

# DESY – an Introduction

*EPICS Meeting – DESY – an Introduction*

DESY, April 24, 2006

Matthias Clausen, DESY / MKS-2

# The Science Center DESY

## Deutsches Elektronen-Synchrotron

Staatliches Forschungsinstitut, 1959 gegründet

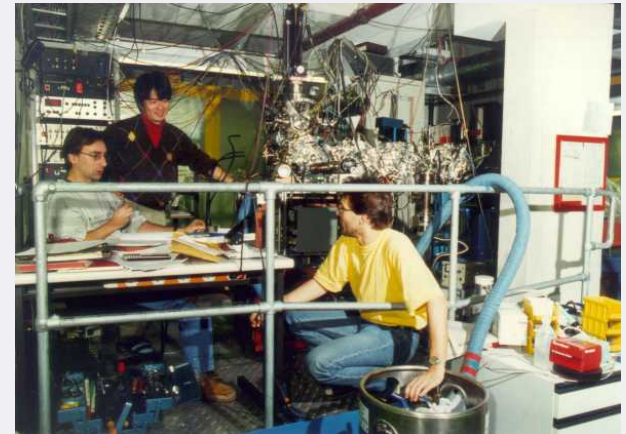
1560 Mitarbeiter wollen wissen:

Wie sieht die Welt im Kleinsten aus?

- in HH-Bahrenfeld und Zeuthen
- 800 Diplomanden, Doktoranden und Nachwuchswissenschaftler
- über 100 Auszubildende
- ca. 2900 Gastwissenschaftler aus 33 Ländern
- ca. 160 Mio. € im Jahr  
(90 % Bund, 10 % Hamburg bzw. Brandenburg)

### Auftrag:

- Entwicklung, Bau und Betrieb von Teilchenbeschleunigern
- Elementarteilchenphysik
- Forschung mit Synchrotronstrahlung

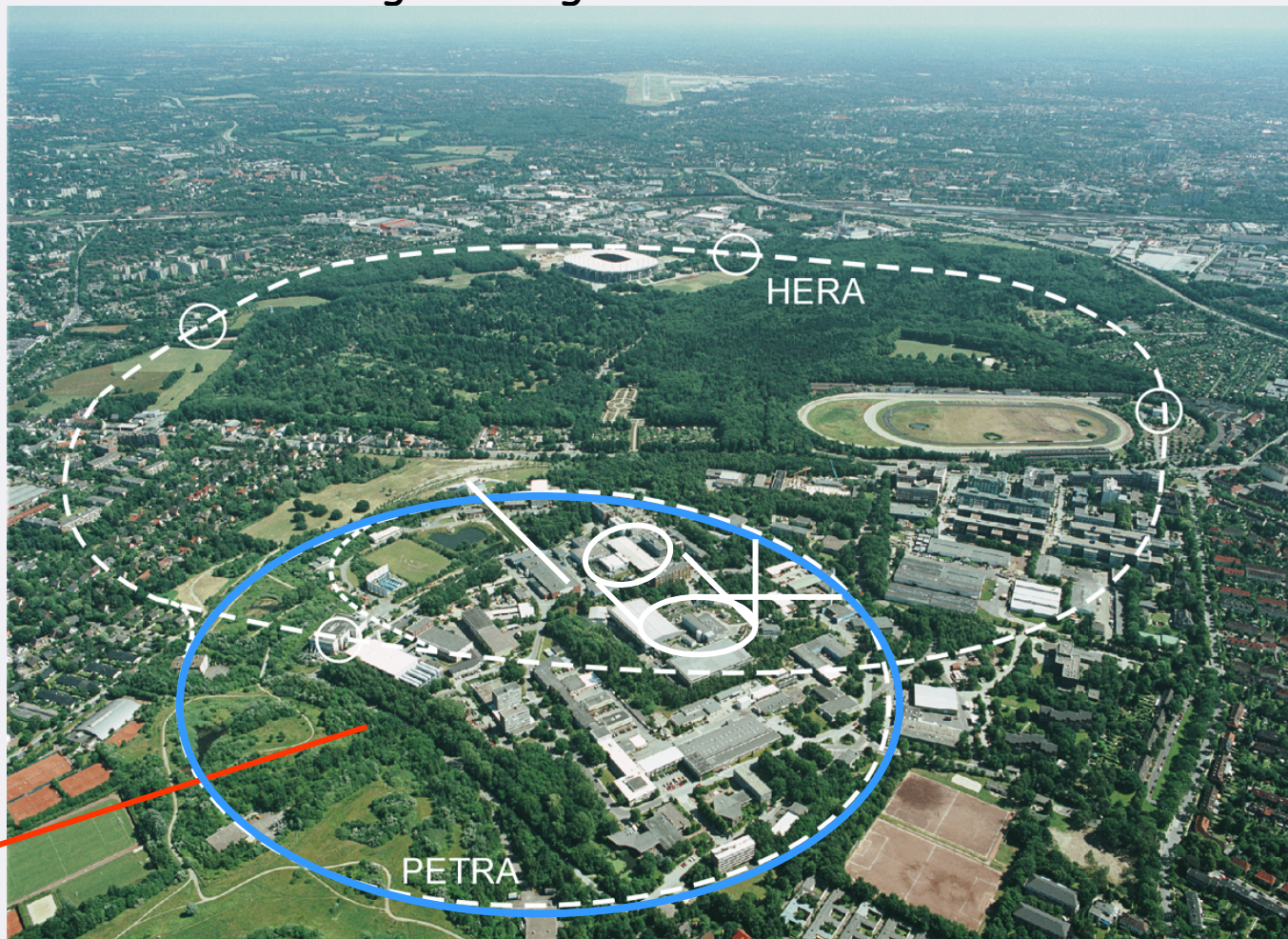


# Bulding 1b – Where we are right now



# The Science Center **DESY**

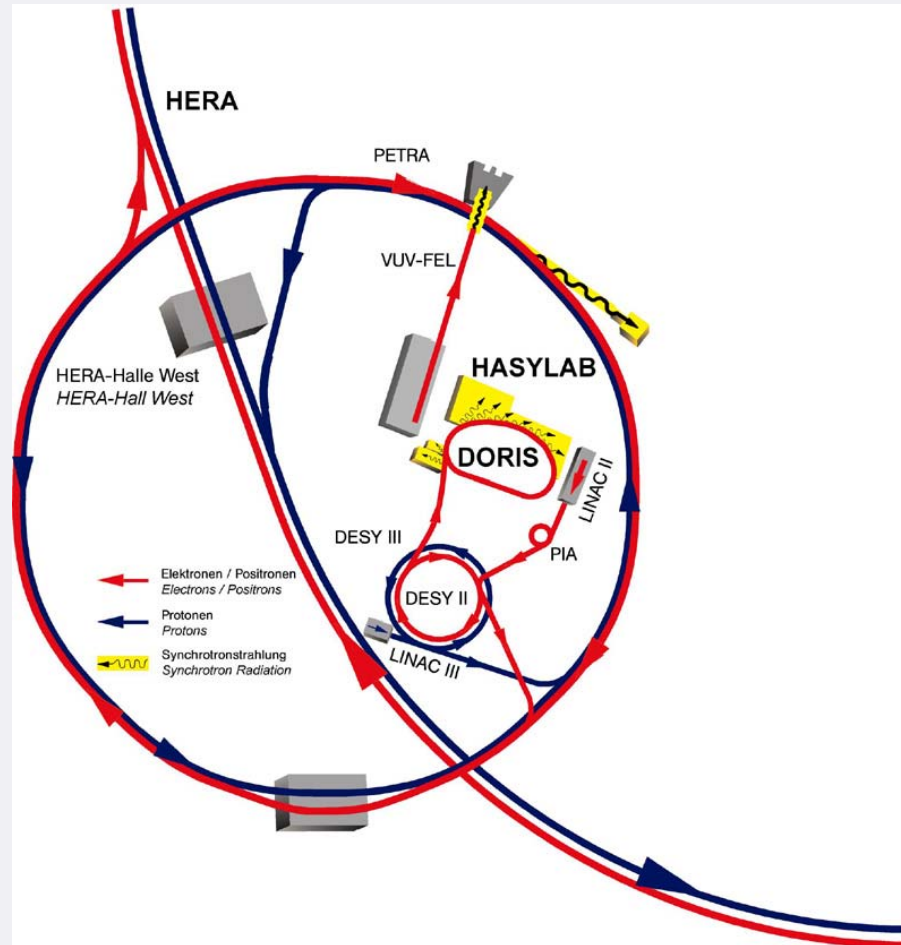
10 Beschleuniger - insgesamt ca. 17 km



- e-Linac
- p-Linac
- PIA
- DESY-I
- DESY-II
- DORIS
- PETRA
- HERA-e
- HERA-p
- FLASH

