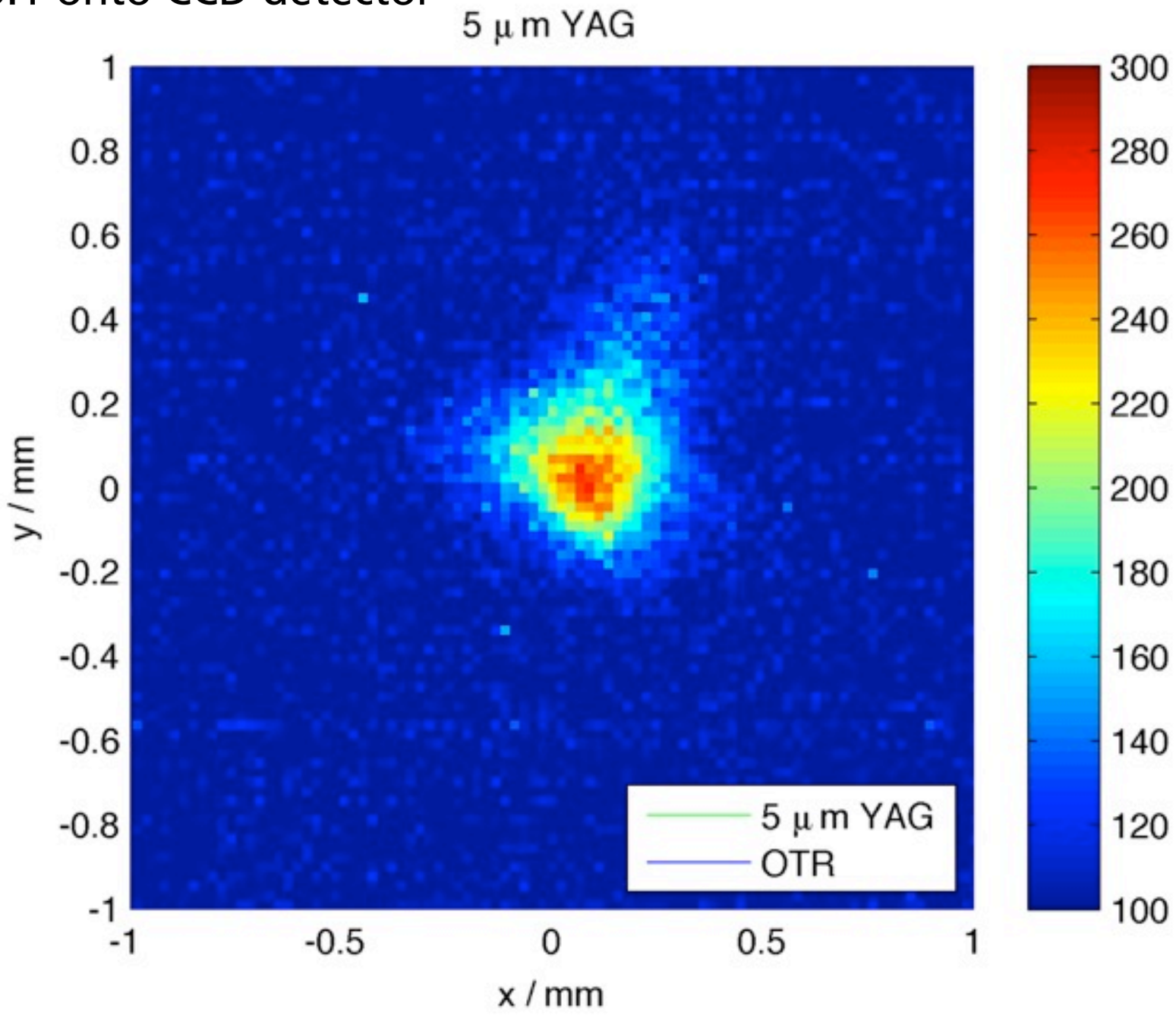
- Electron beam behind a pepper pot (for emittance measurement)
- 200 µm thick Ce:YAG crystal imaged 1:1 onto CCD detector





