Recent developments and plans for Accelerator Physics in the Alliance

E. Elsen

3rd Annual Workshop of the Helmholtz Alliance *Physics at the Terascale*, Hamburg Nov 2009

Overview

- Brief report on activities in the Accelerator Project
  - Some results from this meeting
- Accelerator Developments in Germany
- Future Options

Thursday 12 November 2009

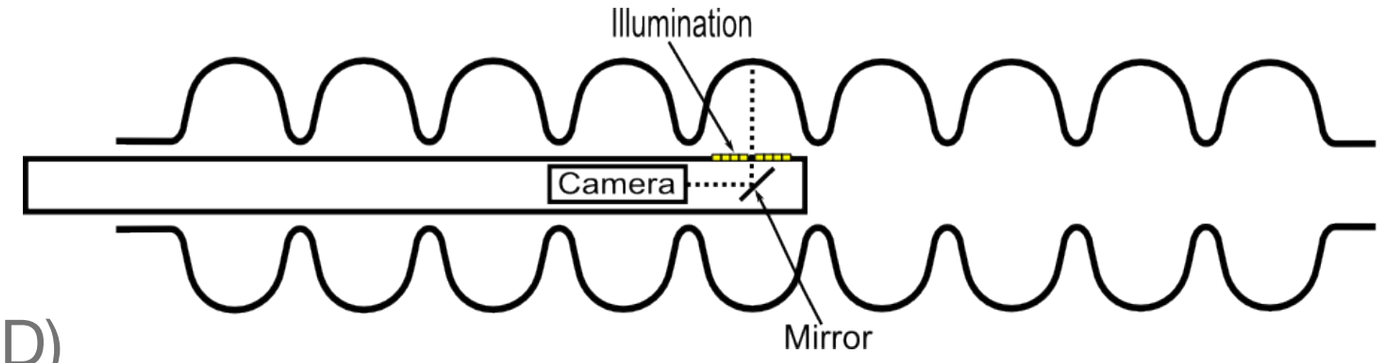
top

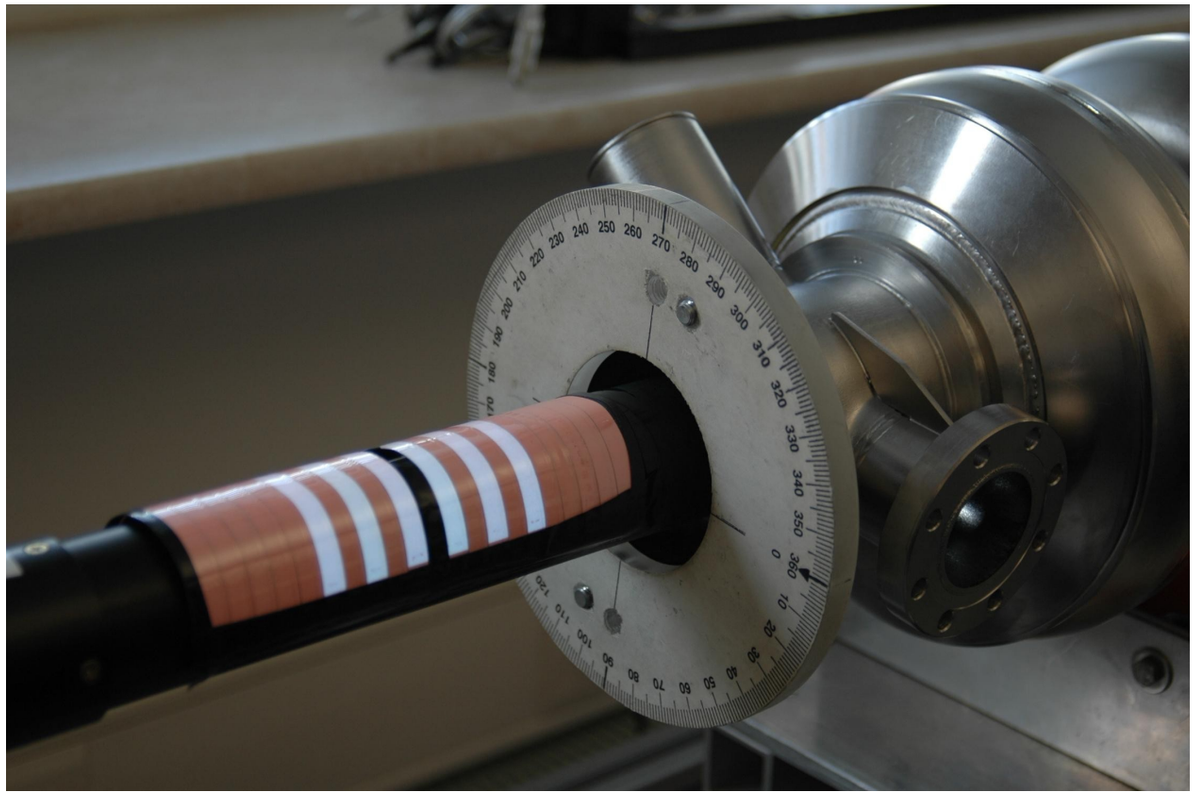
12:30	Lunch break	
14:00->*17:30*	**Accelerator Project** (Convener: Eckhard Elsen (*DESY*) , Wolfgang Hillert (*University of Bonn, Physics Institute*)) (Location: Sem. R. 4 b)	
14:00	Introduction to the Alliance Accelerator Research and Perspectives (15')	Eckhard Elsen (*DESY*)
14:15	Optical inspection of SRF cavities at DESY (20')	Sebastian Aderhold (*DESY*)
14:35	Second Sound as diagnostic tool for SCRF cavities (40') (Slides)	Felix Schlander (*DESY*) , Hannes Vennekate
15:15	A digitally controlled test stand for SCRF cavities (20') (Slides)	Marc Wenskat (*University Goettingen*)
15:35	break	
15:50	Construction of an electron spectrometer for photo-enhanced field emission studies (20')	Benjamin Bornmann (*Uni Wuppertal, physics department, group of Prof. G. Mueller, accelerator physics*)
16:10	Surface roughness and correlated field emission investigations of electropolished Nb samples (20')	Aliaksandr Navitski
16:30	A single bunch injector for ELSA (20') (Slides)	Fabian Klarner
16:50	Multi bunch feedback systems for ELSA (20')	Andre Roth
17:10	Contributions to advanced accelerator concepts (20')	Shaukat Khan (*Technische Universitaet Dortmund*)

Optical inspection system for cavities

S Aderhold

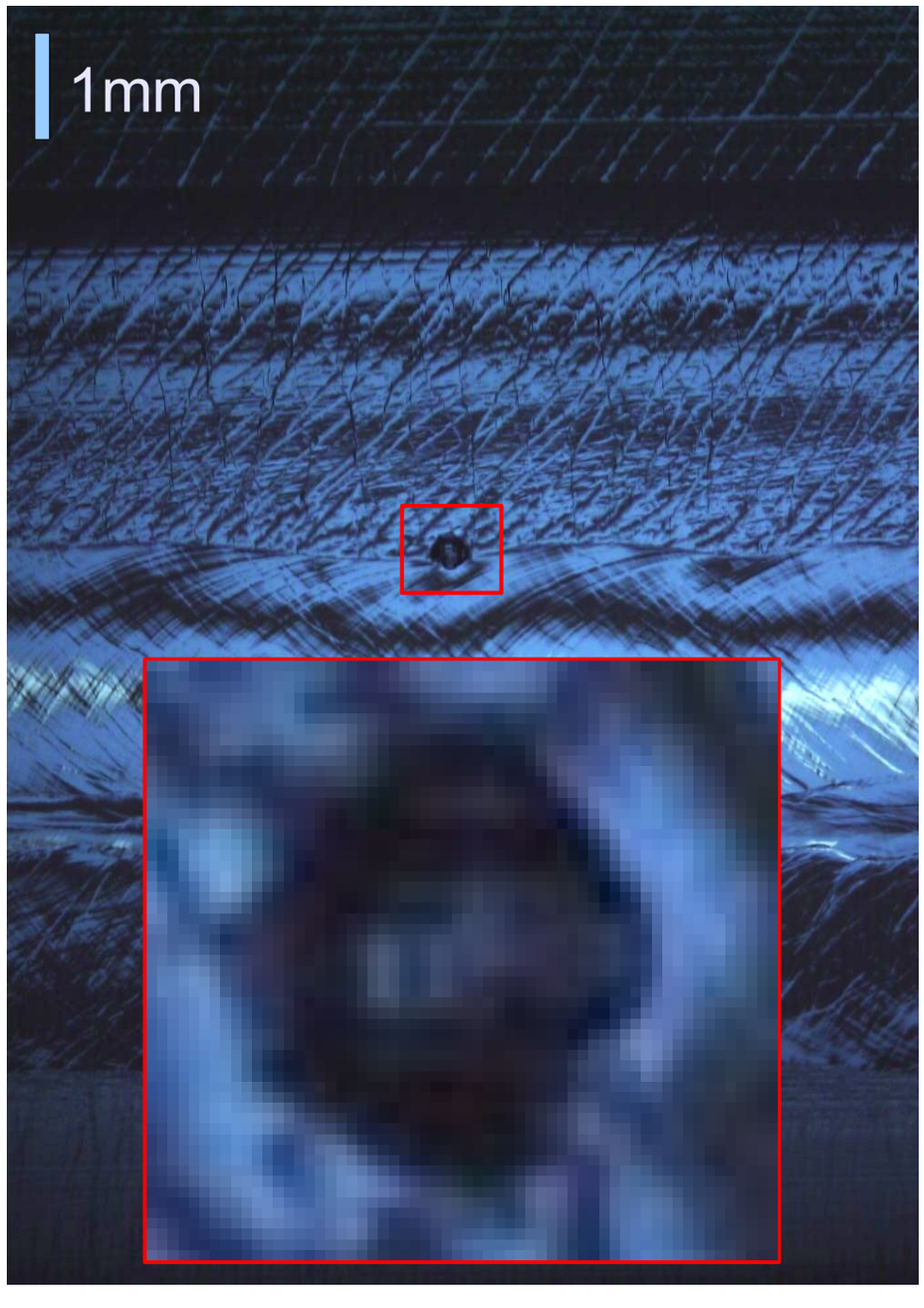
- Kyoto camera
  - sophisticated illuminationscheme (Initially elctro-luminescent, now LED)
- Pixel size
  - 5 µm 1.75 µm
  - effective 3.5 µm/pixel



