# The Bonn Electron Stretcher Accelerator


## *… and the BGO-OD electron beamline*

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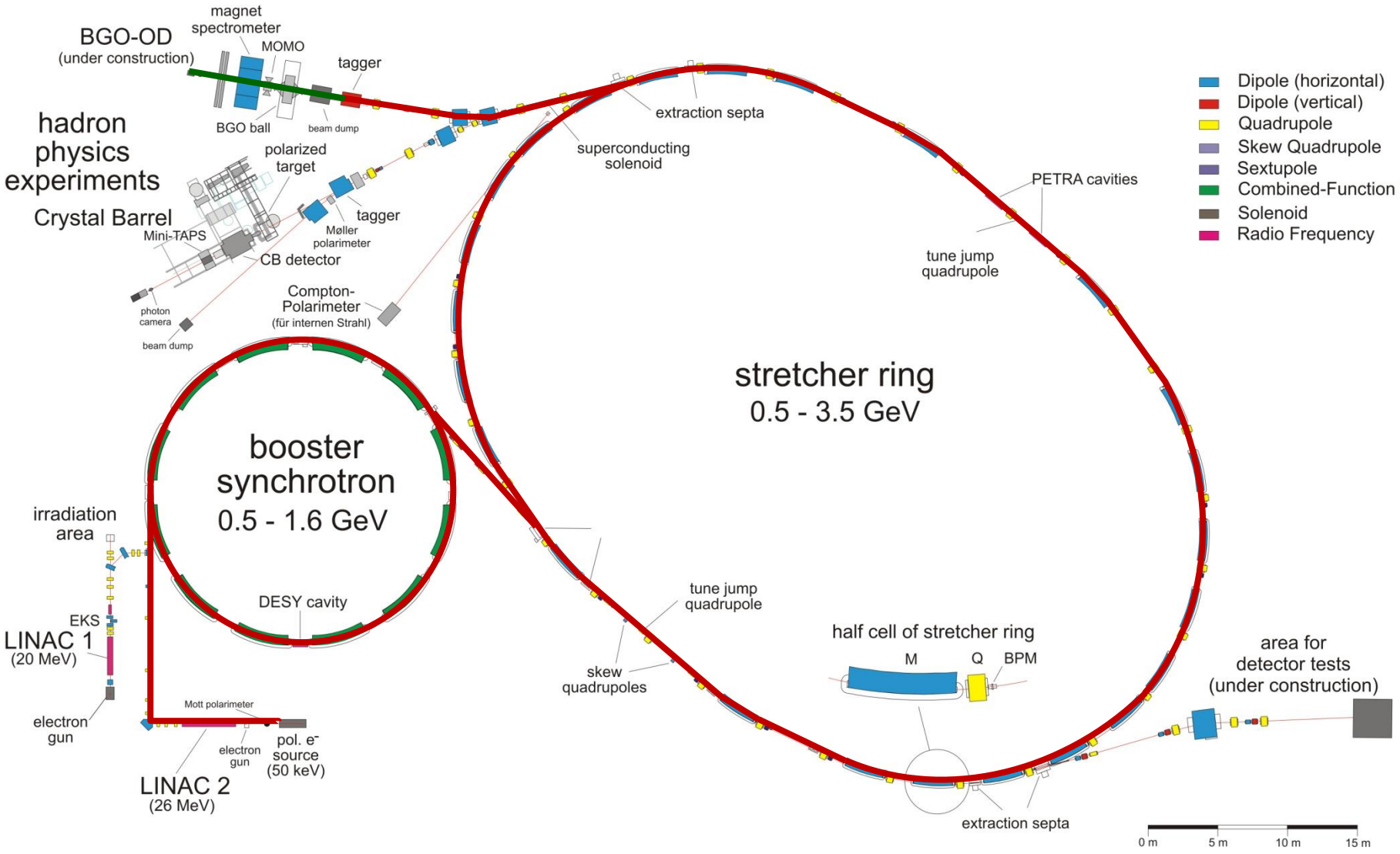
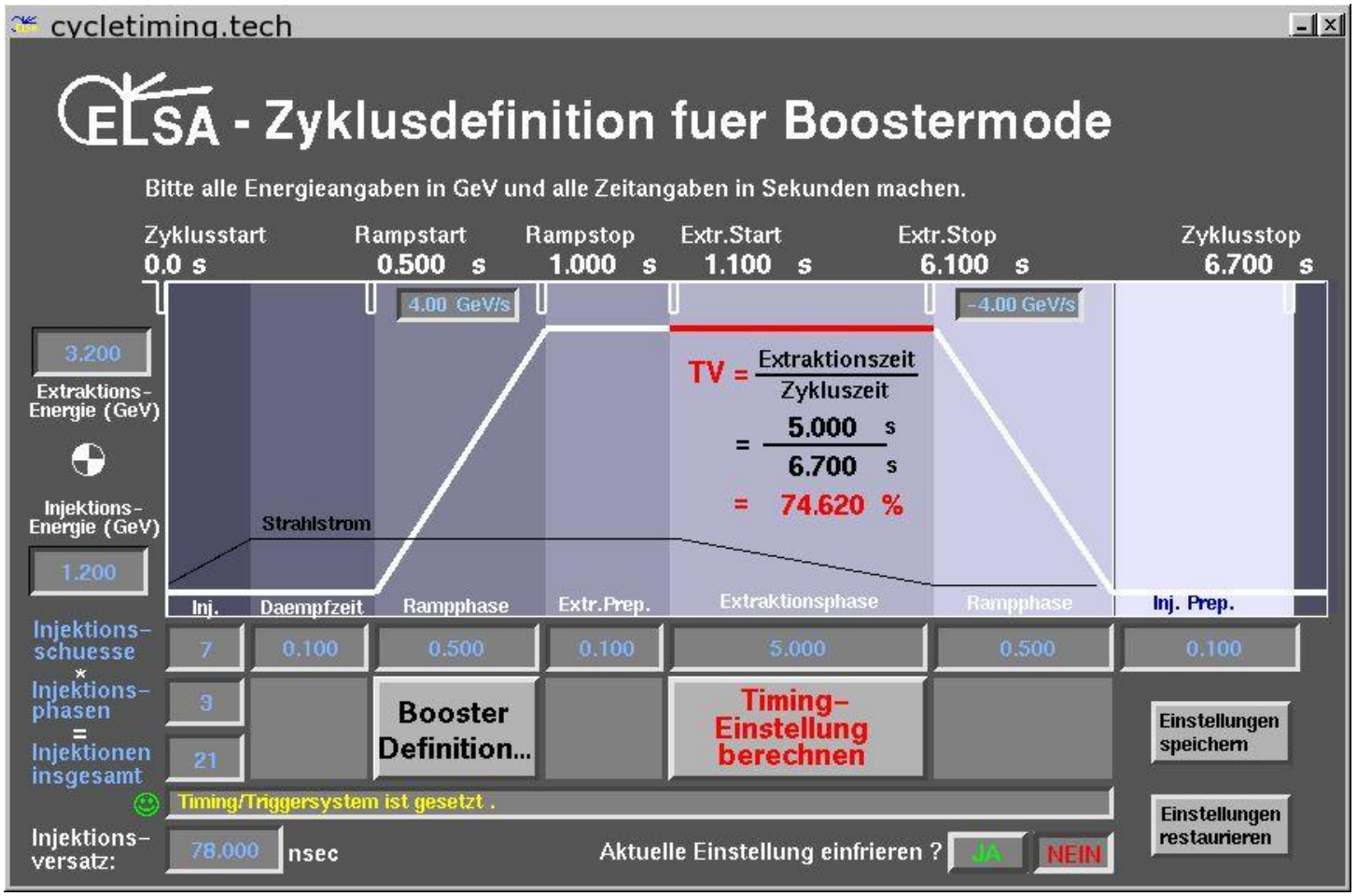
# Electron Stretcher Accelerator (ELSA)