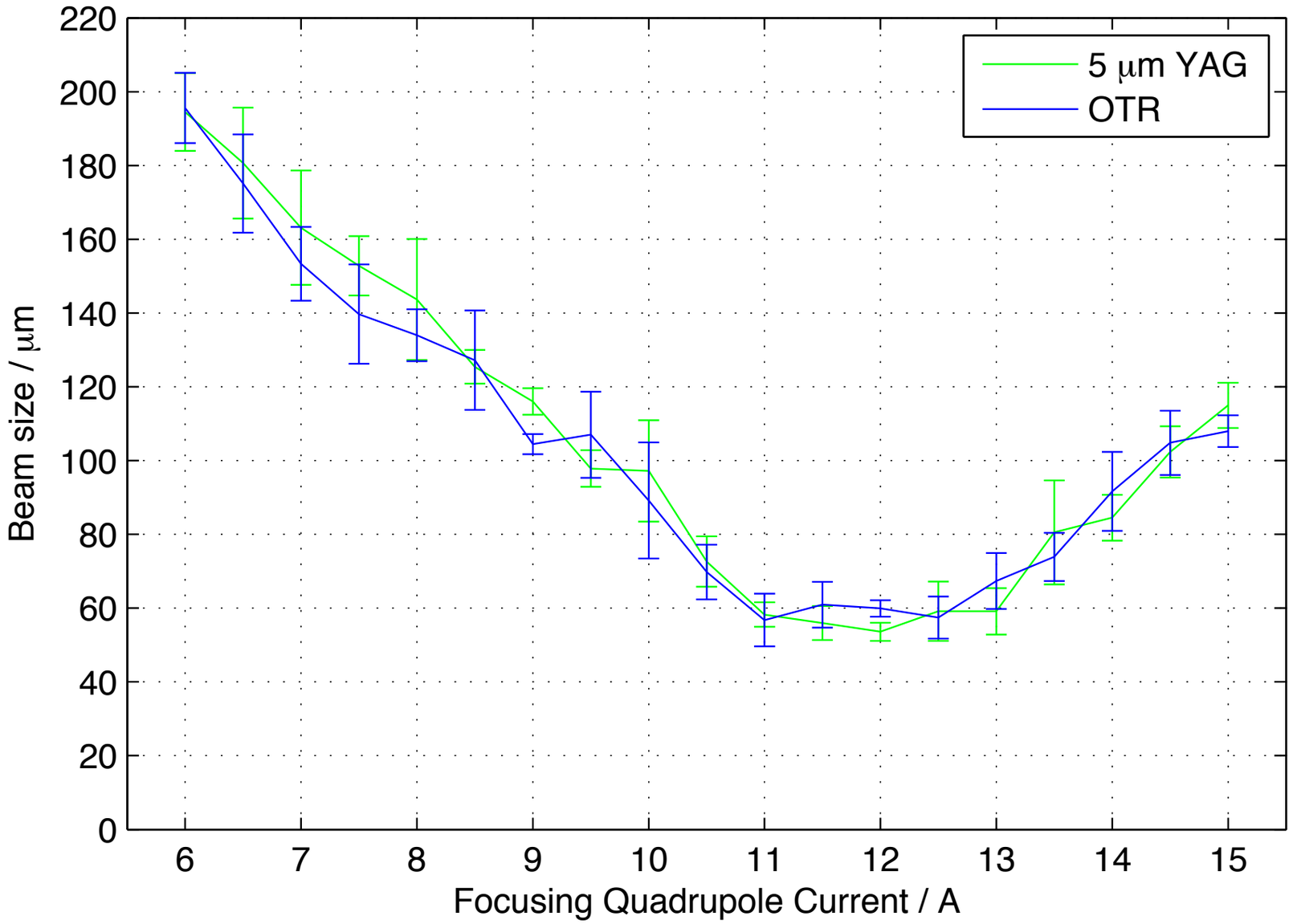
Measurement at 130 MeV

- 200 pC electron beam focused by quadrupole triplet onto Ce:YAG scintillator
- Imaged 5.3:1 onto CCD detector



