Karlsruhe Institute of Technology

Refurbishment of the screen diagnostic system at ANKA

3rd DEELS Workshop 27-28.06.2016, DESY, Hamburg, Germany

Marcel Schuh for the accelerator team

Laboratory for applications of synchrotron radiation (LAS)

Karlsruhe Institute of Technology

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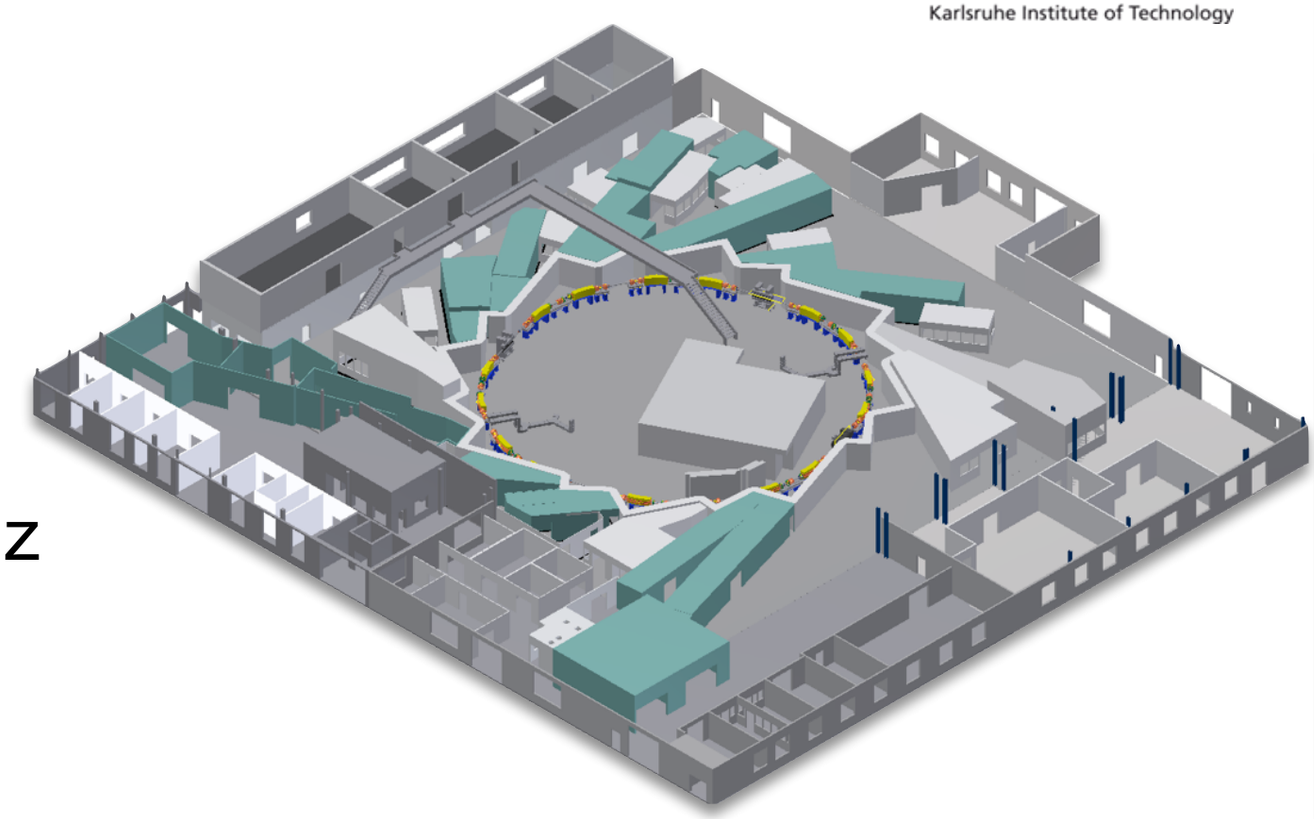
Outline

- ANKA
- Present system
- New transverse diagnostic systems
- Requirements of the new screen readout
- Control and data handling concept
- Status and next steps

Introduction - ANKA

- Energy: 0.5 - 2.5 GeV
  (0.8 - 1.6 GeV during low-αc-mode)
- Circumference: 110.4 m
- Revolution frequency: 2.715 MHz
- RMS bunch length:
  45 ps (for 2.5 GeV),
  10 ps down to 1-2 ps (for 1.3 GeV)
- Filling pattern: single- or multi-bunch
  (min. bunch spacing 2 ns)
- Harmonic number 184

