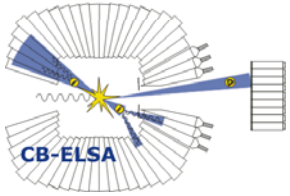
# The Bonn Electron Stretcher Accelerator


## *… and the B1 electron beamline*

*Wolfgang Hillert*

***Physics Institute of Bonn University***

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# Electron Stretcher Accelerator ELSA

**Director:** F. Klein

**Head of the Acc. Department:** W. Hillert

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**Research Associates:**

F. Frommberger C. Nietzel

**Operating Engineer:** F.-G. Engelmann

| Radio Frequency | Electro-Installations | Electronics | Mechanics | Vakuum | Technical Infrastructure |
|---|---|---|---|---|---|
| M. Thelen | K.-P. Faßbender<br>M. Holzhäuser<br>P. Mahlberg<br>H. Schug | H. Bücking<br>A. Dieckmann<br>M. Humpert<br>R. Müller | M. Brock<br>B. Neff<br>J. Schelske | H. Blank<br>J. Karthaus<br>N. Rick | T. Becker<br>W. Merfert<br>R. Schulz<br>Aytekin Yildiz |

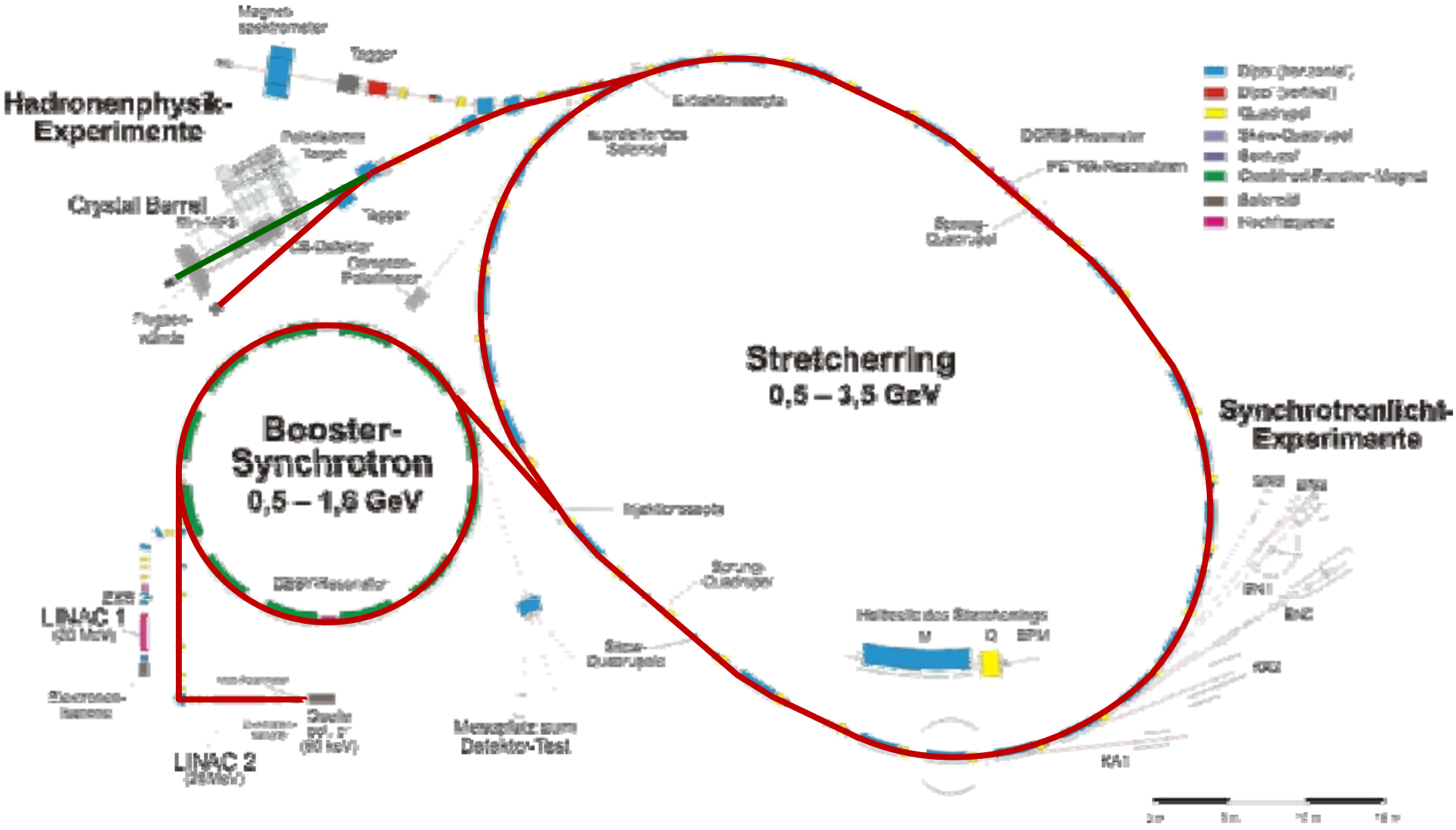
**PhD Stud.:** A. Balling, M. Eberhardt, F. Klarner, O. Preisner, T. Pusch, A. Roth, J. Wittschen, S. Zander

**Diploma Stud.:** B. Aurand, O. Boldt, D. Heiliger, D. Krönung, S. Patzelt

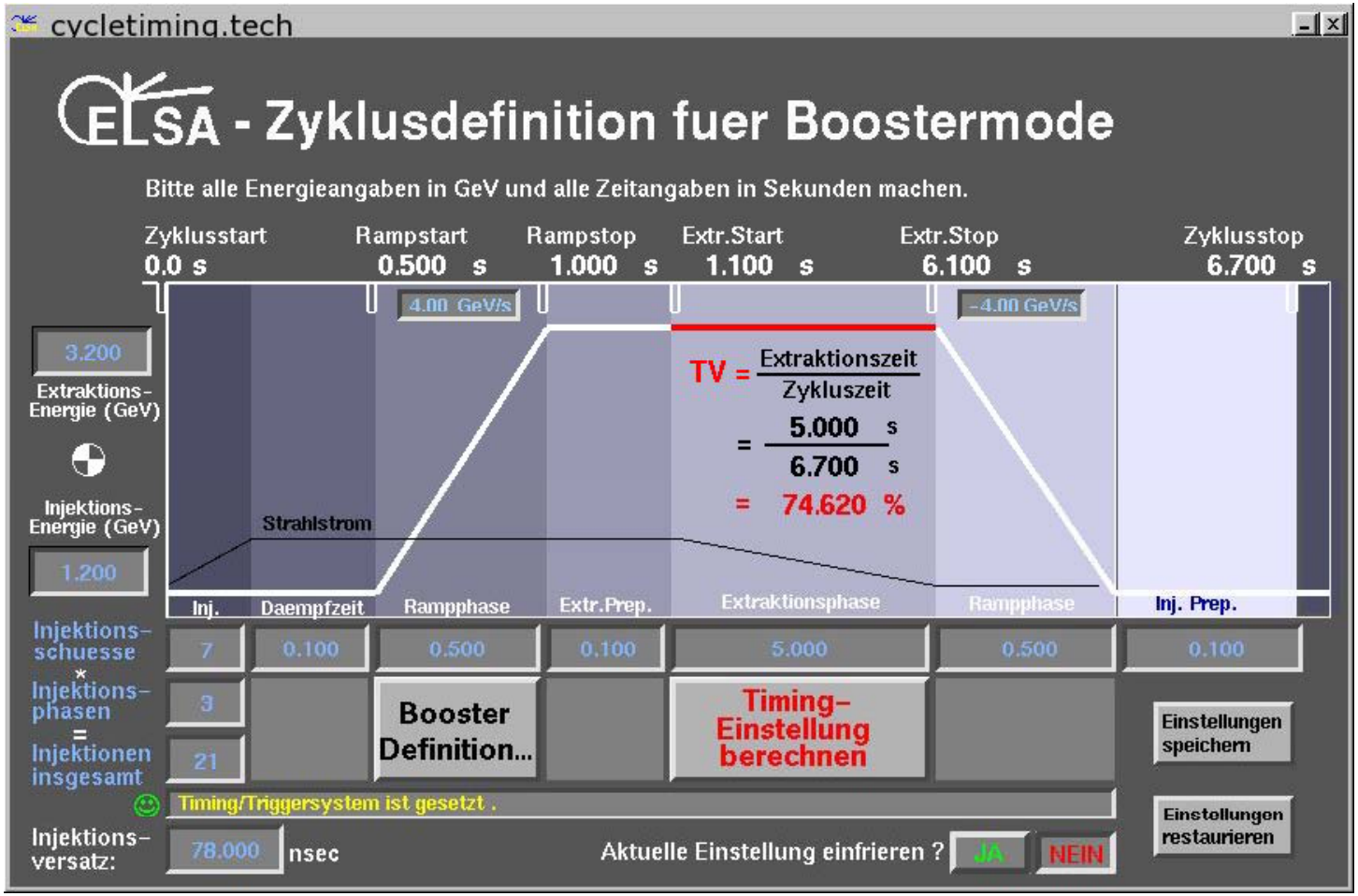
**Radiation Protection:** S. Goertz (conductor), H. Blank, H. Dutz, F.-G. Engelmann, F. Frommberger, W. Hillert, N. Joepen, D. Walther, M. Lang