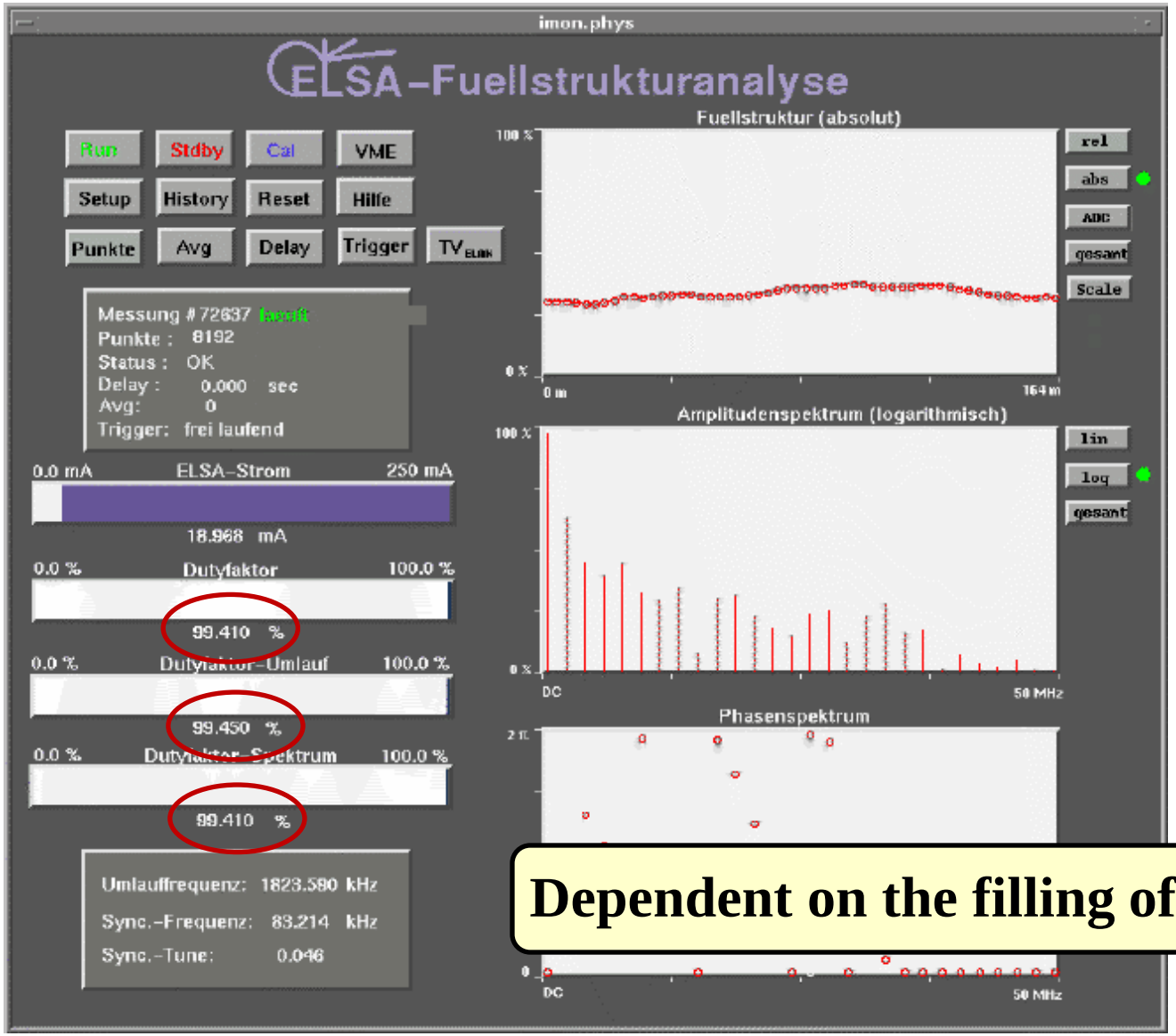


# Duty Cycle



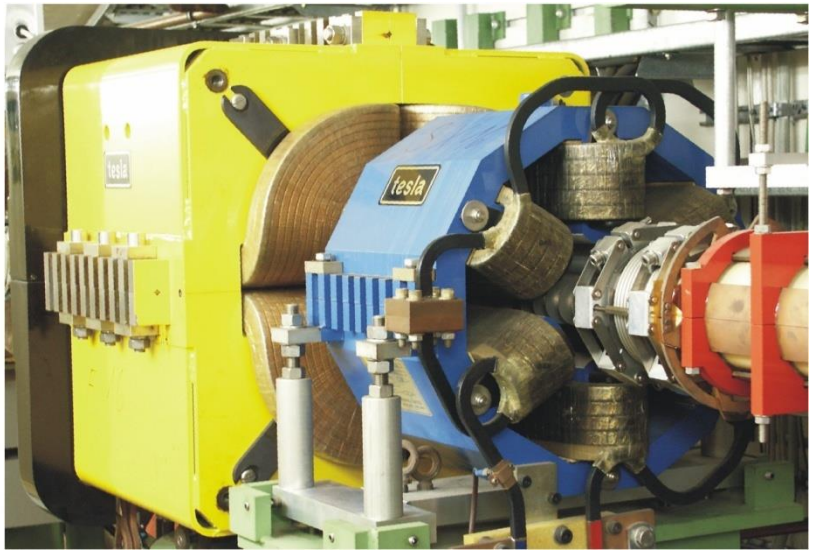

**Macroscopic duty cycle:** $DC_{mac} = \dfrac{\Delta T\,(\text{external beam})}{\Delta T\,(\text{complete cycle})}$

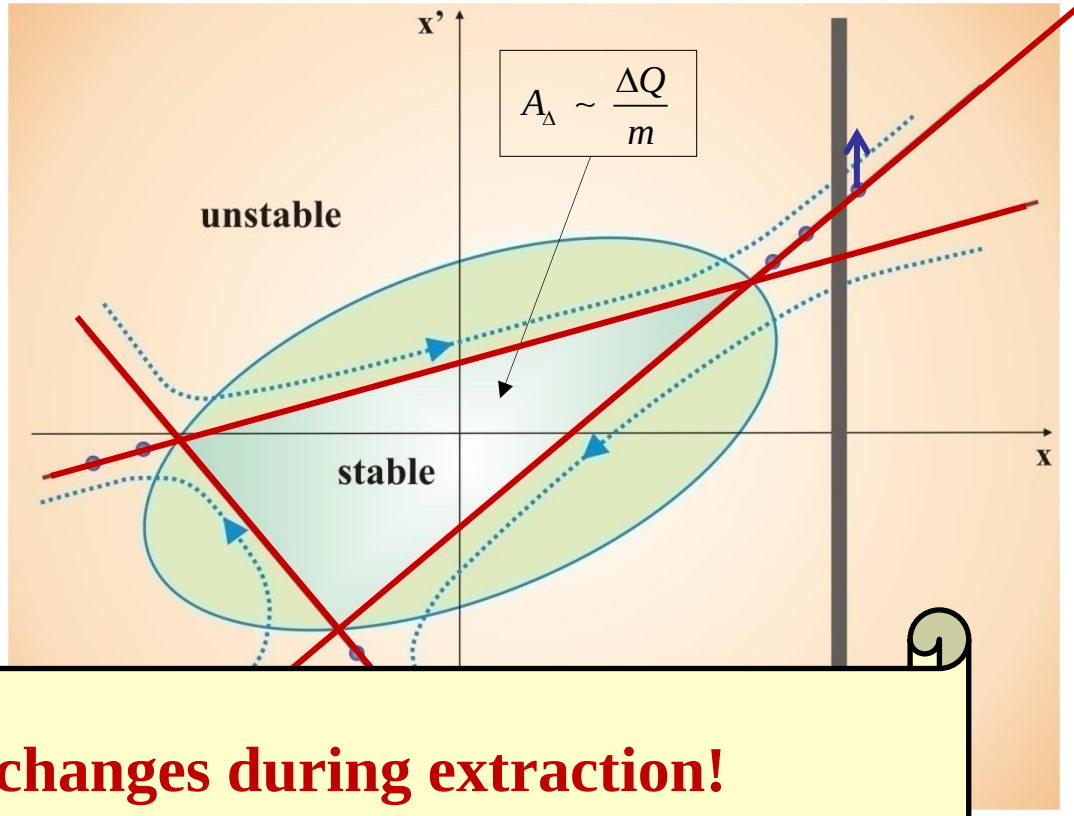
# Microscopic Duty Cycle




**Dependent on the filling of ELSA**

# Slow Beam Extraction



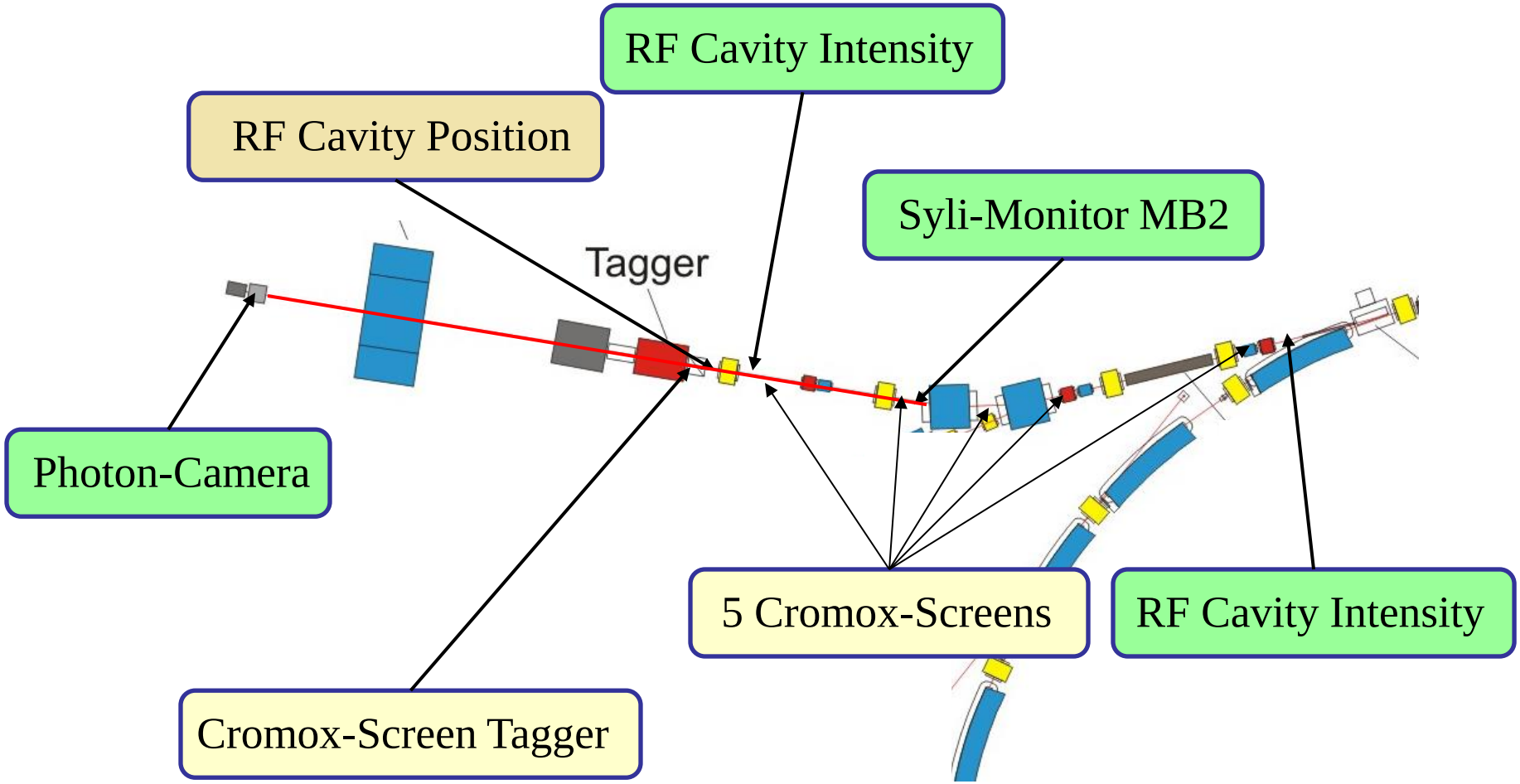




