Progress of the Intense Positron Beam Project EPOS

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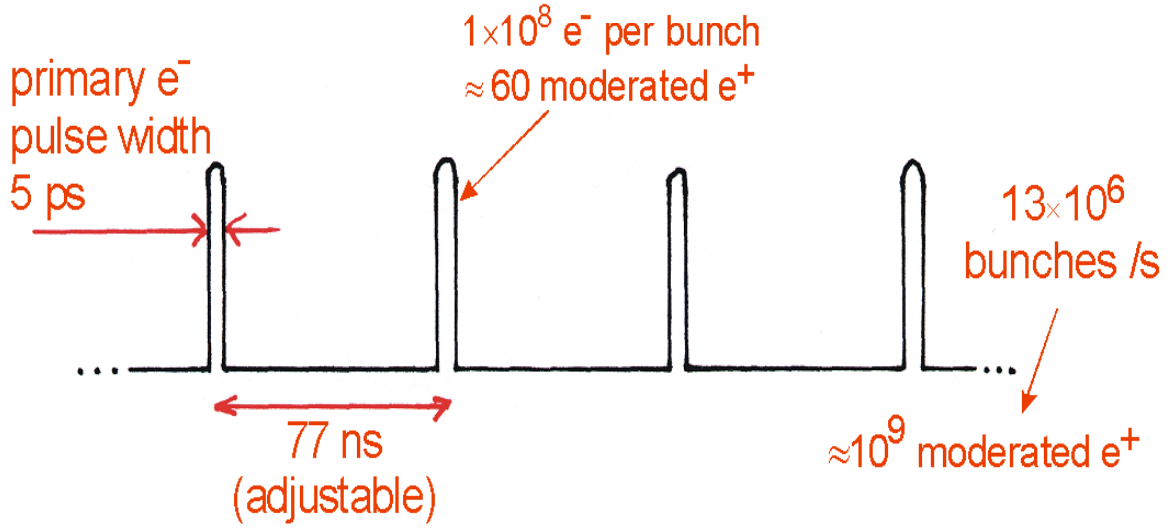
- System Setup
- Electron-Positron Converter
- Positron Extraction
- Chopper / Buncher System
- Radiation Shielding

3 - 7 September 2007
Lądek Zdrój - Poland

The EPOS (ELBE Positron Source) project at Research Center Dresden-Rossendorf

- Radiation source ELBE = **E**lectron **L**inac with high **B**rilliance and low **E**mittance
- Primary electron beam (40 MeV x 1 mA = 40 kW)
- Time structure: infinite sequence of very short electron bunches (cw-mode)
- Spot size: 5mm diameter



electron bunch structure

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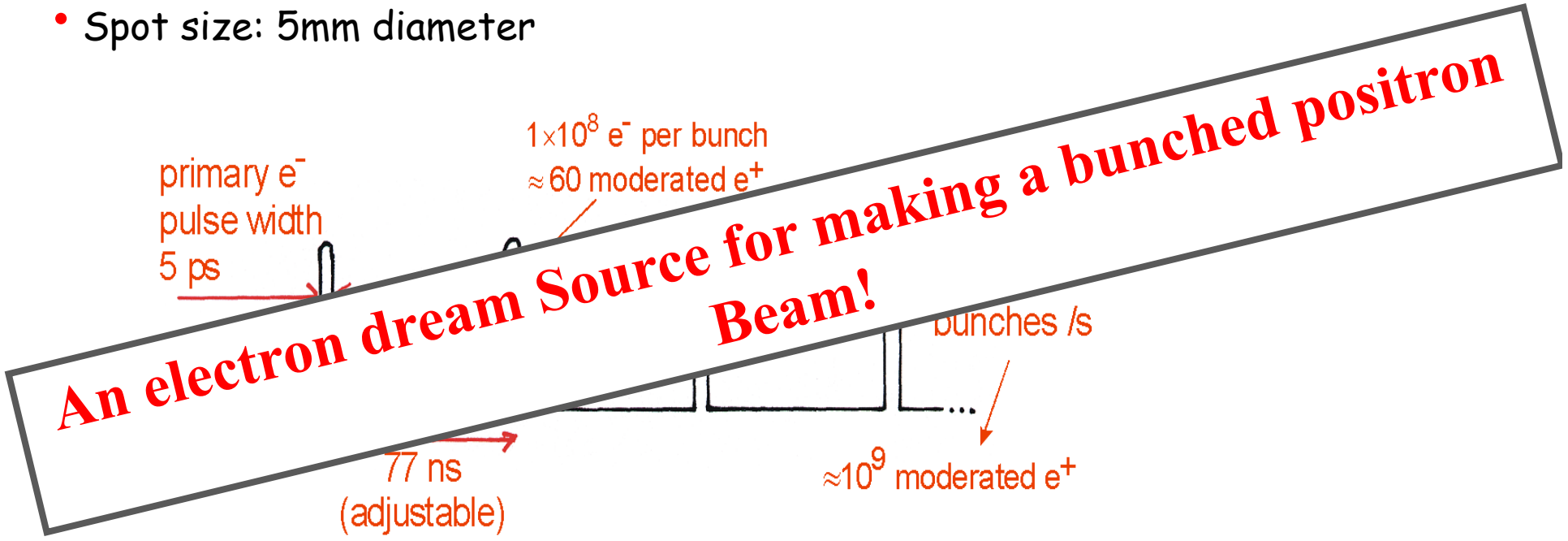
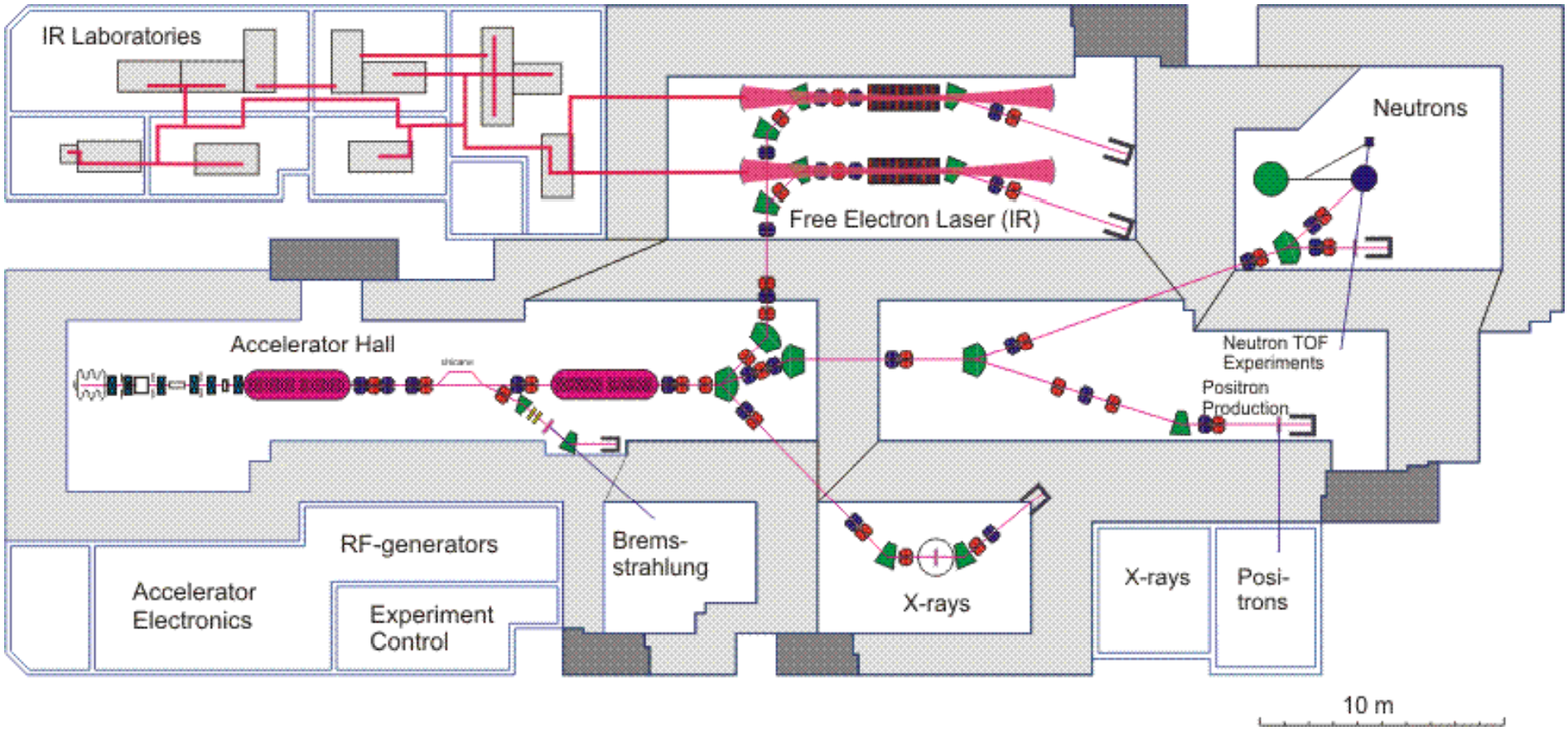
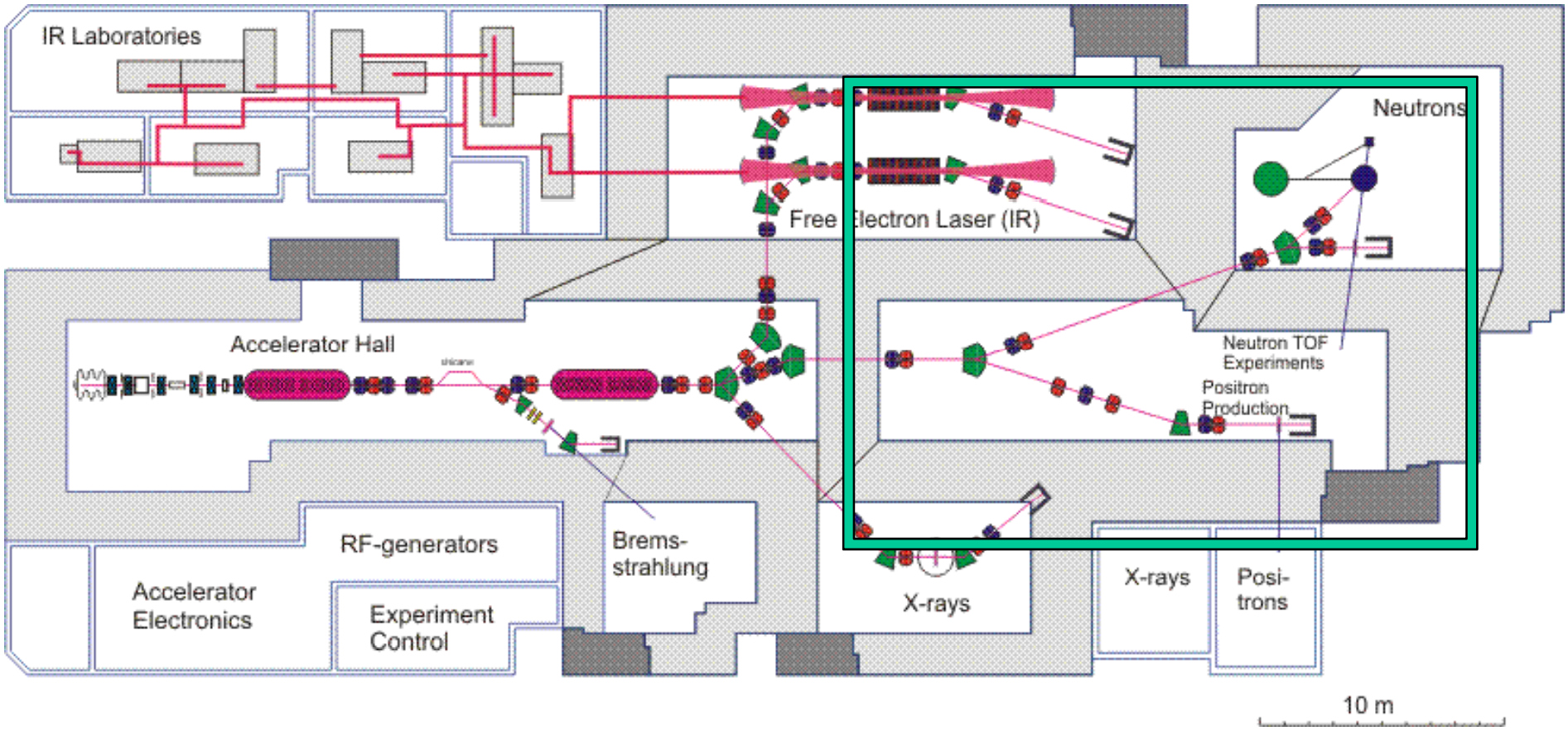


