Possible applications of MicroTCA at PETRA IV

Martin Tolkiehn

Deutsches Elektronen-Synchrotron
Ein Forschungszentrum der Helmholtz-Gemeinschaft

December 3, 2020

Outline

- Introduction — PETRA.IV
- Possible applications of MTCA.4
  - Data acquisition for energy dispersive detectors
  - Beam position monitoring

PETRA IV

Upgrade of PETRA III to a diffraction limited storage ring:

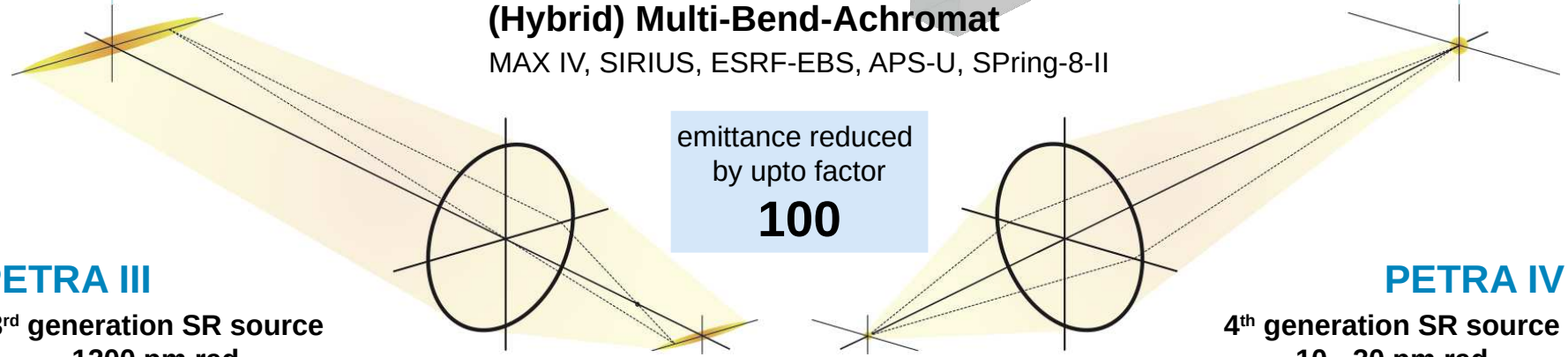
source size
& divergence:
155 µm x 6 µm
7.7 x 3.8 µrad²

extended & divergent X-ray beam

transformative technology:
(Hybrid) Multi-Bend-Achromat
MAX IV, SIRIUS, ESRF-EBS, APS-U, SPring-8-II

source size
& divergence:
11 µm x 3.2 µm
1.7 x 1.5 µrad²

small & collimated X-ray beam



emittance reduced
by upto factor
100

PETRA III

3rd generation SR source
1200 pm rad

Max. brightness: ~10^{21}
Coherence: ~0.1-1%

efficient nanometer focusing

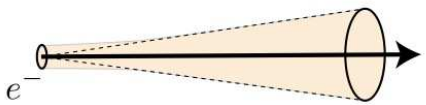
PETRA IV

4th generation SR source
10 - 30 pm rad

Max. brightness: ~10^{23}
Coherence: > 25%

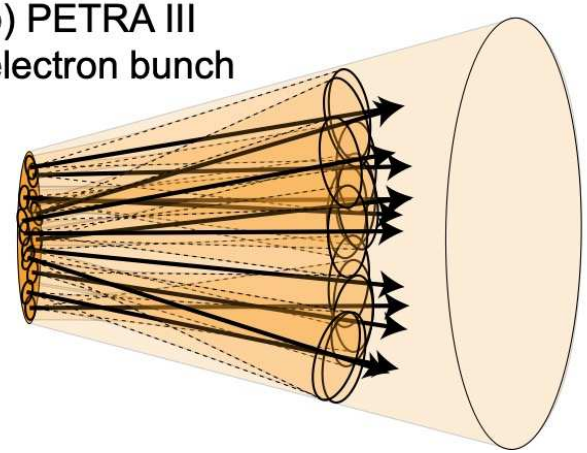
PETRA IV

a) single electron

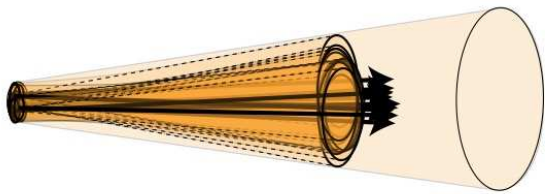


single-electron emission cone
(X-ray energy dependent)

b) PETRA III
electron bunch



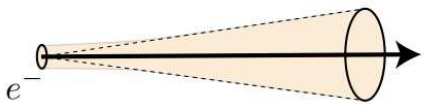
c) PETRA IV
electron bunch



divergence and size of
electron bunches comparable to
single-electron emission cone

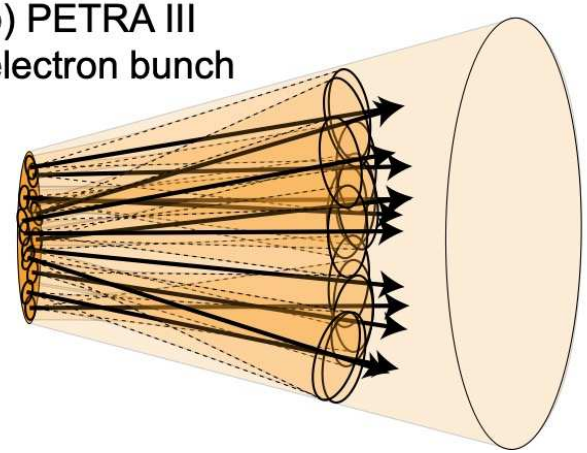
PETRA IV

a) single electron

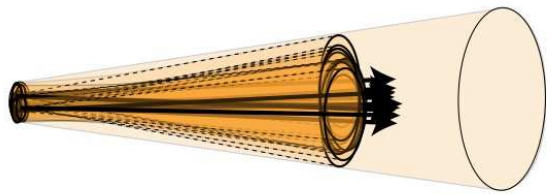


single-electron emission cone
(X-ray energy dependent)