**Laser Protection:** W. Hillert, F.-G. Engelmann

# Elektronen-Stretcher-Anlage (ELSA)

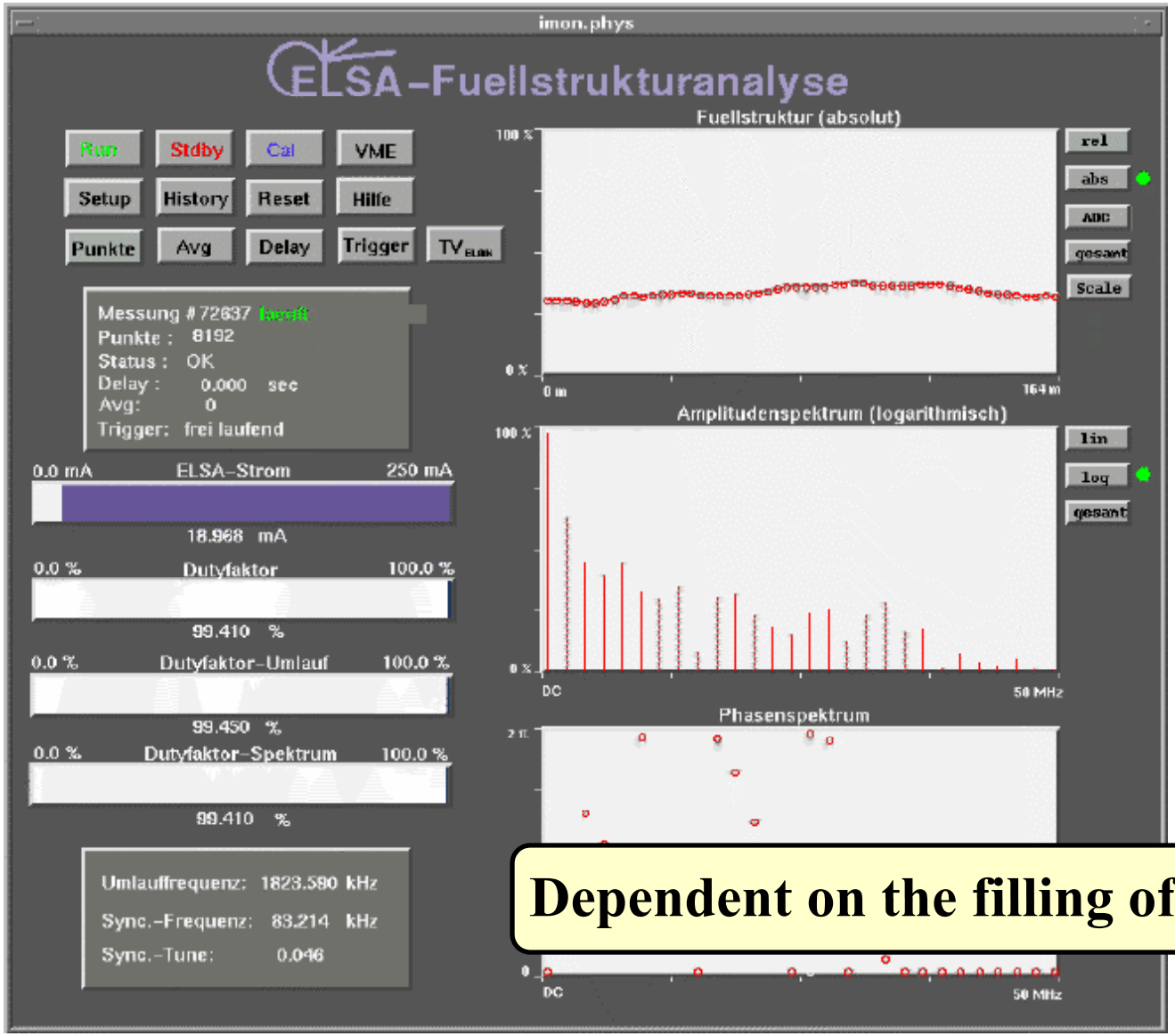


# Duty Cycle




**Macroscopic duty cycle**: $DC_{mac} = \dfrac{\Delta T\,(\text{external beam})}{\Delta T\,(\text{complete cycle})}$

# Microscopic Duty Cycle




**Dependent on the filling of ELSA**

# Beam Characteristics:

## Internal Beam:

### Emittance (natural):

- horz.: $\varepsilon_x \geq 78 \cdot (E[\text{GeV}])^2$ nm·rad , $\varepsilon_z \approx 0.1 \cdot \varepsilon_x$ (typ.)

### Beam Divergence:

- remember: $\sigma_{x'} = \varepsilon / \sigma_x \rightarrow \sigma_{x'}(\sigma_x = 1\text{mm}) \leq 10/\gamma$ (@3.2GeV)

### Intensity Distributions:

- Transverse ↔ Synchrotron light monitor
- Longitudinal ↔ RF-based measurements

# Syli – Monitor

Purpose:

**Profile and Position of stored beam**

**online, non-destructive!**

Resolution:

- **189 μm horizontal**
- **96 μm vertical**

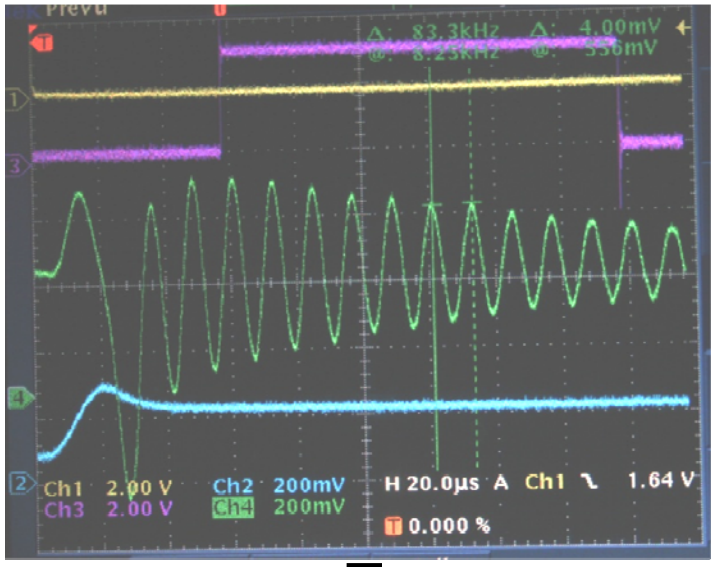
Status: close to operation!

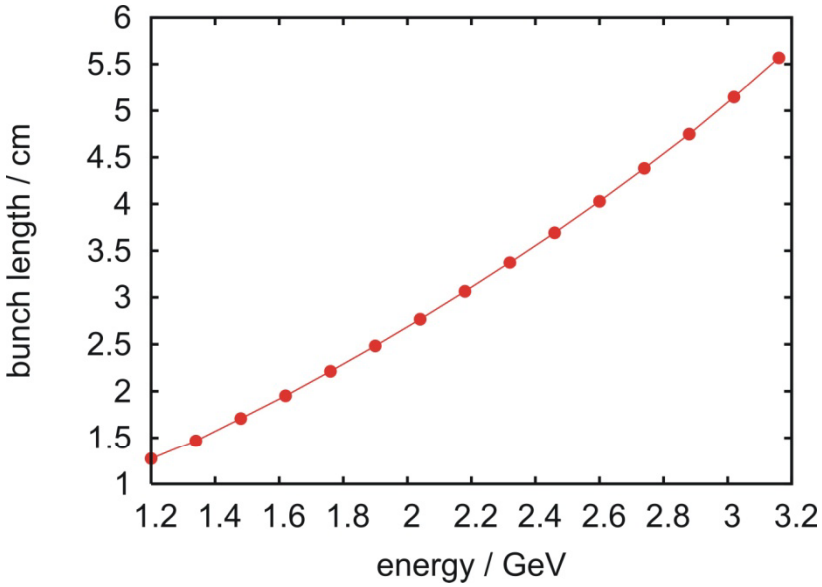
- **Diamond-milling of water-cooled Cu-mirror (Fraunhofer-Institute Aa)**
- **Installation, alignment, bake-out**

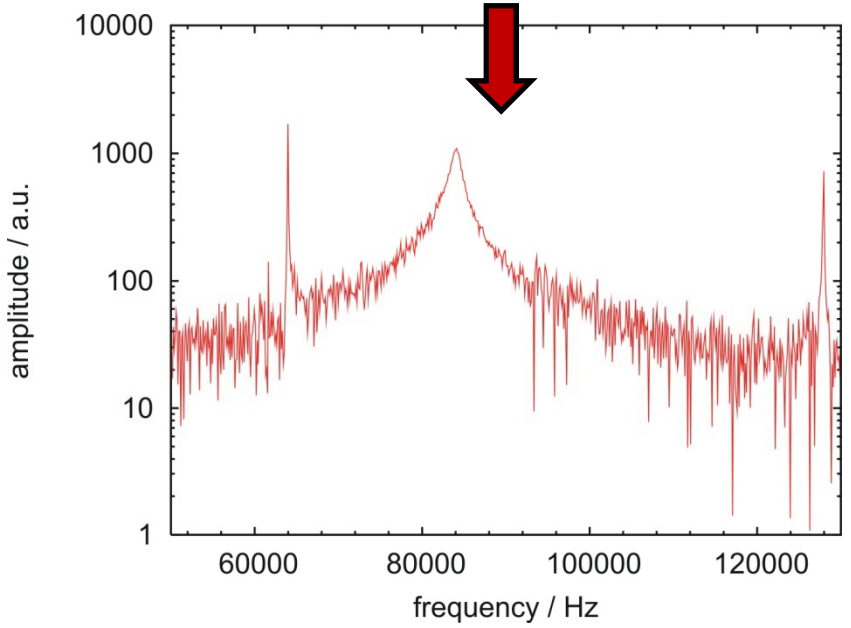
# Synchrotron-Tune Measurements

**Parameters @ 3.2 GeV:**

- $\sigma_t \geq 192$ ps $(\sigma_s \geq 5.76$ cm)
- $\sigma_E / E \approx 0.08\%$ $(\sigma_E \approx 2.56$ MeV)
- $\tau = 23.5$ sec, $q = 3.06$
- rel. beam-loss $\approx$ 4.2% / sec