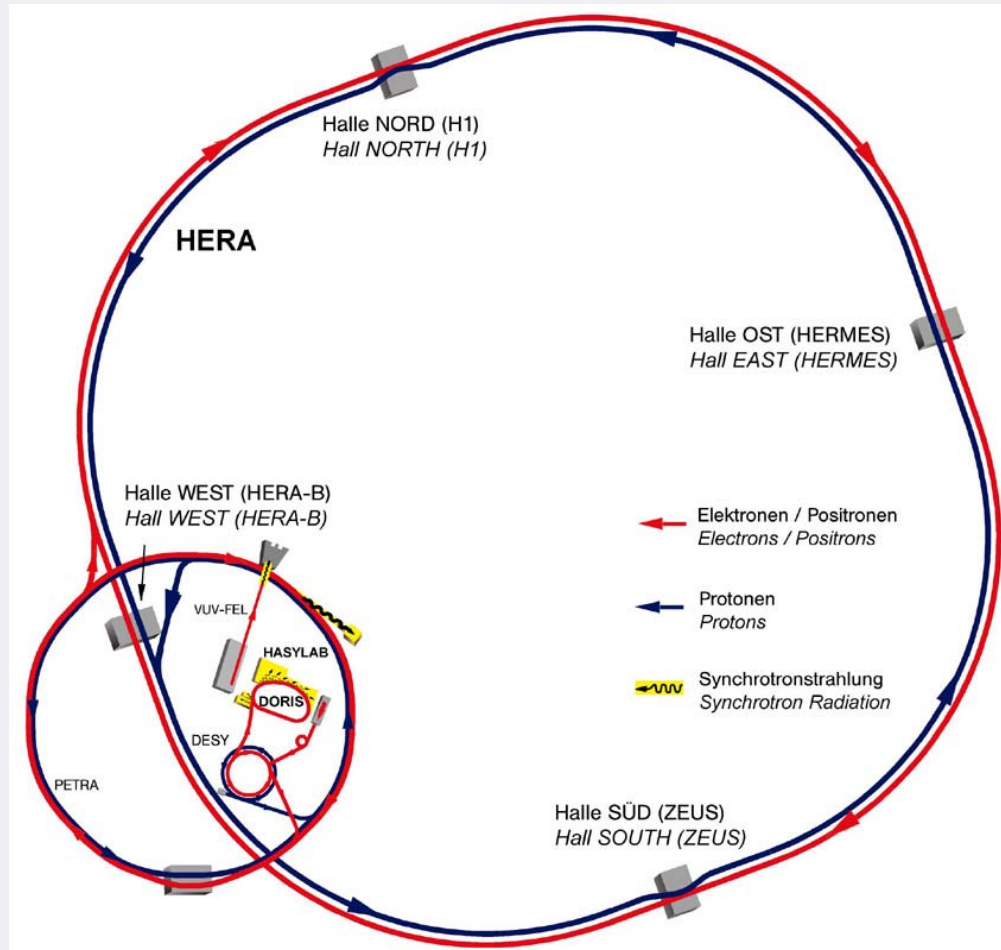
# DESY

## DESY/ DORIS/ PETRA/ (HERA)



# DESY

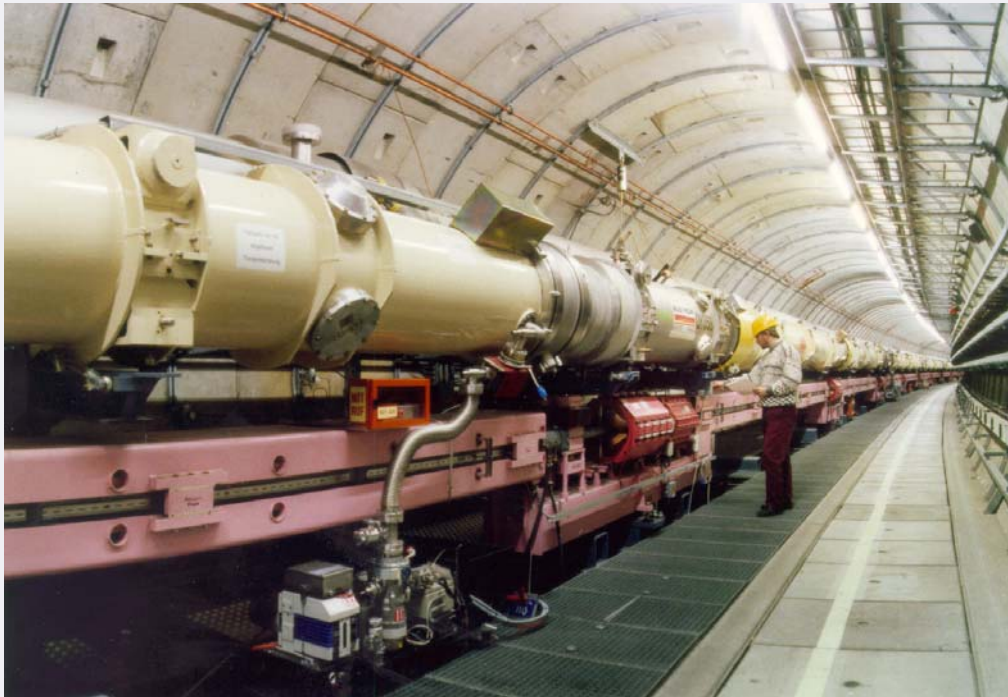
## HERA



# The Science Center **DESY**

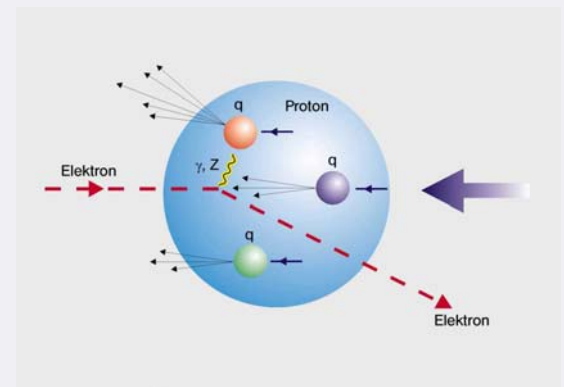
Science since 1992, 4 (since 2002: 3) great Detectors

Data acquisition until 1st July 2007, Data computation at least until 2010



**Electrons** as little Detectors search the inner part of the **Protons**

0,000 000 000 000 000 000 1 m



# Science with Synchrotron Radiation

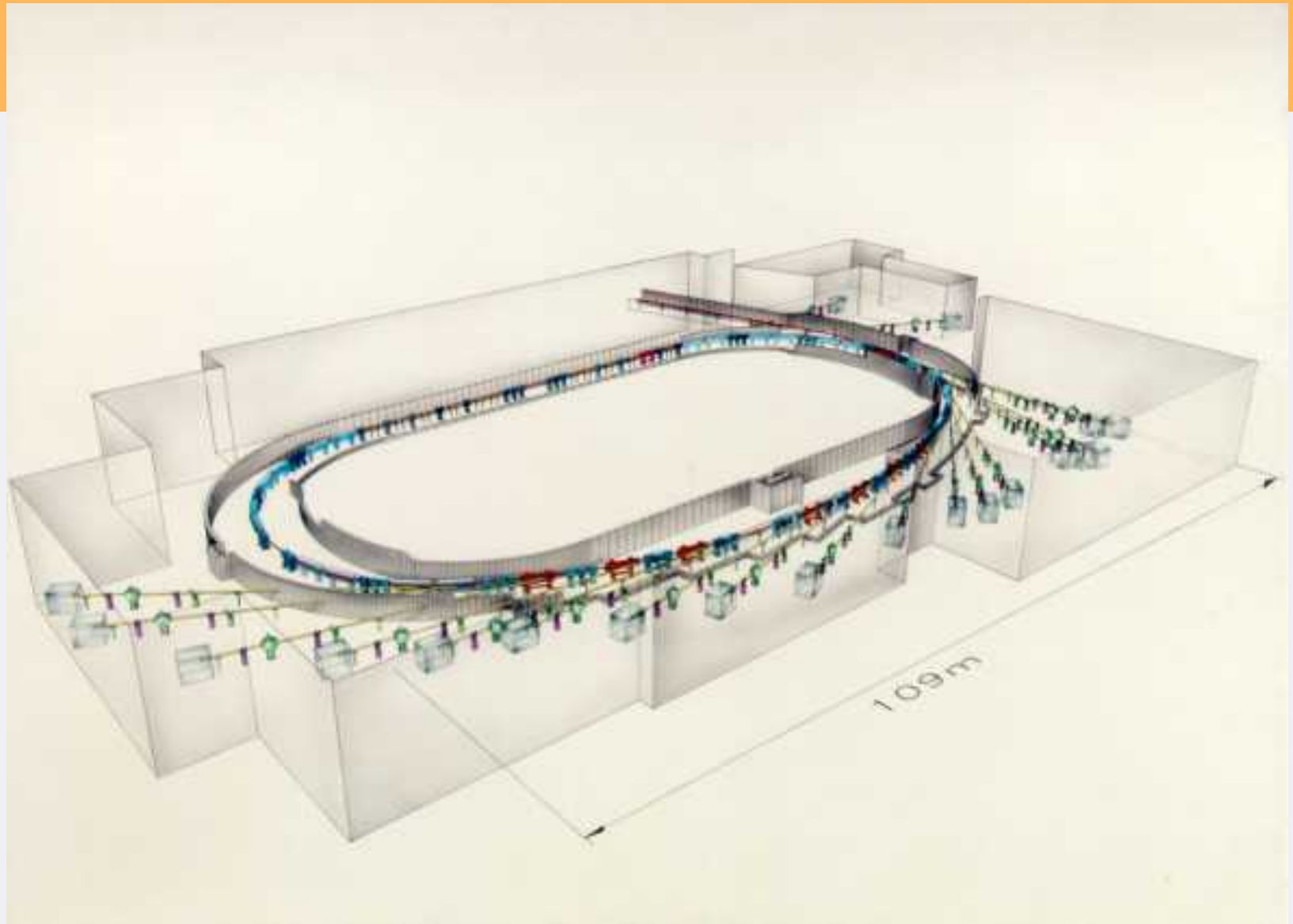
## HAmburger SYnchrotronstrahlungs LABor

Zwei Speicherringe als intensive Lichtquelle: DORIS und PETRA

42 Messplätze mit 80 Instrumenten

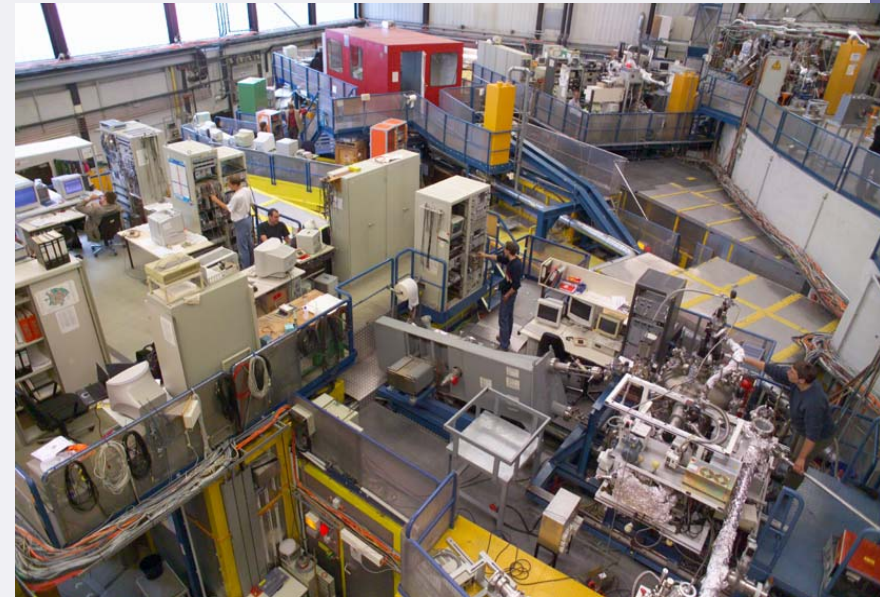
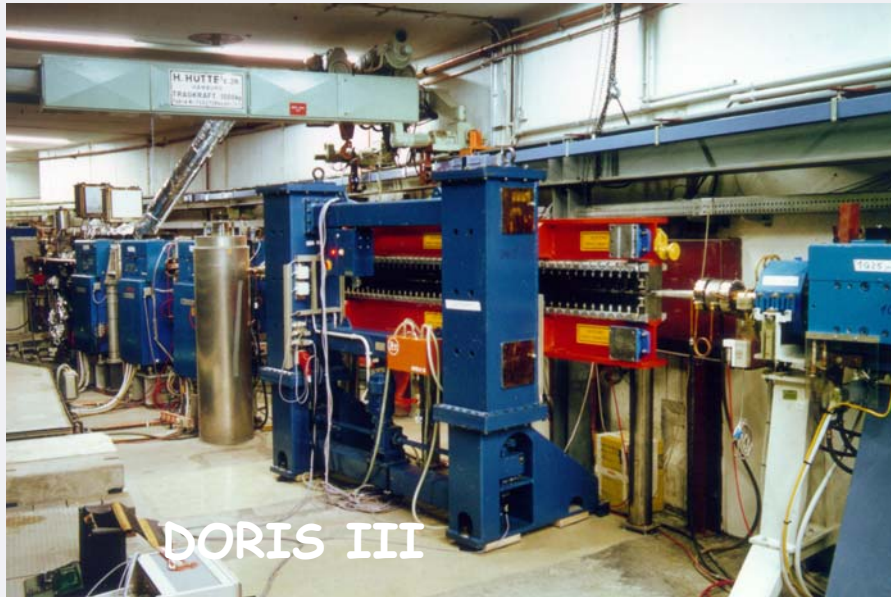
vielfältige Forschungsmöglichkeiten





