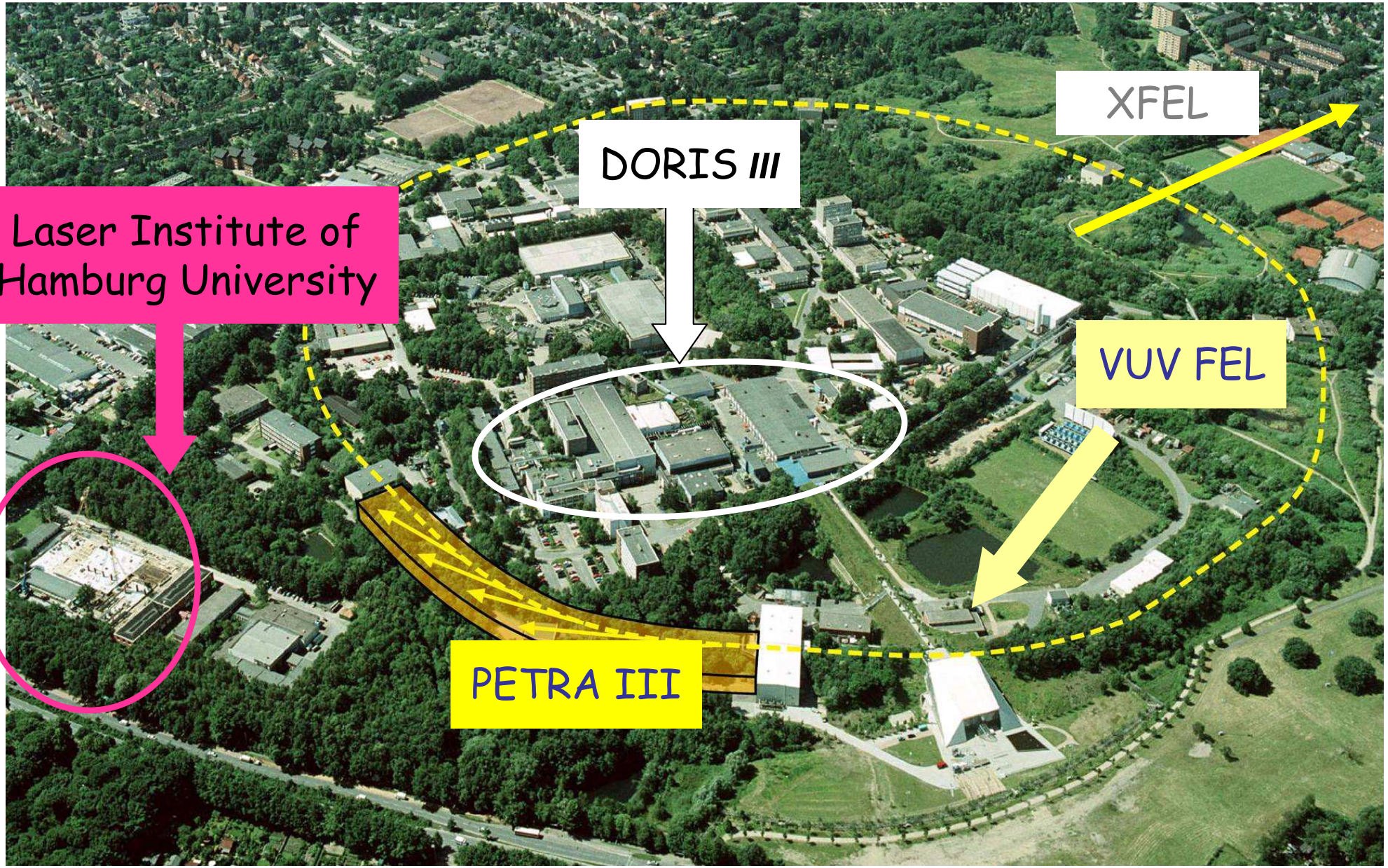
PETRA III,
A New High Brilliant Light Source
At
DESY

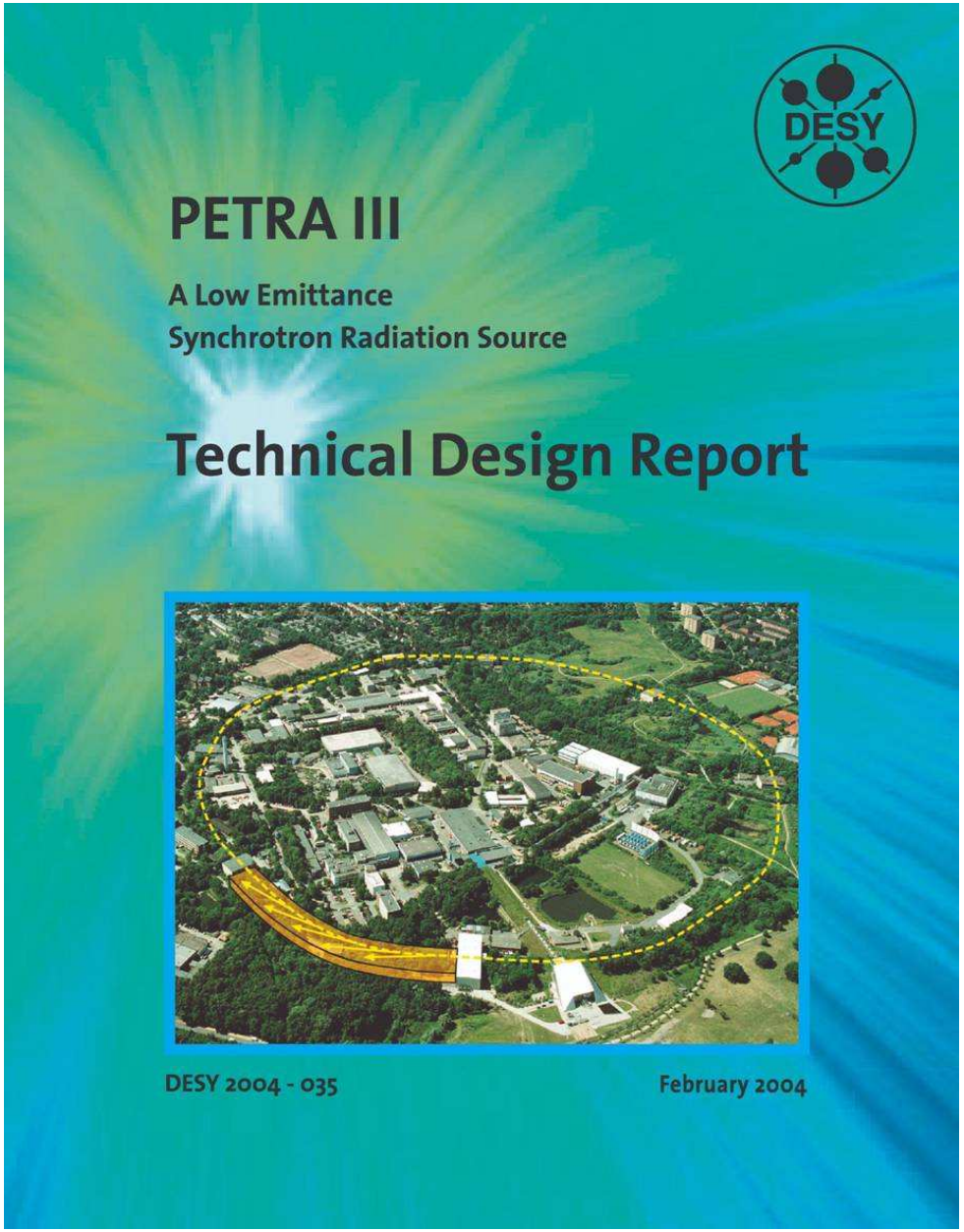
Outline

- Objectives & Key parameters
- Conversion of PETRA II into PETRA III
- Commissioning Results
- Summary

Projects & Plans



PETRA III



Parameters:

- circumference: 2304 m
- energy: 6 GeV

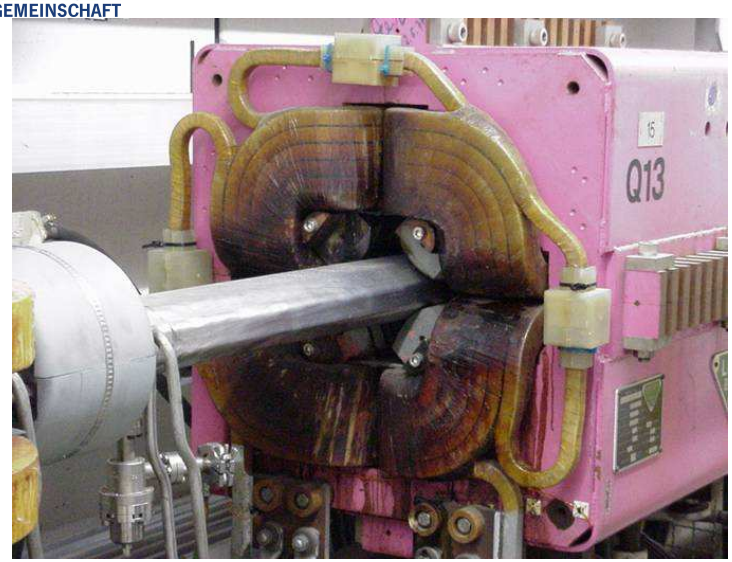
- emittance: 1 nmrad
- emittance coup.: 1% (10 pmrad!)