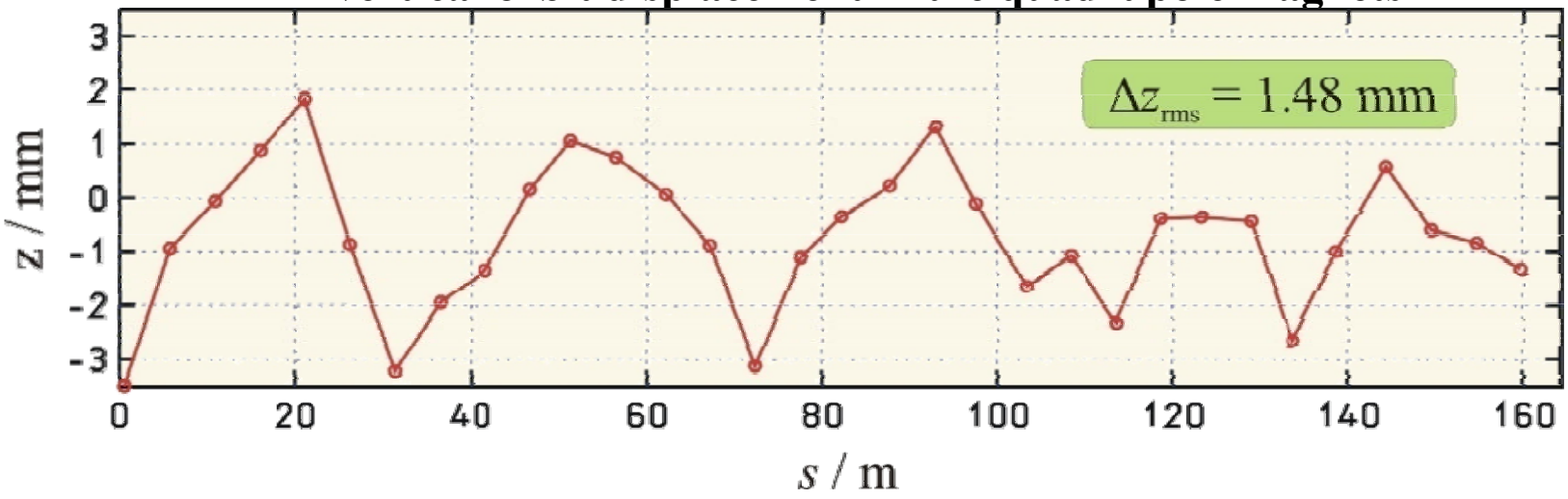


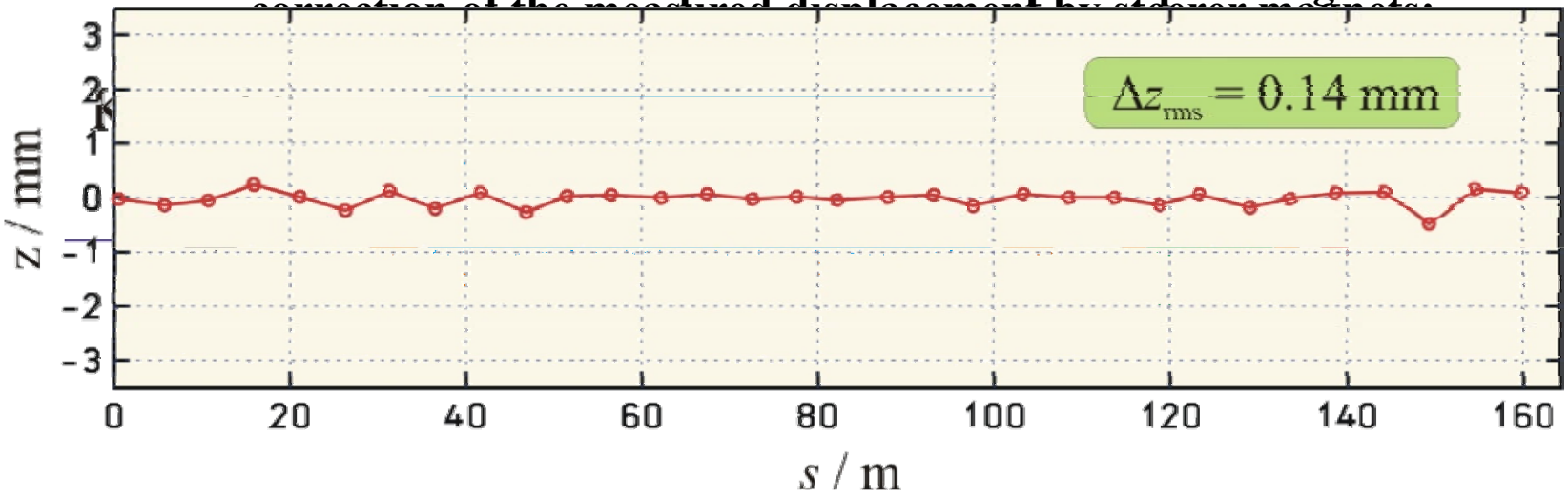



# Closed Orbit

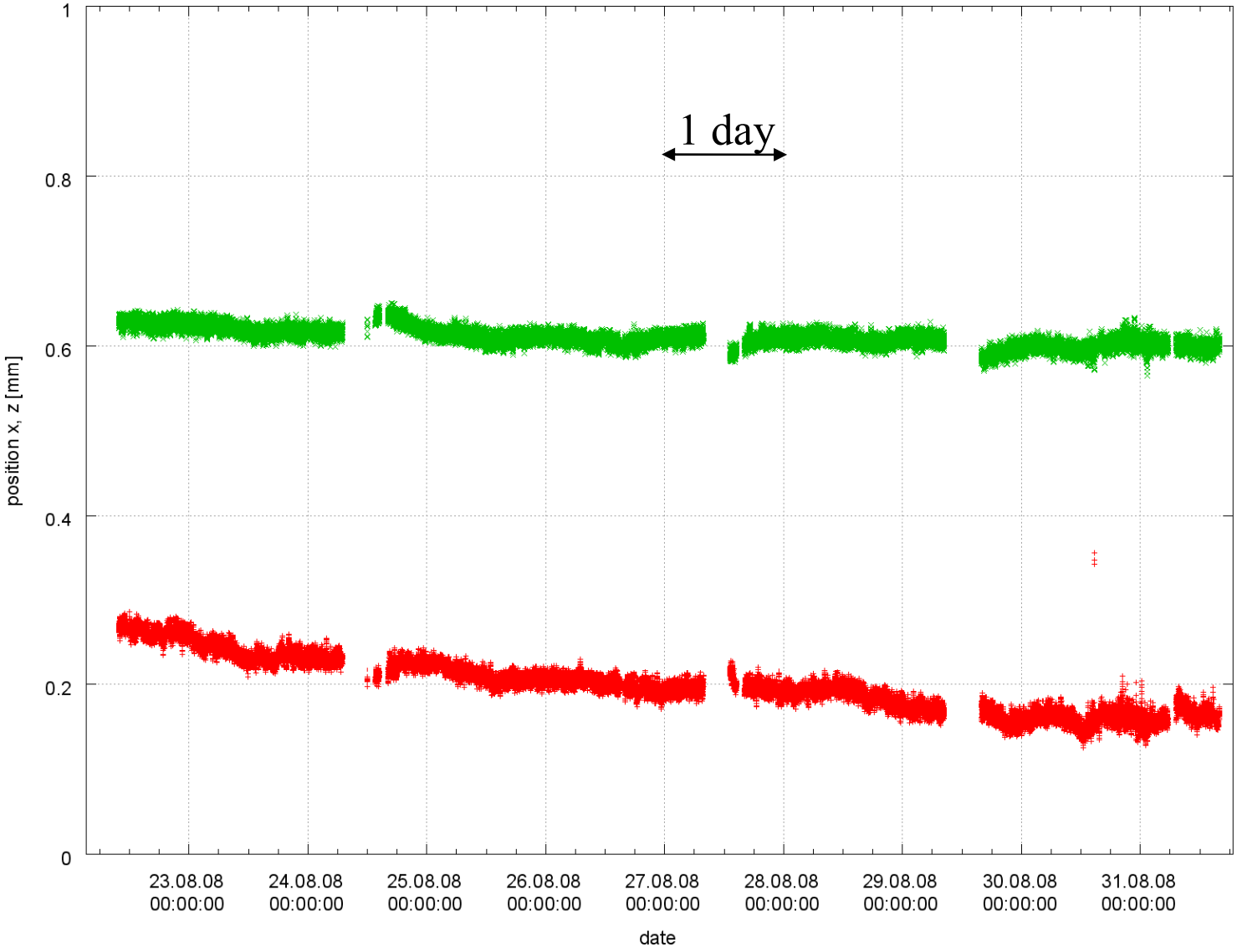
**vertical orbit displacement in the quadrupole magnets**




