The Bonn Electron Stretcher Accelerator

(Polarized) GeV-photons for the BGO-OD experiment

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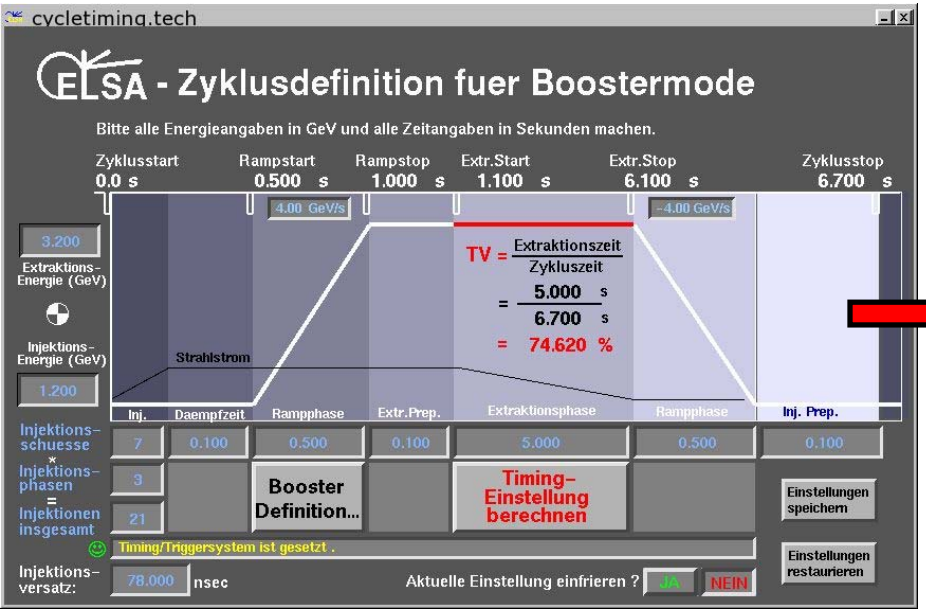
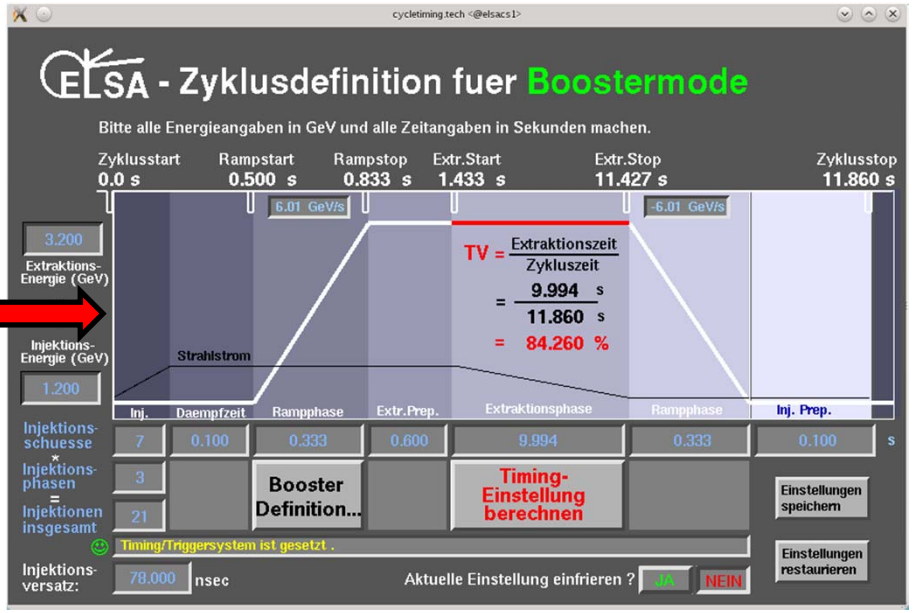
1. Linear Polarization (Coherent Bremsstrahlung)
2. Circular Polarization (Polarized Electrons)
3. Possible Sources and Cures of Background
4. Future Developments (New RF System)

Acc. Improvements → Duty Cycle

- Increase of ramping speed: 4 GeV/s → 6 GeV/s
- Increase of extraction efficiency: < 40% → > 90%
- Increase of circulating beam current: < 30mA → > 100mA?!



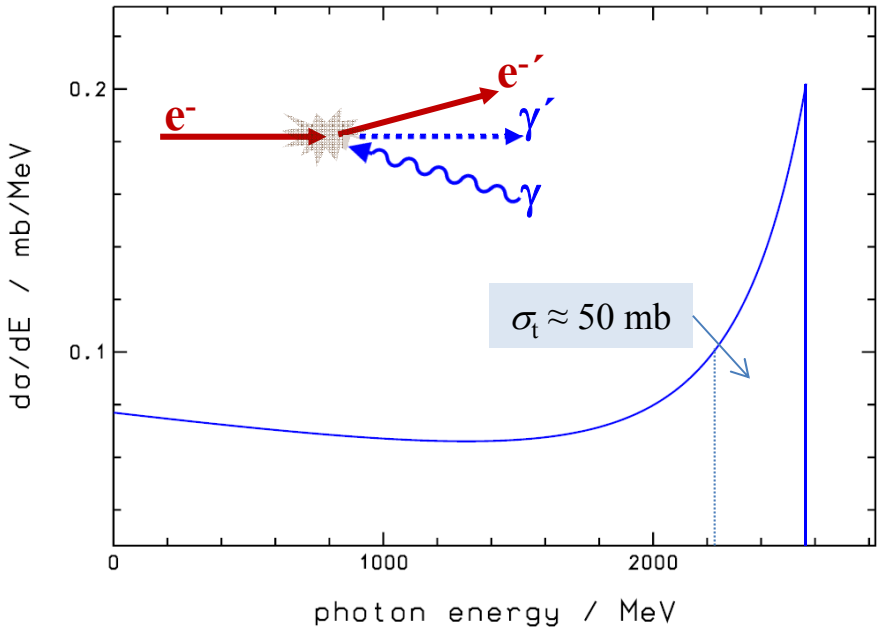


Macroscopic duty cycle: $DC_{mac} = \frac{\Delta T(\text{external beam})}{\Delta T(\text{complete cycle})}$

Linearly Polarized Photons

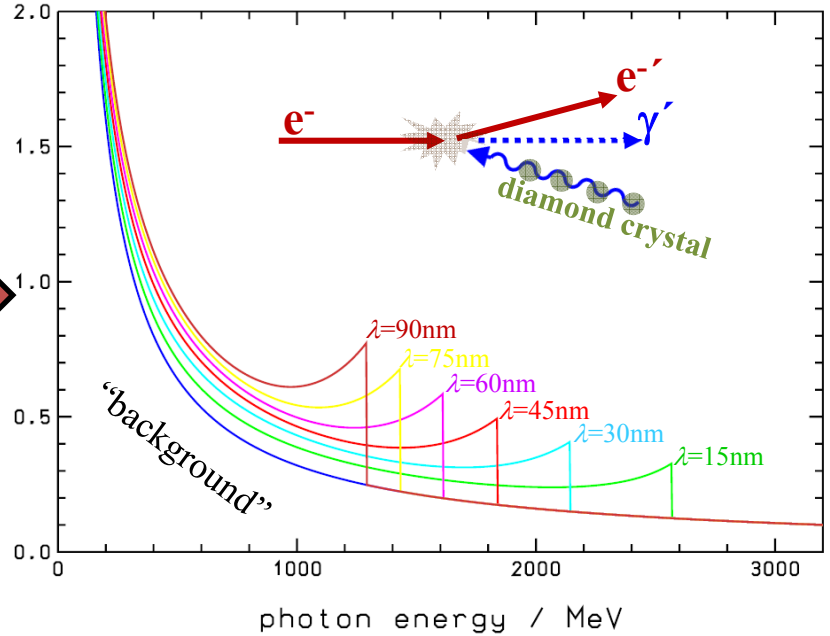
Compton Backscattering:

Beam energy: $E = 3.2$ GeV
Beam current: $I = 100$ mA
Incoming photon: $\lambda = 15$ nm (80 eV)



Coherent Bremsstrahlung:

Beam energy: $E = 3.2$ GeV
Beam current: $I = 1$ nA
Momentum transfer to crystal radiator!