# Das Forschungszentrum DESY

## Das Hamburger Synchrotronstrahlungslabor HASYLAB



- ca. 2000 Gastwissenschaftler pro Jahr aus 31 Nationen
- Physicists, Chemists, Geologen, Biologen, Mediziner und Materialforscher
- 40 Messplätze mit 80 im Wechsel betriebenen Instrumenten

# Das Forschungszentrum DESY

## Forschung mit Photonen/Synchrotronstrahlung

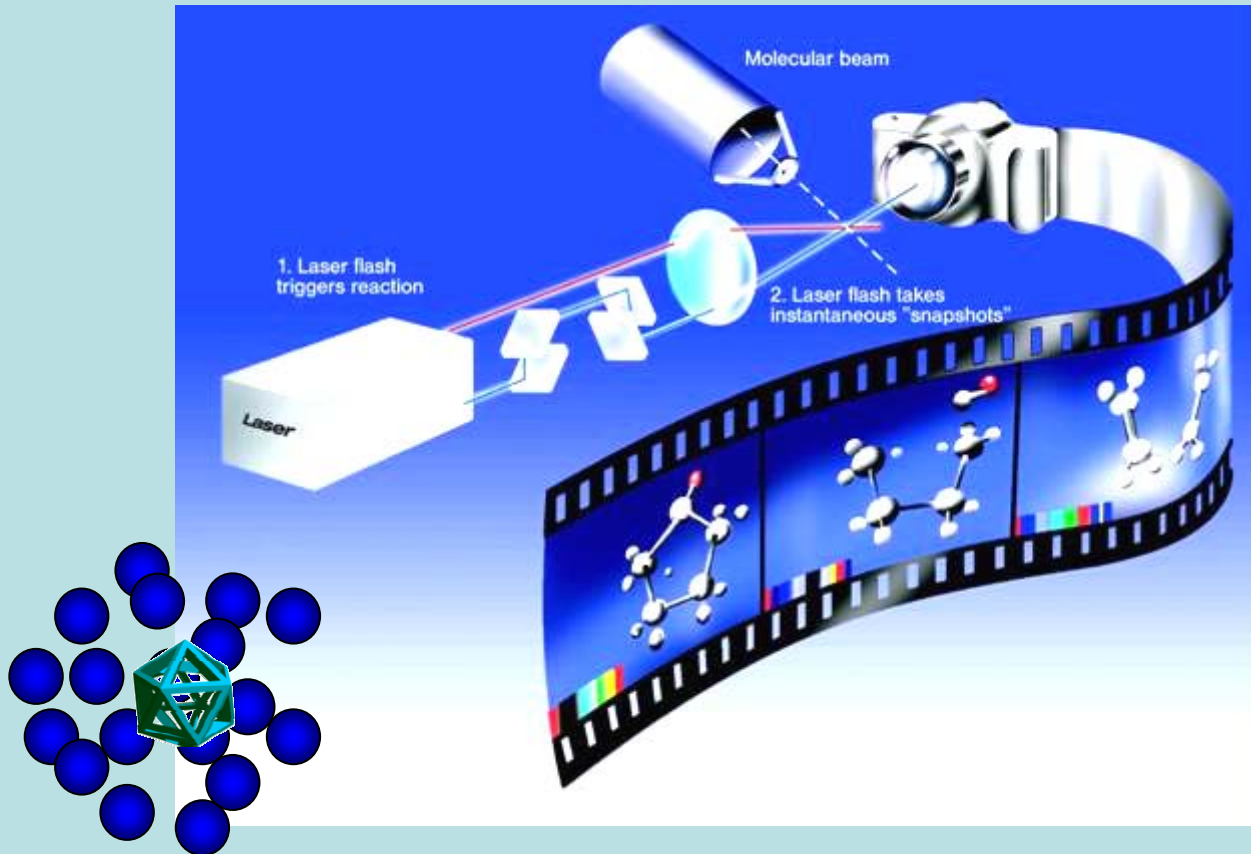


### Das PETRA III-Projekt

- Start: 2009
  - 225 Mio. €  
(90 % Bund, 10 % HH)
  - Umbau des HERA-Injektors ab Juli 2007
- 
- Weltweit leistungsstärkste Speicherringquelle für Synchrotronstrahlung
  - Anordnung von Atomen in Materialien: Werkstoffkunde, Proteinstruktur, ...

# X-Ray Pictures of the Future

Realtime-Hologram of the ultrafast movements of Atoms, Molekülen and Elektronen



Typical Time Scale of the X-Ray Flashes: 10-1000 Femto-Seconds

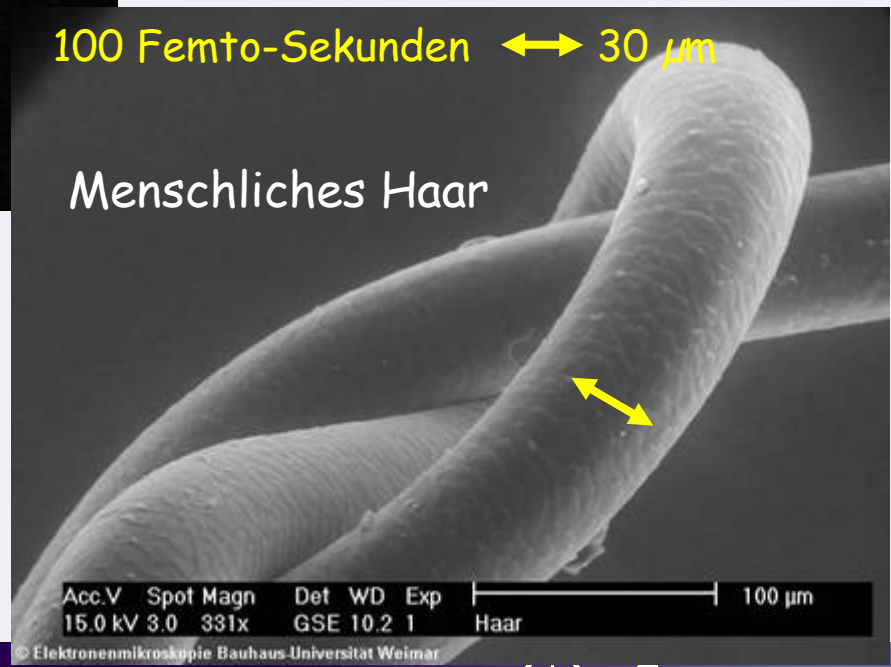
# Röntgenbilder der Zukunft



Was sind "Femto-Sekunden?"

100 Femto-Sekunden ↔ 30 μm

Menschliches Haar



Für die Untersuchung des **Ultrakurzzeit**verhaltens der Materie braucht man eine neue Röntgenquelle:

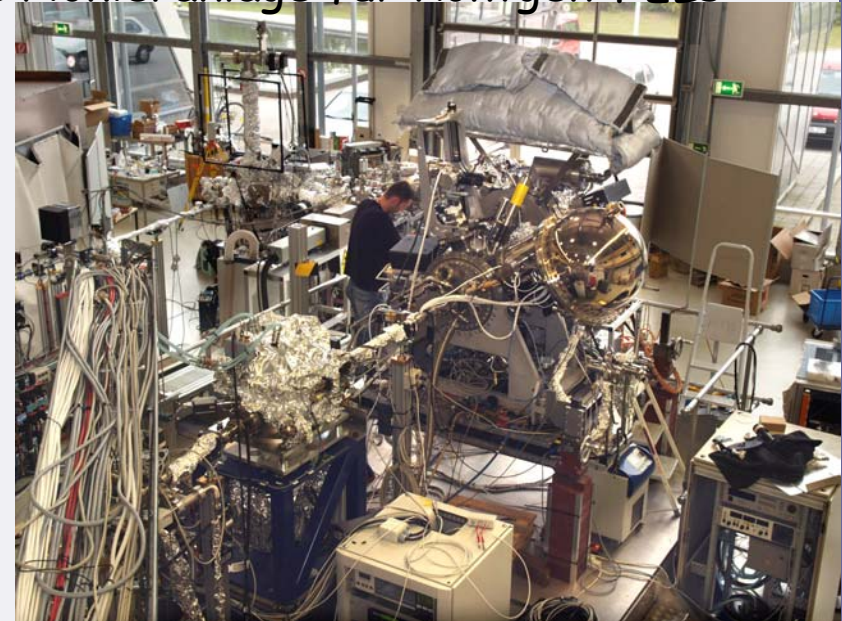
Den **X**-Strahlen **Freie-Elektronen-Laser**

