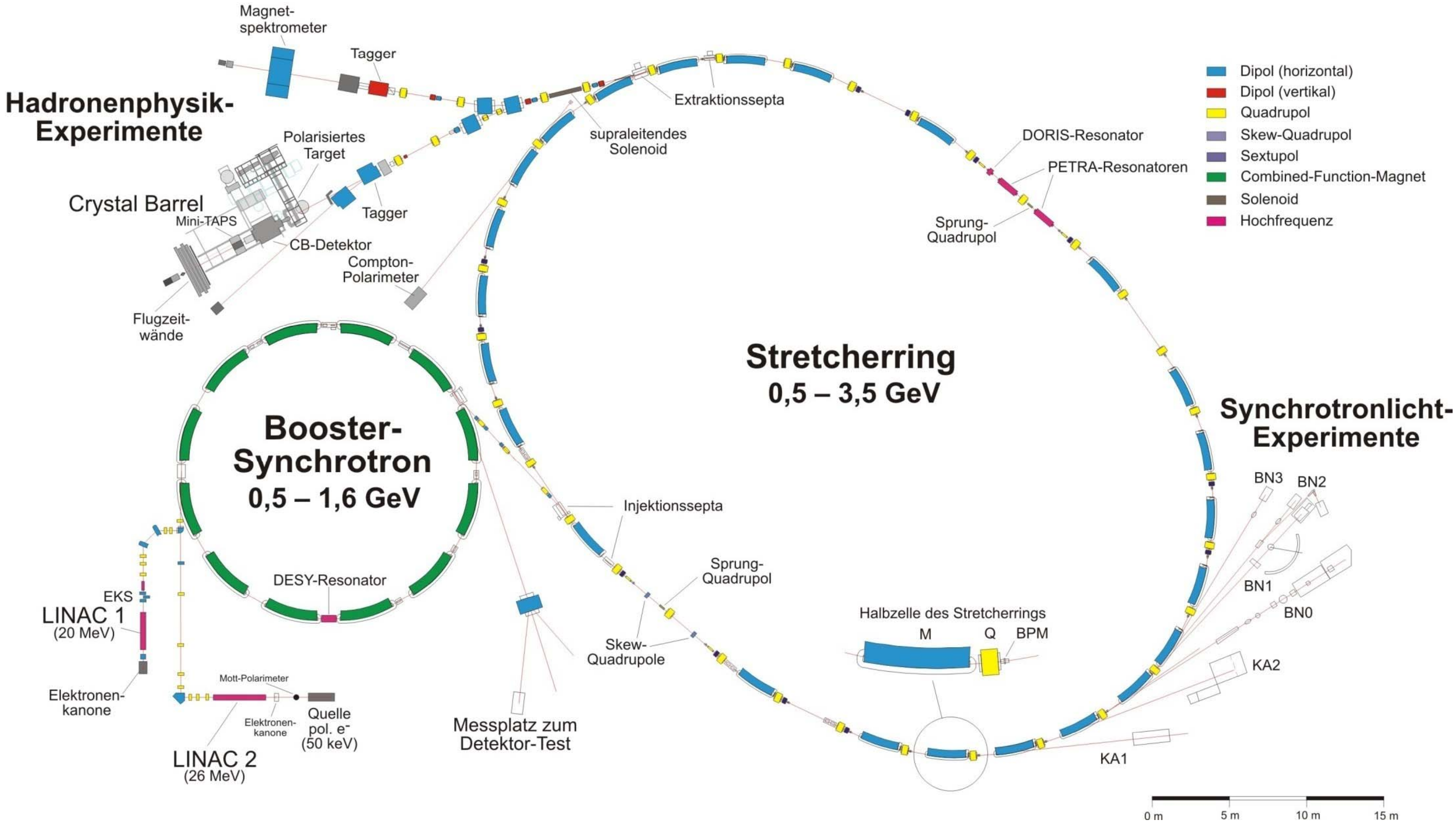
SFB/TR 16 TP D.2.

Status and Actual/Planned Work Program

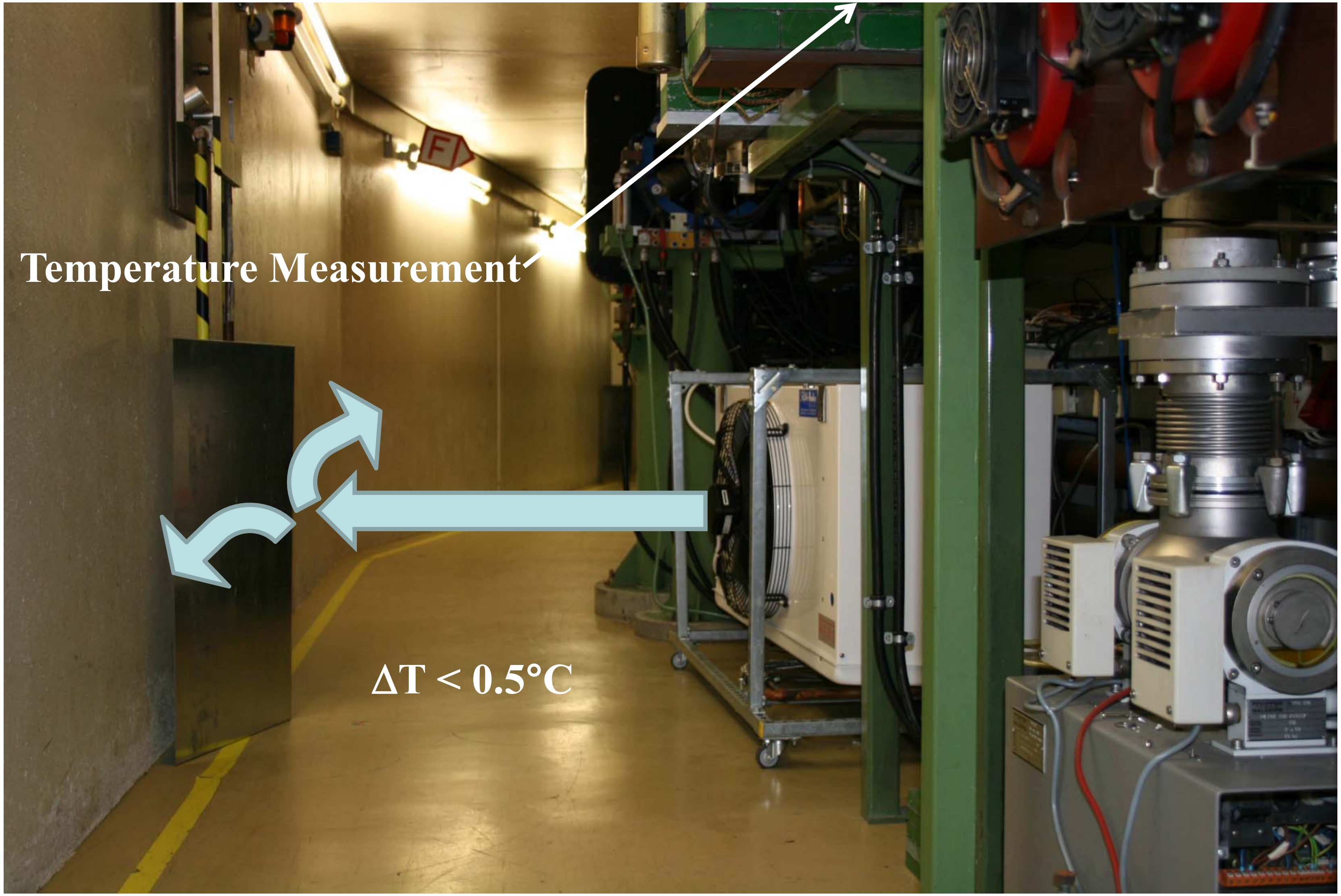
Contents:

- General Accelerator Performance
- Improved Diagnostics
- Linearly Polarized Photons
- Circularly Polarized Photons
- Increase of Dynamic Range

Elektronen-Stretcher-Anlage (ELSA)