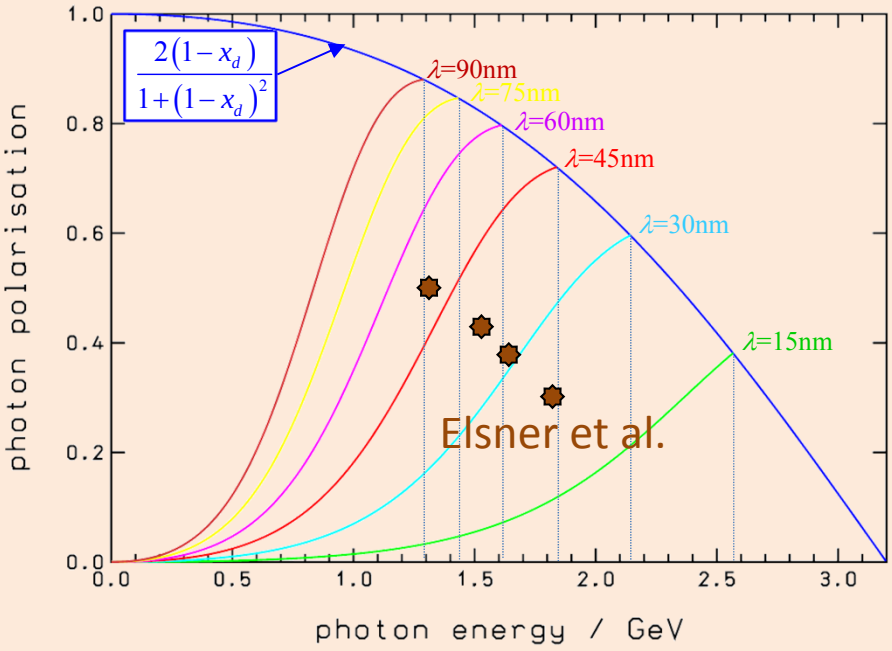
$N_\gamma > 10^{19}$ s^{-1} required!
P_L(15nm) > 100W!

Polarization determined by orientation of the crystal!

Coherent Bremsstrahlung

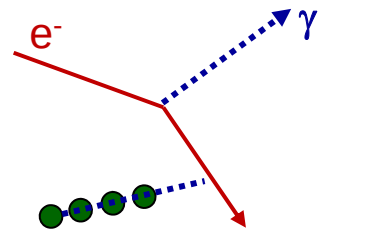
Beam energy: 3.2 GeV

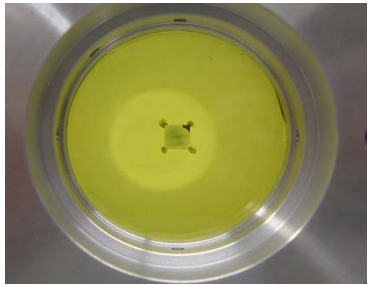
Linear polarization

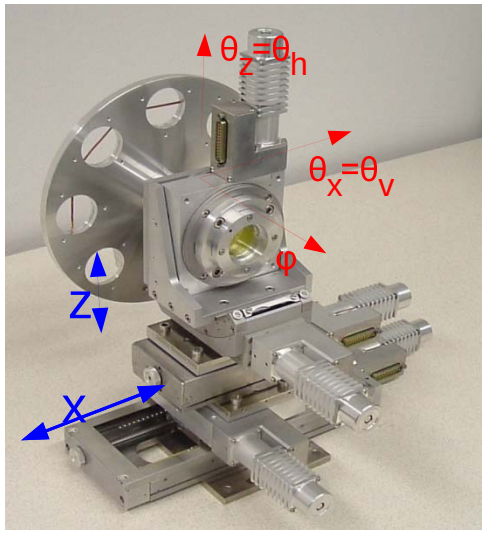


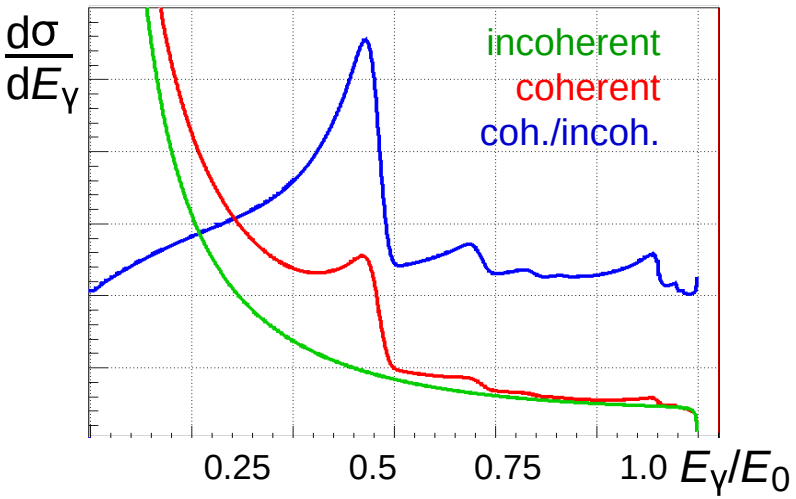
$$P = \frac{2x^2Q^2}{1-x}\left\{1+(1-x)^2 - \frac{4x^2Q^2}{1-x}\left(\frac{1-x}{xQ}-1\right)\right\}^{-1}$$

Increase of beam energy desirable!



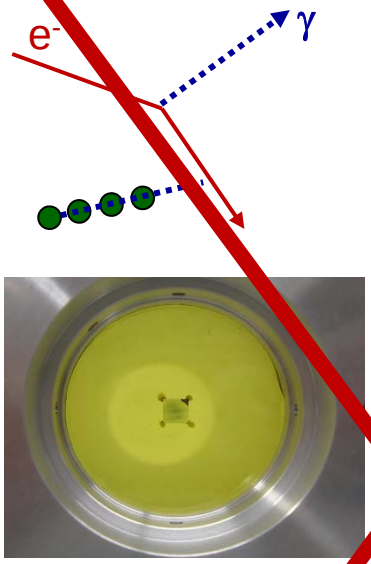


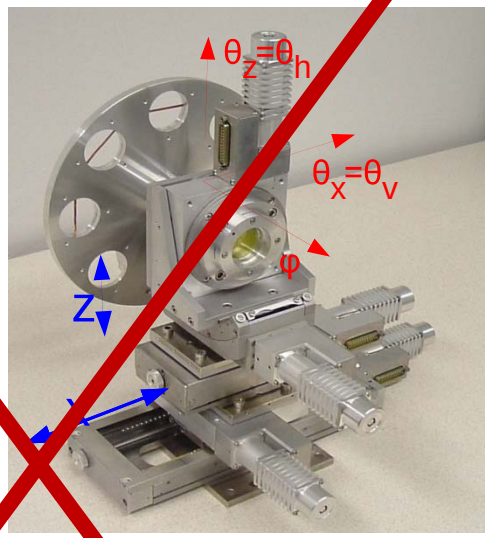


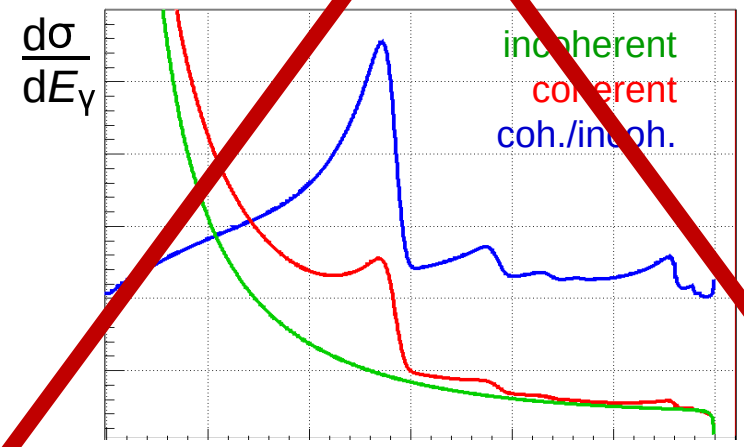


Circularly Polarized Photons

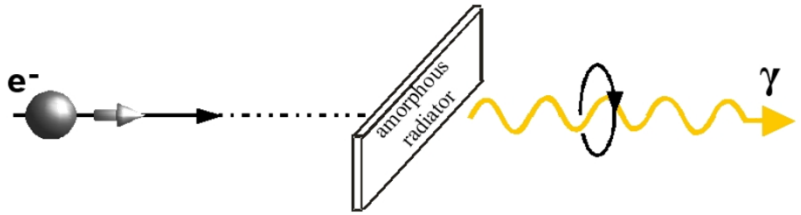
Transverse:

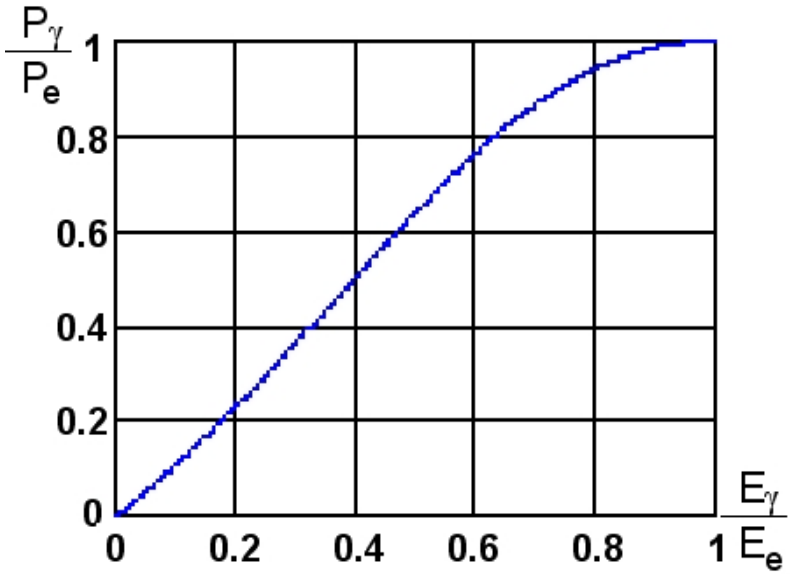






Longitudinal:





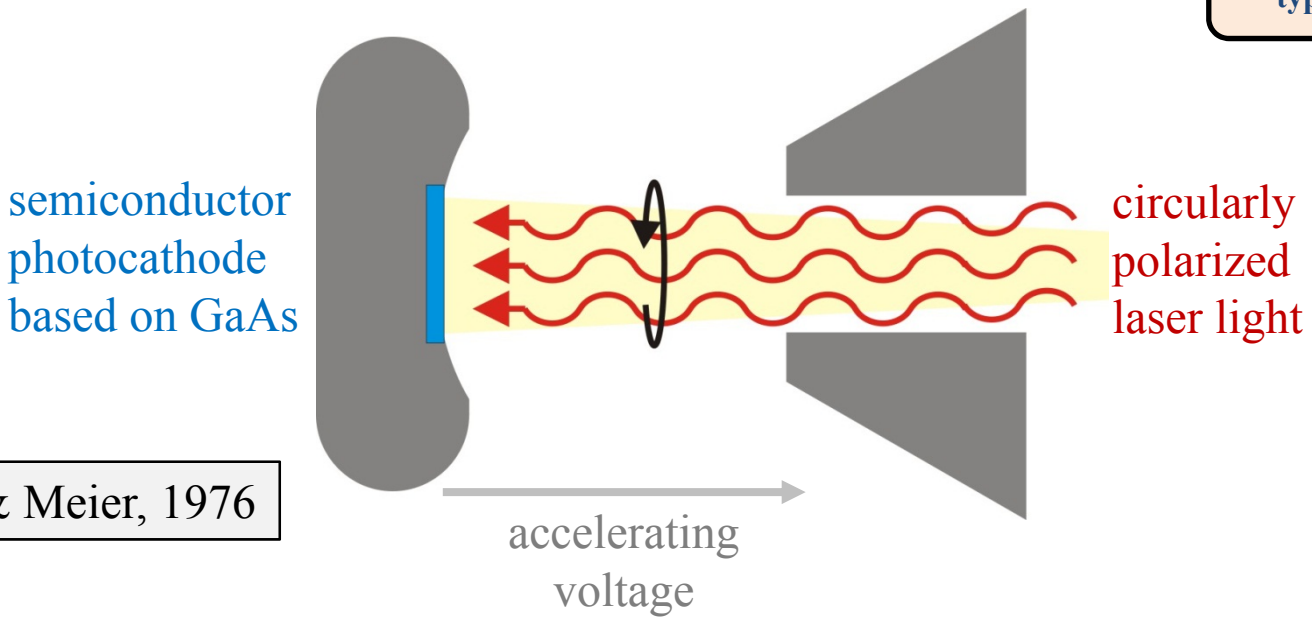
$$\frac{P_{\gamma,circ}}{P_e} = \frac{E_\gamma}{E_0}\,\frac{1 + \tfrac{1}{3}(1-E_\gamma/E_0)}{1 - \tfrac{2}{3}(1-E_\gamma/E_0) + (1-E_\gamma/E_0)^2}$$

H. Olsen & L.C. Maximon, PR 114 (1959) 887

Generation of Polarized Electrons

Functional Principle:

P_{typ} = 80 - 85 %

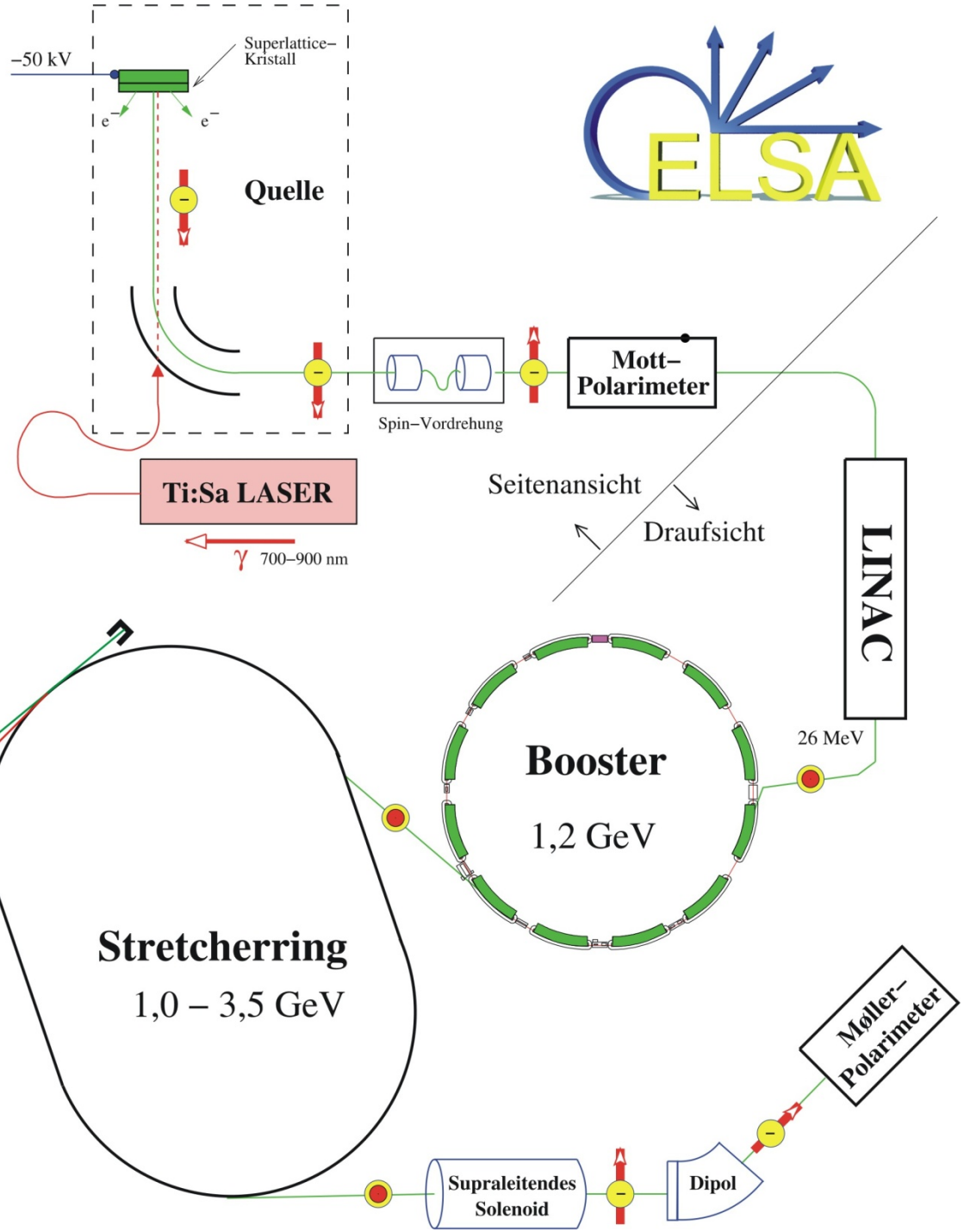


Pierce & Meier, 1976

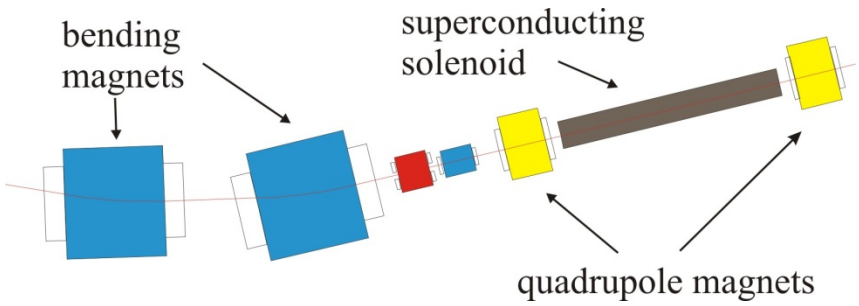
Photoelectron emission from GaAs

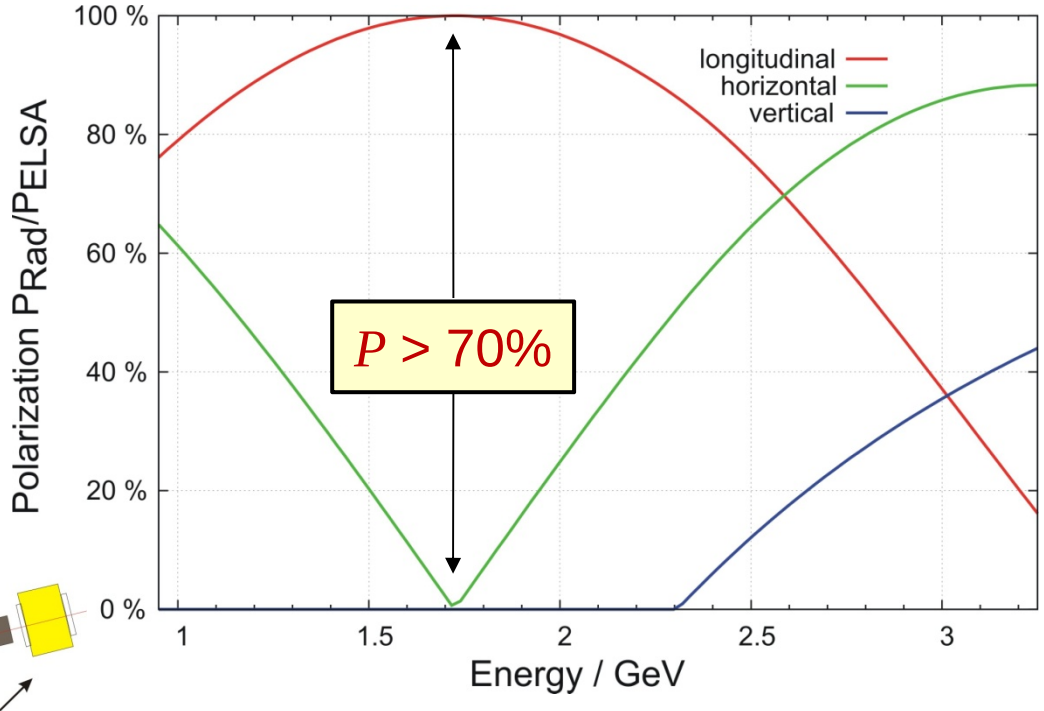
polarization transfer from laser photons to emitted electrons

Transport of polarized electrons



Spin Transmission to BGO-OD

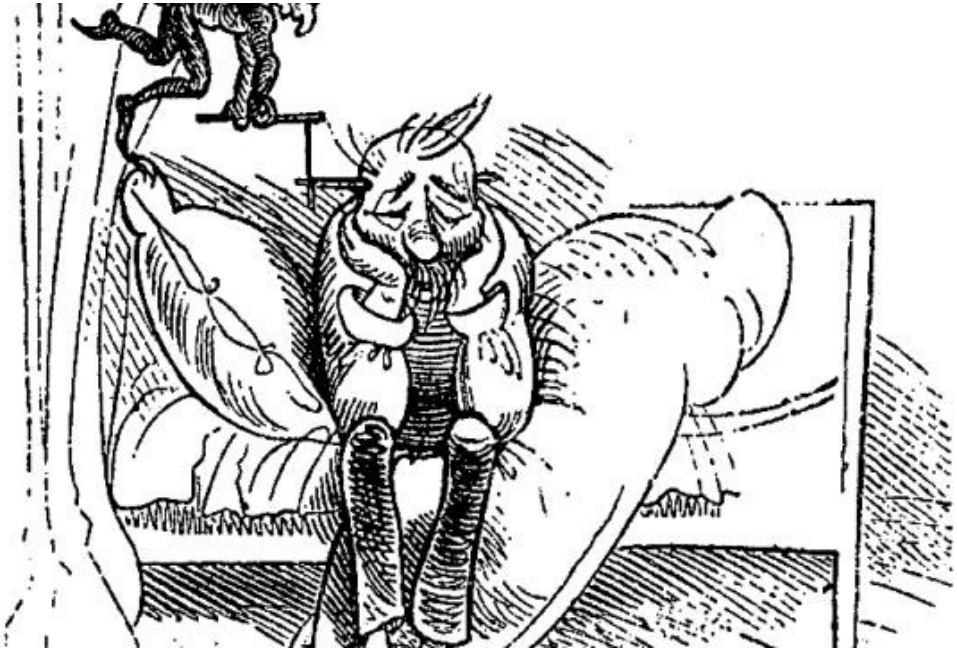




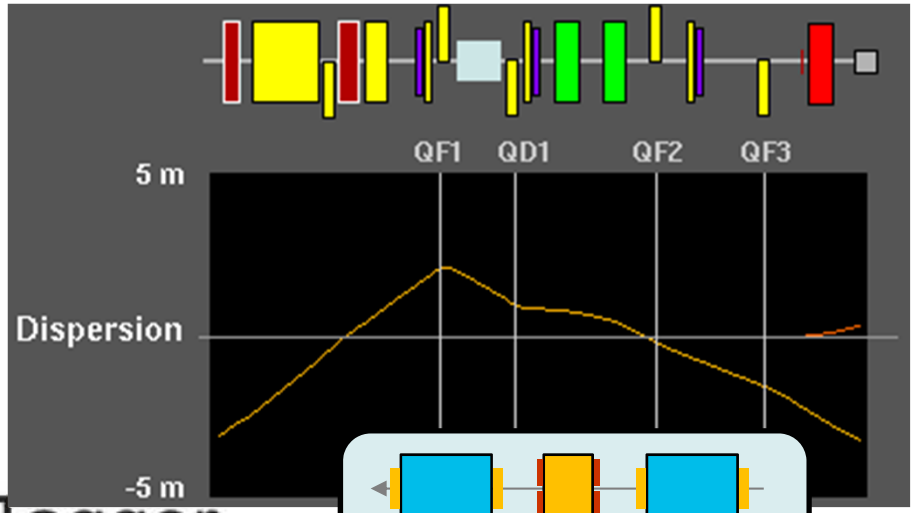
Spin Transfer to the Tagger of the BGO-OD Beam Line

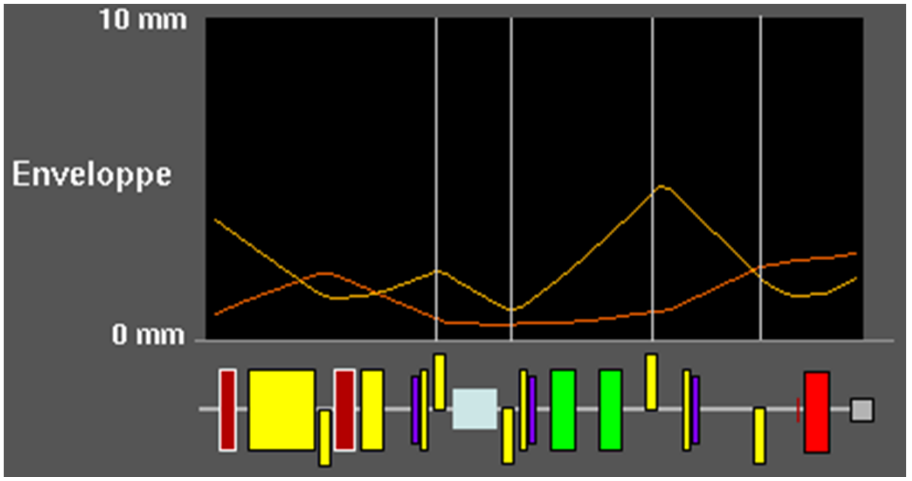
Achieved Polarization: P = 74±2%@2.35 GeV, P = 65±2%@2.92 GeV