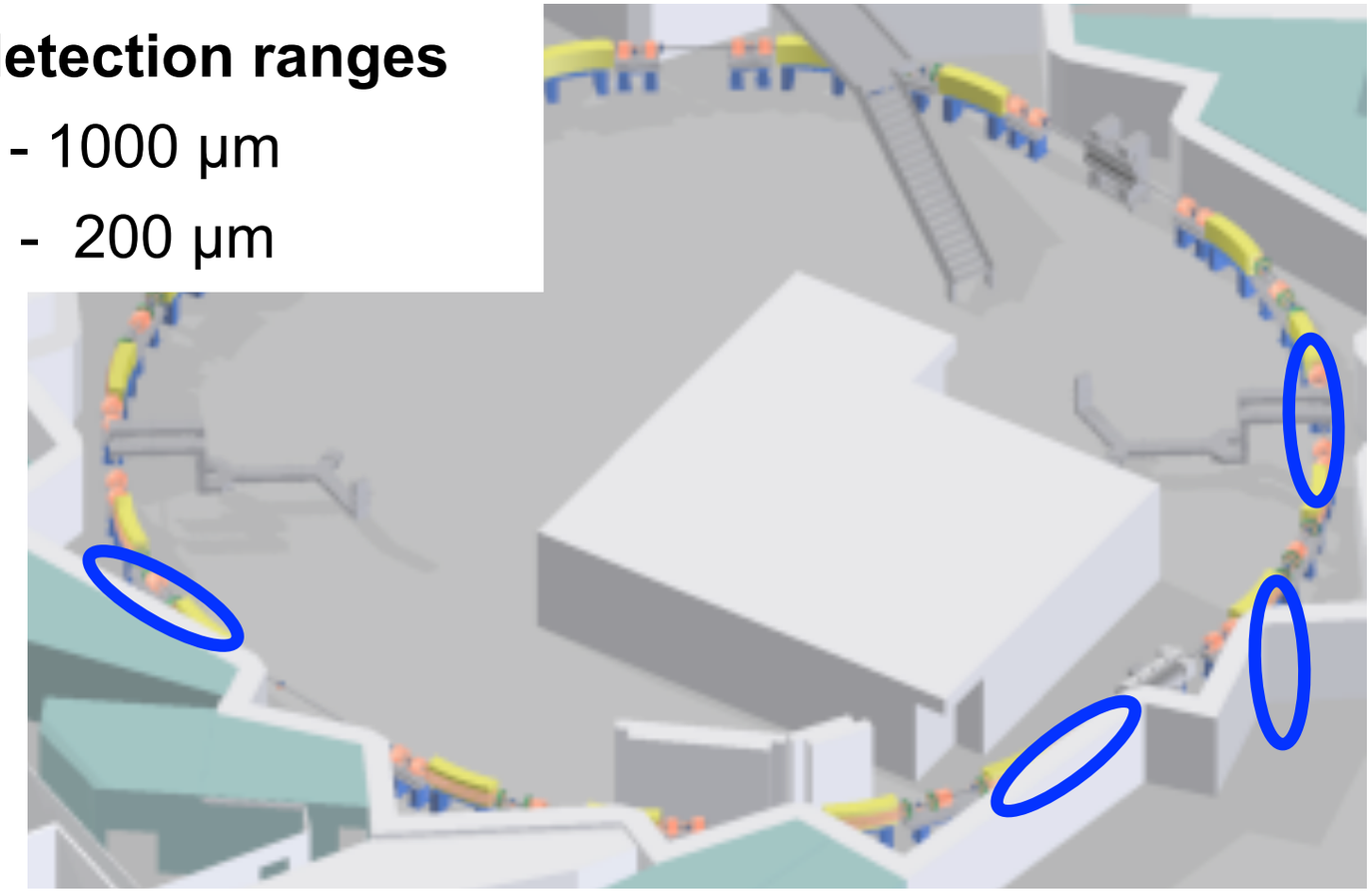


- EPICS Control System
- DIMTEL 3D BBB Feedback
- σx ~ 100 - 600 µm
- σy ~ 30 - 150 µm

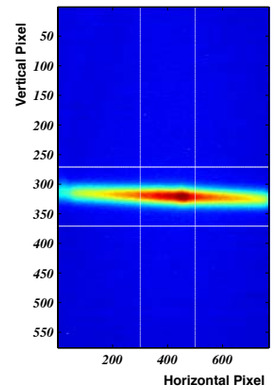
Transverse beam profile diagnostics at ANKA

Required detection ranges

- σ_x ~ 200 - 1000 µm
- σ_y ~ 20 - 200 µm

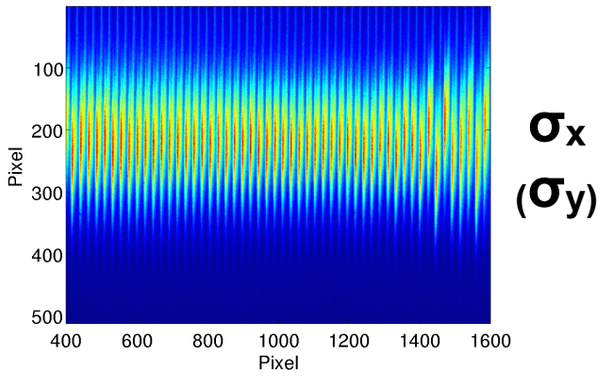


DIAX
11.5° Port inside of ring



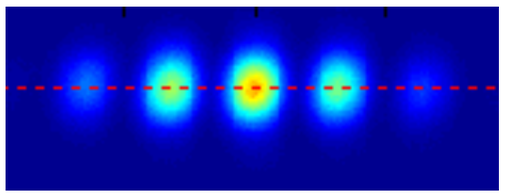
σ_y

Visible light diagnostics beamline
5° Port outside of ring
- Streak camera
- TCSPC
- **Fast-Gated Camera**



