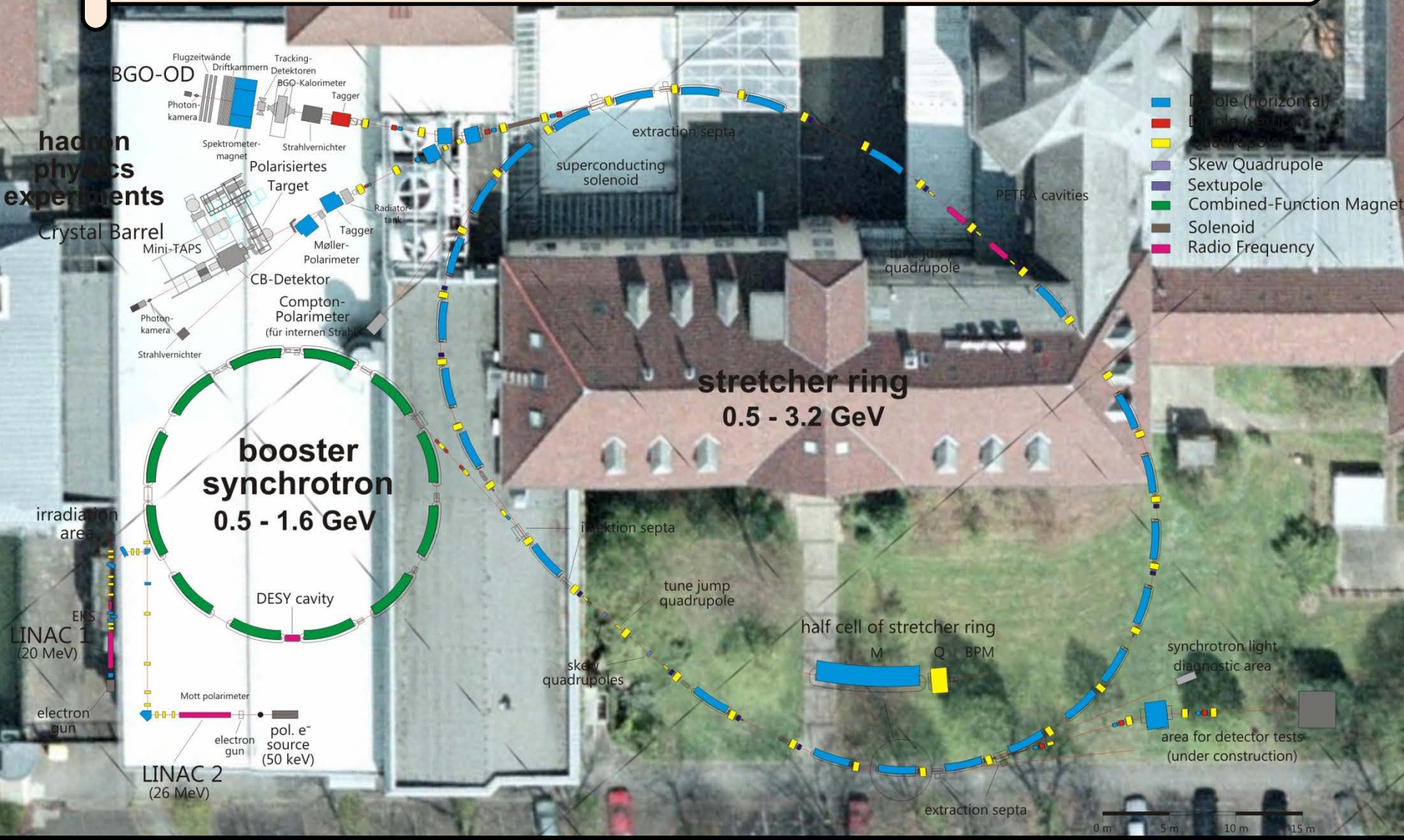
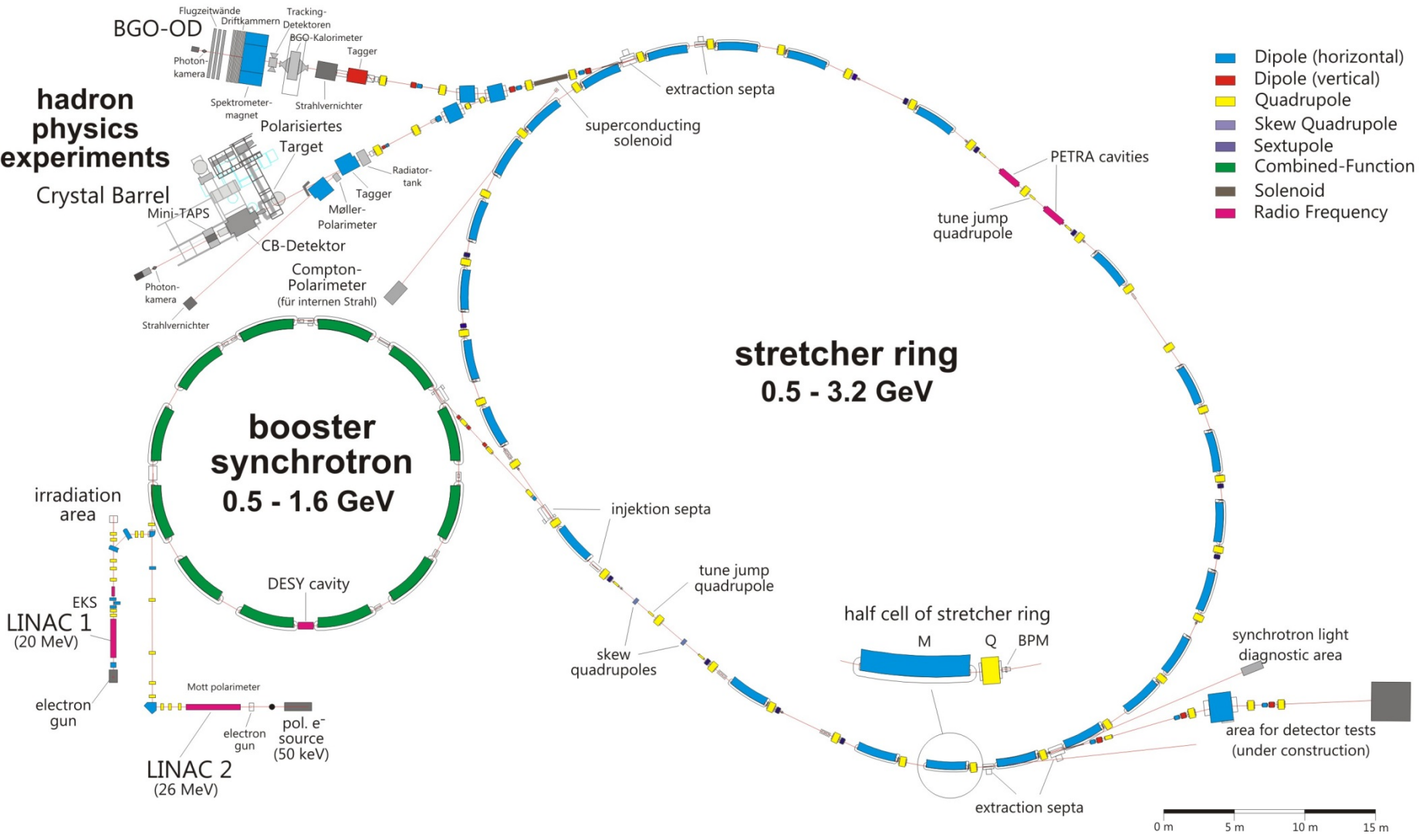