**XFEL**

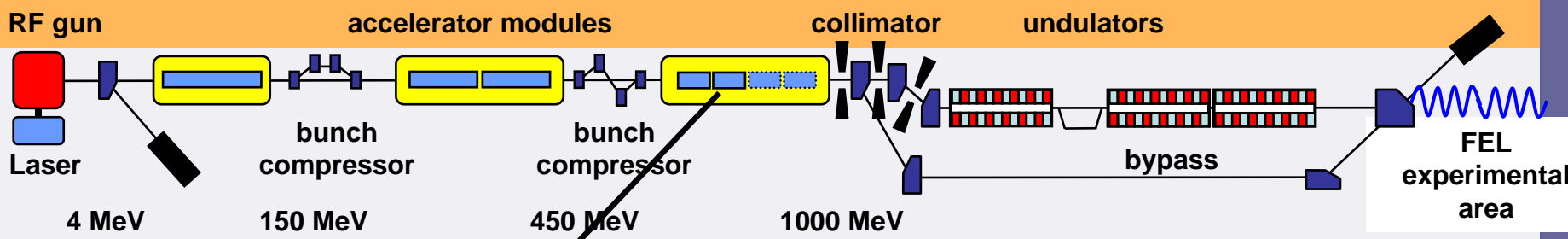
# Das Forschungszentrum DESY

Seit 2005: Forschung am VUV-Freie-Elektronen-Laser FLASH

bis 2008 weltweit einmalig und wichtigste Pionieranlage für Röntgen-FELs



- 260 m lang ( future: **XFEL**: 3,4 km lang)
- Elektronenbeschleuniger: supraleitende TESLA-Technologie
- Wellenlänge: 6 bis 30 Nanometer (**XFEL**: 6 bis 0,085 nm)
- Röntgenblitze: 10 bis 50 Femtosekunden
- 117 Mio.€, davon 9 Mio. € HH (**XFEL**: 908 Mio. €, 50 % Bund, 10 % HH + S-H)

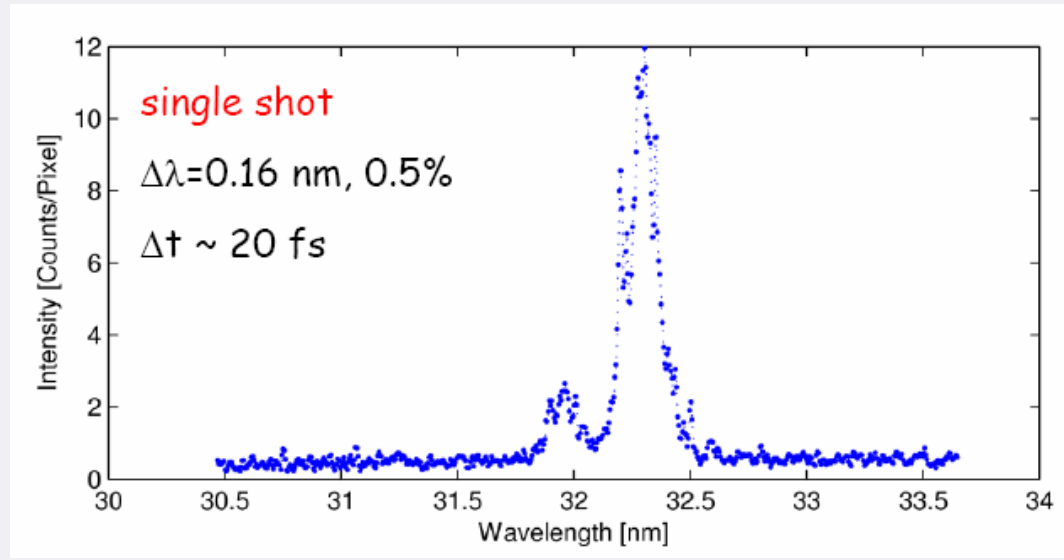


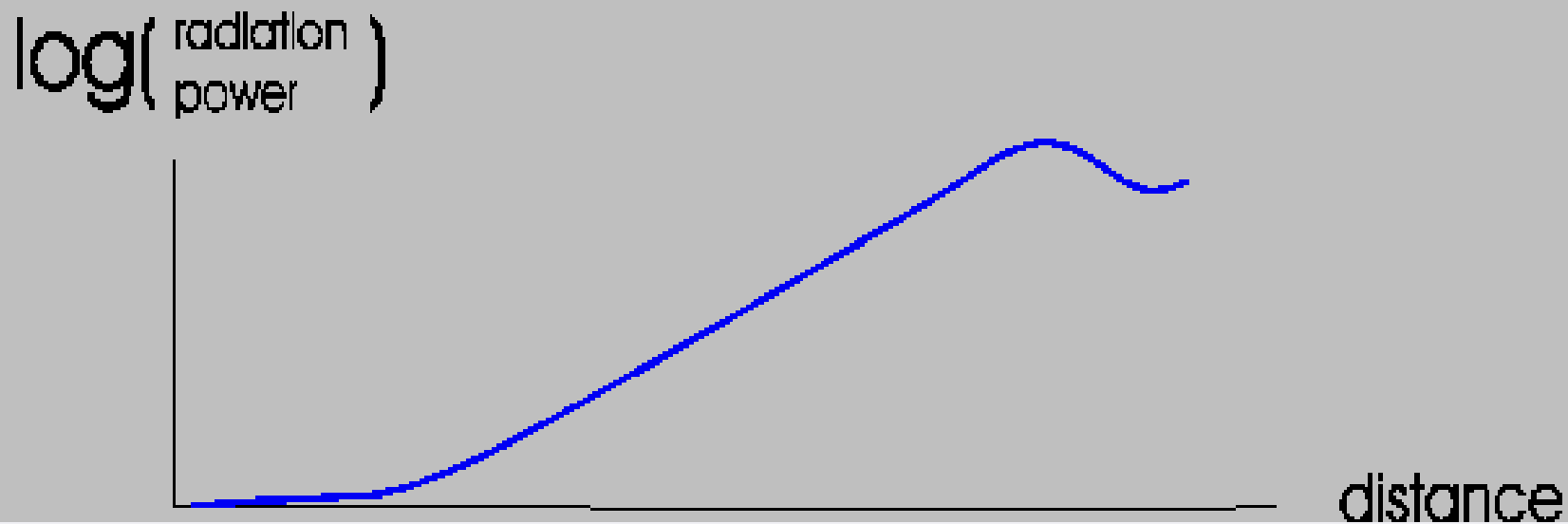
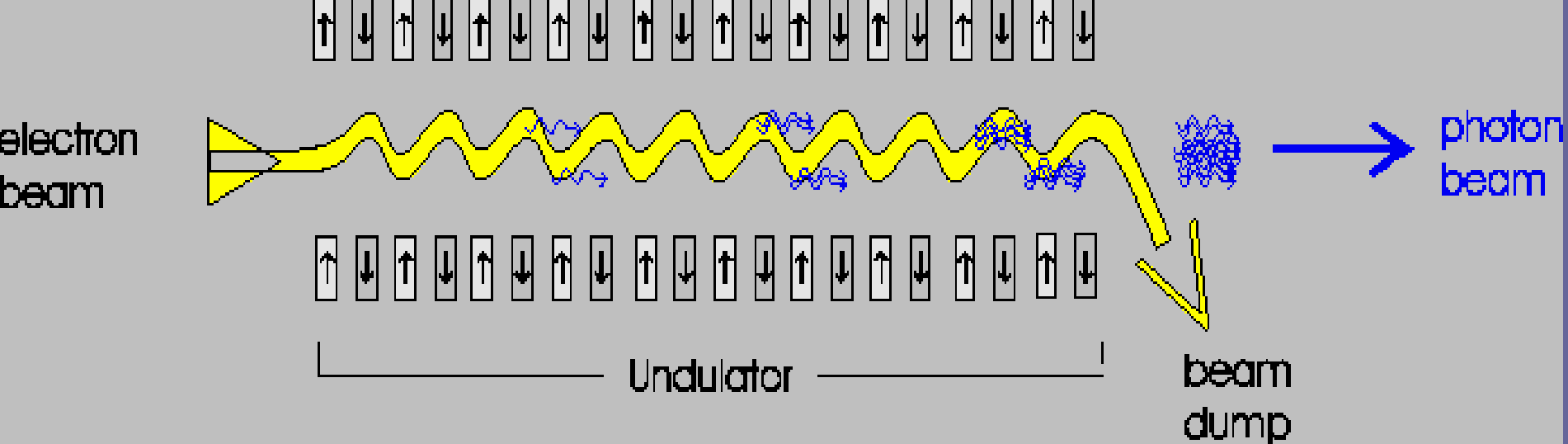
## TTF / VUVFEL: pilot facility for the XFEL

Jan. 14, 2005: lasing at 32 nm! → new wavelength record for SASE FEL in VUV regime



