DITANET

‹‹ novel **DI**agnostic **T**echniques for future particle **A**ccelerators:
A Marie Curie Initial Training **NET**work ››

Carsten P. Welsch
- On behalf of the DITANET Consortium -

MARIE CURIE ACTIONS

QUASAR GROUP

PEOPLE

Outline

- What is DITANET ?
- Network structure
- Research
- Training
- What does it mean to you ?

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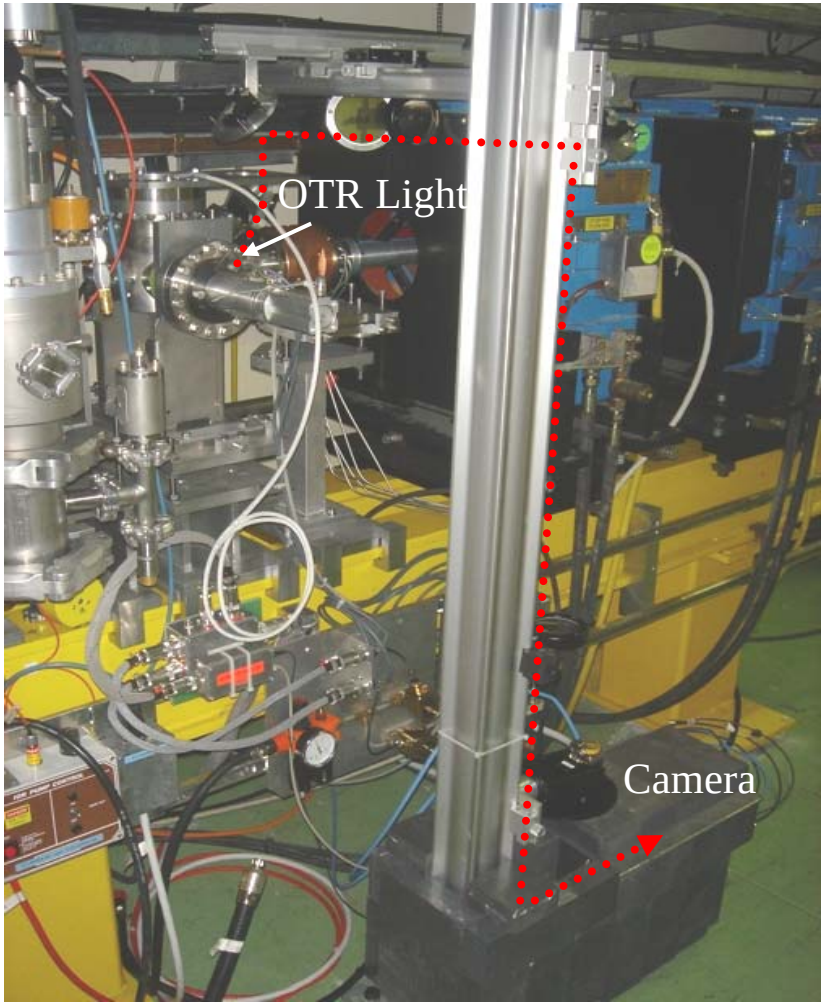
A „typical“ Monitor



- Material sciences
- Thermodynamics
- Electro-Magnetism
- Optics
- Mechanics
- Electronics
- Nuclear Physics
- …

⇨ Multi-disciplinary field !

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What is DITANET ?

- One of the largest Marie Curie Initial Training Networks ever funded by European Union !
- Funding for 20 fellows (17 ESR and 3 ER)
- Gives industry an important role !
- Allows for inter-sectorial collaboration !
- Recognized importance of beam diagnostics at European level !

(in physics top 12, 2007 – under extreme competition)

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The DITANET Consortium

Network Participants










Associated Partners












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Including Partners From Industry

Full Network Partner	Offer research training & **Recruit** eligible researchers	Level 1
Associated Partner	Provide research training, **complementary skills courses,** (communication, enterprise cycles, innovation, IPR, …) **secondments**	Level 2
	Member of the **Supervisory Board**: definition of skills requirements for targeted researchers	Level 3

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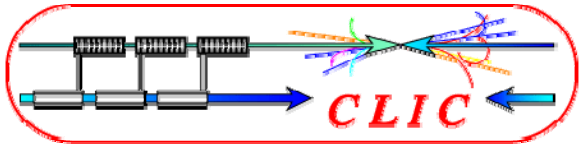
Examples from the Research Program