**vertical orbit displacement in the quadrupole magnets**



# Long Term Stability



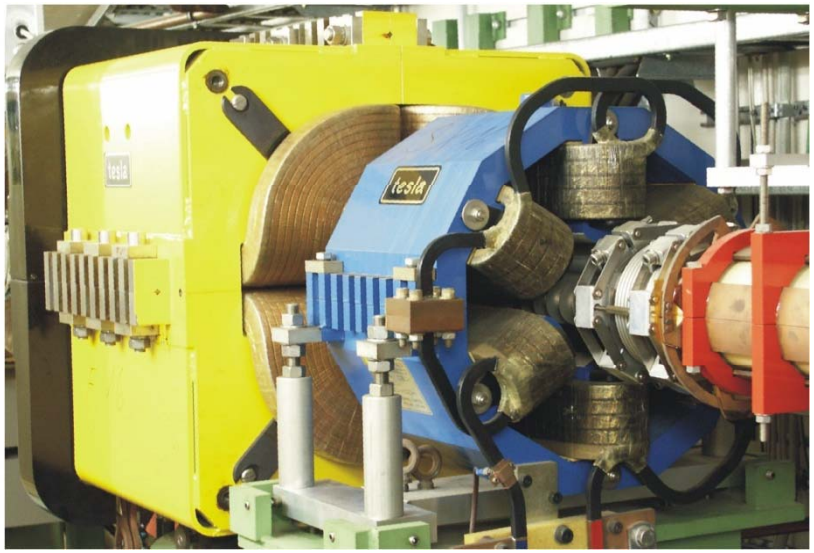
# Beam Characteristics:

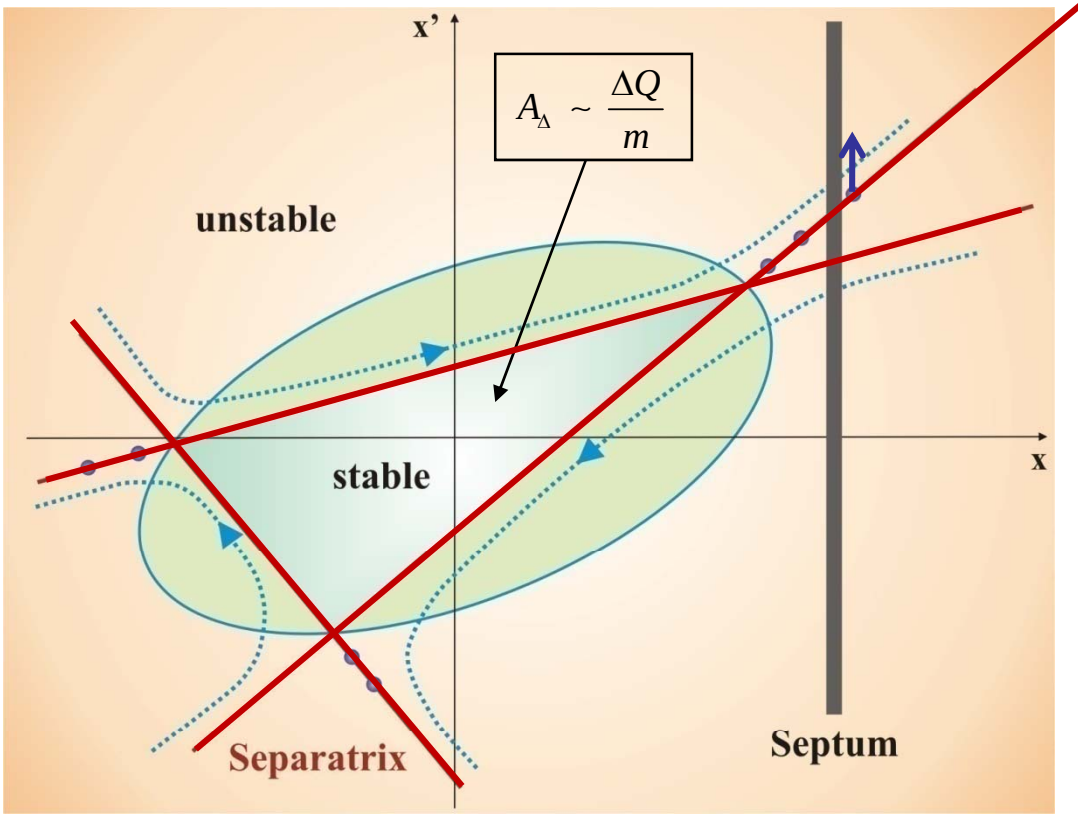
## External Beam:

### Beam Parameters:

- **horz.:** affected by extraction, **have to be measured**
- **vert., long.:** about the same as the internal values