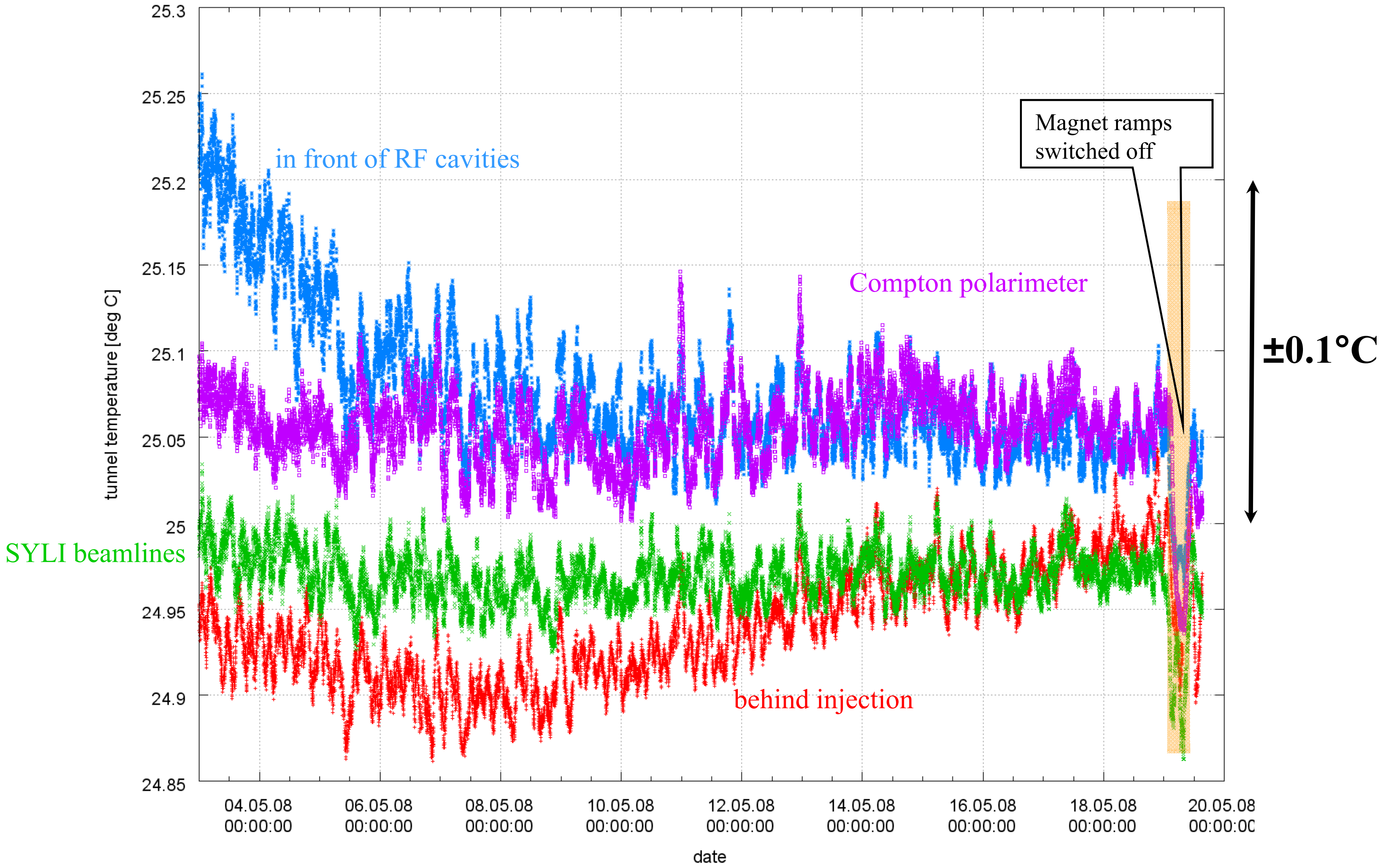


Long Term Stabilization

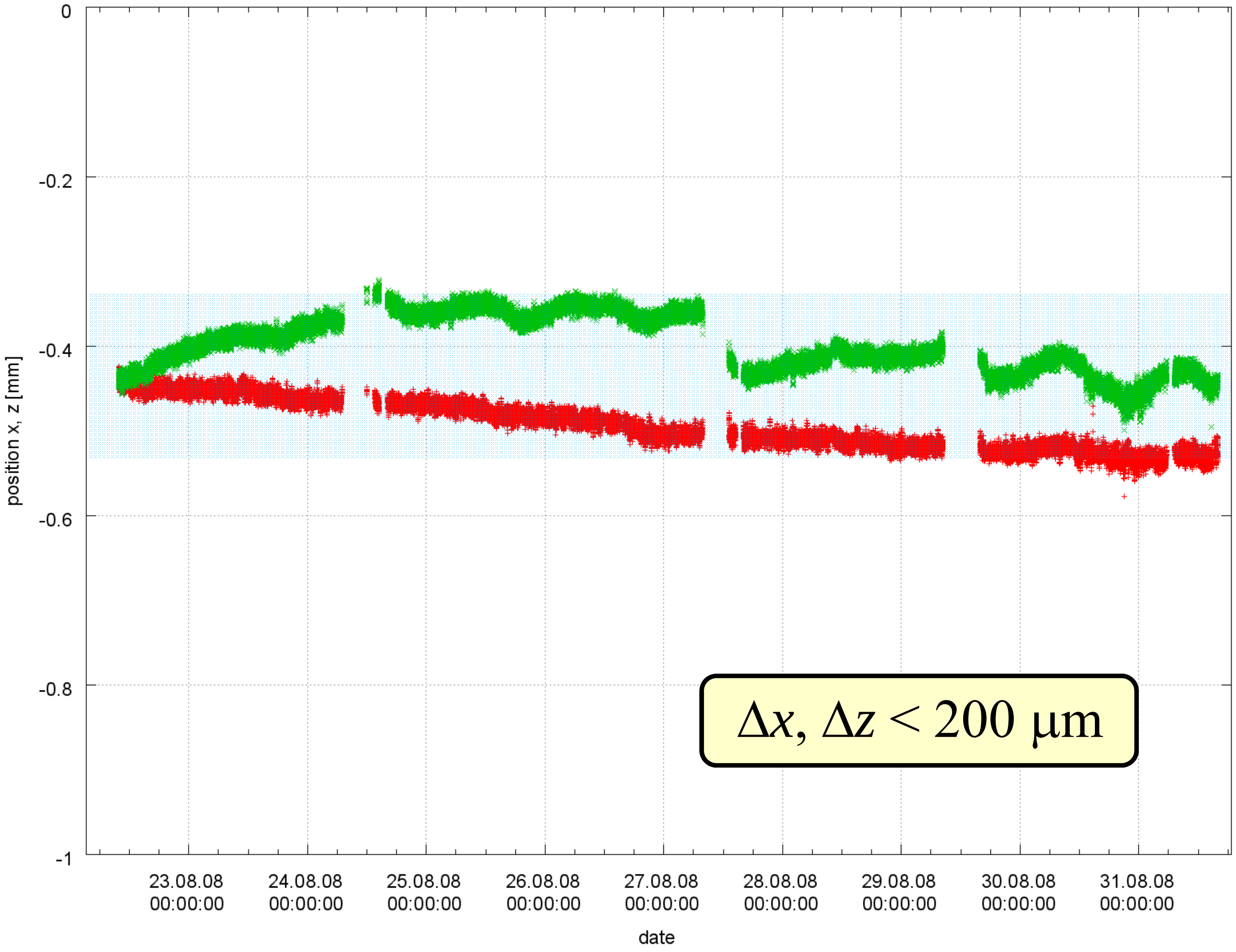


Temperature in ELSA Tunnel

moving average 100 min



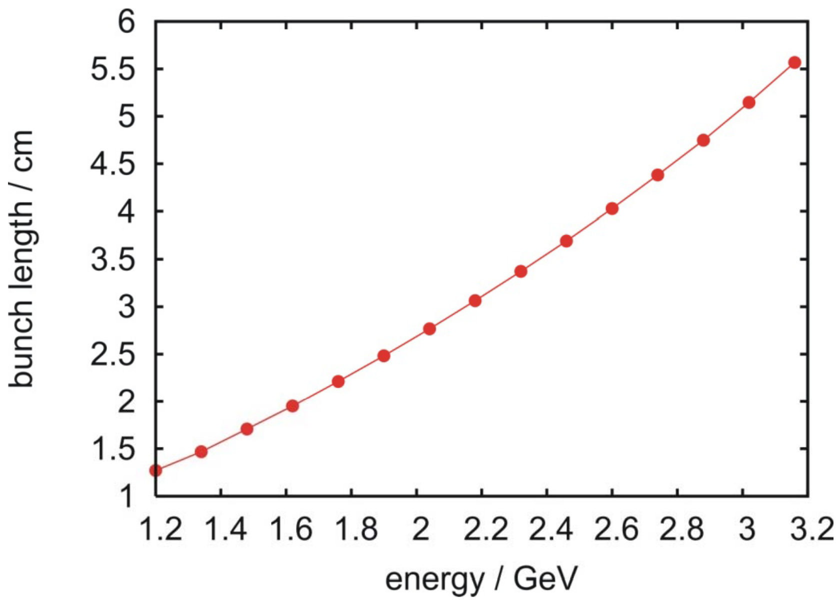
Position Long Term Stability



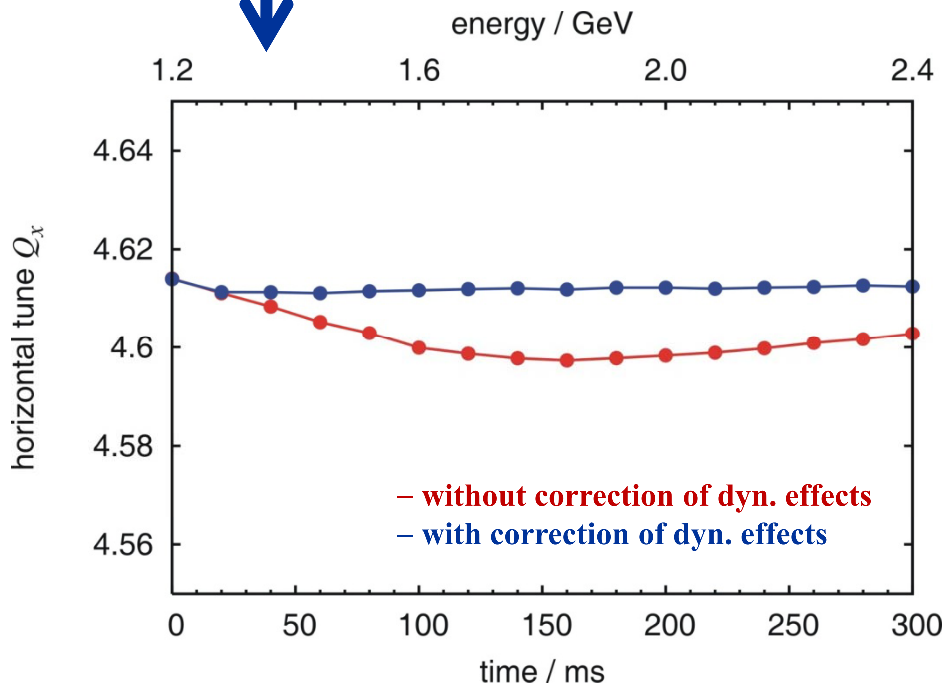

ELSA

Improved Diagnostics

Tune Measurements and Stabilization on the Ramp

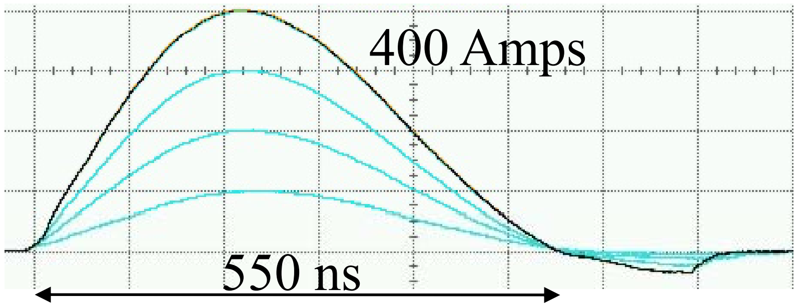


Excitation of coherent oscillations on the fast energy ramp:
- kicker magnets
- RF phase jumps



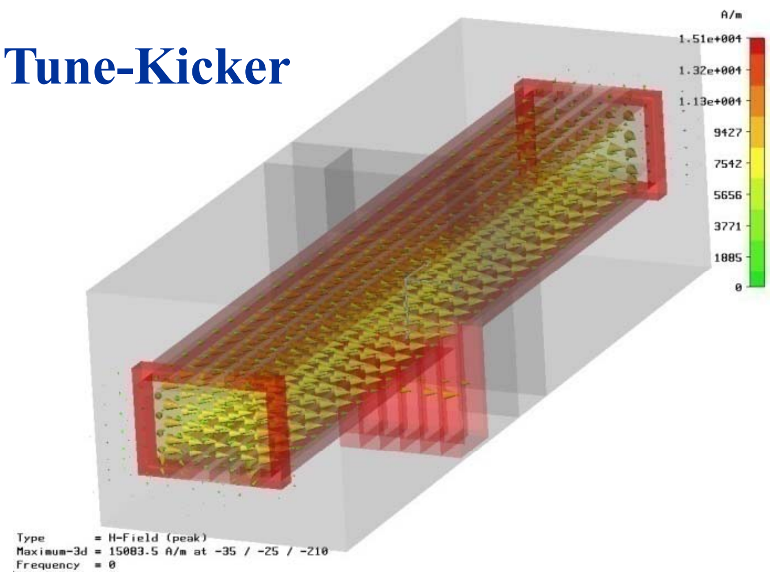
- Design of tune kickers
  (num. simulations with CST™)
- Tune kicker power supplies
  (in collaboration with co. PPT)