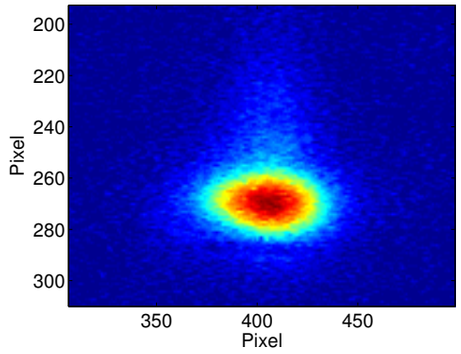
σ_x (σ_y)

Double-Slit Interferometer
5° Port inside of ring



σ_y

Synchrotron Light Monitor
5° Port inside of ring

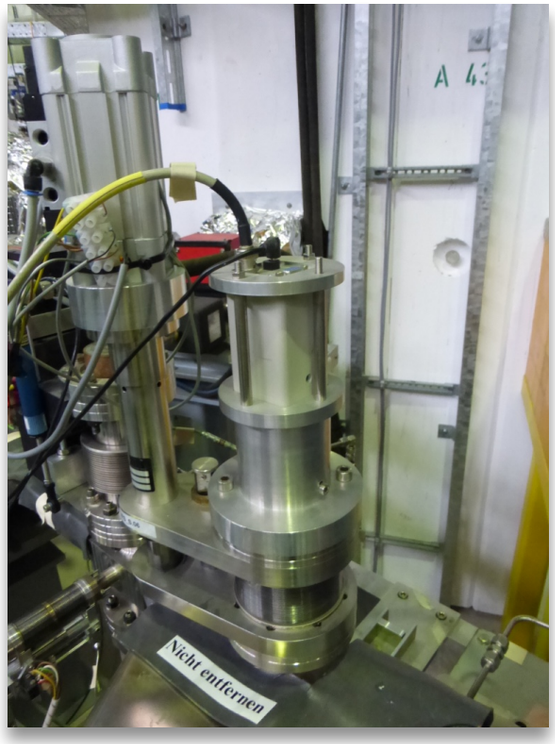


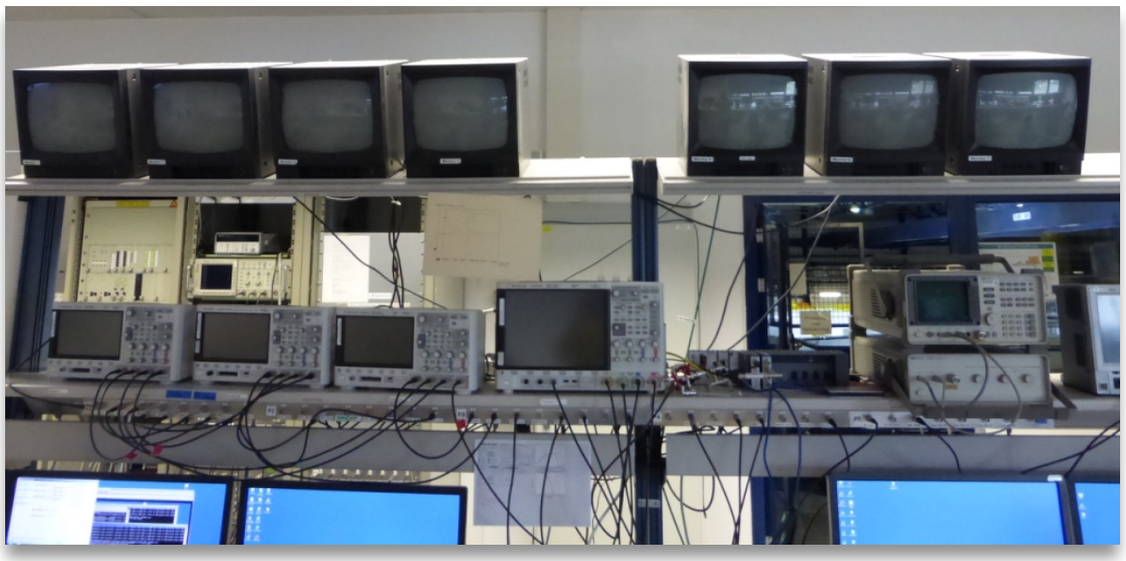
σ_x (σ_y)

Courtesy of N. Hiller

Present screen diagnostic system at ANKA

- Aluminium oxide screens / synchrotron light monitors
  - Microtron: 3 + 1
  - Transfer line to booster: 2
  - Booster: 3 + 1
  - Transfer line to storage ring: 3
  - Storage ring: 5 + 2 + 2
- Analog cameras
  - 1/3“ monochrom CCD
- Video switch
- TVs in the control room
- Frame grabber card
- Limitations:
  - Data taking, processing and archiving
  - Hardware starts to fail