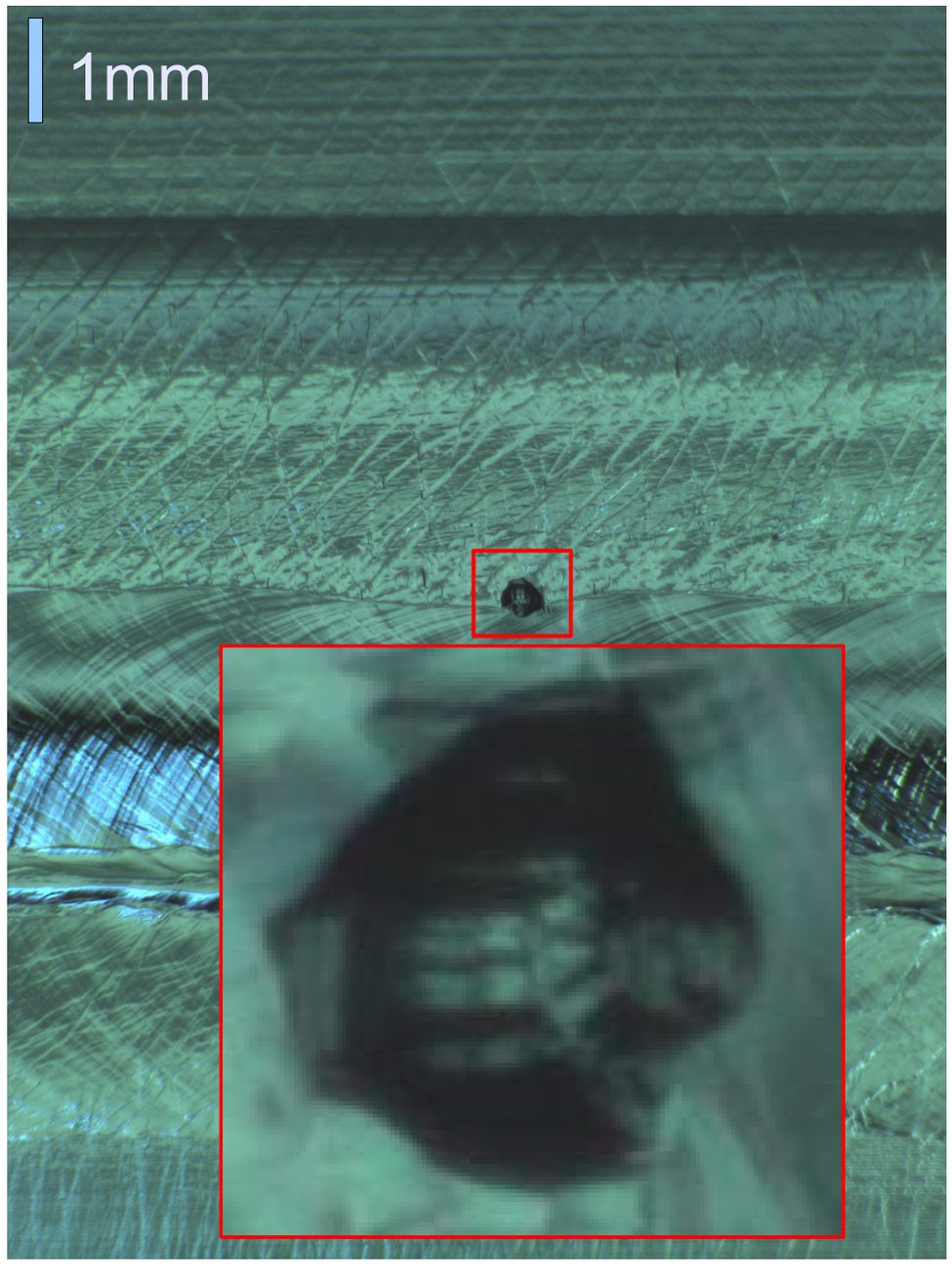


Optical Inspection – New camera

S Aderhold



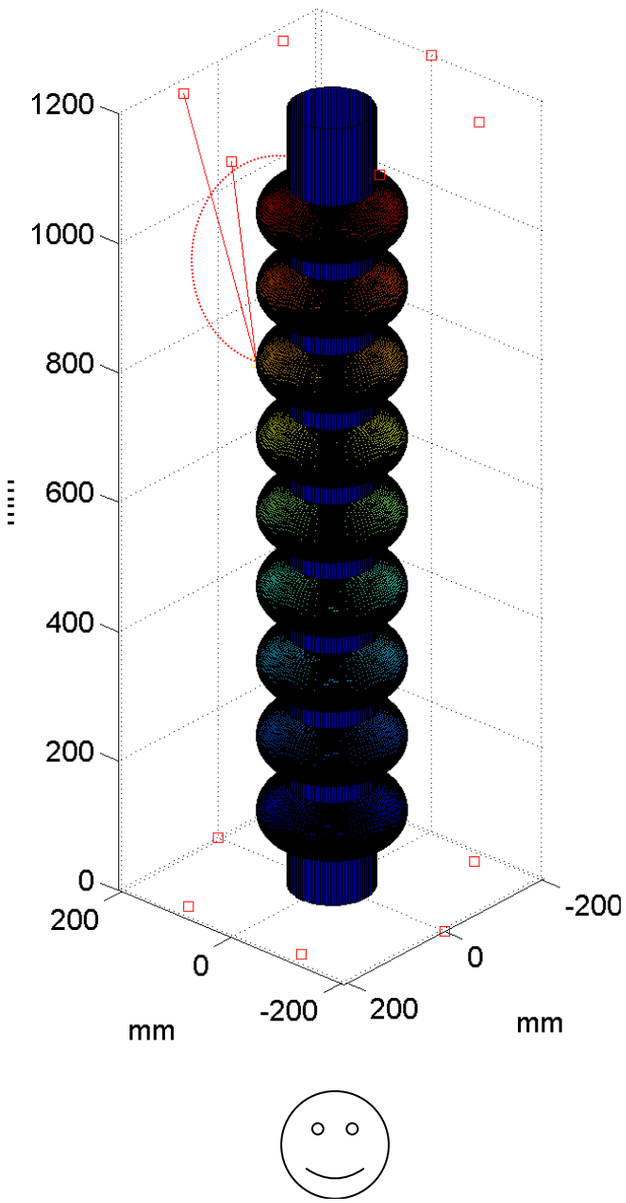
old

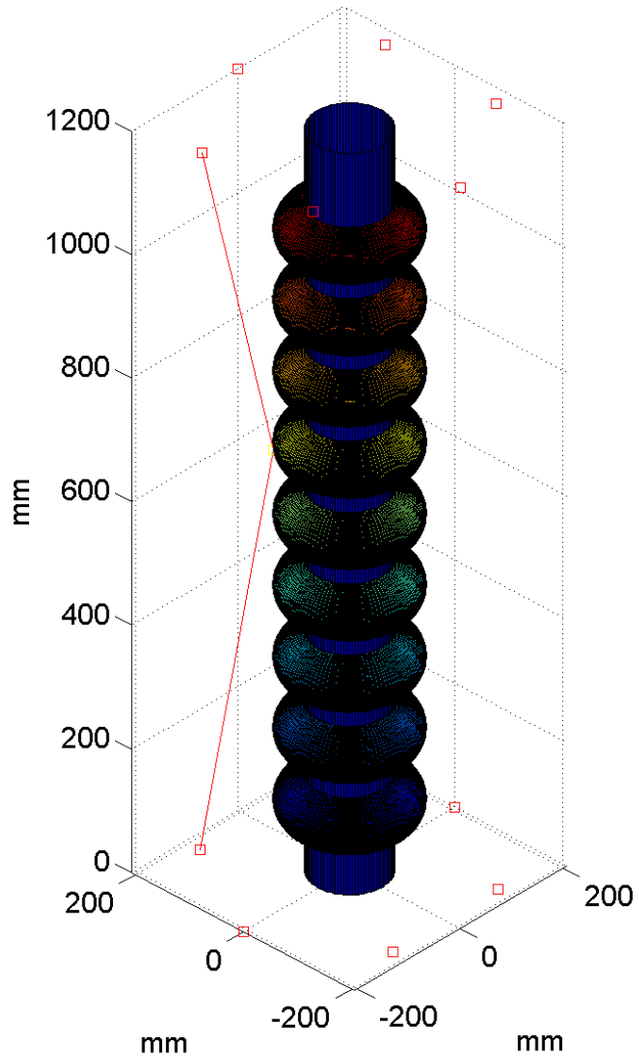


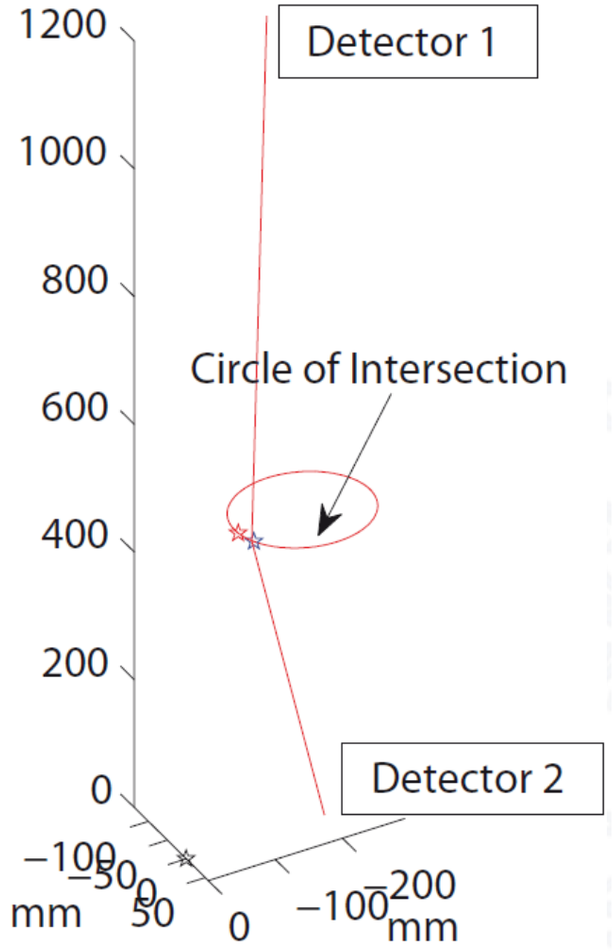
new

Locating quenches using 2nd sound

H Vennekate; F Schlander

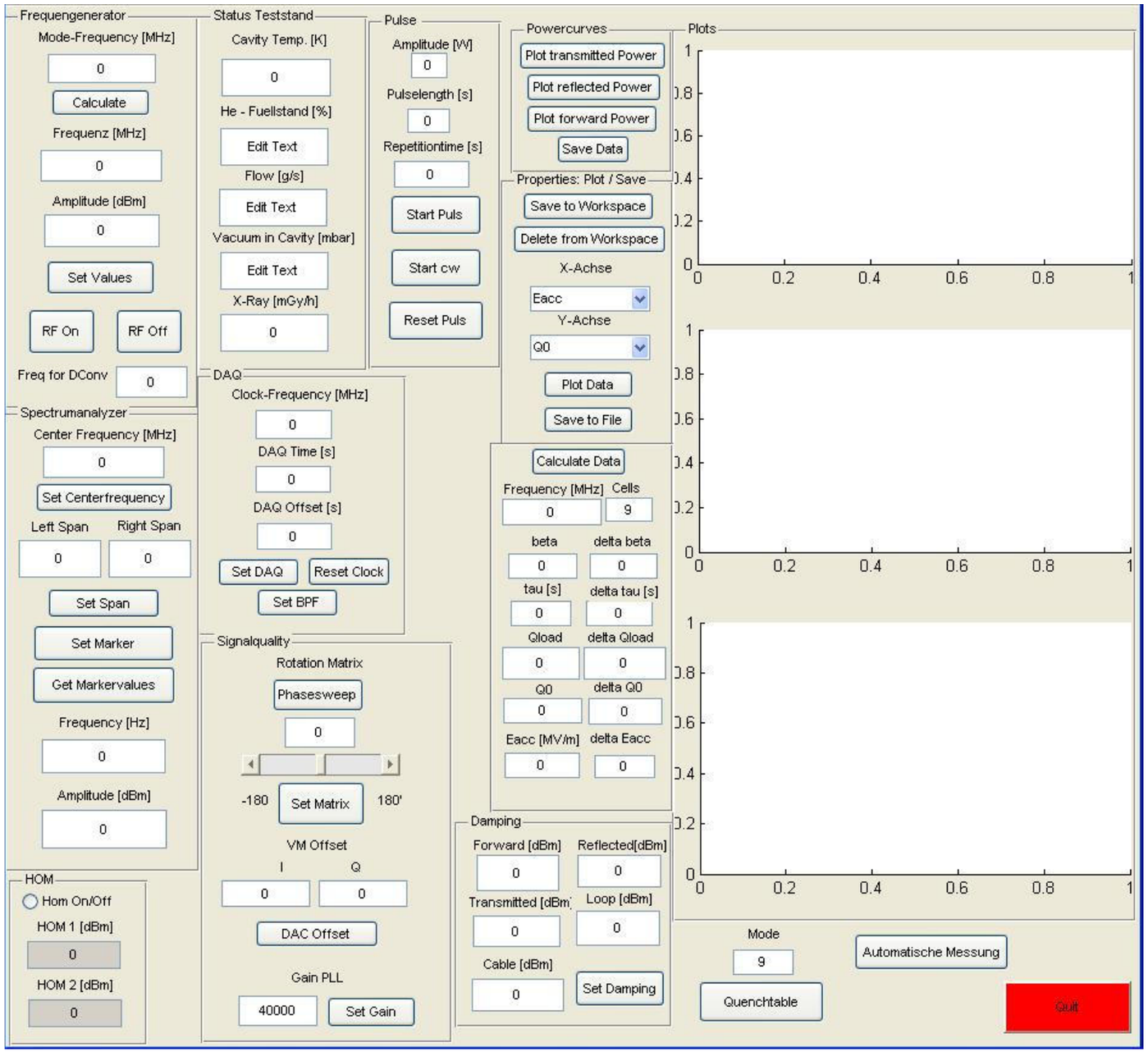


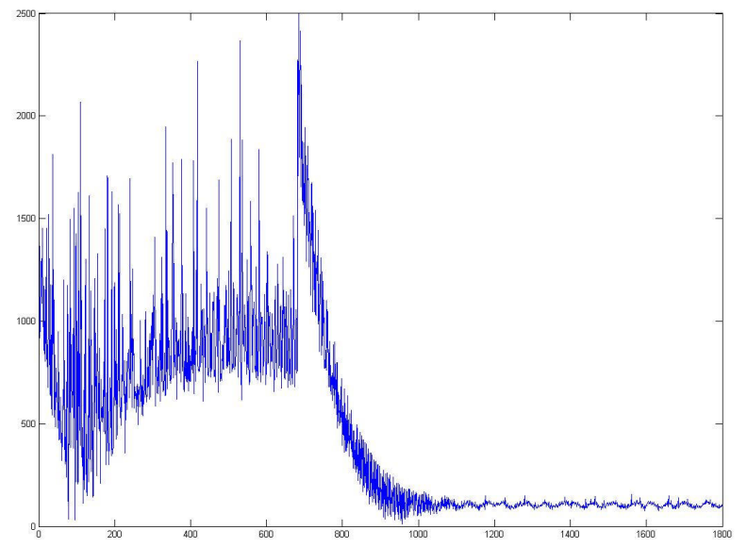


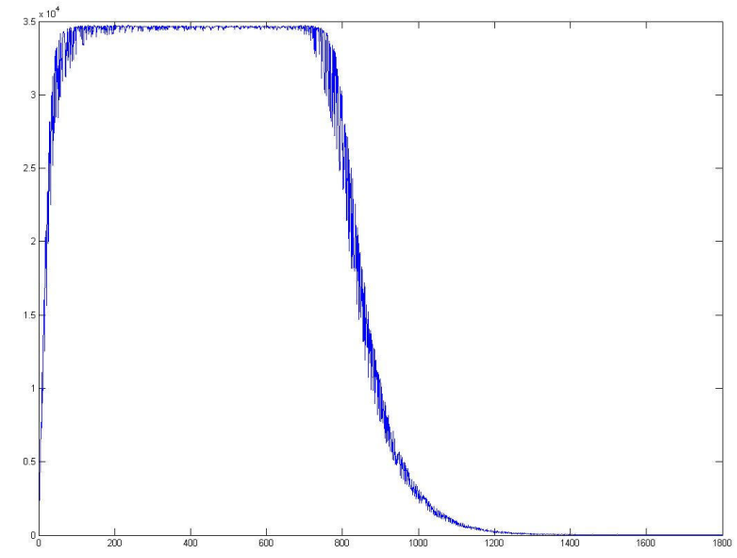


A digitally controlled test stand for SCRF cavities

M.Wenskat