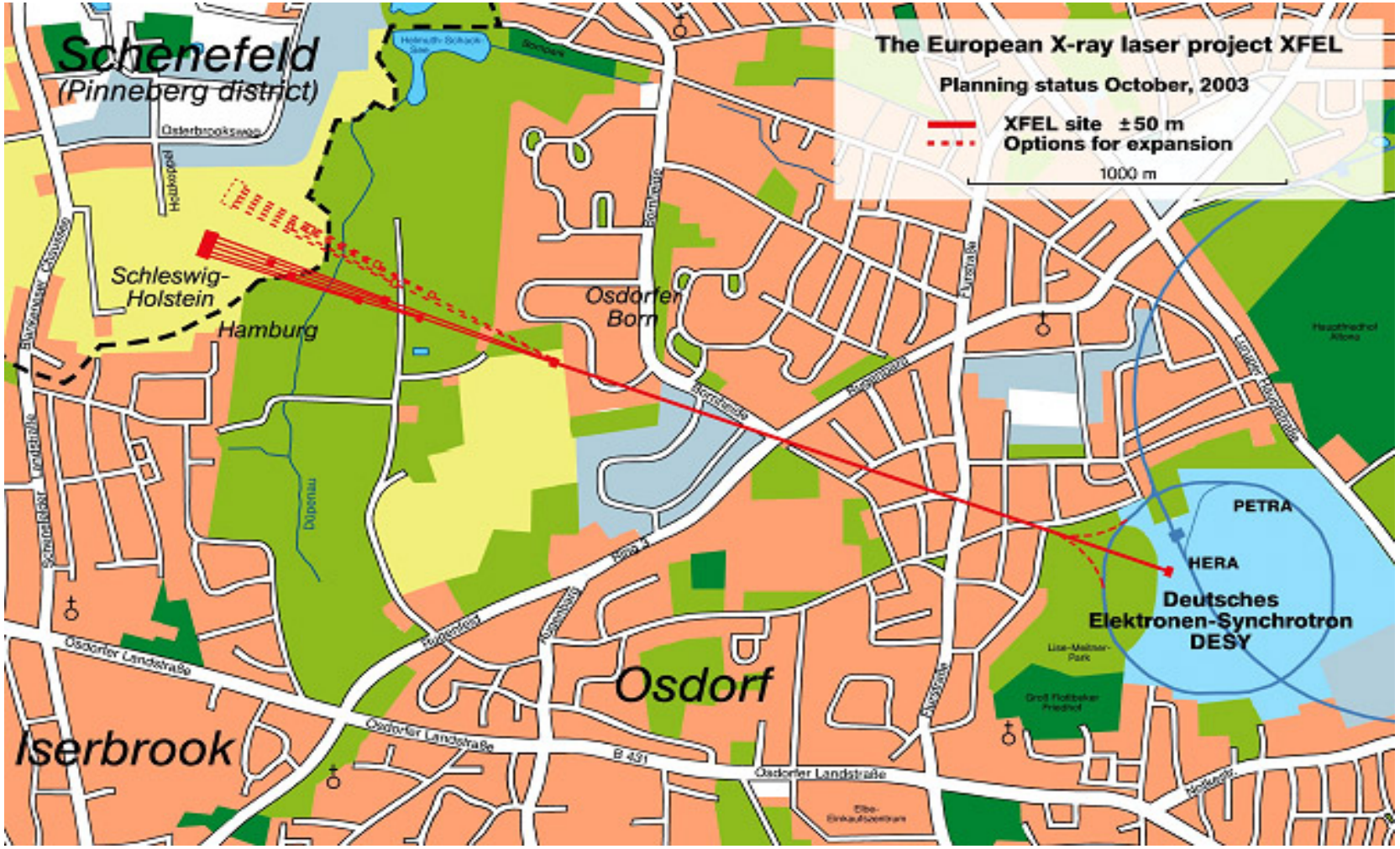
XFEL



CTF3

USR @ F(L)AIR

The XFEL Project



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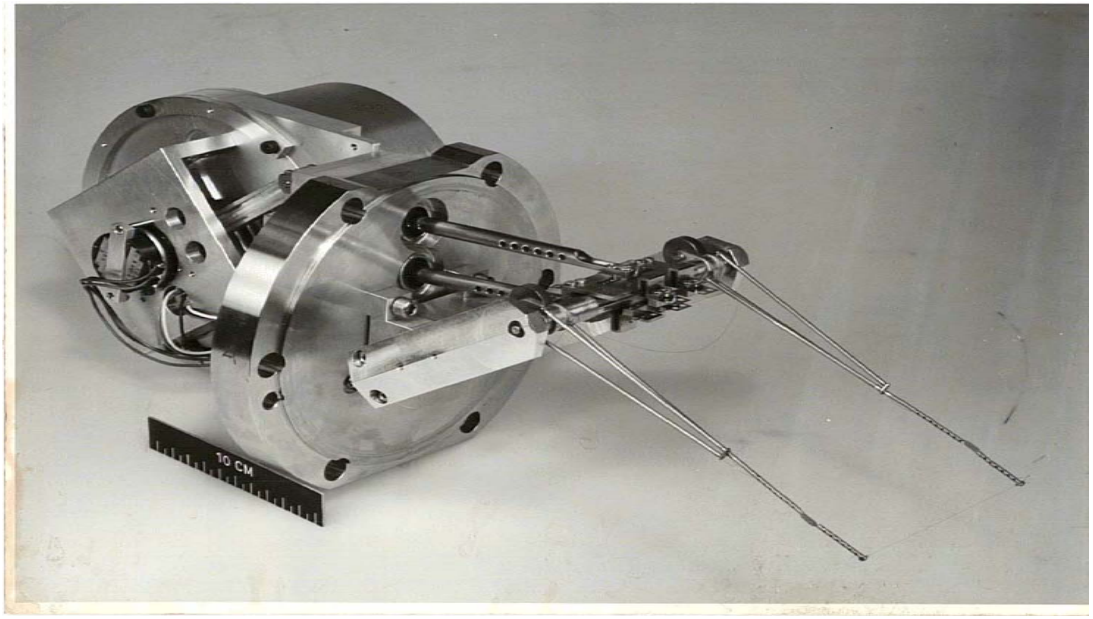
Wire Scanners

..established for measurements in accelerators.

Advantages:

- Resolution: 1 μm
- Reliable
- Direct



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Challenge: Heat Load on Wire

$$-\frac{dE}{dx} = \frac{4\pi}{m_e c^2} \cdot \frac{nz^2}{\beta^2} \cdot \left(\frac{e^2}{4\pi\varepsilon_0}\right)^2 \cdot \left[ln\left(\frac{2m_e c^2 \beta^2}{I \cdot (1-\beta^2)} - \beta^2\right)\right]$$

$$T = C \cdot \frac{dE}{dx} \cdot d' \cdot N \cdot \frac{1}{c_p \cdot G} \; [°C]$$

T_{max} ~ 2000°C

$$N = \frac{d' \cdot f_{rev}}{\nu} \cdot (NB \cdot n_{Bunch})$$

Required: Speed of 10-20 m/s with 1 μm resolution.

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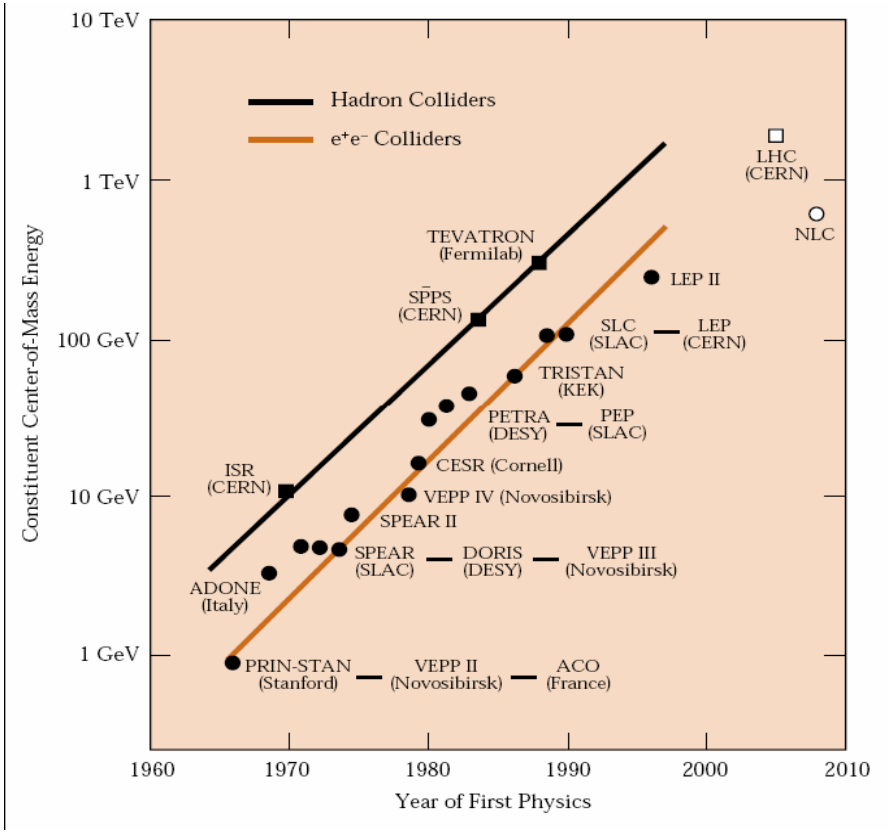
Why highest Energies ?

- Particle accelerators are indispensable tools to understand nature at smaller and smaller scales.
- Since the 70ies, most new revelations through colliders.



- Energy increase by Factor ten every 8 years !
- Hadron-Collider at the energy frontier.
- Lepton-Collider for precision physics.
- **LHC** start in 2008
- Consensus for a lepton collider with E_{cm} > 500 GeV to complement the LHC physics.

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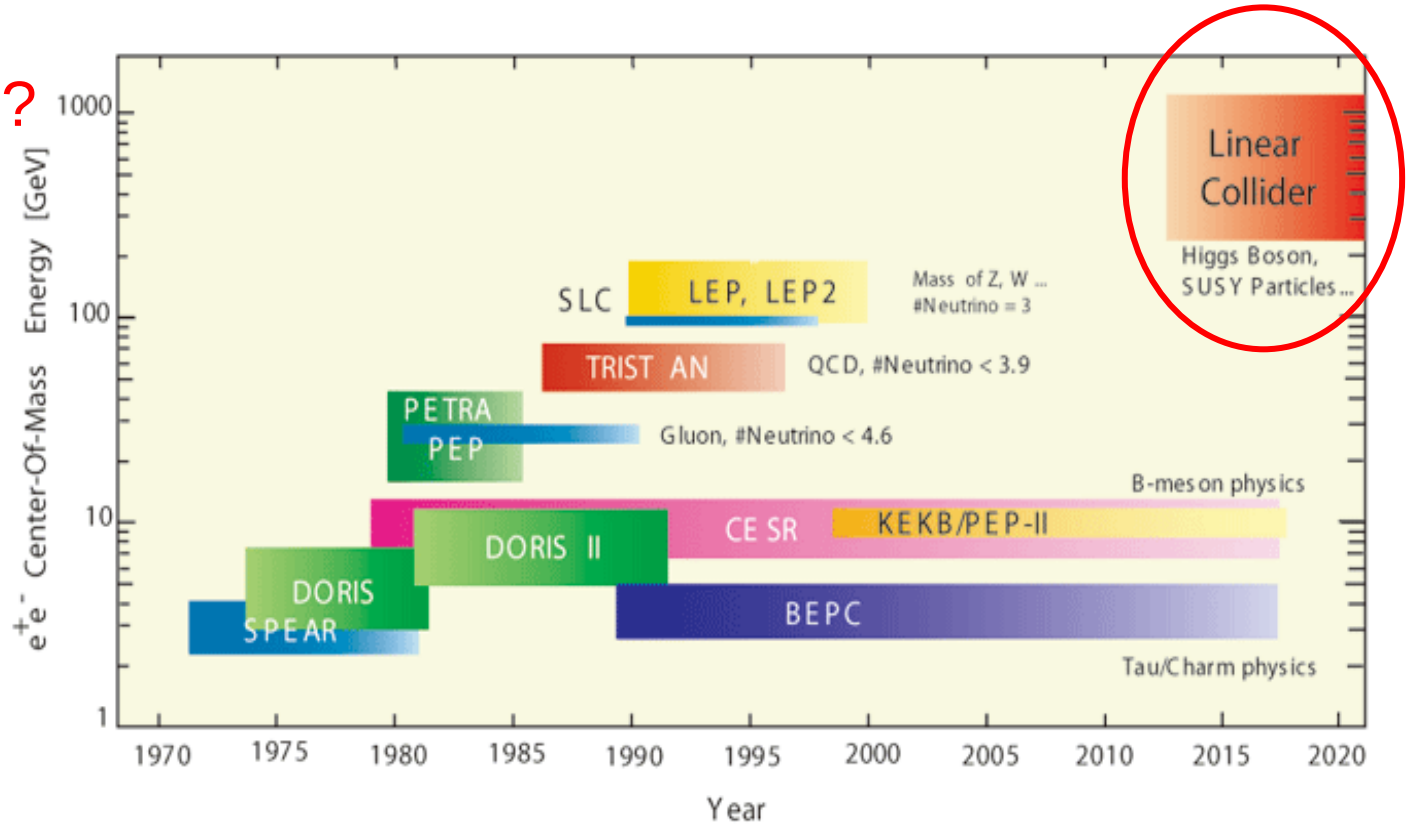
At the Energy Frontier

???