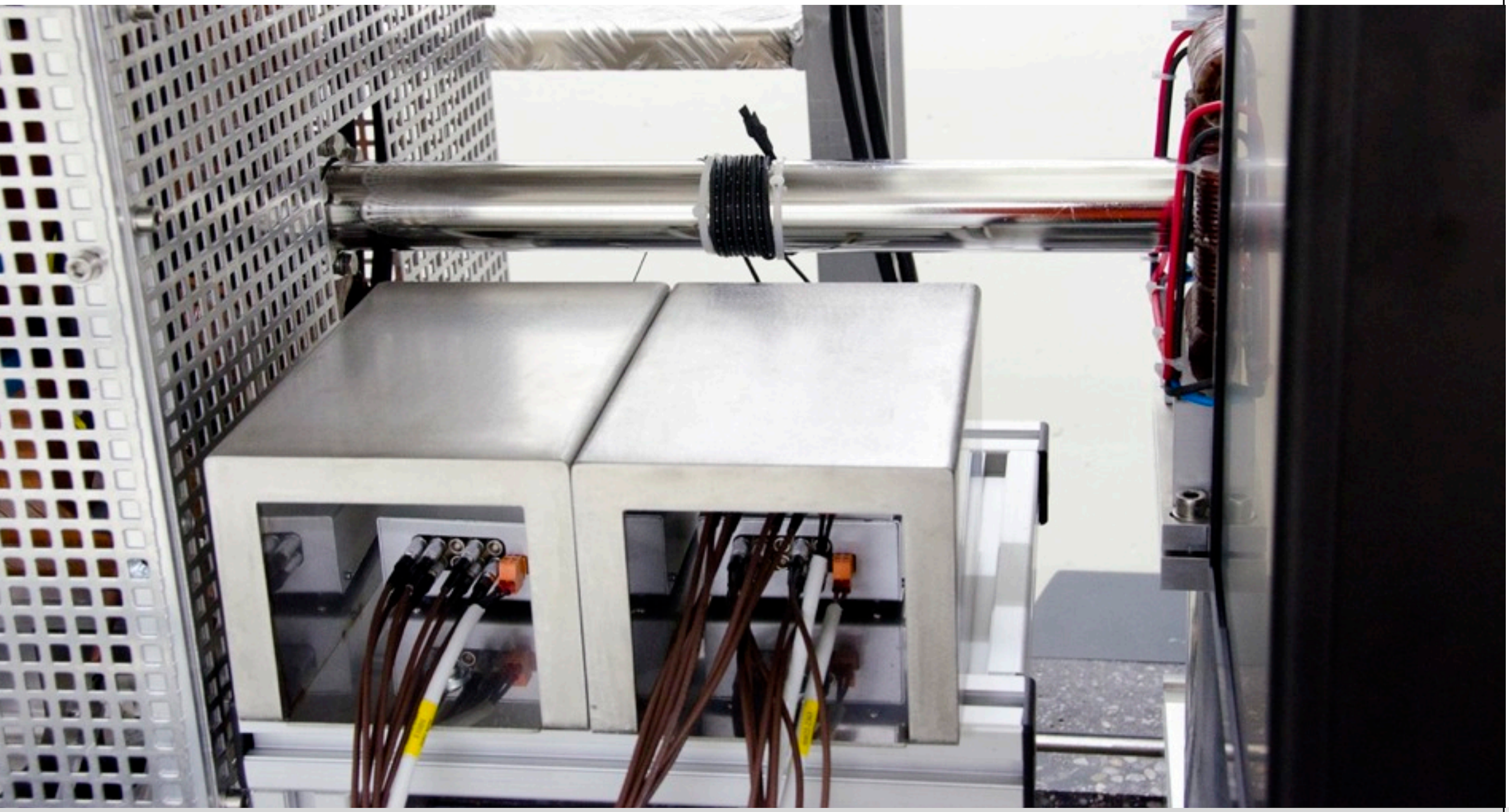
Measurement at 130 MeV

- Comparison to beam size measurement with optical transition radiation shows good agreement down to 60 µm rms
- Gauss fit to beam size; error bars represent statistical variation in 5 images each