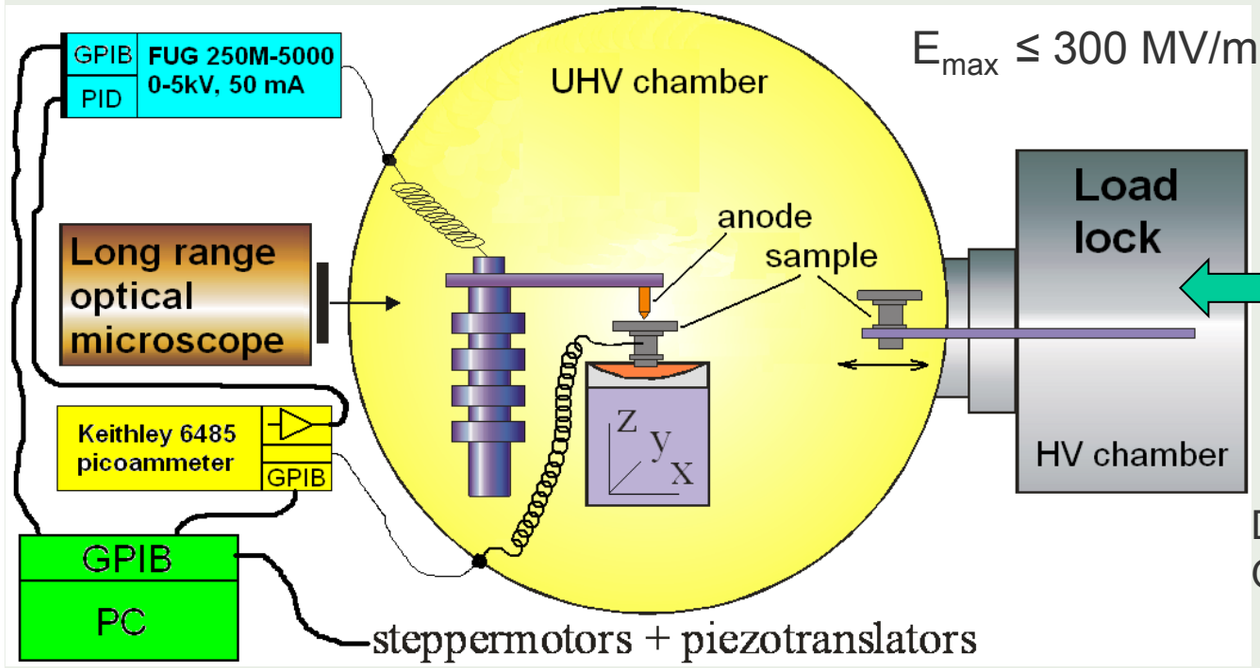


Detailed Nb surface investigation

A Navitski

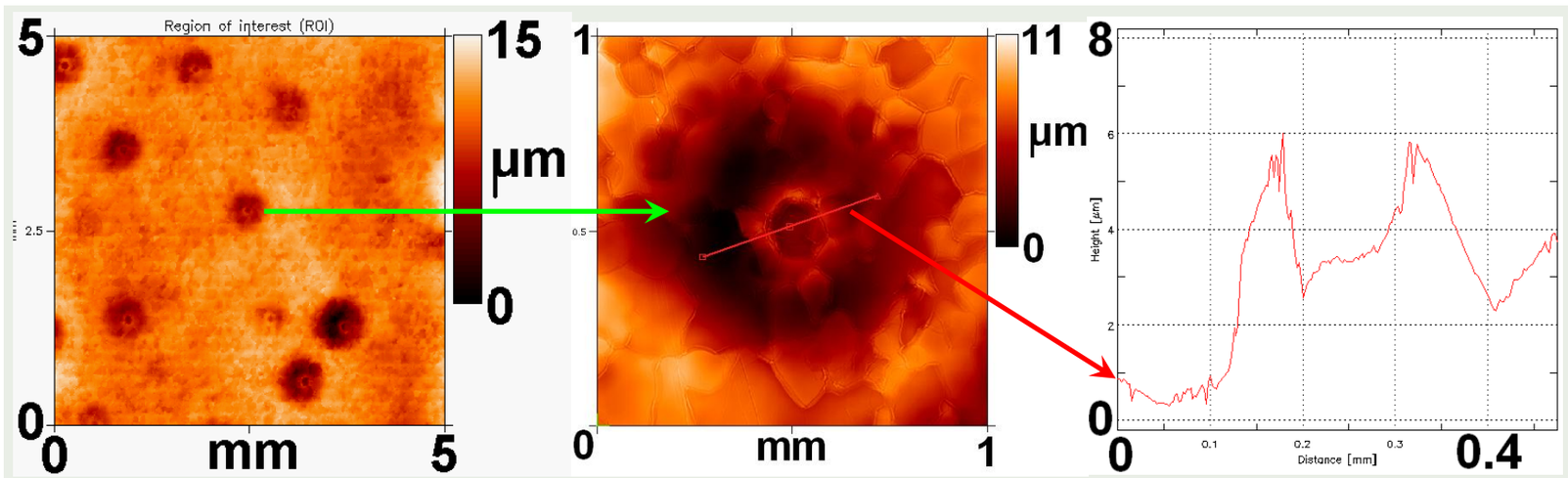
Measurement technique:

Field Emission Scanning Microscope (FESM):



Dust-free transport
Opening under UHV

⇒ Regulated V(x,y) scans for a fixed FE current and gap ⇒ maps of defects
⇒ Spatially resolved I(E) measurements of single defects ⇒ Eon, β'_E



Construction of an electron spectrometer for photo-enhanced field emission studies