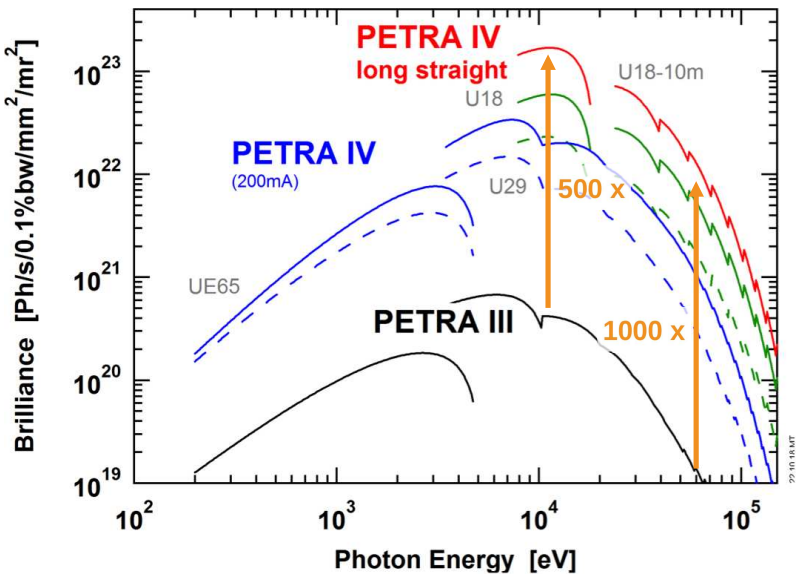
b) PETRA III
electron bunch



c) PETRA IV
electron bunch



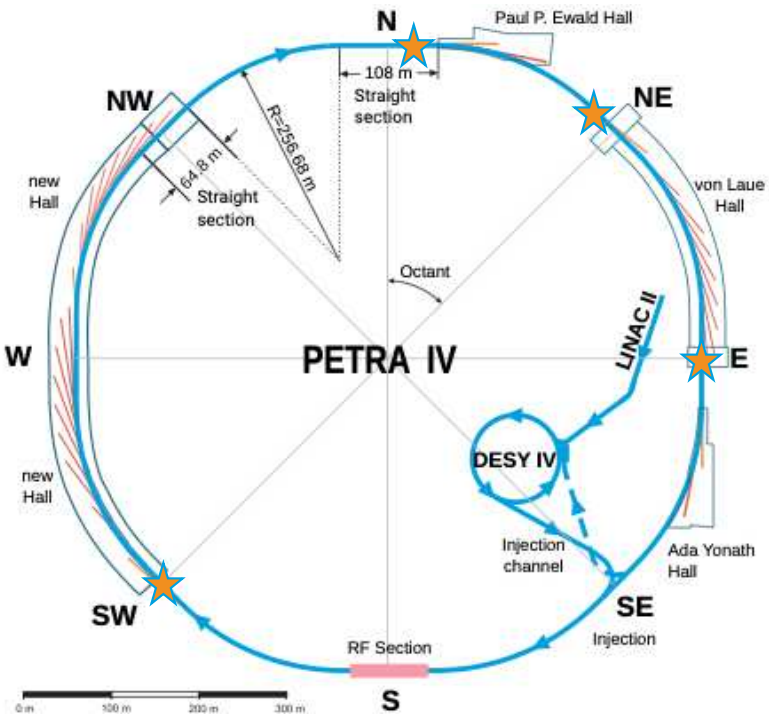
divergence and size of
electron bunches comparable to
single-electron emission cone



PETRA IV

Design lattice:

Hybrid 7 Bend Achromat (H7BA)
adopted from ESRF-EBS



On-Axis Injection using fast kickers

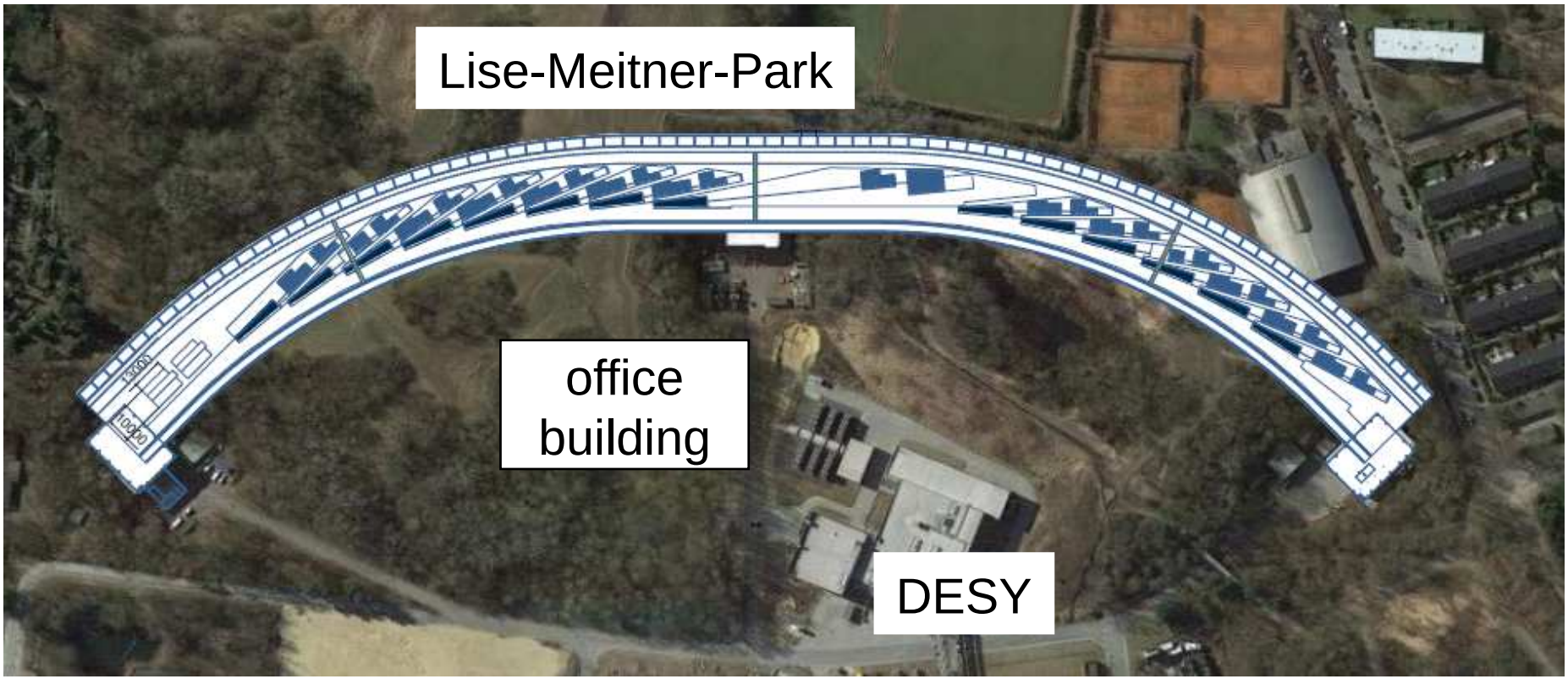
Optimised **insertion devices** in long straight sections

Main Parameters:

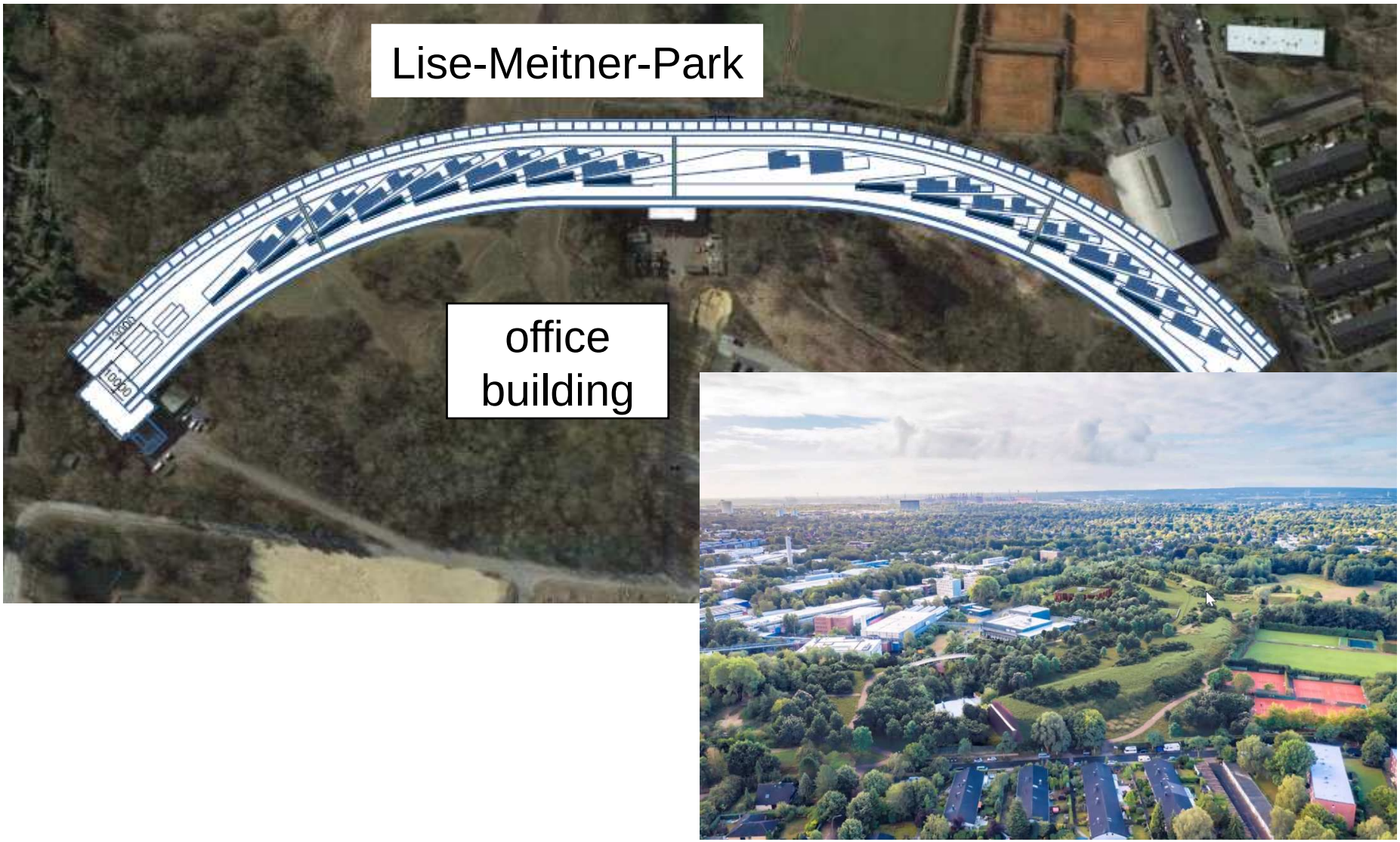
Design Parameters	high brightness	timing
Energy [GeV]	6	
Circumference [m]	2304	
Emittance (hor./vert.) [pm rad]	< 20 / 4	< 50 / 10
Total current [mA]	200	80
Number of Bunches	1600 = 80 x 20	80
Bunch population [10^{10}]	0.6	4.8
Bunch separation [ns]	4 + gaps (20)	96

C. G. Schroer, et al., JSR **25**, 1277 (2018).

PETRA IV – Place for new beamlines

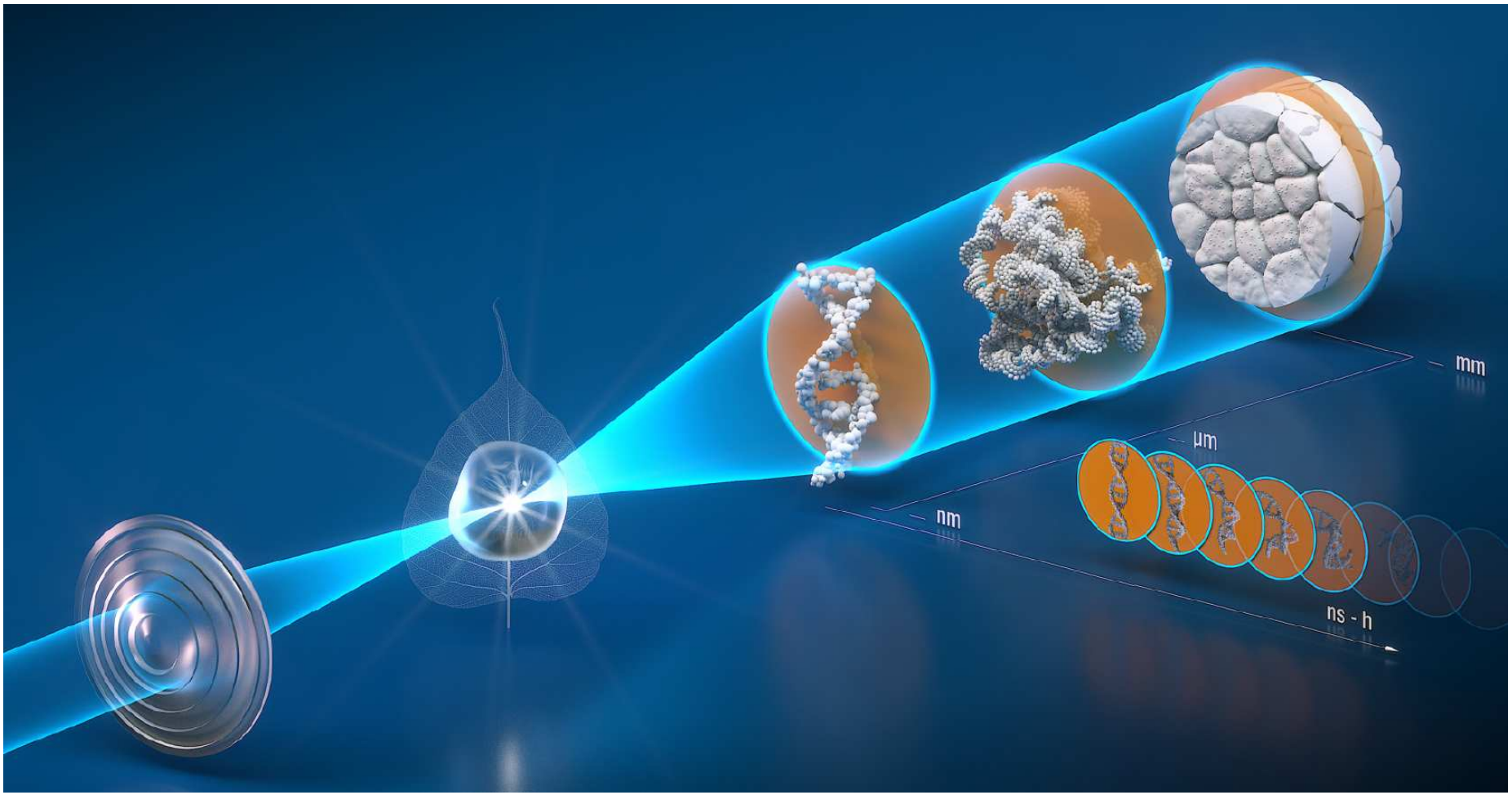


PETRA IV – Place for new beamlines



PETRA IV - The Ultimate 3D X-ray Microscope

Imaging of disordered samples with molecular resolution:



Images: O. Seeck, C. Schroer

Why MicroTCA?