Wait for the LHC results (~ 2010).

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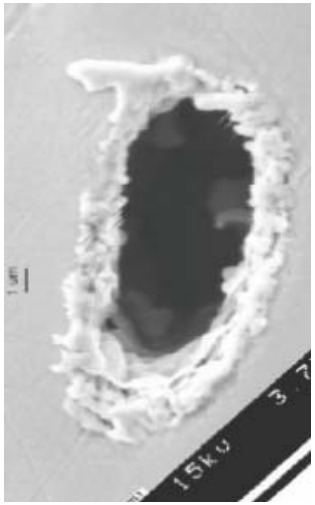
Linear Collider: Challenges

Measure very small beam size.

Linac: $\sigma \sim 1$ mm

Final Focus: $\sigma \sim 1$ nm (!)

High beam charge 10^9 / 10^{12} nC/cm^2.



Thermal limit for ‚best' materials is

(C, Be, SiC,…) ~ 10^6 nC/cm^2

New diagnostic concepts required !

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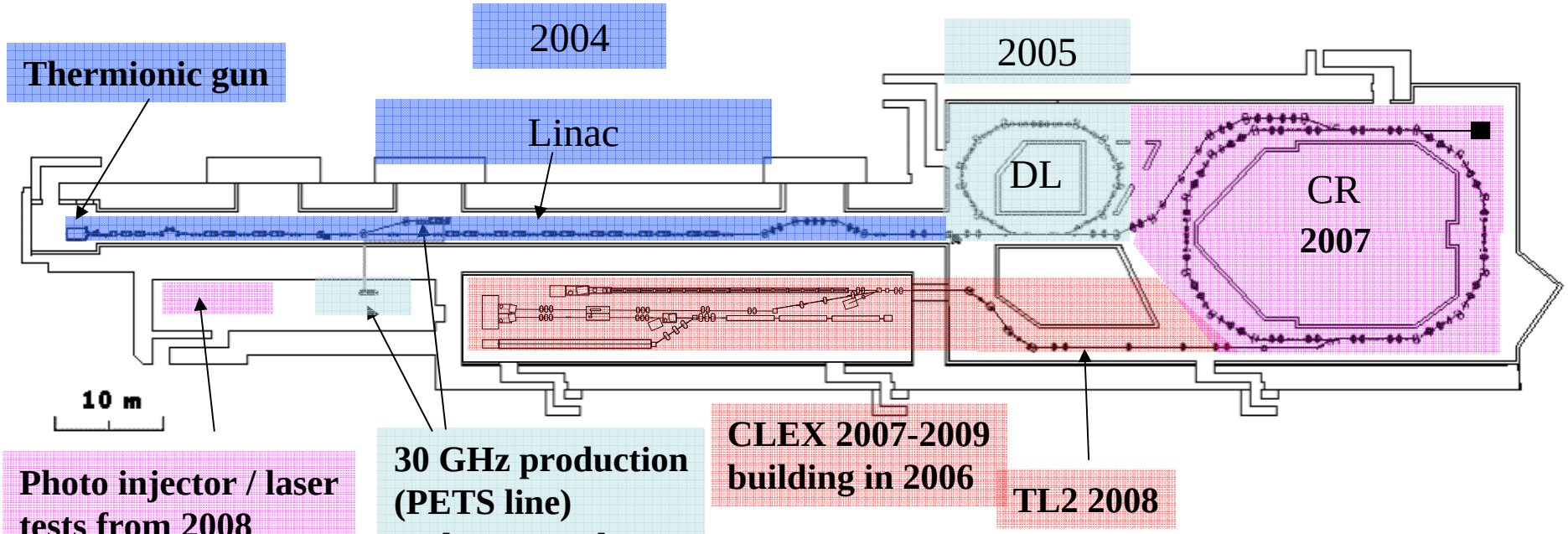
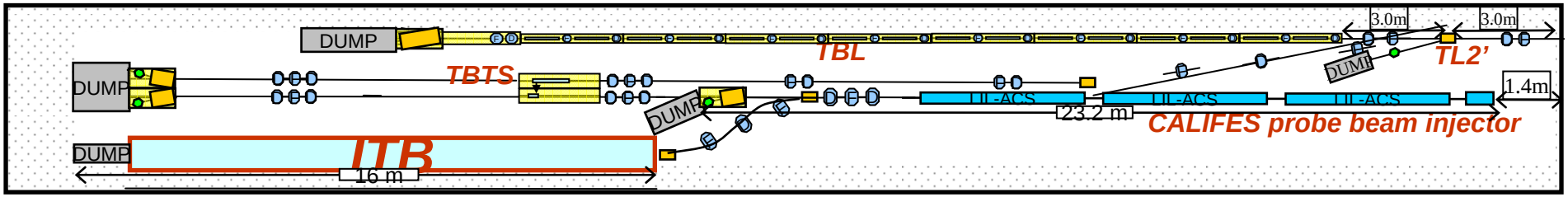
CTF3 - Overview





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CTF3: An Ideal Experimental Platform

- Time-resolved spectroscopy
- Beam Halo Monitoring
- Simulation of CDR; compare to measurements
- Beam position monitors
- ITB instrumention

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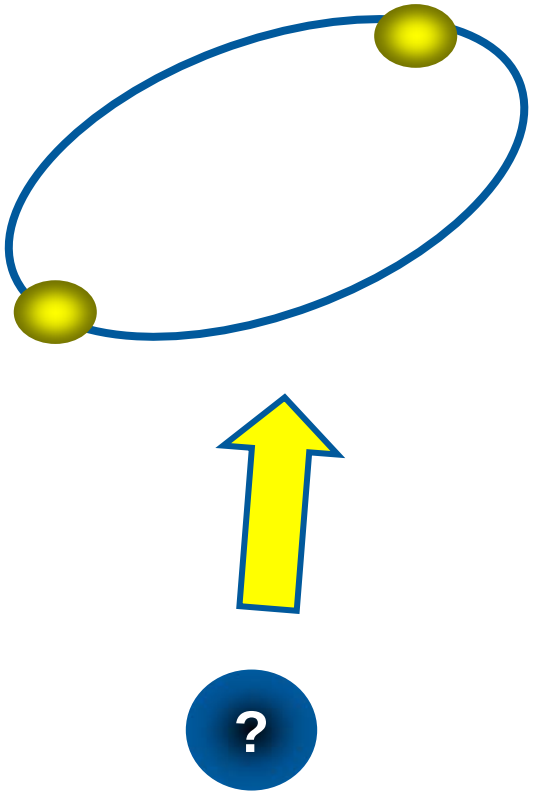
The task:

Few-body problem: Interaction with "clean" projectile.



<u>Important</u>:

- No (or only few) add. reaction channels,

- Possibility to control perturbation strength Z/v,

- Variation of interaction time between as => fs.