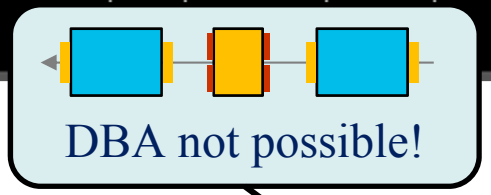
Background Problem



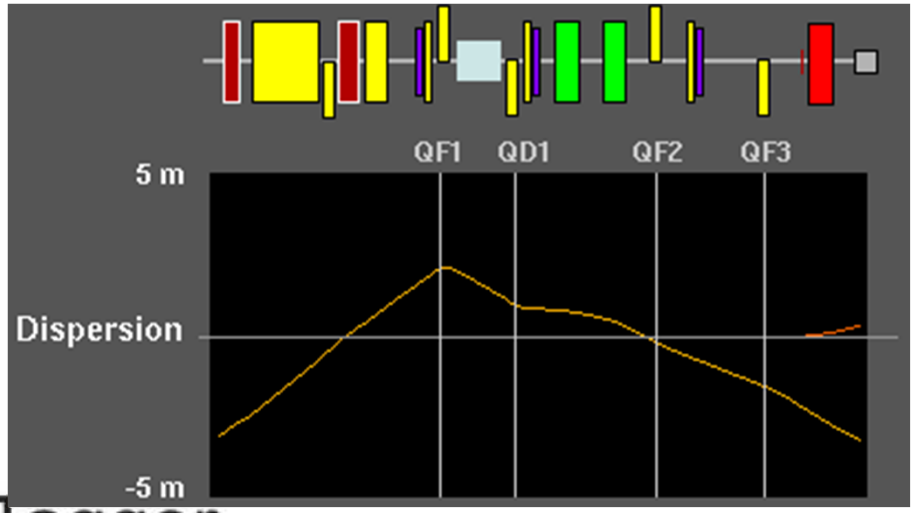
BGO-OD Beam Line

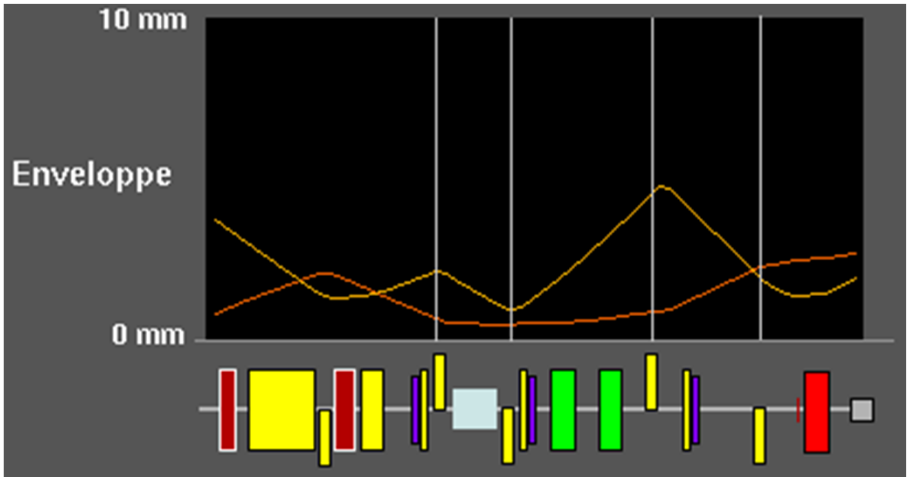


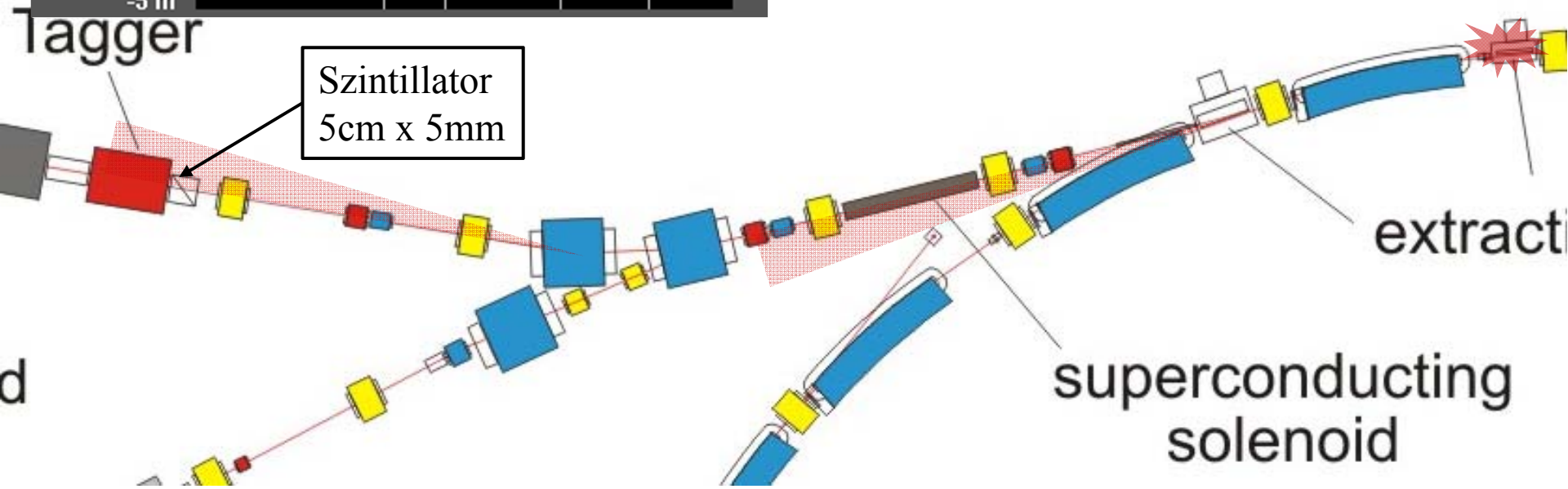




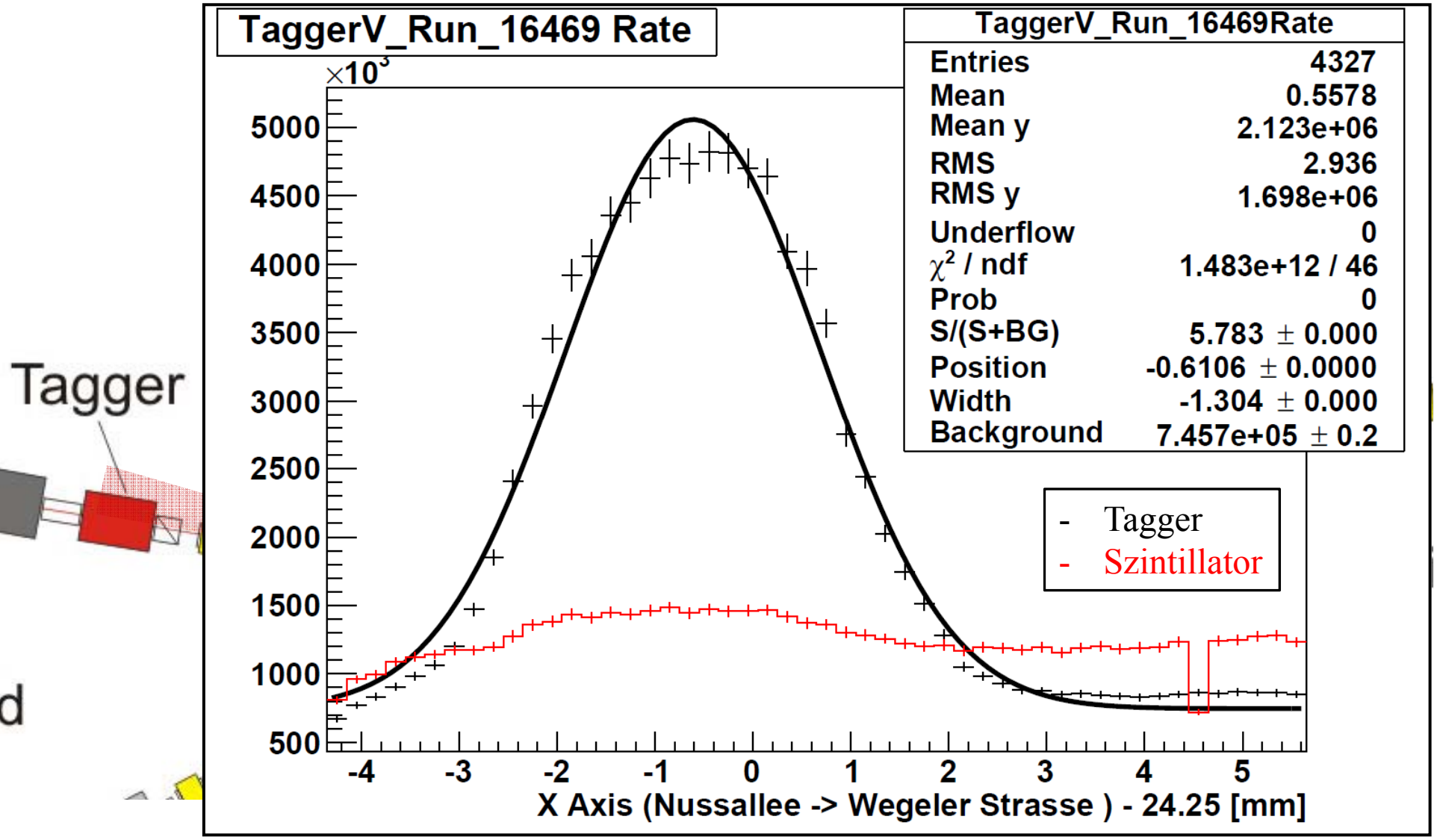
BGO-OD Beam Line



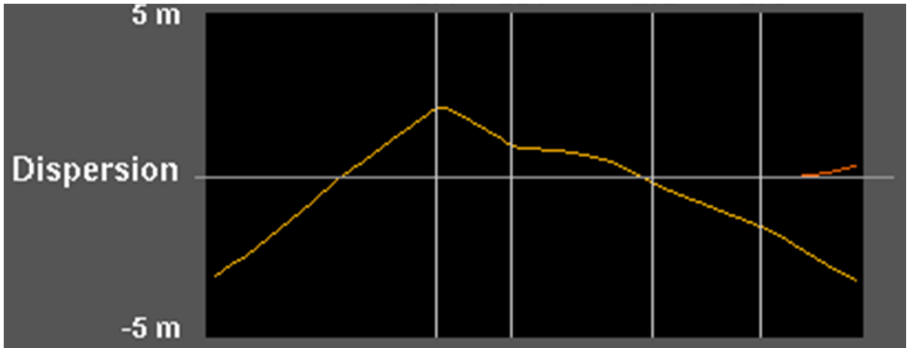


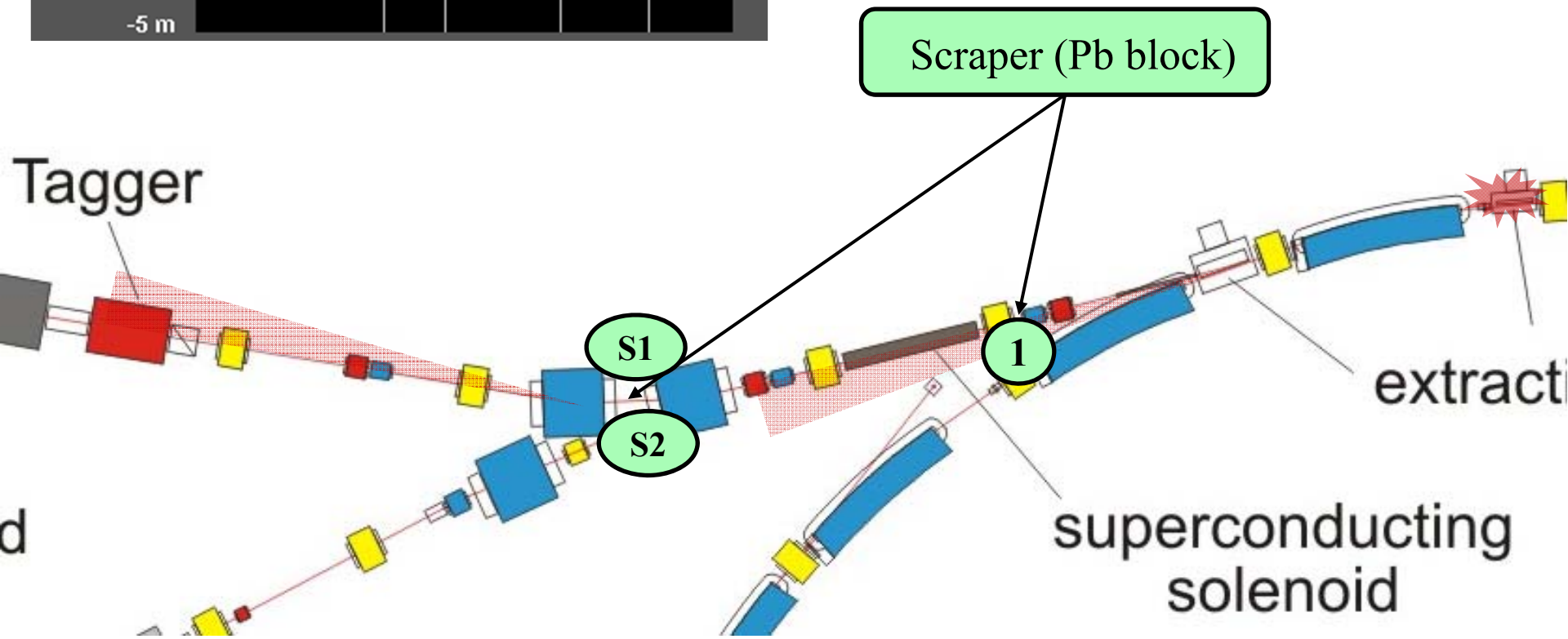


BGO-OD Beam Line

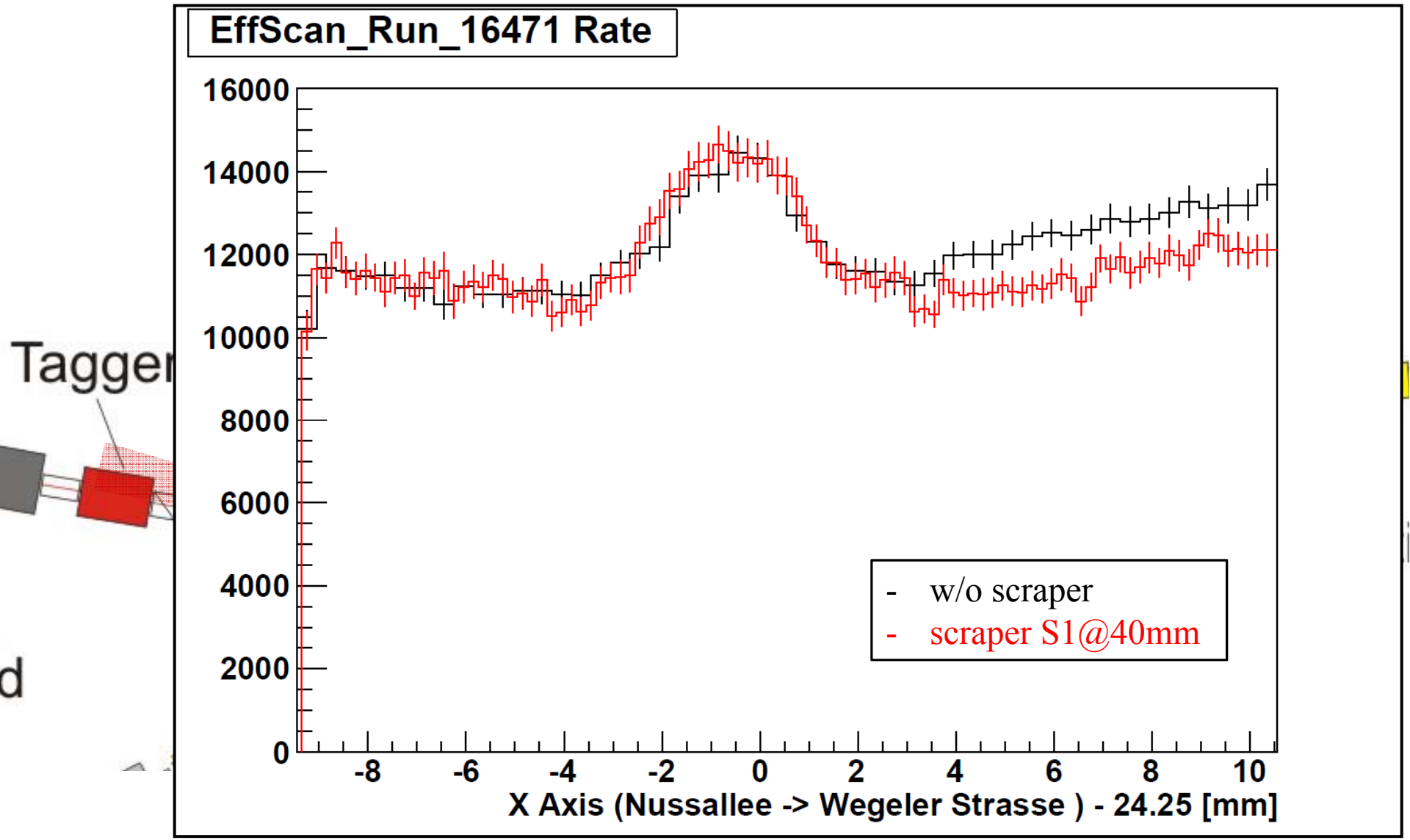


BGO-OD Beam Line

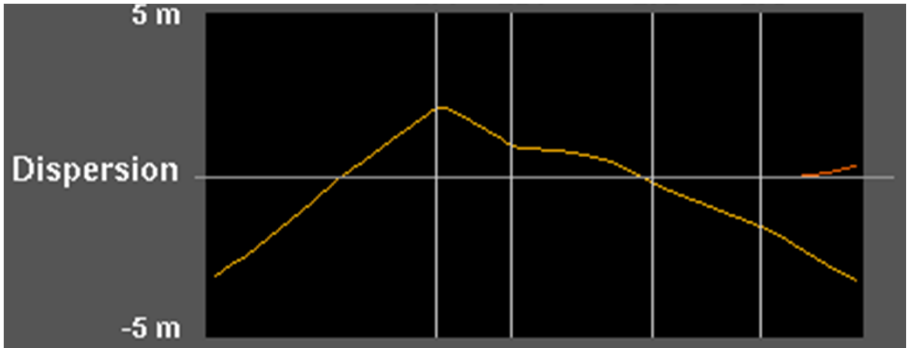


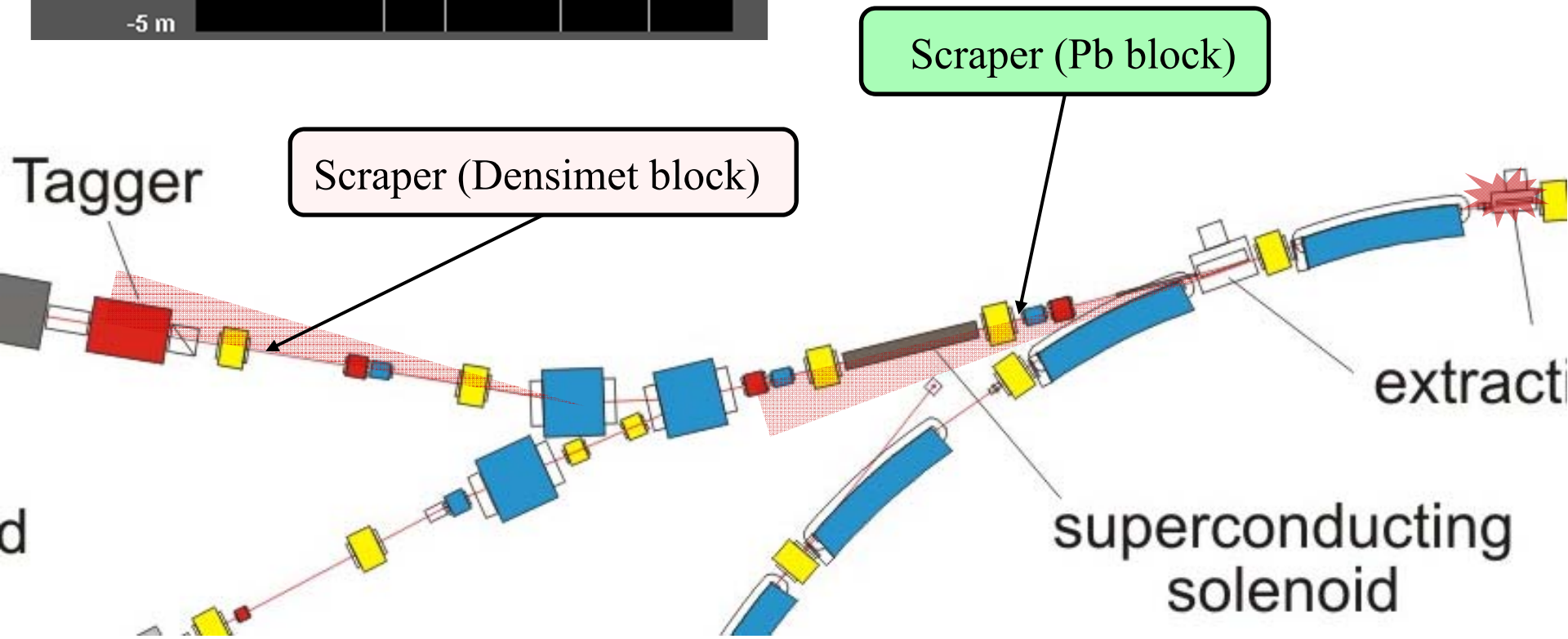