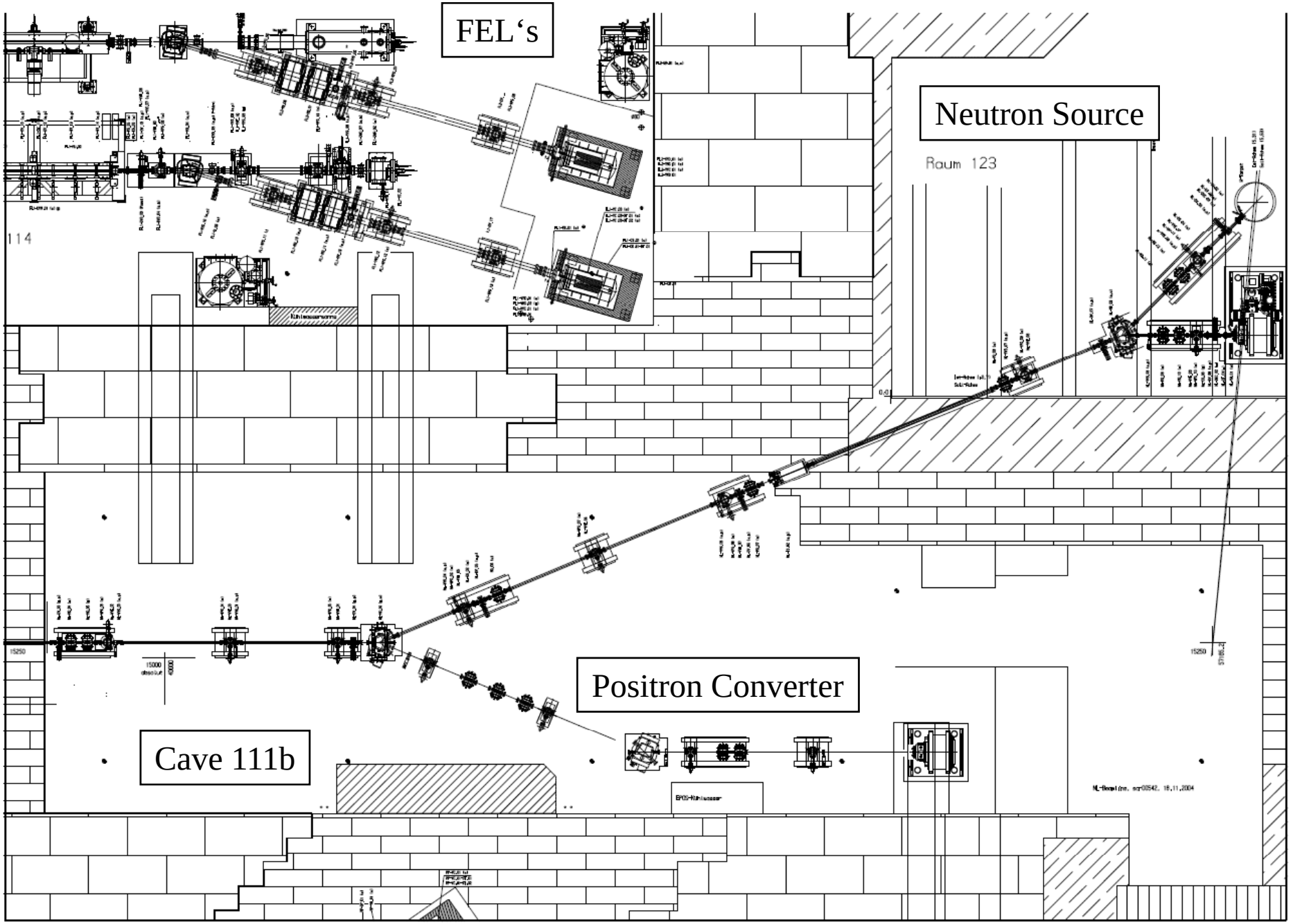
electron bunch structure

Ground plan of the ELBE hall



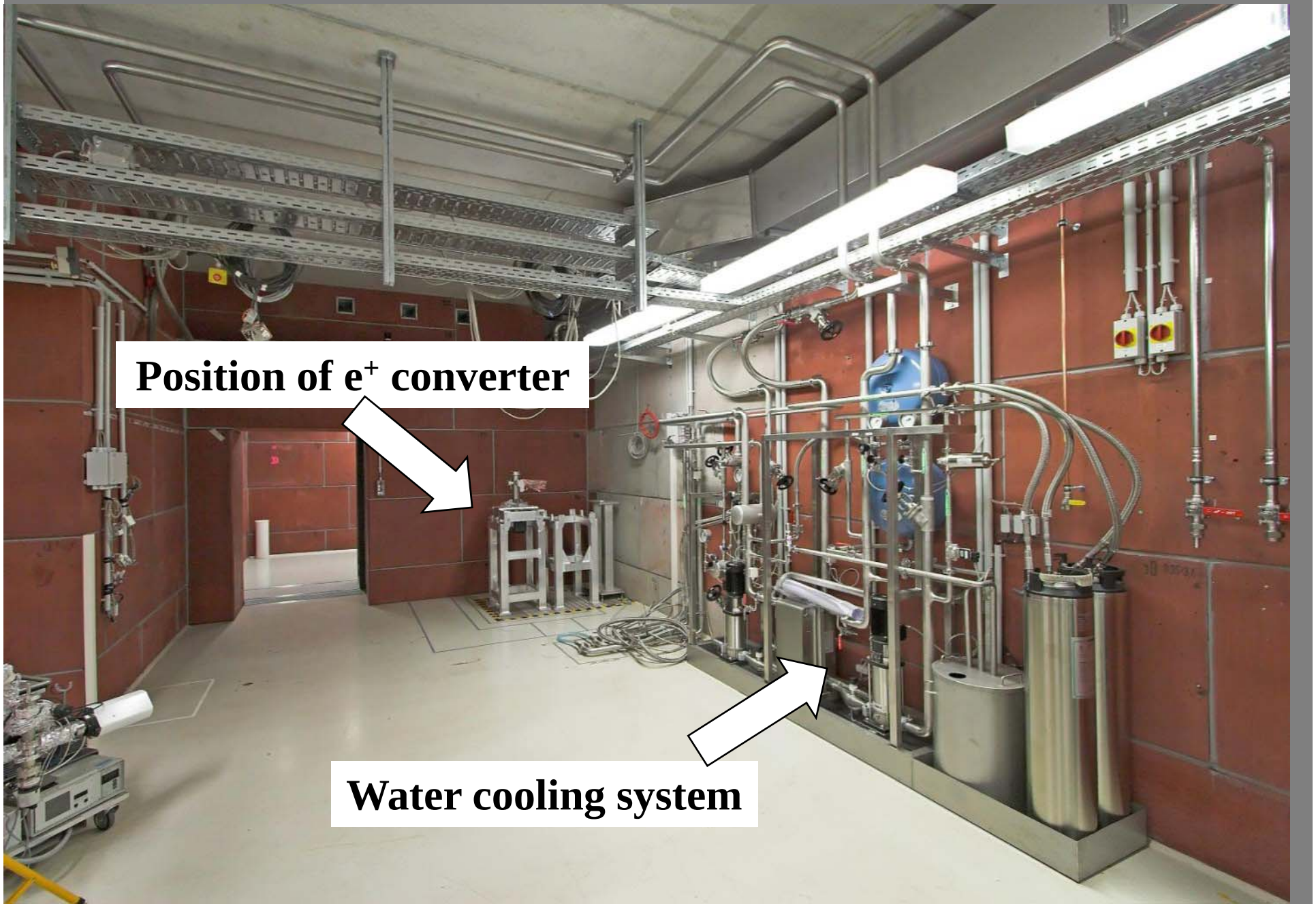
Ground plan of the ELBE hall

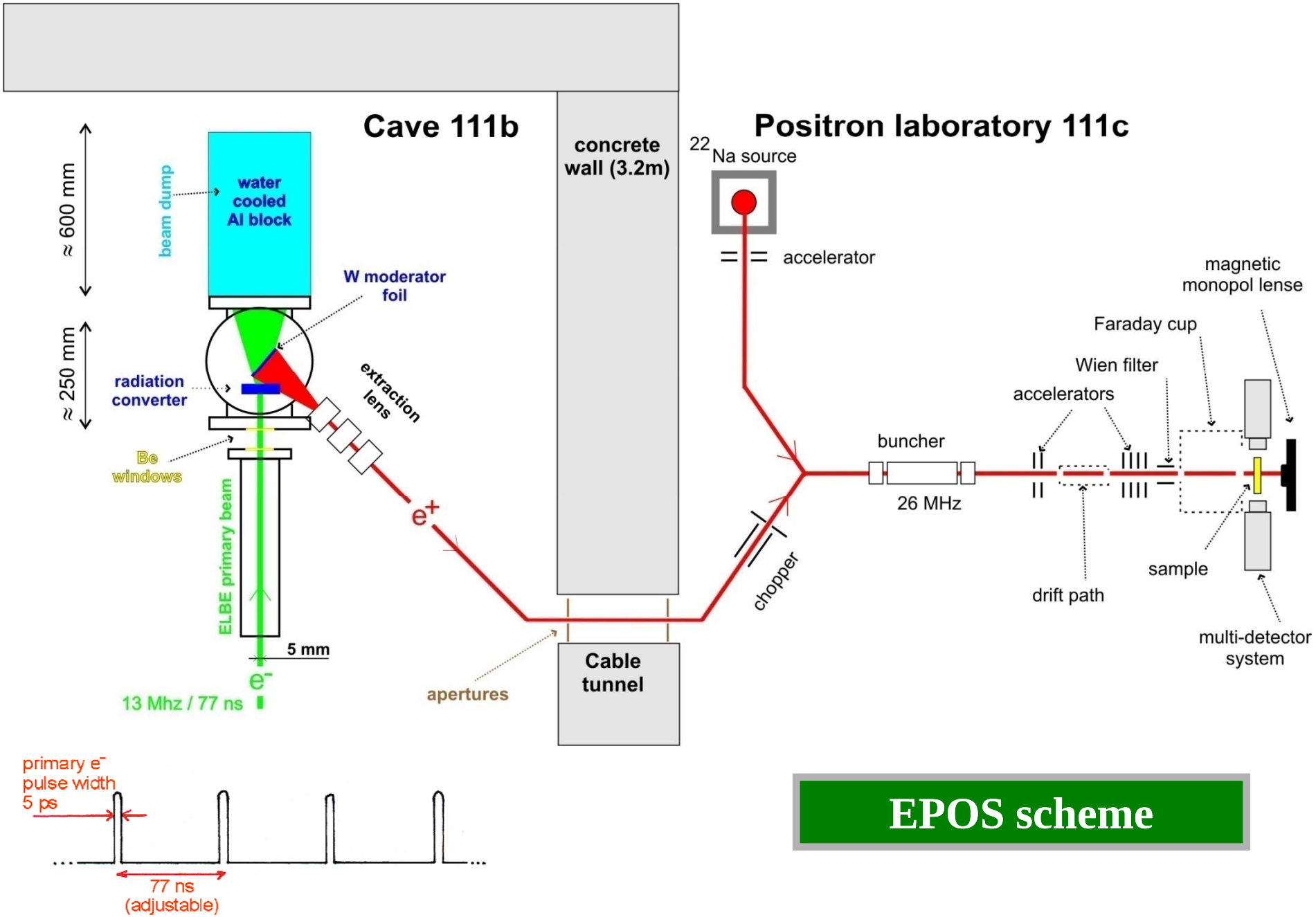



FEL‘s
Neutron Source
Raum 123
114
Positron Converter
Cave 111b


Kaltwasser Vorl.
ZARGES
Unbefugten
Betreten
der Baustelle
verboten

Cave 111b

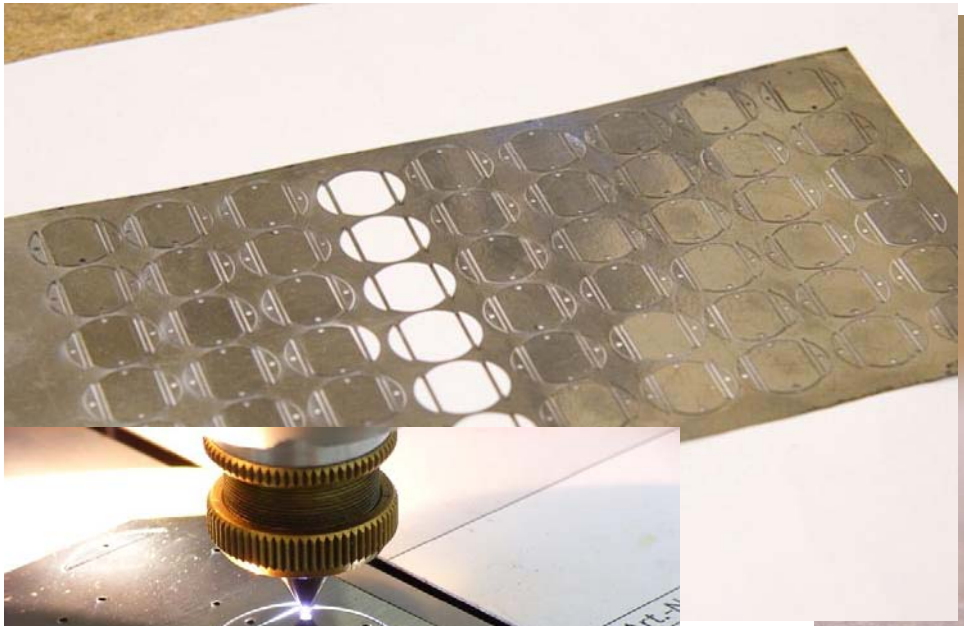


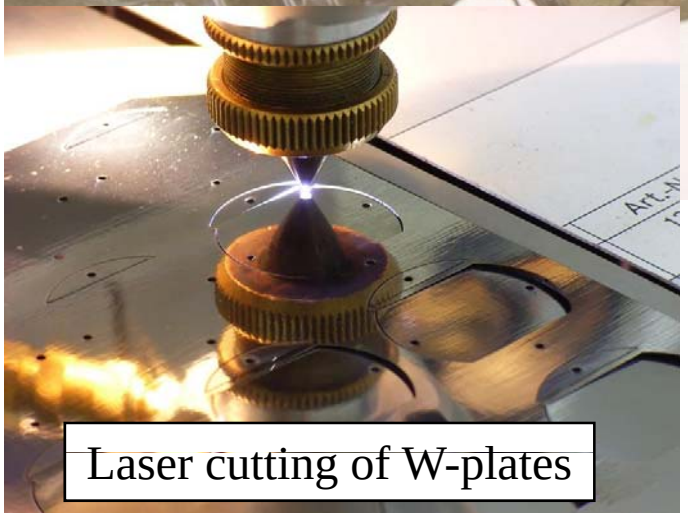

Cave 111b
Positron laboratory 111c
concrete wall (3.2m)
22Na source
accelerator
≈ 600 mm
≈ 250 mm
beam dump
water cooled Al block
W moderator foil
radiation converter
extraction lens
Be windows
ELBE primary beam
5 mm
e-