**M5 Test with RF,  $Q_0 = 8 \cdot 10^9$  at 25 MV/m**

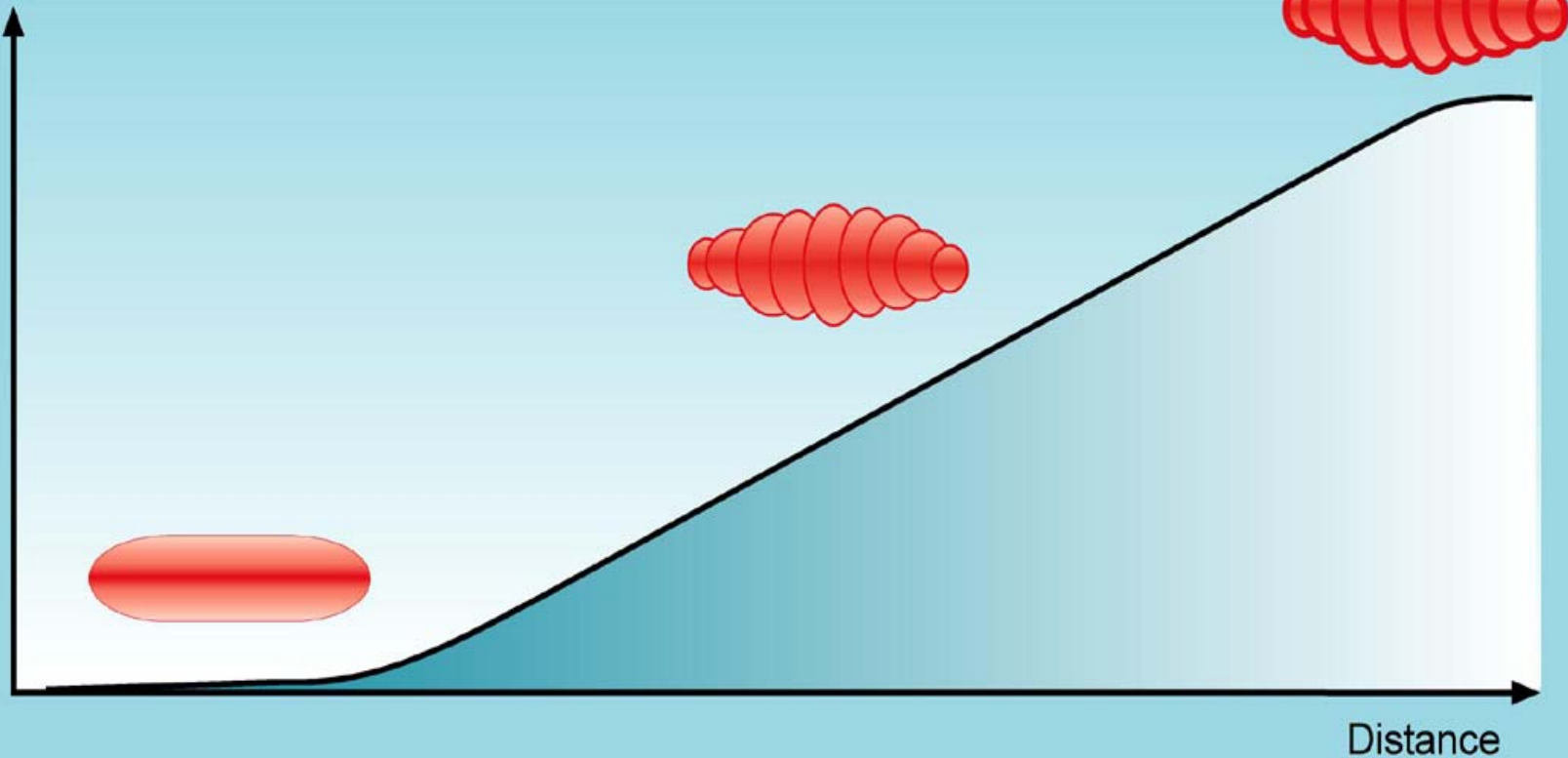




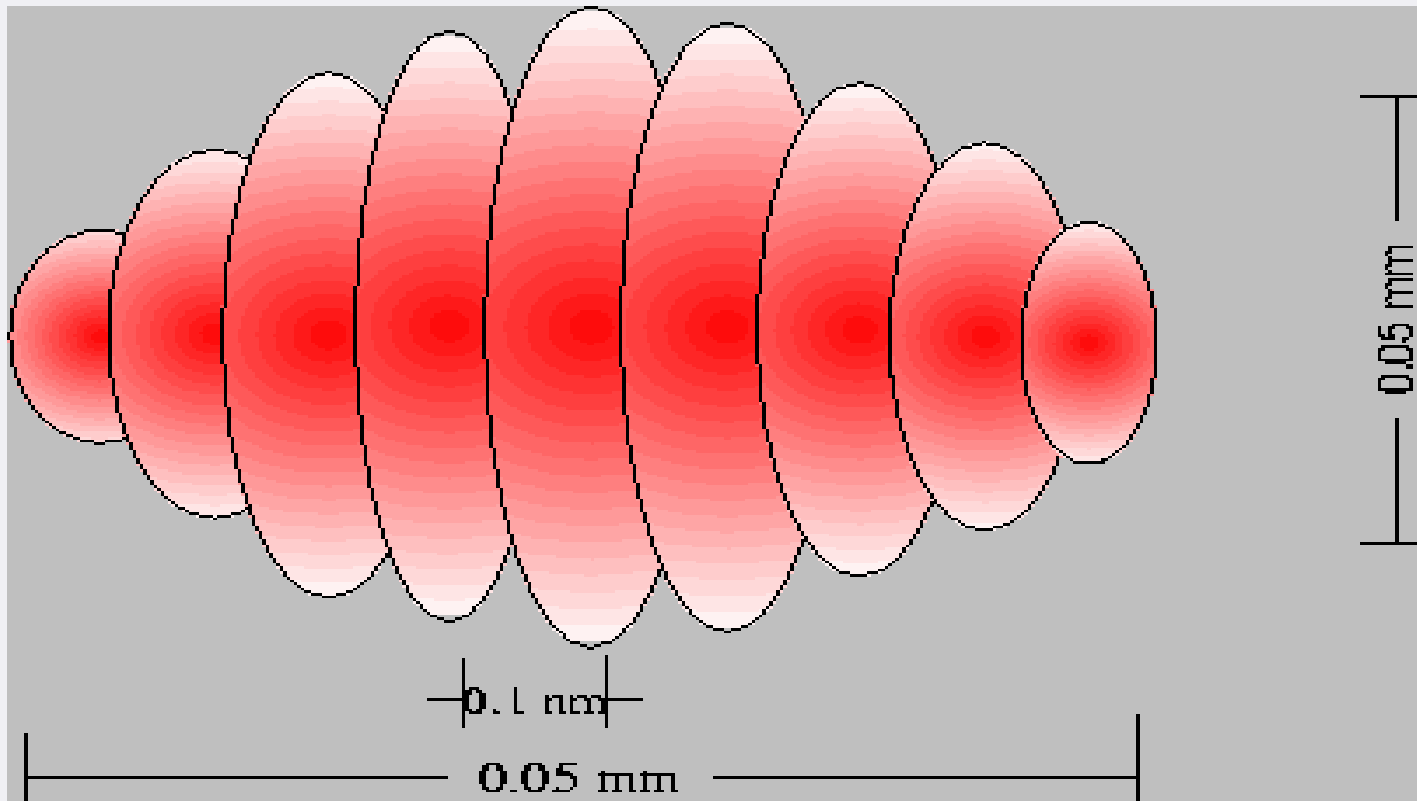
**Figure : Schematic Diagram of a Single-Pass Free Electron Laser (FEL) operating in the Self-Amplified-Spontaneous-Emission (SASE) mode.**



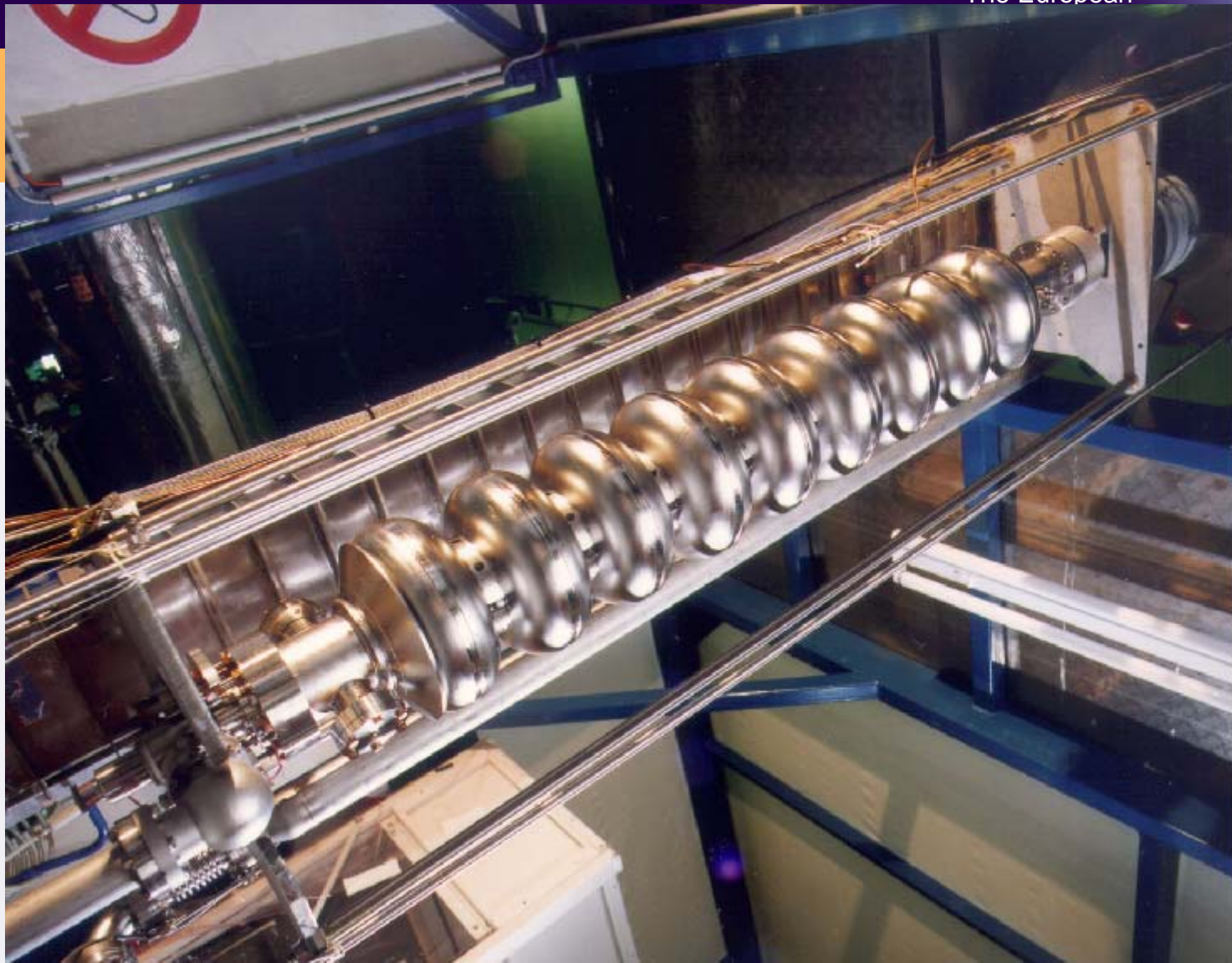
Radiation power on a logarithmic scale



After through the undulator, beam bund was modulated with very many of thin pieces dish.



**Figure 3: Schematic Diagram of the micro-bunching of the X-ray FEL electron beam engraved density-modulation. Note that in reality the number of slices is much larger.**



In Figer, this is an one meter long 9-cell super-conducting RF cavity (1.3GHz 10MW).



