

MicroTCA for photon science experiments

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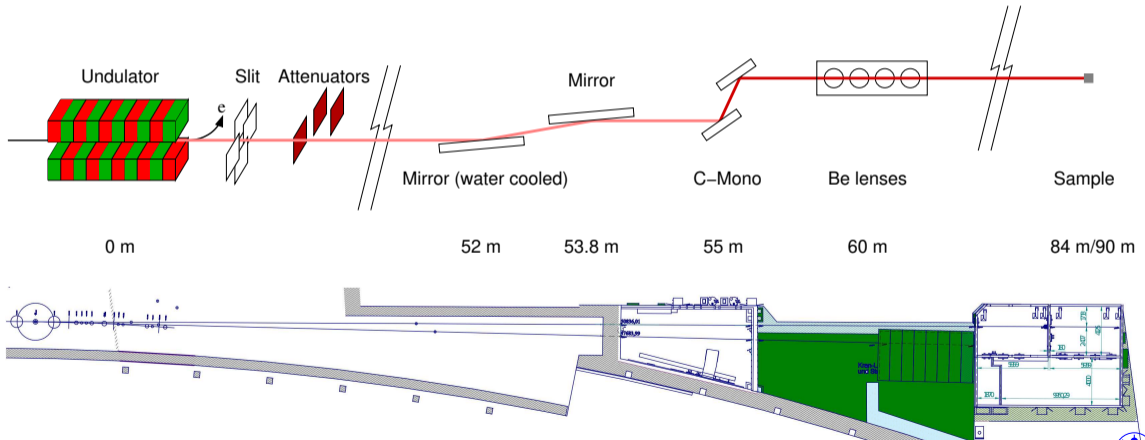
August 24, 2021



- ▶ Introduction — PETRA.IV
- ▶ Possible applications of MTCA.4
 - ▶ Data acquisition for energy dispersive detectors
 - ▶ Motion control

Beamline P24

- ▶ Chemical crystallography beamline, PETRA extension
- ▶ 2 Experimental stations at 84m and 90m
- ▶ Optical elements at 55 ± 5 m

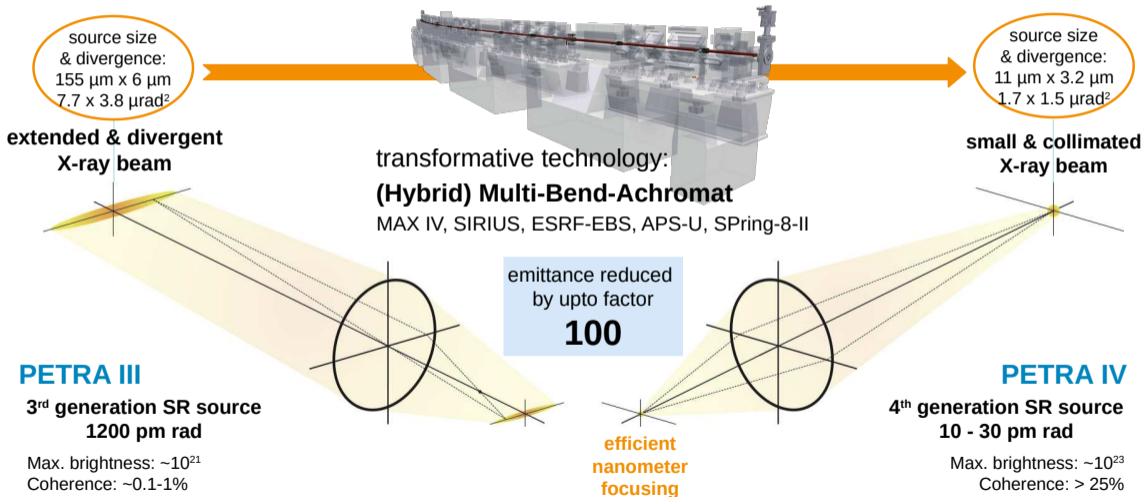


P24 under construction (in early 2017)



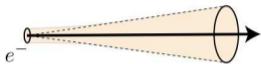
PETRA IV

Upgrade of PETRA III to a diffraction limited storage ring:



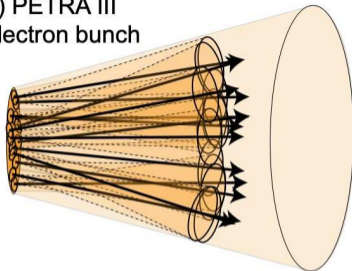
PETRA IV

a) single electron

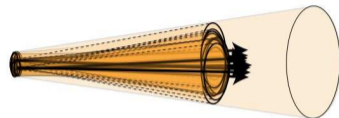


single-electron emission cone
(X-ray energy dependent)