**Sext**
Excit

**Beam direction changes during extraction!**

**Compensated by ramping the current of the septum extraction magnet coil!**

# BGO-OD Beamline



ext_diag_poshist2.phys <@elsahp20>

# Strahllagemessung ELAN-Beamline

| | Betrag | Phase | Mittel | Position | Mittel |
|---|---|---|---|---|---|
| X | 15.7 µV | -89 ° | -96 ° | -0.38 mm | -0.42 mm |
| Y | 54.6 µV | -88 ° | -89 ° | -1.68 mm | -1.69 mm |
| I | Bunch-Faktor: 0.808 | | | 612 pA | 604 pA |

## Lock-In-Verstaerker

Zeitkonstante

◀ 30 ms ▶

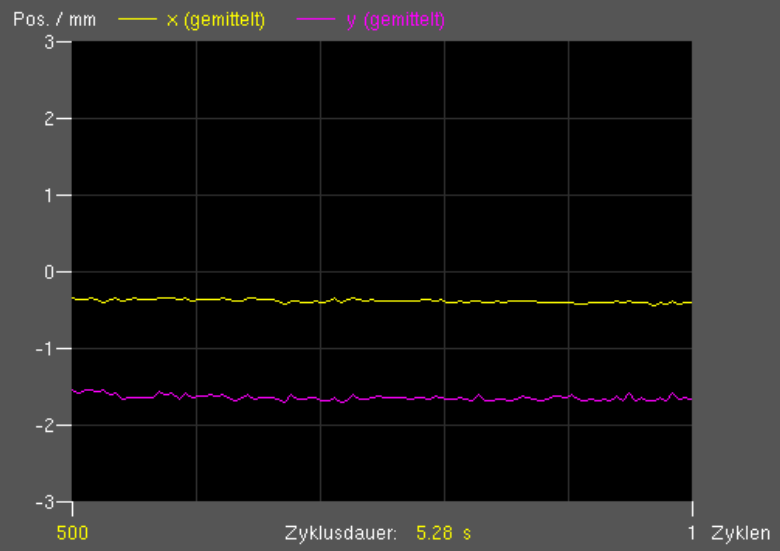
Status ● ● ●

## Datenerfassung

| Messung | Logging |
|---|---|
| AN | AN |
| AUS | AUS |

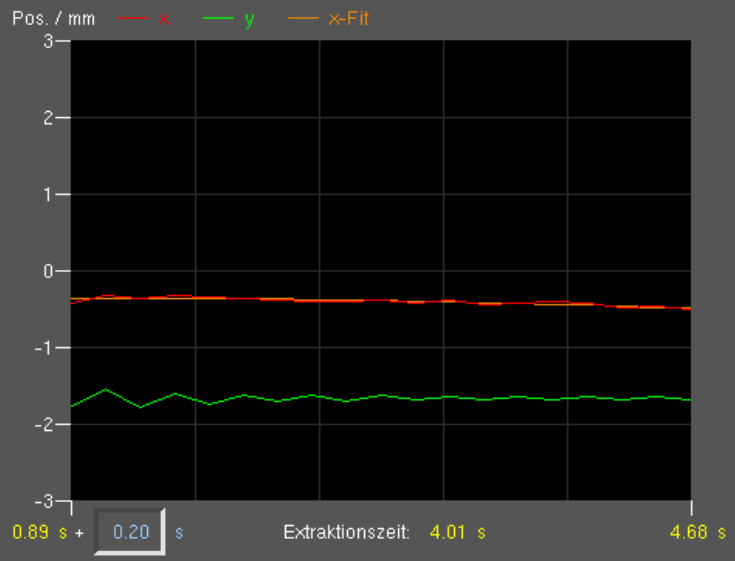
Meldungen: Messung laeuft.