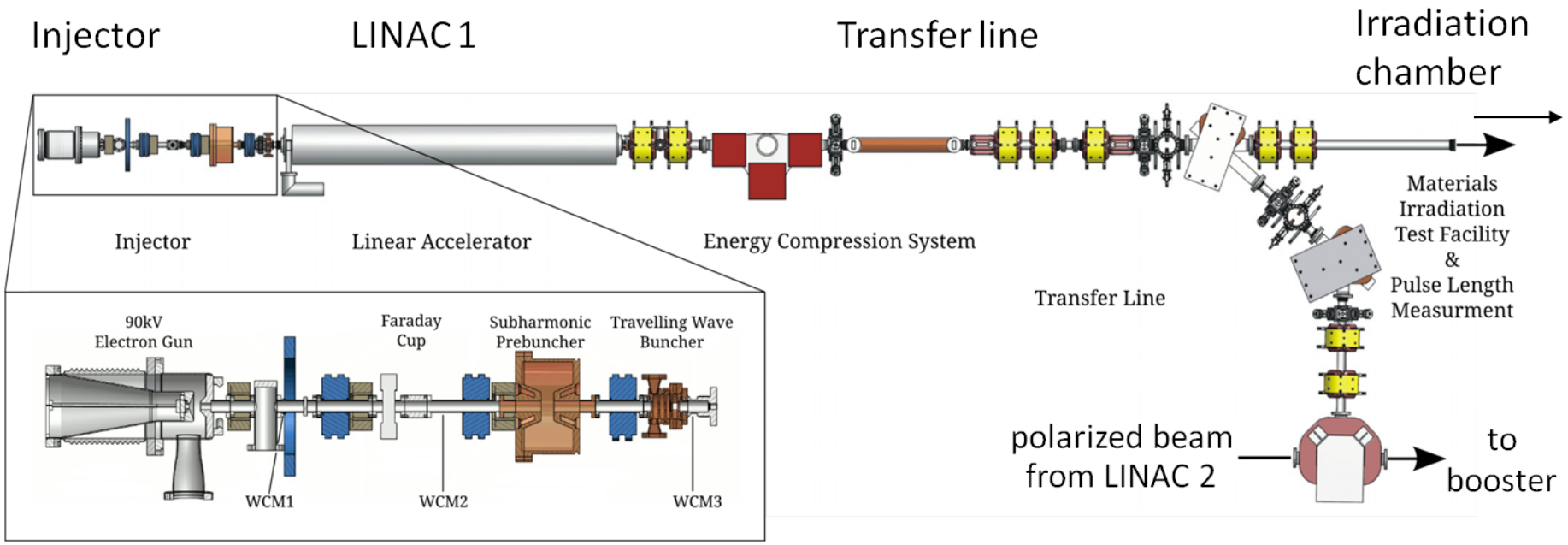
ELSA @ University of Bonn