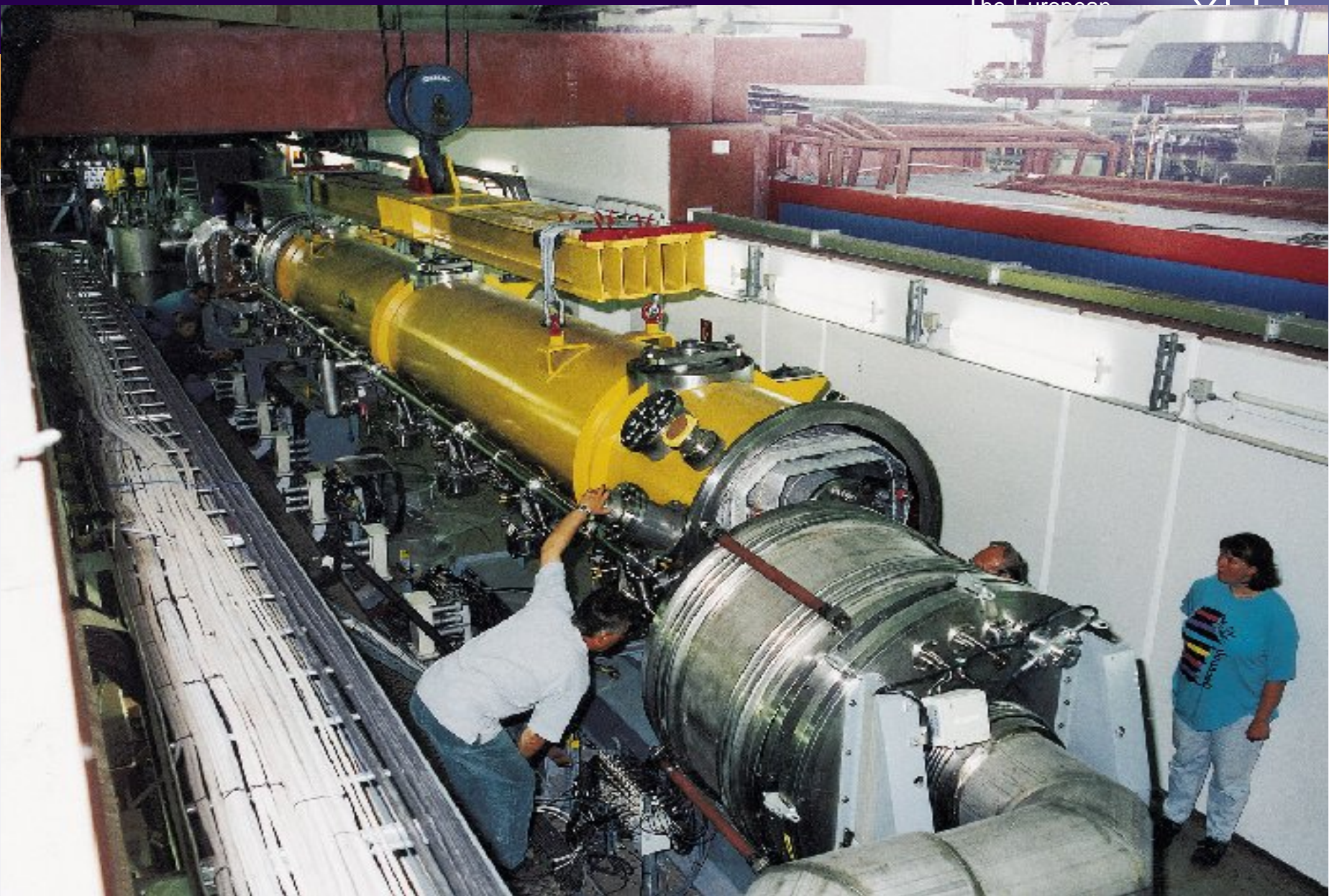
## Working in a clean-room

The TESLA superconducting accelerator structures are manufactured from purest niobium.

Matthias Clausen, DESY – MKS-2

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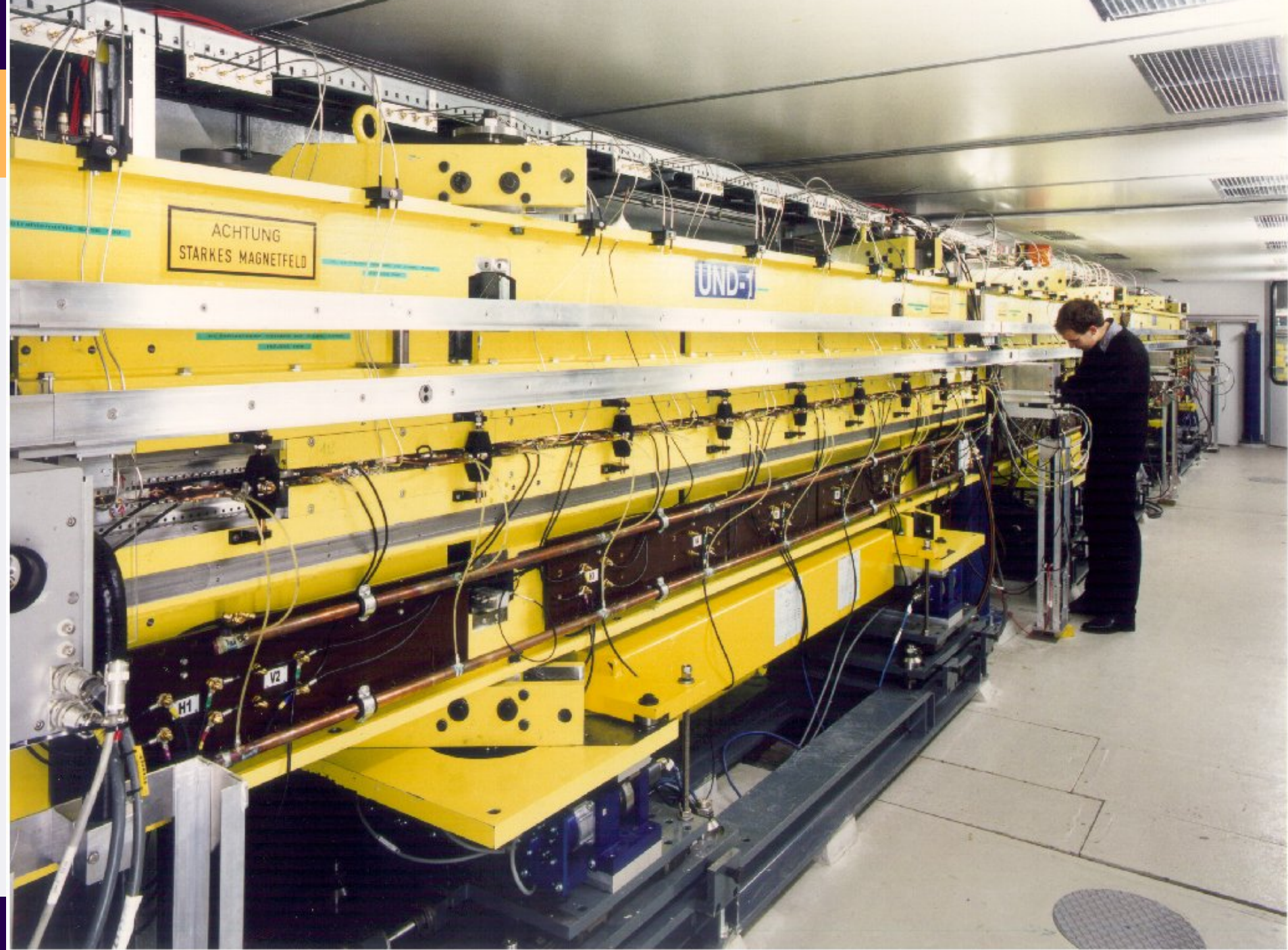




Instrumentation and assembly of an 17 meter long accelerator cryomodule

© Matthias Clausen, DESY, MKS-2 (XFEL cavities)  
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ACHTUNG  
STARKES MAGNETFELD