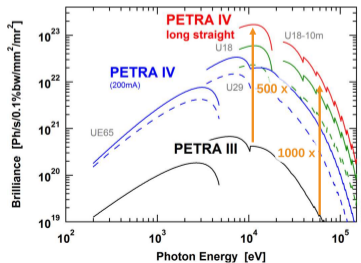
b) PETRA III
electron bunch



c) PETRA IV
electron bunch



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

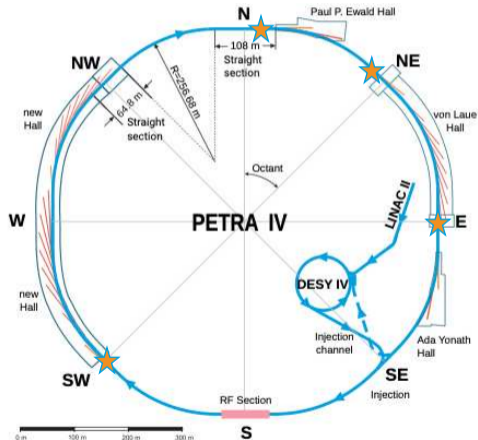


PETRA IV

Design lattice:

Hybrid 7 Bend Achromat (H7BA)

adopted from ESRF-EBS



On-Axis Injection using fast kickers

Optimised **insertion devices** in long straight sections

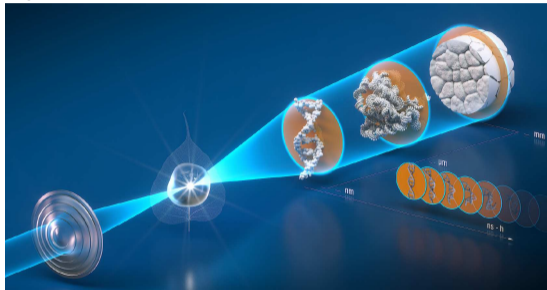
Main Parameters:

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 - The Ultimate 3D X-ray Microscope

Imaging of disordered samples with molecular resolution:

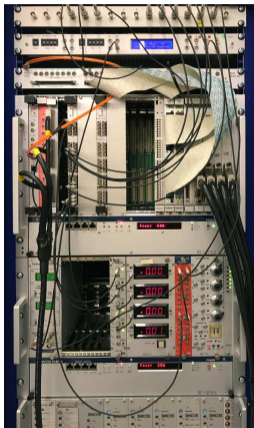


Images: O. Seeck, C. Schroer

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 \Rightarrow modern motion control with fast synchronization

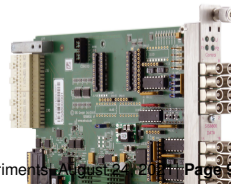
Upgrade of control and data acquisition electronics



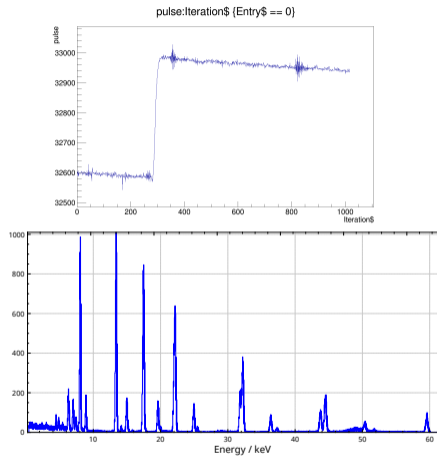
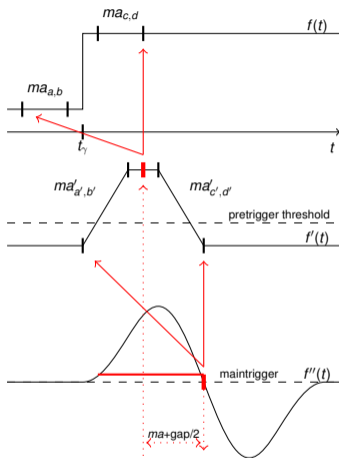
PETRA III
VME and NIM