Electron Stretcher Accelerator (ELSA)



LINAC I



Thermionic Gun:

- U = 90 kV
- I = 800 mA (1-2μs) / 2 A (1ns)

Bunching:

- 500 MHz Prebuncher
- 3 GHz TW Buncher (4 cells)

LINAC:

- 20 MV 3GHz TW structure (constant gradient)
- „old-fashioned“ de-Q‘ing modulator

Energy Compression System:

- 3-bend magnetic schikane
- 3GHz TW Structure

2.5 GeV Booster Synchrotron

50 Hz, 10mA typ., energy < 1.6 GeV

12 combined function magnets of type F/2 – D/2

in operation since 1967

number of windings = 36, maximum current = 1380 A

Bending Radius:

$\rho = 7.65$ m

max. Dipole Strength:

$B_{max} = 1$ Tesla (@2.5GeV)

Field Indexes:

$n_f = -22.26 \rightarrow g_f = 29.2$ T/m

$n_d = 23.26 \rightarrow g_d = 30.5$ T/m

Acceleration:

3-cell 500MHz cavity (type DESY), $P_{RF} < 10$kW

3.5 GeV Stretcher-Ring

FODO lattice, *L*=164.4m:

- 24 dipoles, *R*≈11m
- 32 quads, 8 sextupoles

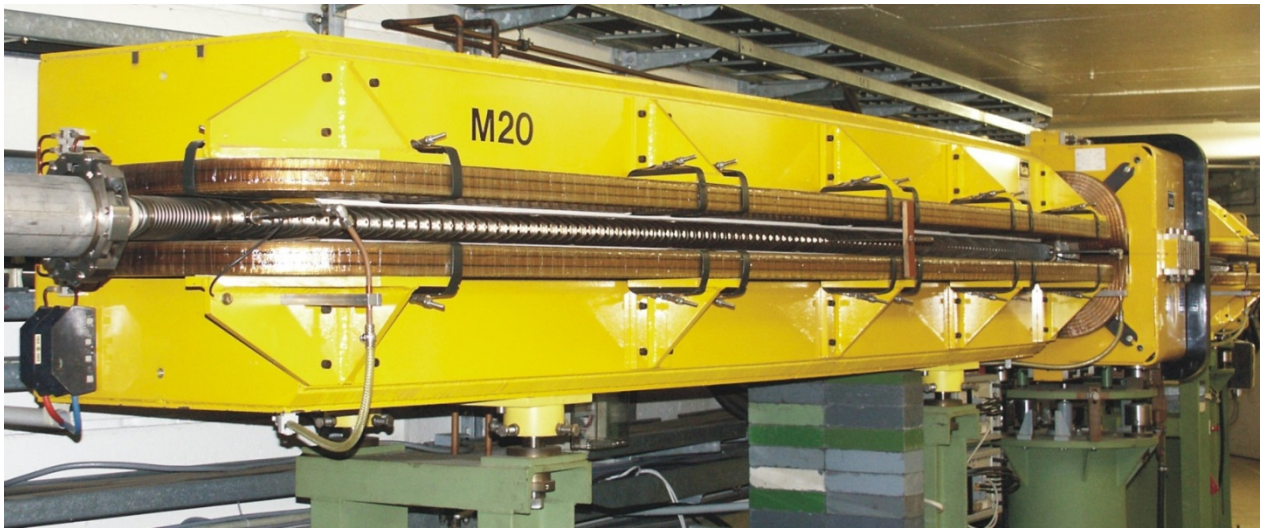
Slow Extraction:

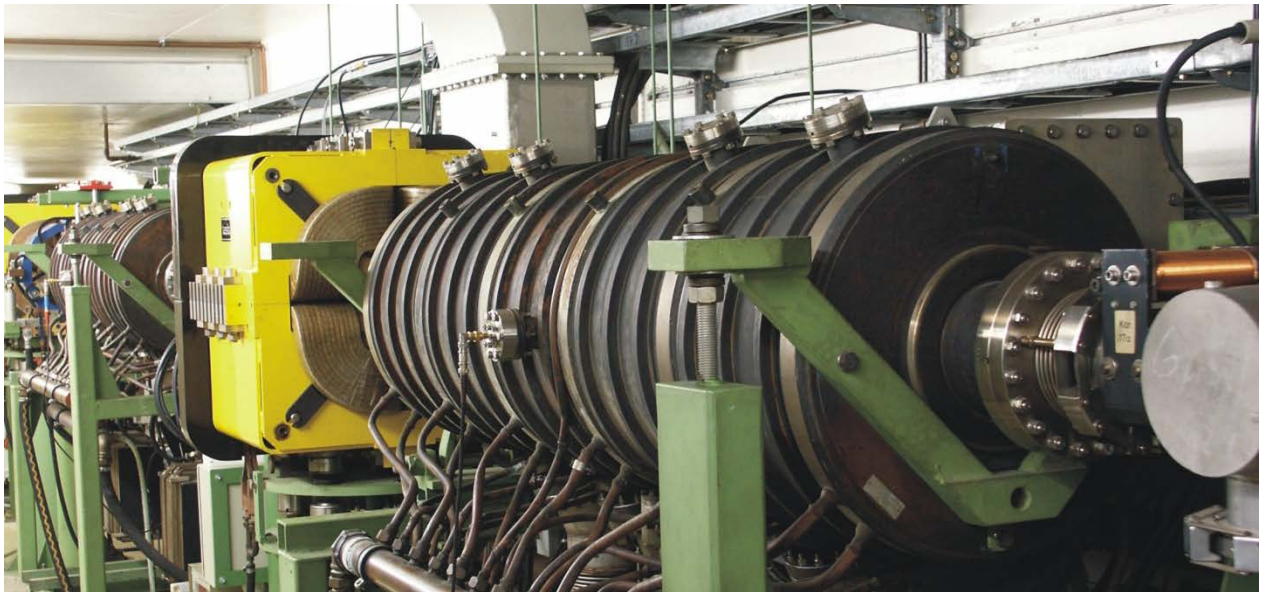
- 4 extraction sextupoles
- 4 ironless quads

Acceleration:

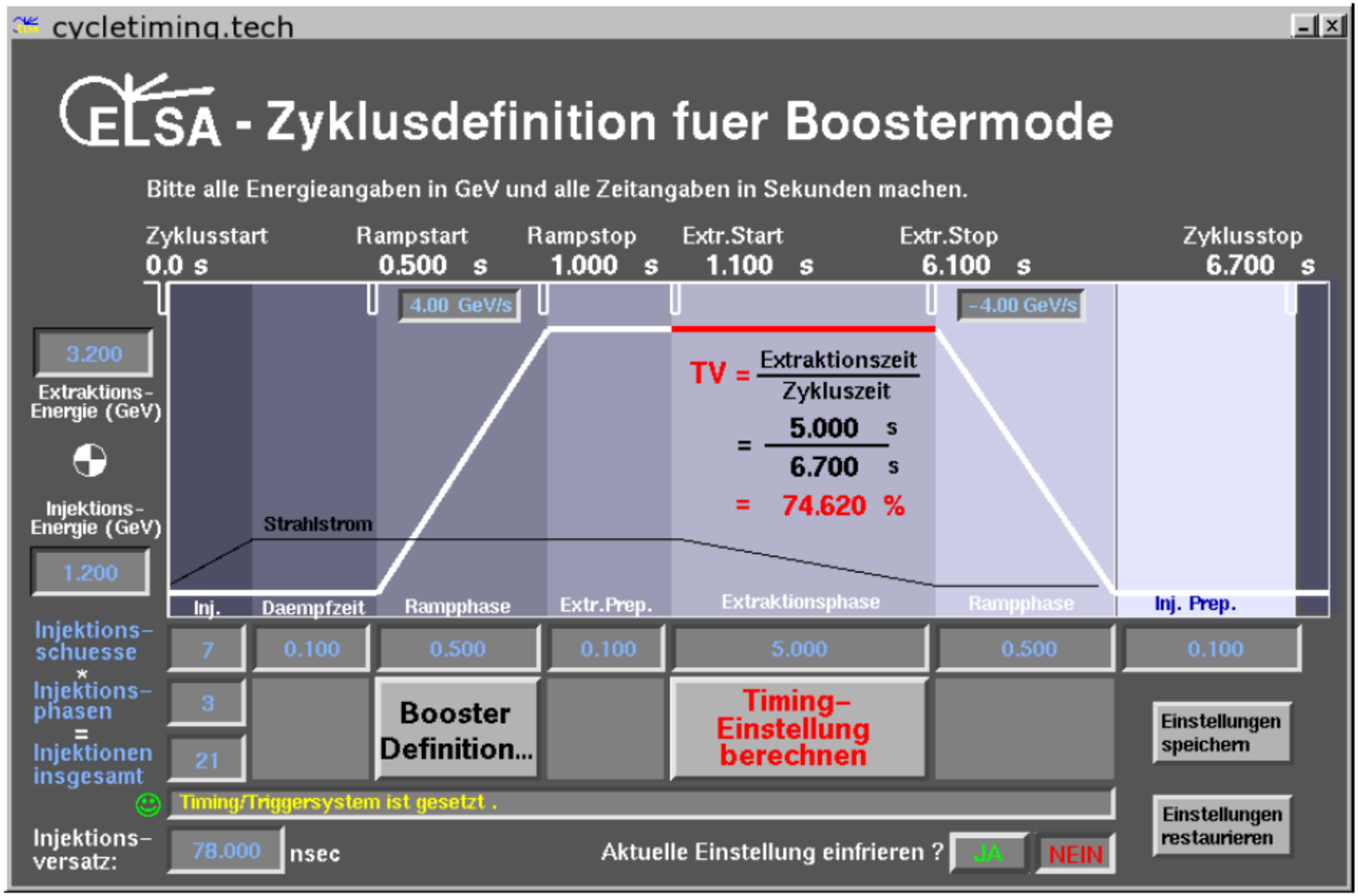
- two 5-cell 500 MHz cavities (type PETRA)
- 250kW klystron