# Slow Beam Extraction

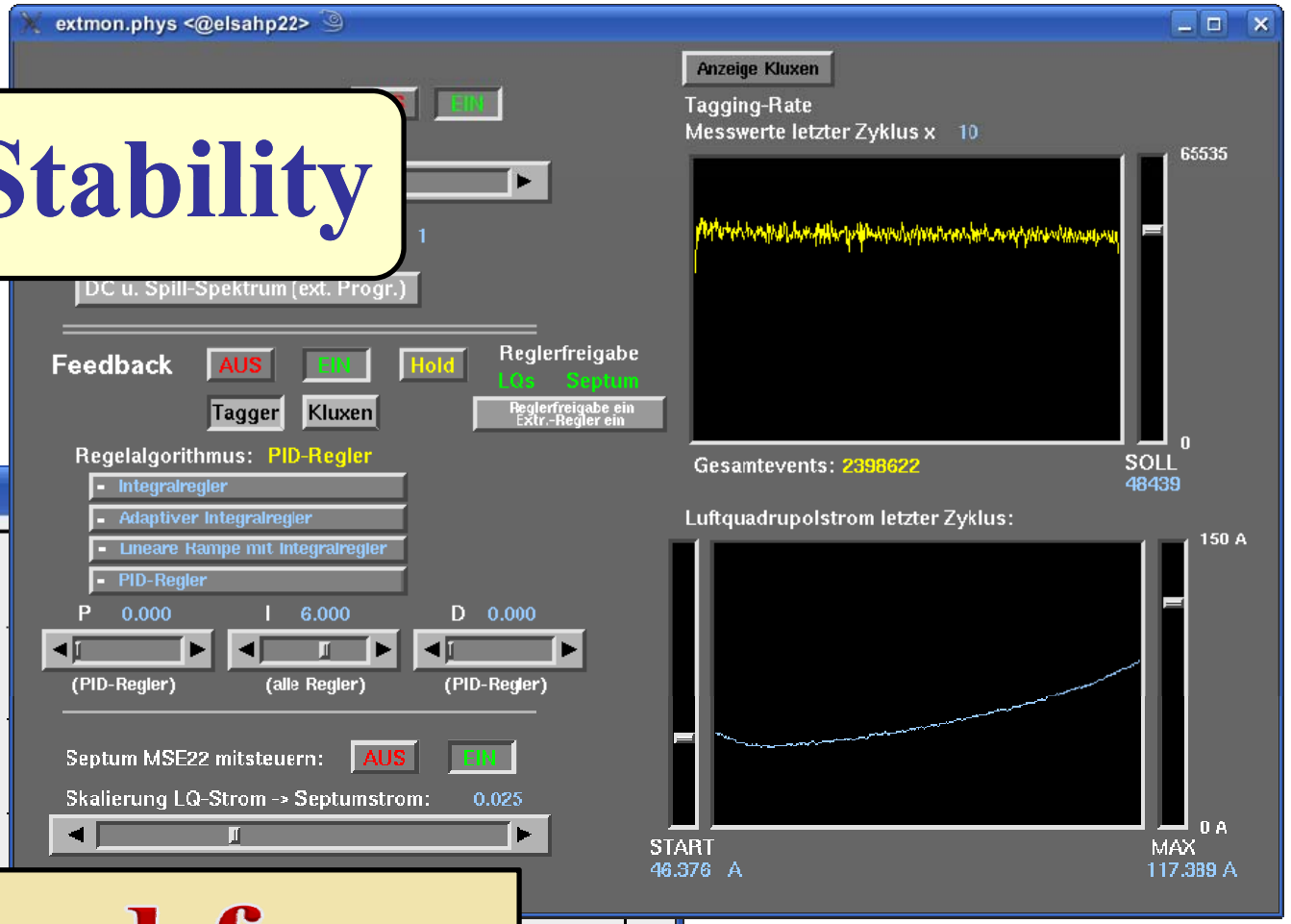


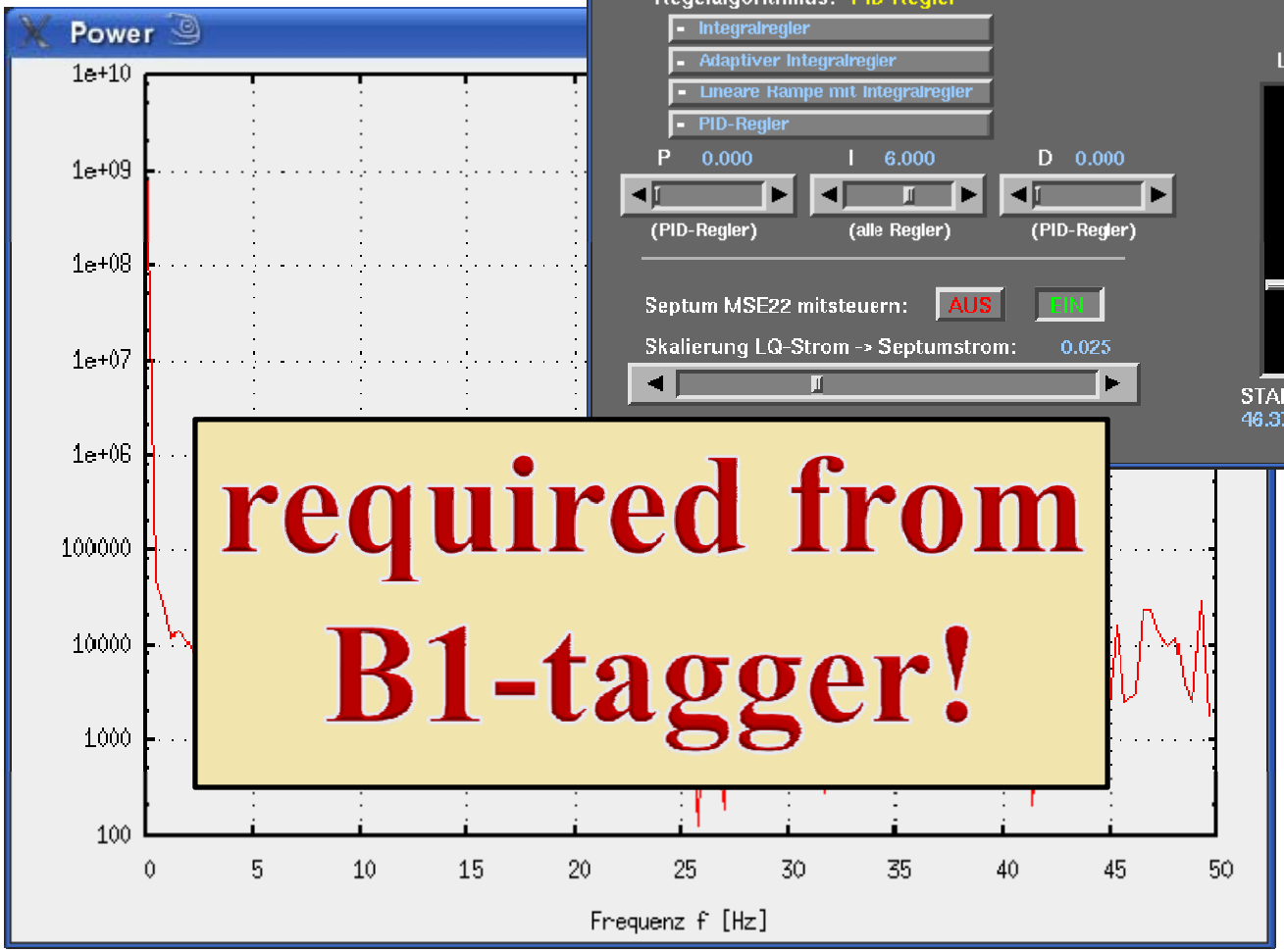




**Sextupole Magnets (Extraction):**
Excitation of a third integer resonance

**Ironless Quadrupole Magnets (Extraction):**
Shift of the horizontal betatron tune close to a third integer value, "current feedback-loop"

# Intensity Stability




**required from B1-tagger!**

***Stabilization of "overall" tagging rate (tagger-or)***

# Beam Characteristics:

## External Beam:

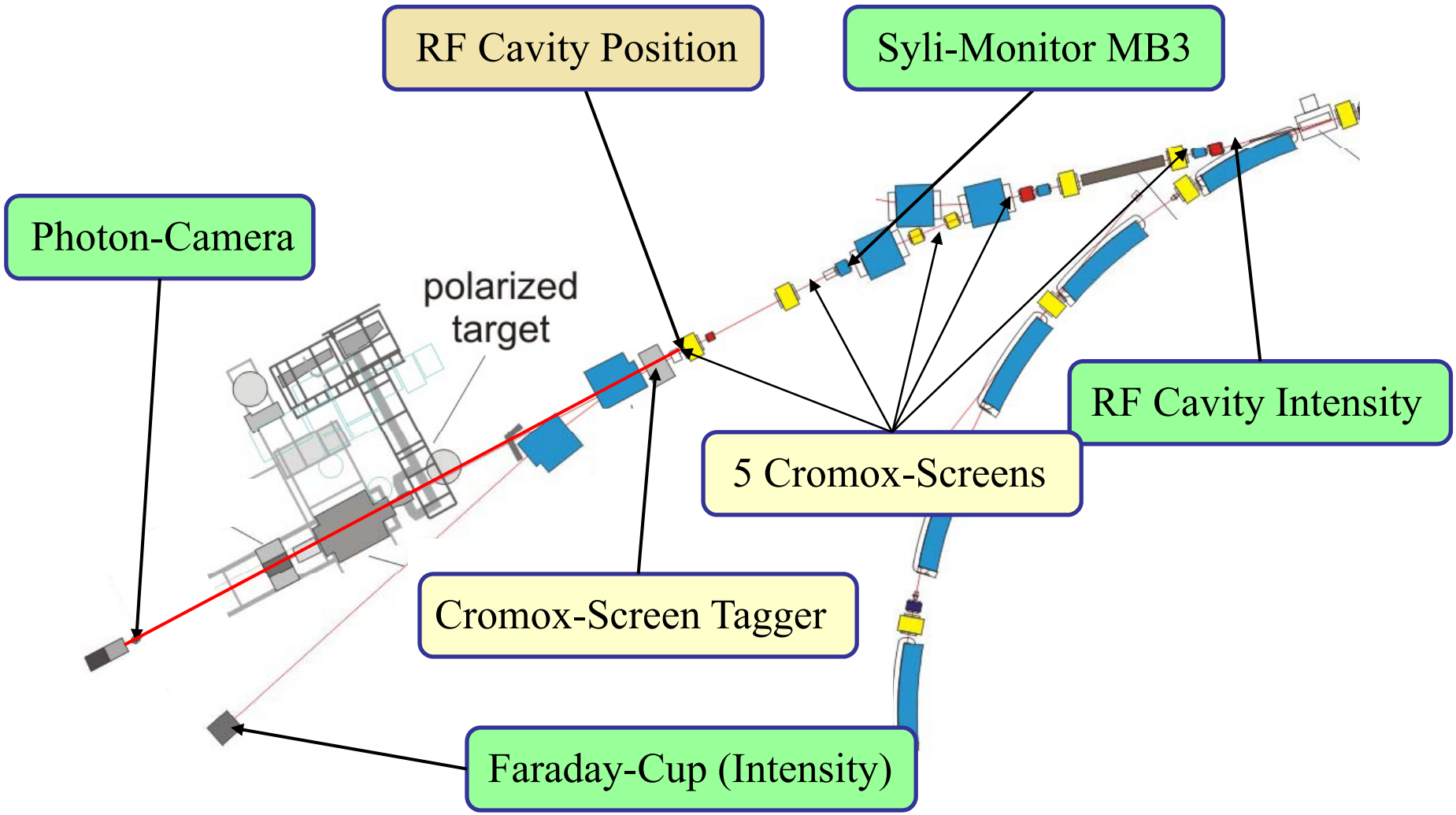
### Beam Parameters:

- **horz.:** affected by extraction, **have to be measured**
- **vert., long.:** about the same as the internal values

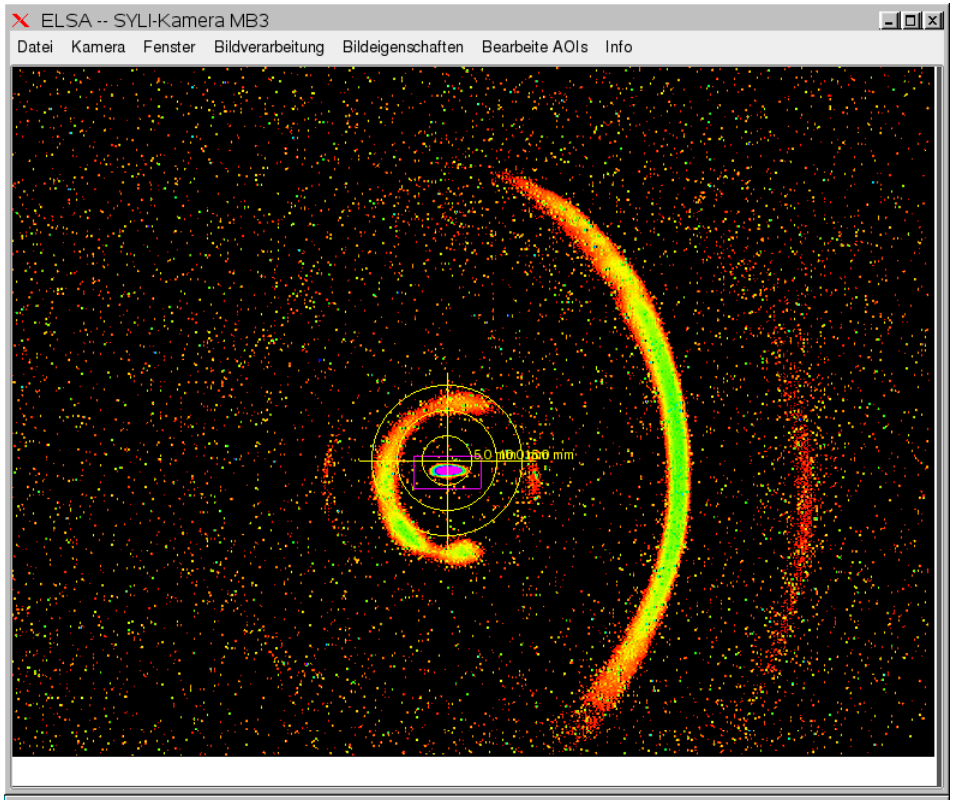
### Long-term Stability:

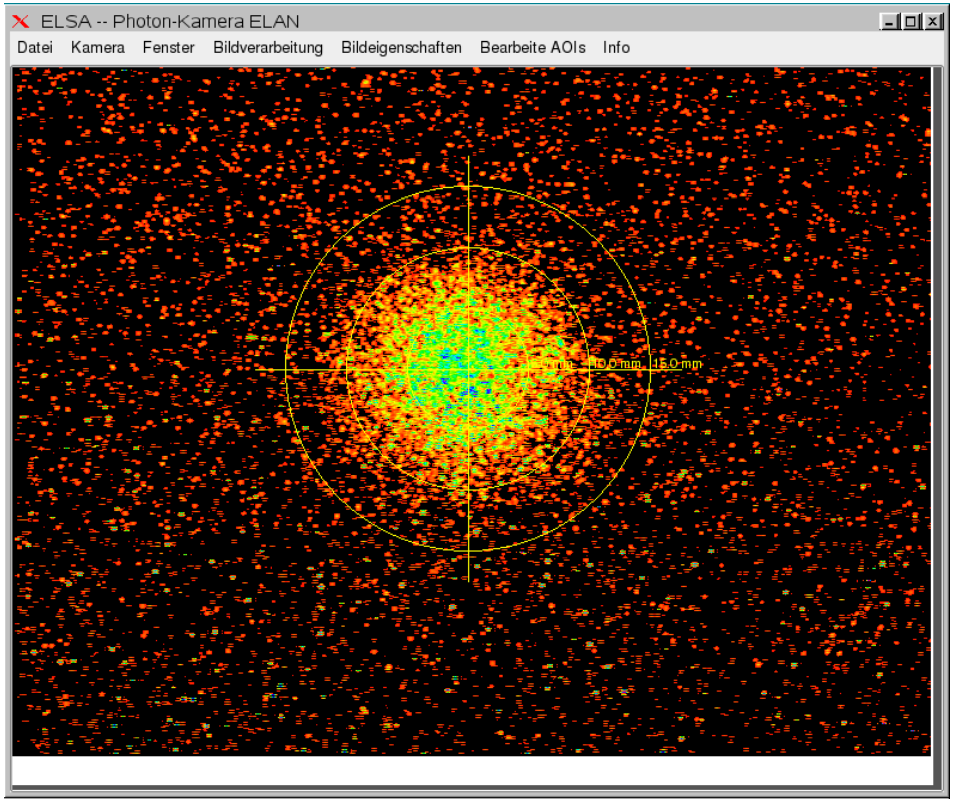
- beam pointing stability ↔ **photon-camera**
- intensity stability ↔ **RF-cavity, tagger**