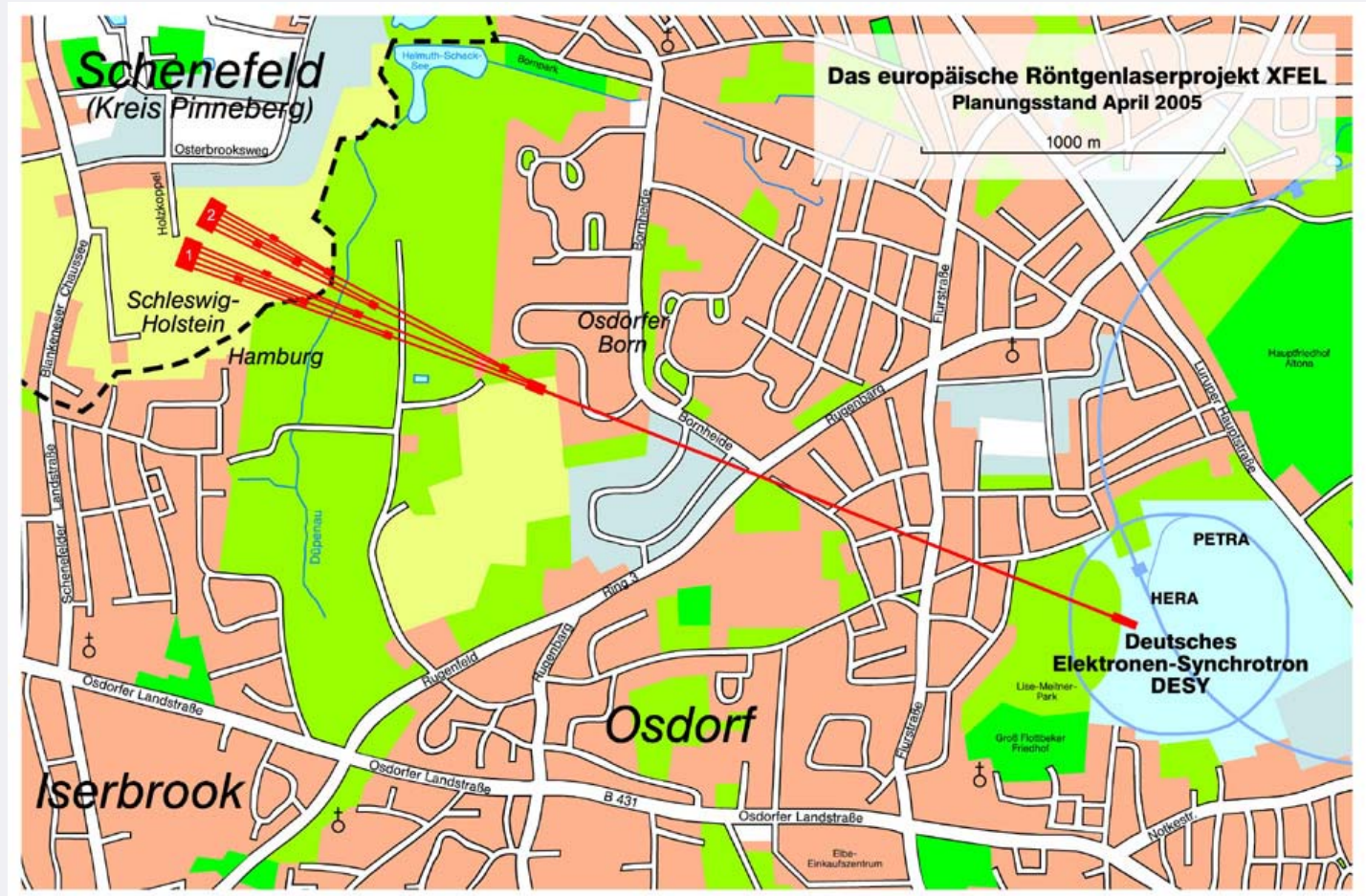
UND-7

H1

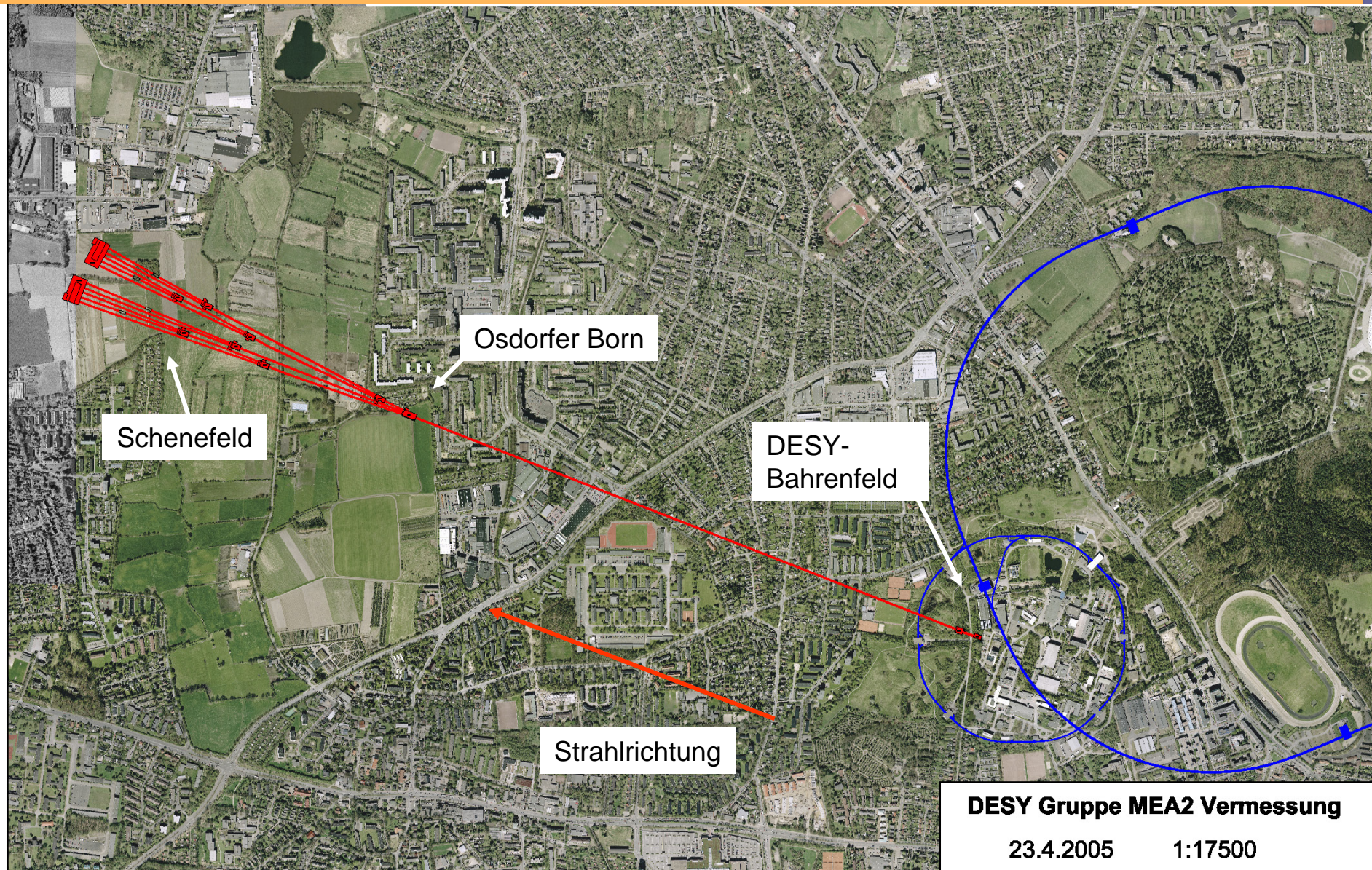
V2

# The new Project: **XFEL**

Übersicht technische Planung **XFEL** - Stand: April 2005



# XFEL-Anlage: 3 Betriebsgelände



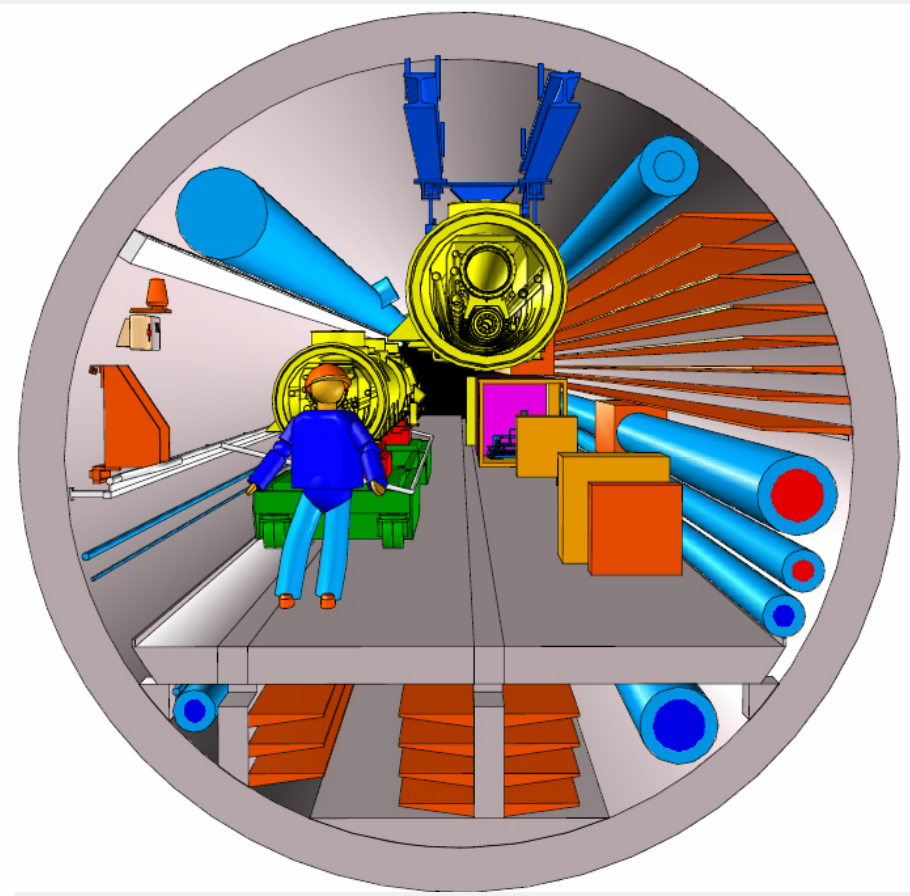
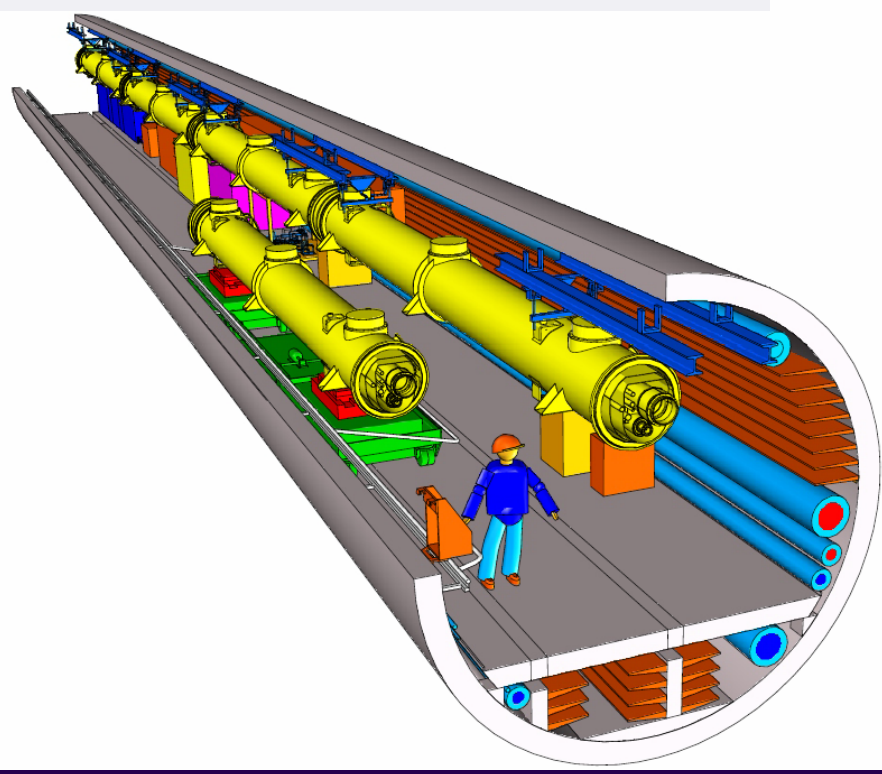




Fotomontage mit Architekturbeispiel für die neuen Hallen, Planungsstand April 2005, © DESY