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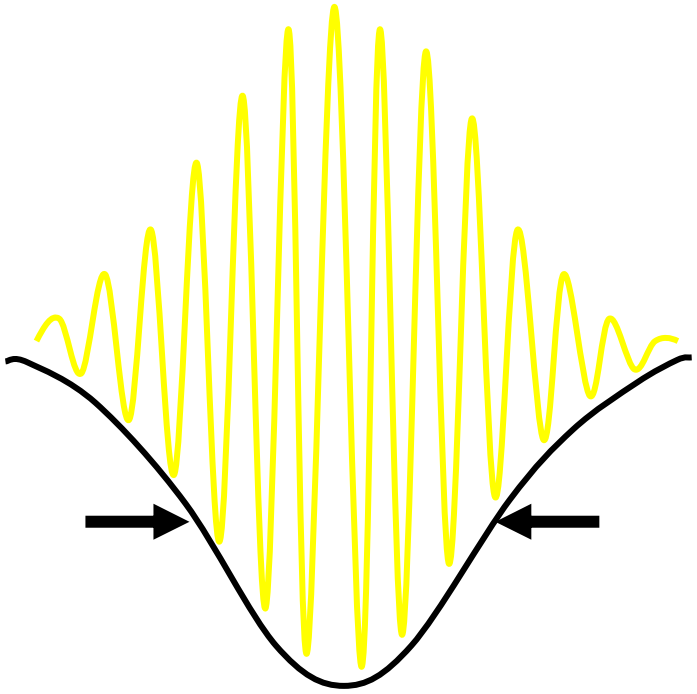
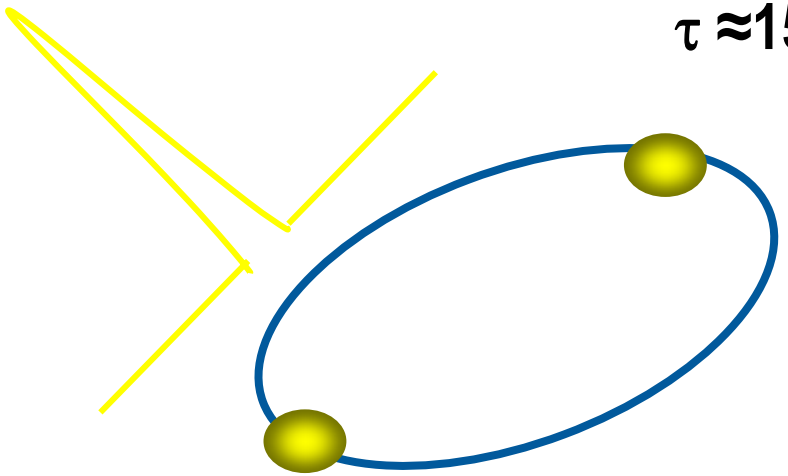
Why Antiprotons ?



$\tau \approx 150$ as



$t = 30 \ldots 6 \ldots 3.5$ fs

$I \geq 10^{15}$ W/cm^2

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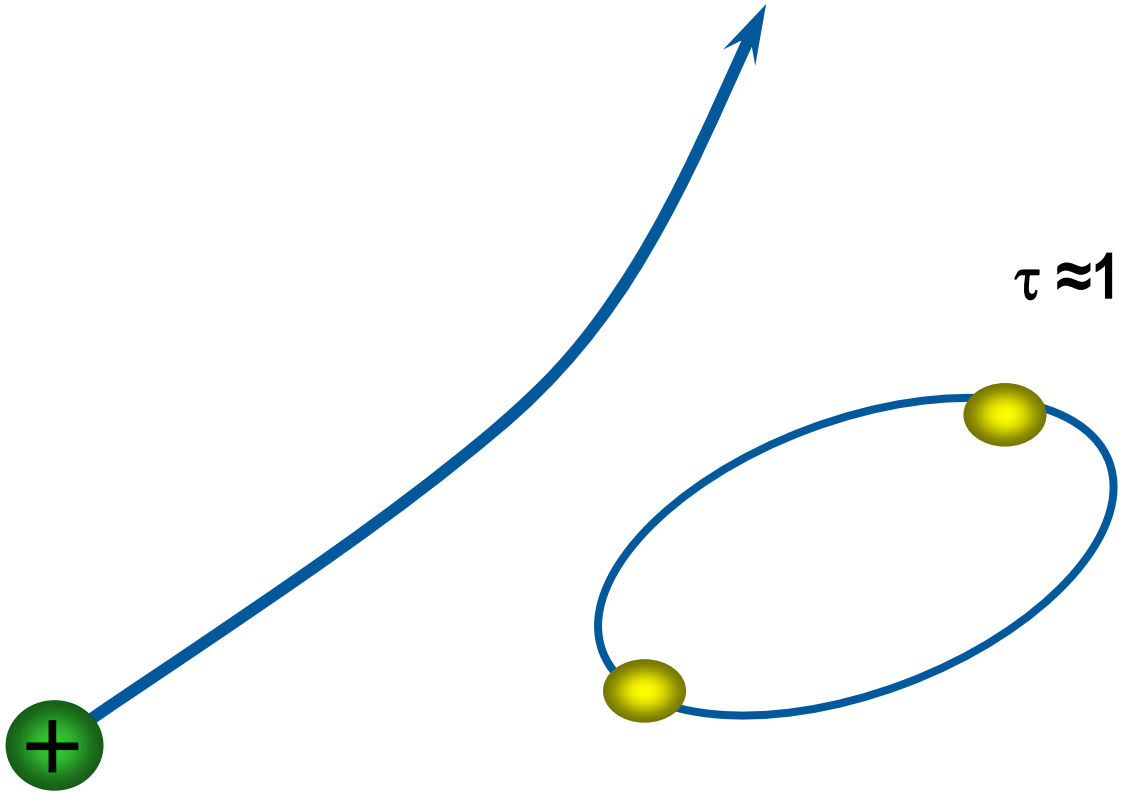
Why Antiprotons ?

Laser

Pos. Ions



$\tau \approx 150$ as

Dominated by capture !

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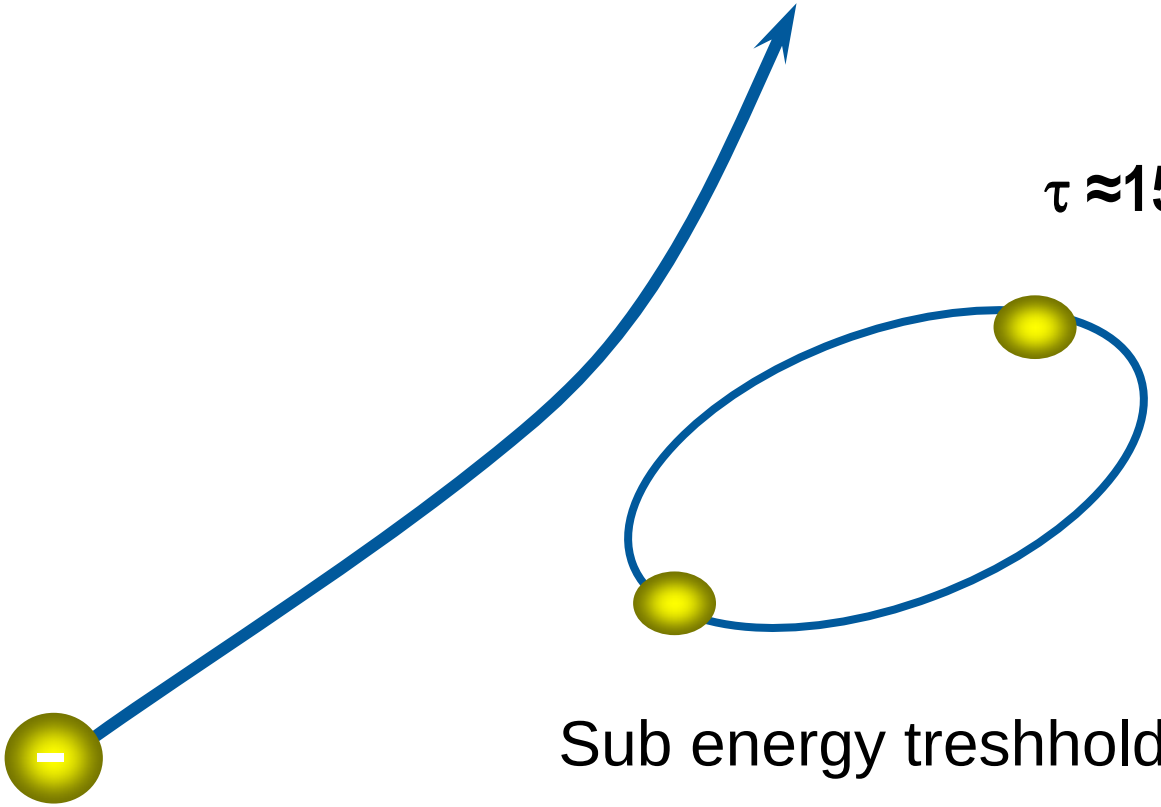
Why Antiprotons ?

Laser

Pos. Ions

Electrons



Sub energy treshhold !

Antiprotons !!!