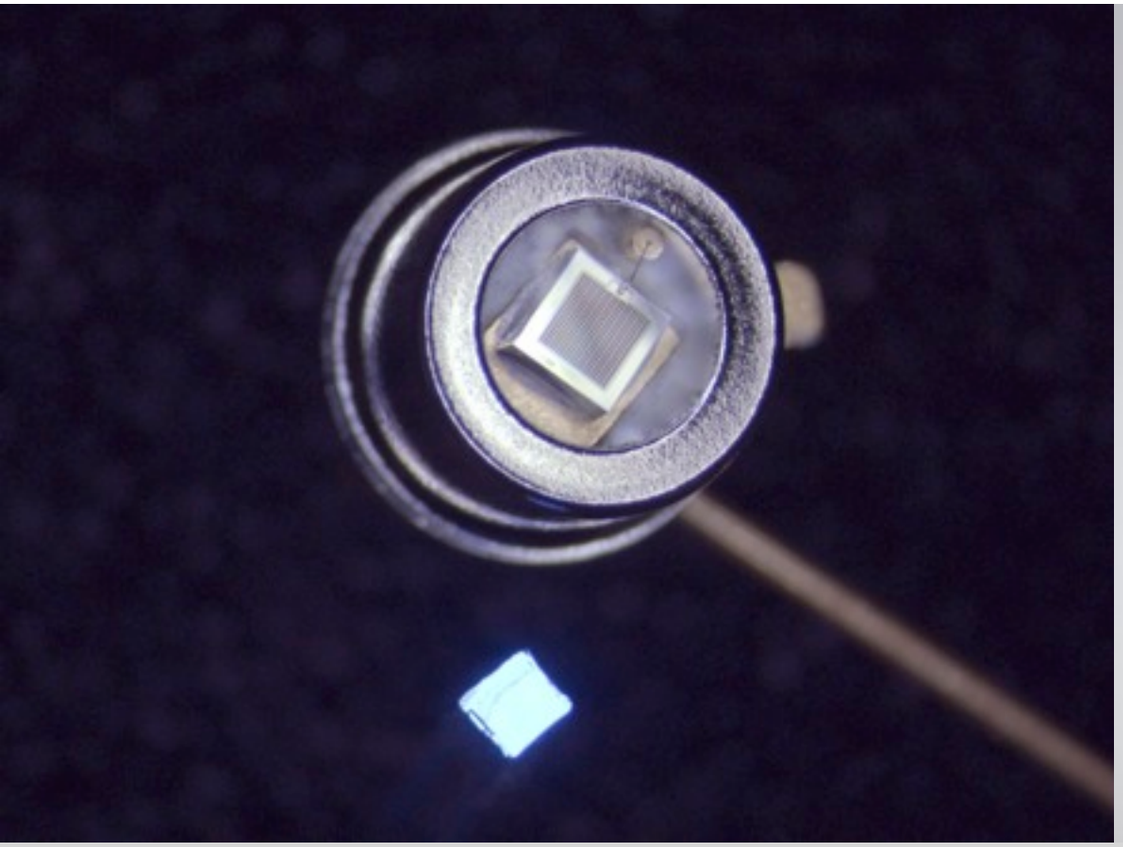
Loss Monitors

- Beam containment
- Wire scanner readout



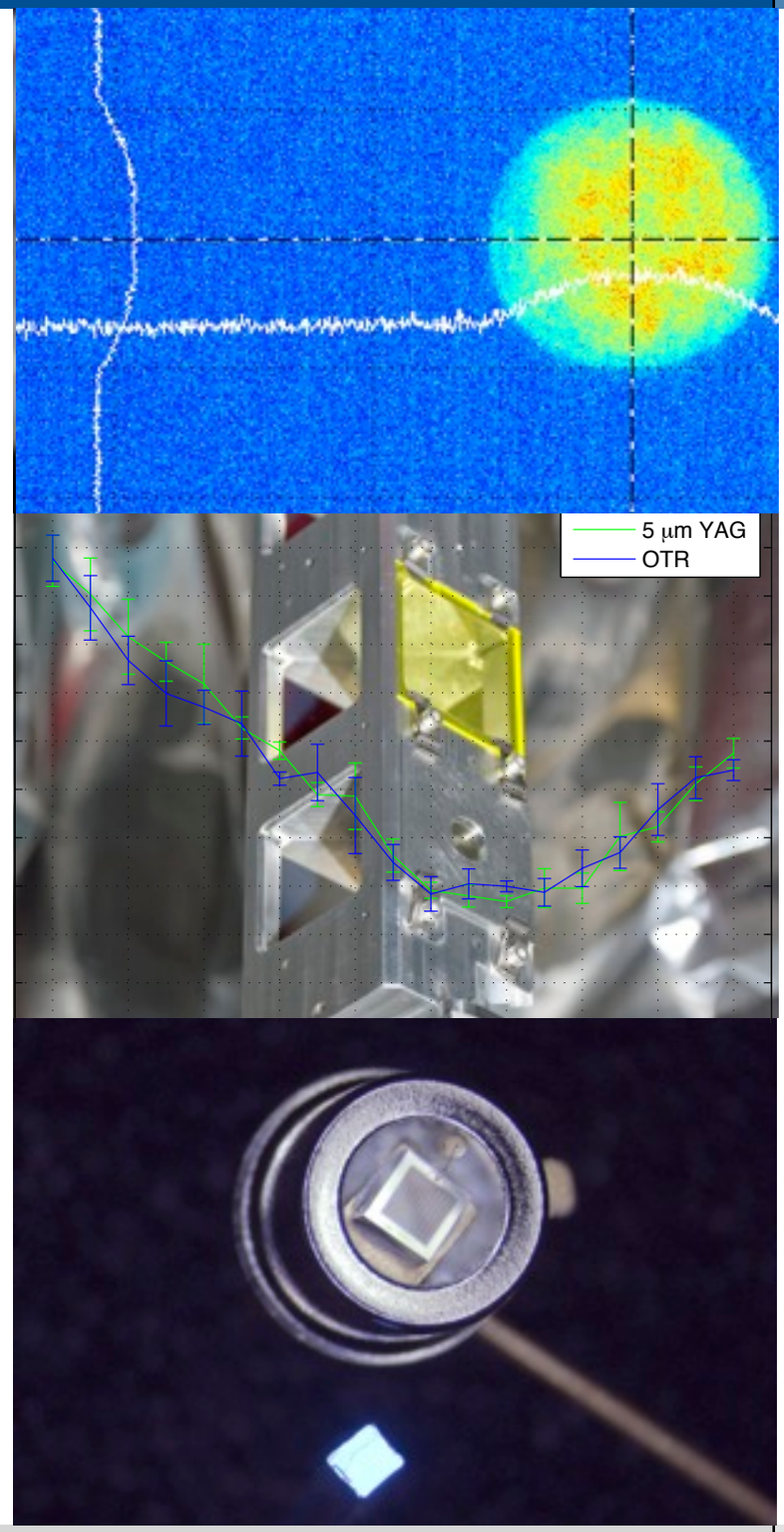
Loss Monitors

- Polystyrene scintillator fiber (1 mm • 1 mm • 1 m)
- Light detected by multi-pixel photon counter
- Pulse height is integrated, then digitized
- Work in progress:
  - Fiber has been installed
  - Digital readout is being commissioned



Summary

- Profile monitors for
  - Photocathode laser
  - Electron beam
- Loss monitors
  - Beam containment
- Wire scanners