- current: 100 (200) mA
- # bunches 40 / 960

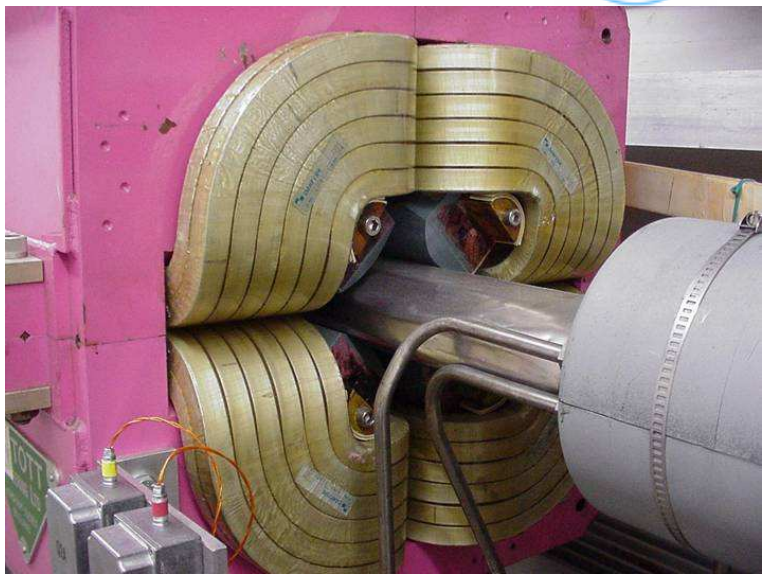
- straight sections: 9
- undulators: 14
- undulator length: 2, 5, 10 (20) m

- supplement to X-FEL
- ➔ cost effective!

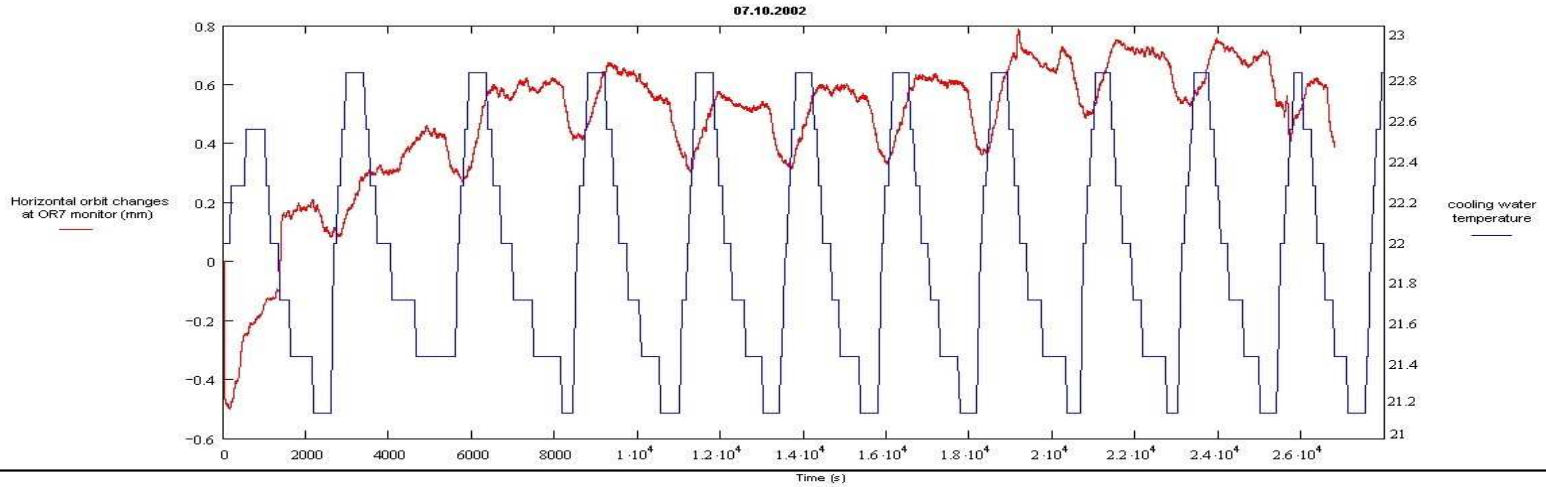
PETRA III
Modernization & refurbishment



New coils



New cooling



New power supplies, new control system, new vacuum system,...

Installation in old octants

Installation of new water pipes

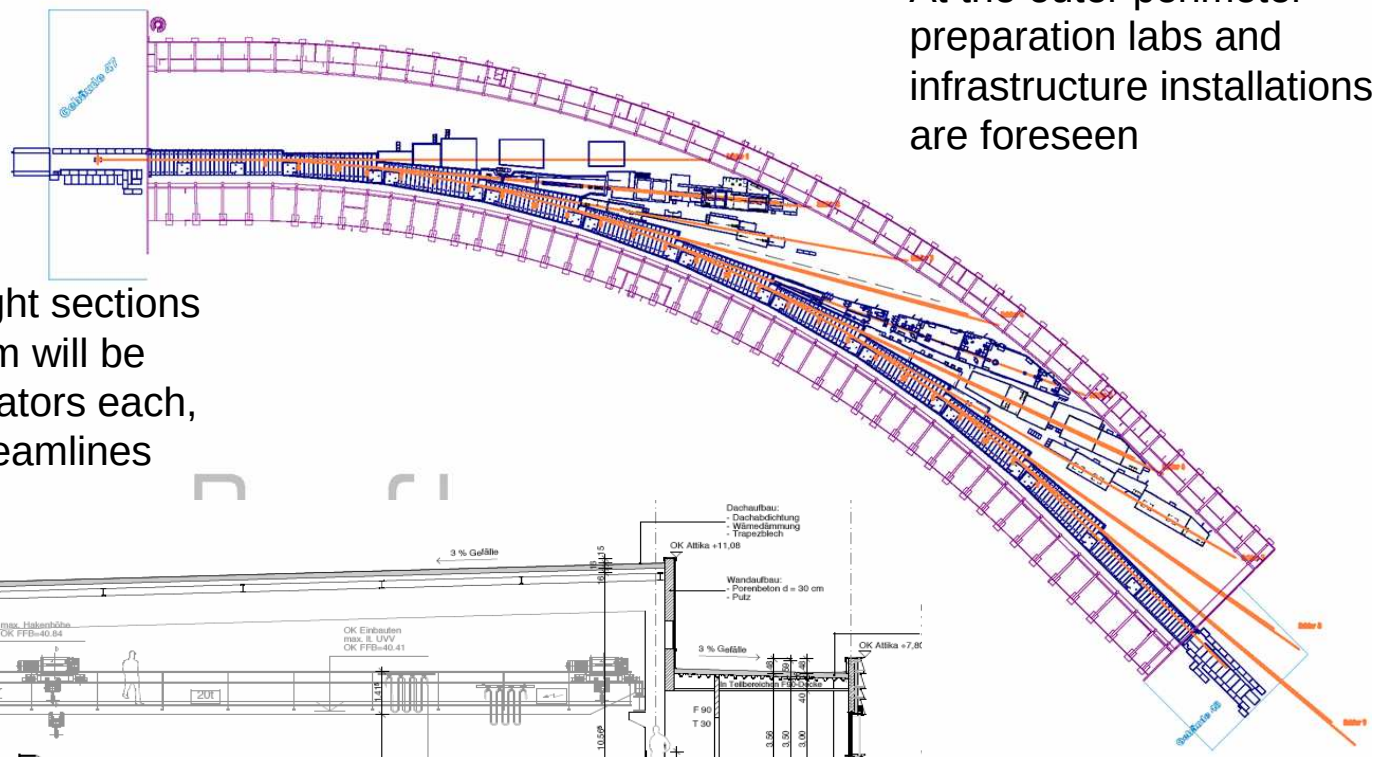
Installation of refurbished dipoles
Including vacuum chamber…