13 Mhz / 77 ns
e+
apertures
Cable tunnel
chopper
buncher
26 MHz
magnetic monopol lense
Faraday cup
Wien filter
accelerators
drift path
sample
multi-detector system
primary e- pulse width 5 ps
77 ns (adjustable)

EPOS scheme

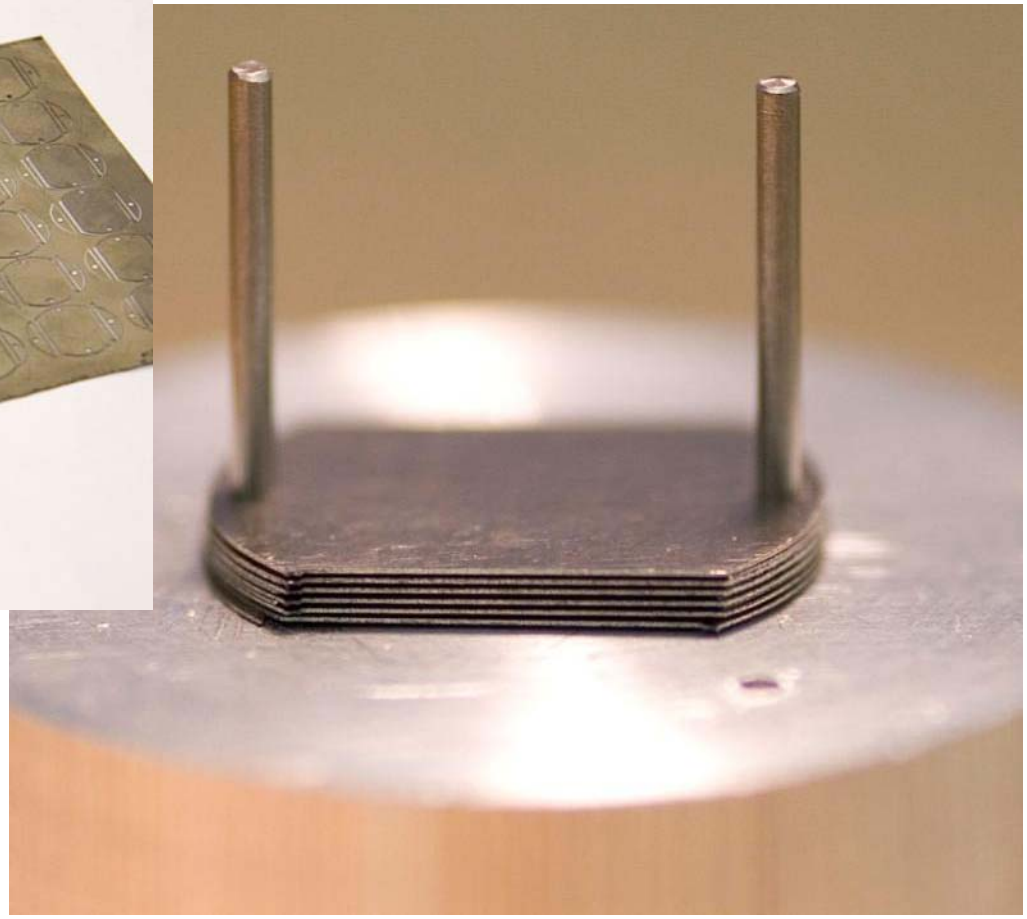
Directly water-cooled Electron-Positron Converter

- stack of 50 pieces W-foils 0,1 mm separated by 0,1 mm -> 13,5 l water at 1,5 bar
- foils cut by IR-laser in our workshop





Laser cutting of W-plates



Directly water-cooled Electron-Positron Converter

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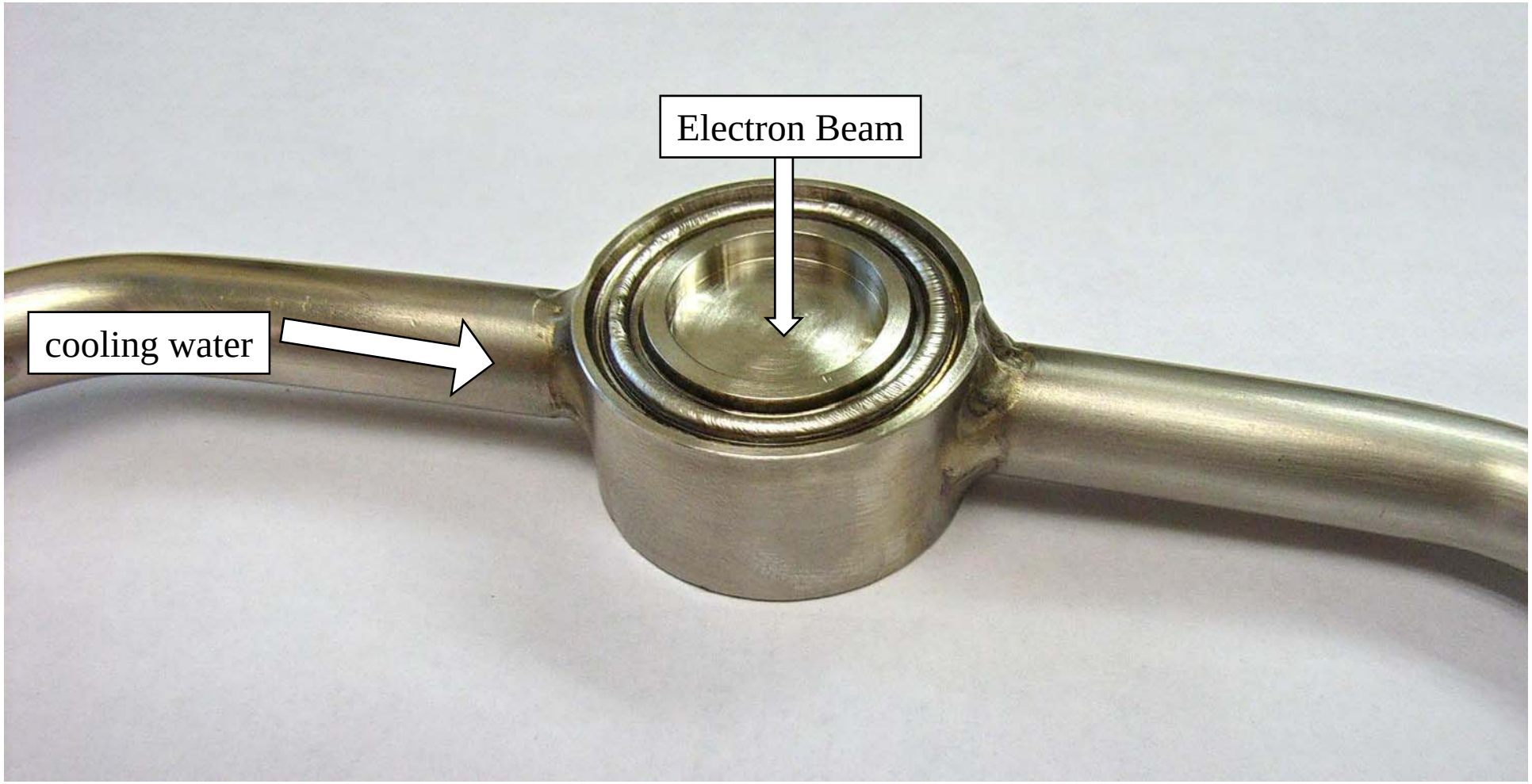
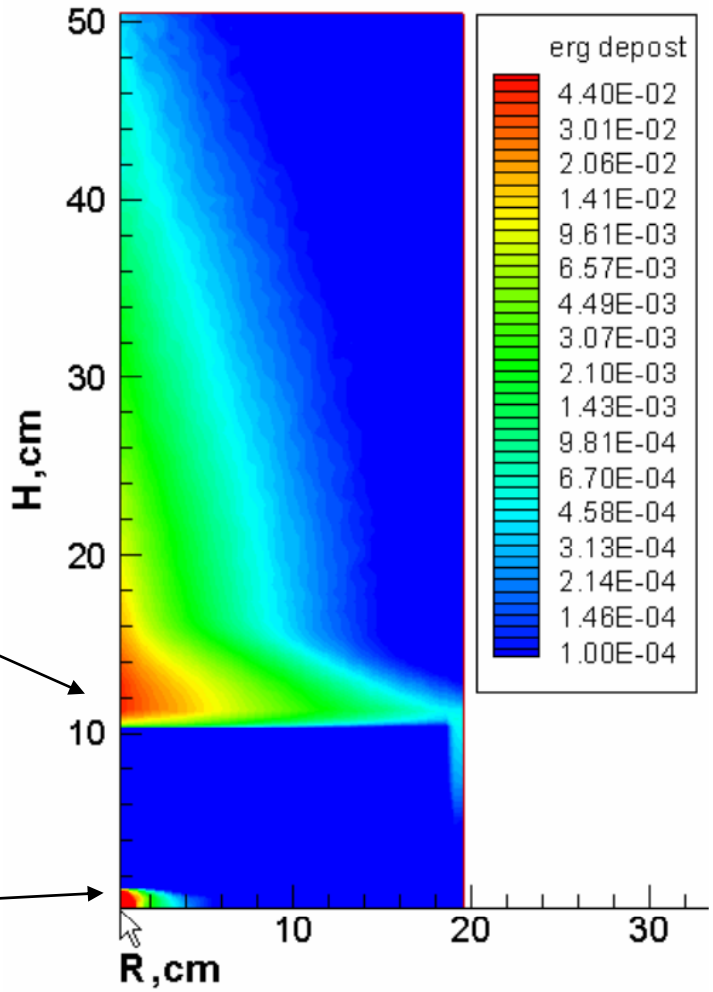