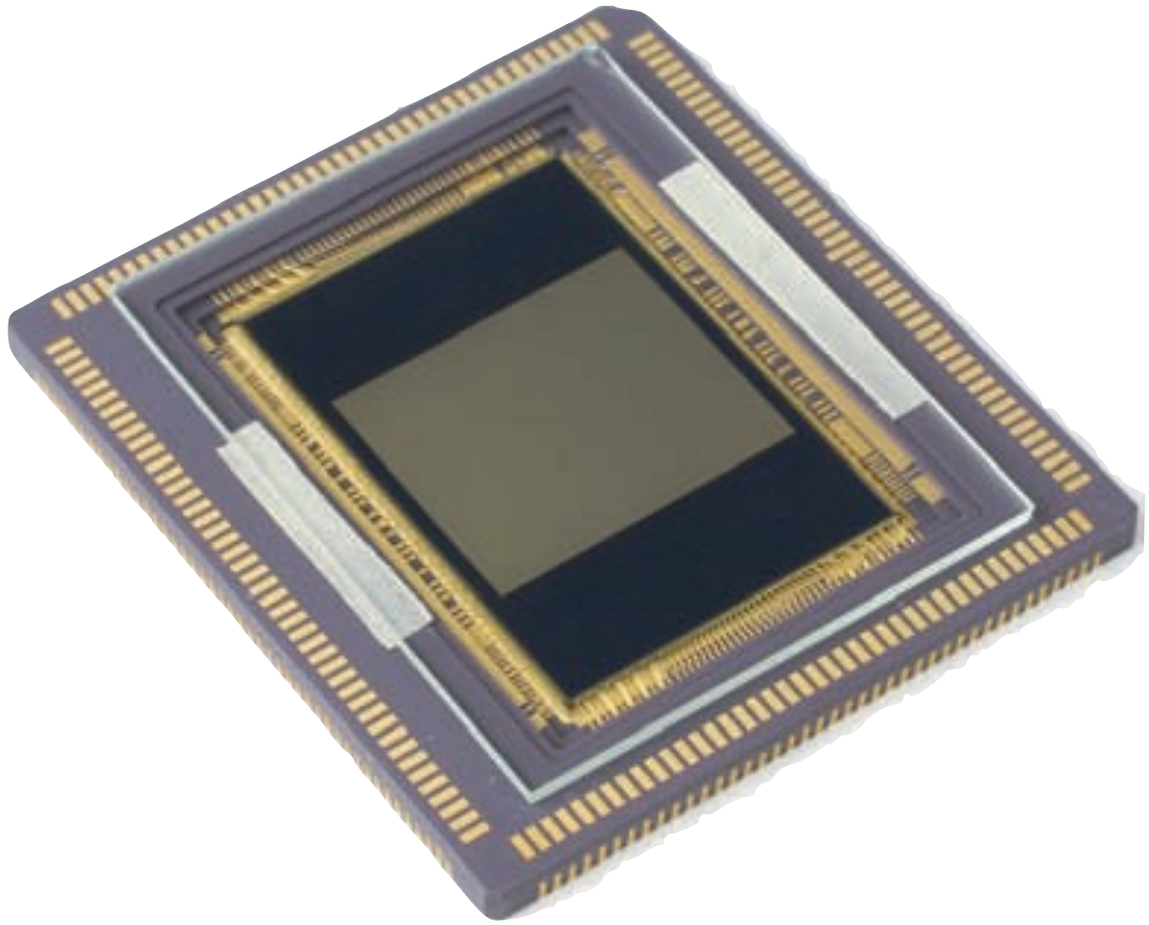
Outlook

- 10 pC operation
  - Use low noise CMOS camera

- 10 µm beam sizes
  - Construct Scheimpflug-corrected objective

- Microbunching instability (COTR)