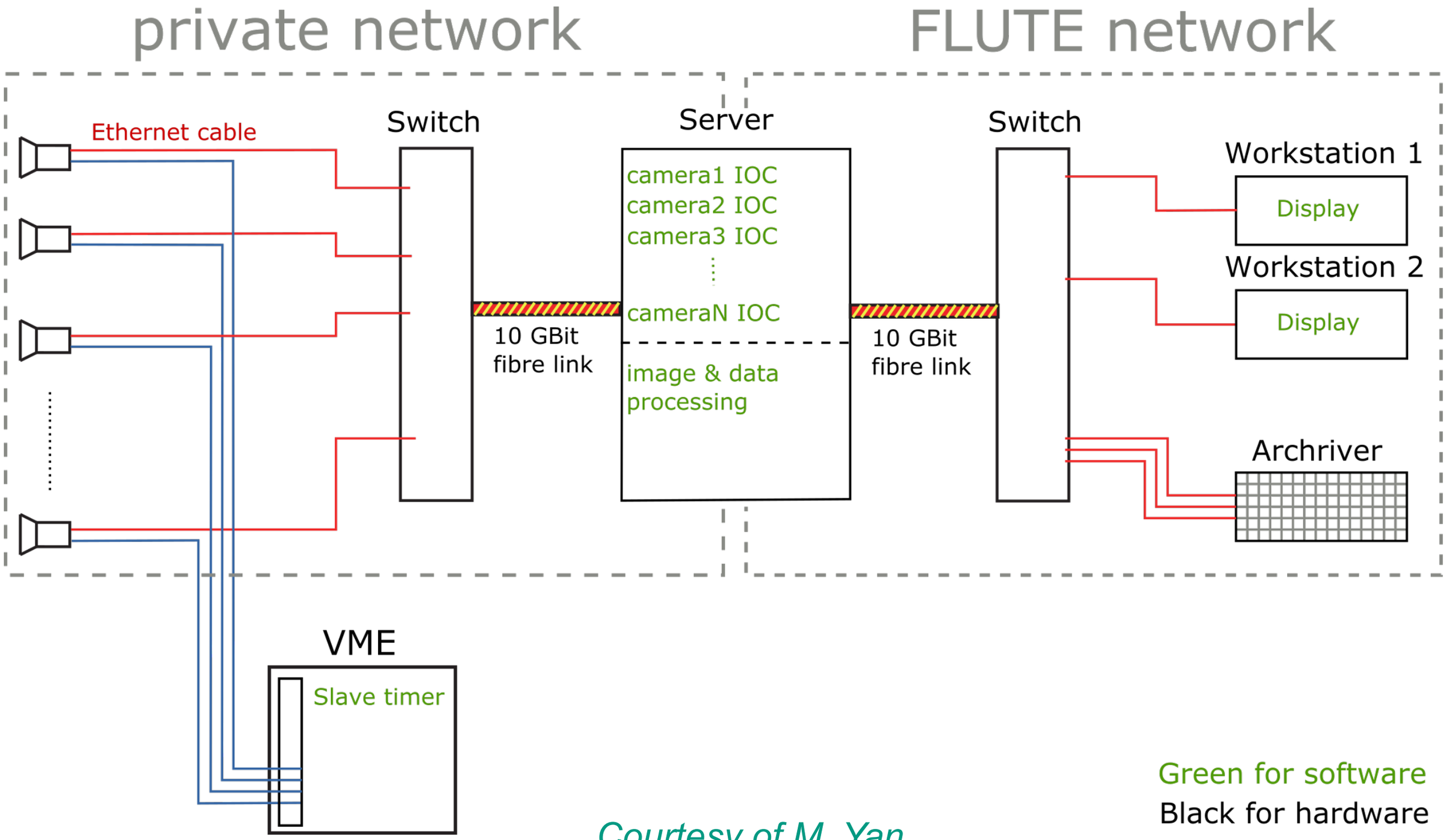


System requirements

Idea: Replace analog camera systems with digital cameras and data analysis framework

- Digital cameras
  - Triggered
  - EPICS control
  - PoE powered
- Reliable live view for operators
- Online data processing
  - Center of mass, RMS, AVG, contour…
  - What is useful for daily operation?
- Archiving?
- …