Installation of Quadrupoles, Sextupoles & Vacuum chambers
Start: 19.11 …

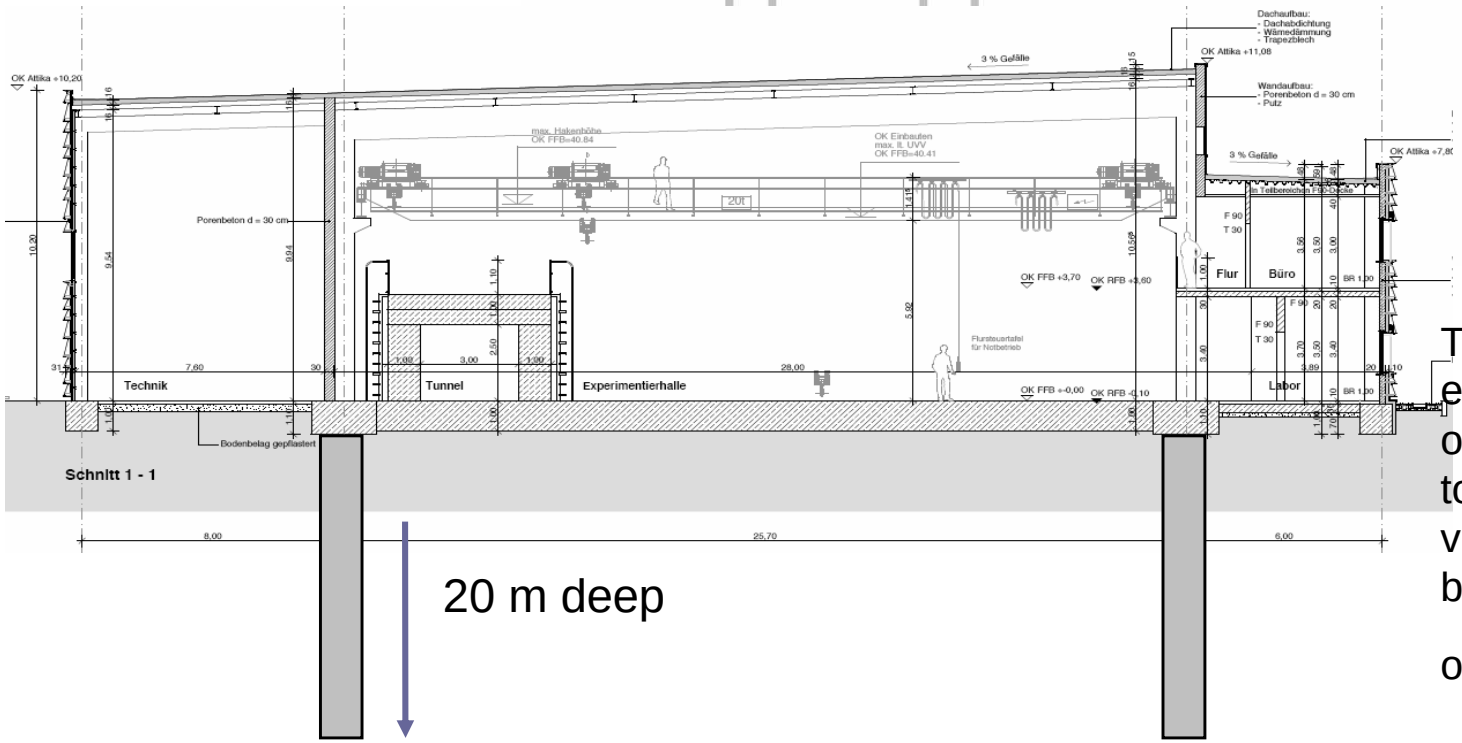
Installation finished middle of 2008

Layout of the new hall

At the outer perimeter preparation labs and infrastructure installations are foreseen



PETRA III will provide 9 straight sections for insertion devices. 5 of them will be equipped with 2 canted undulators each, resulting in 14 independent beamlines



The ring tunnel and the experimental floor are founded on a **1 m thick slab of concrete** to minimize vibrations. For vibrational decoupling, the builiding superstructere rests