  - Use shorter wavelength
  - Use wire scanners

- Real-time data processing
  - Use FPGAs for acquisition and on-line analysis



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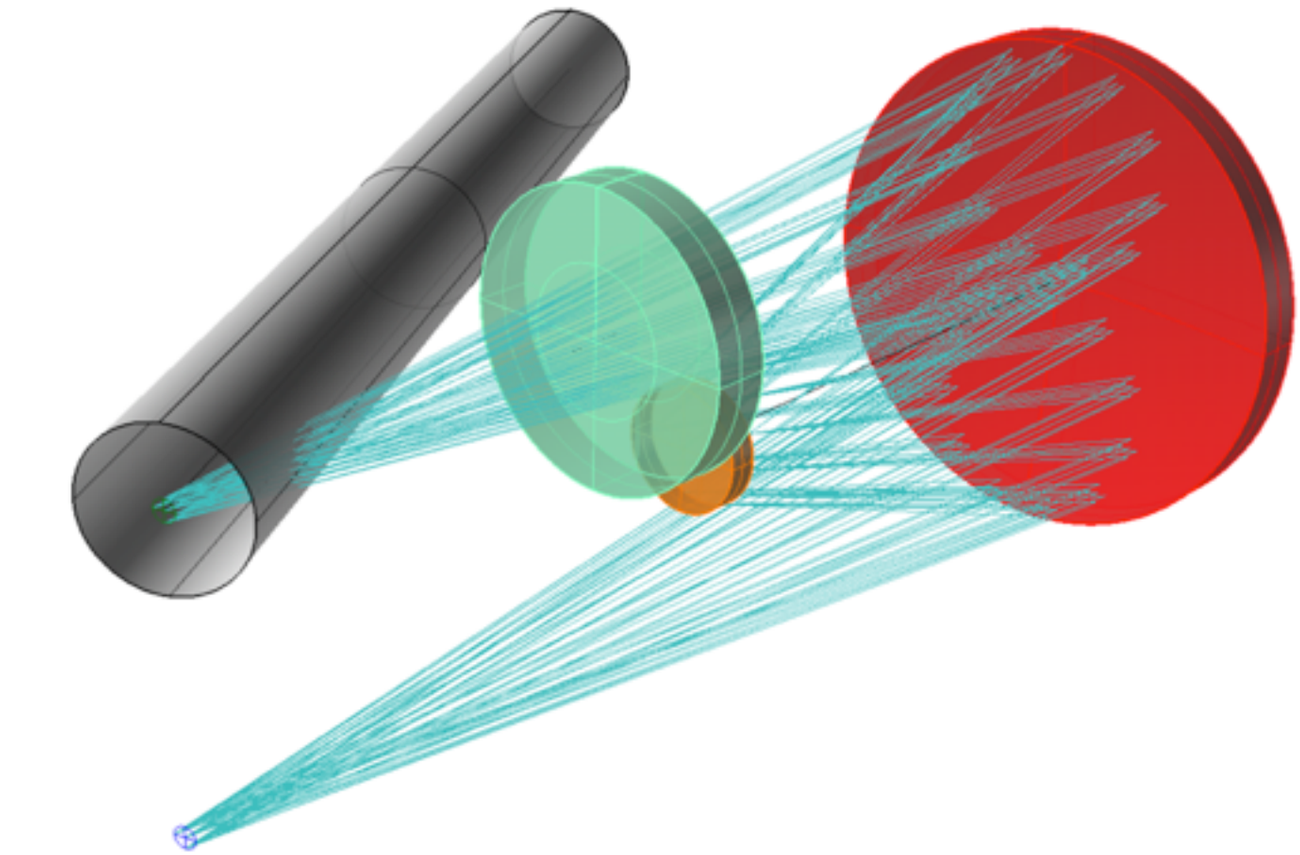