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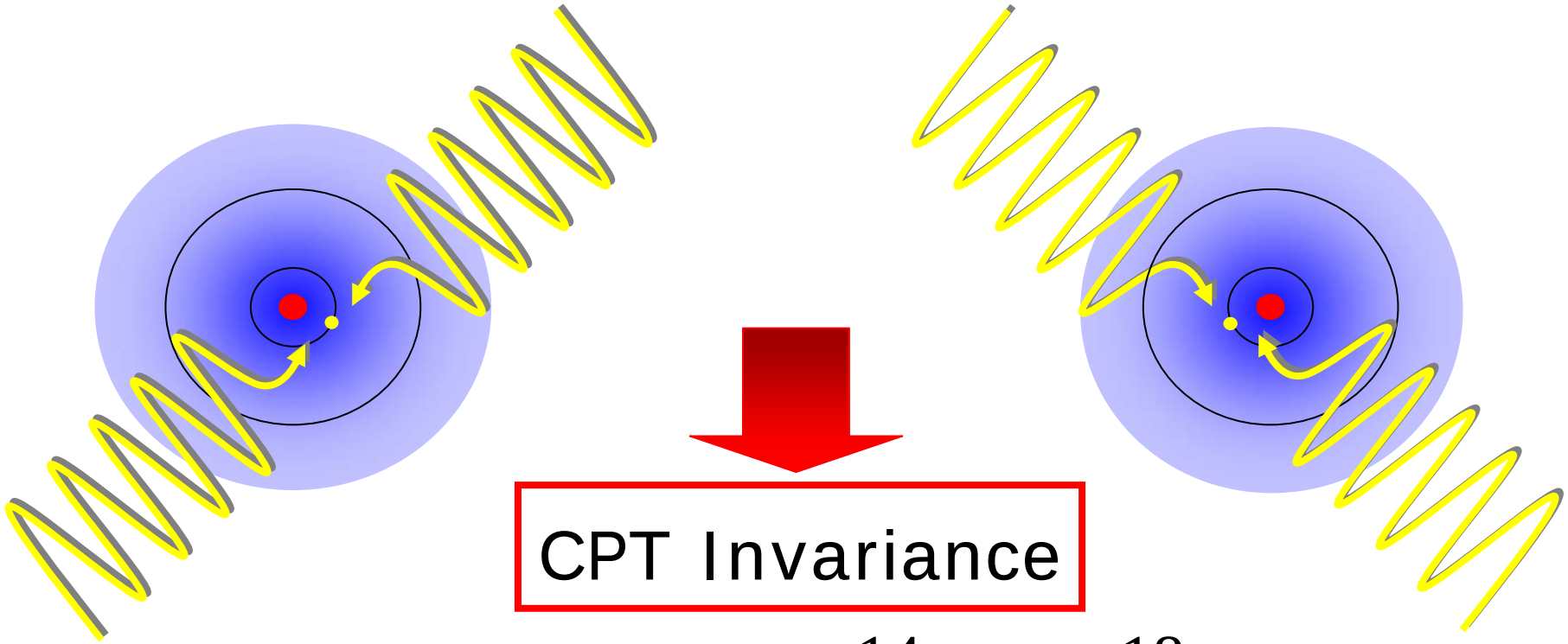
Same Structure ?

Hydrogen **Anti-Hydrogen**



CPT Invariance

$$\Delta E / E \approx 10^{-14} \ldots . 10^{-18}$$

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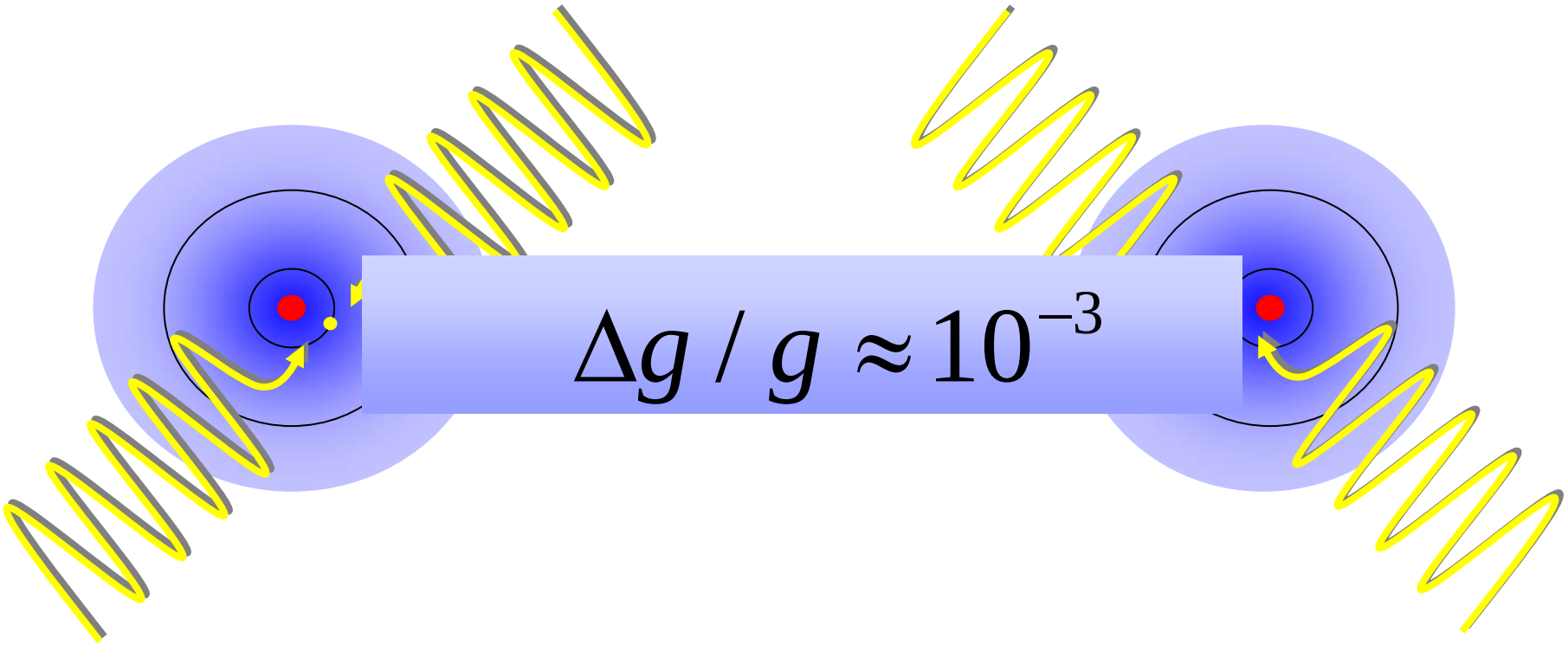
Same Weight ?