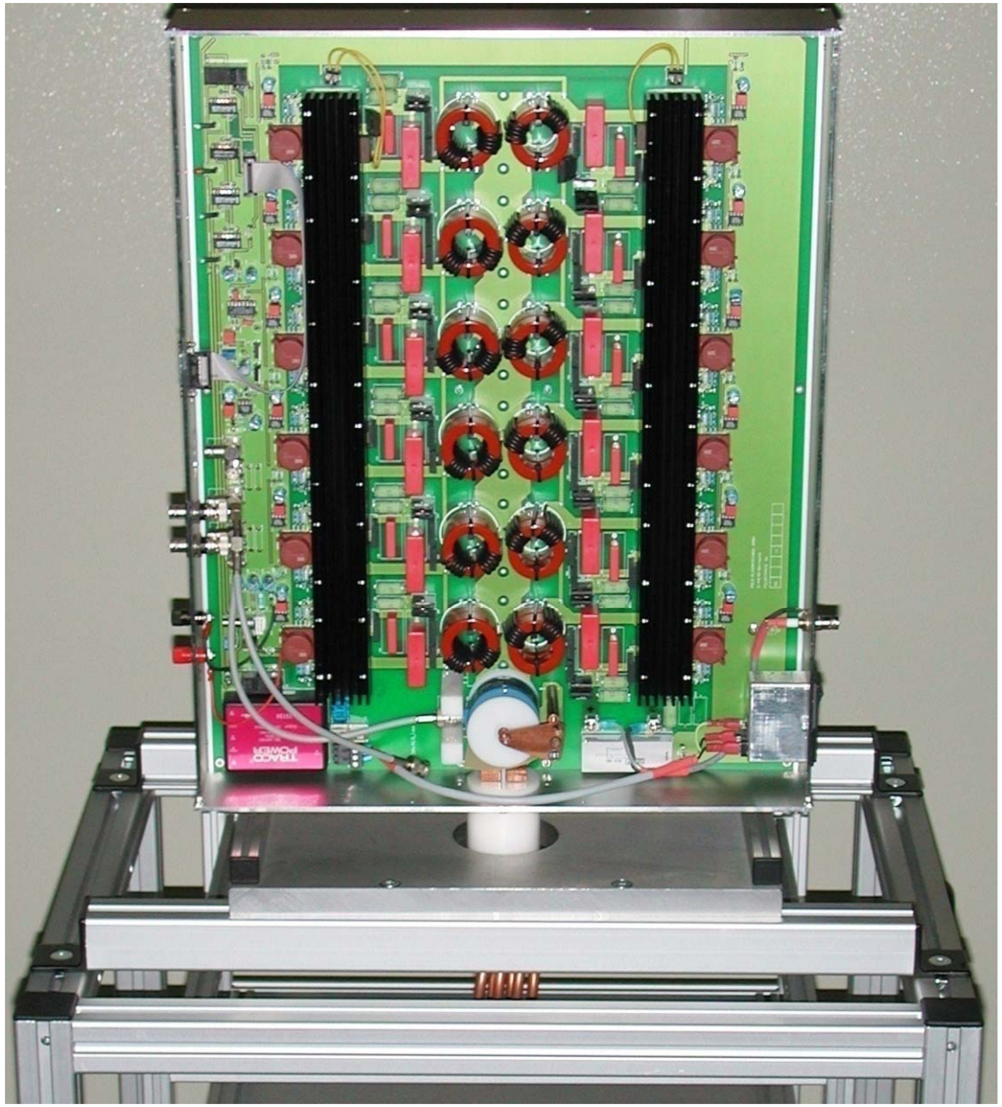
Vertical Tune-Kicker



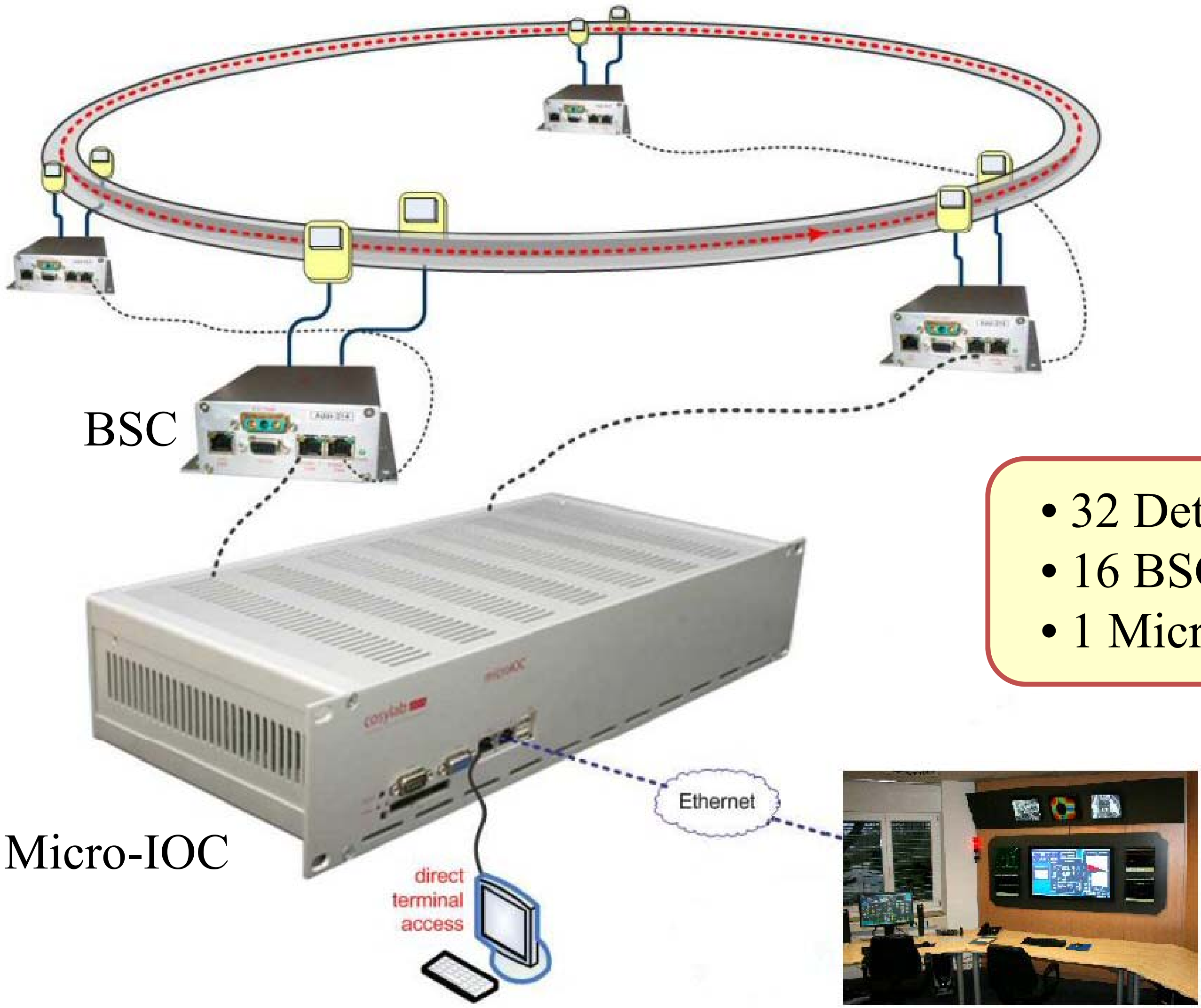
One-Turn Excitation

Tune-Kicker

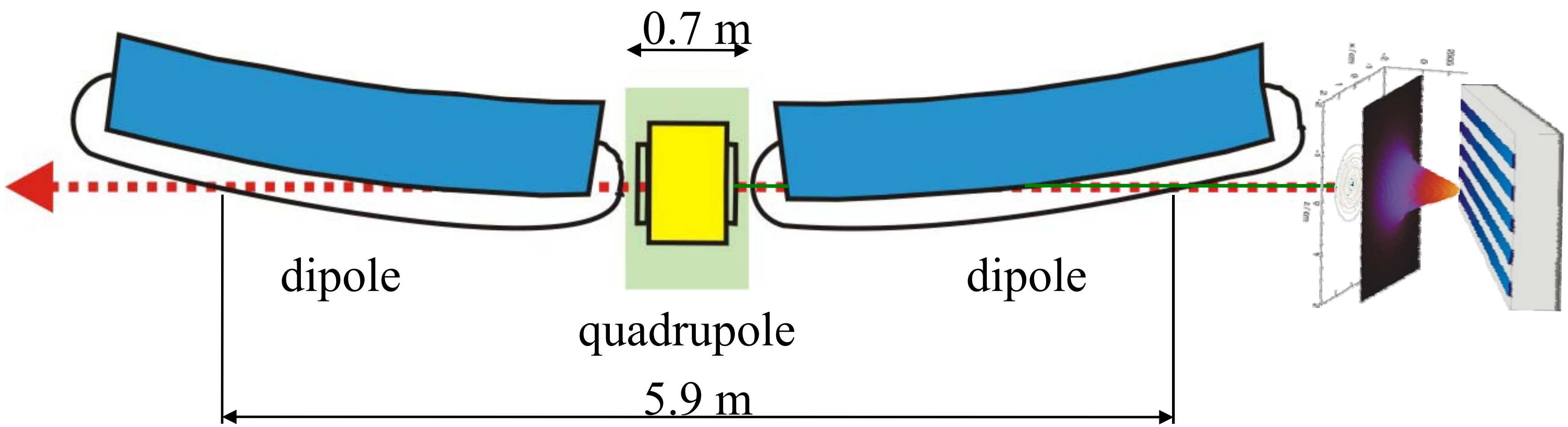


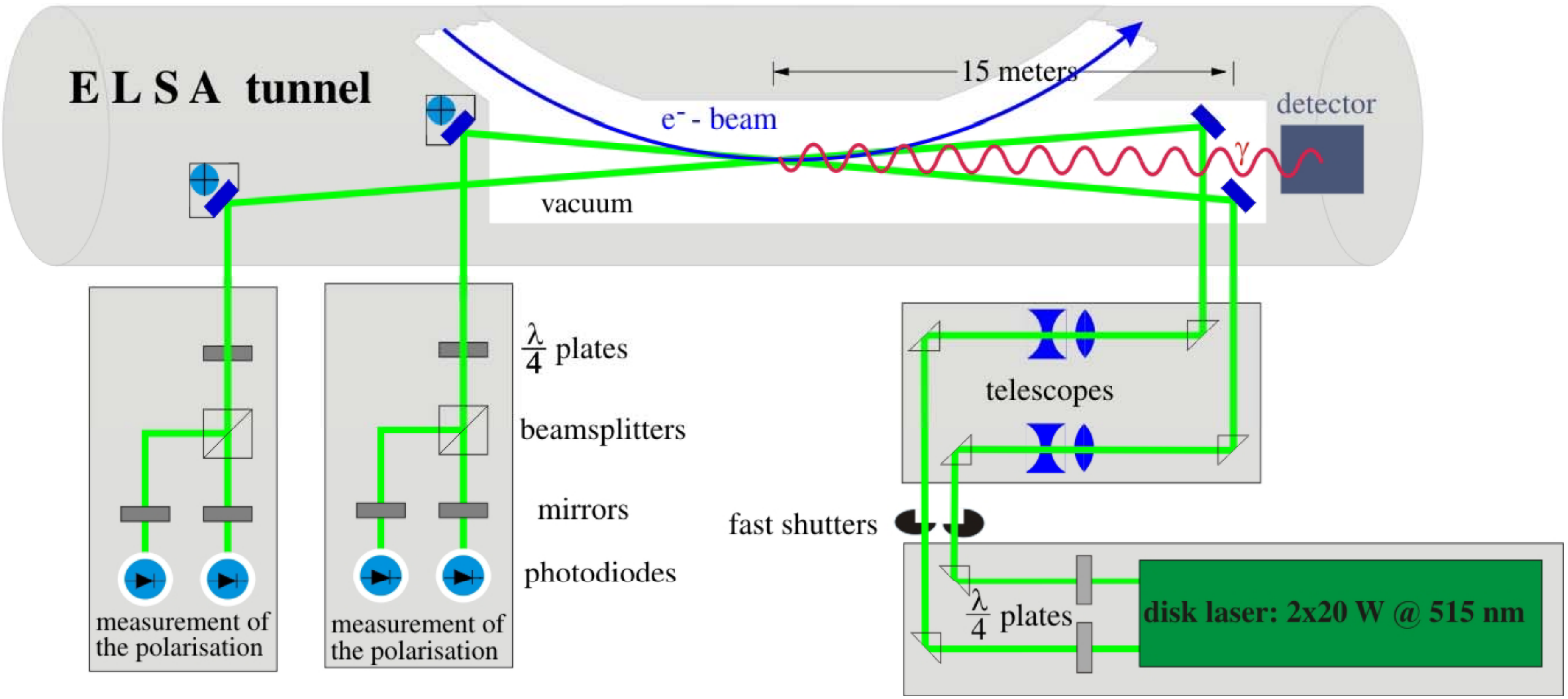


Beam-Loss-Monitor System

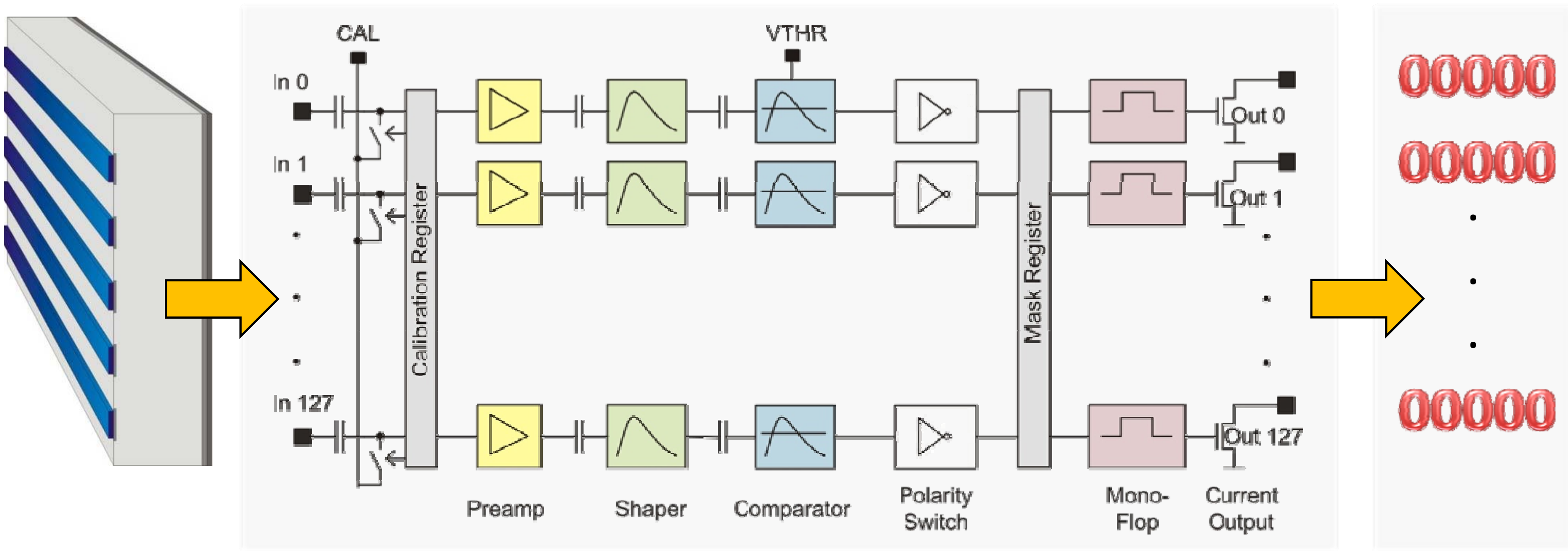


- 32 Detectors
- 16 BSC’s
- 1 Micro-IOC


0.7 m
dipole
quadrupole
dipole
5.9 m


E L S A tunnel
15 meters
e⁻ - beam
detector
γ
vacuum
λ/4 plates
beamsplitters
mirrors
photodiodes
measurement of the polarisation
measurement of the polarisation
telescopes
fast shutters
λ/4 plates
disk laser: 2x20 W @ 515 nm

Counting Microstrip Detector



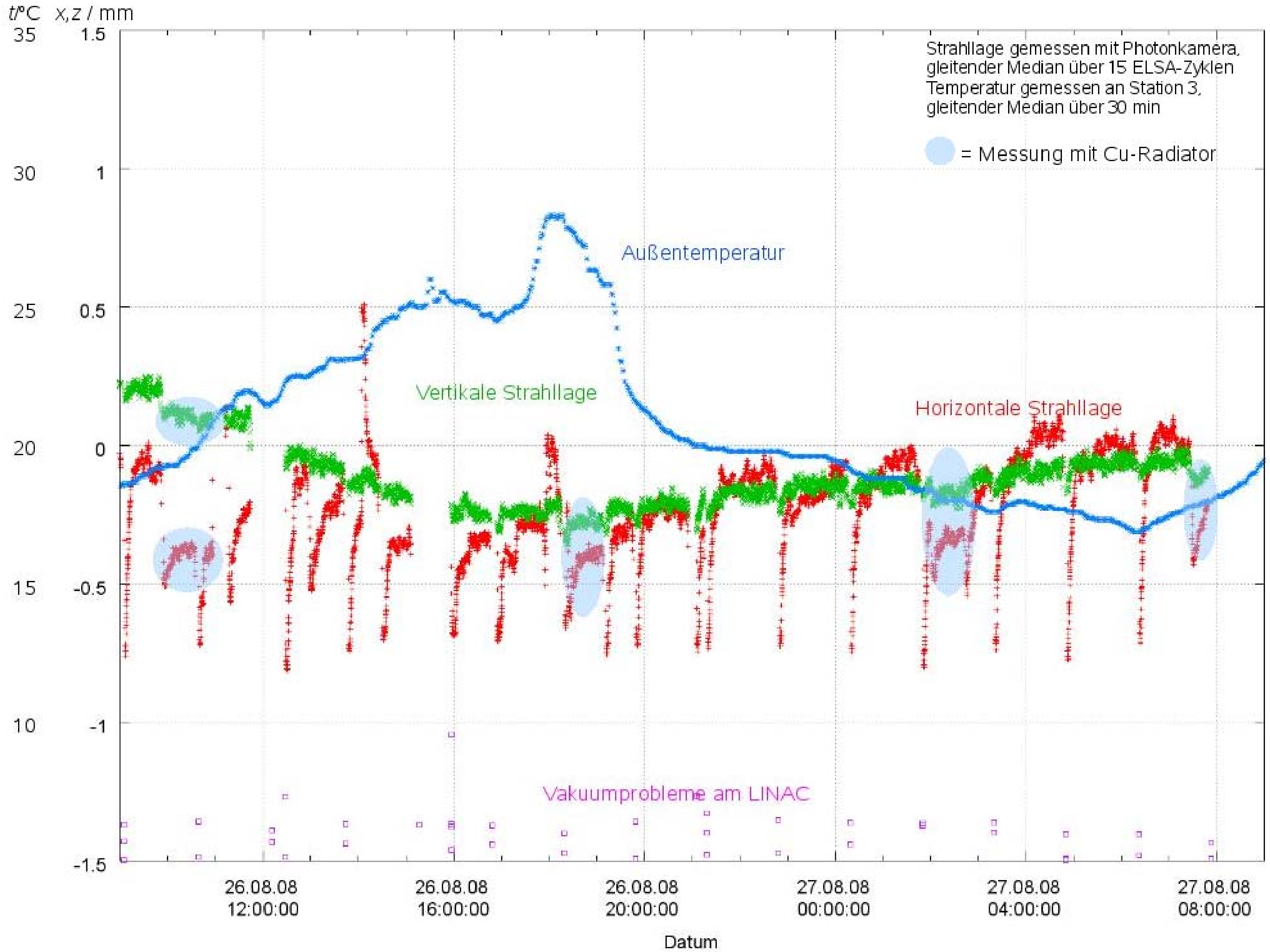
Detector: (BABAR 1)
- 768 strips
- 50 µm pitch
- ➢ **resolution 14 µm**