Beam position monitor,



Struck SIS8300 with Gamma Firmware

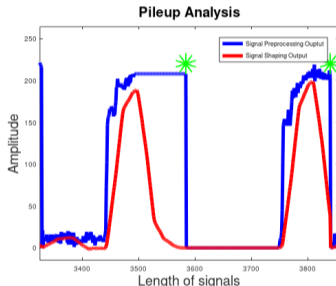
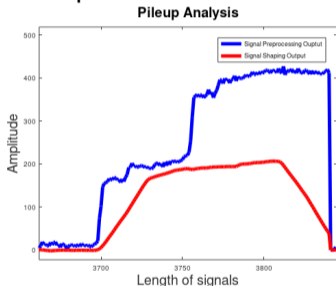


122eV FWHM at 5.4keV, shaping time 560ns

Developed in collaboration with DESY-MSK, Jan Timm

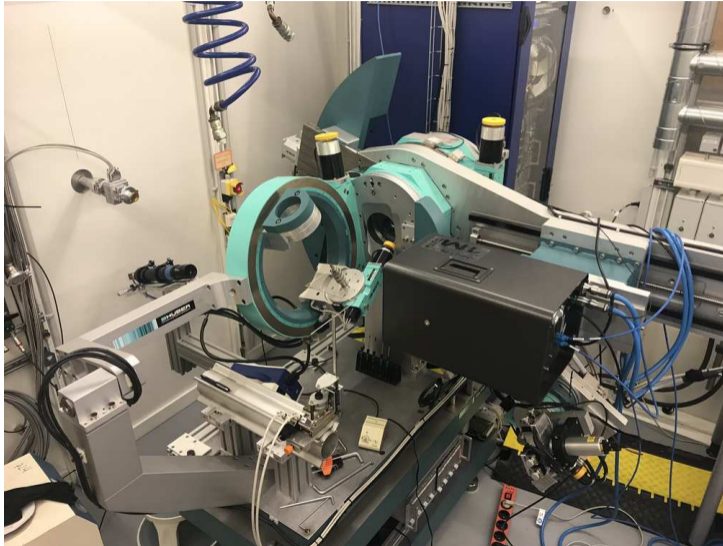
PhD thesis of Sarmad Adeel:

- ▶ Pile up correction



- ▶ Faster filtering algorithms, shaping times $<300\text{ns}$, FWHM $<155\text{eV}$
- ▶ Support of SIS8300-KU with new MSK firmware framework (in progress...)

Motion control: Four circle diffractometer at P24



- ▶ Everything is motorized!
- ▶ Synchronous motion
- ▶ Scan speed $10^\circ/s$
- ▶ Synchronization of Detectors with μs precision

Motion control: Current PETRA III solution



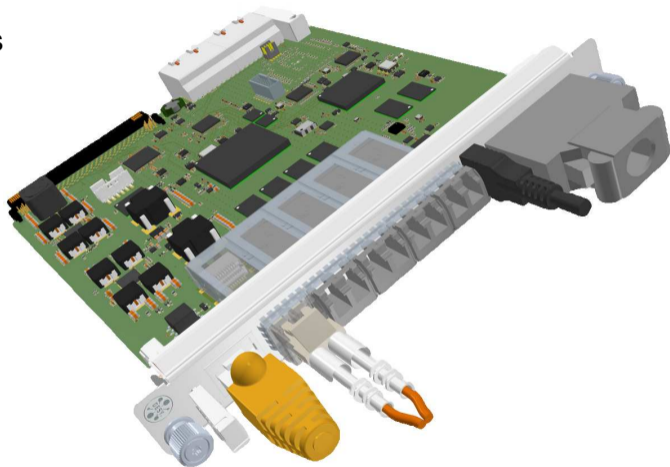
- ▶ VME based motion controller (OMS MAXv):



- ▶ Phytron ZMX motor drivers in home made crates
- ▶ 2 OMS cards per ZMX crate (16 motors) needed
- ▶ Synchronization and on-the-fly scans limited

The PETRA IV solution based on MTCA.4

- ▶ 16 axes per card
- ▶ Synchronization of many cards
- ▶ Triggering via MLVDS
- ▶ Compatible with ZMX
- ▶ Support of modern drivers via EtherCAT, Sercos...
- ▶ Compatible with existing software
- ▶ Prototype will be ready soon!



Old VME electronics can be replaced by MTCA:

- ▶ Different types of ADCs are available
- ▶ Photon counting
- ▶ Motor controller is in development
- ▶ Much more: Camera interface, GPIO, DACs, Piezo controller, beam stabilization. . .

Thanks:

- ▶ J. Timm, S. Adeel, M. Kamiński
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- ▶ H. Schlarb
- ▶ DESY-ITT (Funding)