Hydrogen **Anti-Hydrogen**



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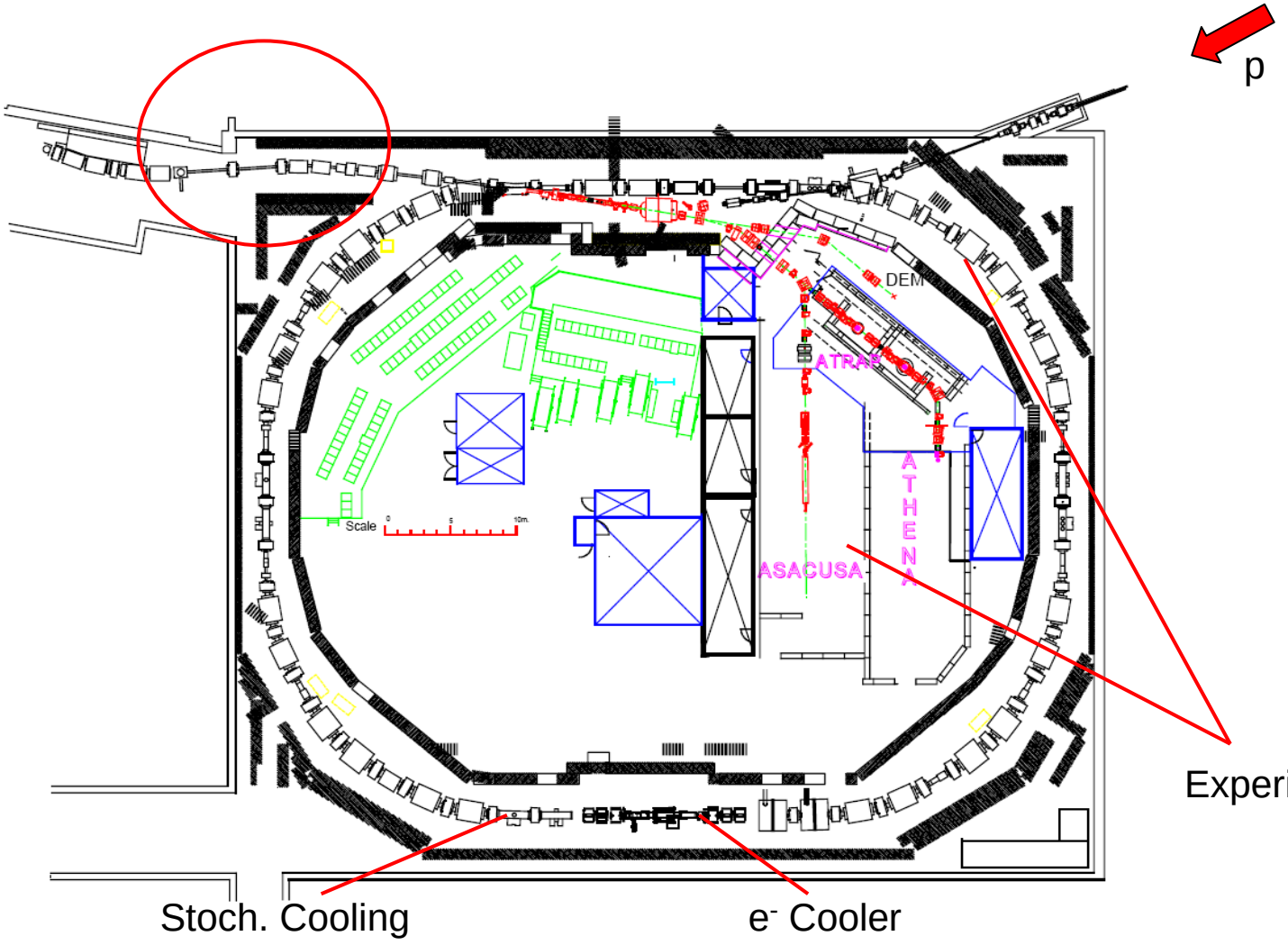
Present Situation: AD @ CERN

Target

26 GeV/c p
➡ 3.57 GeV/c p^-

Yield: $4 \cdot 10^{-6}$



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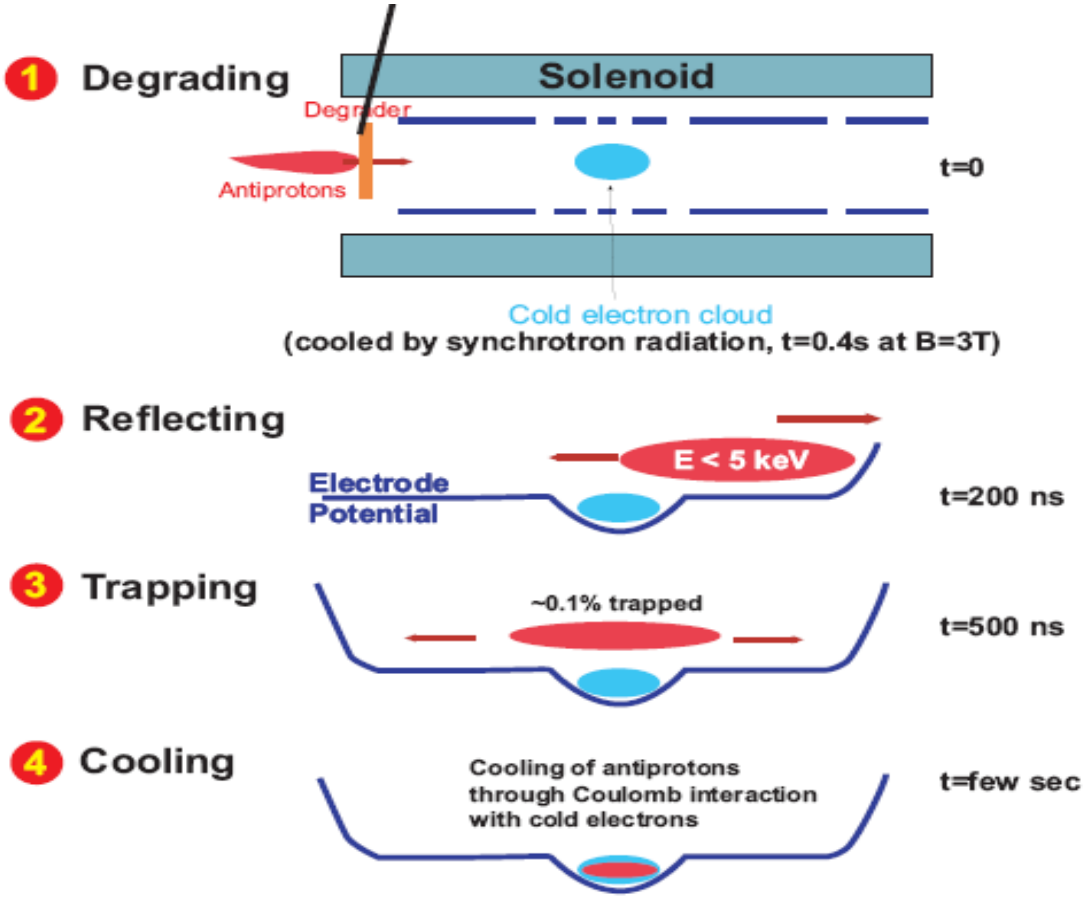
Problem: 5 MeV too high for trapping !



- > 99.9 % of pbars lost in degrader.

  ~ 10.000 pbars/shot

- ASACUSA: RFQ-D

  ~ 2.000.000 pbars/shot

<u>BUT</u>: $\Delta E/E$, $\varepsilon_{x,y}$

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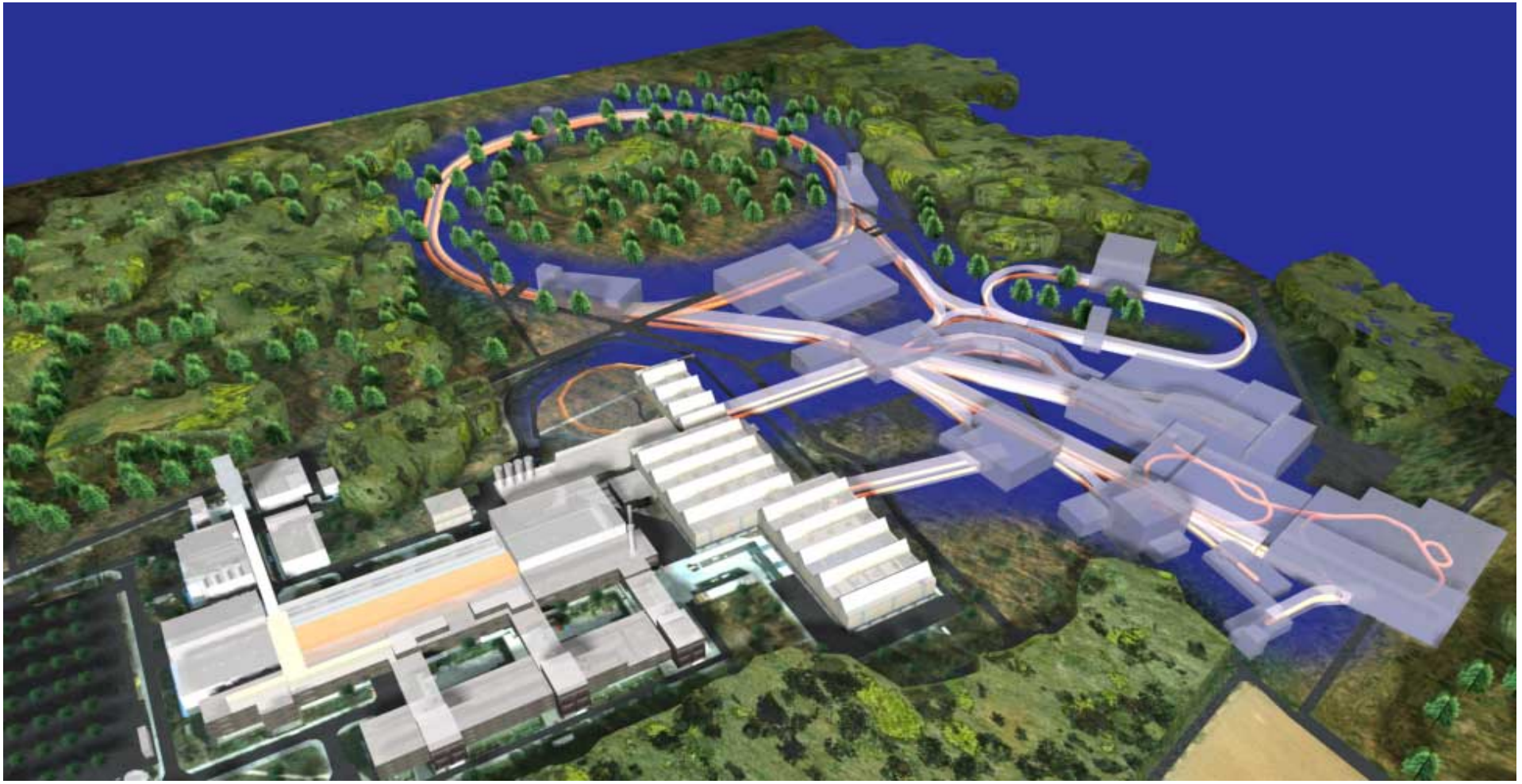
FAIR – Facility for Antiproton and Ion Research