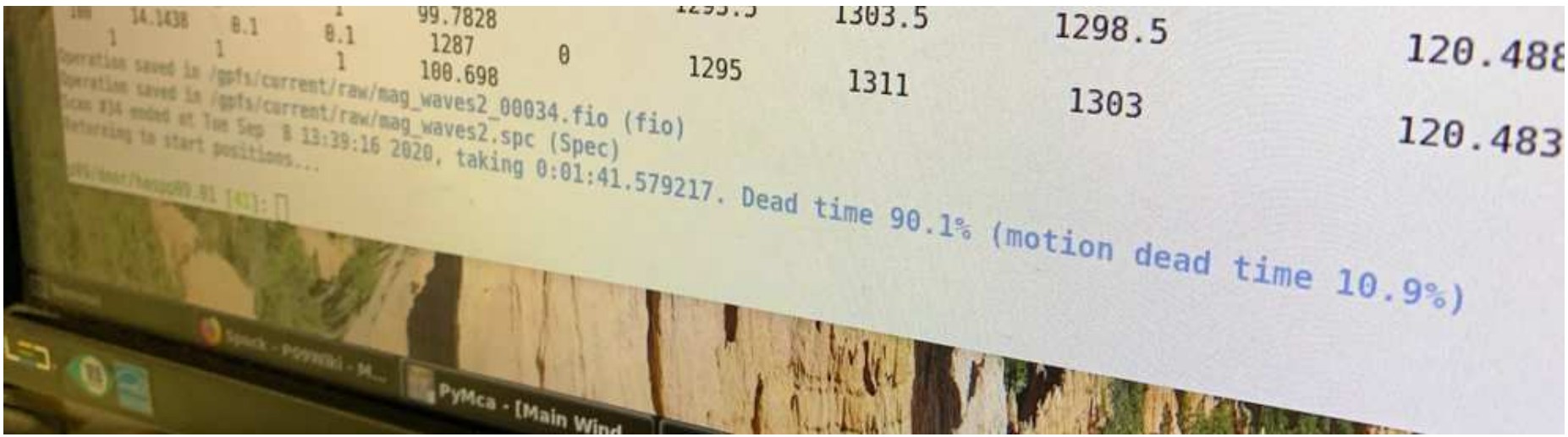
Petra IV will need:

- Real time data processing, data reduction
- Fast feedback systems, e.g. for beam stabilization
- Fast, efficient data acquisition
- On-the-fly scanning

Why MicroTCA?

Petra IV will need:

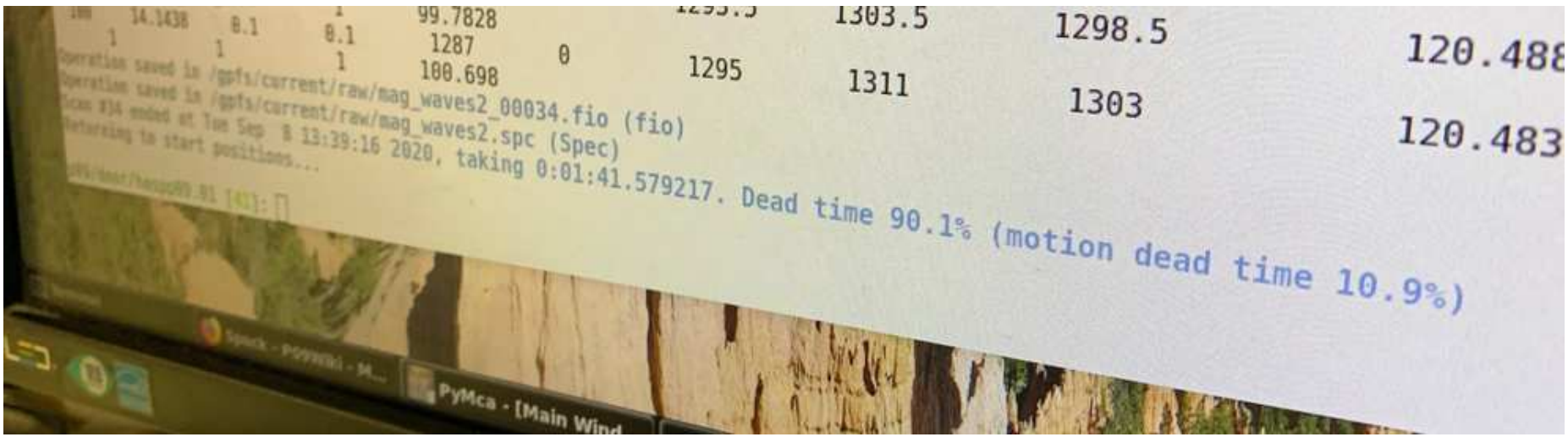
- Real time data processing, data reduction
- Fast feedback systems, e.g. for beam stabilization
- Fast, efficient data acquisition
- On-the-fly scanning



Why MicroTCA?

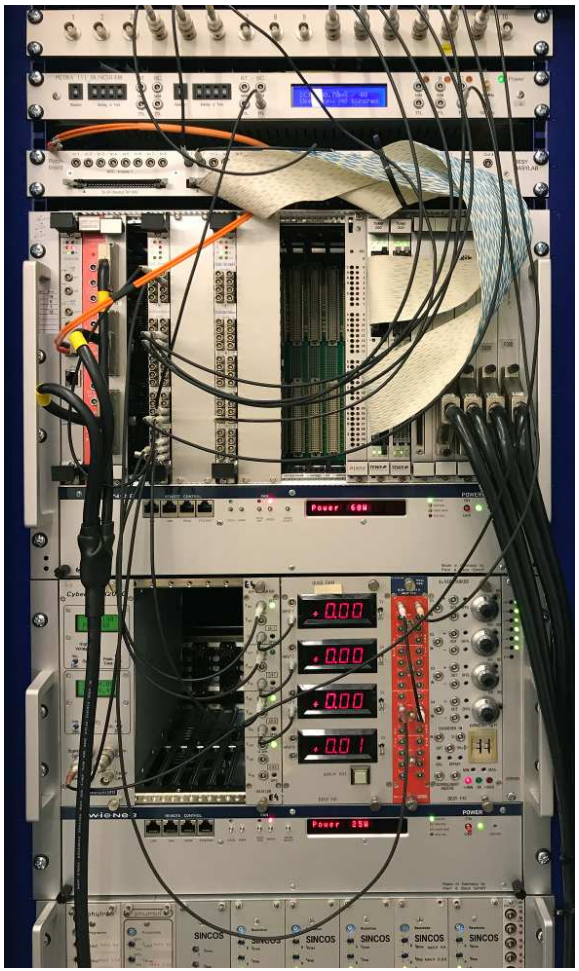
Petra IV will need:

- Real time data processing, data reduction
- Fast feedback systems, e.g. for beam stabilization
- Fast, efficient data acquisition
- On-the-fly scanning



This picture was NOT taken at P24!