6 front-end chips: amplifier, shaper, discriminator, counter
- high rate acceptance (10 - 150 MHz, single channel!)
- digital part built in LVDS technology
- FPGA controlled

Developed in close collaboration with ATLAS pixel-detector group of Prof. N. Wermes, PI Bonn

Linearly Polarized Photons

Beam Pointing Stability



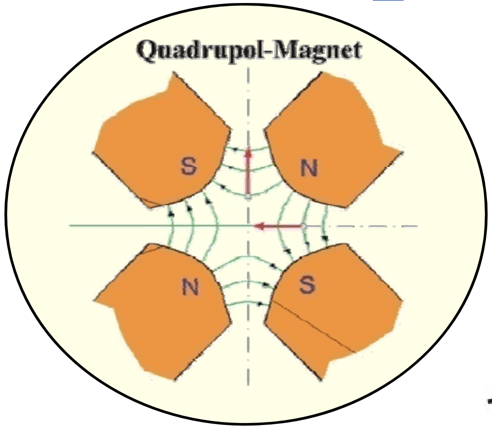
Linearly Polarized Photons

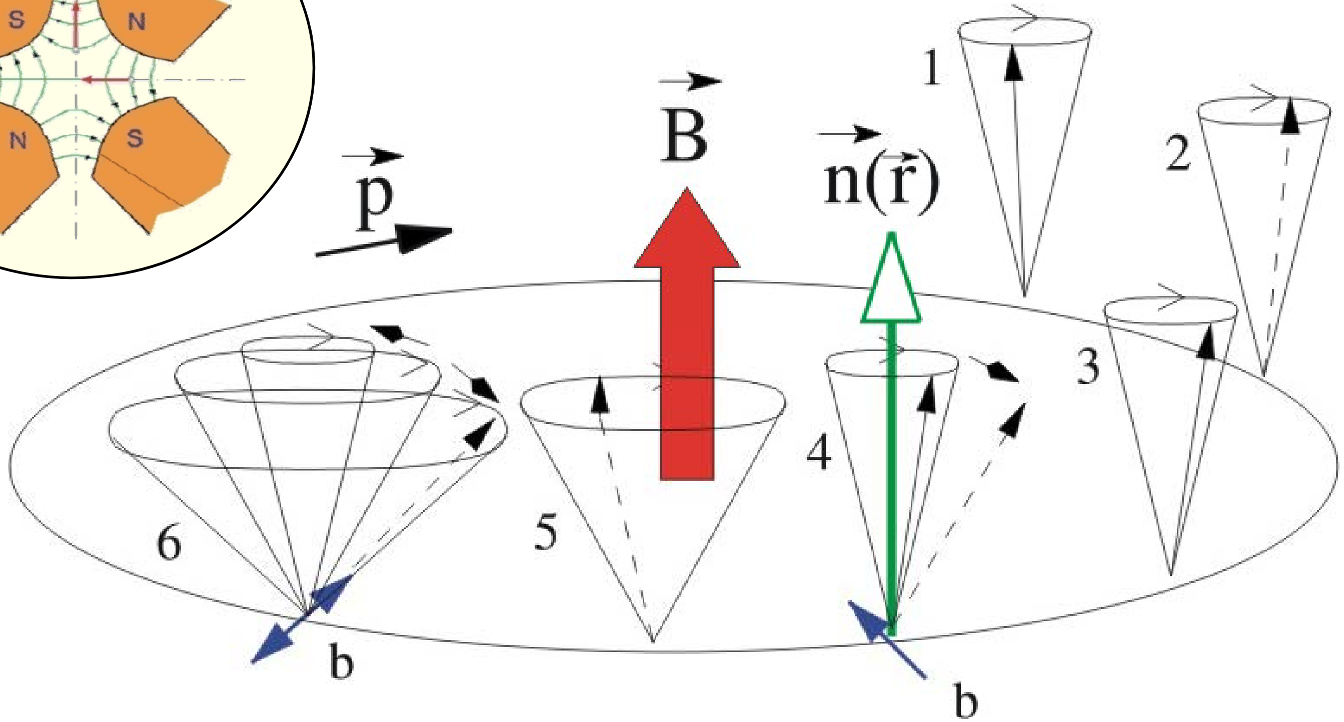
- **Orientation ±45° without changing beam settings**
- **High beam pointing stability**
- **Stable position of coherent edges**
- **High long term overall stability**

$P \approx 60\%$ (dependent on setting of coherent peak)

Circularly Polarized Photons

Depolarizing Resonances



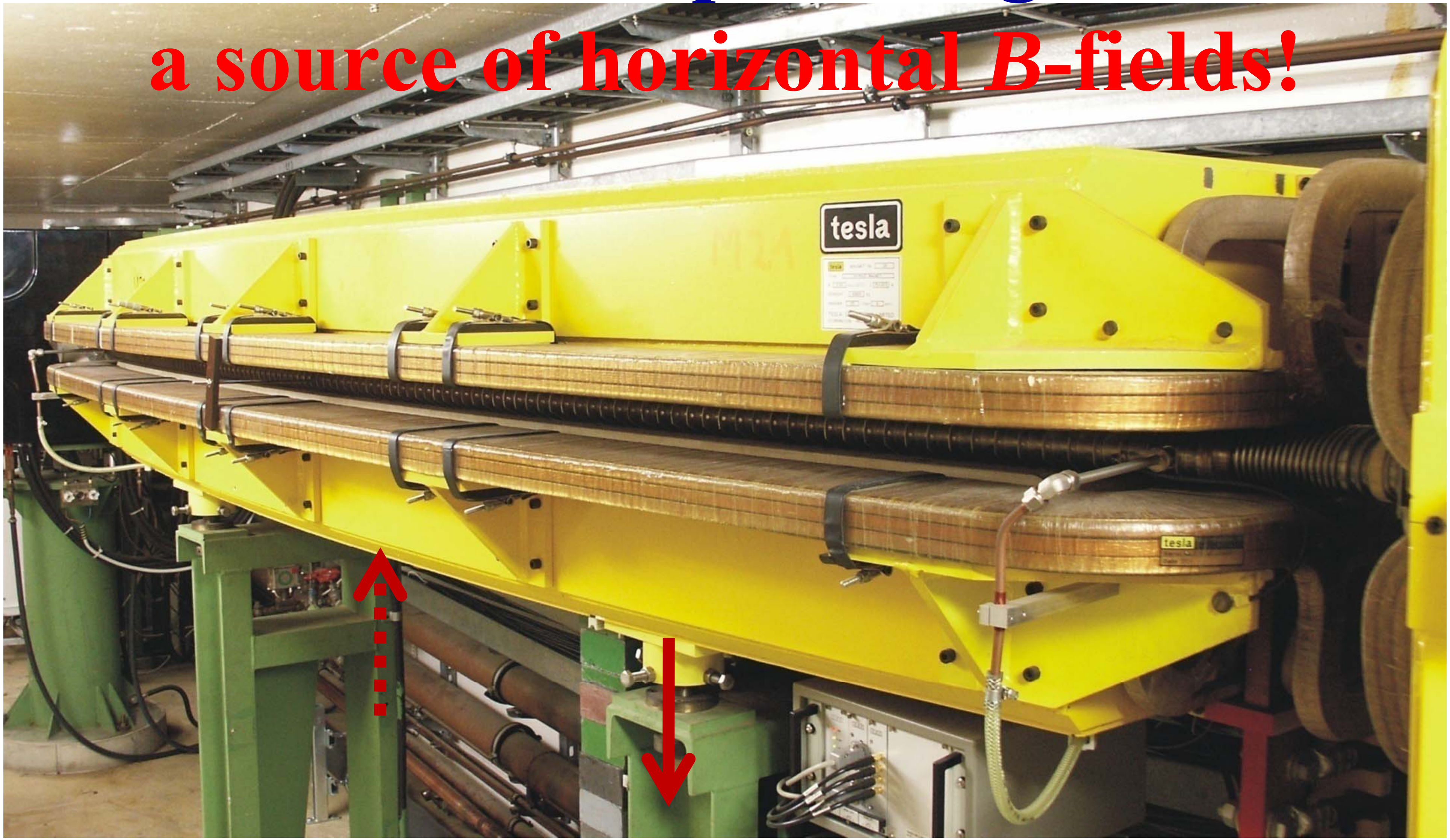


Imperfektions-Resonanz: $\gamma \cdot a = n, \quad n \in Z$

Intrinsische Resonanz: $\gamma \cdot a = n \cdot P \pm Q_z, \quad n \in Z$

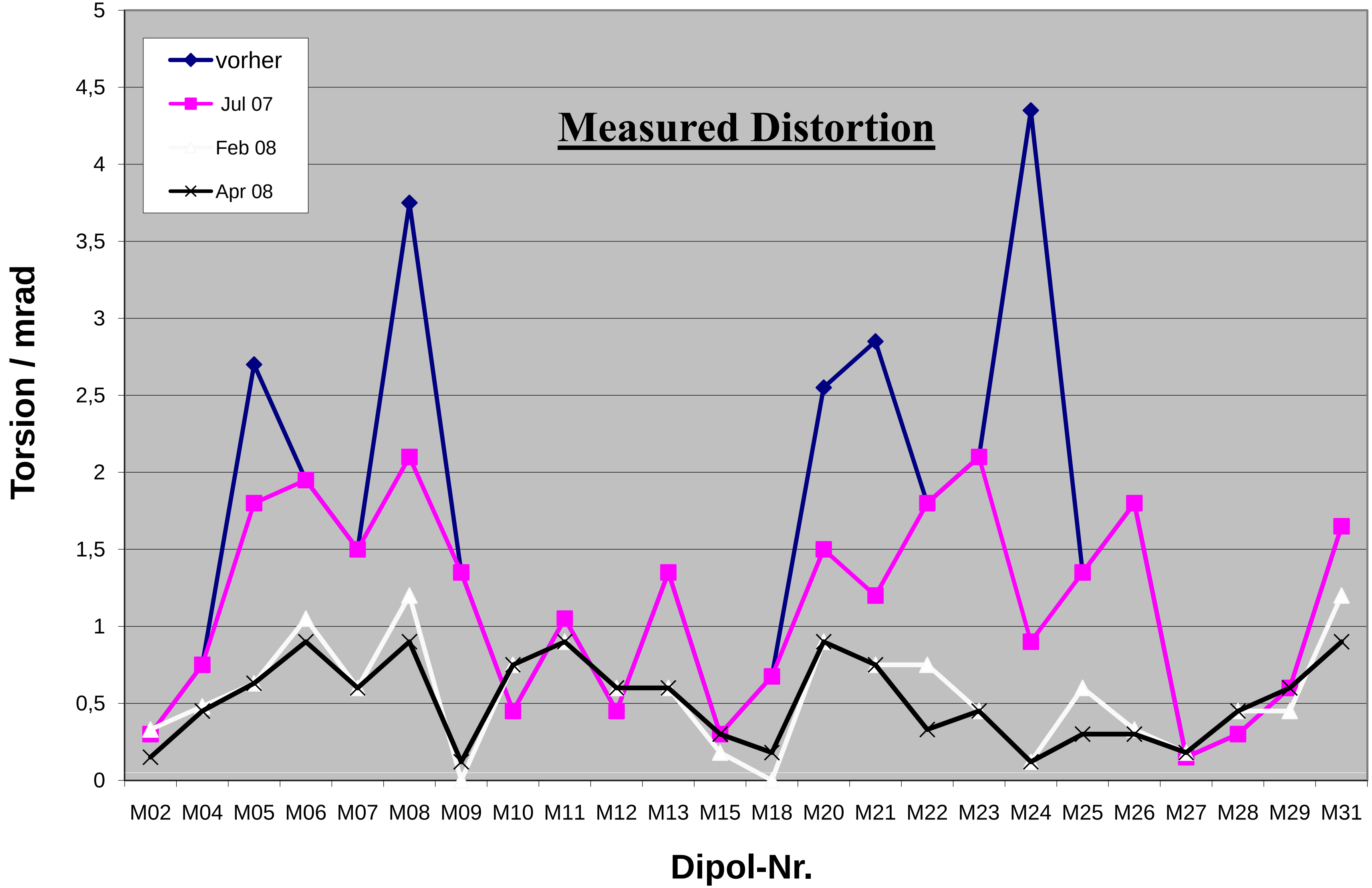
Distorted Dipole Magnets:

a source of horizontal *B*-fields!



a “simple” but very useful idea?!!