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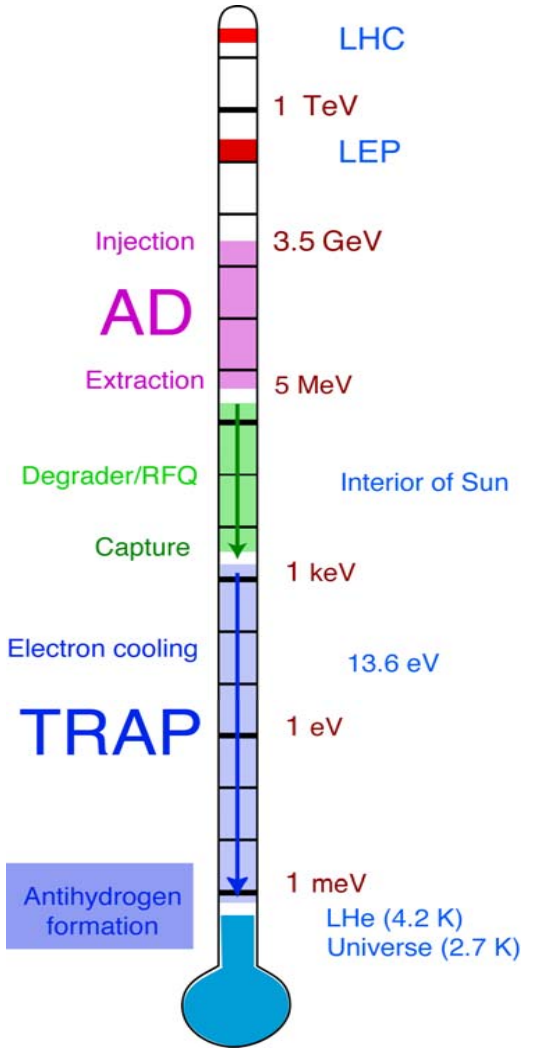
Challenges

Antiprotons and Positrons are created at very high energies (GeV).

H-atom is a weakly-bound system:

E (1s) = - 0.000 000 013 6 GeV

Deceleration & Cooling necessary !



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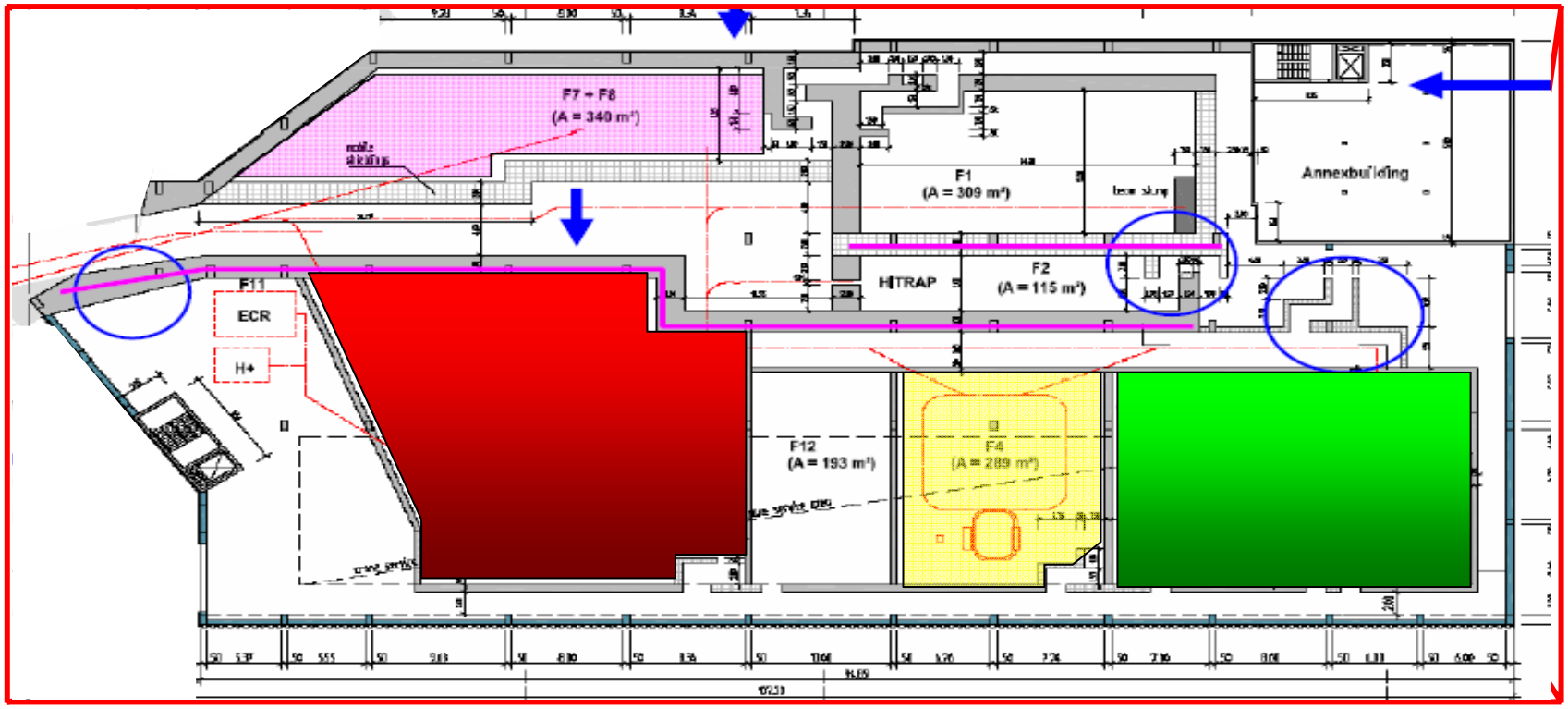
FLAIR @ Facility for Antiproton and Ion Research



30 MeV - 300 keV

300 keV - 20 keV

keV - ... eV

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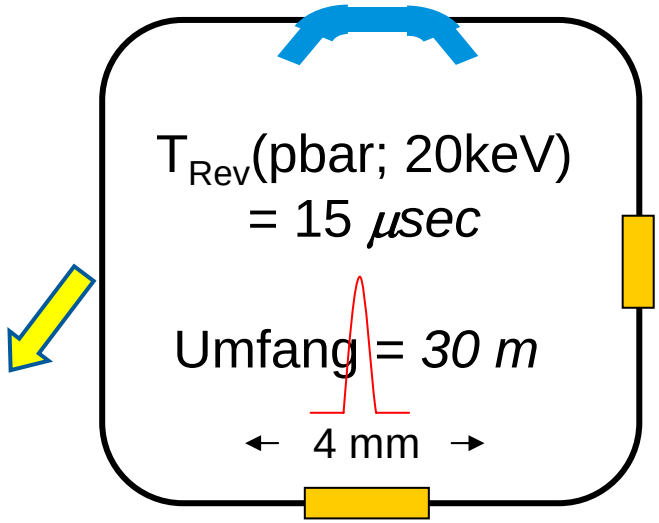
USR - Goals

- Variable to lowest energies
  - 300 keV ~ 20 keV
- High luminosity for in-ring experiments
- Well-defined extracted beams:
  - Small emittance
  - Small momentum spread
- Multi-user operation:
  - 2 straight sections for in-ring experiments
  - Slow and fast extraction
  - Additional beam lines possible
- Central requirements
  - $\Delta t \sim 500$ nsec for Injection in traps
  - $\Delta t \sim$ 2 nsec / 10^4 ions for collision studies