Data readout and handling concept



Courtesy of M. Yan

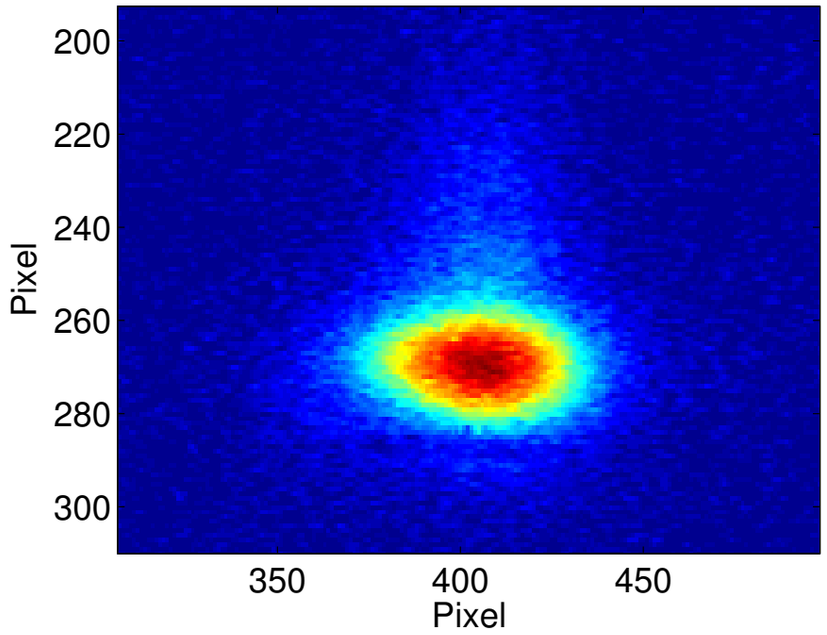
Status and next steps

- Define system and camera requirements
  - Resolution
  - Objective
- Use FLUTE as prototype for ANKA injector
- Control system integration for existing camera systems

- Questions
  - Experience with different Hardware interfaces?
  - EPICS support?
  - Software frameworks available?