Dipole "Flattening" 2007/2008

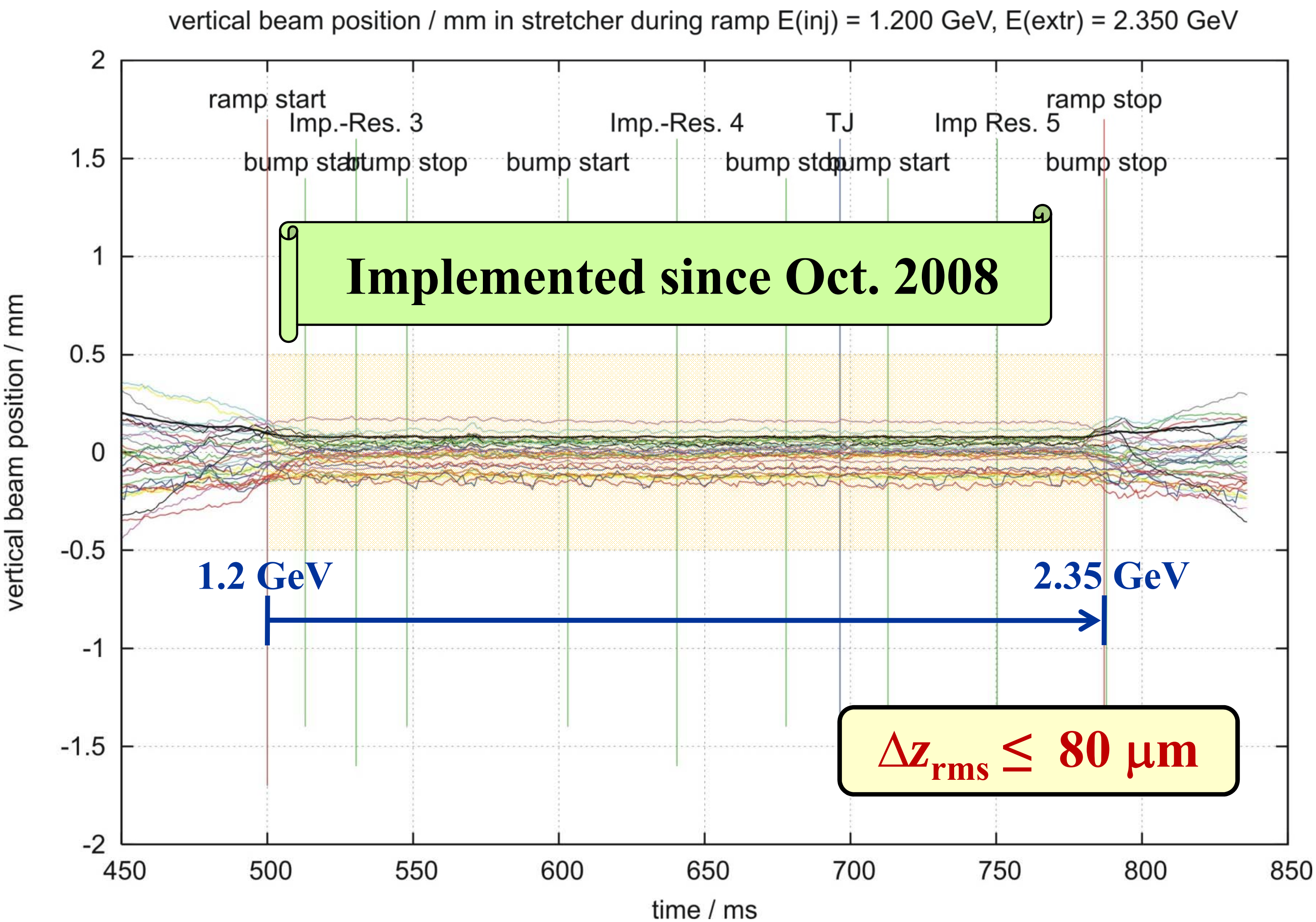


Closed Orbit Correction

32 beam position monitors for 32 quadrupole-magnets
40 steerer-magnets (correctors)

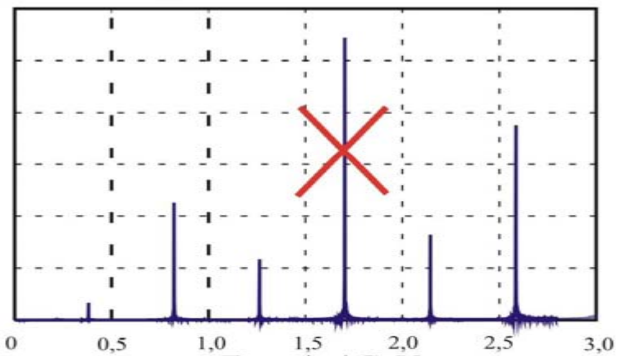
- measurement of beam position every millisecond
- computation of correcting currents
- generation of a current ramp for each steerer

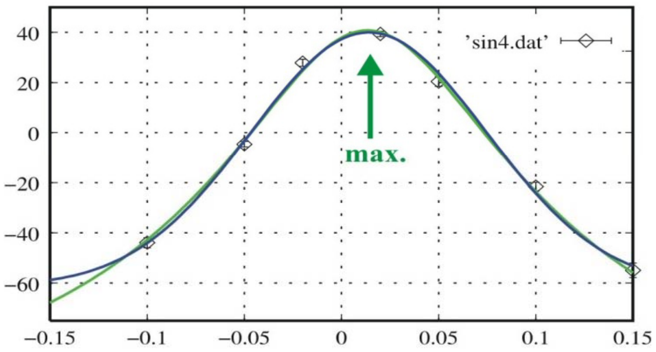
Orbit Correction on the Ramp

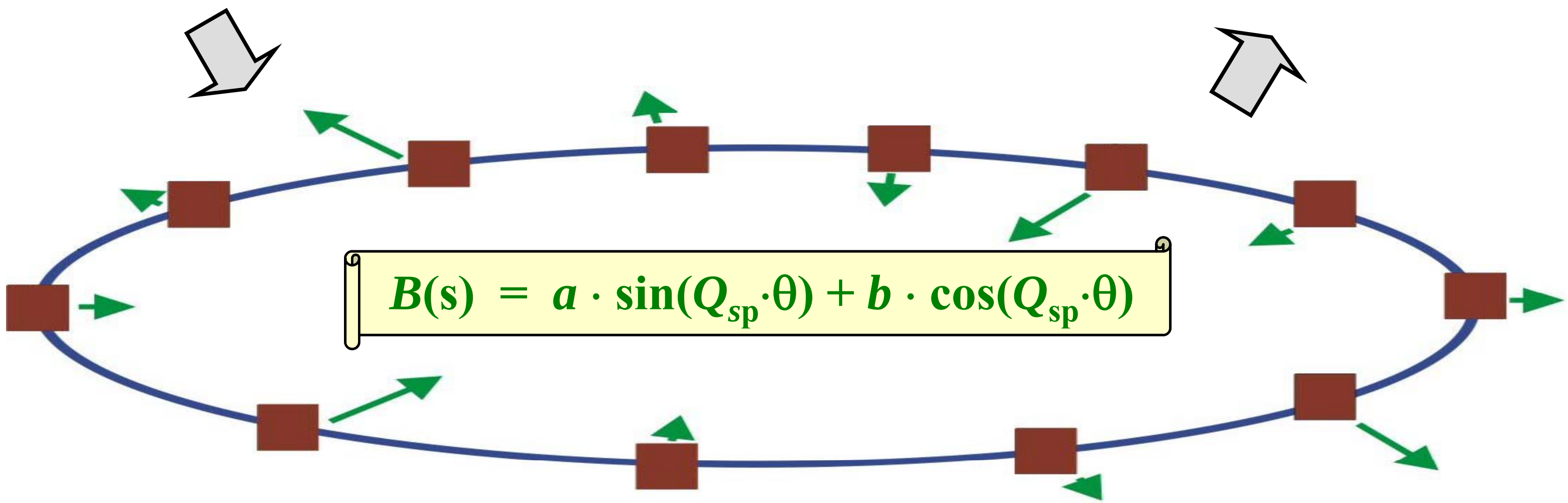


Harmonic Correction

(Imperfection Resonances)

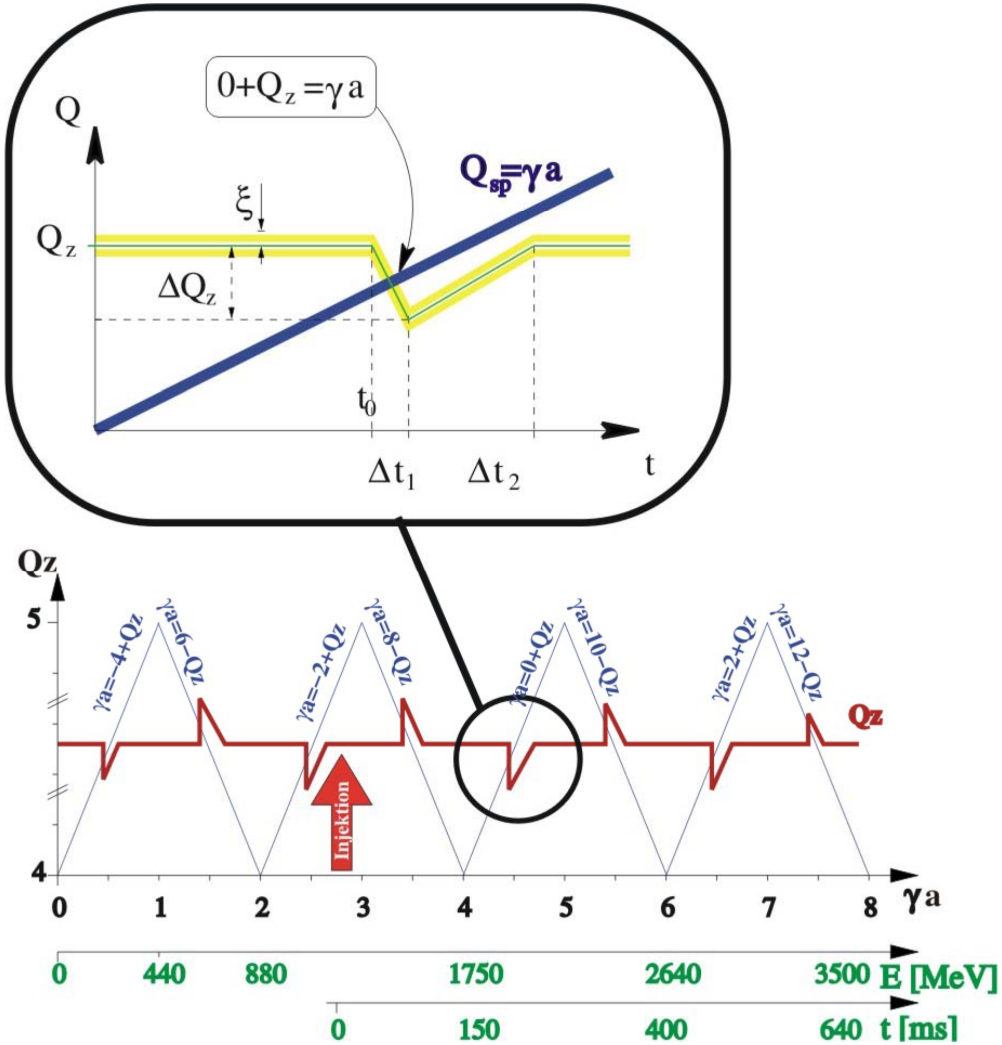






$$B(s) \;=\; a \cdot \sin(Q_{sp}\cdot\theta) + b \cdot \cos(Q_{sp}\cdot\theta)$$

"Tune Jumping"