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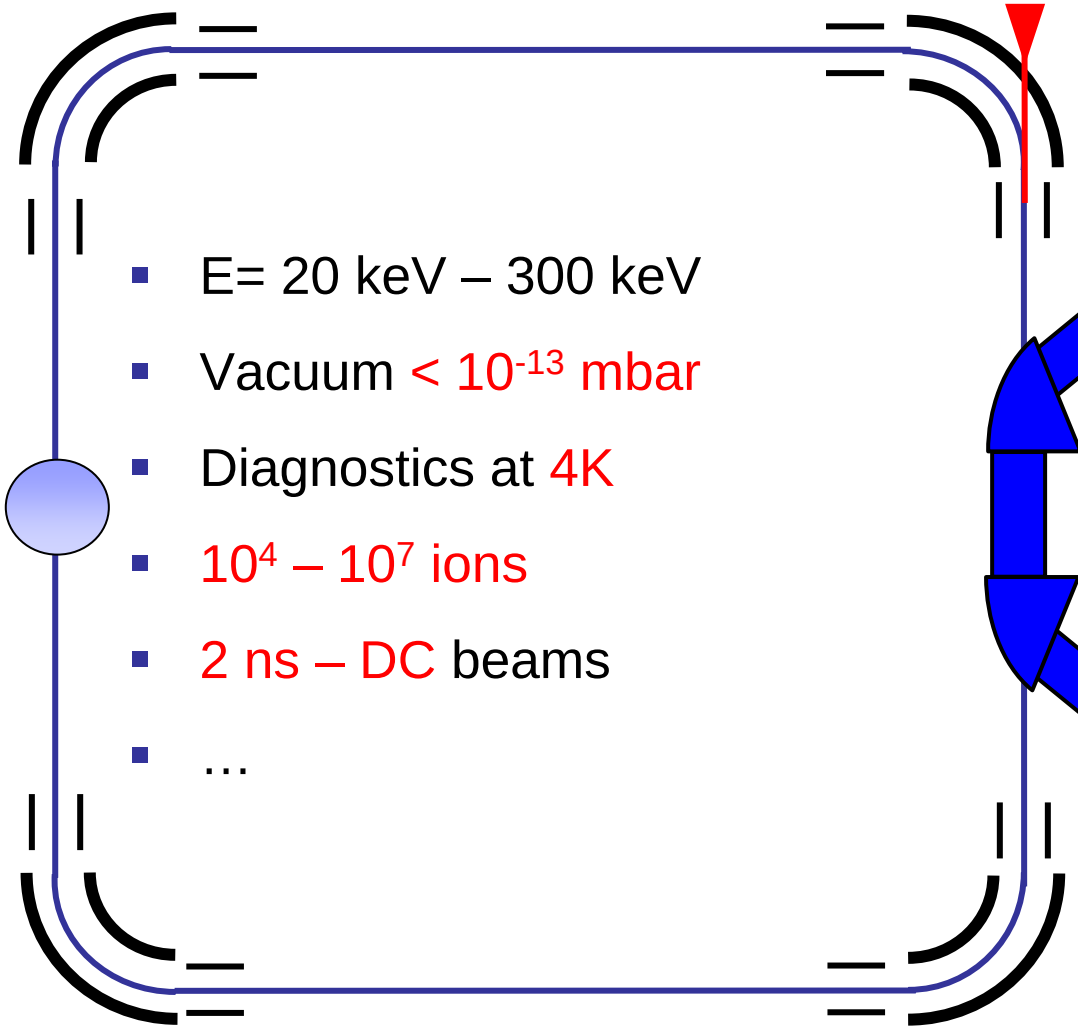
USR - Challenges



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Training

- Local training by host
- Network-wide schools on diagnostic techniques
- Inter-network exchange of researchers
- Secondments to partners from industry
- Training in complementary skills

⇨ Motivation: Find the *ideal* Training.

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Outreach

- DITANET schools in 03/2009 (London) and 09/2010 (Stockholm)
- DITANET conferences in 2009 and 2011 (DIPAC ?!)
- Mini-Symposia, workshops throughout 4 years

Open to external participants.

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What DITANET means to you

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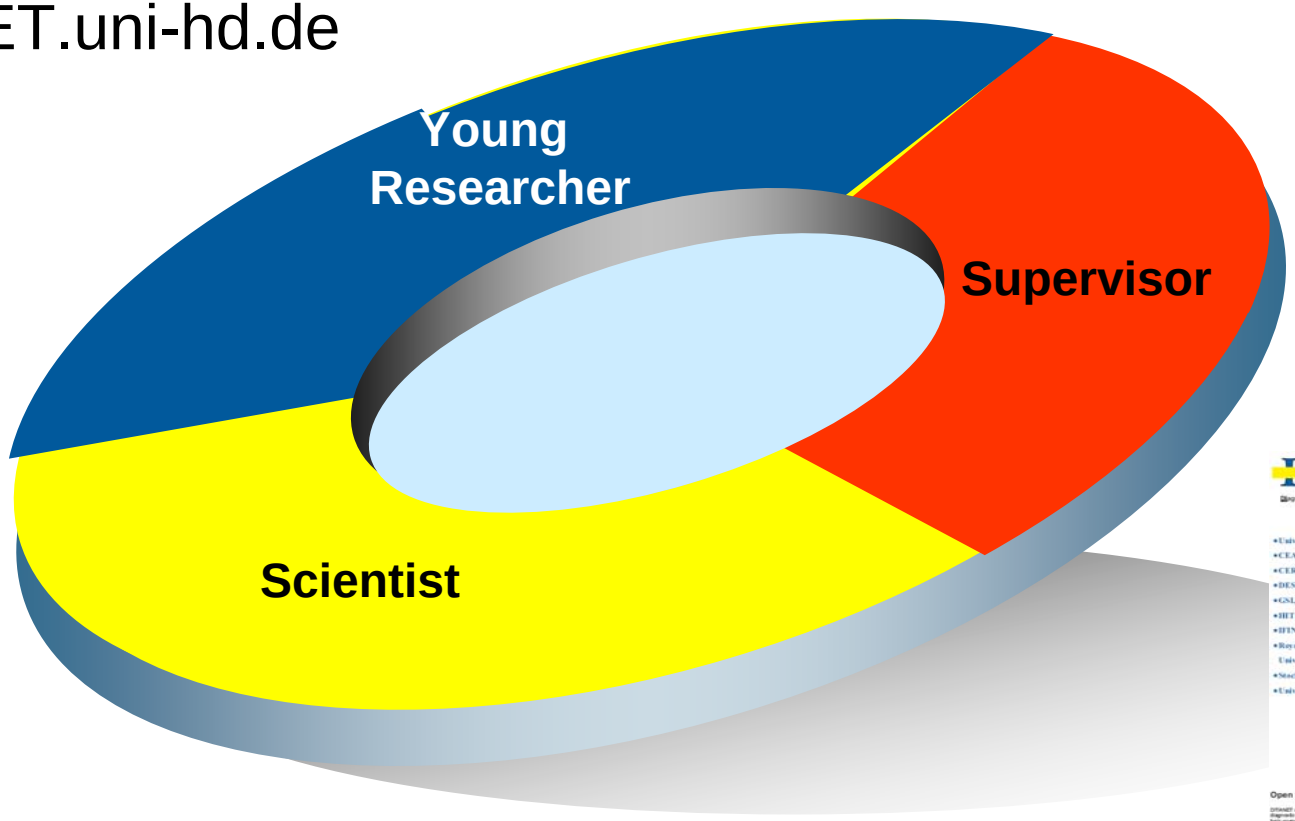

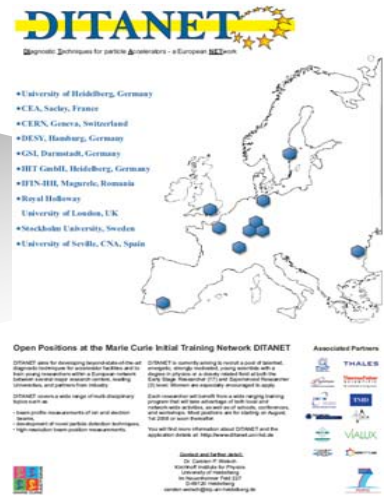

Join in !

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Conclusion

- Unique opportunity to push our field;
- Developments through joint effort between research centers, Universities and the private sector;
- Innovative approach to training of young researchers;
- Many events interesting for whole community;
- Stimulation of research careers in beam diagnostics.

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