storage and booster mode

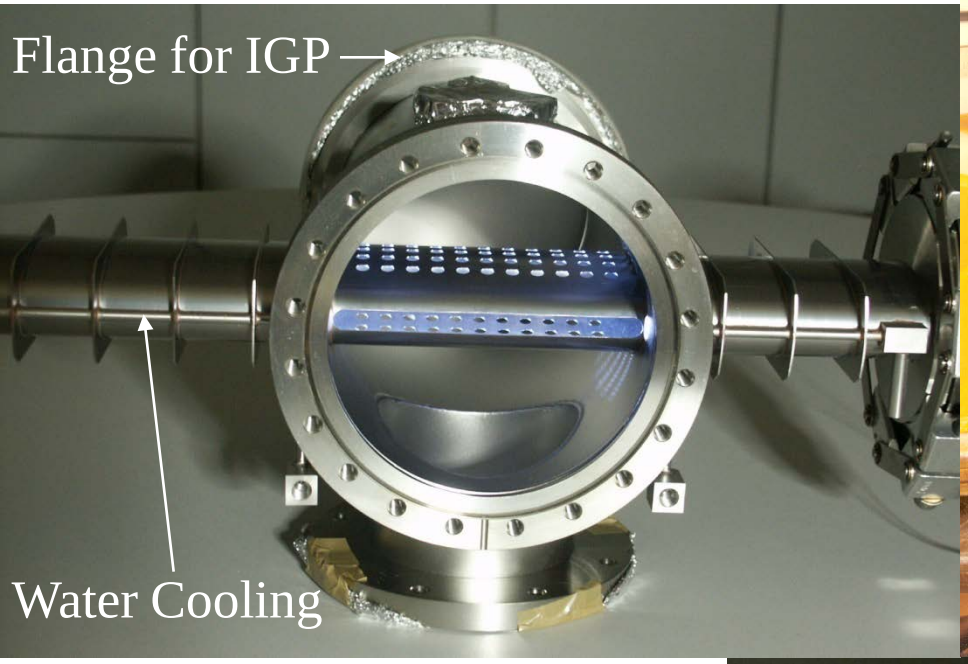


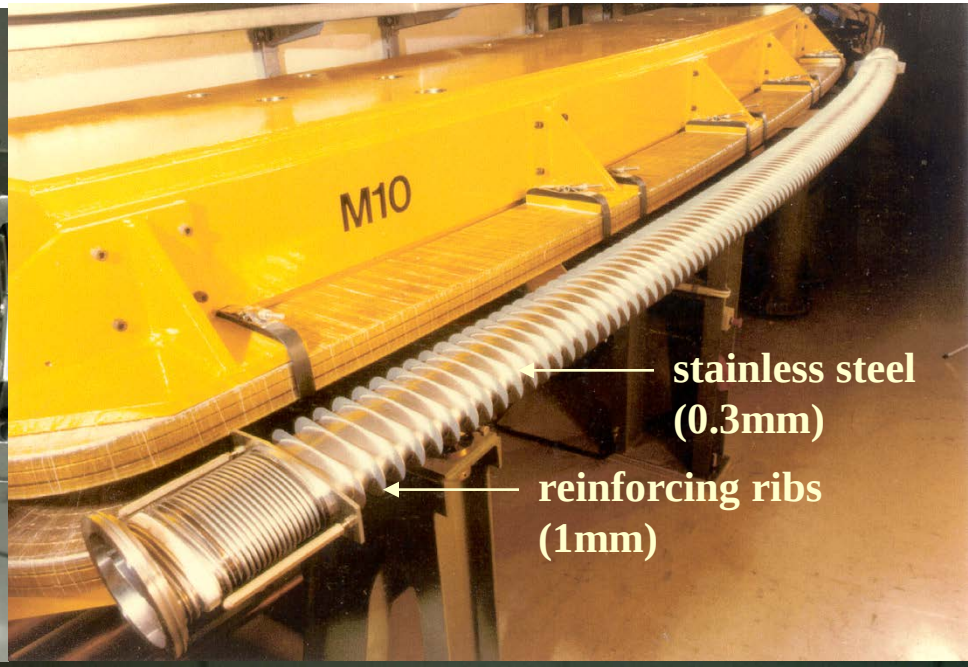


Typical Operation Mode