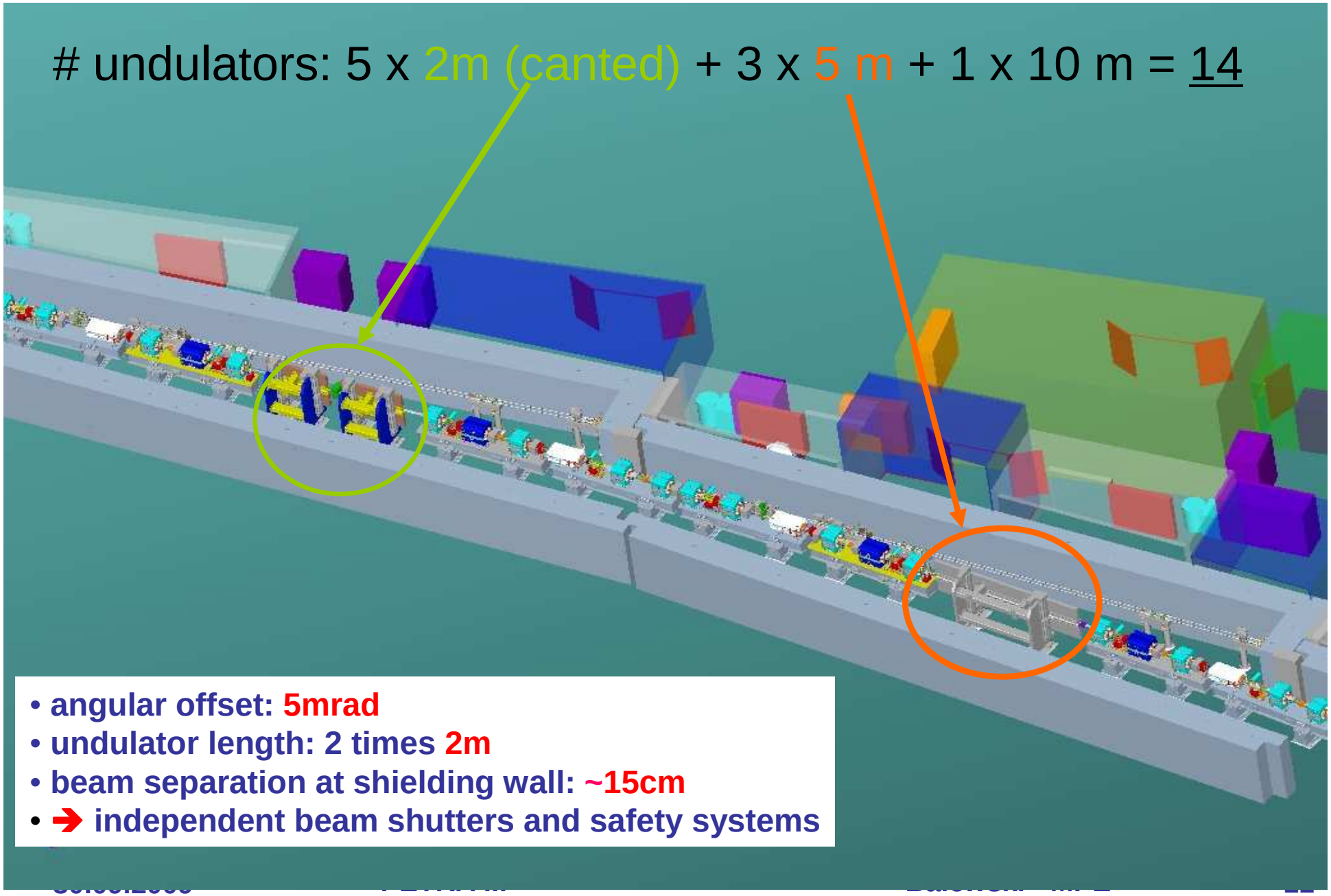
on **20 m long sleeved piles**

New Experimental Hall

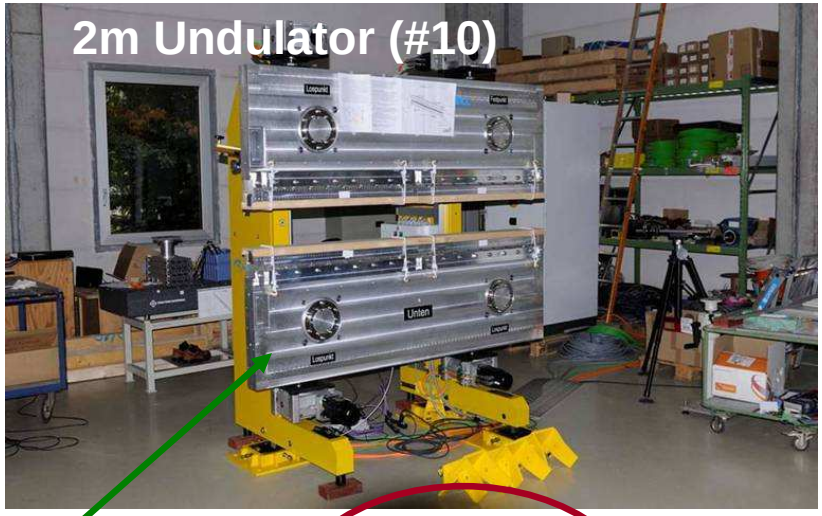
Building of the concrete slab

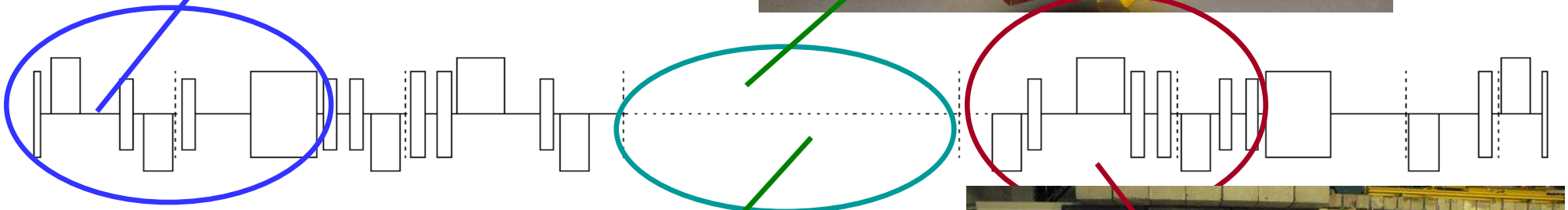
New Experimental Hall

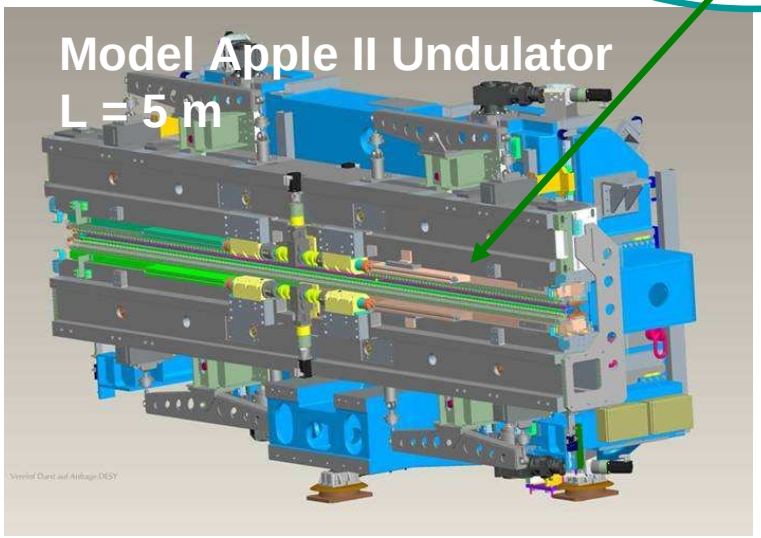
PETRA III
new experimental hall



Aufbau DBA Zelle (# 8)

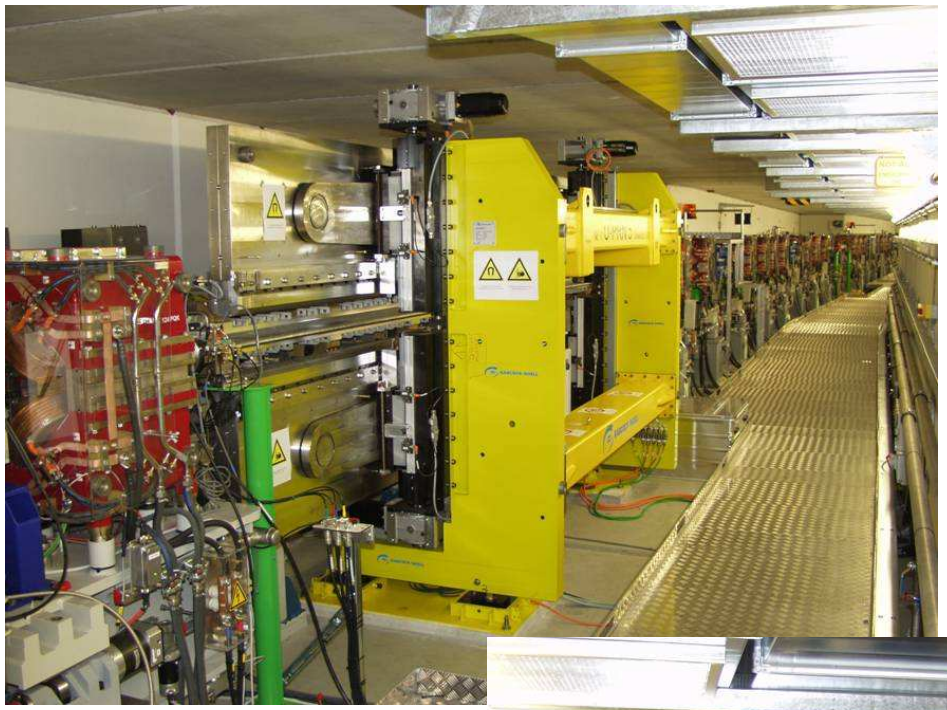






Undulators

Undulator PU 10



Undulator PU 8 & 9

8 of 14 Undulators have been installed

Optics & experimental hutches

PETRA III: ε_x = 1 nmrad

ε_x = 6 nmrad @ 6 GeV
(PETRA II low emittance lattice)

ε_x = 4.5 nmrad @ 6 GeV
(PETRA II low emittance lattice & new octant)

$$\varepsilon \propto f(\phi) \cdot \theta^3$$

Possibilities:

- designing new optics with *existing magnet hardware (TME)* ***(B)***
- designing new optics with *new magnet hardware (FODO 90° shorter dipols)* ***(C)***
- designing new optics with *existing magnet hardware* and use of damping wigglers **(A)**