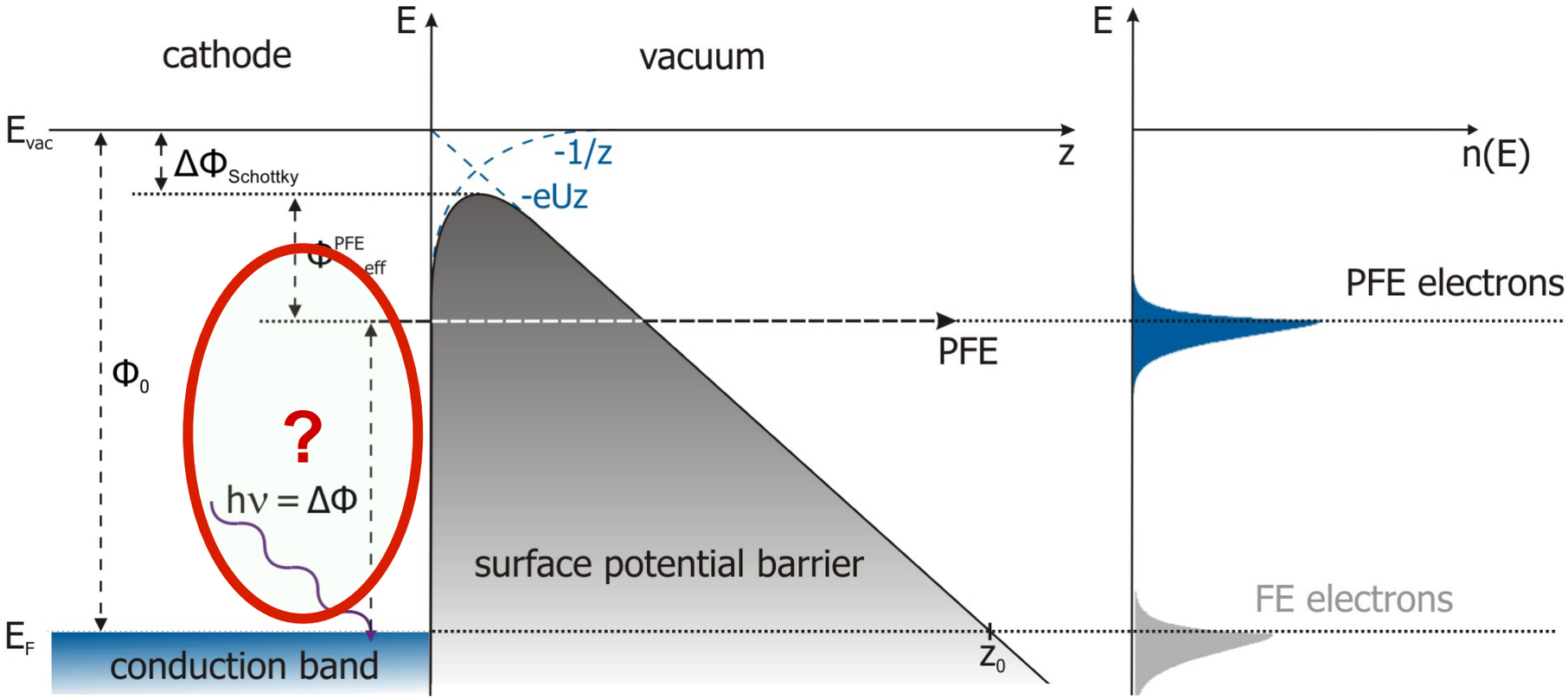
B Bornheim

Illumination of a FE cathode with photons ($h\nu < \Phi$)

Increased current due to lower effective work function:

$$\Phi^{PFE}_{eff} = \Phi_0 - \Delta\Phi_{Schottky} - h\nu$$

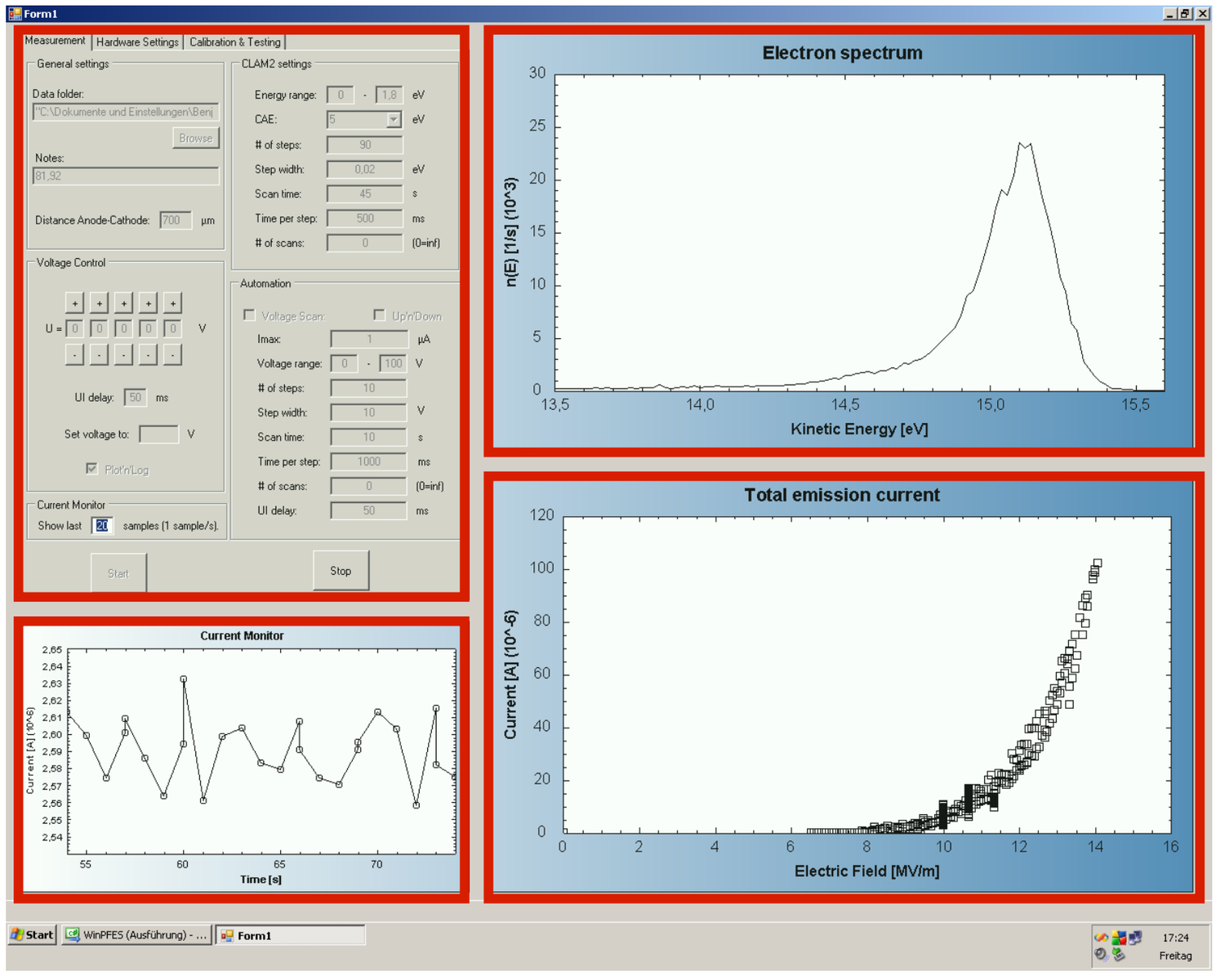
→ **tuneable laser!**
→ **spectrometer!**



Construction of an electron spectrometer for photo-enhanced field emission studies

B Bornheim

Settings



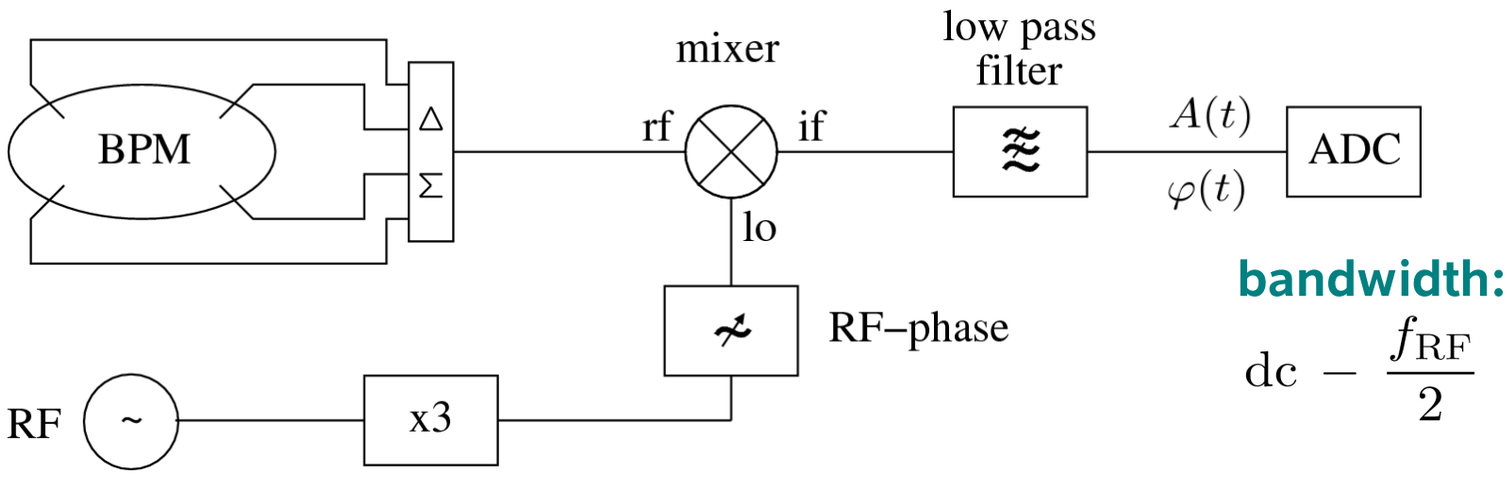
Electron Spectrum

Current Monitor

I(E)-curve

Multibunch feedback systems for ELSA

A. Roth



bandwidth:

$$\mathrm{dc} - \frac{f_{\mathrm{RF}}}{2}$$

Betatron oscillation: amplitude demodulation of Δ-signal

$$A(t)\ \sin\left(3\,\omega_{\mathrm{RF}}\,t\right) \cdot \sin\left(3\,\omega_{\mathrm{RF}}\,t\right)\ \propto\ A(t)$$

Synchrotron oscillation: phase demodulation of Σ-signal

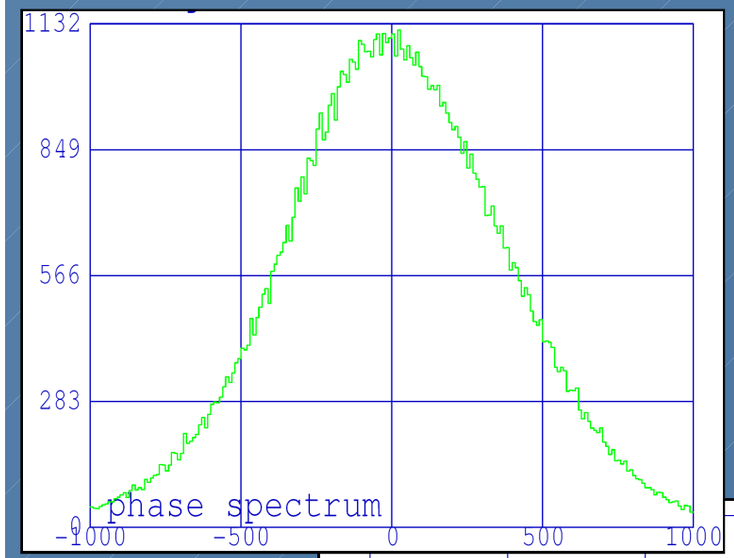
$$\sin\left(3\,\omega_{\mathrm{RF}}\,t\ +\ \varphi(t)\right) \cdot \sin\left(3\,\omega_{\mathrm{RF}}\,t\ +\ \pi/2\right)\ \propto\ \varphi(t)$$