Upgrade of control and data acquisition electronics



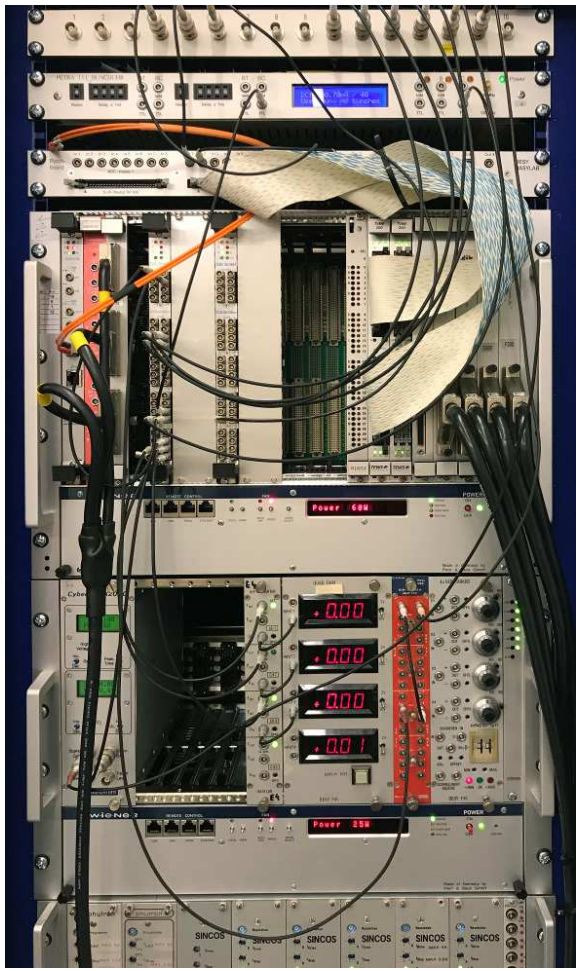
PETRA III
VME and NIM

$\Longrightarrow$

Beam position monitor,
HV source

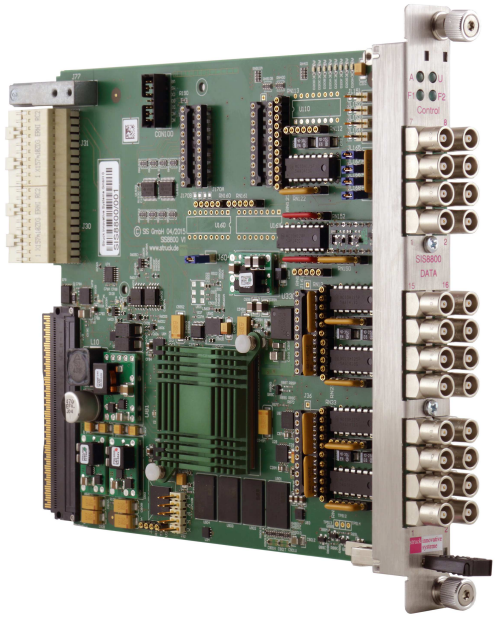
PETRA IV
MTCA.4

Upgrade of control and data acquisition electronics



PETRA III
VME and NIM

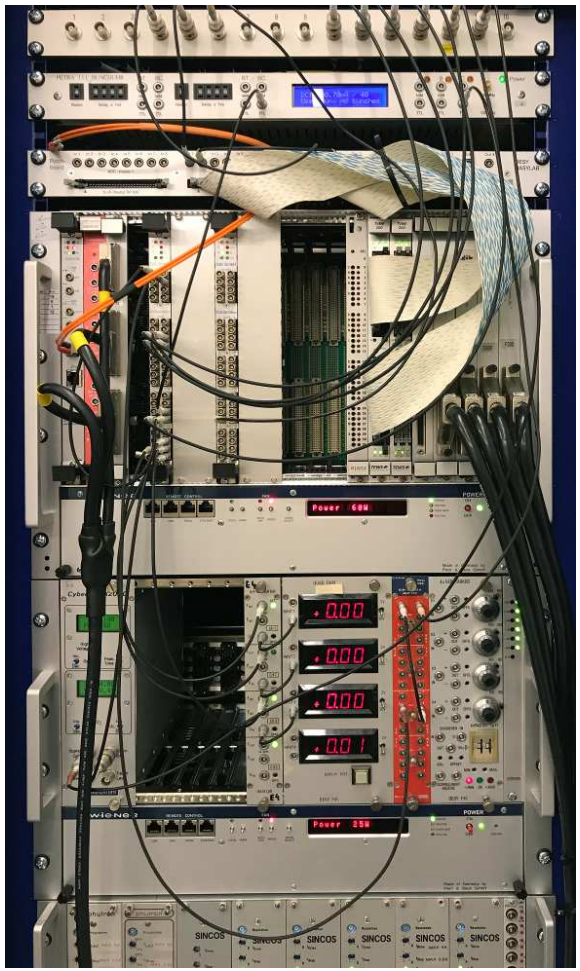
$\Longrightarrow$



SIS8800 counter AMC

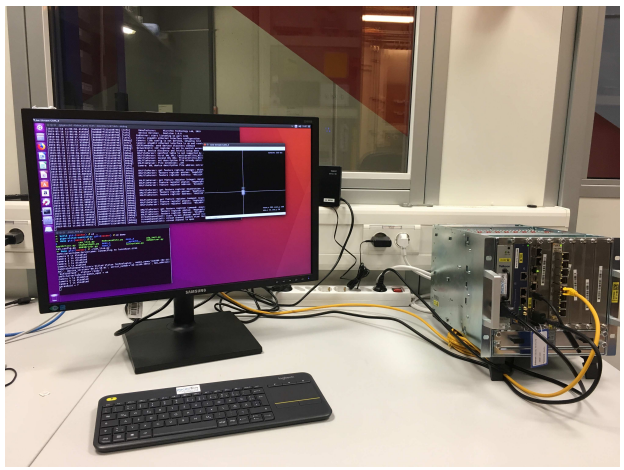
PETRA IV
MTCA.4

Upgrade of control and data acquisition electronics



PETRA III
VME and NIM

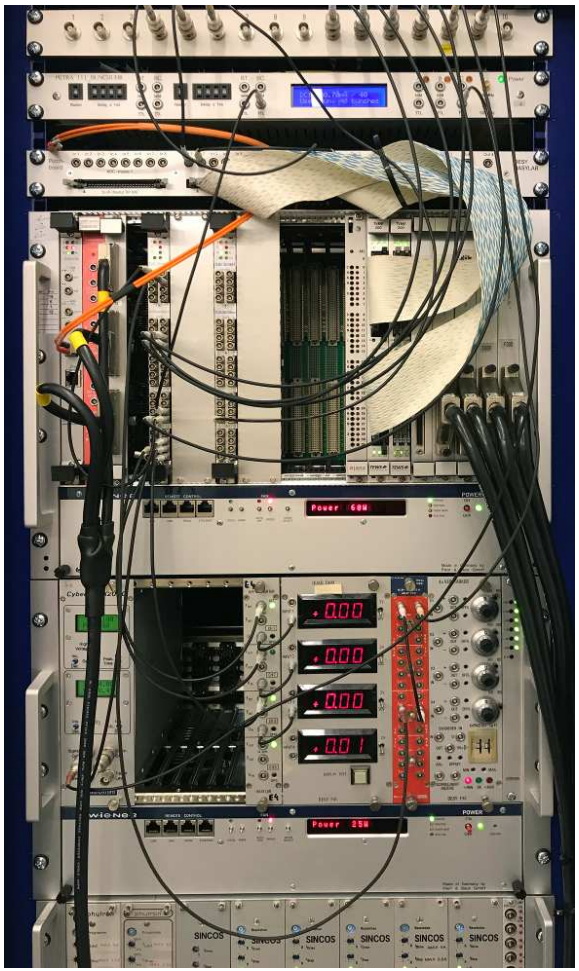
$\Longrightarrow$



TCK7, BLICK
BeamLine Instrumentation Camera Kit

PETRA IV
MTCA.4