BGO-OD Beam Line



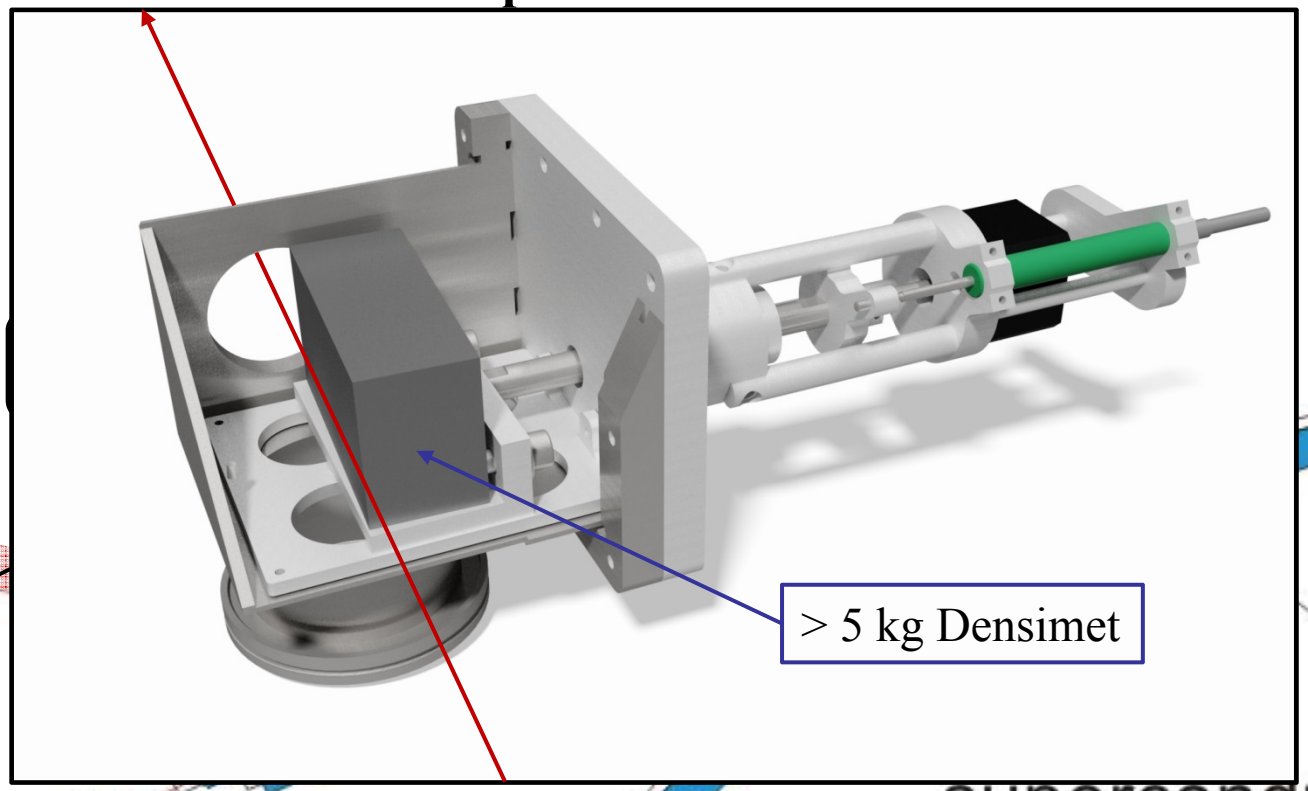
BGO-OD Beam Line





BGO-OD Beam Line

new beam scraper: installation this month

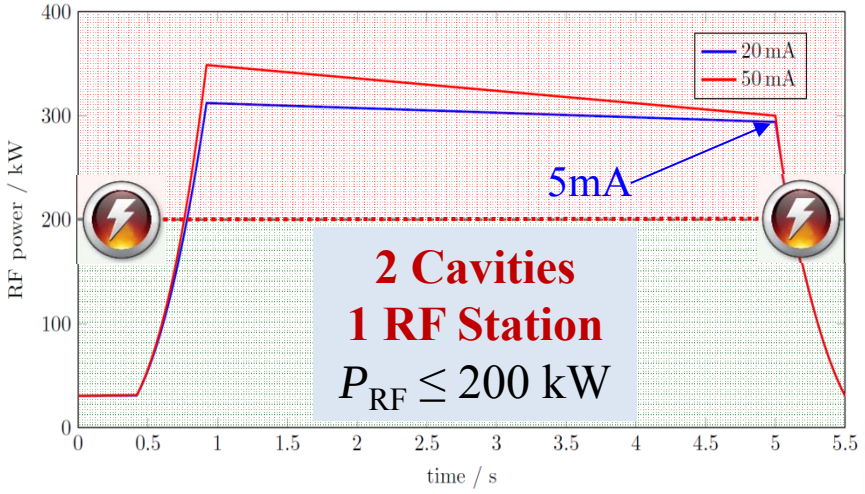


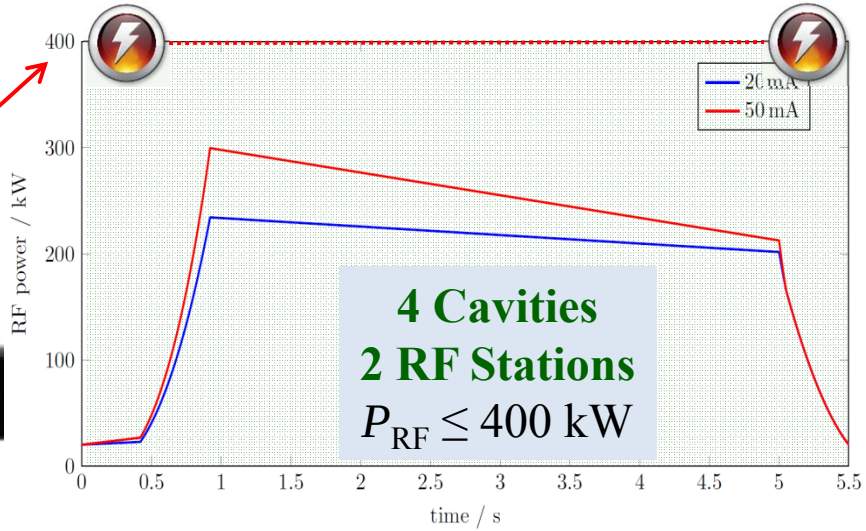
Tagger

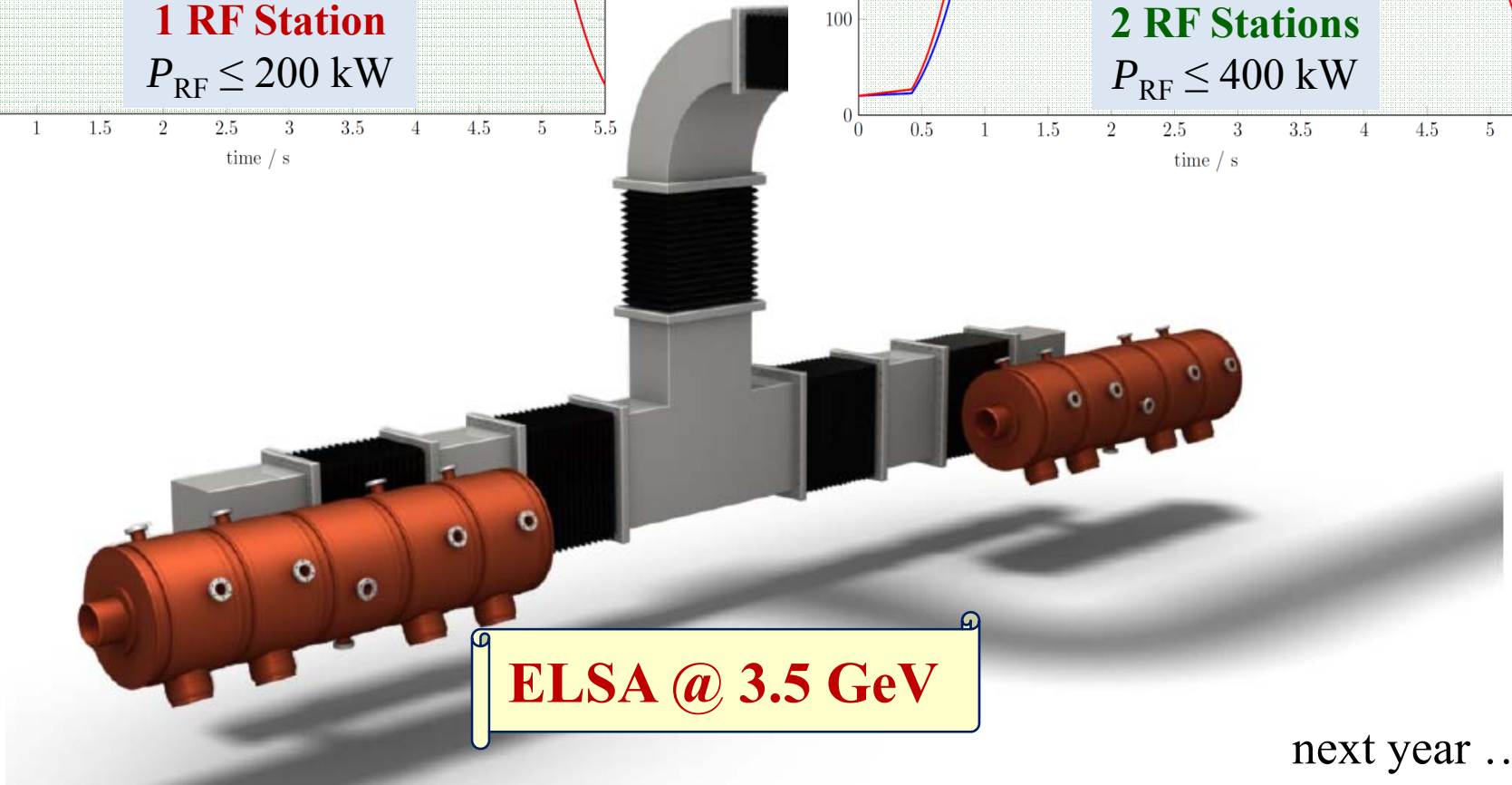
extracti

superconducting
solenoid

Outlook: New RF System







ELSA @ 3.5 GeV

next year …

Conclusions:

Linearly polarized photons:

Radiated by unpolarized electrons via coherent bremsstrahlung

→ highest possible energy (recoil!!!) and intensity (photon beam collimation!!!)

- 3D bunch by bunch feedback, HOM suppression, tapered chambers, new LLRF, …
- **2nd RF station serving two additional 7-cell resonators → operation @ 3.5GeV**

Circularly polarized photons:

Radiated by longitudinally polarized electrons, full polarization transfer at max. energy

→ highest possible electron polarization at desired (max?!) energy

- polarized source, spin manipulation, num. simulation, resonance compensation
  achieved so far: ***P*** **= 74±2%@2.35 GeV,** ***P*** **= 65±2%@2.92 GeV (in ELSA!)**
- **new corrector system → appl. spin response harmonic correction technique**

Background at BGO-OD tagger:

Low energetic “fan”, probably caused by partial beam loss in extraction septa

→ achromatic beam line impossible, scraping of beam halo investigated instead

- beam scraper installed in first part of beam line, no dramatic effect so far
- **2nd beam scraper under construction, will be installed before Nov. in front of radiator**