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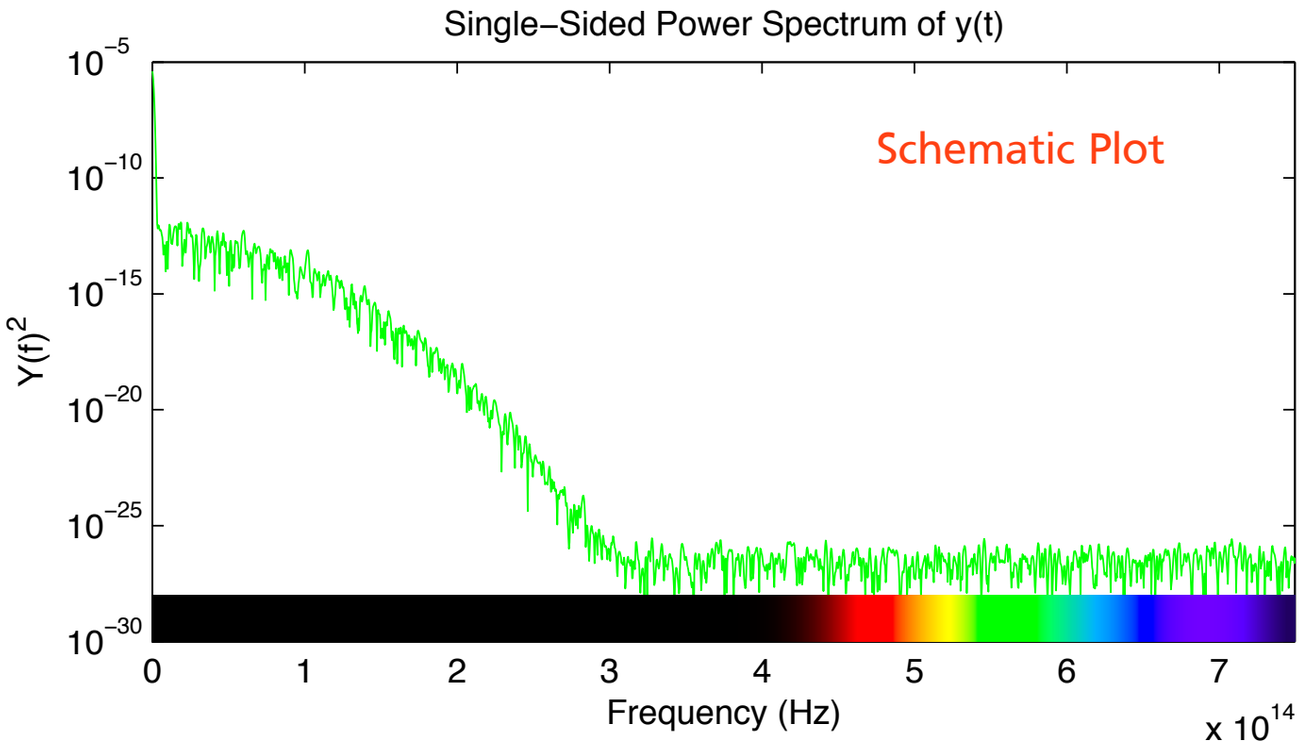