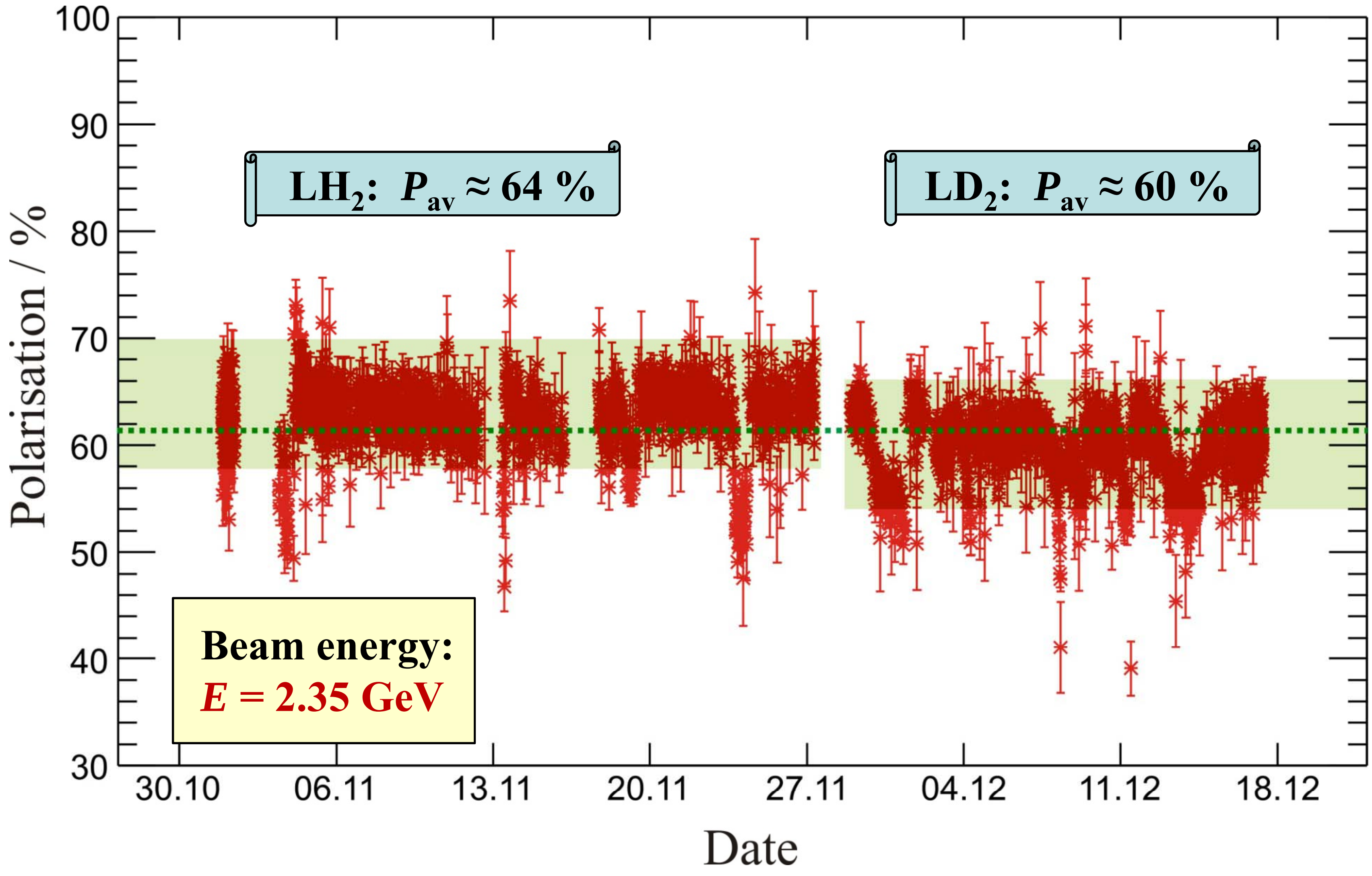


Sprungquadrupol

Panofsky-Typ Quadrupol mit Ferrit-Joch

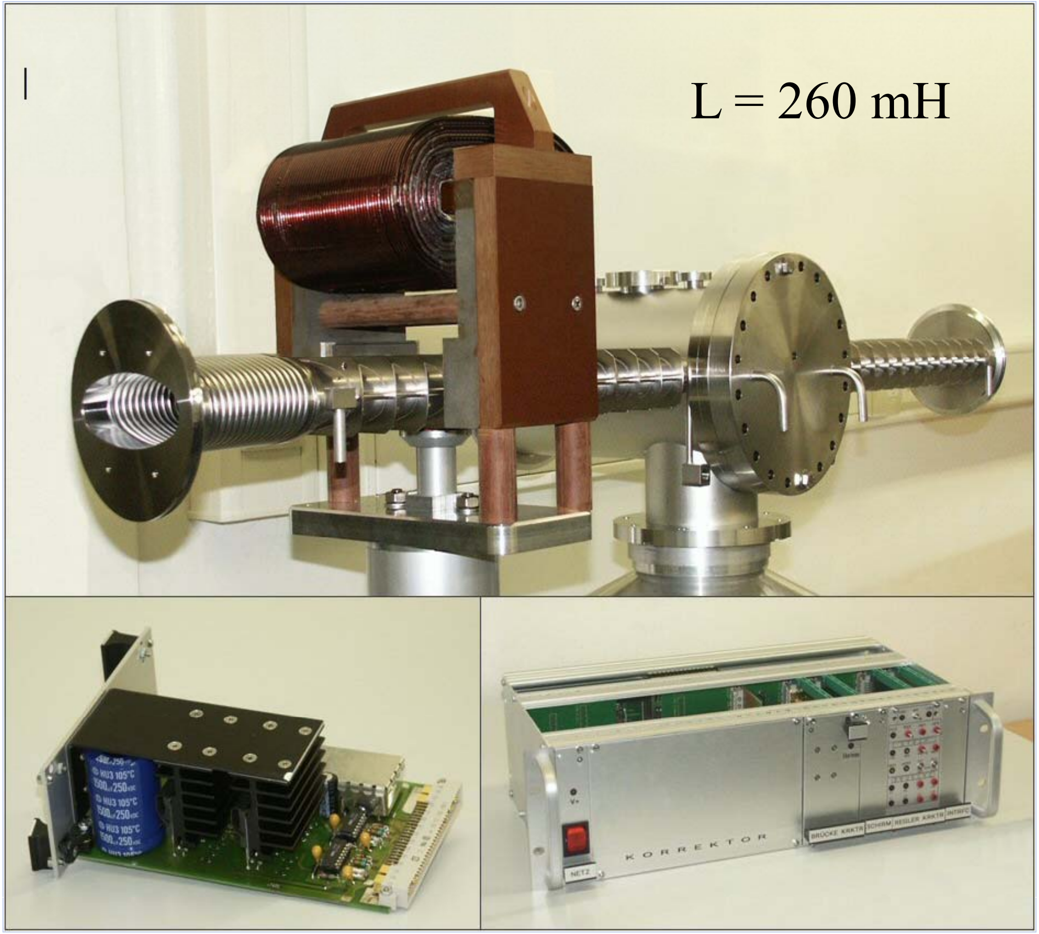
Vakuumkammer:	AL_2O_3 Keramik mit 10 μm Titanbeschichtung
Widerstand:	(4,298±0.001) mΩ (DC)
Induktivität:	(9,0±0,1) μH (DC)
max. Pulsstrom:	500 A
max. Feldgradient:	(1,1241 ±0,005) T/m
steigende Flanke:	4 - 14 μs
fallende Flanke:	4 - 20 ms

Polarization Nov. / Dec. 2008



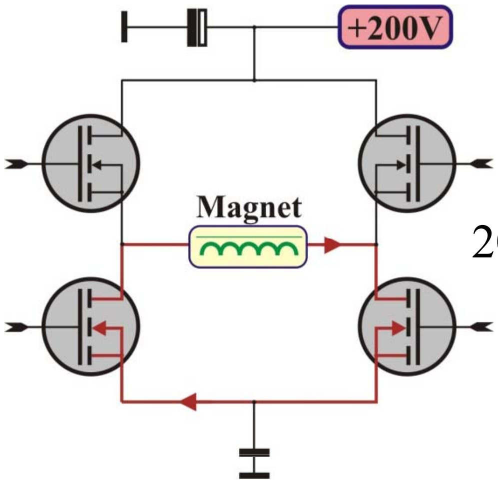
Orbit Correction System

New corrector magnet & fast switching power supply



Beam pipe optimized for eddy current suppression

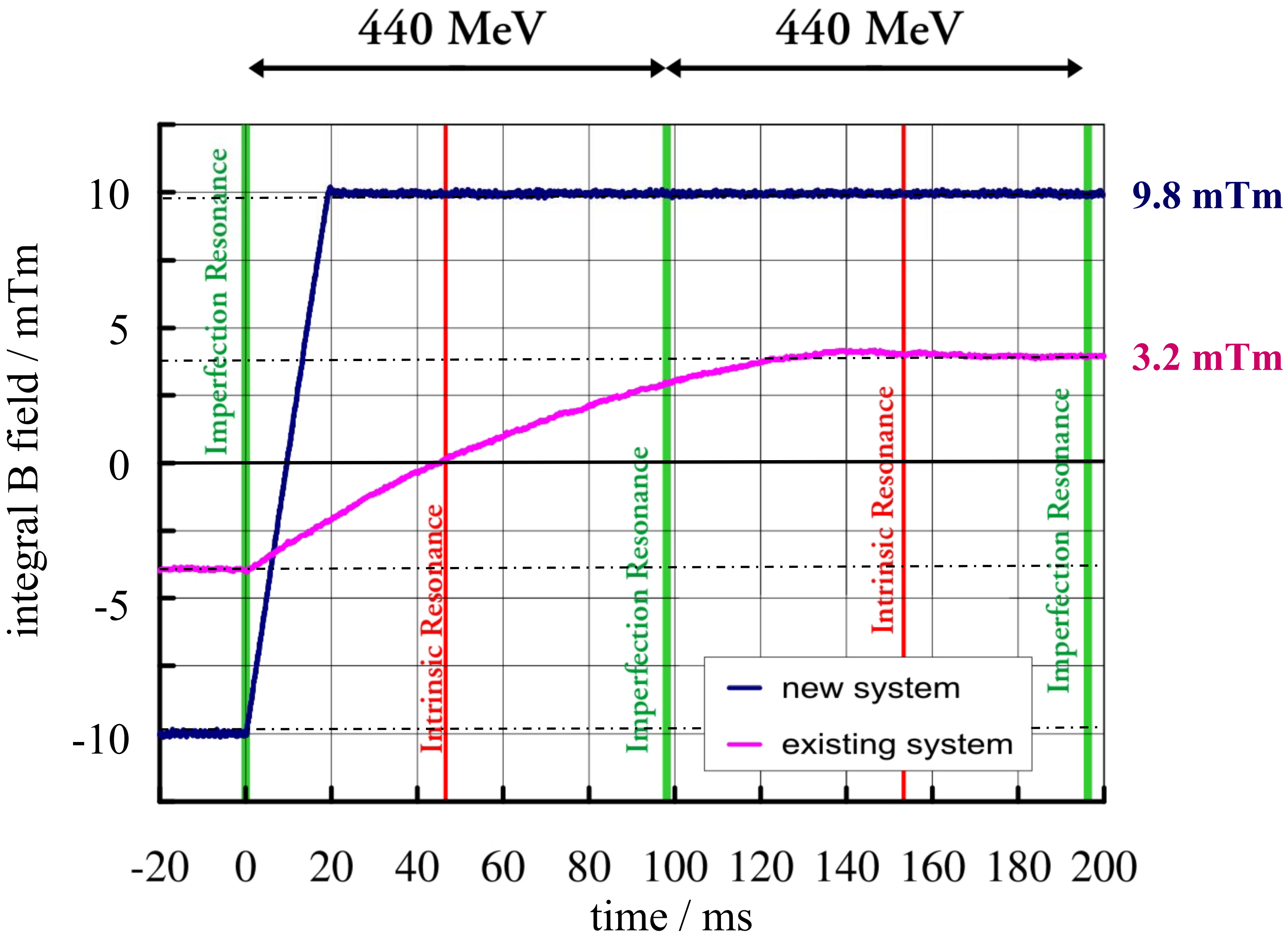
Programmable 4-quadrant power supply with microcontroller