PETRA III :damping wiggler

ε_x: 4.5 → 1 nmrad

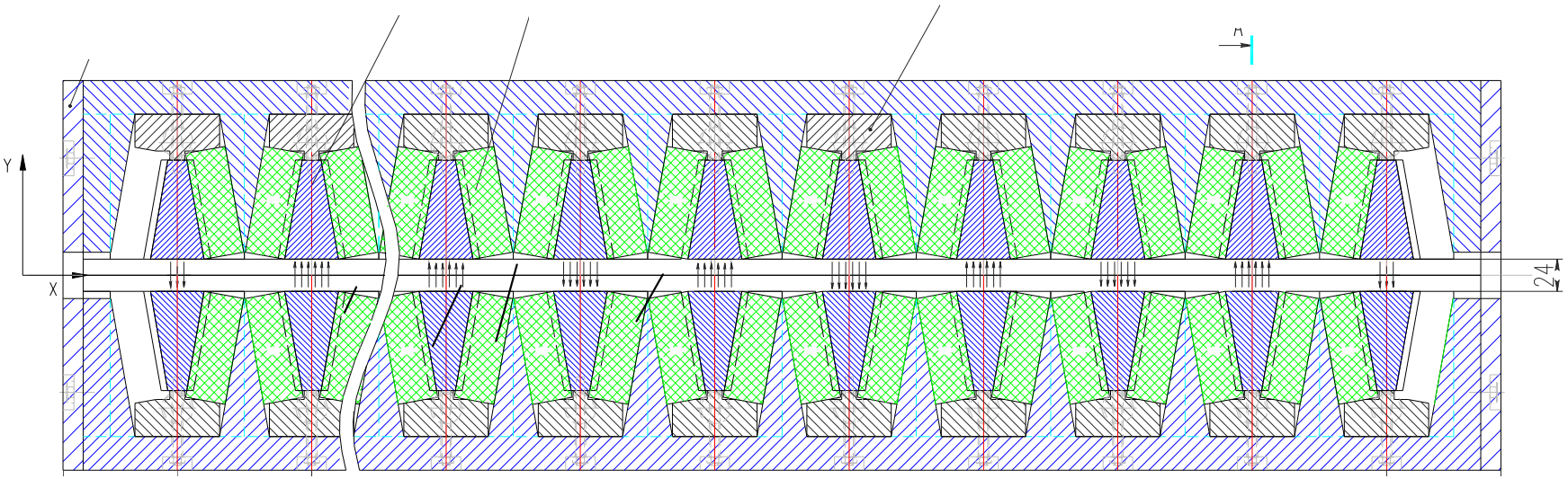
Damping wiggler sections

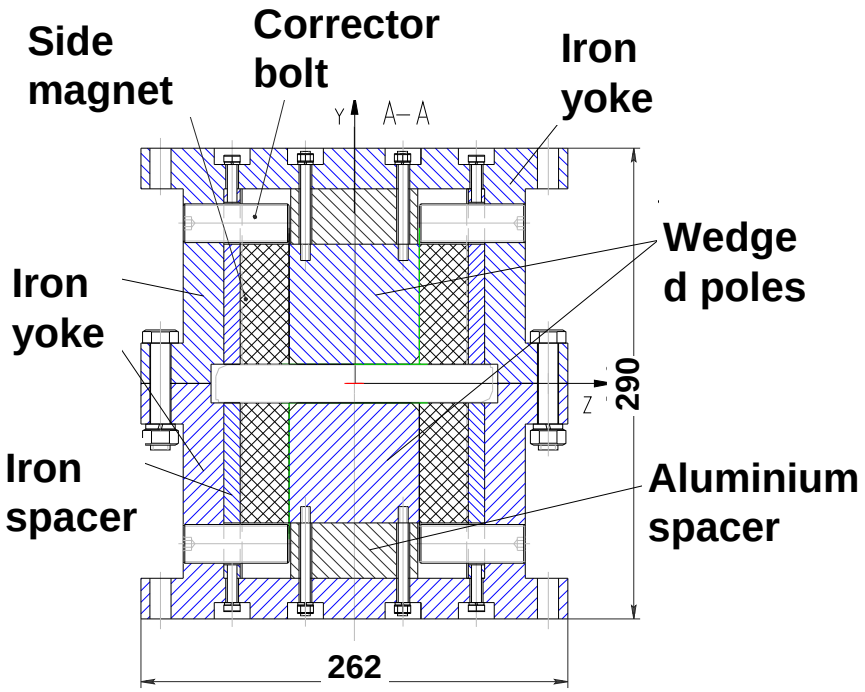
Collaboration with BINP

Damping wigglers

- **B = 1.5 T**
- **λ = 0.2 m**
- **h = 0.025 m**
- **L_{tot} = 80 m (2x40m)**

Damping Wigglers

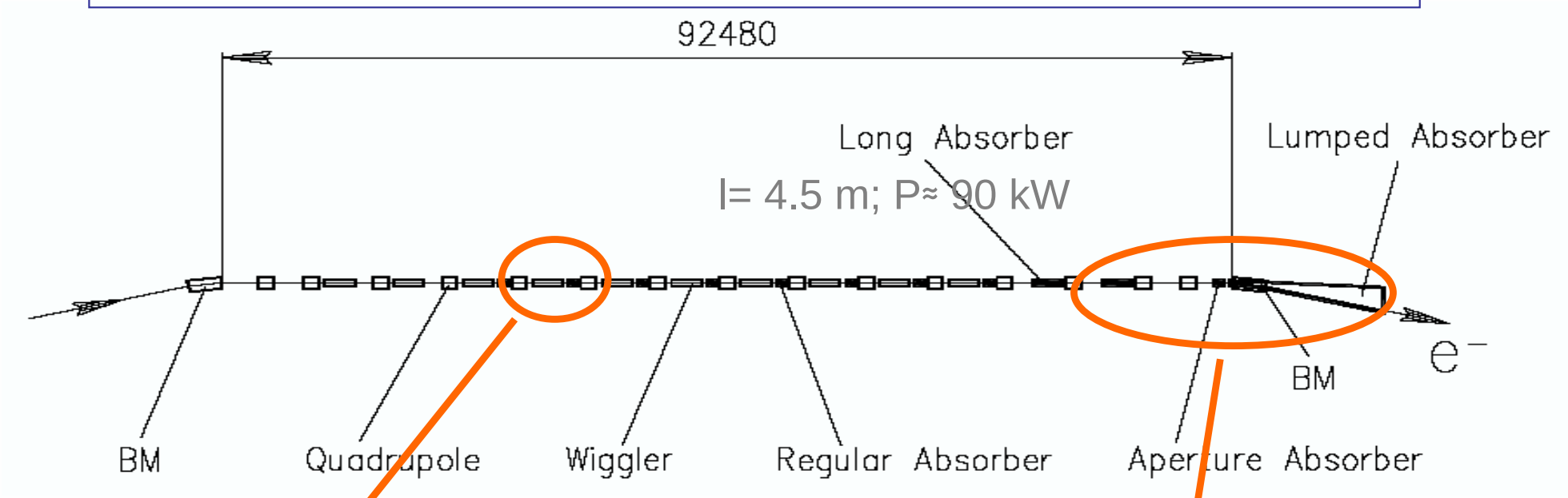


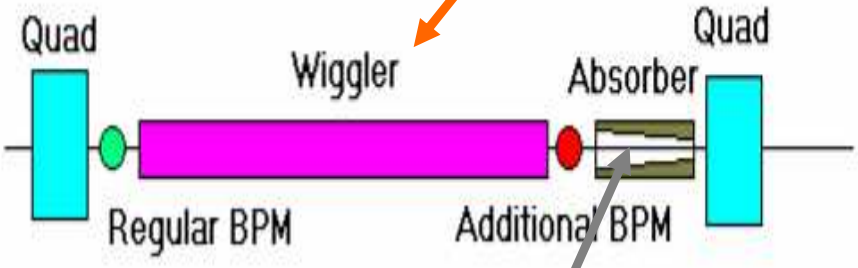


- **Modified hybrid structure**
  poles also powered from aside
- **Iron plates enclose the whole structure**
  act as magnetic yoke on zero magnetic potential
  serve as mech. support for magnetic assembly
- **compact, and mechanically stable design**
  cross section ~ 260 × 290 mm^2
- **easy and cheap**

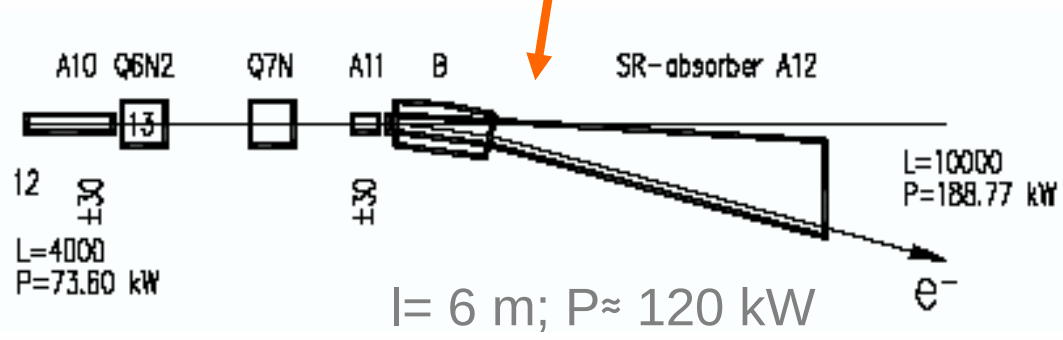
Wiggler Section

440 kW @ 200 mA, ε_c=36 keV
Opening angle: 5 mrad horizontal, 0.085 mrad vertical