“Fast” ramping Stretcher-Ring

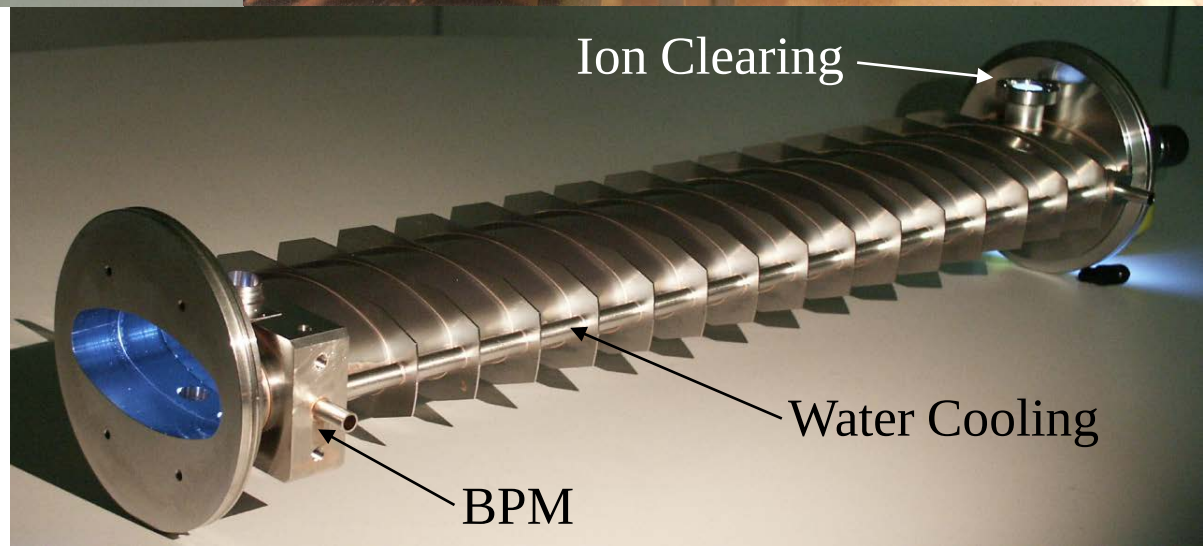




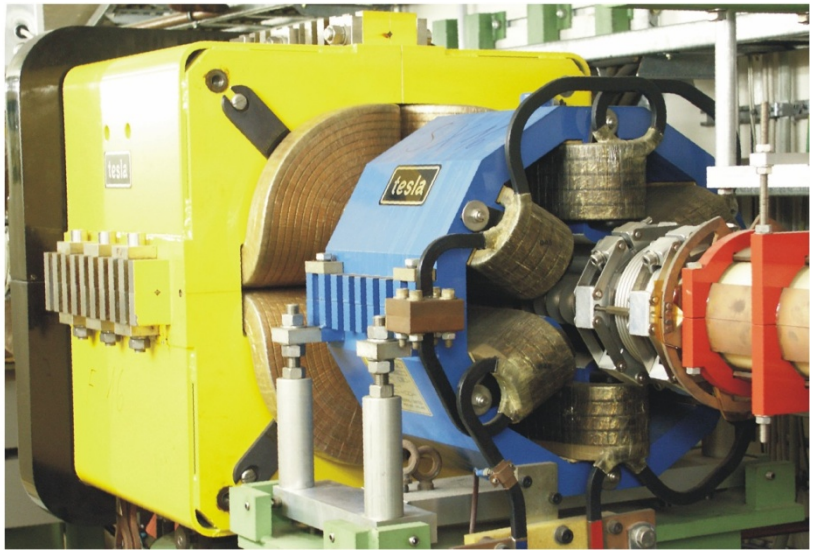
“Fast” Ramping Operation:

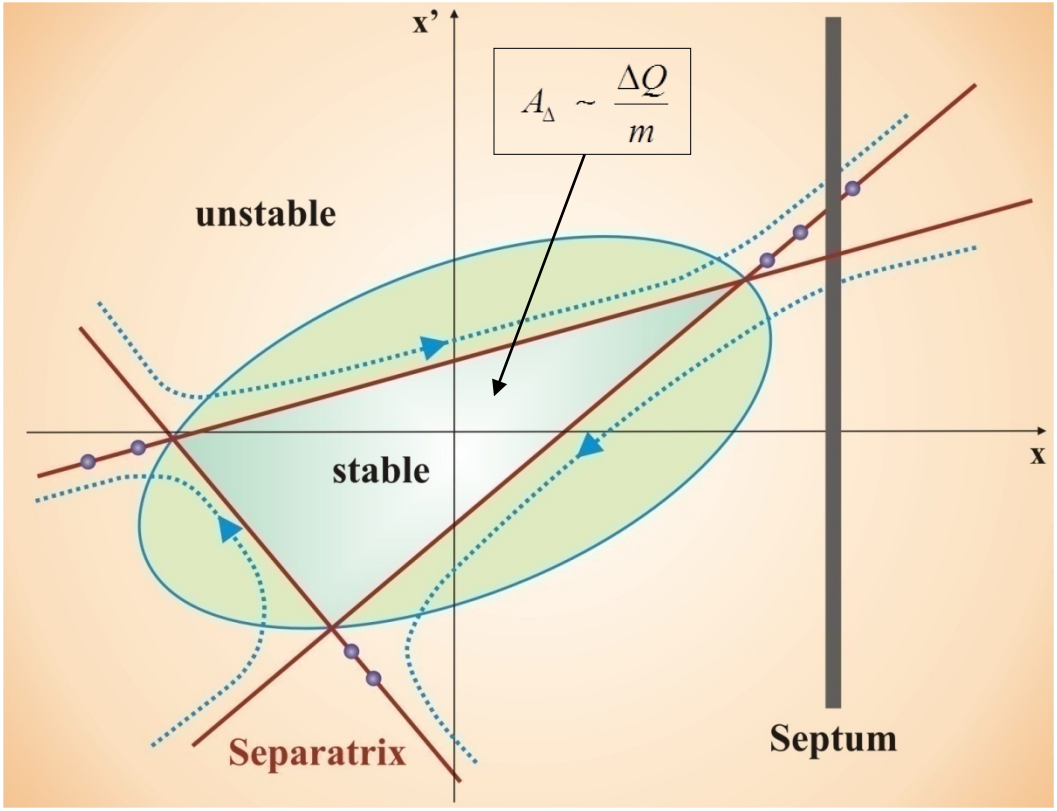
- $\dot{E} \leq 7.5$ GeV/s
- $\dot{B} \leq 2.1$ Tesla/s

→ reduction of **eddy currents**



Slow Extraction





Extraction Sextupole-Magnets:
excitation of a 3rd integer resonance

Extraction Quadrupole-Magnets:
tune-shift close to a 3rd integer resonance, feedback (TAG-OR) stabilizes the external current