Simulation of Energy deposition



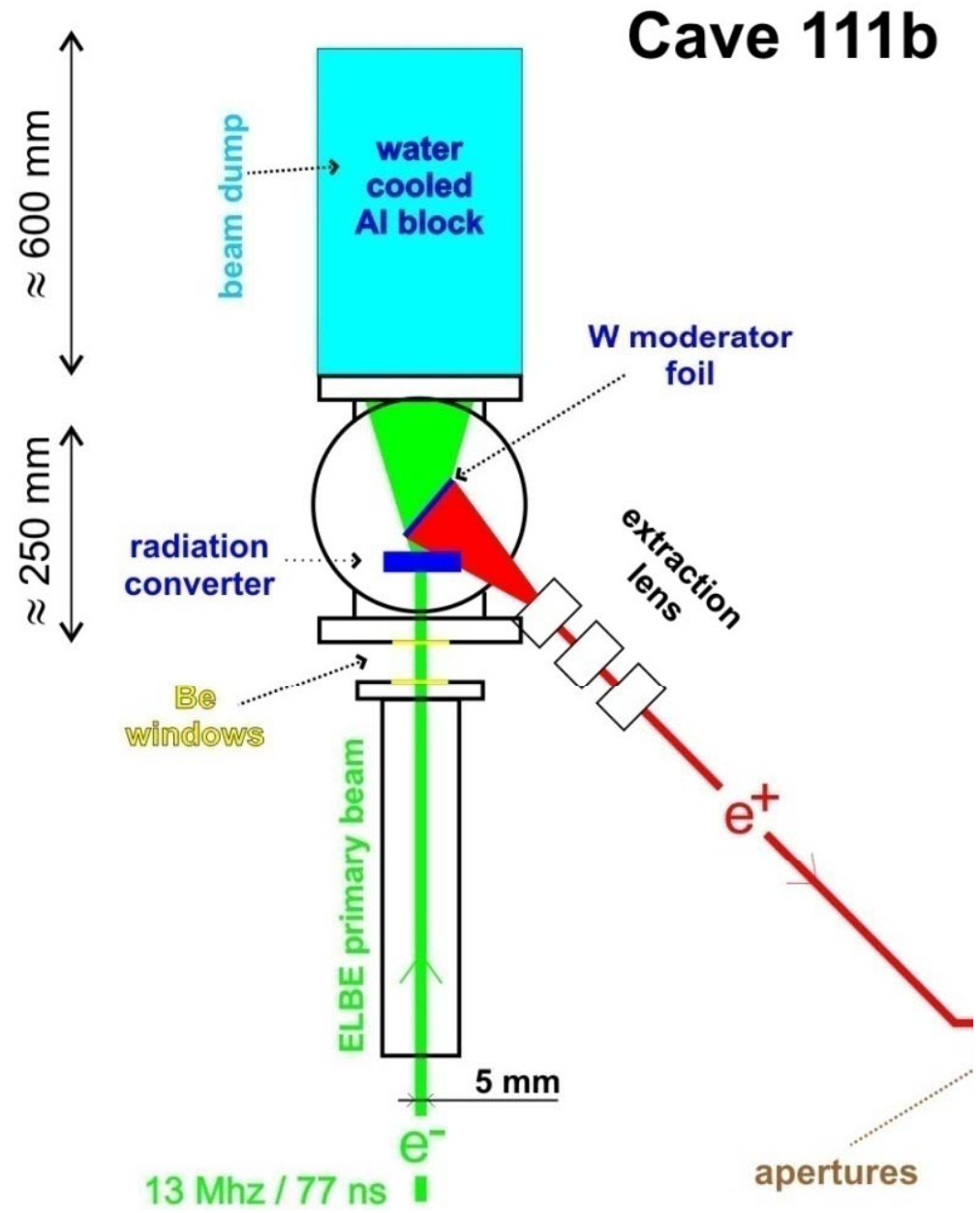
Al beam dump 21 kW (made of 5N-purity)

W target 14 kW

EPOS Density Energy Deposition (in MeV/cm^3) for Distance = 10cm

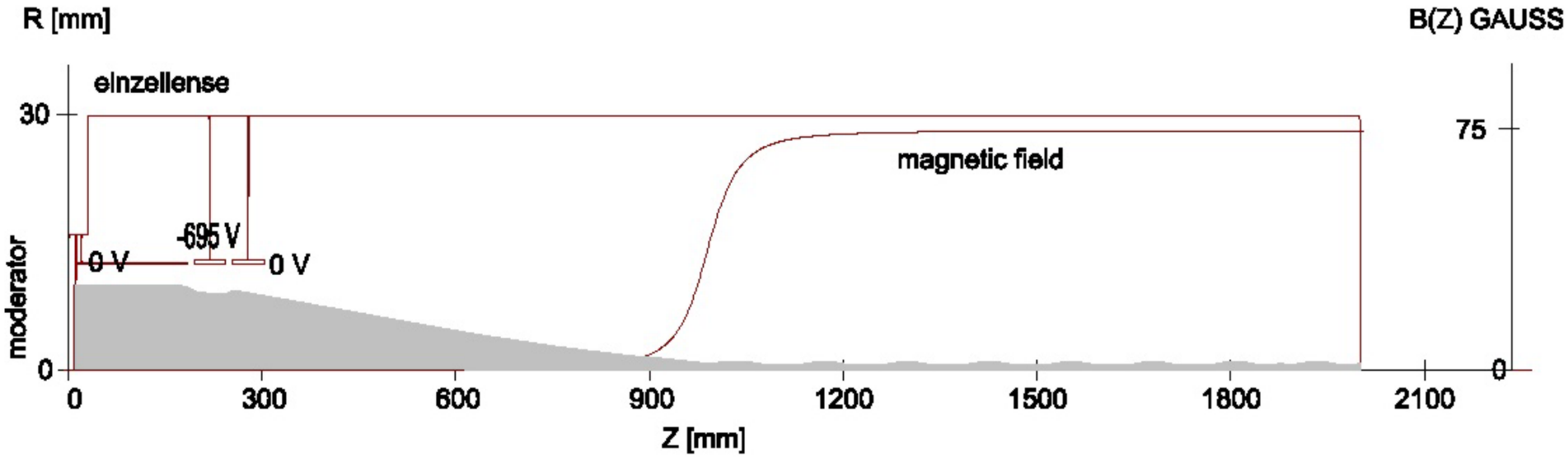
primary beam

Positron extraction electrodes



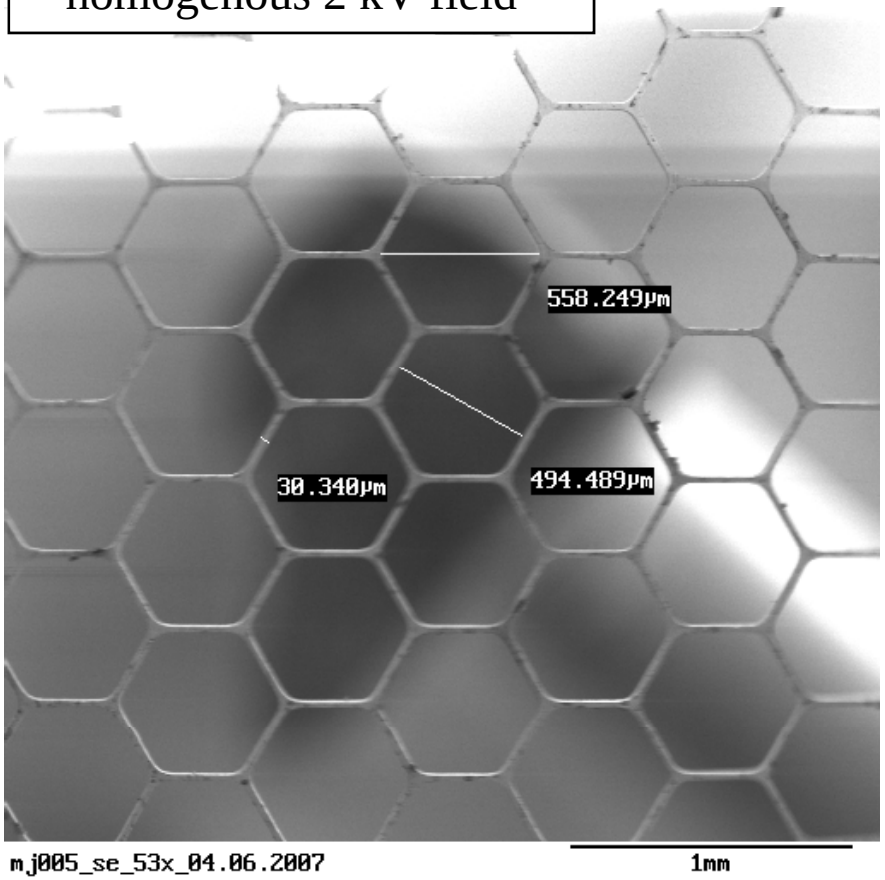
Simulation of positron extraction

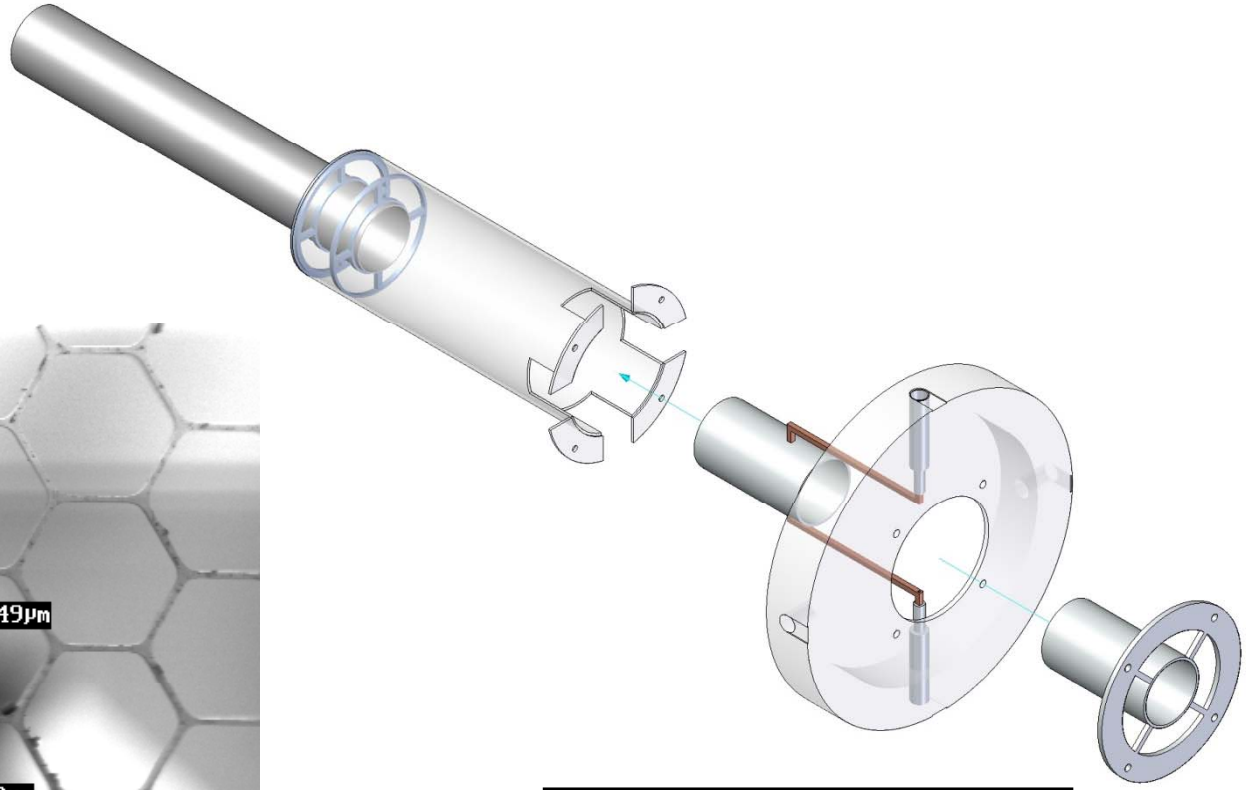
- simulation done by EGUN
- area of 20 mm diameter at moderator is used and squeezed to about 2 mm