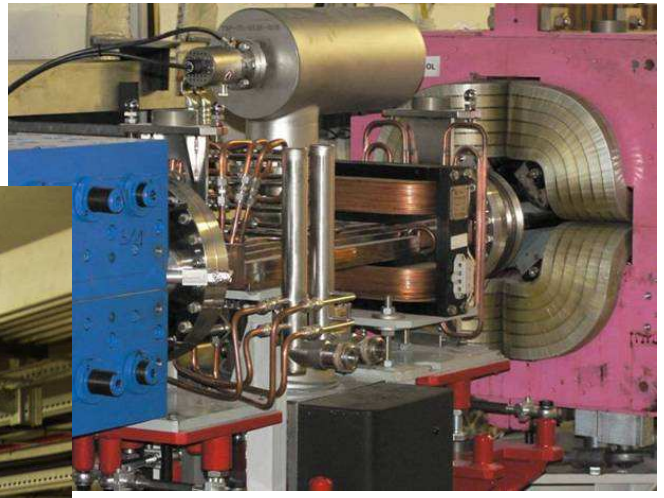
l= 0.8 m; P≈ 26 kW



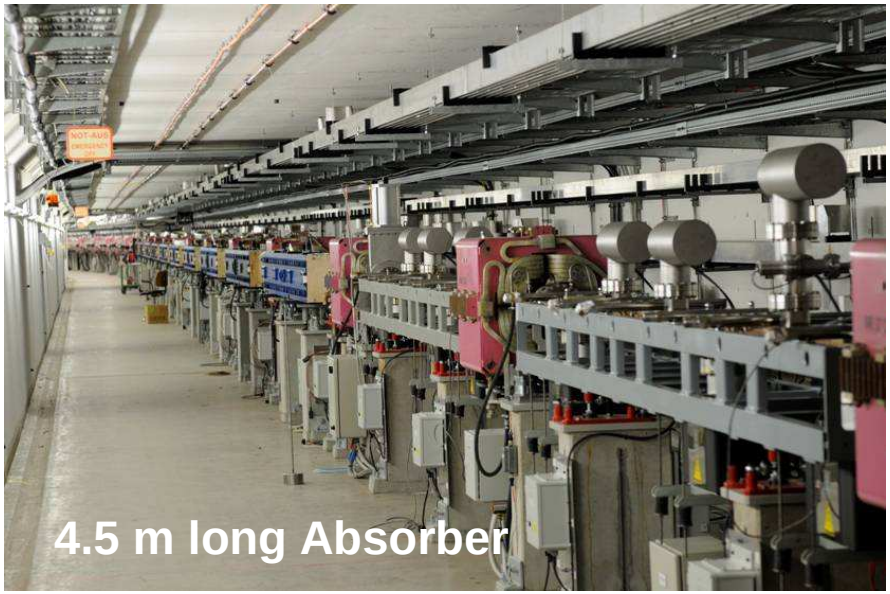
l= 6 m; P≈ 120 kW

Damping Wiggler Sections

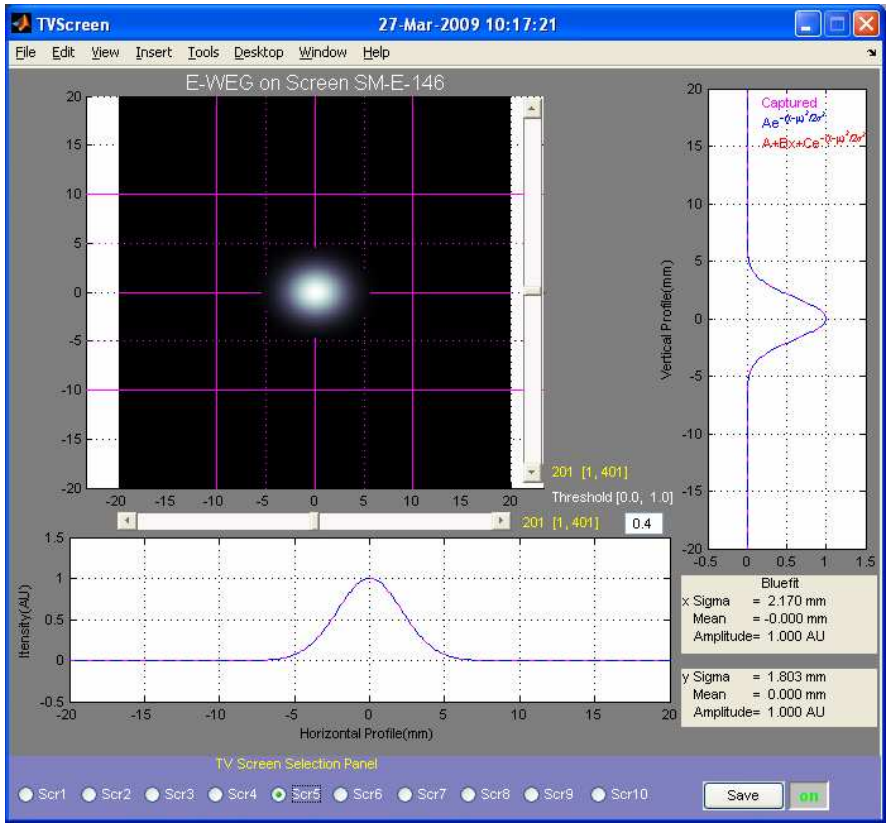
Both sections completely installed.
All wigglers moved in



Damping Wiggler Sections

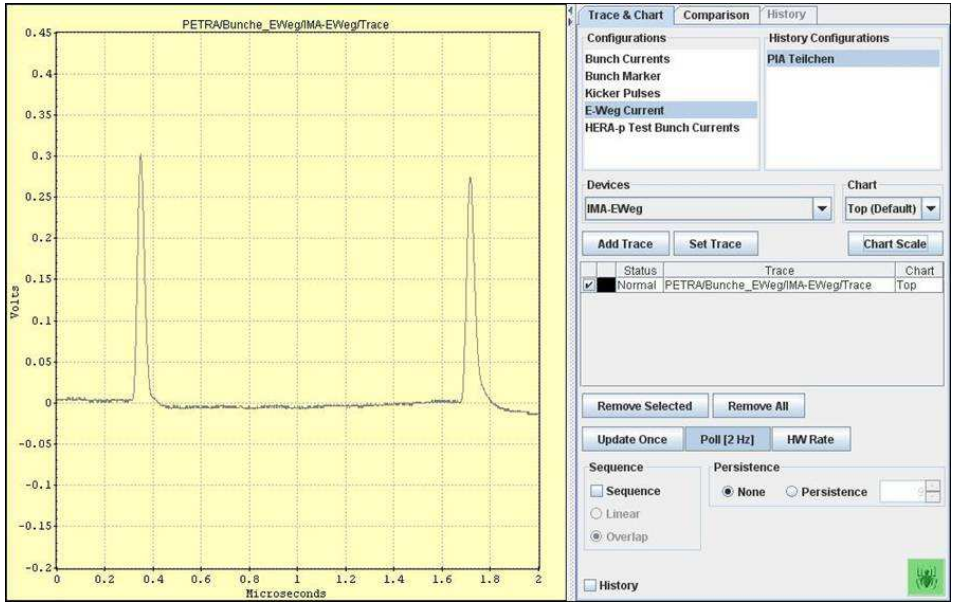


Transferline



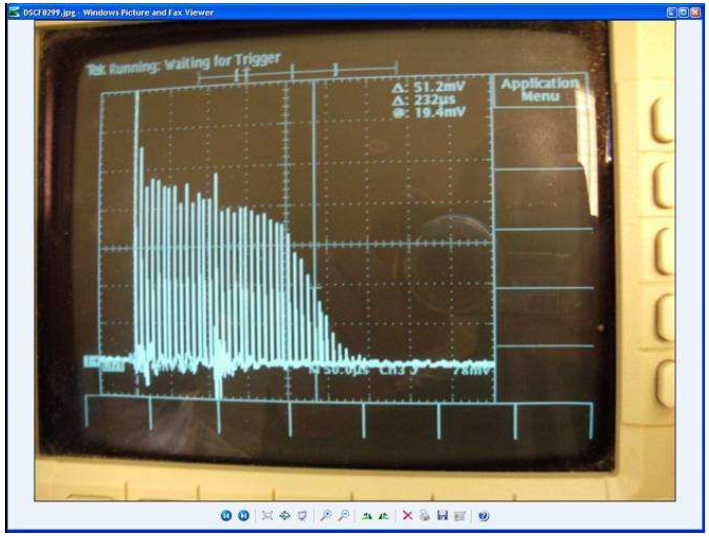
First beam through transferline on 24.03

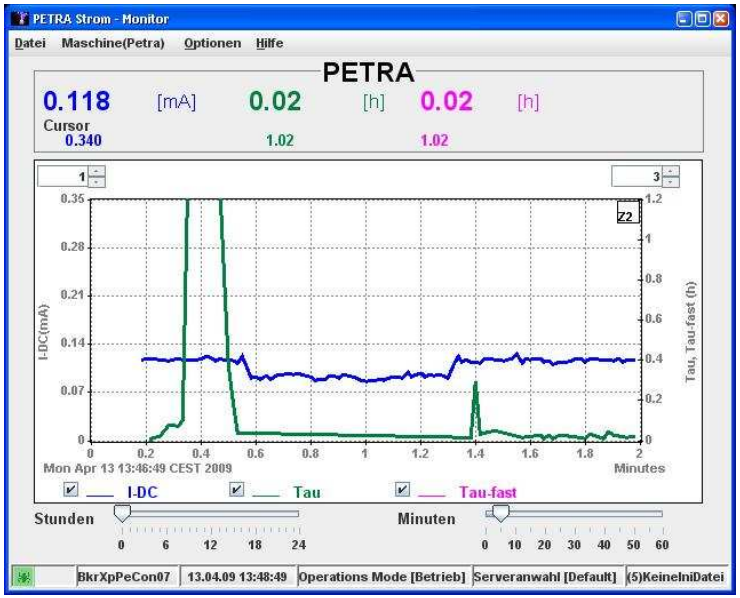
Optics about correct, i.e. measured profiles agree with theoretical within 10%

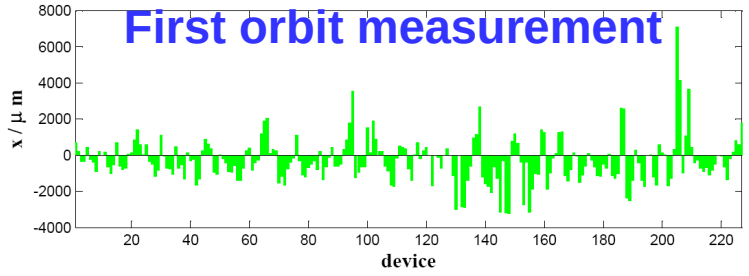


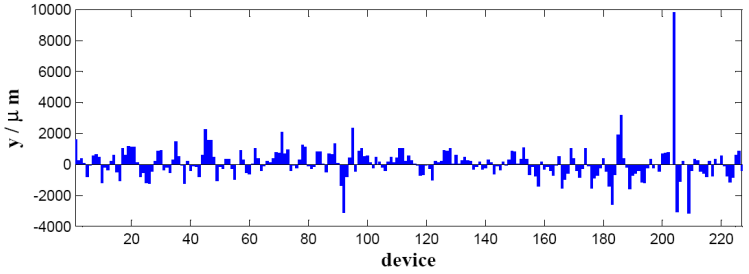
Stored beam

Beam was stored on April 13 (one bunch with 20 µA i.e. about 10^9 e+)
RF – phase right and orbit empirically corrected in the new octant