A single bunch injector for ELSA

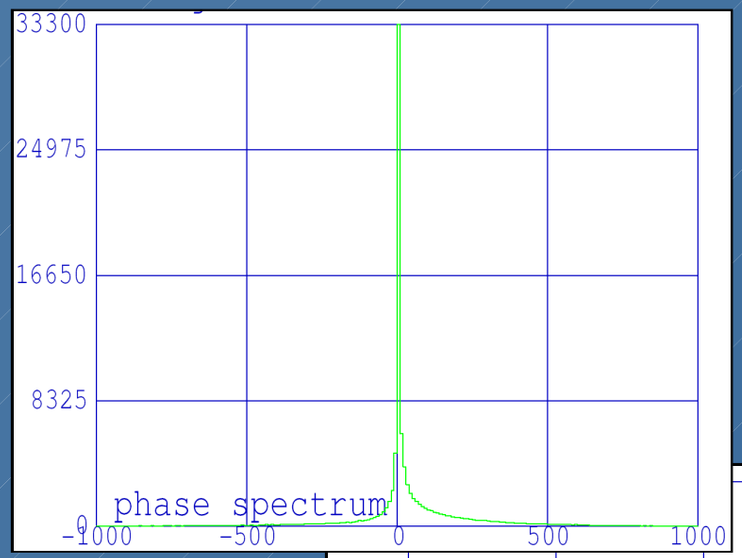
F Klarner

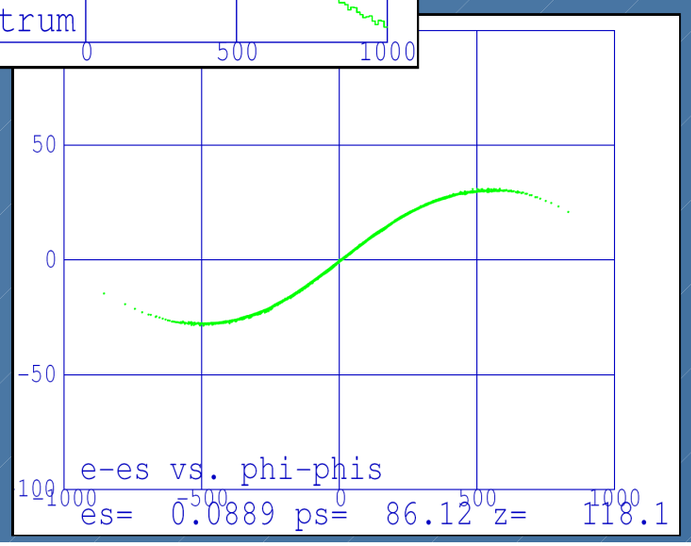
PARMELA: „Phase and Radial Motion in Electron Linear Accelerators“

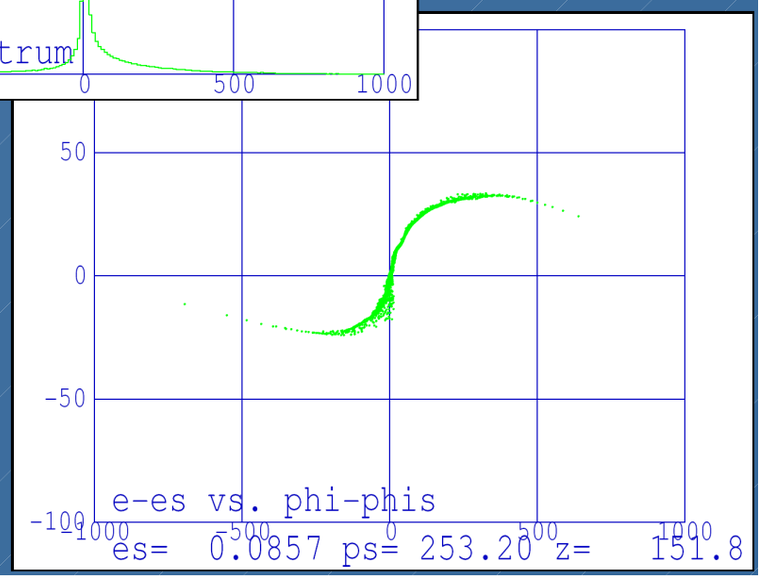
- Particle tracking code
- longitudinal and transversal 2-D/3-D Space Charge Calculations



32,5 cm







Laser induced Plasma Wakefield Acceleration

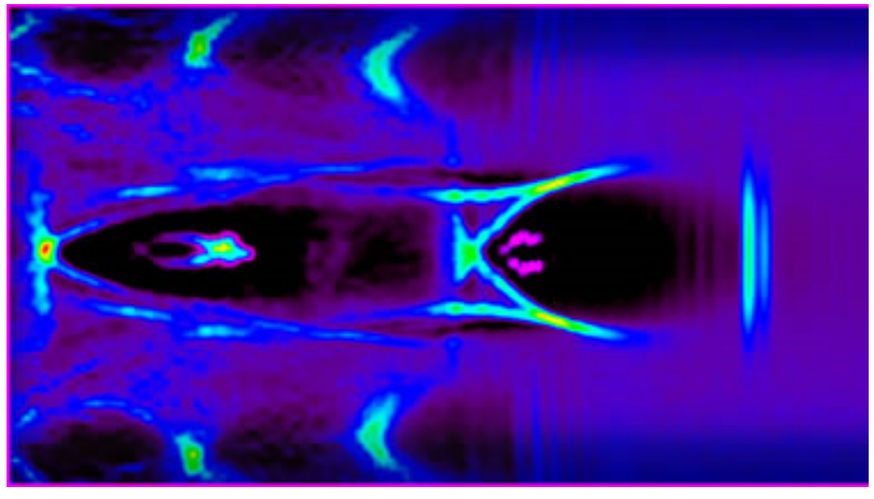
S Khan

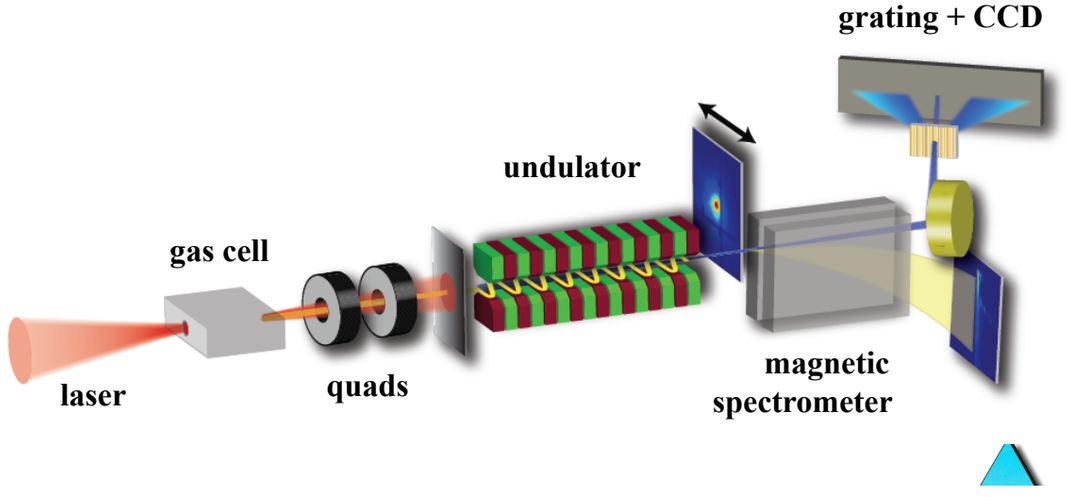
theory („wave breaking“, „bubble“)
A. Pukhov and J. Meyer-ter-Vehn, Appl. Phys. B (2002), 355

breakthrough („monoenergetic electrons“) in 2004:
S.P.D. Mangles et al., Nature 431 (2004), 535
C.G.R. Geddes et al., Nature 431 (2004), 538
J. Faure et al., Nature 431 (2004), 541

more recent breakthroughs:
W.P. Leemans et al., Nature Physics 2 (2006), 696
M. Fuchs et al., Nature Physics 5 (2009), 826