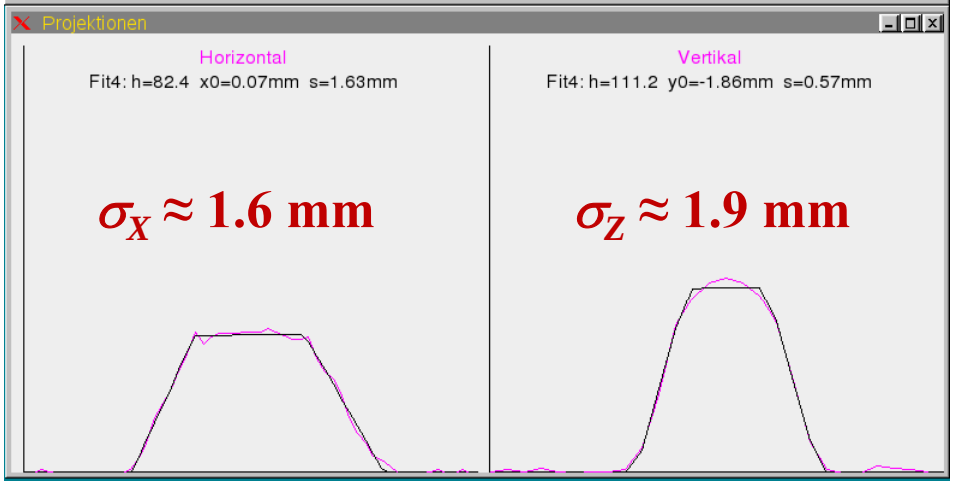
# Useful Instrumentation: CB

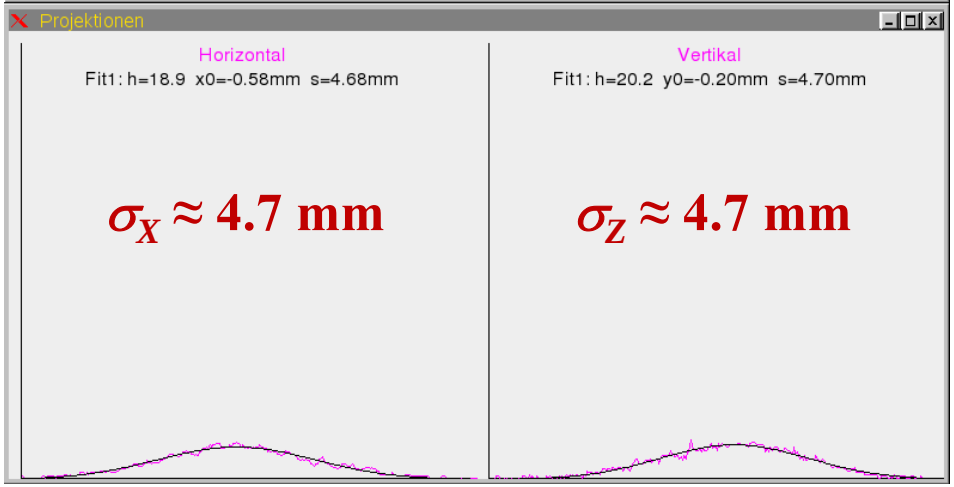


# SYLI-Monitor / Photon-Camera

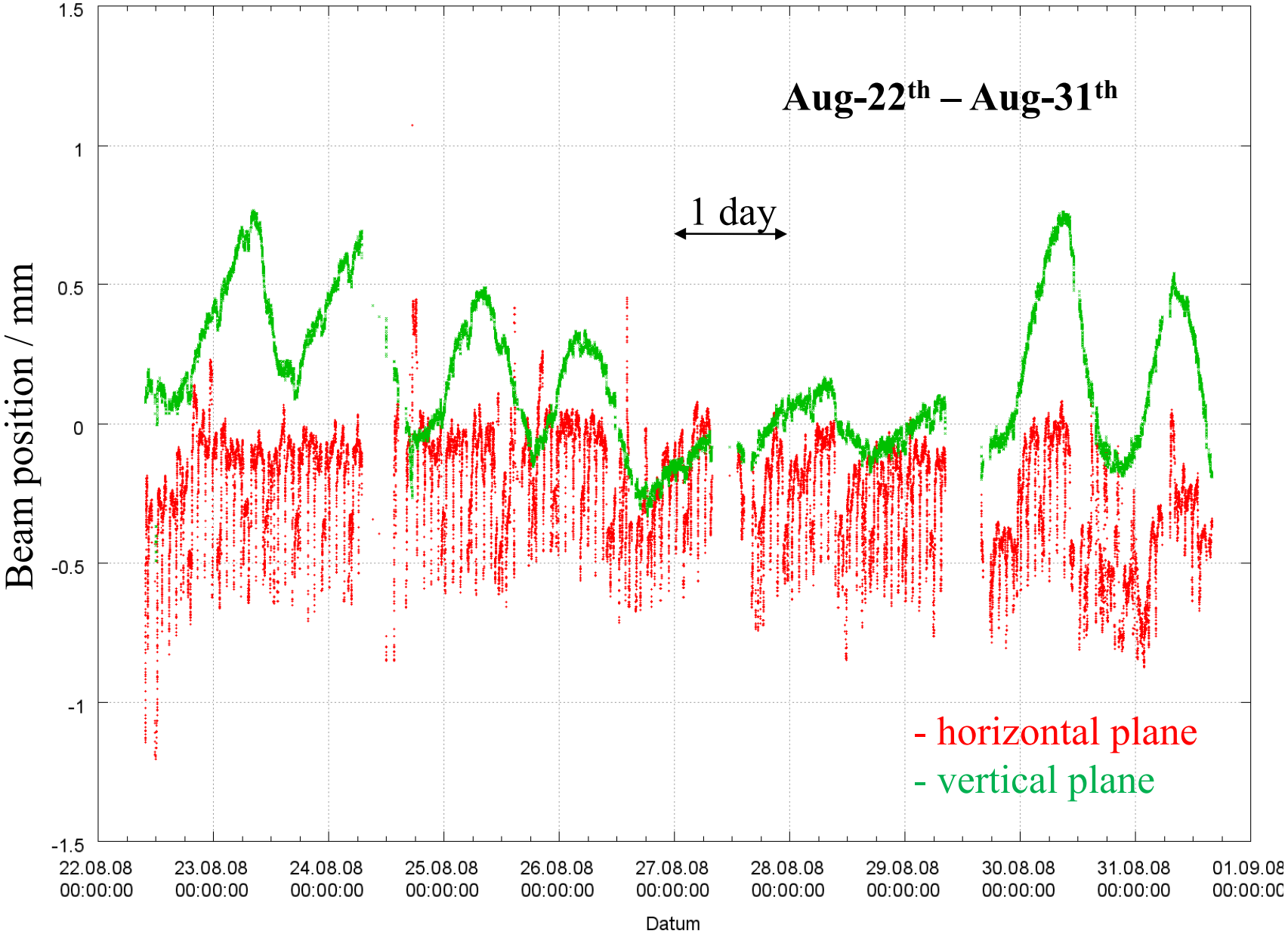


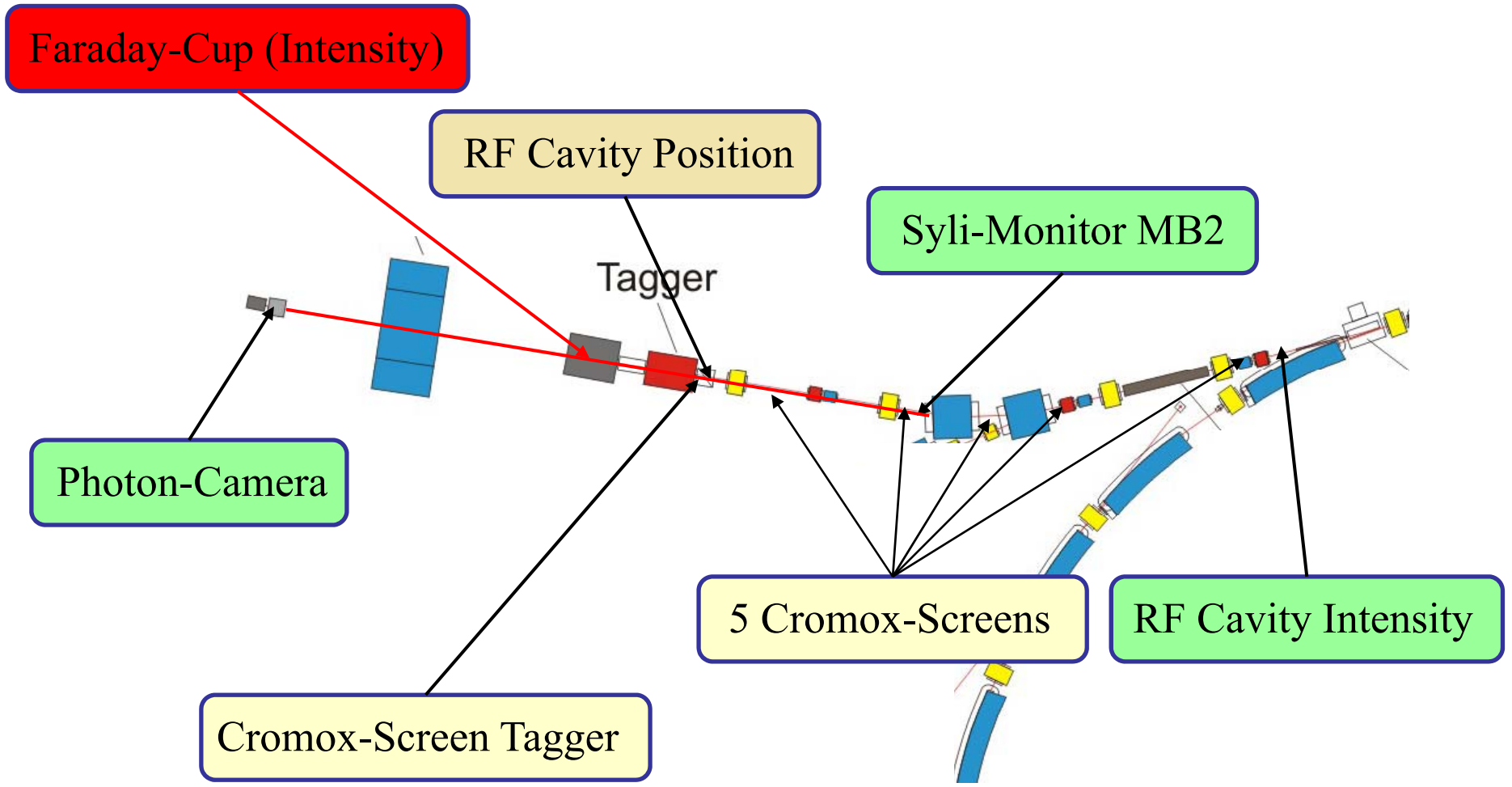



# Beam Pointing Stability CB

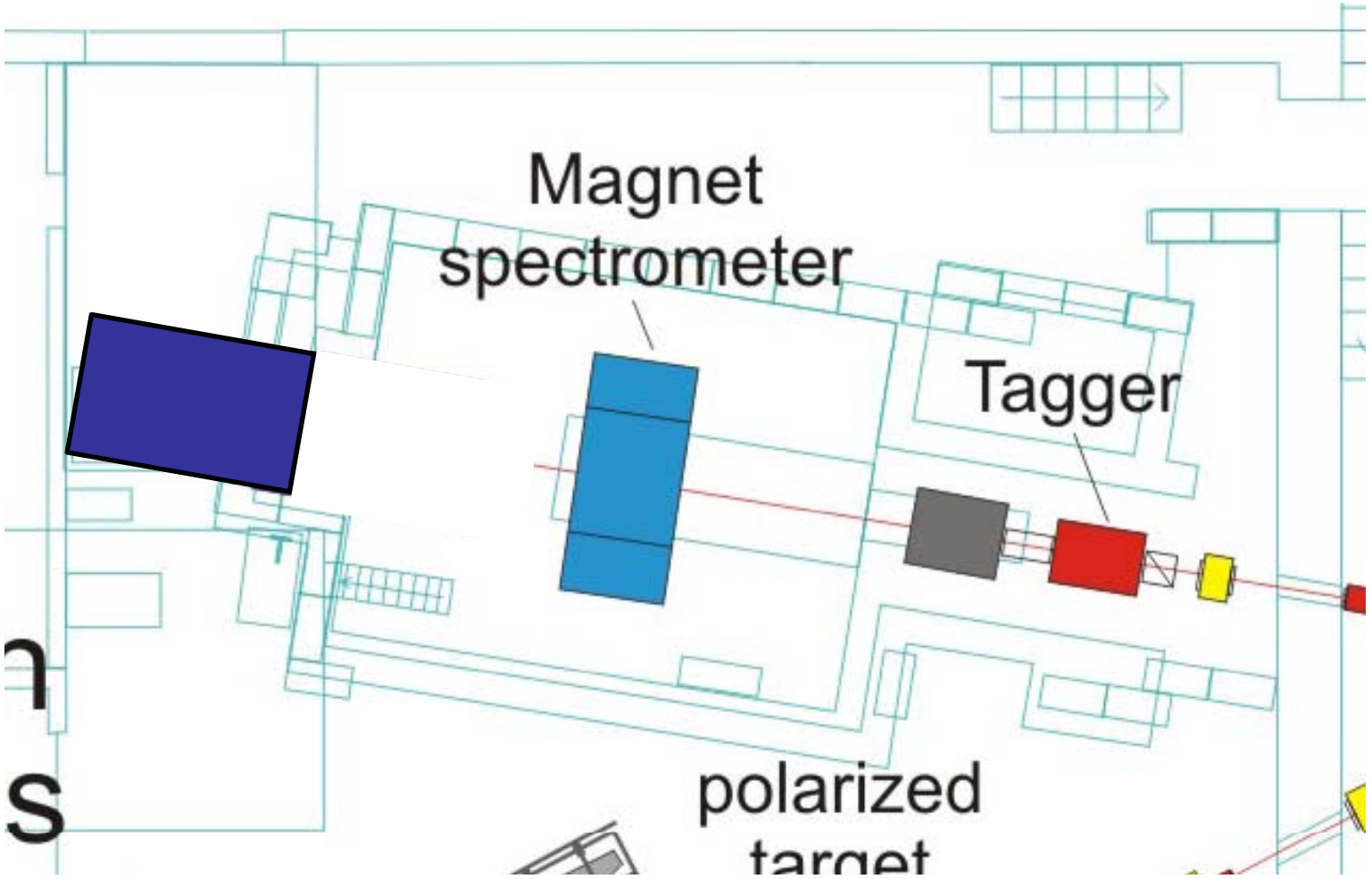


# Useful Instrumentation: B1




**Careful alignment of experimental components (collimators!!) required!**

# Electron Scattering Experiments

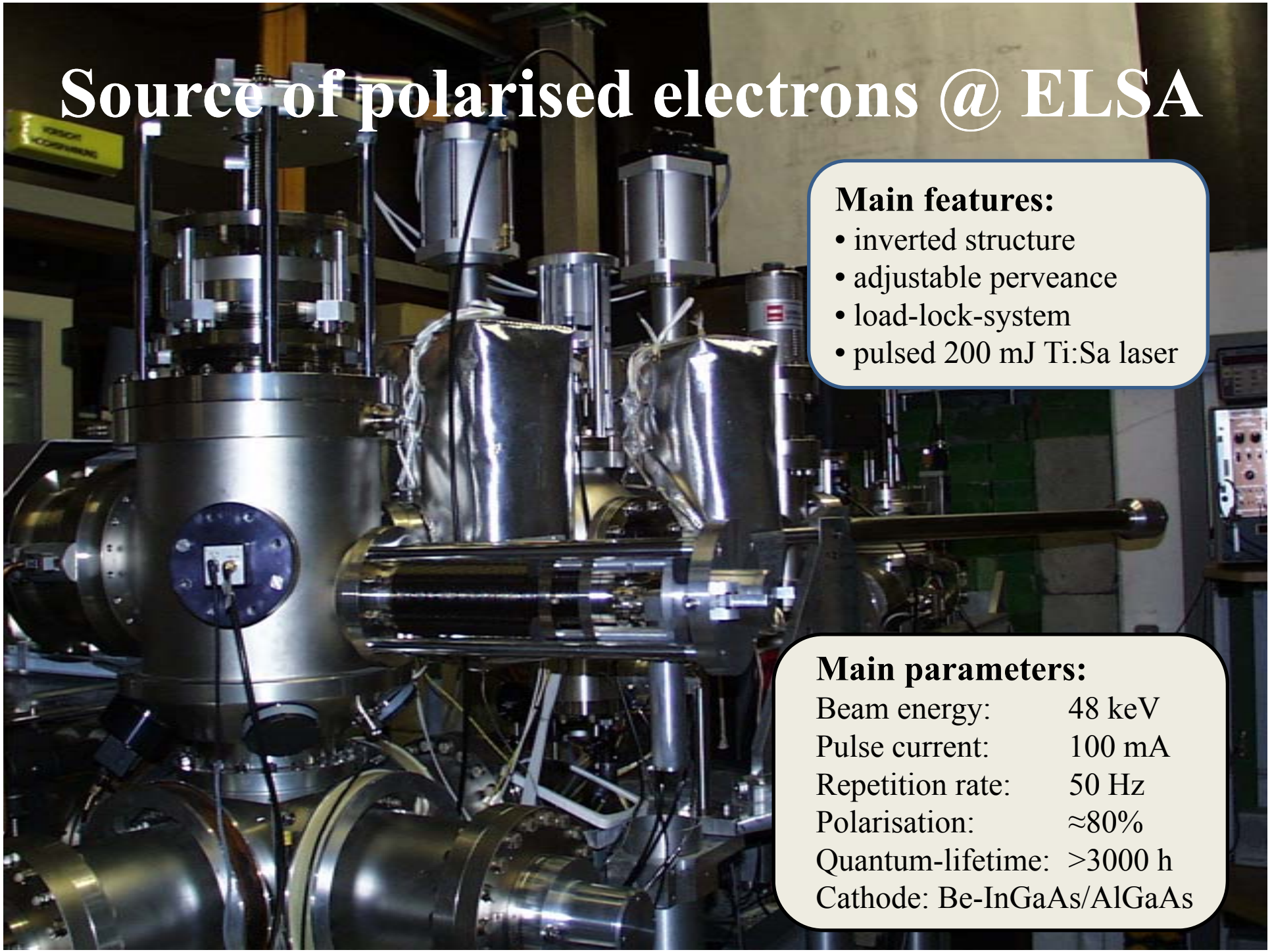


# Polarized Beams

- **Linearly polarized photons**
  - **coherent bremsstrahlung** (→ next talk)
- **Circularly polarized photons**
  - produced from **longitudinally polarized electrons**
- **Polarized electrons**

External Polarimetry mandatory!!!