Positron extraction electrodes

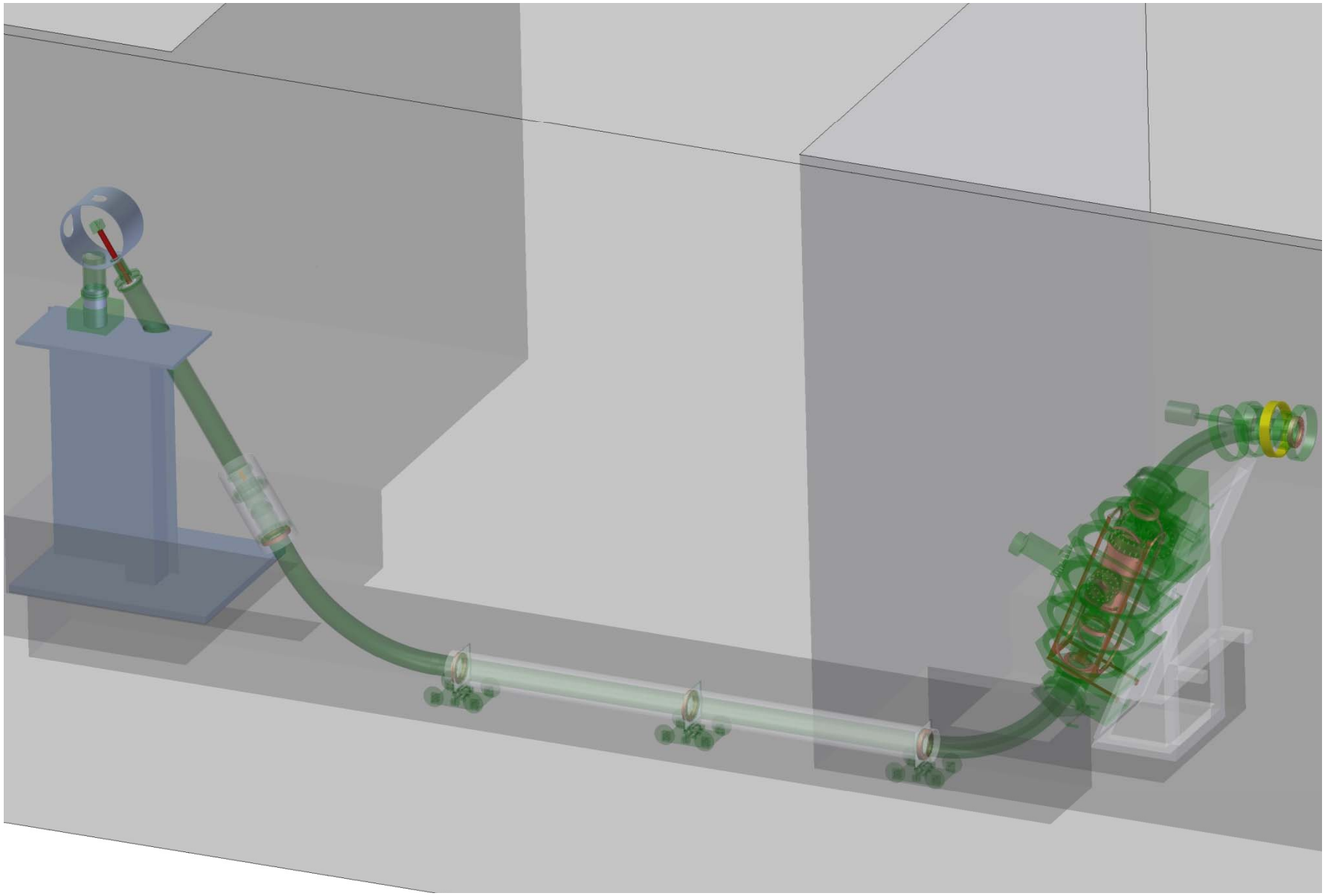
- stainless steel mesh
- 90% opening
- in front of Einzel lens
- provides very homogenous 2 kV-field





Einzel lens for extraction

Magnetic Beam Guidance System



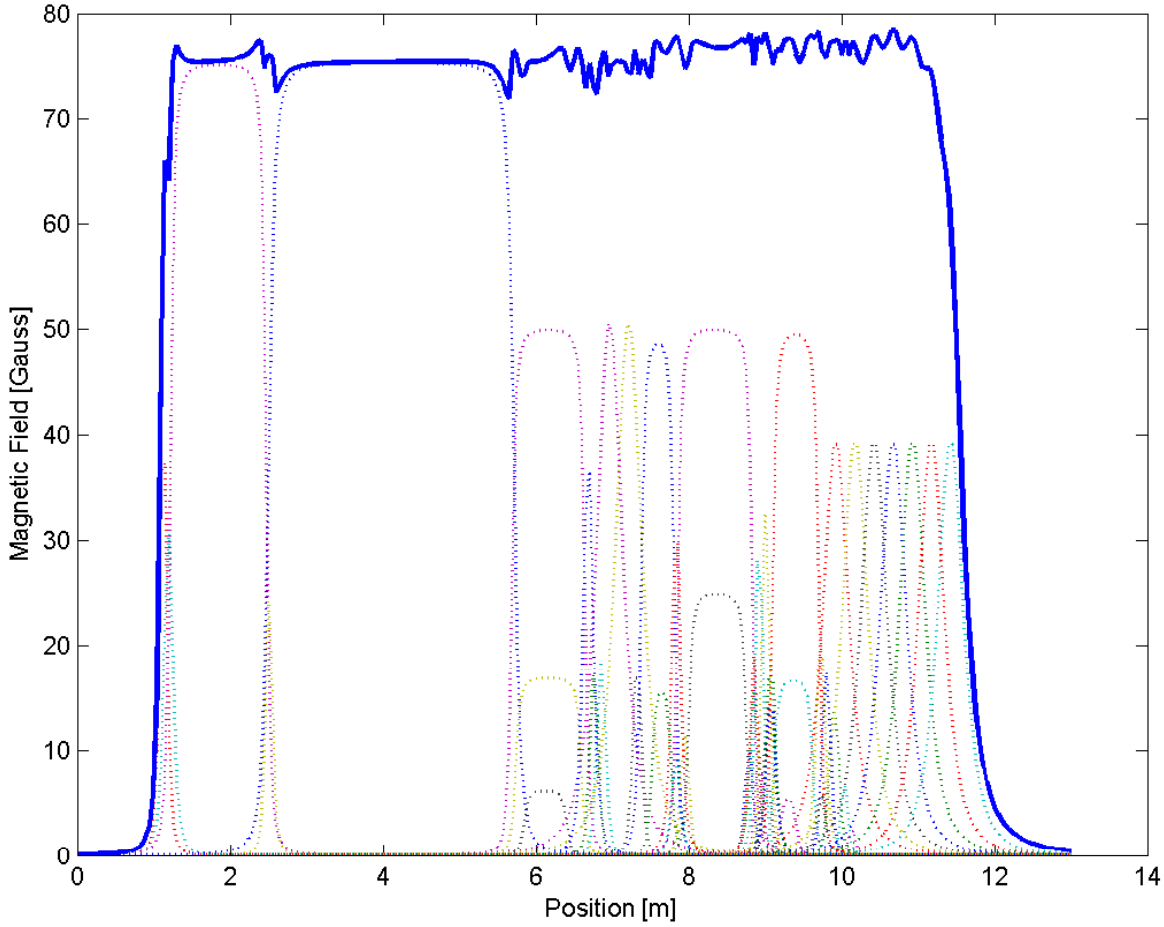
Magnetic Beam Guidance System

Magnetic field of 75 Gauss provides by long coils and Helmholtz coils

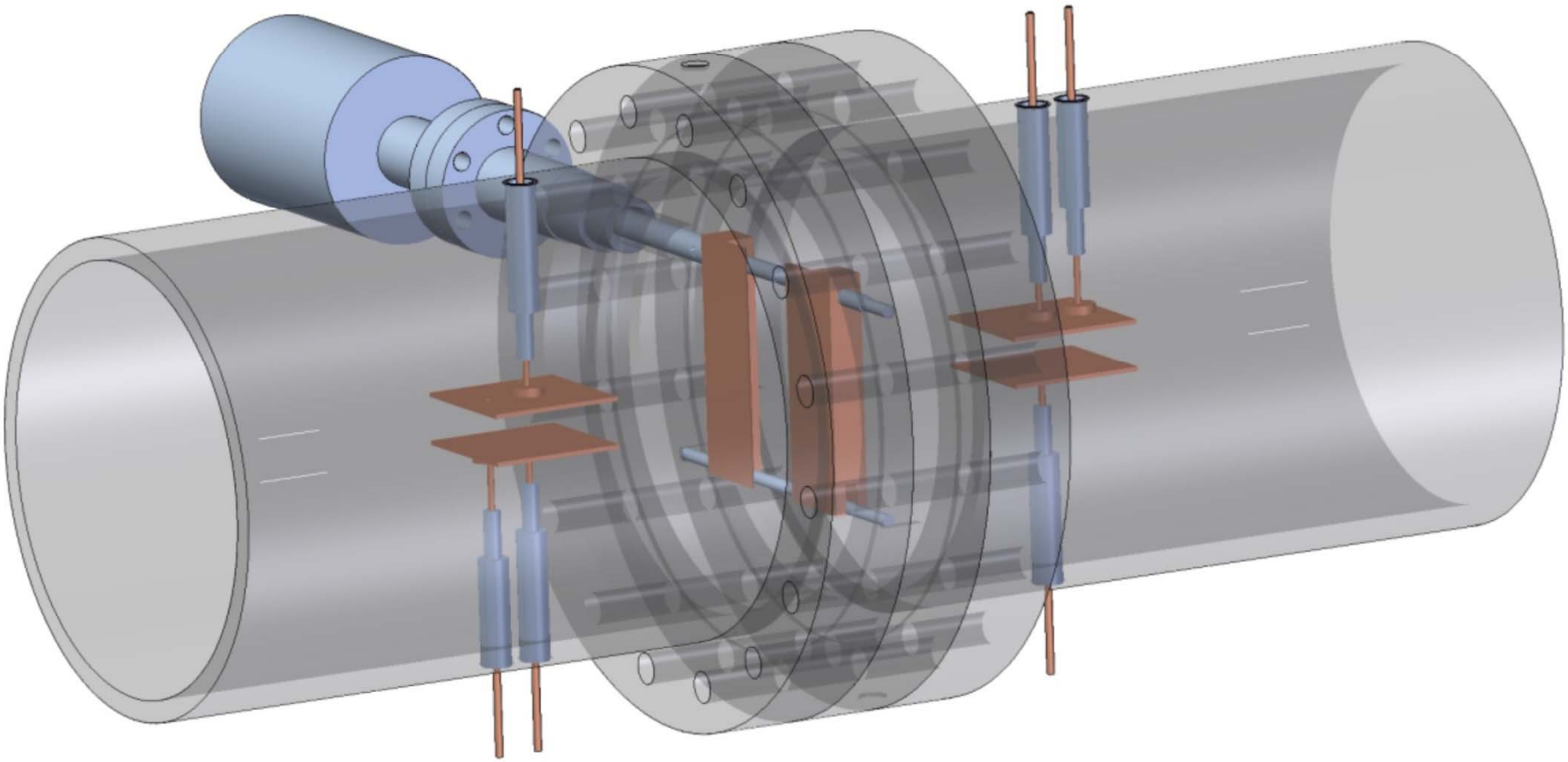
- 45 coils but only
- 5 different currents
- 5 Power supplies