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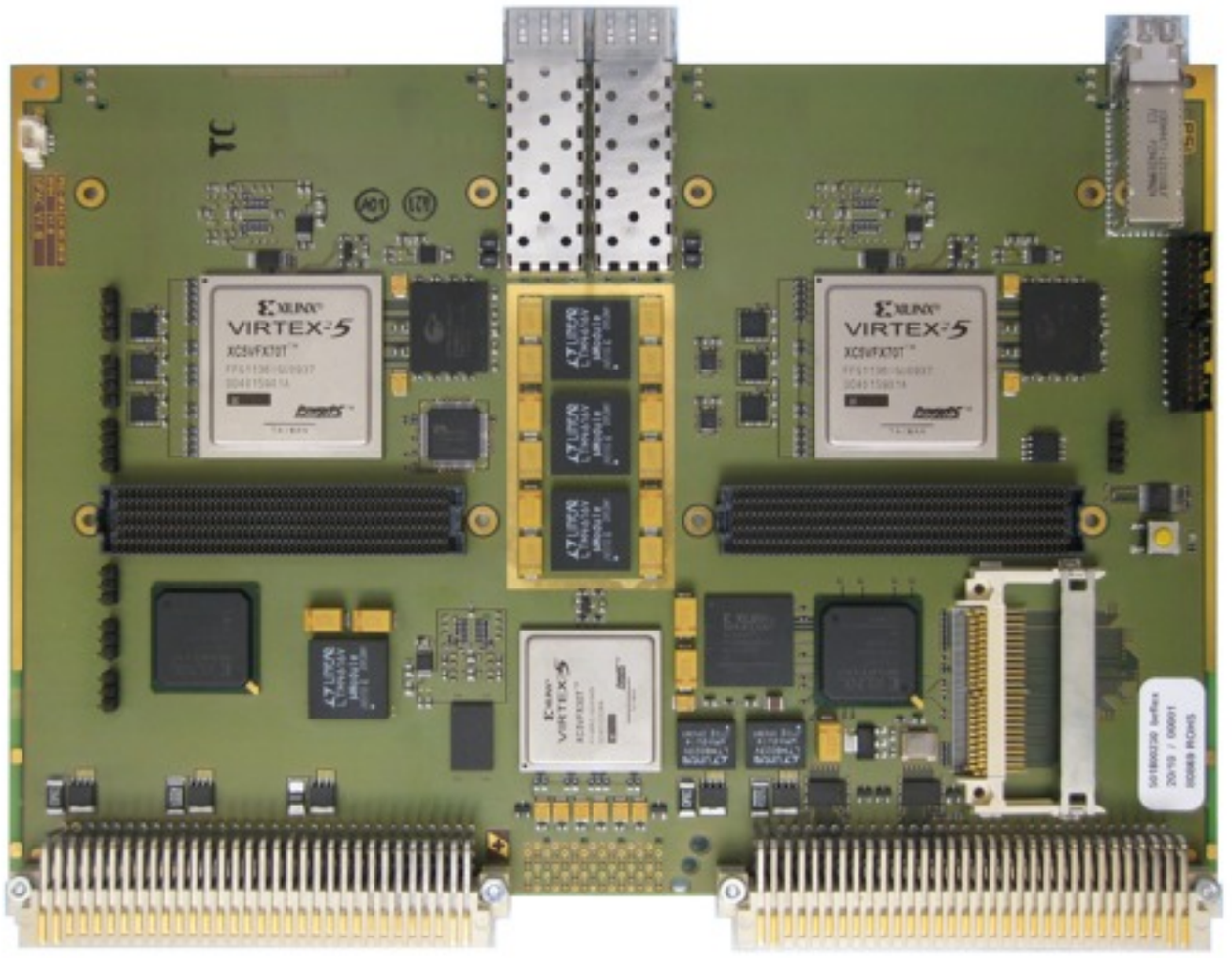

Scintillators for SwissFEL

Rasmus Ischebeck, for the PSI Diagnostics Group

- Thank you to the Diagnostics Group & the SwissFEL Team
- Special thanks for slides, drawings & help with this talk
  - Markus Baldinger, Peter Heimgartner, Goran Marinkovic, Gian Luca Orlandi, Federico Piffaretti, Thomas Schietinger, Volker Schlott, Vincent Thominet, Carlo Vicario

http://people.web.psi.ch/ischebeck