- **laser-plasma acceleration**

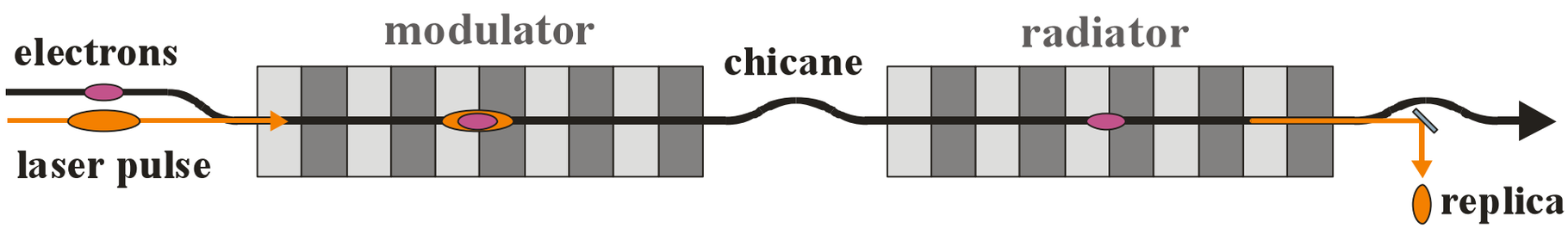


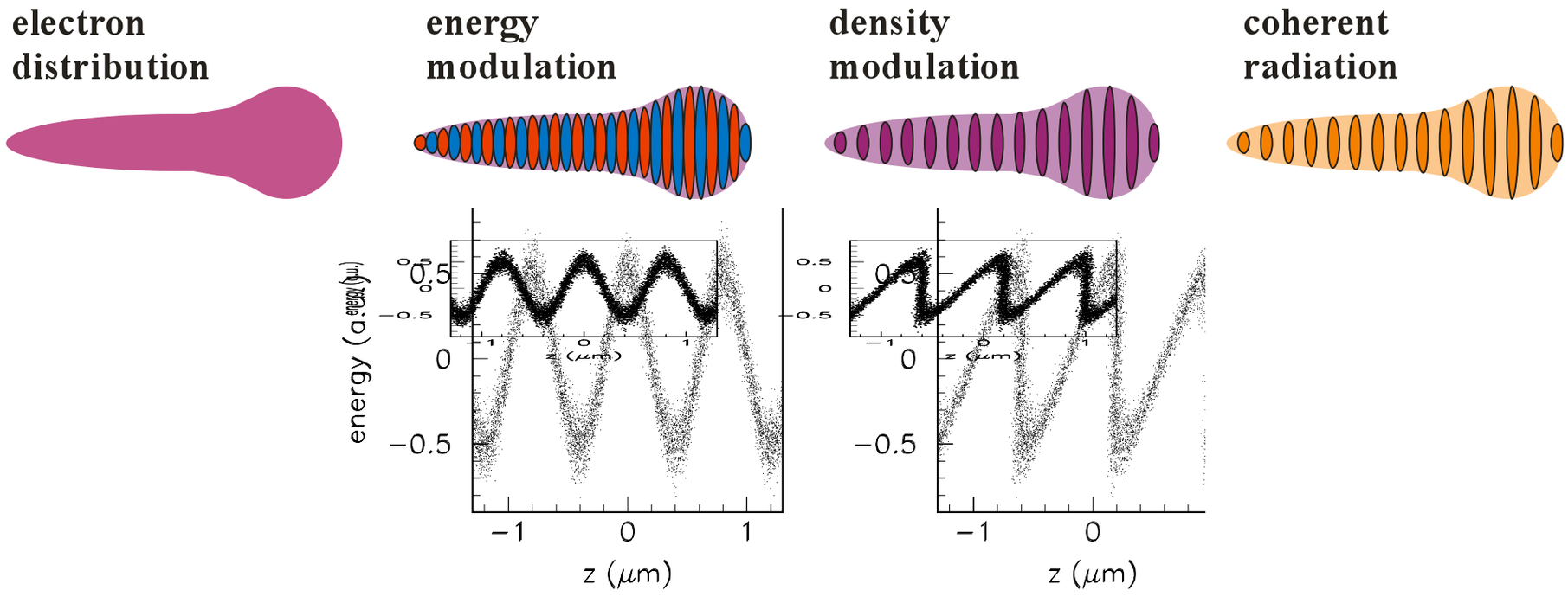


Diagnostics for ultrashort bunches

S Khan

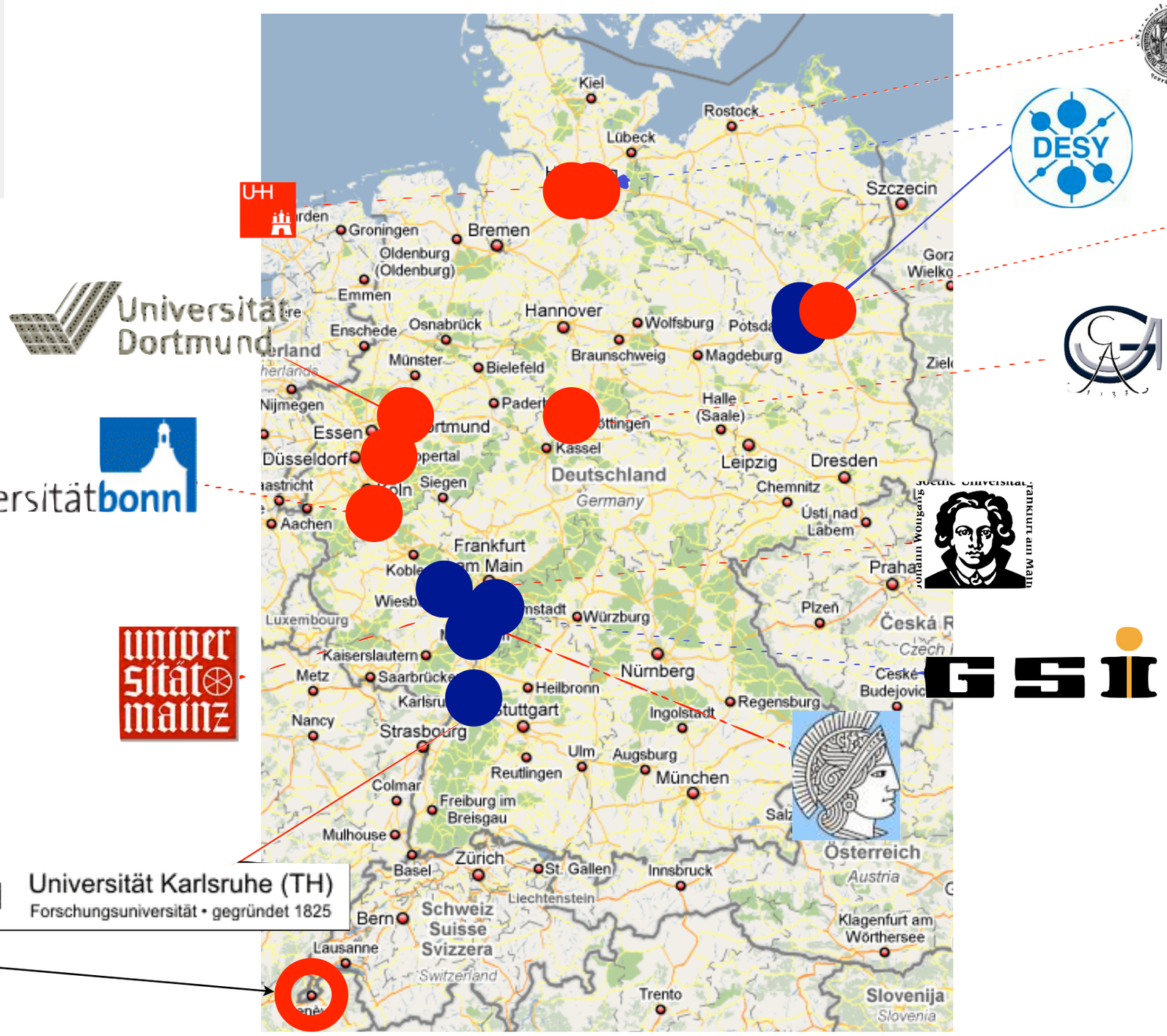
E. Saldin, E. Schneidmiller, M. Yurkov
Nucl. Inst. Methods A 539 (2005), p. 499





Accelerator Research in Germany

- Terascale
- other

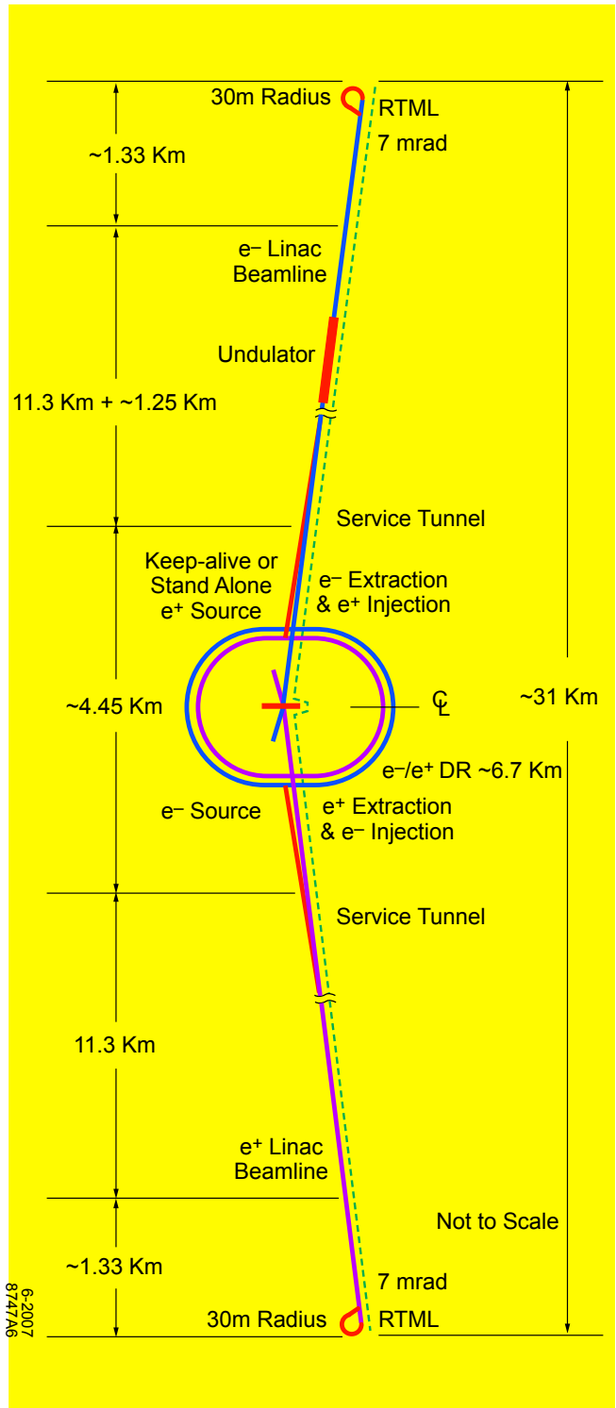


Research Topics for HEP

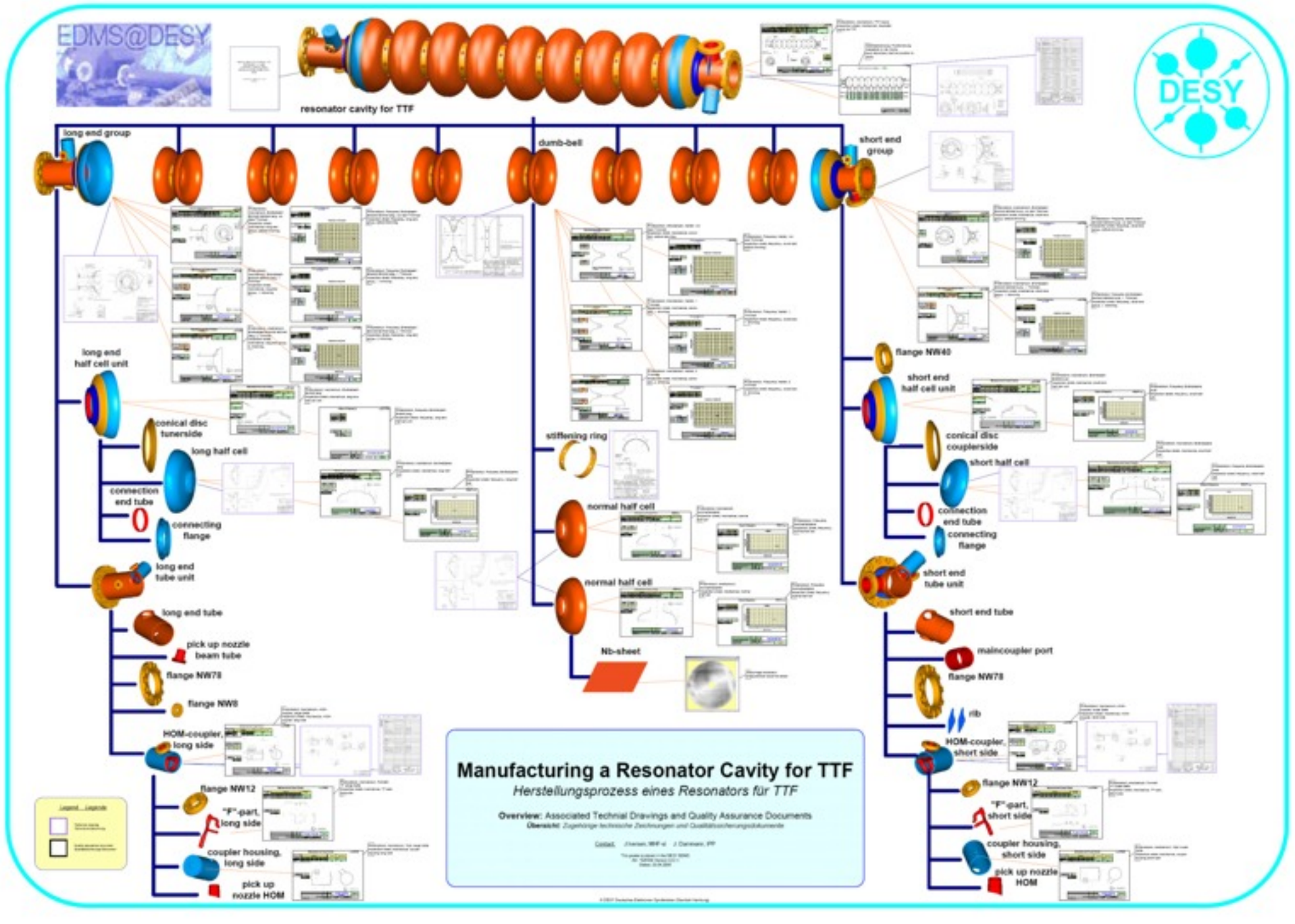
- High Energy
  - Linacs
    - High Gradients
  - Circular machines
    - High magnetic fields
- High Luminosity
  - Low emittance