Mittelwerte, alle 5 Zyklen erfasst

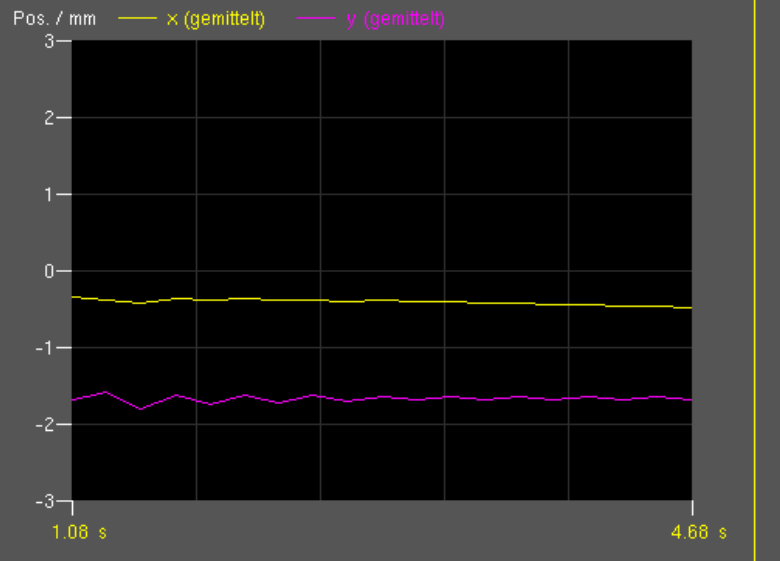



## Zeitliche Entwicklung waehrend der Extraktion

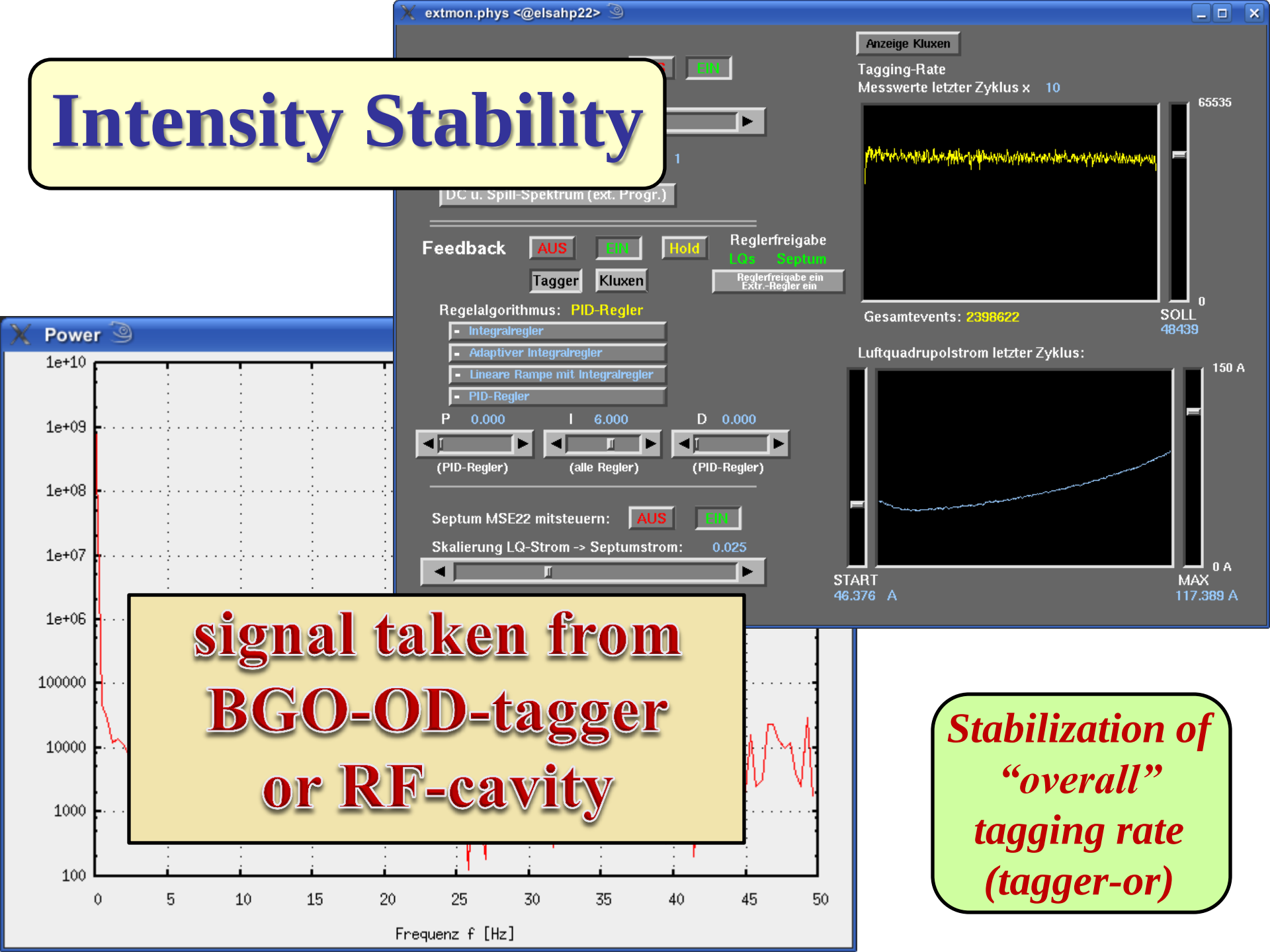
Letzte Extraktion, Ausleserate: ● 5.0 Hz