Backup slides

Synchrotron light monitor

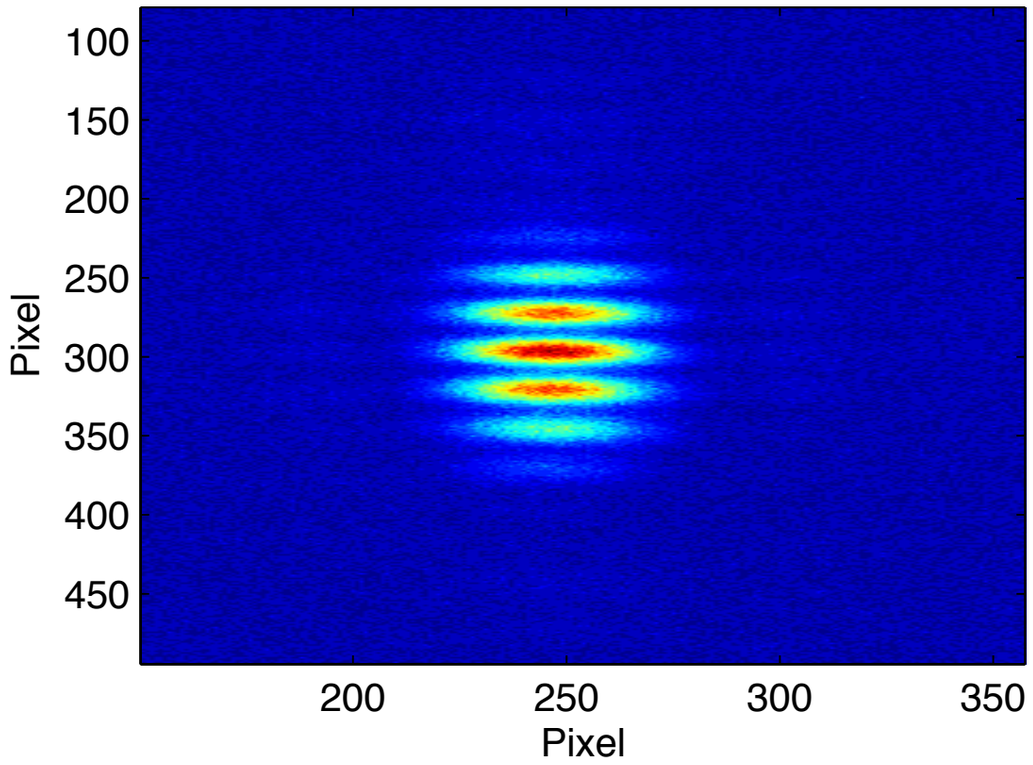


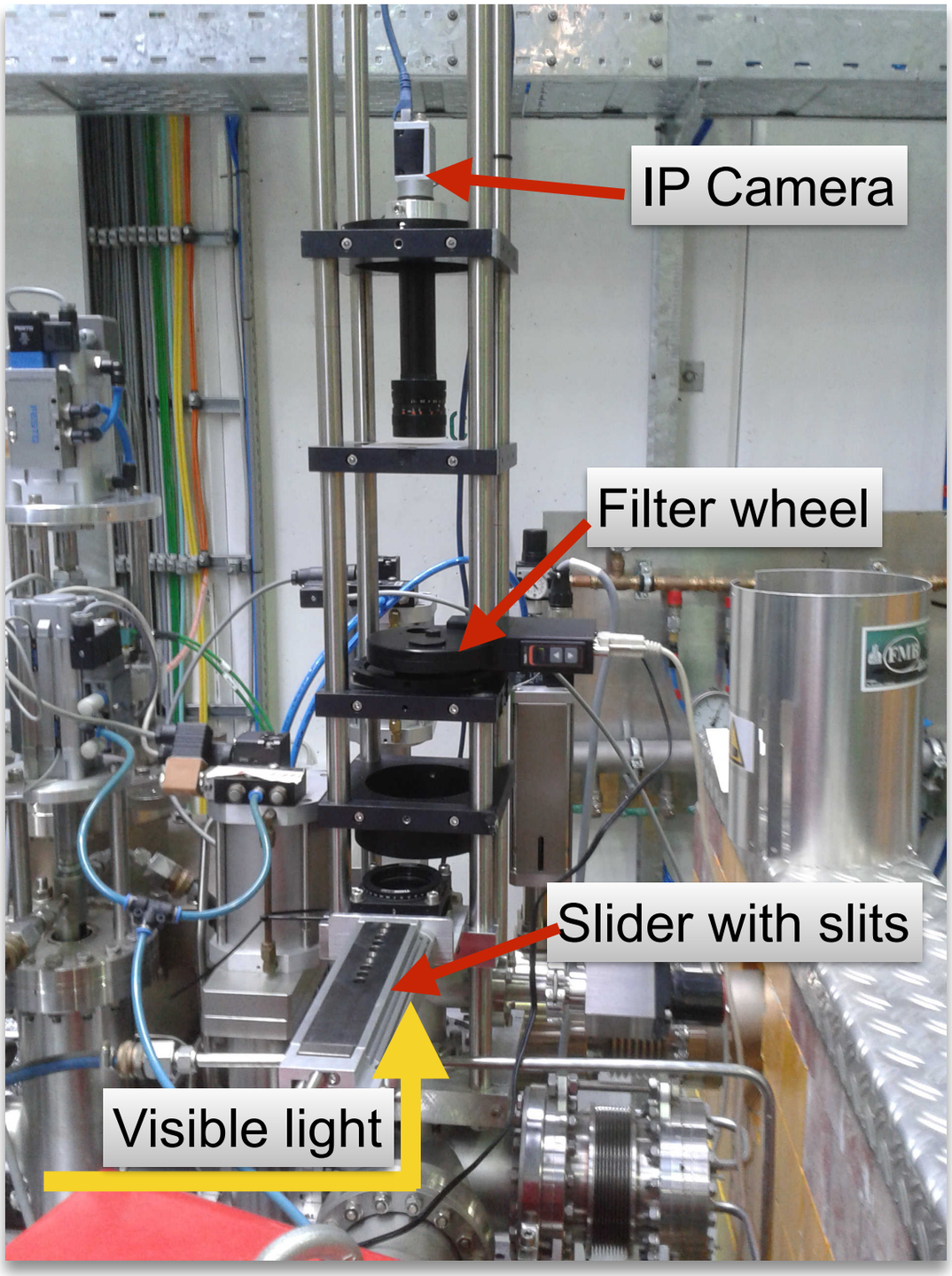
- One of the first diagnostics devices installed at ANKA
- Analog camera
- Fixed neutral-density filters
- Intensity adjusted for multi-bunch currents
- Diffraction limited in the vertical plane

Courtesy of N. Hiller

Synchrotron light monitor (SLM) upgrade

- Digital camera to improve processing
- Filter wheel to increase dynamic range for single and multi-bunch operation
- Double slit interferometer to overcome diffraction limit in vertical plane