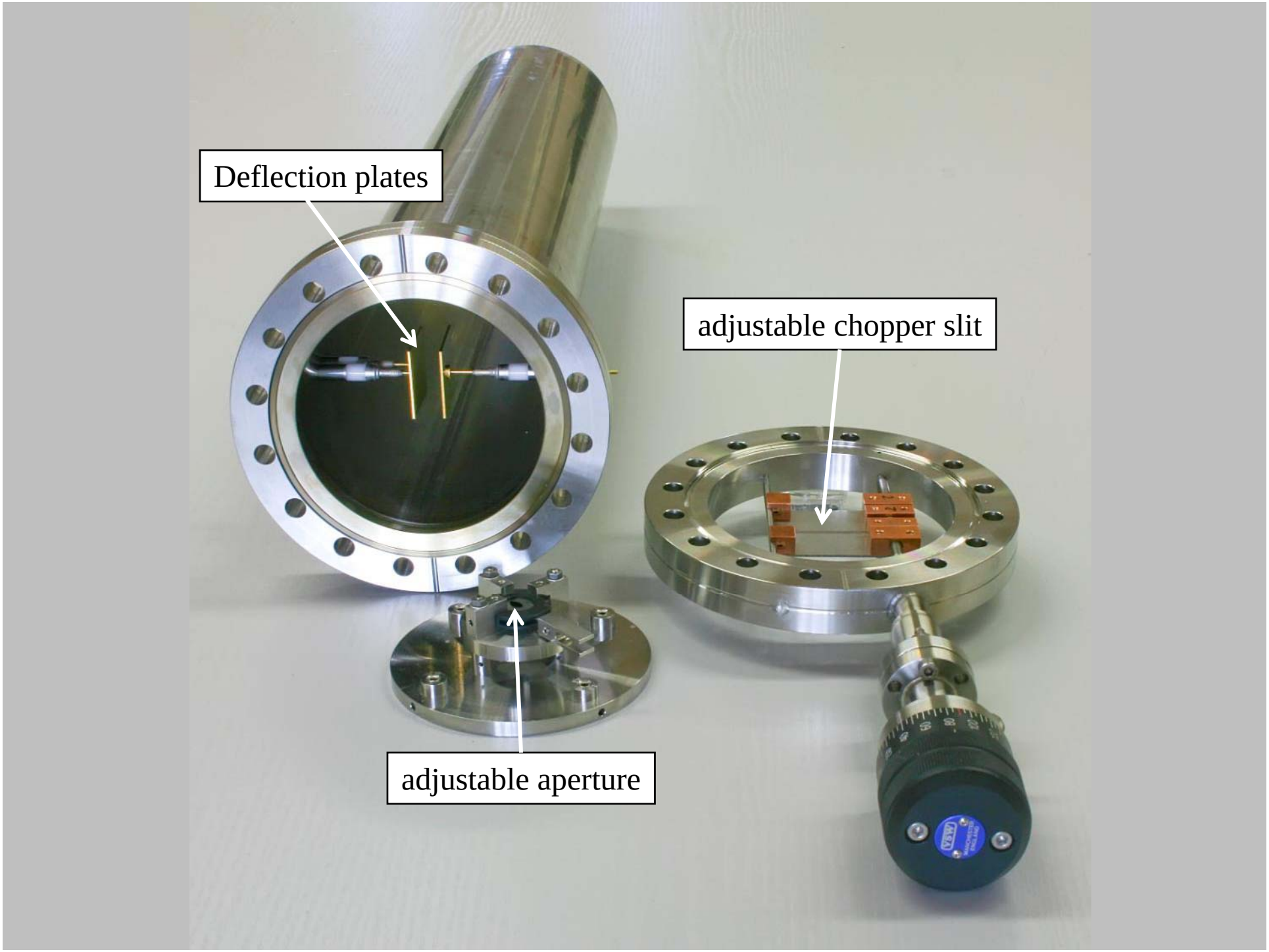
- maximum change 6 G
- gradient < 0.11 G/mm