Upgrade of control and data acquisition electronics



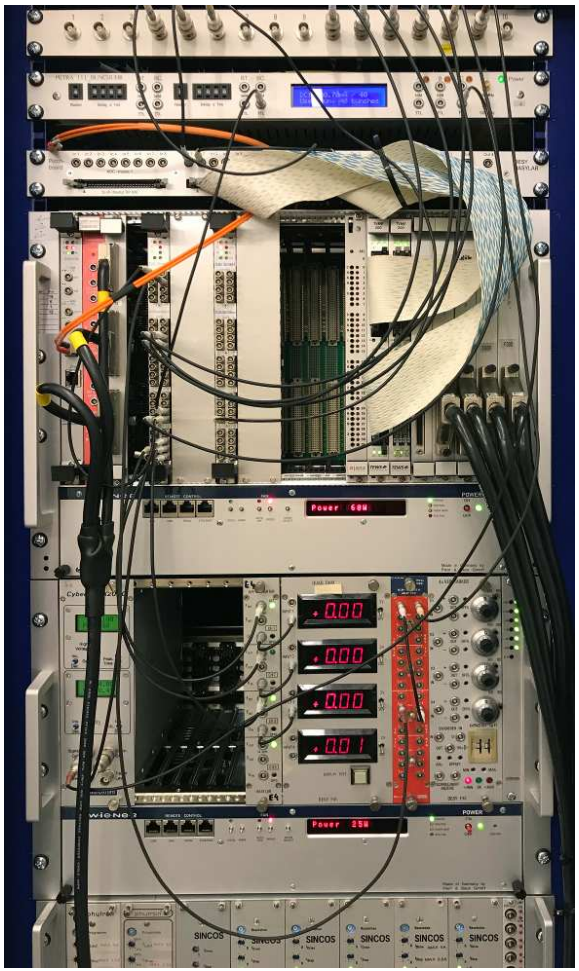
$\Longrightarrow$

Motor controller
Talk by Nikola Radakovic

PETRA III
VME and NIM

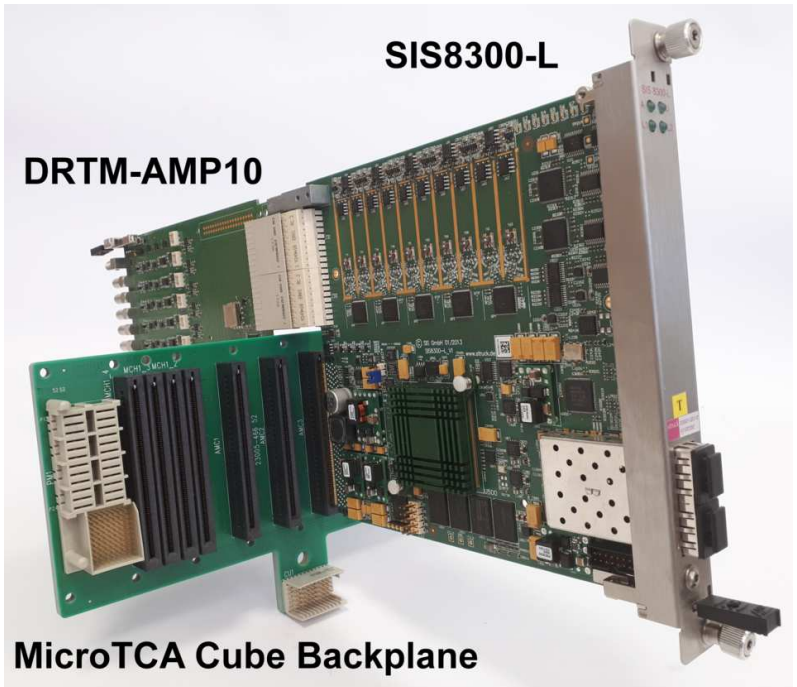
PETRA IV
MTCA.4

Upgrade of control and data acquisition electronics



PETRA III
VME and NIM

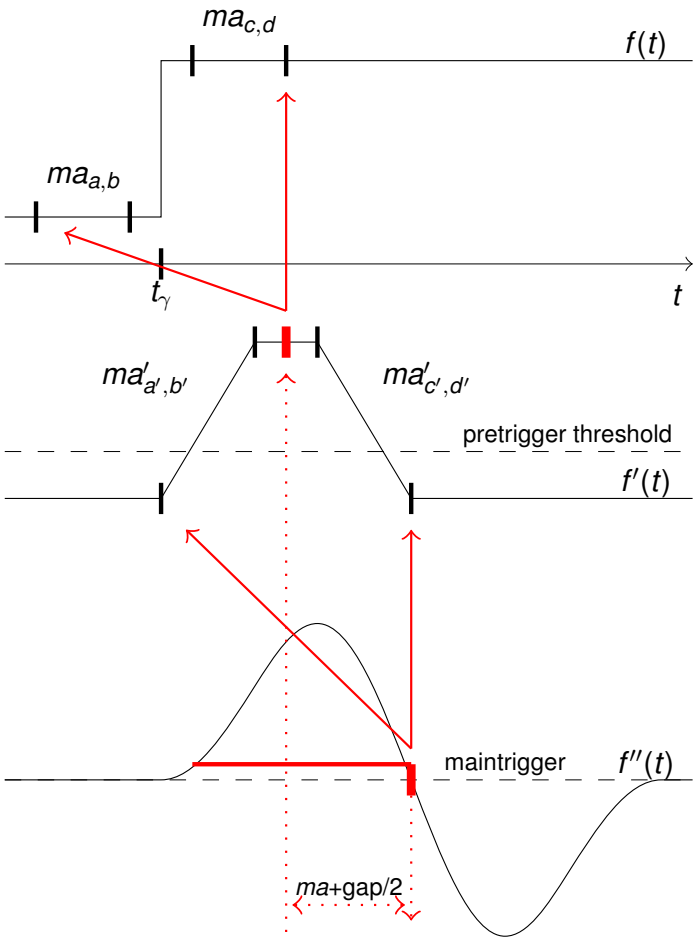
$\Longrightarrow$

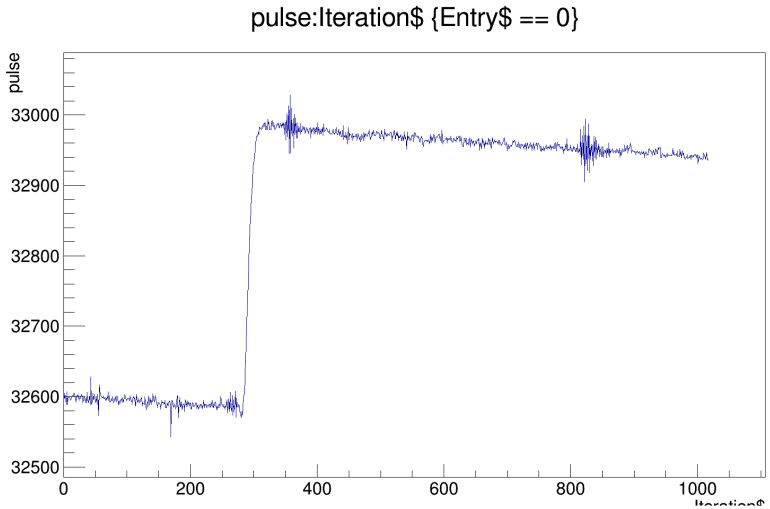


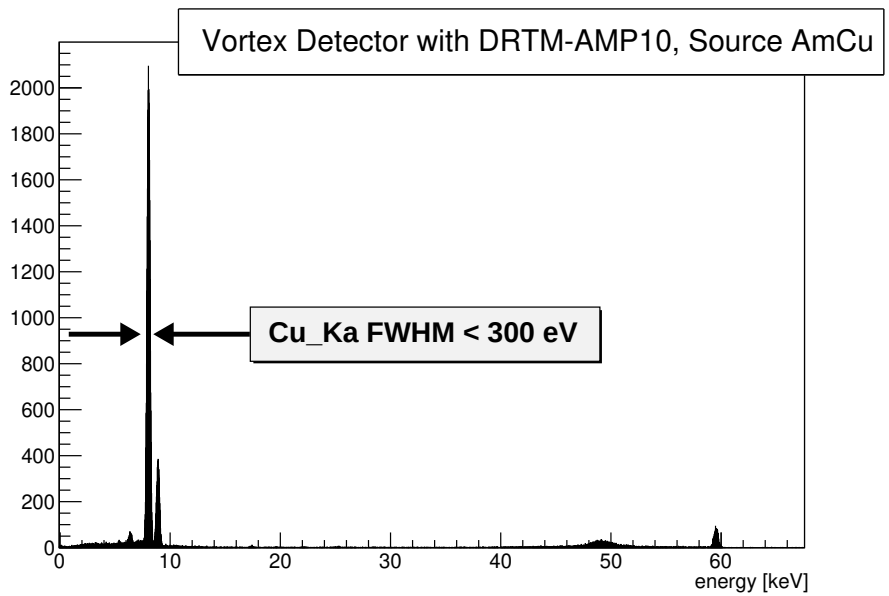
SIS8300-L and DRTM-AMP10
Gamma spectroscopy firmware

PETRA IV
MTCA.4

Struck SIS8300 with Gamma Firmware







Developed in collaboration with DESY-MSK, J. Timm

Fast feedback system

Building blocks:

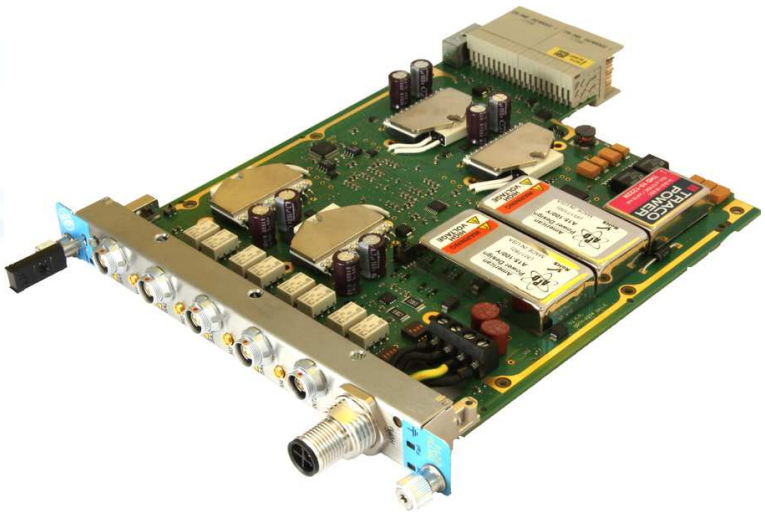
FMC

PICO-1M4,
2SFP+

AMC

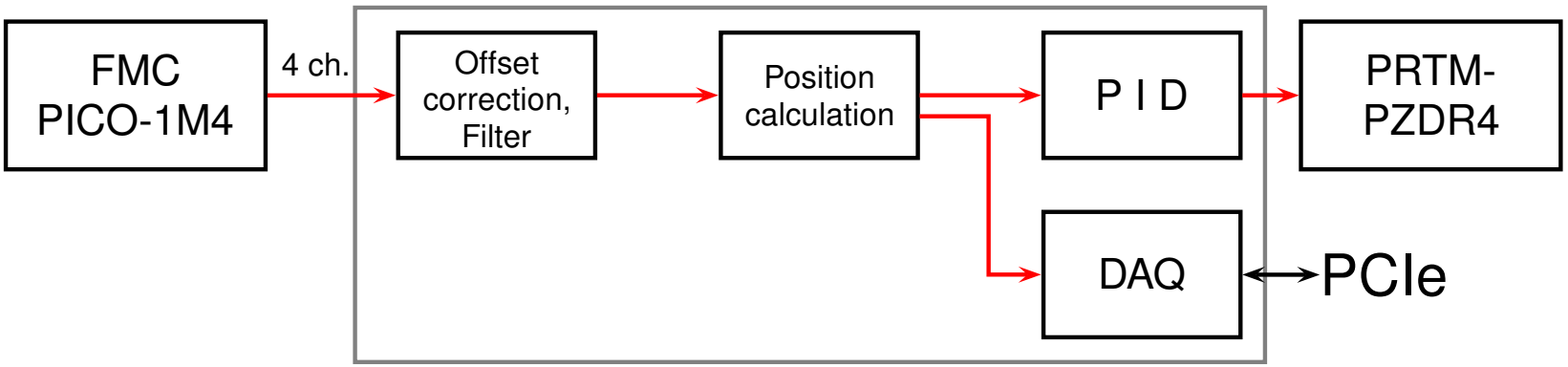
DAMC-FMC25

RTM

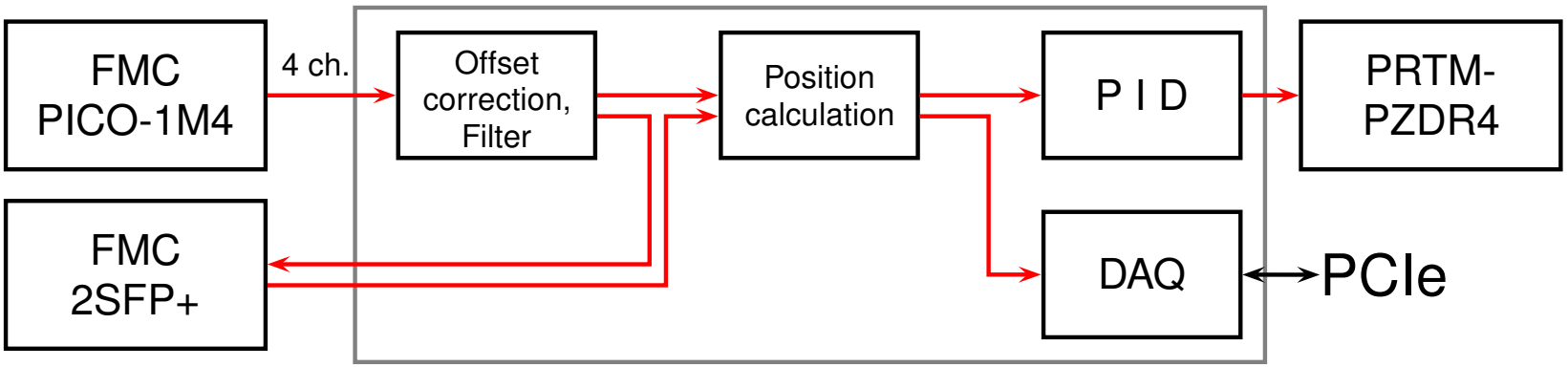


PRTM-PZDR4

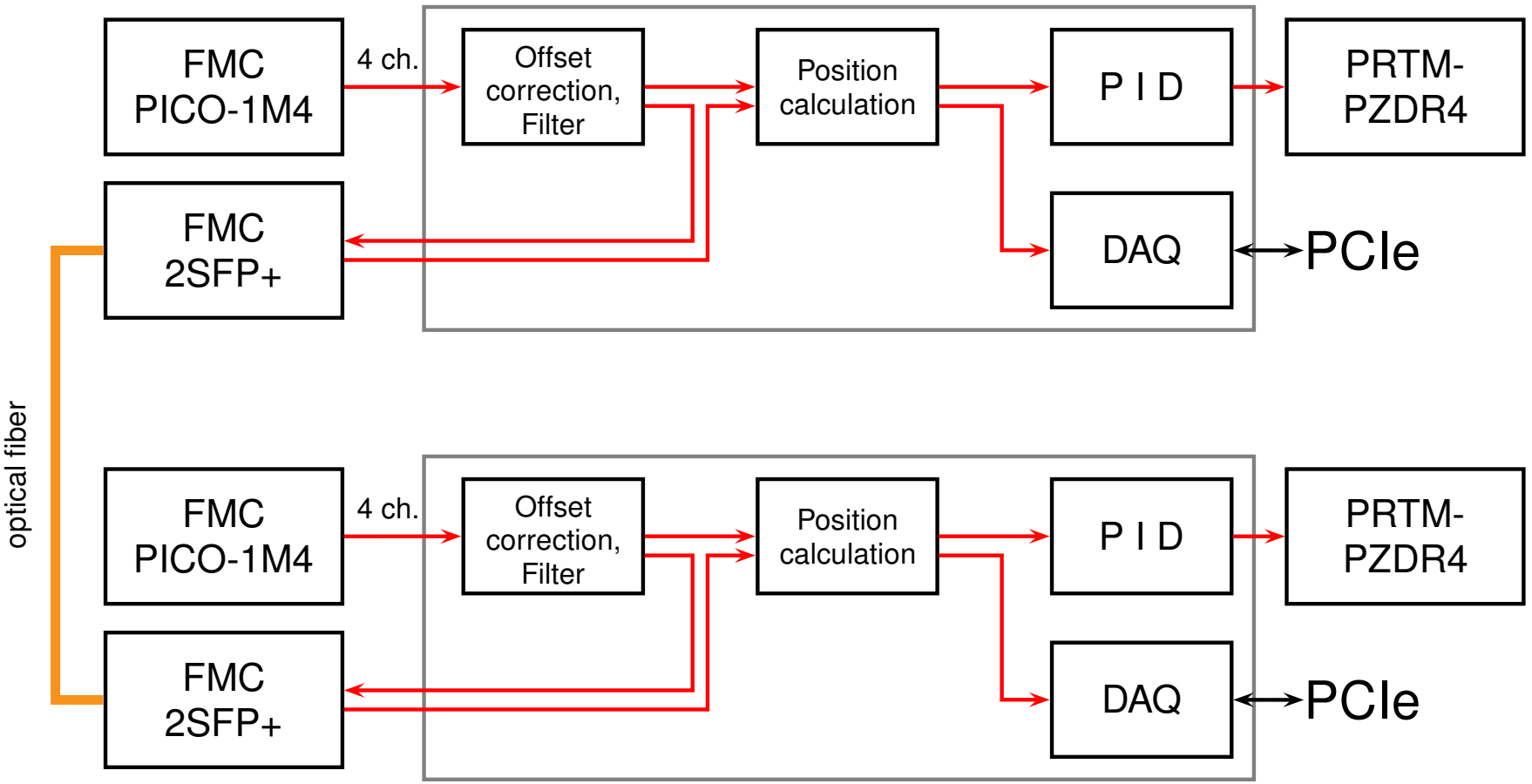
Fast feedback system