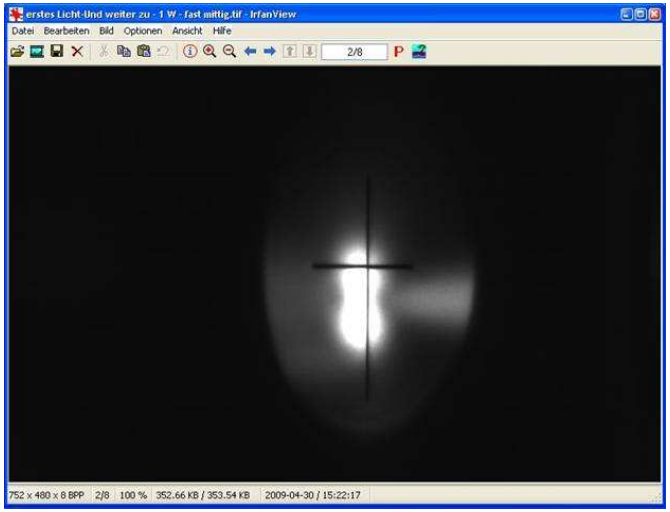




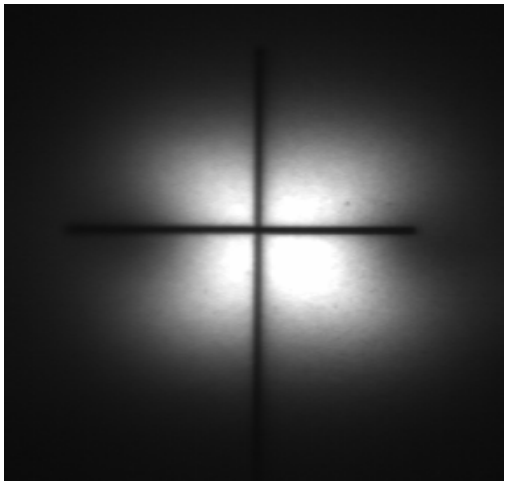
First Light on April 30

First light on April 30:
- **Undulator PU 9 (OL 142m)**
- **Single bunch 0.5 mA**
- **Gap closed to 10 mm (foreseen 9.5)**
- **No effect on machine (orbit / tune)**
- **Beam centred with horizontal and vertical Bumps**
- **Power up to 8W**

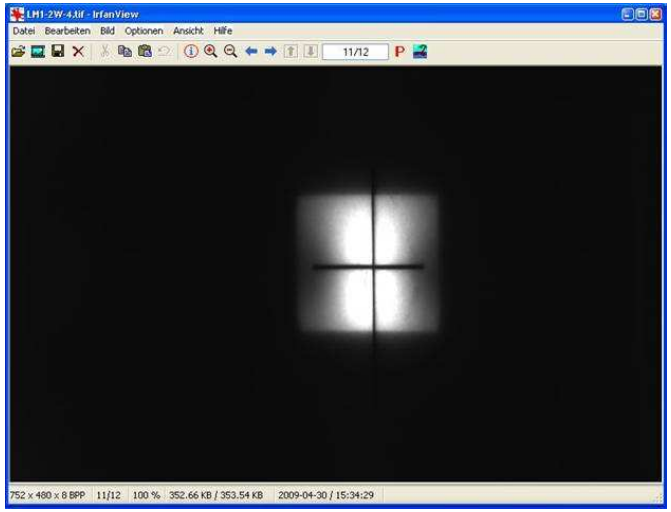
Screen monitor at 17.5 m



Picture at screen monitor at 28 m With corrections



Screen monitor at 28m



PETRA III
current limitations

- **Multibunch instabilities are a problem:**
  Situation **PETRA II**

	longitudinal	horizontal	vertical
I_{thres} (mA)	7	6	6
$1/\tau$ (Hz)	35	50	60
Z_{eff}	3.6 MΩ	45 MΩ/m	54 MΩ/m