Accelerator R&D

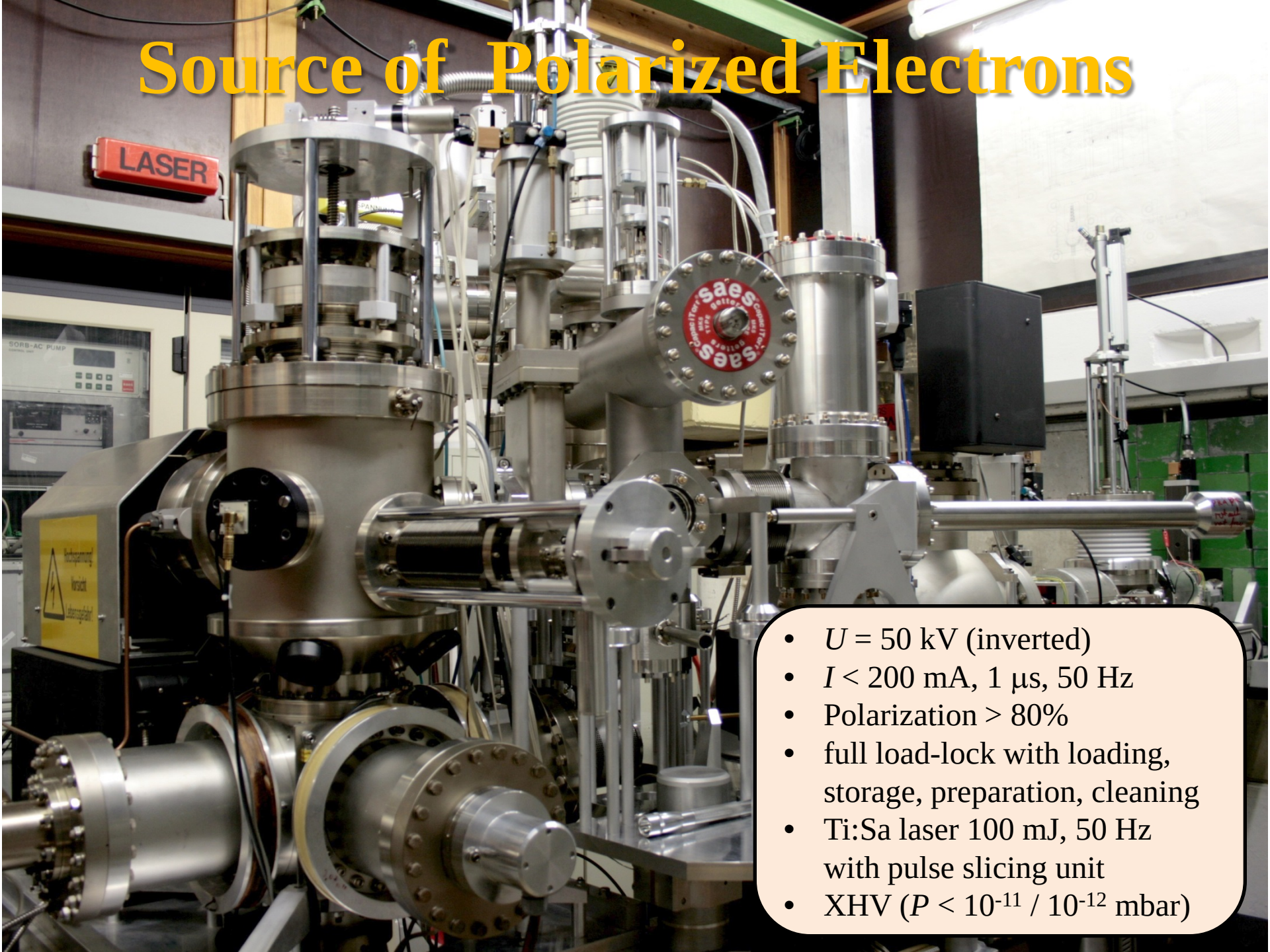
Polarized electrons:

- polarized source (construction, operation, cathode handling)
- polarization preserving post-acceleration in LINAC, booster, stretcher
- polarimetry (Mott, Møller, Compton)

High internal currents (up to 200mA):

- investigation of sources of instabilities
- 3D bunch by bunch feed-back (500 MHz)
- HOM compensation, narrow band feed-back
- beam neutralization and ion clearing
- dedicated diagnostics (RF-based and optical, streak camera)

Source of Polarized Electrons



- U = 50 kV (inverted)
- I < 200 mA, 1 μs, 50 Hz
- Polarization > 80%
- full load-lock with loading, storage, preparation, cleaning
- Ti:Sa laser 100 mJ, 50 Hz with pulse slicing unit
- XHV ($P < 10^{-11}$ / 10^{-12} mbar)

Acceleration of Polarized Electrons

Crossing of depolarizing resonances in circular accelerators:

- fast ramping (up to 2 Tesla/s)
- precise closed orbit correction on fast ramp (rms < 80μm)
- compensation of tune-shifts (caused by eddy currents)
- harmonic correction of resonance driving horizontal fields
- tune jumping

→ Dedicated beam control and diagnostics required:

- feed forward techniques for orbit corrections
- harmonic correction based on spin response matrix
- fast correctors (10ms), tune kickers, pulsed quadrupoles
- fast BPM's (1kHz) for CO measurement on energy ramp
- polarimetry

Simulation of spin dynamics, development of dedicated software

Resources

Accelerator group:

- 3 scientists, 3 engineers, 15 technicians, PhD and master students

Infrastructure:

- accelerator complex, large acceptance detectors
- polarized nucleon target (frozen spin, 80mK)
- mechanical workshops (CNC milling, turning)
- Electrical workshop (ELSA-related)
- HV soldering oven (metal shielded)
- He liquefier (< 80 l/h)

Expertise at ELSA

Operation of electron linacs and circular accelerators

(incl. repair and construction of PS's, RF, cabinets, protection, …)

Special knowledge in the fields:

- polarized electrons (photo-injector, spin dynamics)
- beam control (CO correction, tune jumping, slow extraction, fast ramping)
- beam diagnostics (optical, RF-based, etc.)
- accelerator control

Development and construction of accelerator components:

- XHV systems, beam pipes (e.g. thin SS)
- RF resonators and actuators (TM_{01}, TM_{11}, kicker cavity), stripline-kicker
- pulsed magnets (tune kicker, tune jump quadrupoles,…)
- beam diagnostics, beam lines, …