30 pairs of steering coils with different (computer-driven) current sources

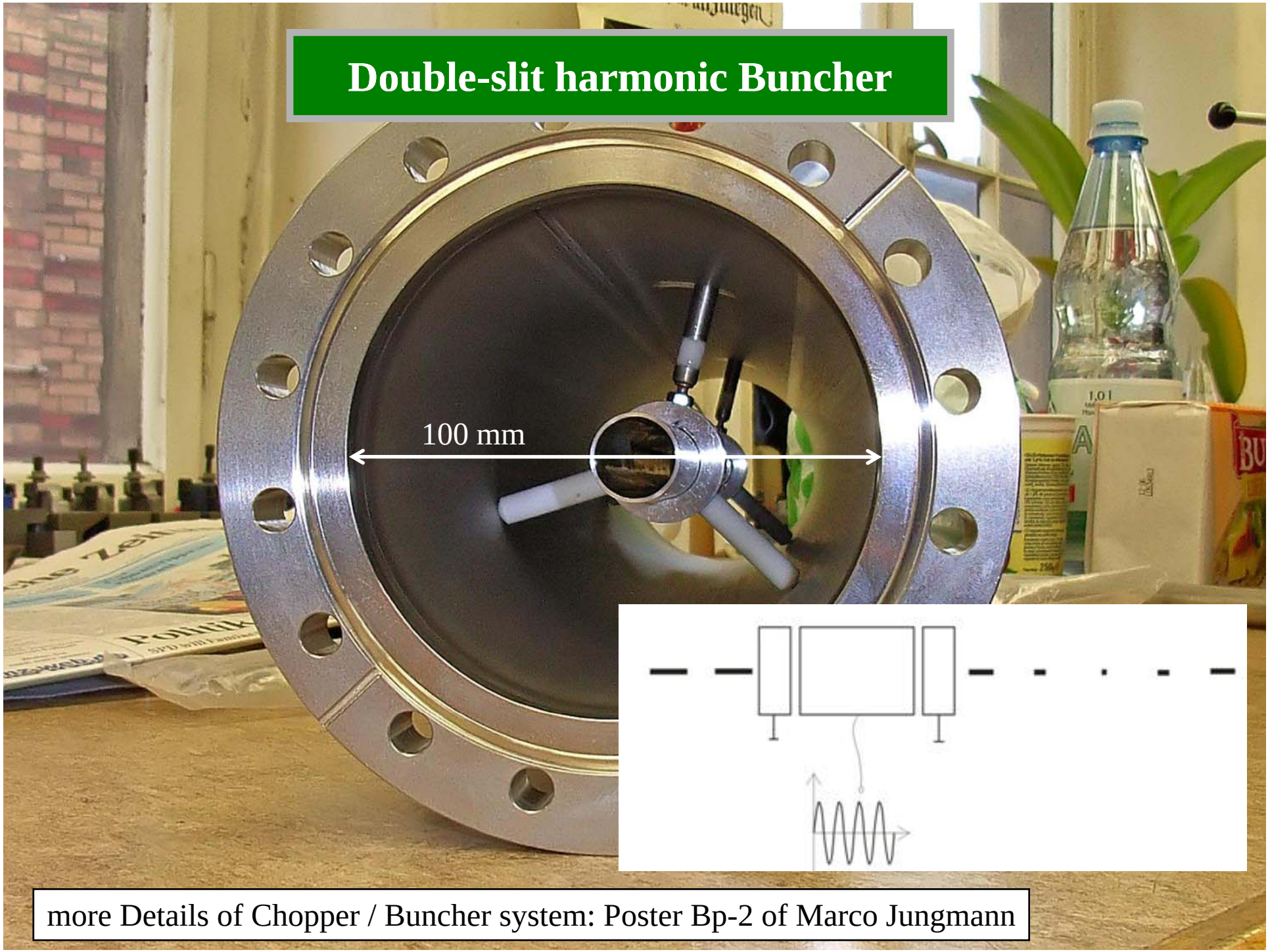


Chopper

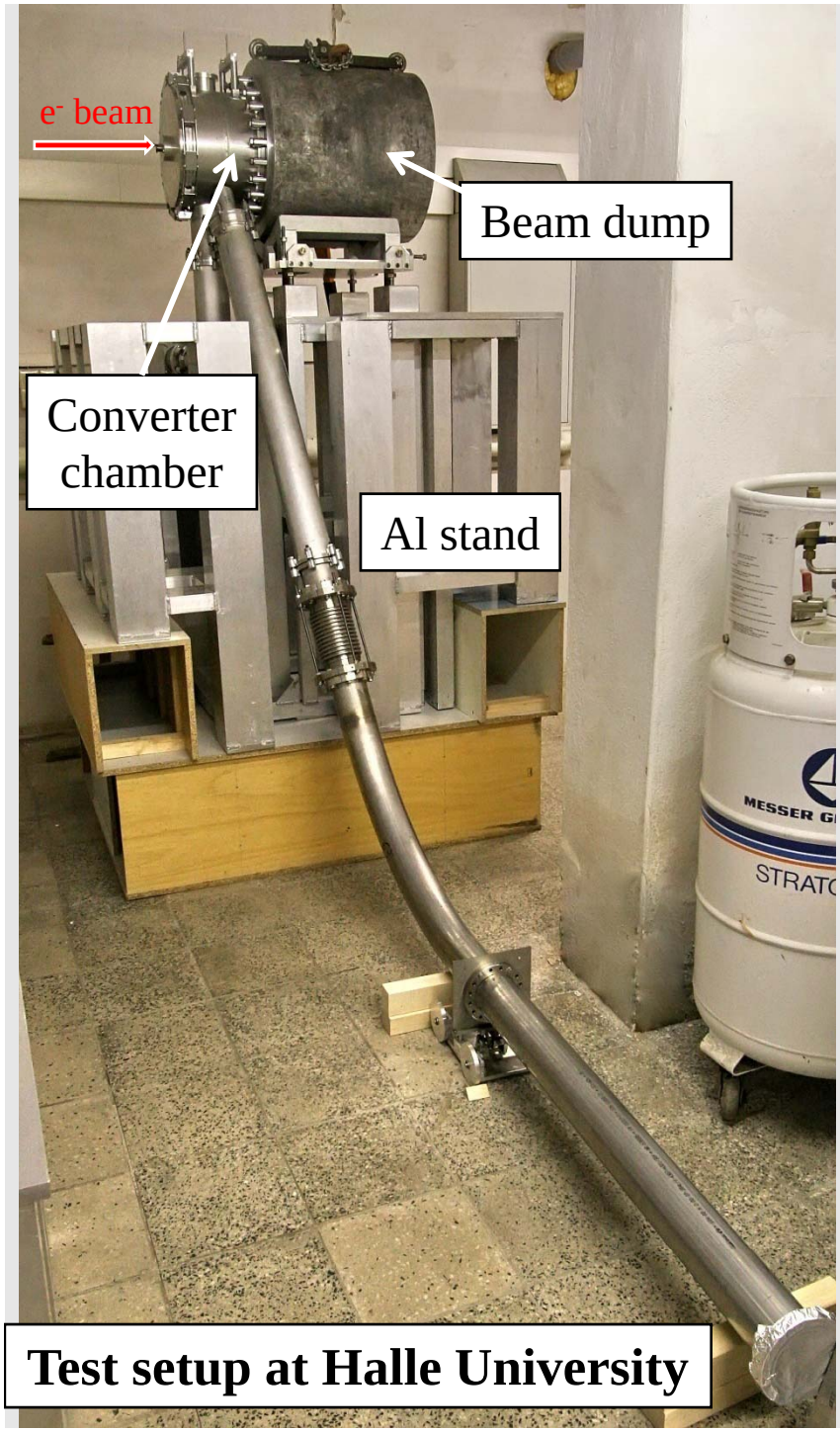



Deflection plates
adjustable chopper slit
adjustable aperture

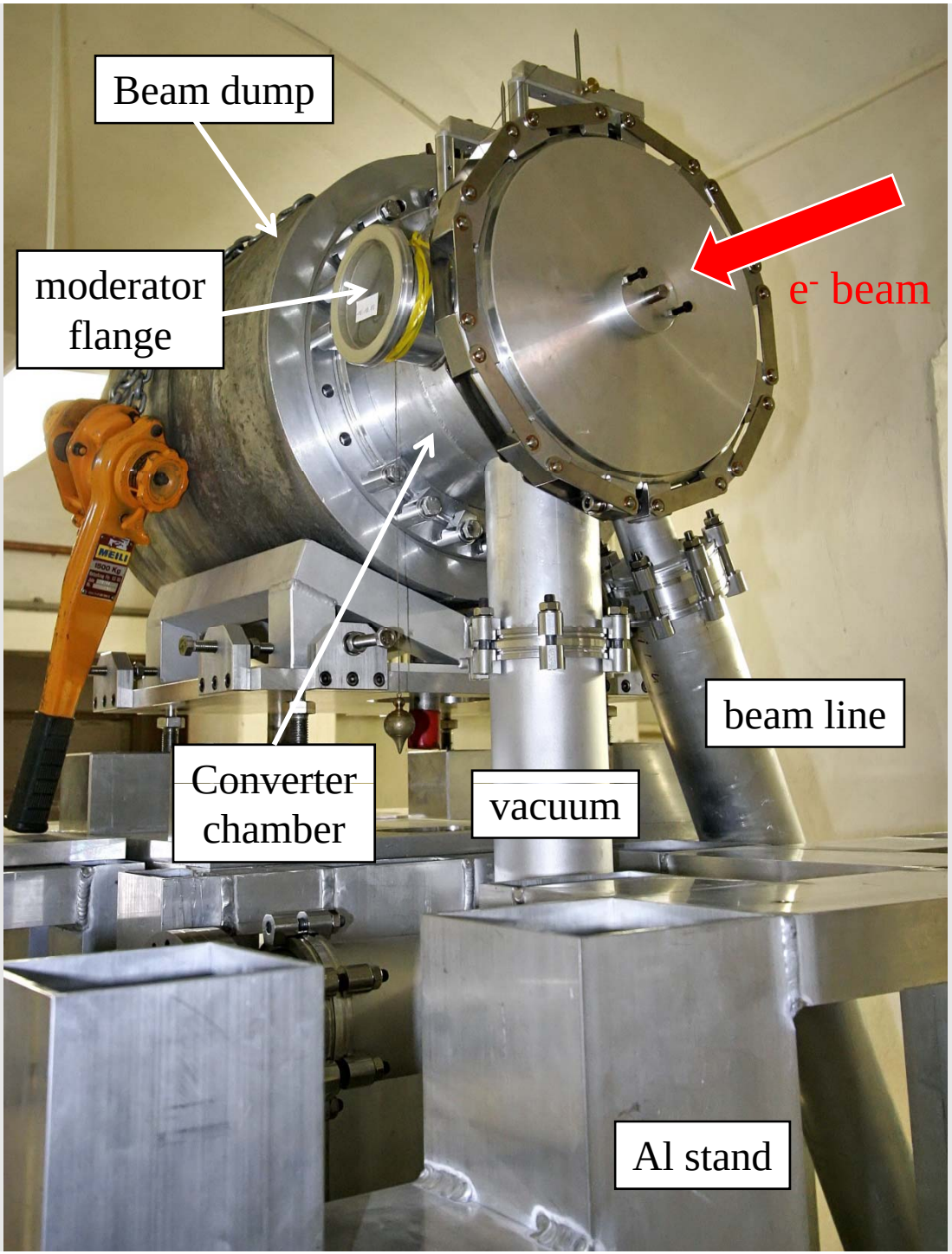
Double-slit harmonic Buncher



more Details of Chopper / Buncher system: Poster Bp-2 of Marco Jungmann

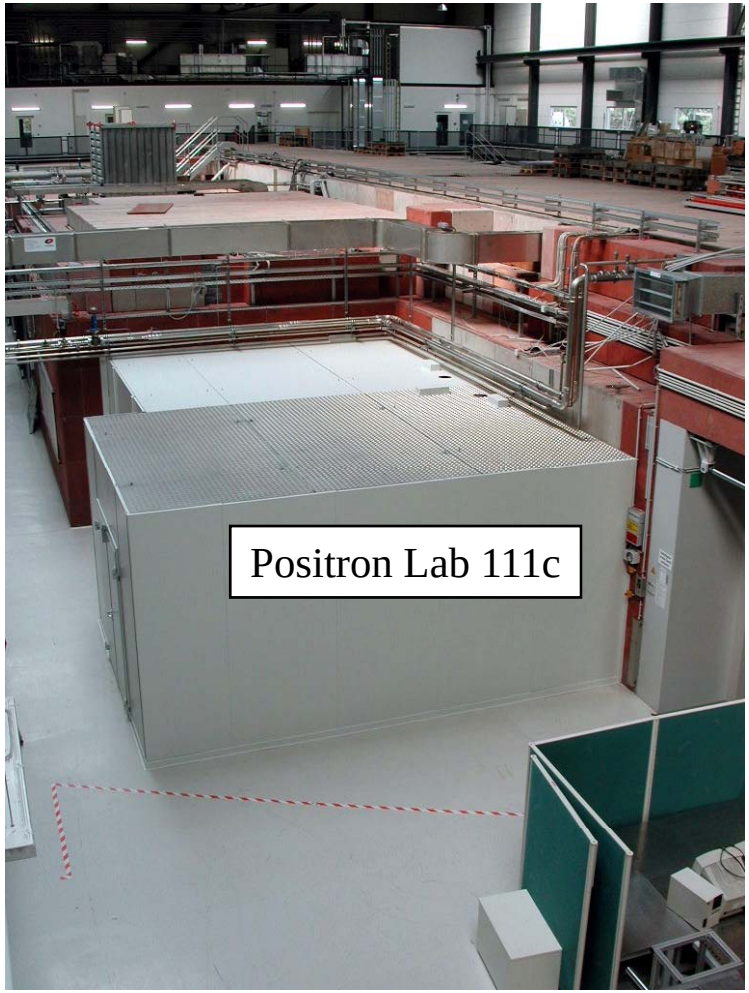


Test setup at Halle University

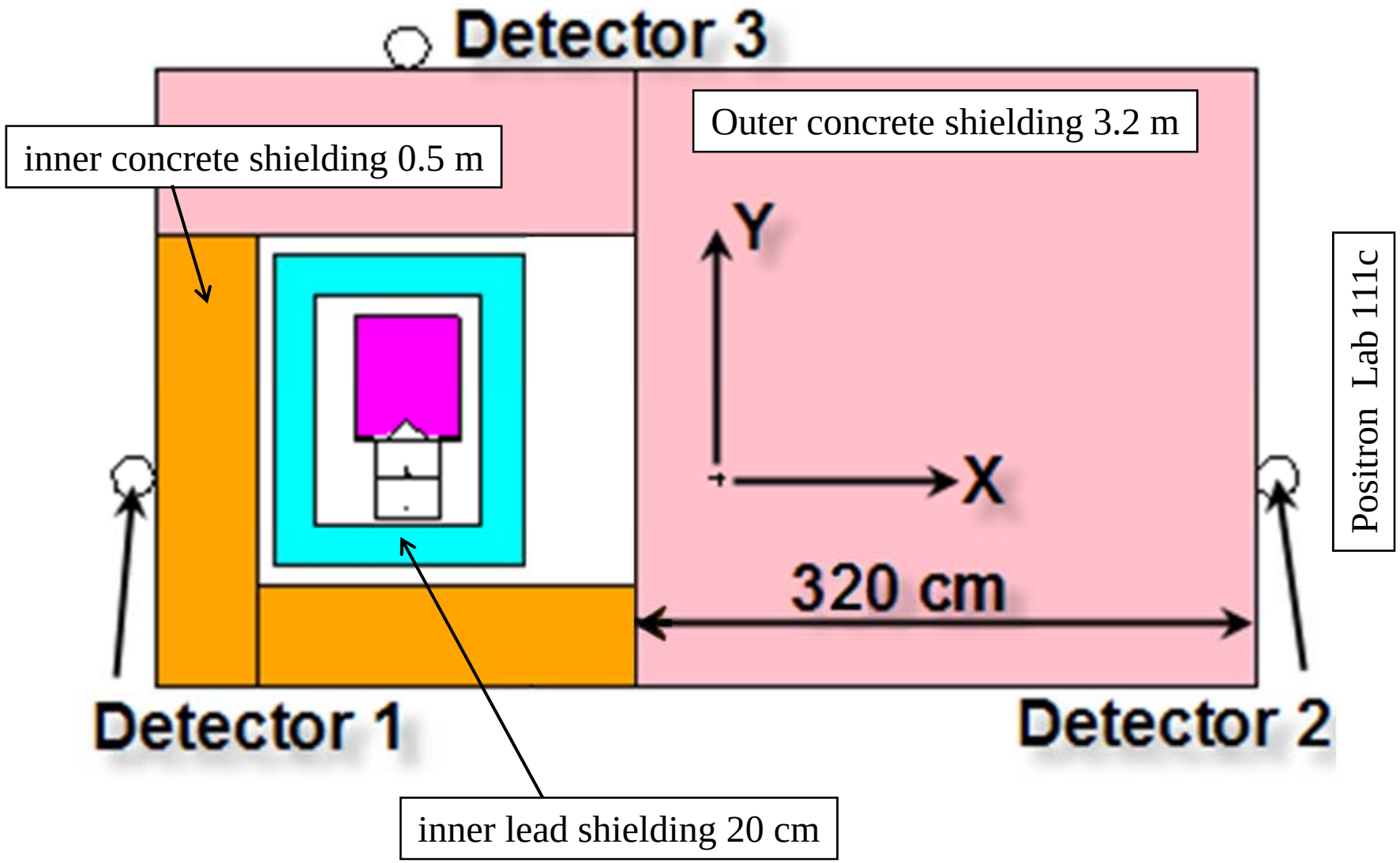

Beam dump
moderator flange
e- beam
beam line
Converter chamber
vacuum
Al stand

Radiation Protection

- Rather important dose rate < 0.5 μSv/h at any point outside of room 111b (also on ceiling)
- This corresponds to 1 mSv/2000 h which is the lowest level in radiation protection (normal environment)
- Does not require any measures of radiation protection