On the timescale of the Alliance, 2012:

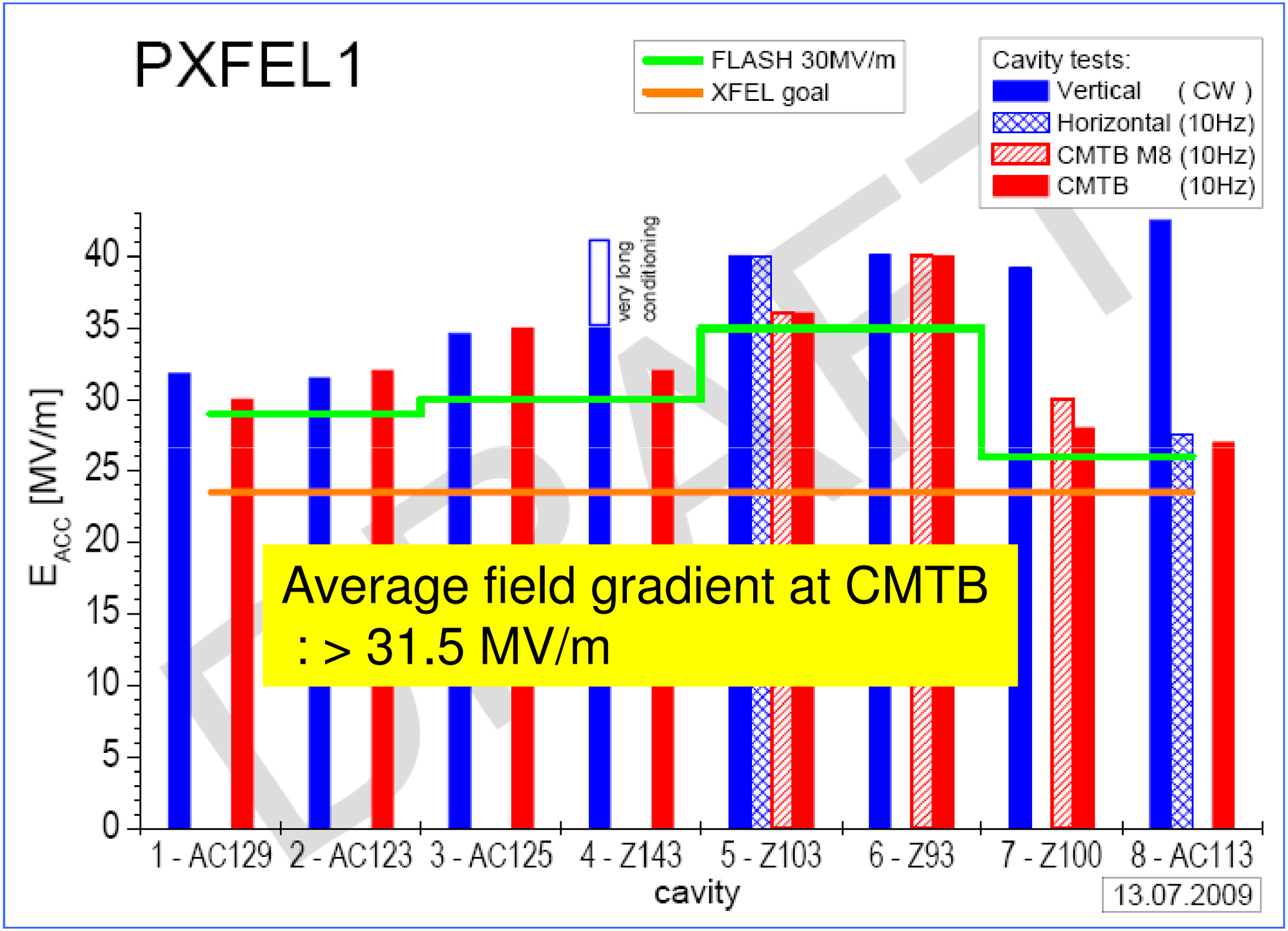
ILC



Fabrication of Accelerator Structures

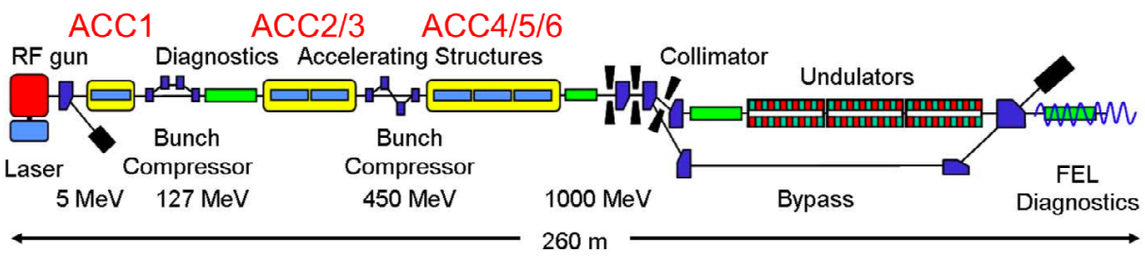


Accelerator Gradient in SRF Structures

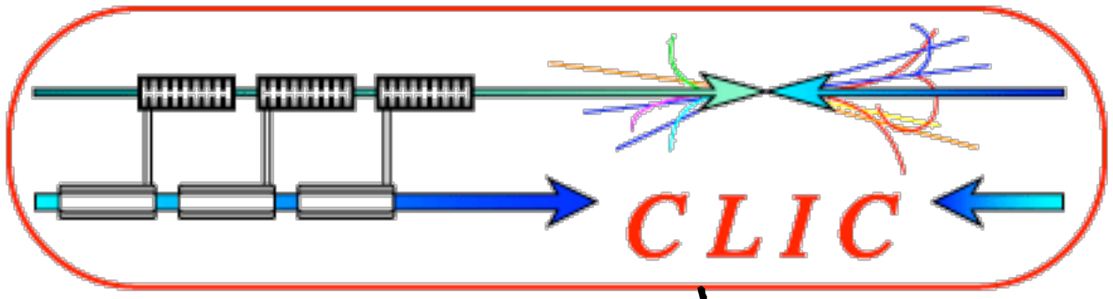


Beyond acceleration

- Source
  - low emittance e^-
  - high intensity e^+
  - Polarization
    - Polarimeter tests in Bonn
  - Damping ring
  - Main linac
    - FLASH 9 mA



- Beam delivery
  - ILC & CLIC
- Feedback
  - Multibunch feedback
    - ILC & CLIC



many additional opportunities (currently not pursued...)

Opportunities at CERN
LHC Commissioning and Upgrade

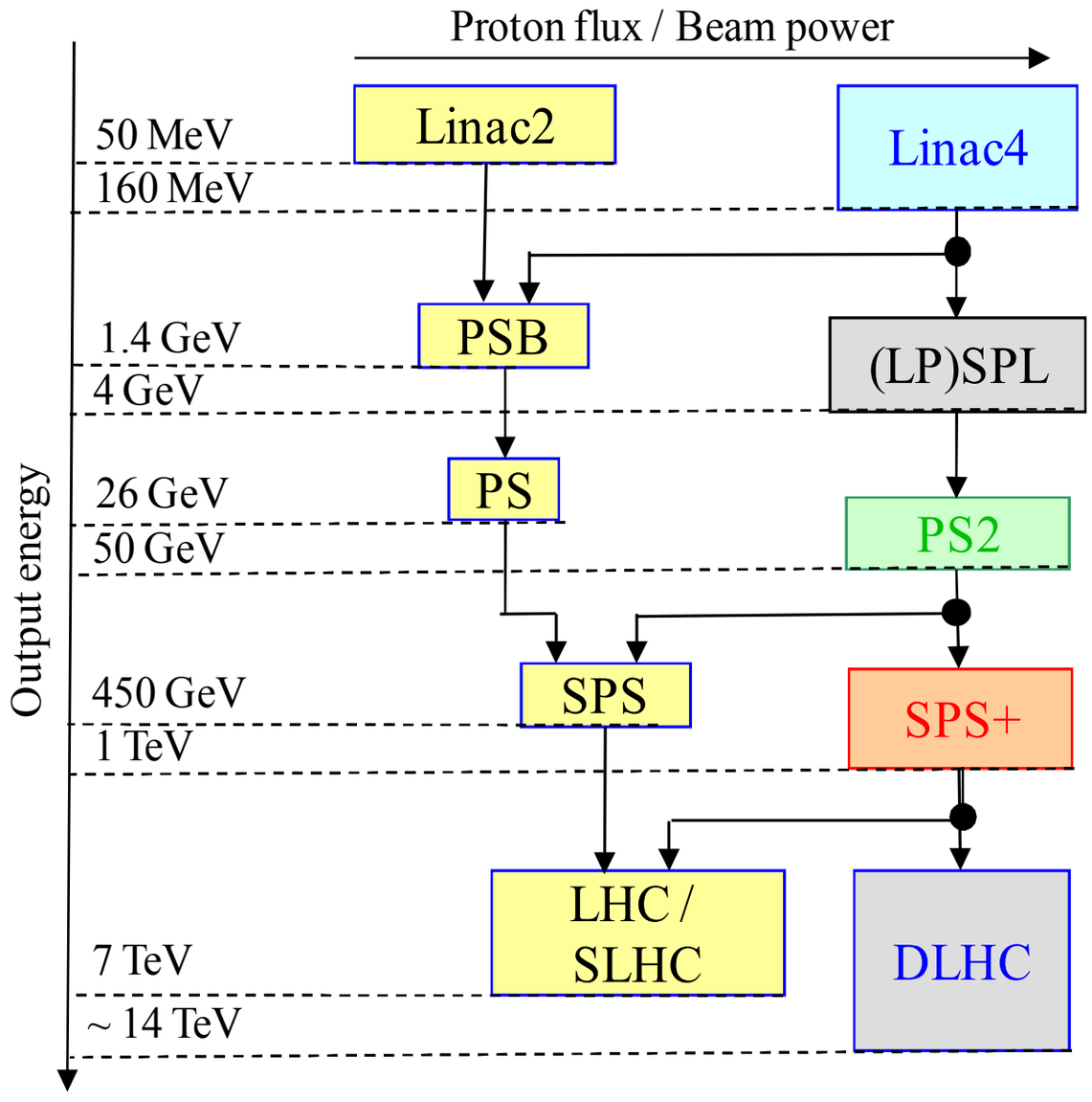
- The start of the LHC is happening – expert action

- LHC injector complex will be upgraded;