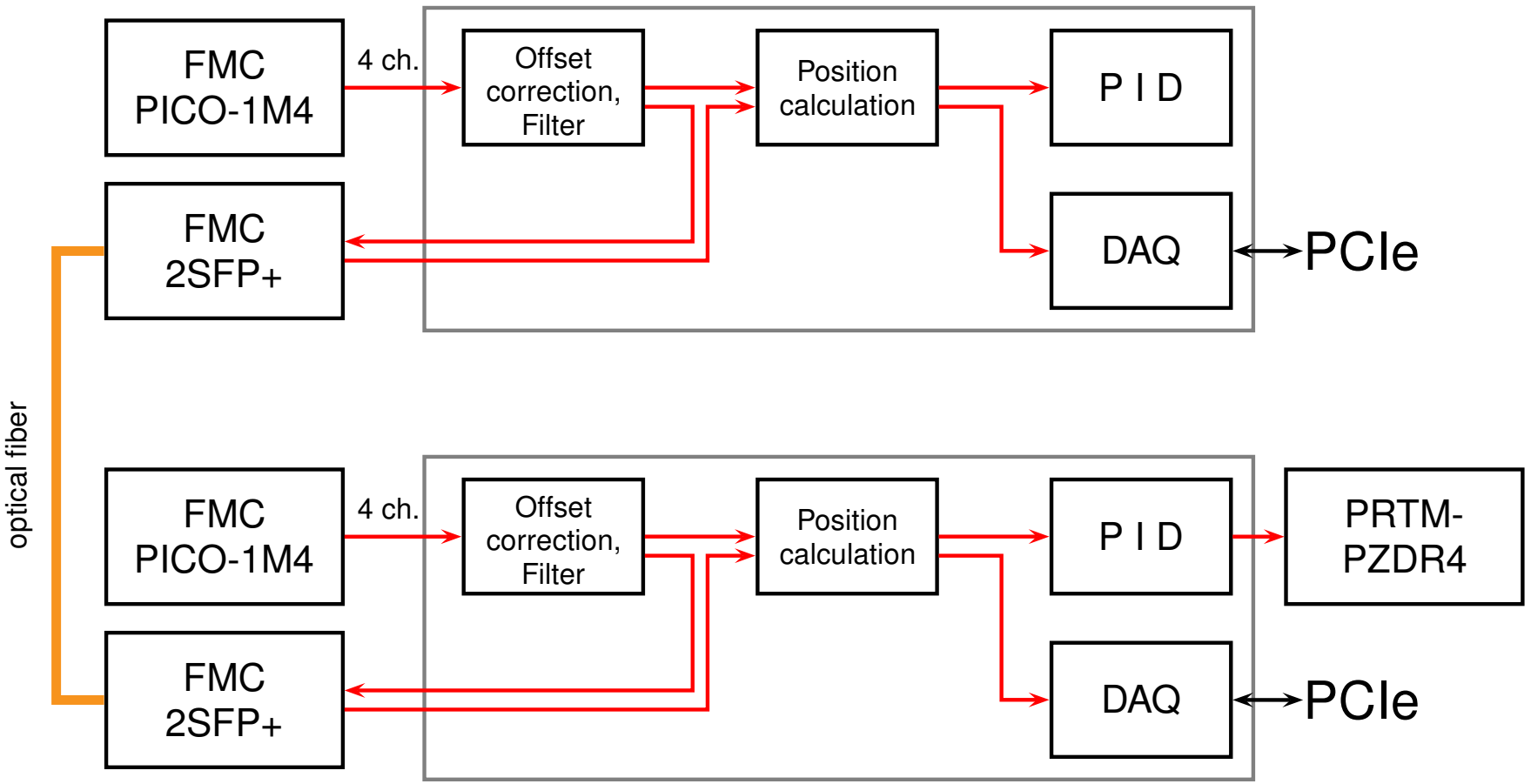
Fast feedback system



Fast feedback system



Fast feedback system



FPGA firmware is based on MSK firmware framework.

Test at P24

Was planned for spring 2020, but. . .

Test in the lab

Test in the lab

Thank you for your attention!