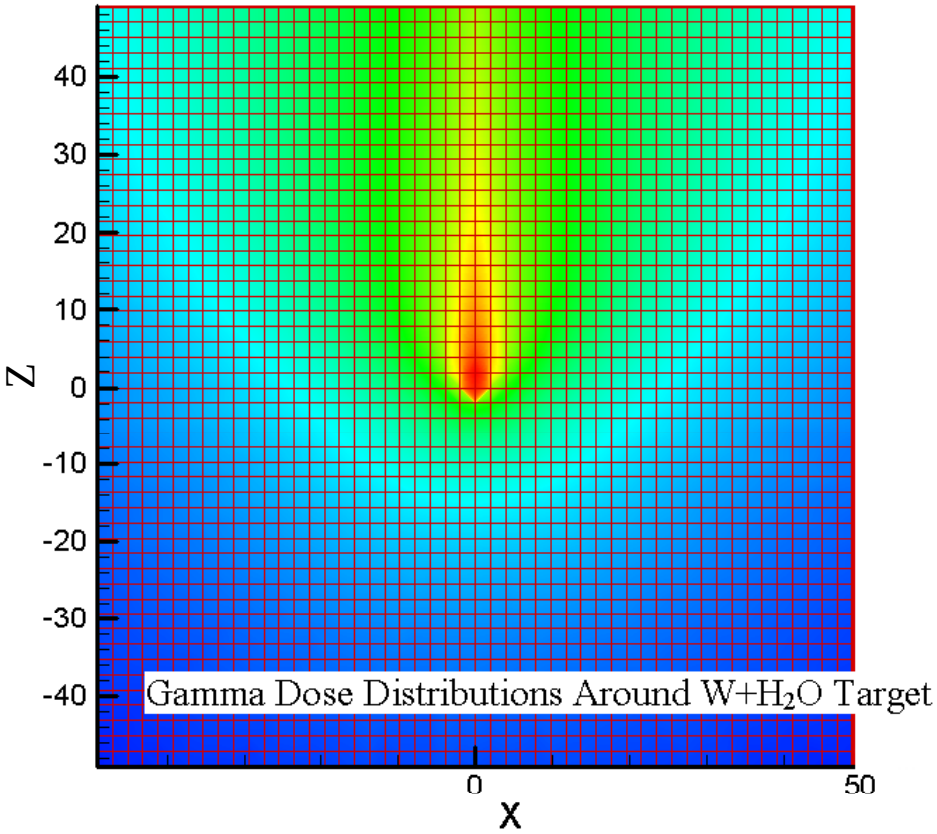


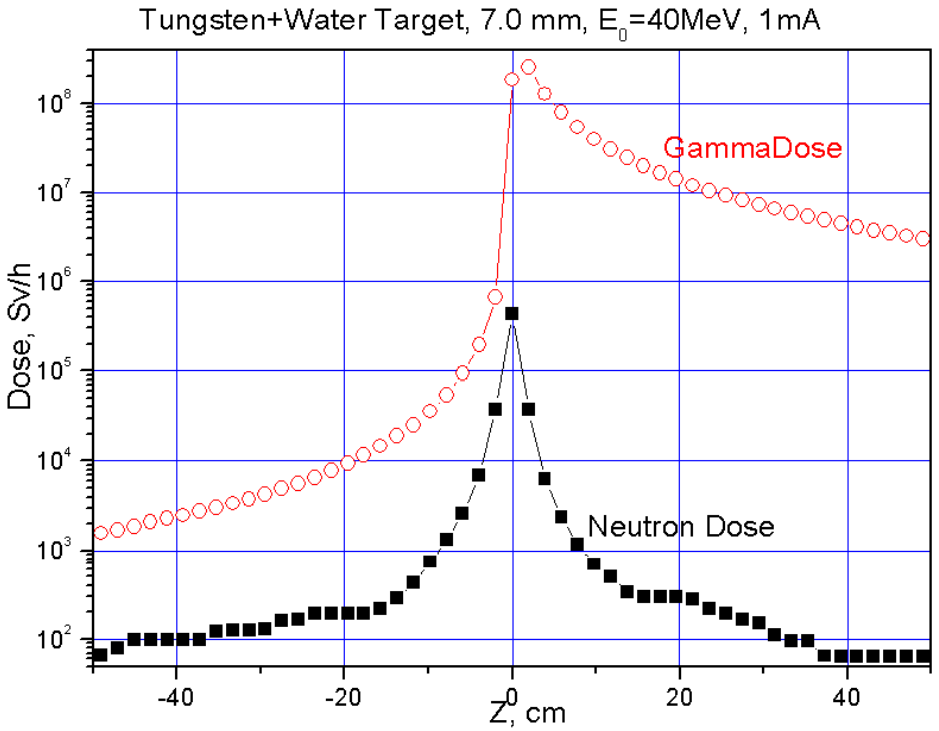
Top view



Positron Lab 111c

Simulation of expected γ and n dose



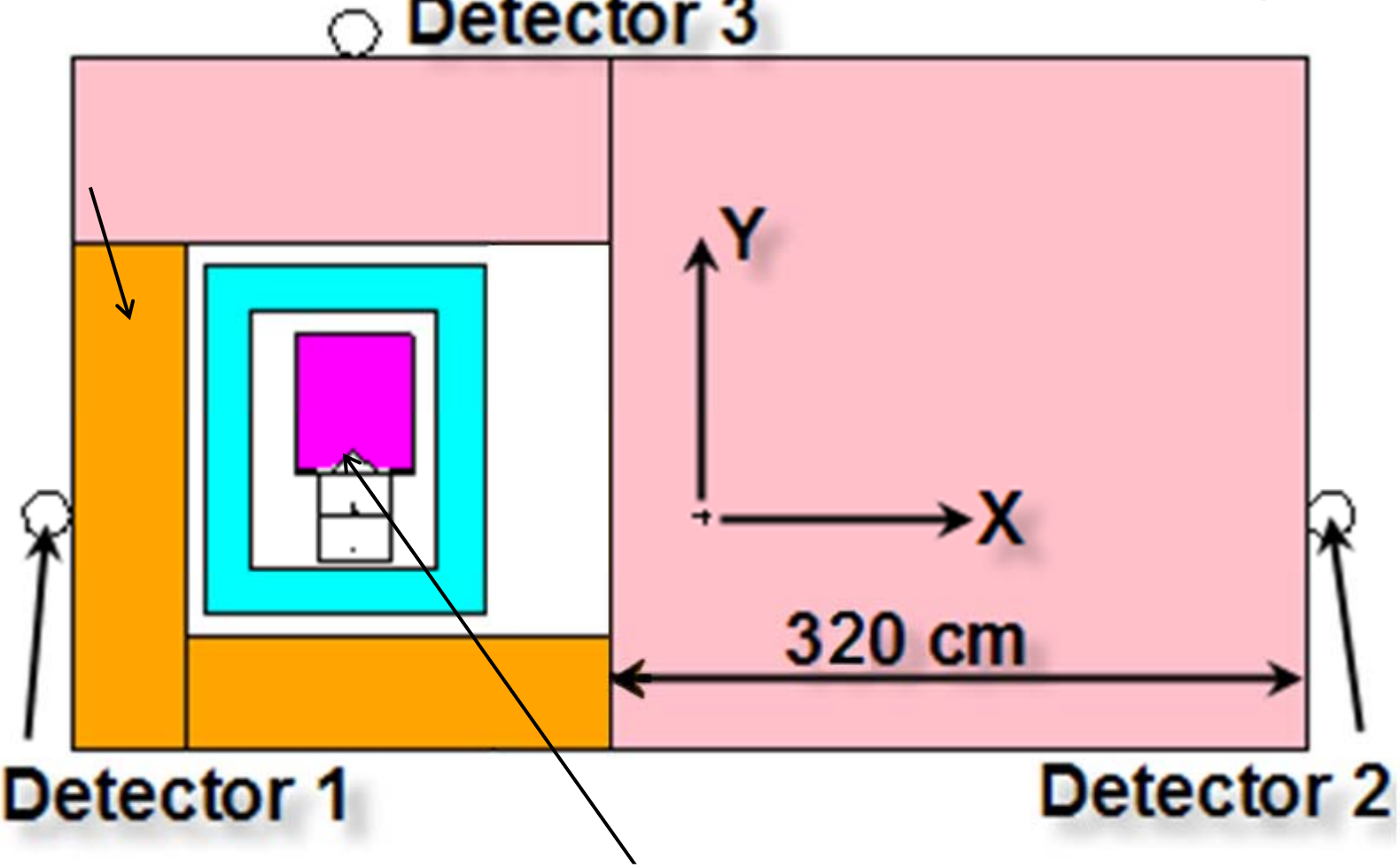


Neutron and Gamma Dose Distributions Around W+H_2O Target in Axial Direction

normal environment
D = 0.15 µSv/h

Dγ > 0.25 µSv/h
Dn > 0.6 mSv/h

at ceiling (1.6 m concrete):
Dγ = 0.2 µSv/h
Dn < 4×10^{-6} µSv/h



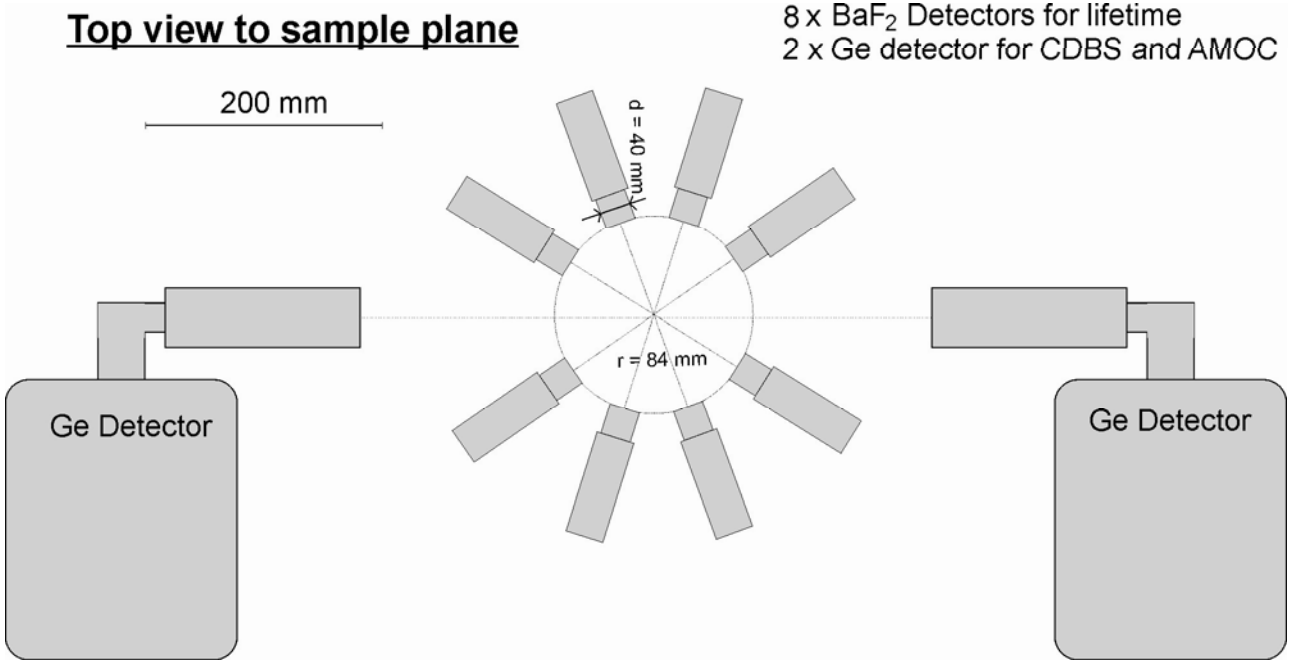
Dγ > 0.42 Sv/h
Dn > 0.23 Sv/h

Dγ > 10^{8} Sv/h
Dn > 10^{6} Sv/h

Dγ < 6×10^{-7} µSv/h
Dn < 10^{-18} µSv/h

Detector system (see talk Do-4 Arnold Krille)

- **3 experiments**: lifetime spectroscopy (8 BaF_2 detectors); Doppler coincidence (2 Ge detectors), and AMOC (1 Ge and 1 BaF_2 detector)
- **complete digital detection system**:
  - lifetime: almost nothing to adjust; time scale exactly the same for all detectors; easy realization of coincidence
  - Doppler: better energy resolution and pile-up rejection expected
  - pulse-shape discrimination improves spectra quality



Conclusion

- System ready for installation at FZD in autumn 2007

- See the talk Do-4 of Arnold Krille tomorrow afternoon "Digital positron lifetime spectroscopy at EPOS"
- please visit our poster Bp-2 by Marco Jungmann "Construction and Timing System of the EPOS Beam System"

- This presentation can be found at **http://positron.physik.uni-halle.de**