Gemittelt ueber 10 von 10 Extraktionen



# Intensity Stability




**signal taken from BGO-OD-tagger or RF-cavity**

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

# Beam Characteristics:

## Internal Beam:

### Emittance (natural, standard optics):

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

**Quadratic scaling with energy!**

### Energy spread (natural, ~ 1/R):

- $\sigma_E / E = 3.7 \cdot 10^{-4} \cdot E\,[\mathrm{GeV}]$

**Linear scaling with energy!**

### Bunch length:

- ≈ cm, depends on RF acceleration voltage and beam energy

# Beam Characteristics:

## External Beam:

### Beam Parameters:

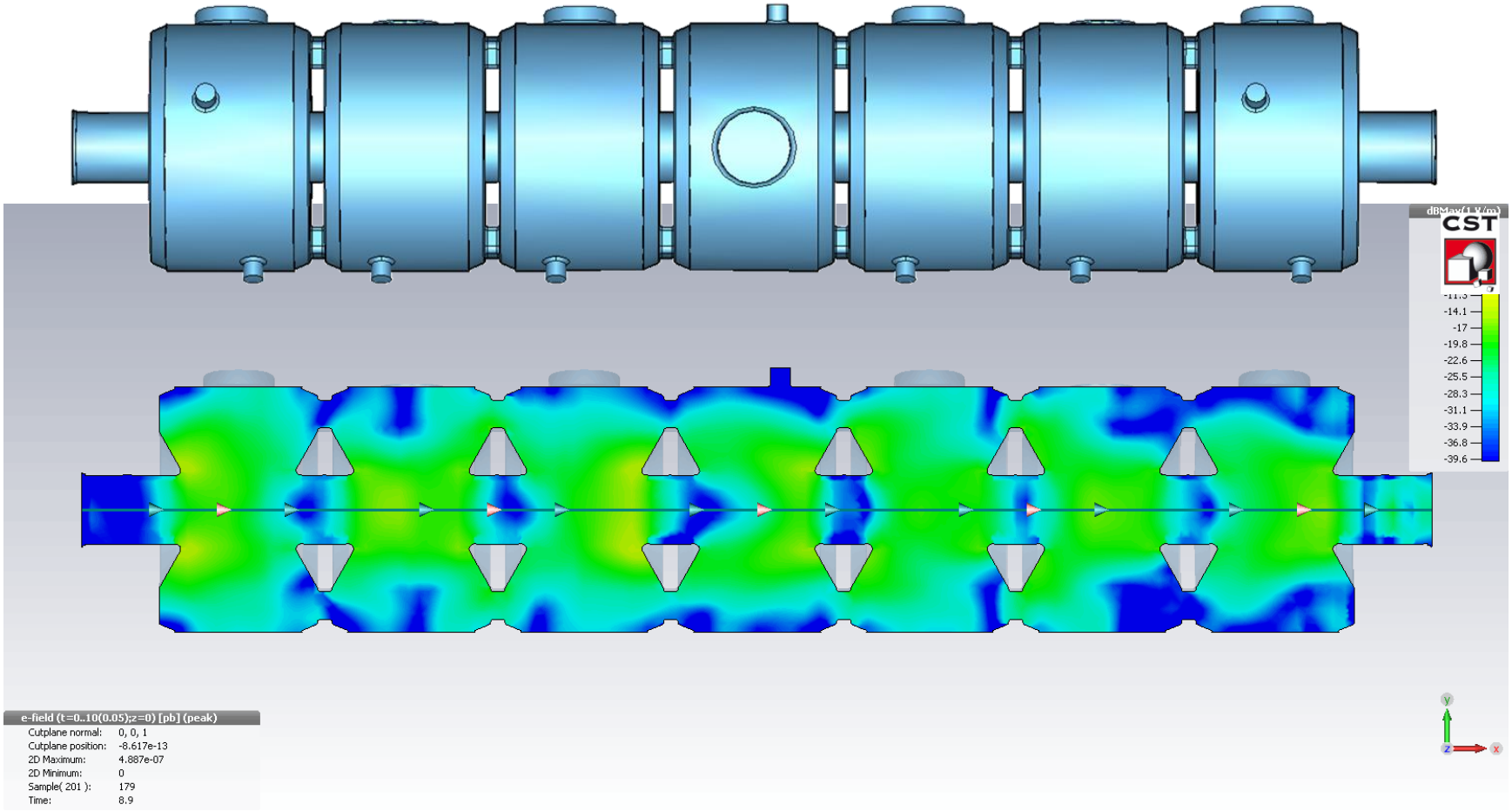
- **horz.:** affected by extraction, **have to be measured**
- **vert., long.:** about the same as the internal values

### Long-Term Stability (experience from CB):

- beam pointing stability ≤ 20 μrad ↔ **photon-camera**
- beam position stability ≤ 0.2 mm ↔ **RF-cavity**

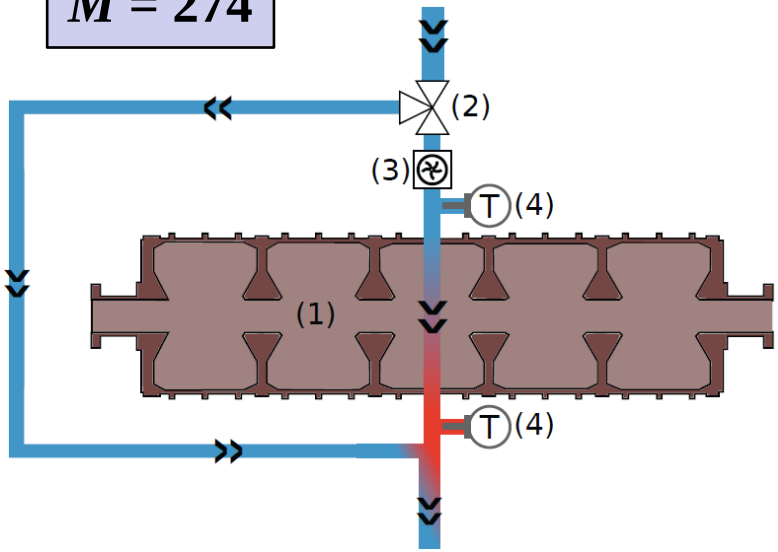
# Operation with Higher Currents

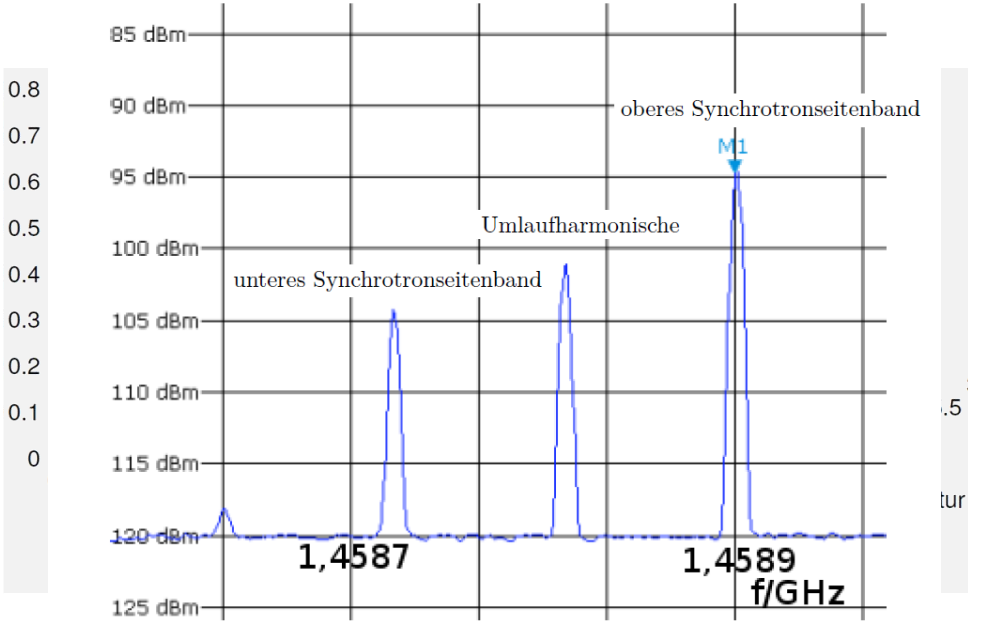
## Beam affected by … e.g. accelerating cavities:



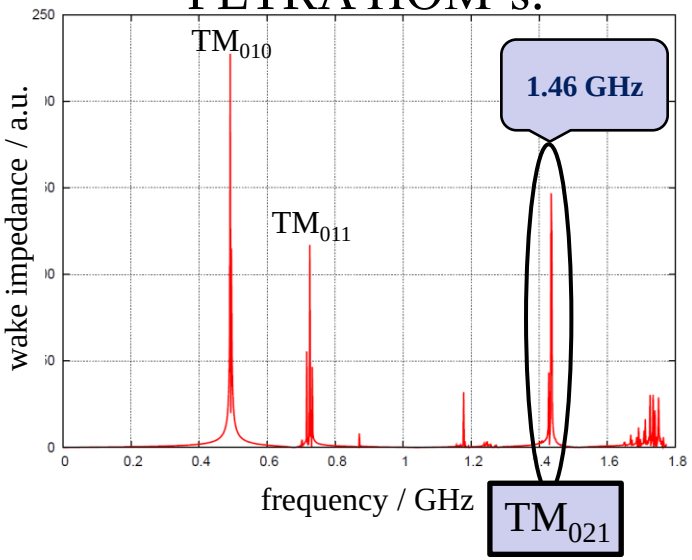
# ELSA‘s favorite mode:

**$M = 274$**



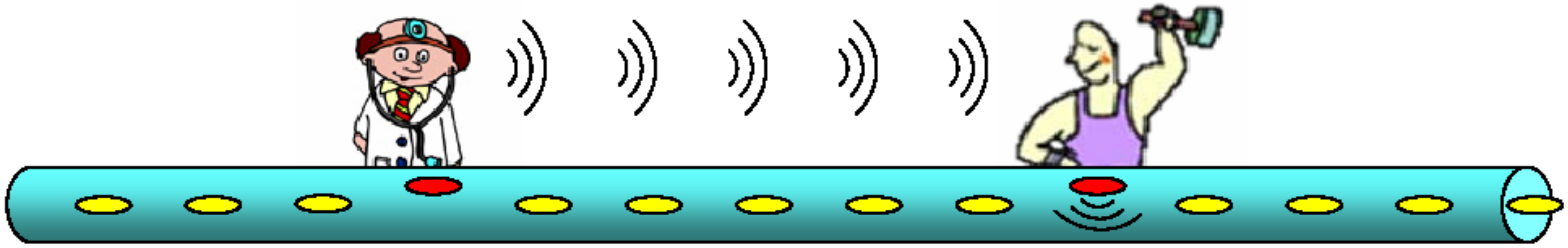

PETRA HOM‘s:



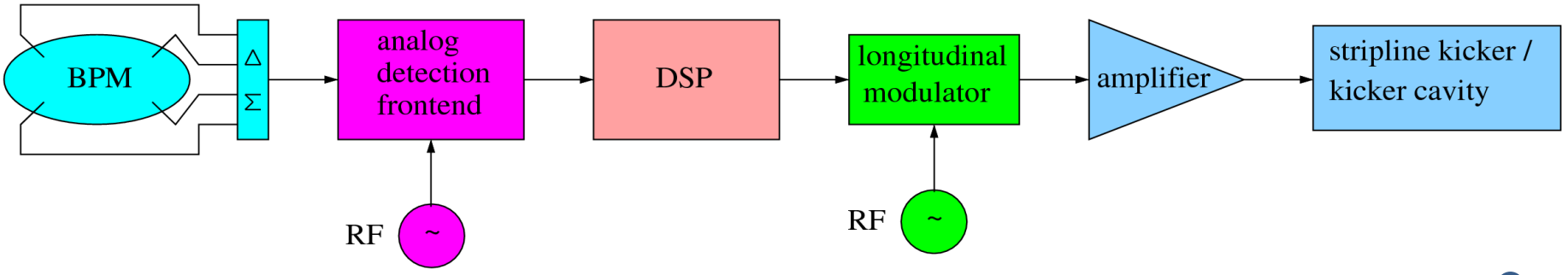

**HOM @ 1.460GHz ↔ Mode 252**

$$\omega_n = (n + pM)\cdot\omega_0 + m\Omega_S$$
$$= (252 + 2\cdot 274)\cdot 1.824\,\mathrm{MHz} + \Omega_S$$
$$\approx 1.460\,\mathrm{GHz}$$