Opportunities for Diploma/Master theses

- Linac 4
- SPS
- …

Research carried out at CERN; Theses at home university



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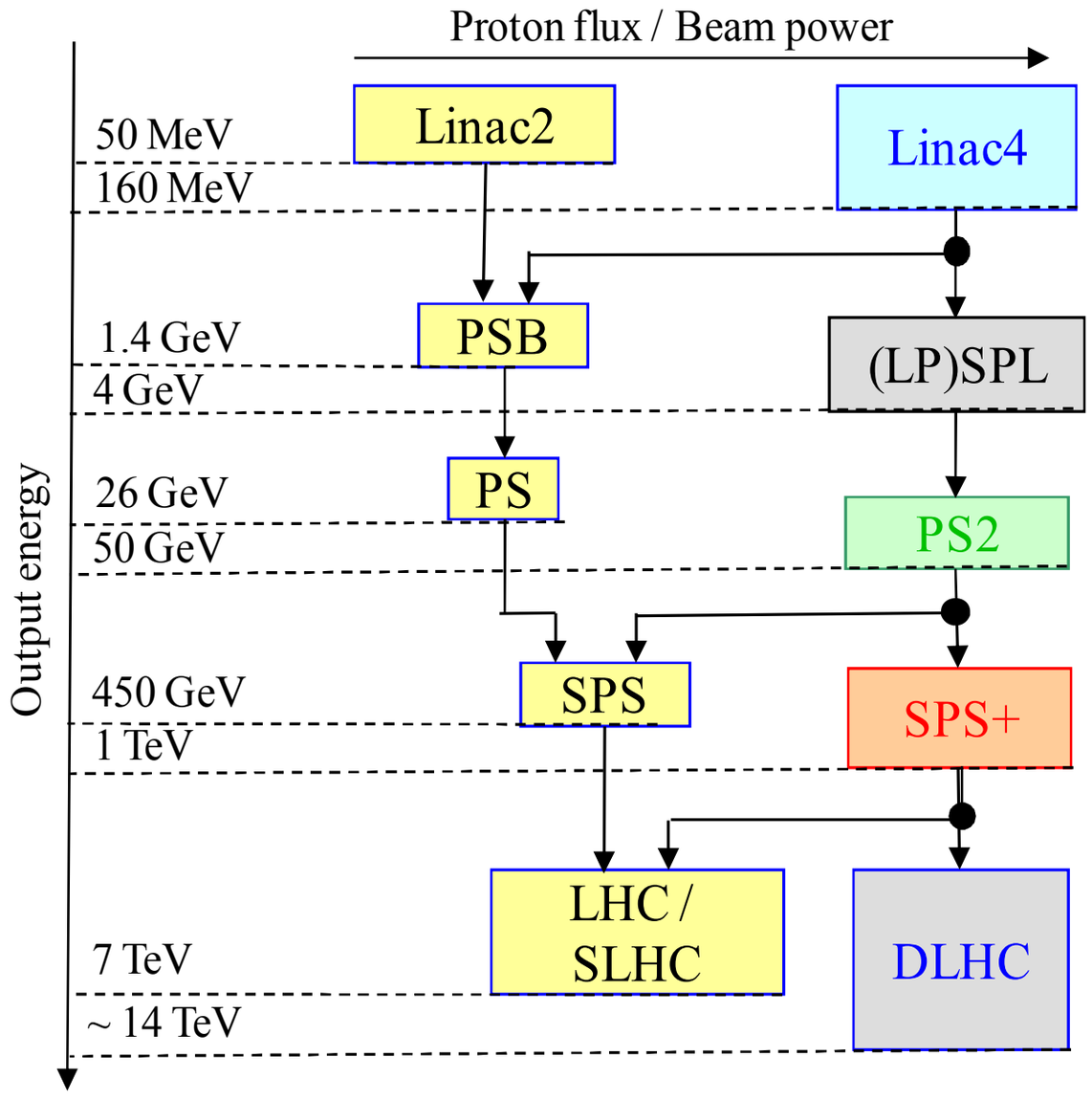
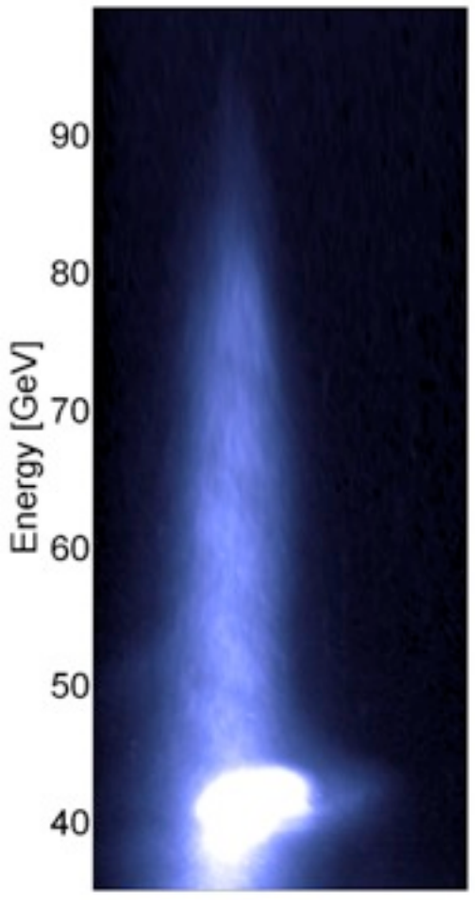


Formally associate CERN in Project Board?

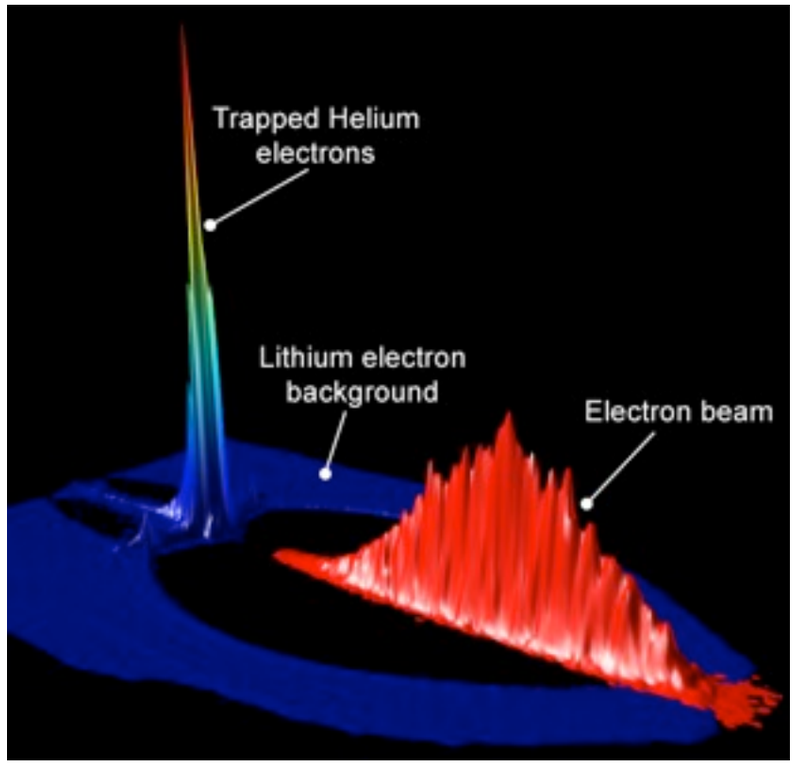
Beyond current technologies

- Future Terascale accelerators have to achieve gradients of 1GV/m
  - Plasma Wakefield is one candidate



Some examples from SLAC.
Planned facility:
FACET

- YIG (Hamburg, currently being filled) to explore the options for high-gradient
  - collaboration with DESY/ infrastructure
- consistent approach in Terascale has to be developed



Verbundforschung

- Initiative to establish a research field accelerator physics
- join forces on common topics
- Workshop tried to identify interests, establish contacts
- possibly form a wider network (Verbund) – as in particle physics for HEP experiments
  - A S Müller and W Hillert

Beschleunigerentwicklung an deutschen Hochschulen für die Grundlagenforschung an Großgeräten

from **Thursday 17 September 2009 (12:00)**
to **Friday 18 September 2009 (16:00)** (Europe/Berlin)
at **Universität Hamburg & DESY**
chaired by: ***Jörg Roßbach (Uni Hamburg)***
support: pt@desy.de

Thursday 17 September 2009 | Friday 18 September 2009 |

Thursday 17 September 2009 top

12:00 Ankunft, meet&greet — Business Lunch (Sem. 4, Geb. 1)

13:00->*13:20* Begrüßung (Location: Sem. 4, Geb. 1)

13:00 Begrüßung durch die Tagungsleitung (10') (Slides) — Jörg Roßbach (*DESY*)
13:10 Begrüßung durch DESY (05') — Reinhard Brinkmann (*DESY*)

13:20->*16:30* Überblick: Stand der Beschleuniger-R&D in Deutschland (Location: Sem. 4, Geb. 1)

13:20 Förderziele des BMBF (20') (Slides) — Monica Pantea (*BMBF*)
13:40 Hochenergiephysik (40') (Slides) — Eckhard Elsen (*DESY*)
14:20 Hadronen- und Kernphysik (40') (Slides) — Ulrich Ratzinger (*Uni Frankfurt*)
15:00 Kaffeepause
15:30 Erforschung kondensierter Materie (40') (Slides) — Shaukat Khan (*TU Dortmund*)
16:10 Förderinstrumente (20') (Slides) — Hanna Mahlke (*PT-DESY*)
16:30 Pause

17:00->*19:00* Schwerpunktthemen (Location: Sem. 4, Geb. 1)

17:00 Strahldynamik (30') (Slides) — Wolfgang Hillert (*Uni Bonn*)
17:30 Strahldiagnostik (30') (Slides) — Jörg Roßbach (*Uni Hamburg*)
18:00 Beschleunigertechnologie (30') (Slides) — Malte Kaluza (*Uni Jena*)
19:30 Dinner

Friday 18 September 2009 top

08:30->*12:30* Konkrete Vernetzungsmaßnahmen

08:30 Arbeitsgruppe "Strahldiagnostik/Strahldynamik" (1h45') (Paper ; Slides) (Location: Sem 4, Geb. 1) — Atoosa Meseck (*HZB*) , Wolfgang Müller (*TU Darmstadt*)
08:30 Arbeitsgruppe "Beschleunigertechnologie" (1h30') (Slides) (Location: Sem 3a, Geb. 1) — Anke-Susanne Müller (*Uni Karlsruhe*) , Malte Kaluza (*Uni Jena*)
10:15 Kaffeepause
10:45 Berichte aus den Arbeitsgruppen (45') (Slides) (Location: Sem. 4, Geb. 1) — Atoosa Meseck (*HZB*) , Wolfgang Müller (*TU Darmstadt*) , Anke-Susanne Müller (*Uni Karlsruhe*)
11:30 Round Table (1h00') (Location: Sem. 4, Geb. 1)
Vernetzung der Beschleunigerphysik in Deutschland und internationale Zusammenarbeit im Rahmen der BMBF-Förderung
12:30 Lunch

13:30->*15:00* Ausbildung von Beschleunigerphysikern (Location: Sem. 4, Geb. 1)

13:30 Beruf: Beschleunigerphysiker (30') (Slides) — Hans Weise (*DESY*)
14:00 Ausbildungsangebote der Universitäten (Bachelor/Master) (30') (Slides) — Jörg Roßbach (*Uni Hamburg*)
14:30 Outreach (30') (Slides) — Hanna Mahlke (*PT-DESY*)
15:00 PETRA III-Führung
nach Absprache; bei Interesse bitte anmelden

Summary – Project Accelerator

- Terascale comprises only a fraction of the accelerator activities in Germany given by the focus on HEP (β=1 accelerators)
- Education is an emphasis
  - Lectures
  - Schools
- Research mainly directed towards ILC
- LHC commissioning/upgrade provides additional opportunities

- Developing plans for engagement for Future Accelerating Technologies