20 kHz

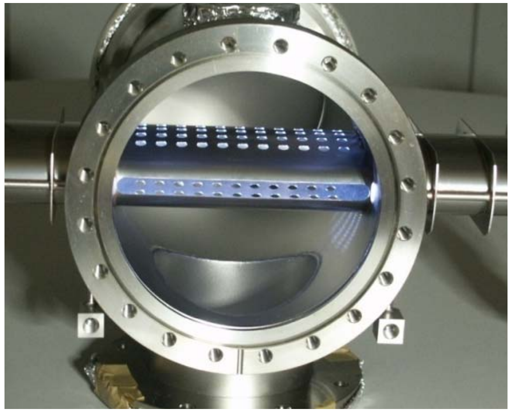
Implementation in 2009

Orbit Correction System



Increase of Dynamic Range

High Intensity Operation
Internal Current I = 200 mA

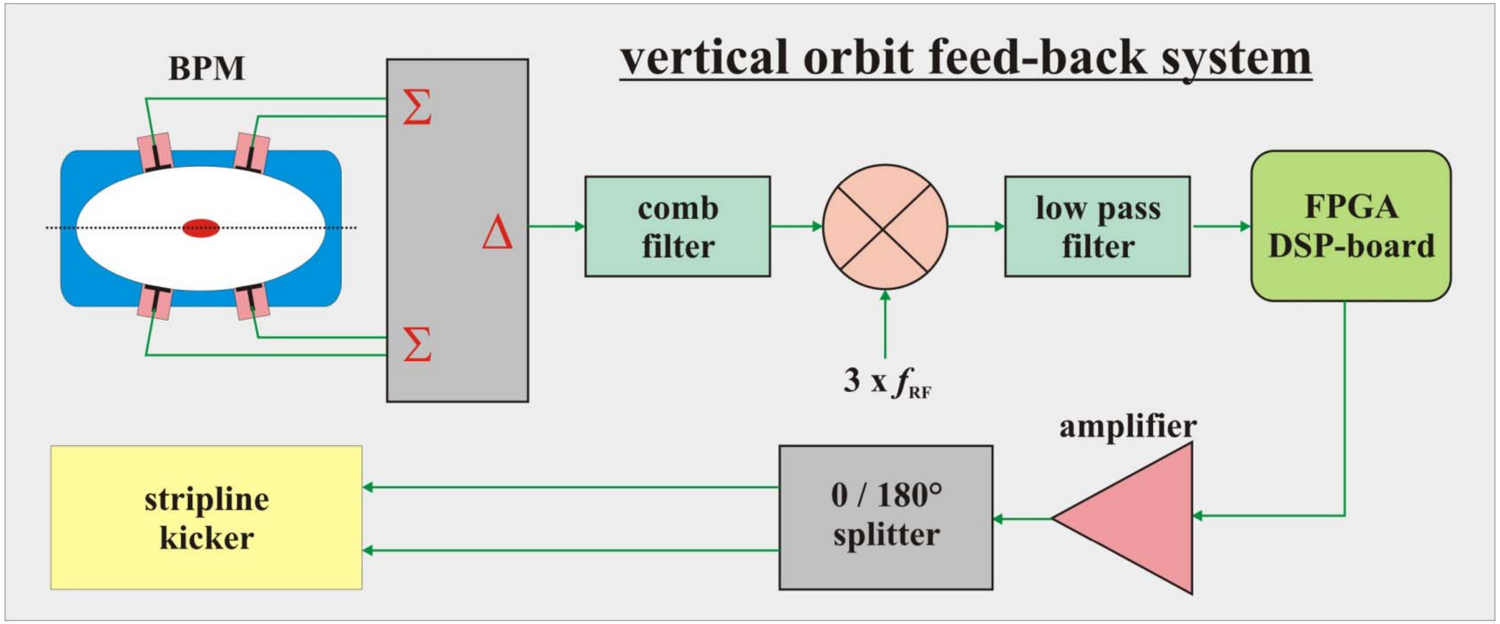


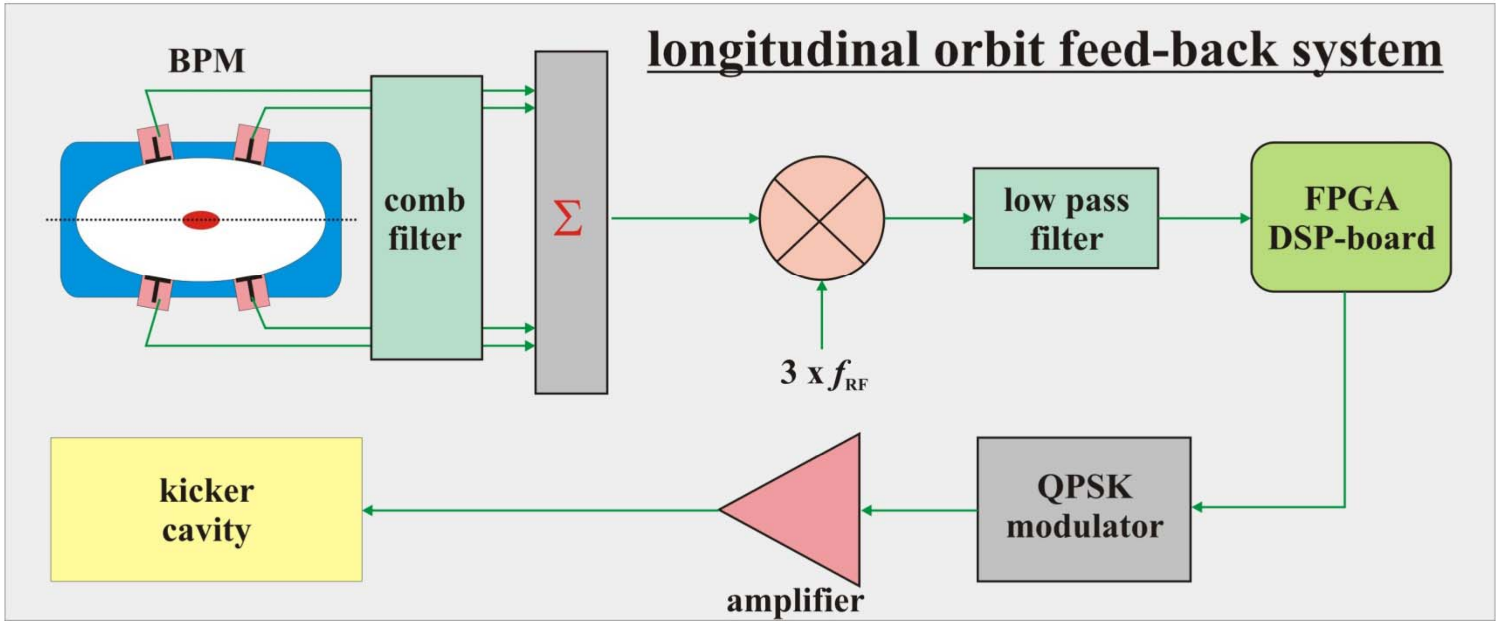
- Reduction of **Coupling Impedance**
- Damping of Cavity-**HOMs**
- Active **Bunch to Bunch Feedback**
- **Single-Bunch** Operation (diagnostic purpose)
- Upgrade of **Beam Diagnostics**
- Intensity Upgrade **Photoinjector**

SFB/TR 16

PHYSICS AT THE TERA SCALE
Helmholtz Alliance

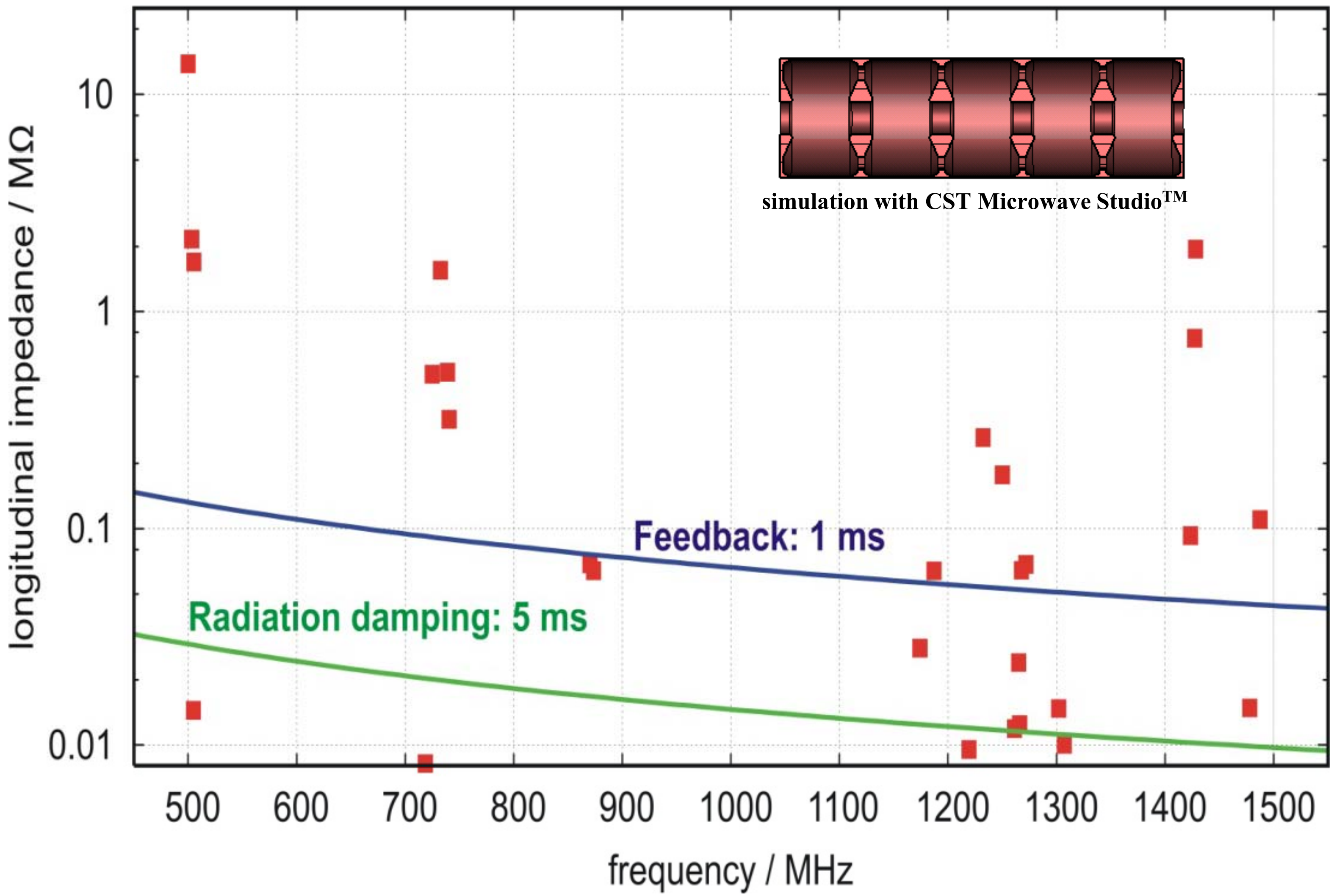
Bunch to Bunch Feed-Back System



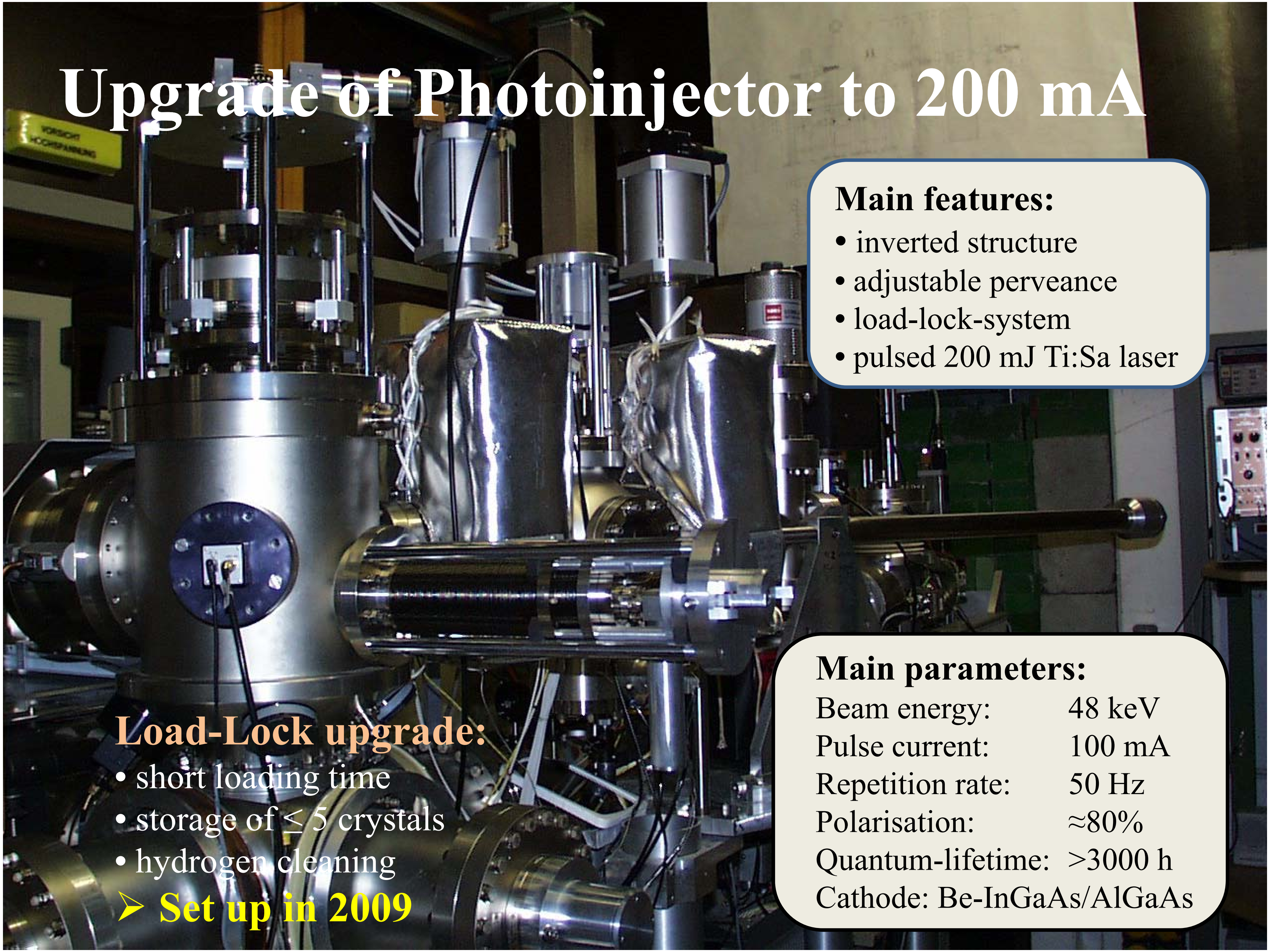


High Current Operation

Impedances of undamped monopol HOMs of Petra cavity at ELSA
and typical thresholds for beam instabilities at 30 mA and 2.4 GeV