# Source of polarised electrons @ ELSA



**Main features:**

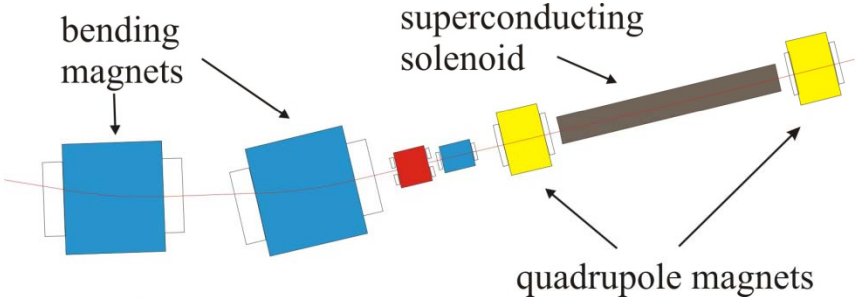
- inverted structure
- adjustable perveance
- load-lock-system
- pulsed 200 mJ Ti:Sa laser

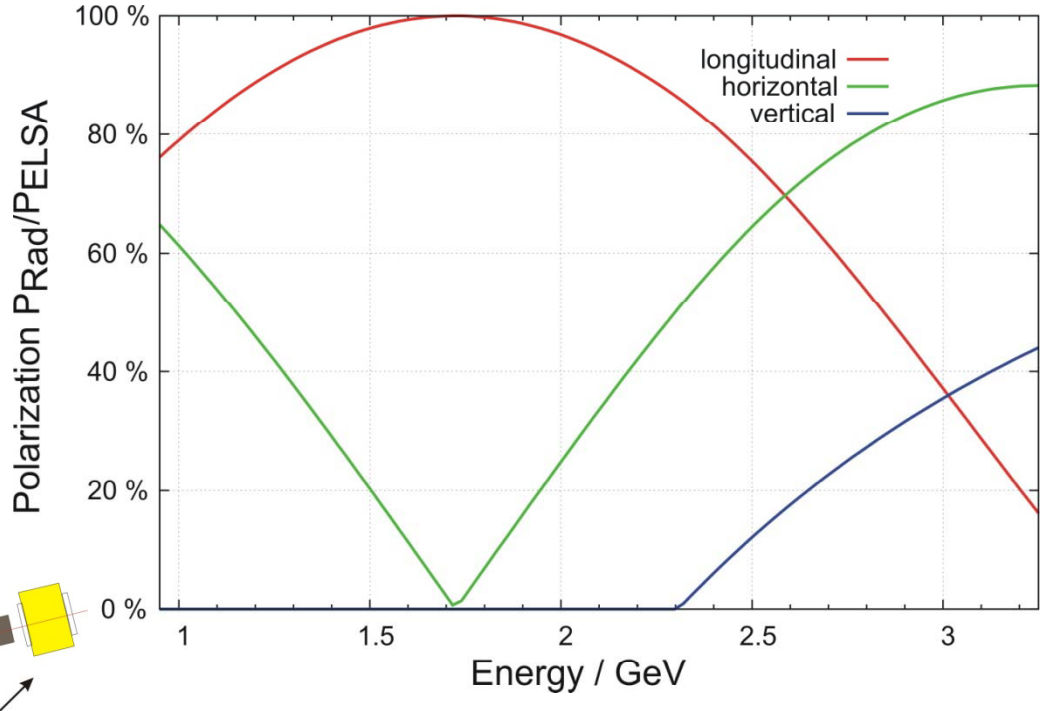
**Main parameters:**

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

Cathode: Be-InGaAs/AlGaAs


# Spin Rotation II



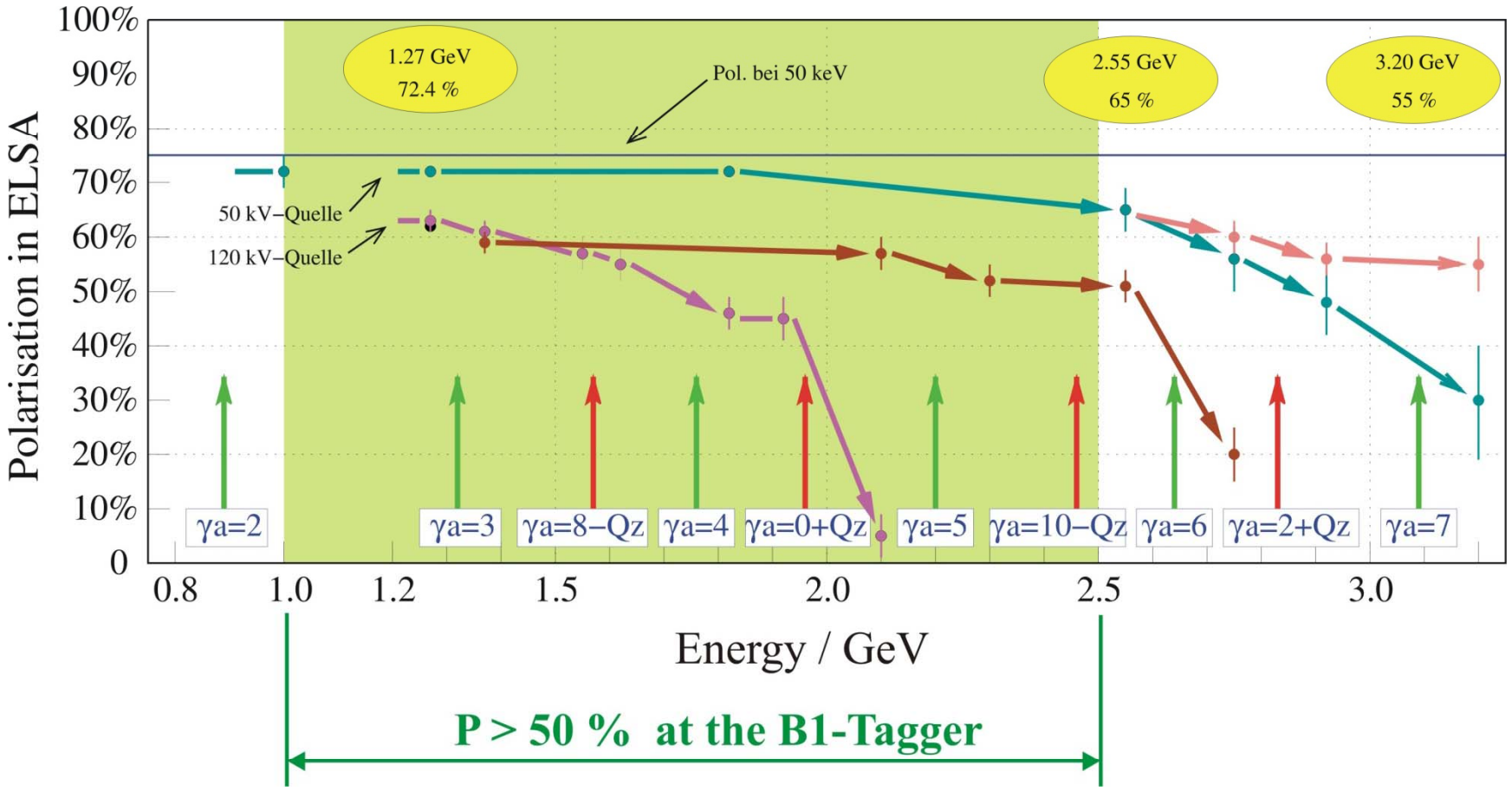




**Spin Transfer to the Tagger of the Saphir Beamline**

Lamor Precession $\Delta\phi = -\frac{e}{m_0 c} \cdot \frac{1+a}{\sqrt{\gamma^2 - 1}} \cdot \int B_s(s) \cdot ds$

Thomas Precession $\Delta\phi = \gamma \cdot a \cdot \vartheta$

# Achieved maximum Polarization



# Actual Status & Outlook

**Saphir (B1) – beamline operational with unpolarized beam:**

- **Tagged photon** operation only (incl. lin. polarization)
- **Energy range:** 1.0 GeV < ***E*** < 3.5 GeV
- **Current range:** 10 pA < ***I*** < 1 nA

} electrons

**Photon camera and tag-or required for stabilization purpose!**

**Circularly polarized photons require Møller-polarimeter!**

**E-Experiments require new beam dump for electron beam!**

*Thank you for your attention!*