# Bunch by Bunch Feedback

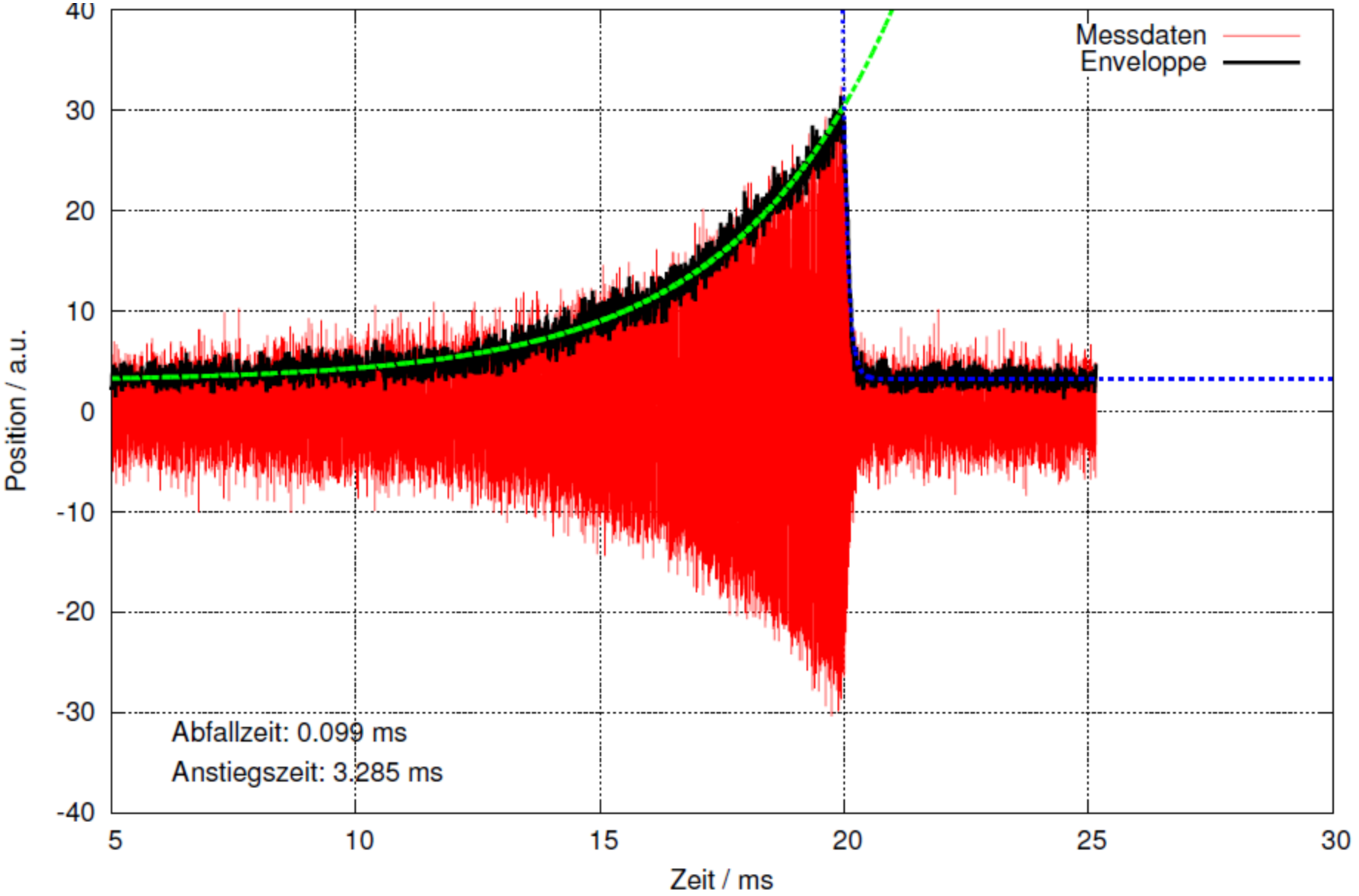


**$\Delta t$ = 2 ns, BW = 250 MHz**




**Full 3D system installed at ELSA, very promising!**

# Feedback Performance



# Actual Status & Outlook

**BGO-OD – beamline "operational" with unpolarized beam:**

- **Tagged photon** operation only (incl. lin. polarization)
- **Energy range:** 1.0 GeV < ***E*** < 3.3 GeV
- **Current range:** 10 pA < ***I*** < 1 nA

} electrons

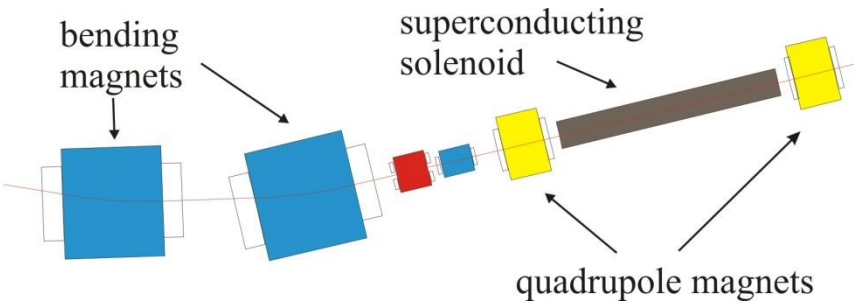
**Intensity stabilization using RF cavity or tagger-or**

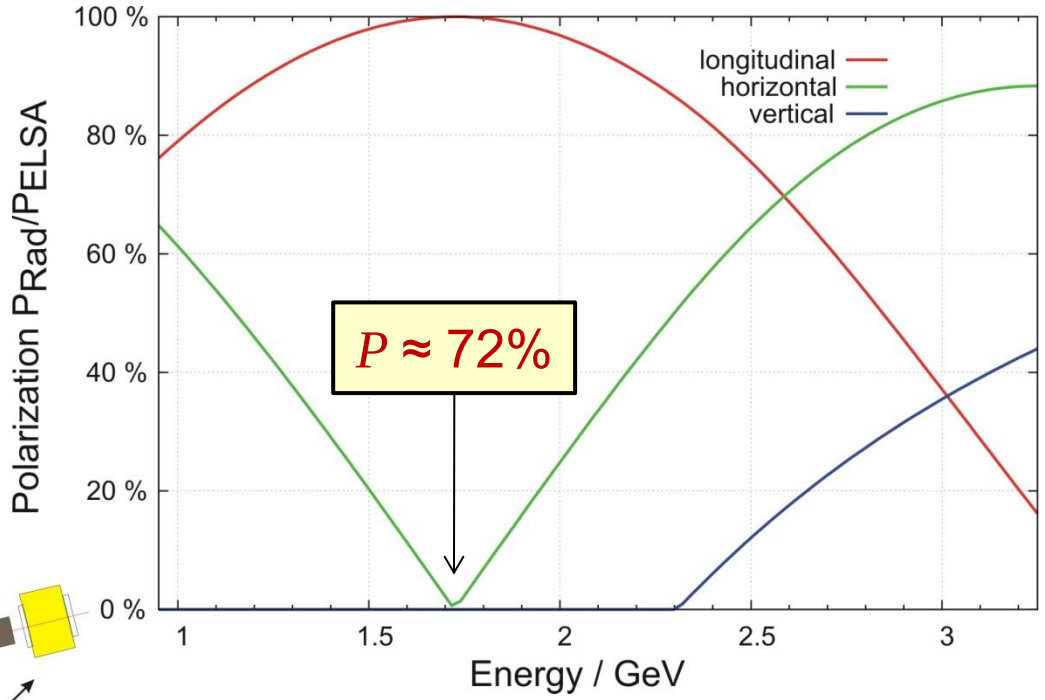
**Up to 10 nA envisaged within next year(s)!**

**Linearly polarized photons avail. from coh. bremsstrahlung**

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

# Spin Transmission to BGO-OD




**Spin Transfer to the Tagger of the BGO-OD 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 $\Delta\phi = \gamma \cdot a \cdot \vartheta$