Upgrade of Photoinjector to 200 mA



Main features:

- inverted structure
- adjustable perveance
- load-lock-system
- pulsed 200 mJ Ti:Sa laser

Main parameters:

Beam energy:	48 keV
Pulse current:	100 mA
Repetition rate:	50 Hz
Polarisation:	≈80%
Quantum-lifetime:	>3000 h

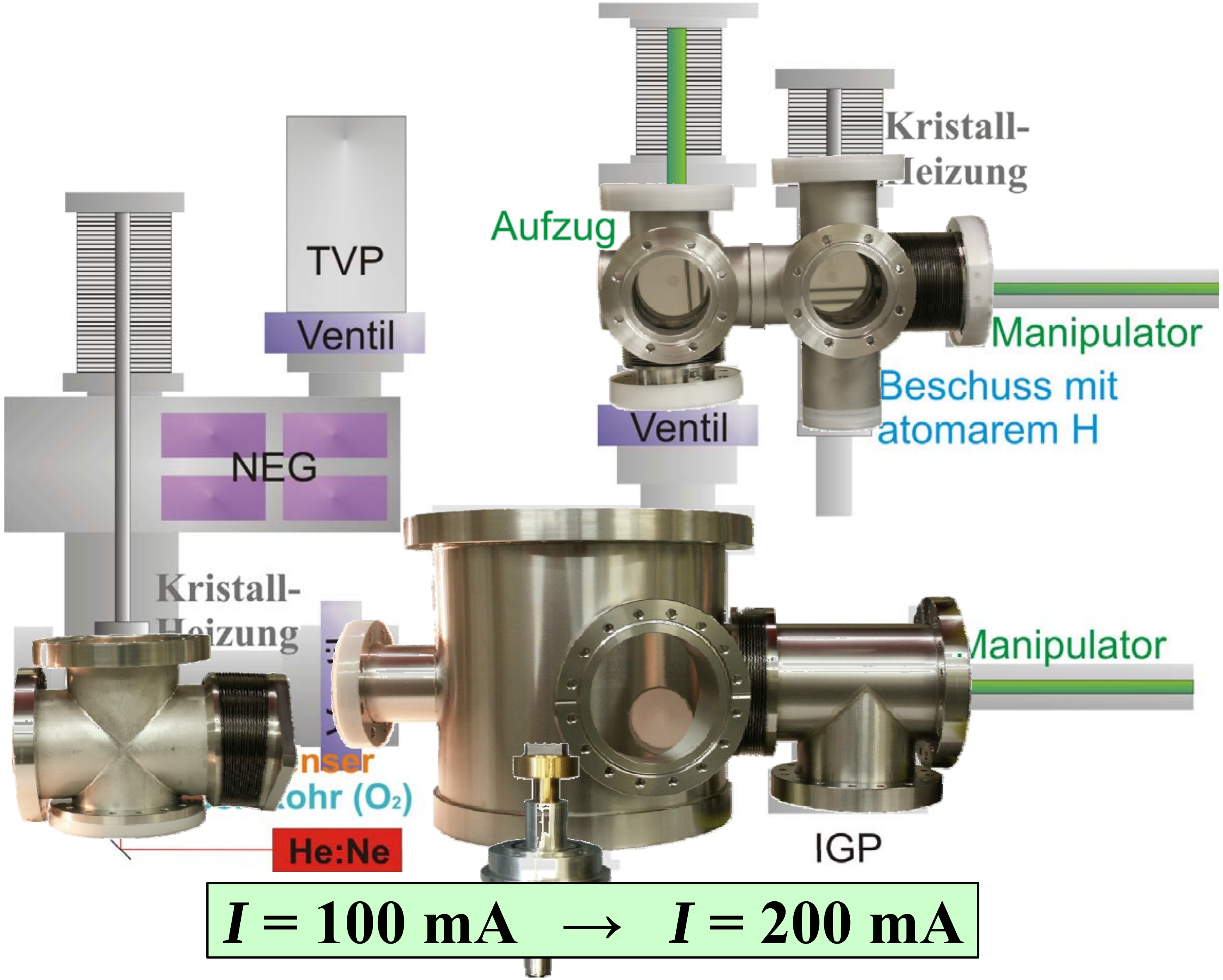
Cathode: Be-InGaAs/AlGaAs

Load-Lock upgrade:

- short loading time
- storage of ≤ 5 crystals
- hydrogen cleaning

➢ **Set up in 2009**

Upgrade Polarized Injector



$I = 100\ \mathrm{mA} \quad \rightarrow \quad I = 200\ \mathrm{mA}$

New Area for Detector Testing

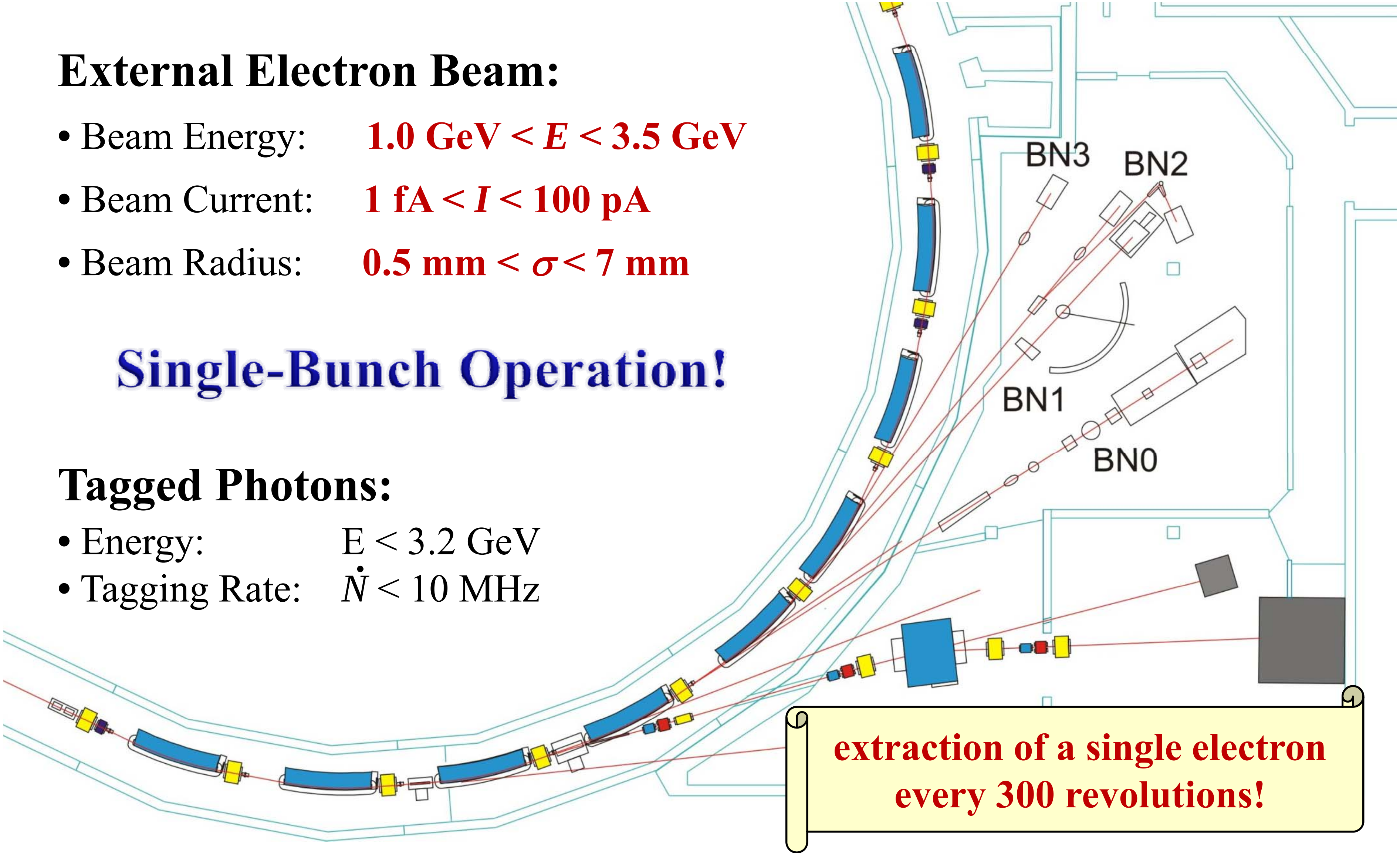
External Electron Beam:

- Beam Energy: **1.0 GeV < E < 3.5 GeV**
- Beam Current: **1 fA < I < 100 pA**
- Beam Radius: **0.5 mm < σ < 7 mm**

Single-Bunch Operation!

Tagged Photons:

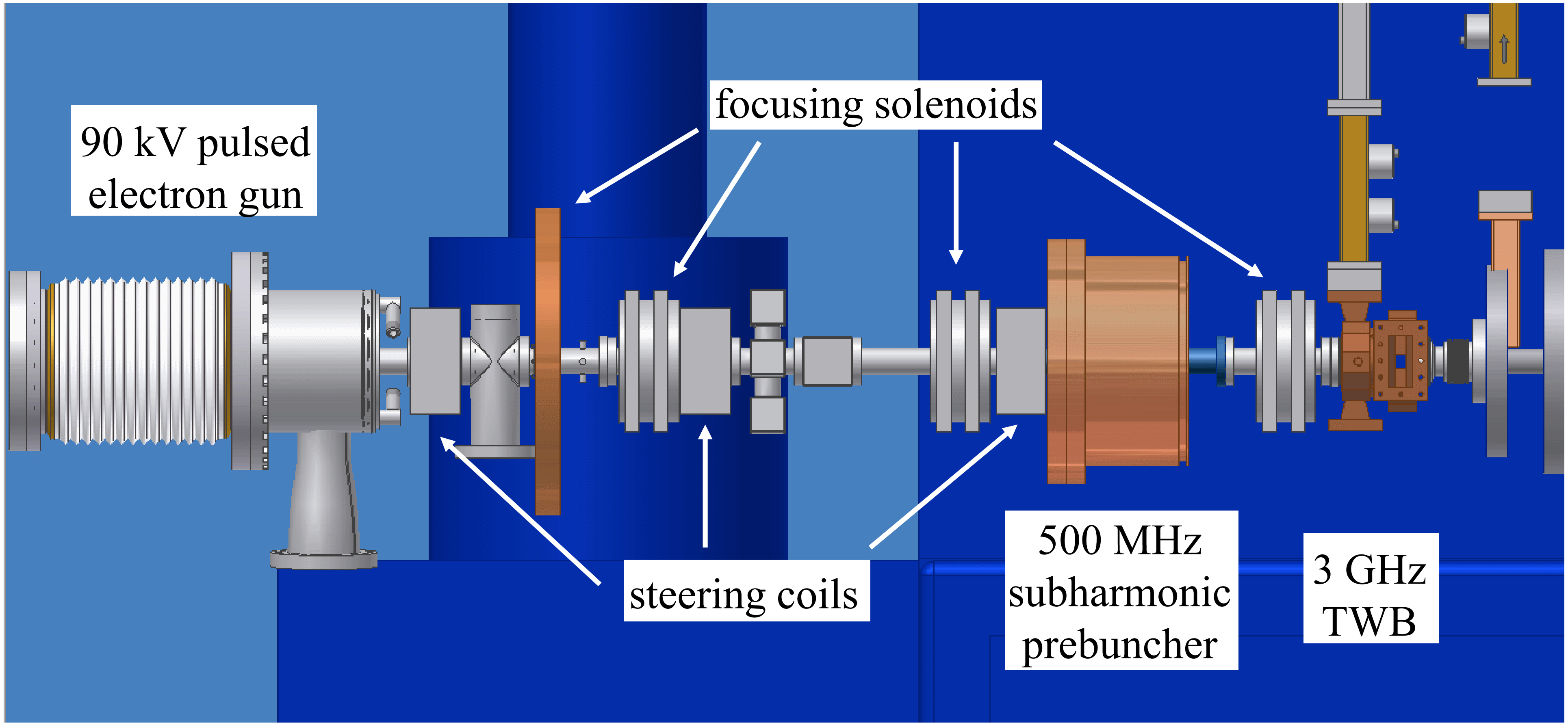
- Energy: E < 3.2 GeV
- Tagging Rate: $\dot{N}$ < 10 MHz



extraction of a single electron every 300 revolutions!

Single Pulse Injector @ LINAC 1

(major components from SBTF-injector / DESY)



+ single pulse accumulation in the stretcher ring ELSA

Conclusions

Meanwhile 2 standard operation modes @ ELSA:

- **linearly polarized photons up to $E_{e^-} = 3.2$ GeV**

  photon polarization dependent on coherent edge

  polarization orientation ±45° routinely achievable

- **circularly polarized photons up to $E_{e^-} = 2.35$ GeV**

  electron beam polarization higher than 60 %

  photon polarization dependent on photon energy

High long term stability of beam position and polarization!

Outlook: Planned Improvements

- **Source**: new **load-lock** with storage and H-cleaning
- **Polarimetry**: **Compton polarimeter** at ELSA
- **Polarization**: new **correctors** and **power supplies**
- **Stability**: **RF-based BPM** @ CB-Tagger
- **Optics**: full accelerator **tune stabilization**
- **Intensity**: high intensity operation (**D2: 2008-2012)**
- **Test-Area**: **new beam-line** for detector testing
- **Single-Bunch** operation: **ultra low intensity** (fA!)

…