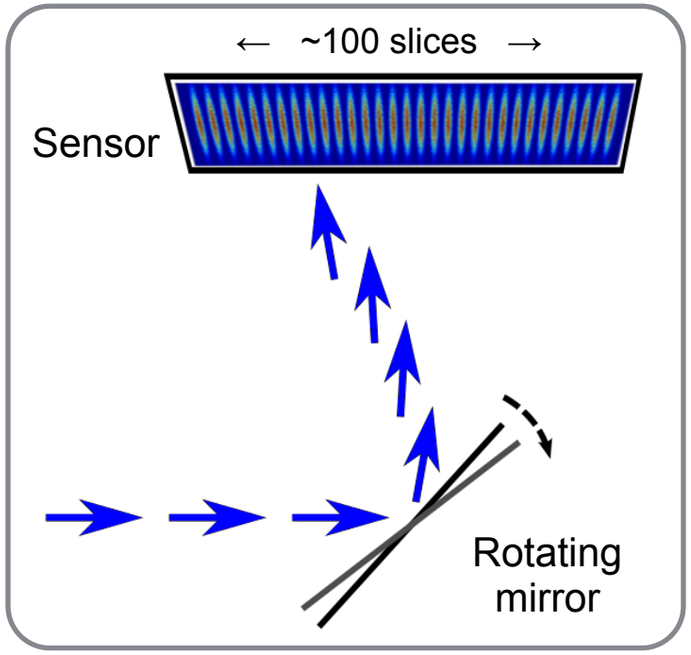


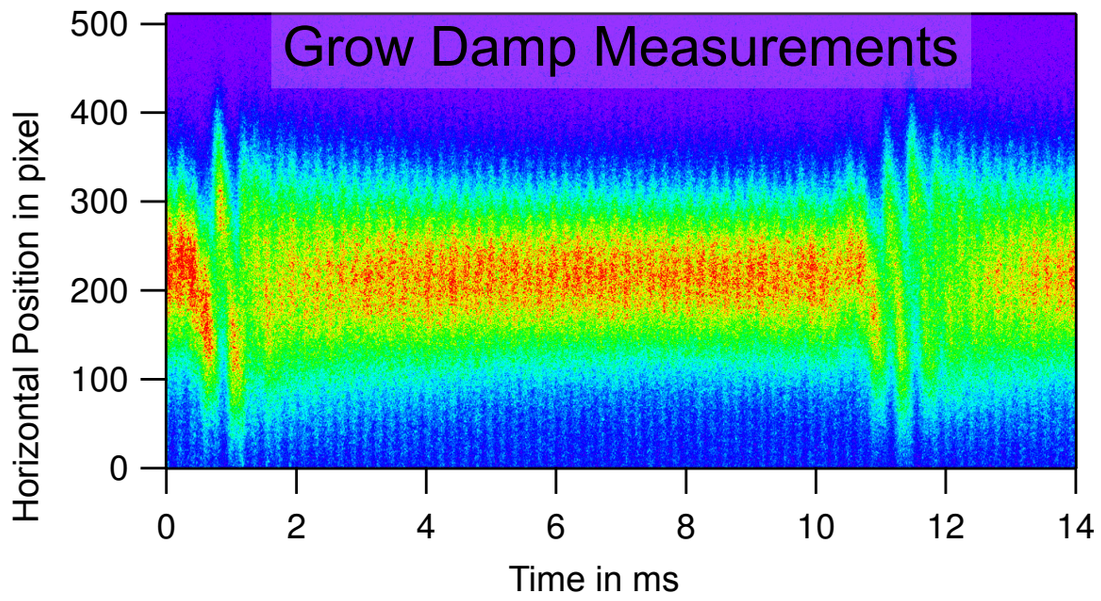


Courtesy of M. Holz, Y. Schön

Fast gated intensified camera

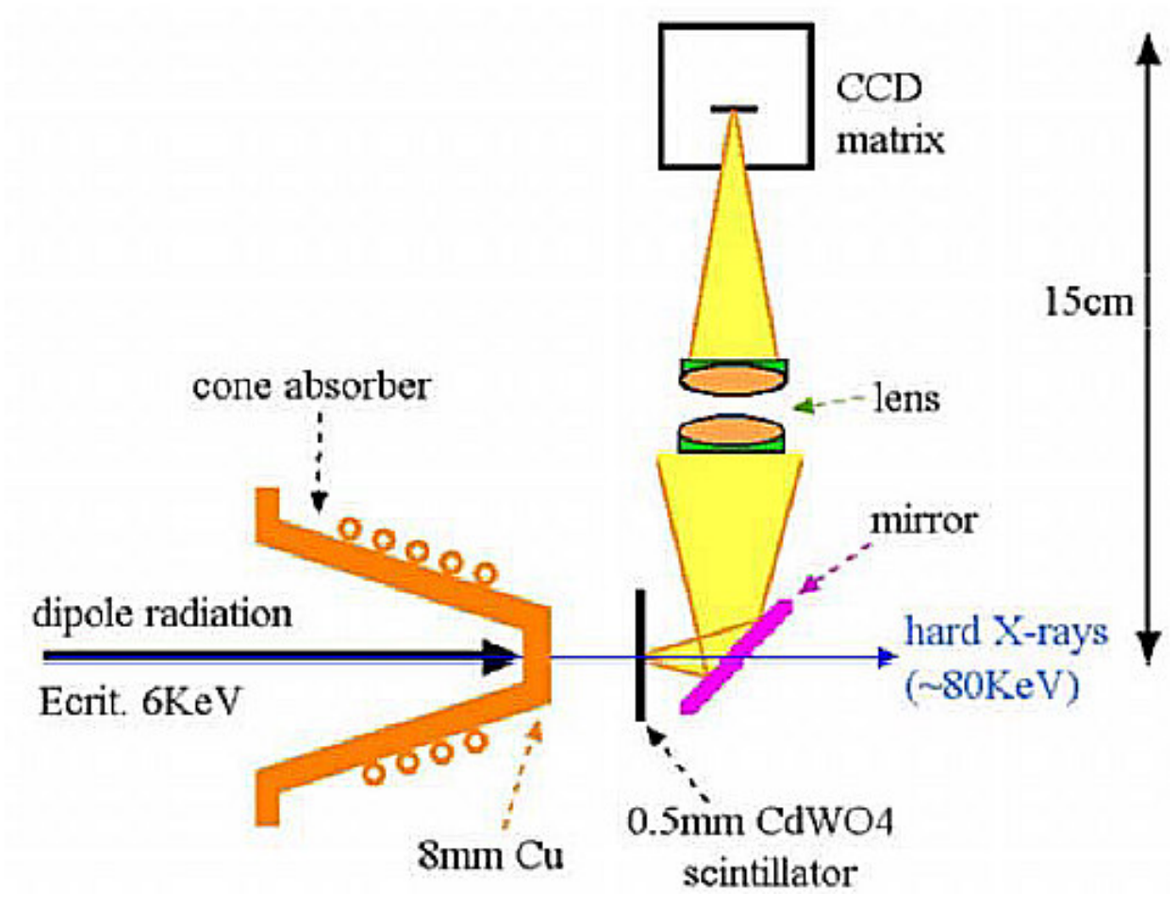
- **Task: Monitor size and position of a single bunch over consecutive revolutions in a multi-bunch environment.**
- Fast gated intensified camera:
  - Optical gate width < 2 ns
  - Maximum gate repetition rate of 500 kHz: Imaging of every 6th turn
- A rotating mirror deflects consecutive pulses to different positions on the sensor
- Acquire up to 100 slices
- Focusing optics optimized for horizontal plane