# Beschleunigertunnel

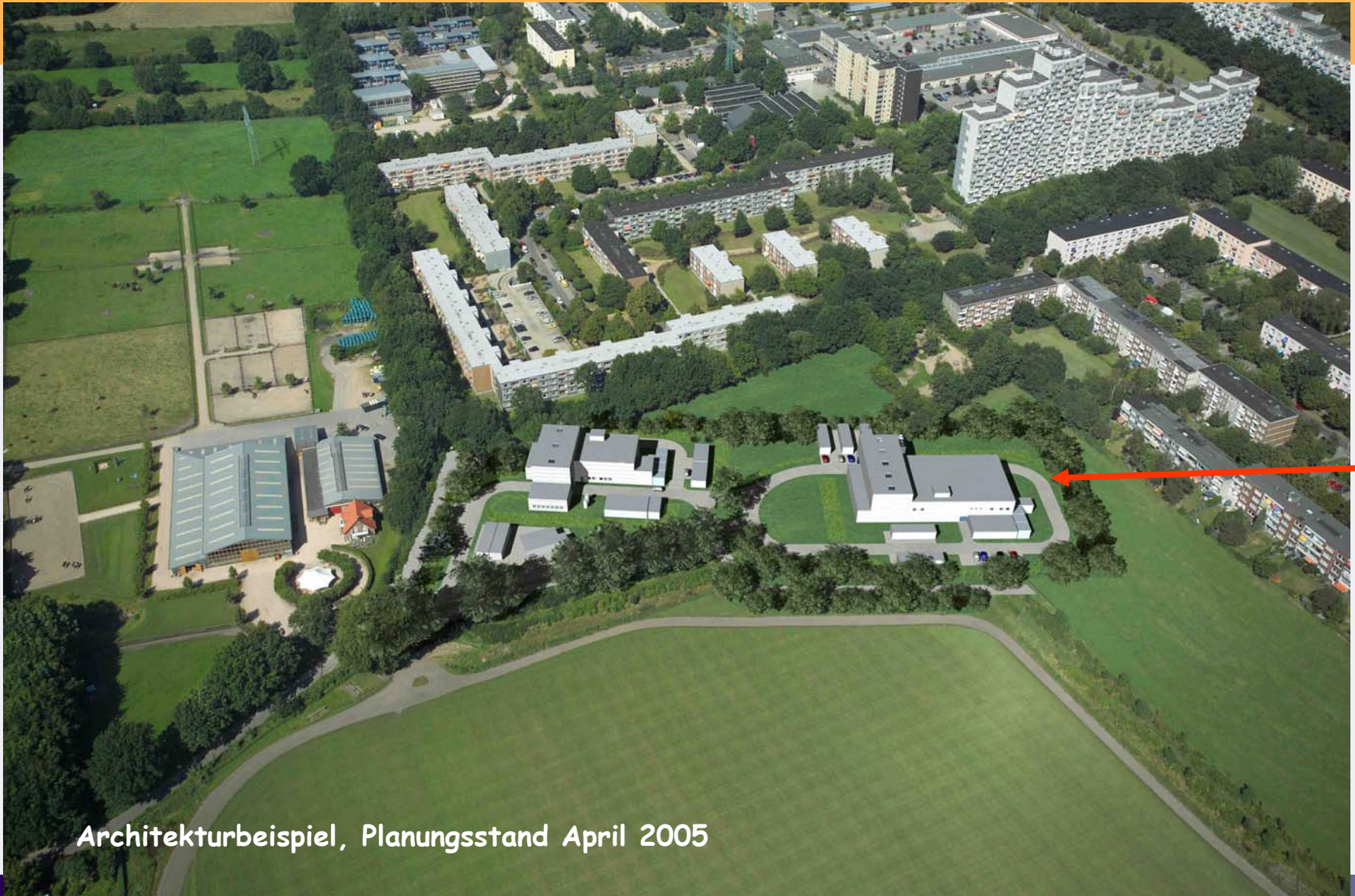
Innendurchmesser ca. 5,20 m



# XFEL-Betriebsgelände Osdorfer Born

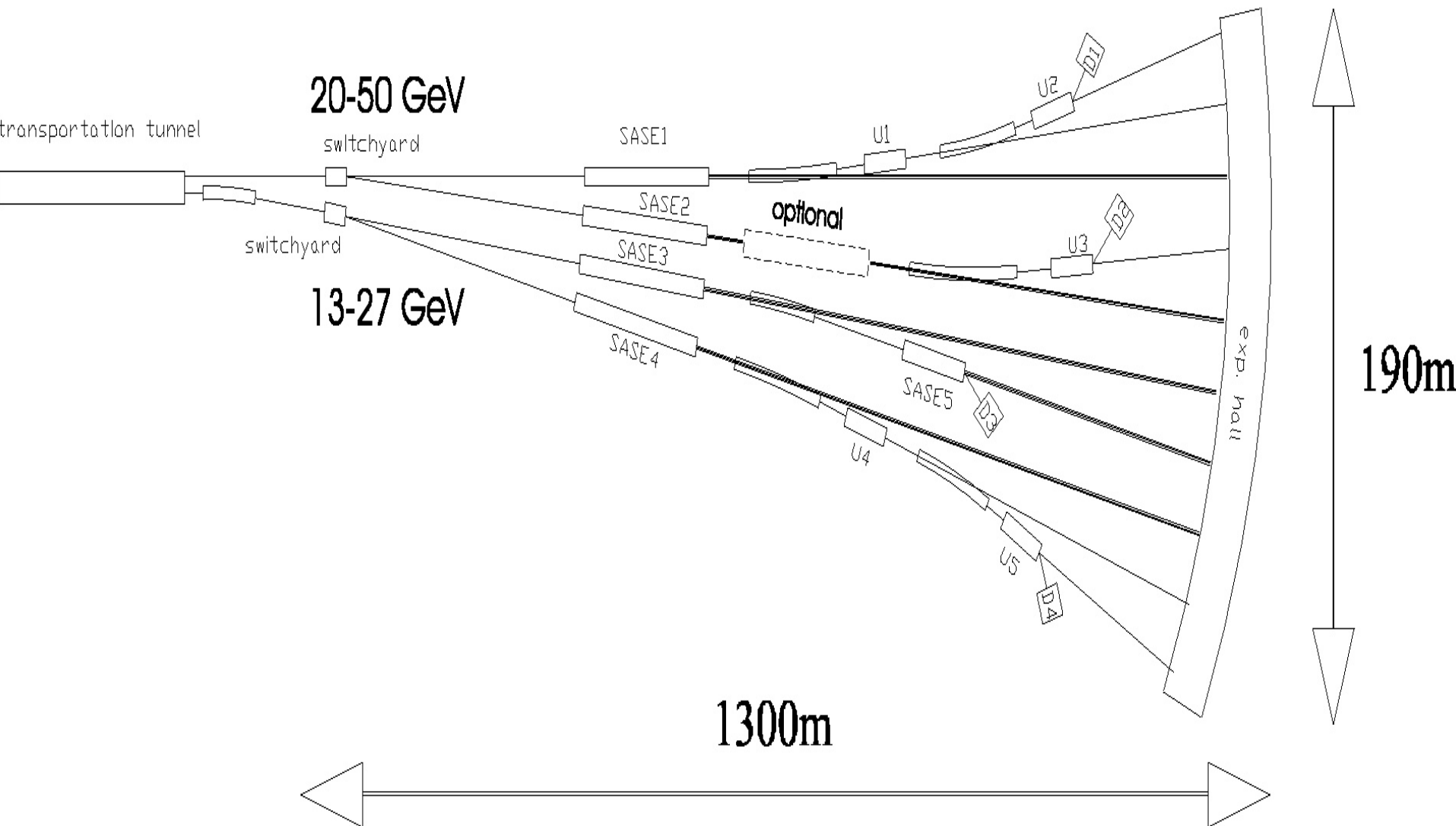


# XFEL-Betriebsgelände Osdorfer Born



Architekturbeispiel, Planungsstand April 2005

# XFEL scheme



Beam switchyard distributing two electron beam lines of different energies to various undulators. SASE1 through SASE5 are FEL undulators while U1 through U5 are undulators for spontaneous radiation.

The scheme sketched can be extended to serve many more undulators. It displays also the long drift lines necessary for the photon beams.

# XFEL-Betriebsgelände Schenefeld



# XFEL-Betriebsgelände Schenefeld



Architekturbeispiel, Planungsstand April 2005

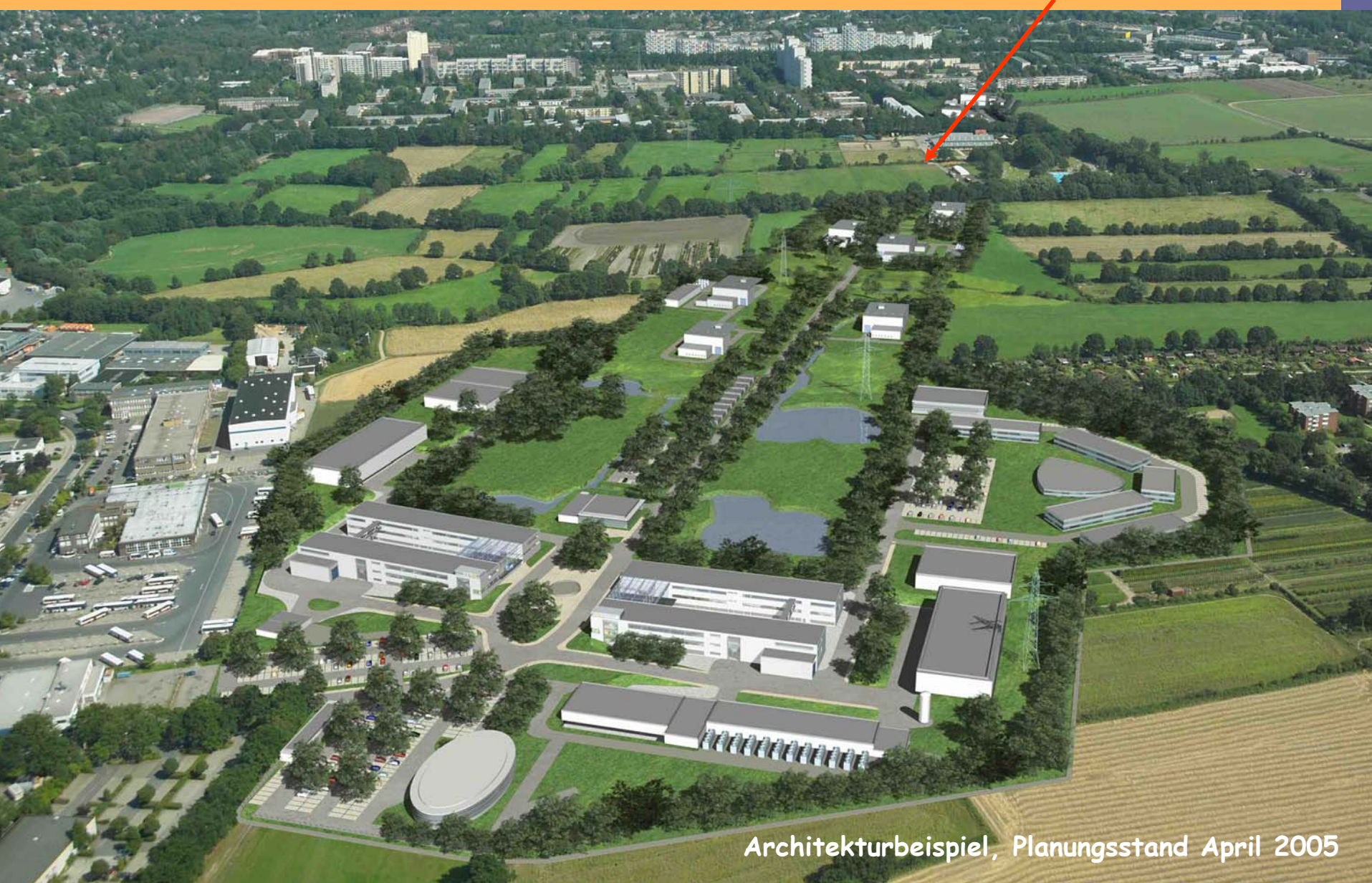
## XFEL-Betriebsgelände Schenefeld

Oberirdisches Hauptgebäude

Unterirdische Experimentierhalle







Architekturbeispiel, Planungsstand April 2005