PETRA III: 12 instead of 16 cav. & larger long. (radiation) damping

→ powerful broadband (BW≥ 60MHz) feedback neccessary

Status
Multibunch Feedback

- Installation complete
- Electronics housed in special climatized huts

- PETRA II MB-Feedback reinstalled to ease commisioning

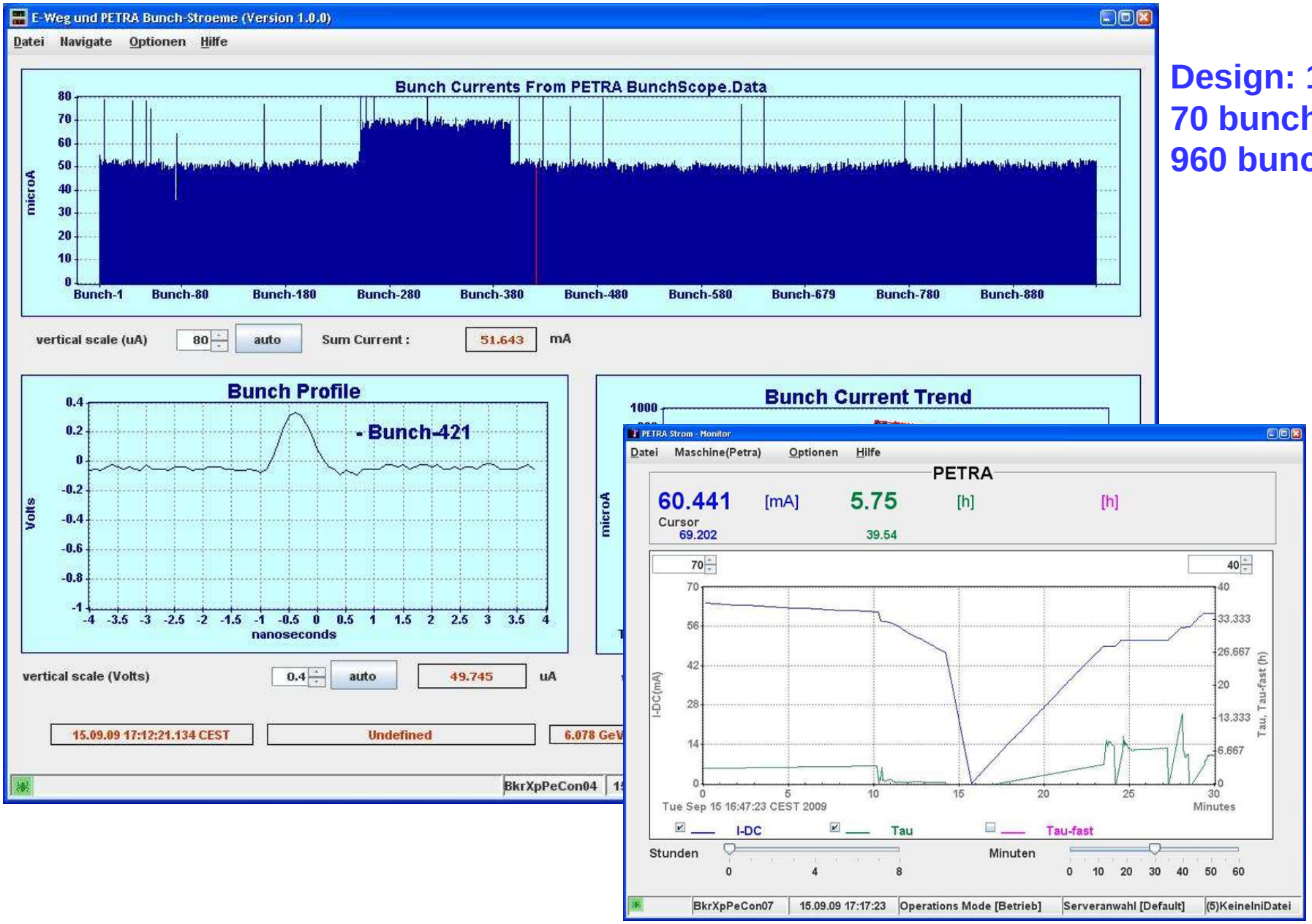

Feedback hut Hall east


old Feedback kicker


new Feedback kicker

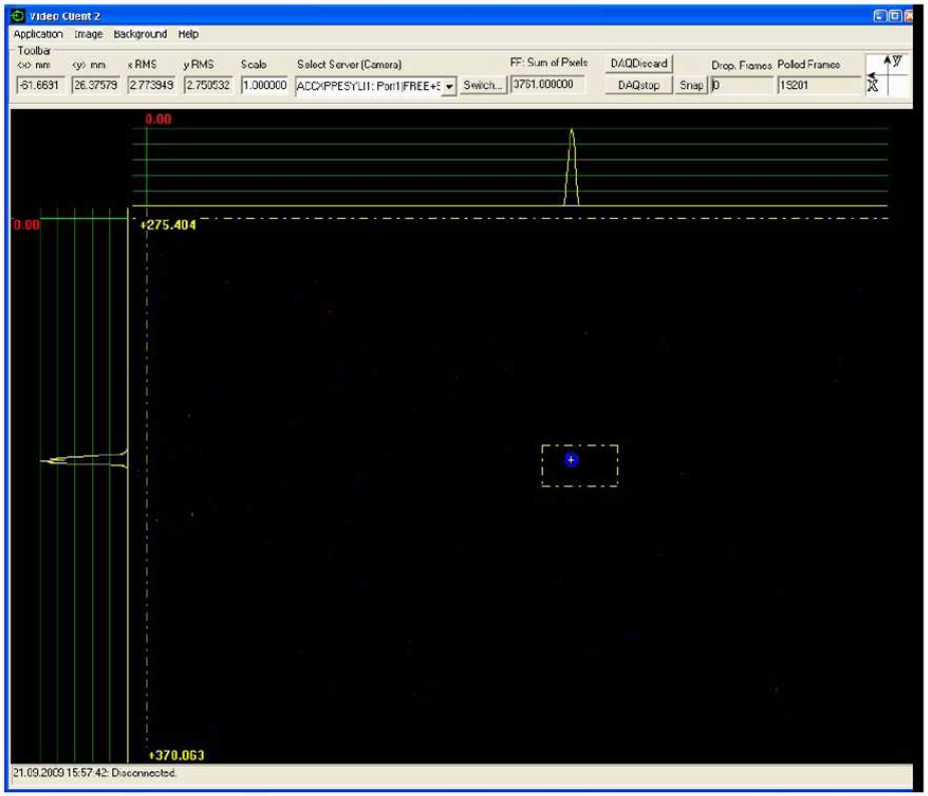

Cavities for longitudinal feedback

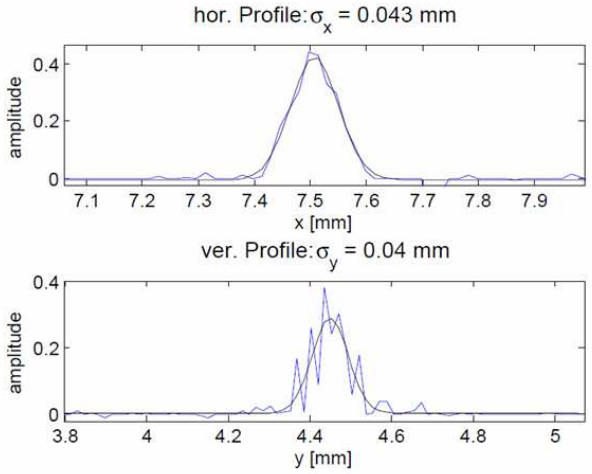
Current limitations multibunch

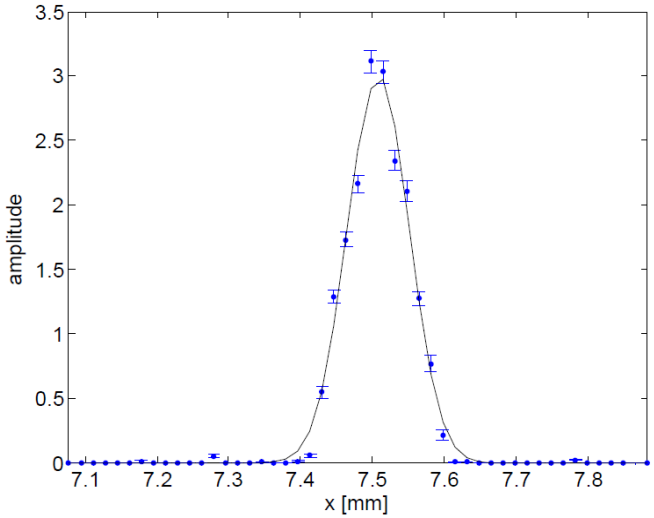


Design: 100 mA
70 bunches: 67 mA
960 bunches: 60 mA

emittance







- gefittete horizontale Strahlfleckgroesse: 42.7mu (1sigma-Breite)

Annahme:
- beta_x = 1.6m
- Dx = 1.3cm
- Delta(p)/p = 1.3E-3

=> **emittanz_x = 0.96 nm rad** (GROBABSCHAETZUNG,
lousy lifetime for I = 1.4 mA => τ = 1.5h

Orbit stability goal

ε_x = 1nmrad coupling 1%

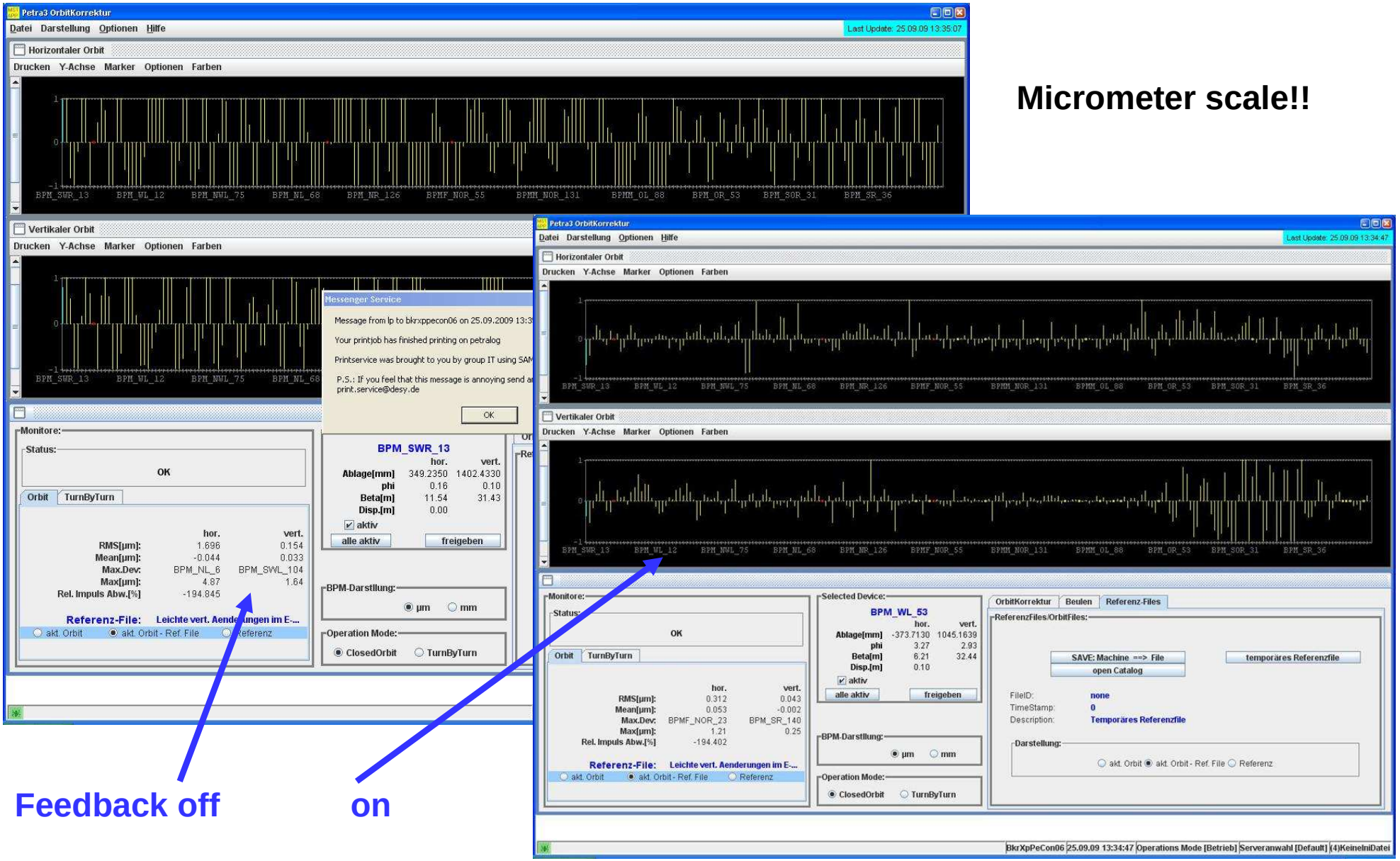
	Low β insertion			High β insertion			
	β(m)	σ(μm)	Amplification factor	β(m)	σ(μm)	Amplification factor	
Horizontal	1.19	34.6	17.25	19.84	141	70.24	
Vertical	4.0	6.3	34.08	2.37	4.9	26.20	

Stab. Requirement 0.1 * σ
→Sub micron orbit stability !!

Status orbit feedback

- air coils installed in tunnel
- installation of electronics in climatized huts

Orbit stability (preliminary results)



Micrometer scale!!

Feedback off **on**

Summary

Parameter	Design	Achieved
Energy (GeV)	6	6
ε_x (nm rad)	1	1
ε_y (pm rad)	10	< 50
Current (mA)	100	67
Orbit stability	10% of beam size	Work in progress
# undulators	14	8

10 more weeks for commissioning until December 21-st

User operation starting in February next year

Thank you for your Attention!