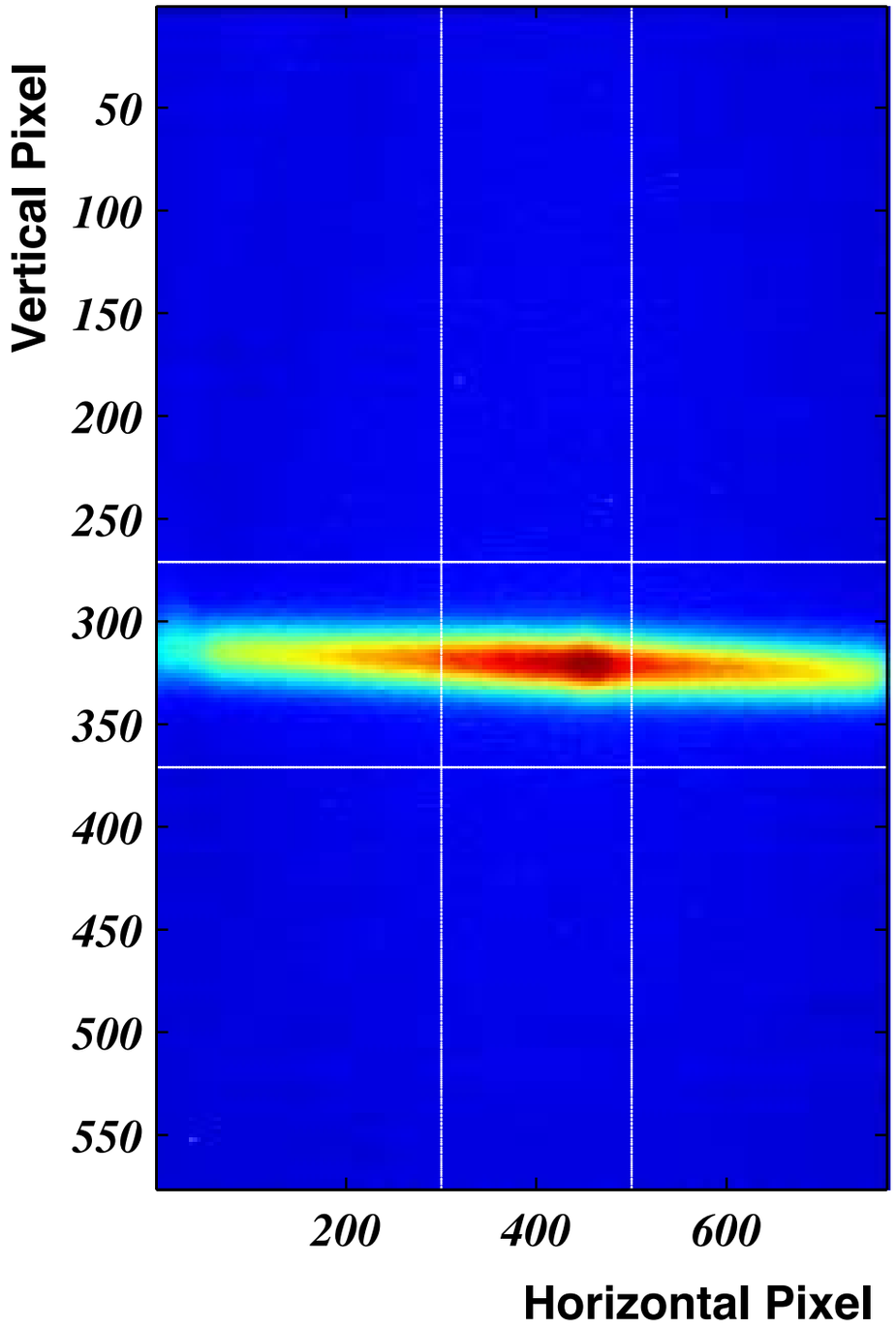




Courtesy of P. Schütze, B. Kehrer

DIAX


CCD
matrix
15cm
cone absorber
lens
mirror
dipole radiation
Ecrit. 6KeV
hard X-rays
(~80KeV)
8mm Cu
0.5mm CdWO4
scintillator


Vertical Pixel
50
100
150
200
250
300
350
400
450
500
550
200
400
600
Horizontal Pixel