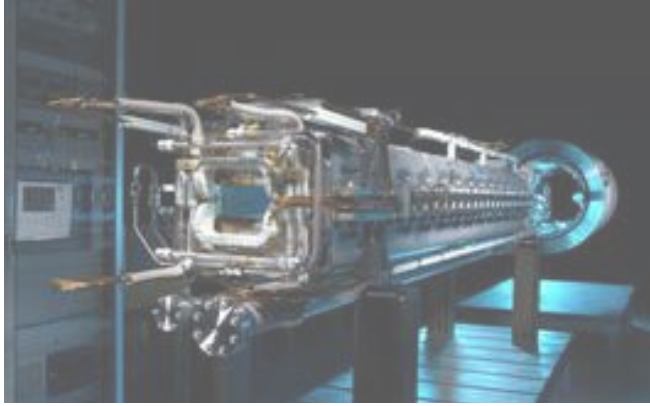




FAIR in Progress

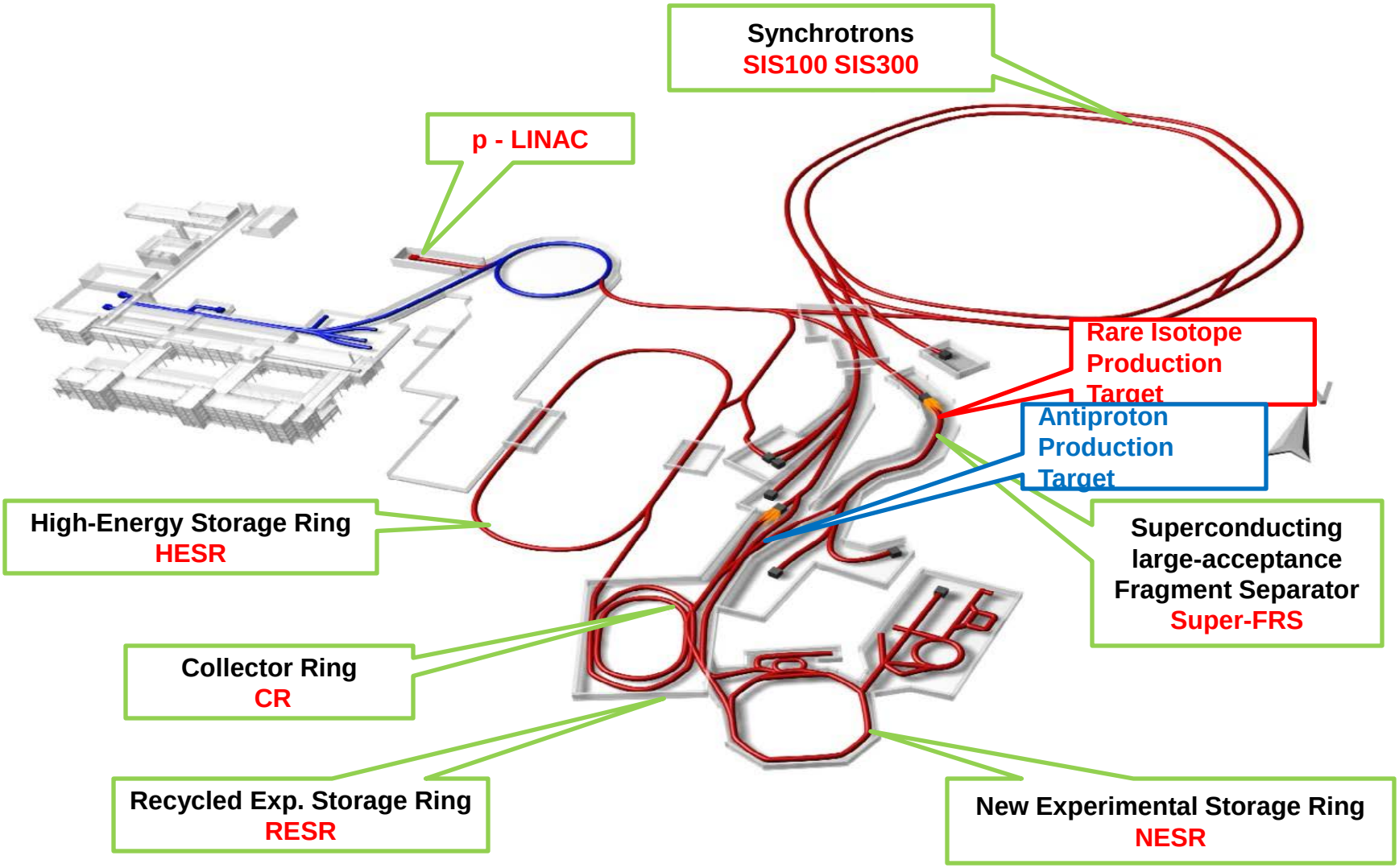
Boris Sharkov

Scientific Director,
Chairman of the Management Board

Finland France Germany India Poland Romania Russia Slovenia Spain Sweden

FAIR

New, worldwide unique accelerator system *entered* construction phase



International FAIR – global dimension

FAIR is building a research infrastructure with a specific focus on international and interdisciplinary collaboration:

~3 000 users from ~50 countries

FAIR Project – an international platform for coordination of efforts, sharing best practices, in order to define research priorities and **maximise** scientific impact

Germany	
Russia	
Finland	
France	
India	
Poland	
Romania	
Slovenia	
Sweden	
UK (associated)	

FAIR Signatory Countries

FAIR – new international research laboratory to explore the nature of matter in the Universe

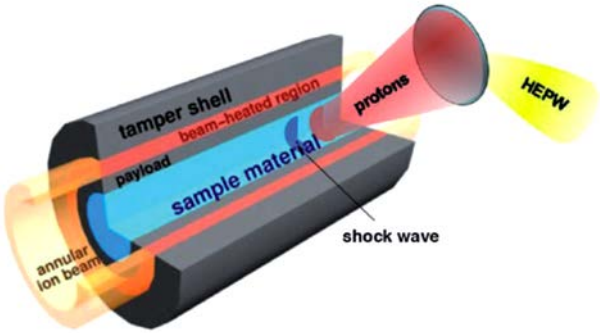
Scientific Pillars:

- **APPA:** Atomic Physics, **Plasma Physics**, Applic.
- **CBM:** Compresed Baryonic Matter
- **NuSTAR:** Nucl. Structure & Astrophysics
- **PANDA:** Hadron Structure & Dynamics

In total: 2500 – 3000 Users

The Modularized Start Version should enable realization of outstanding forefront research program to all four scientific communities of FAIR

FAIR Experimente



APPA

CBM

PANDA

Super-FRS

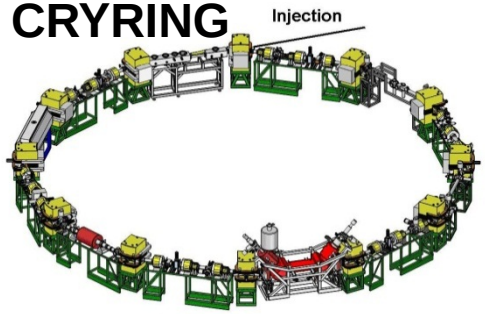
NuSTAR

Construction scenario: to start research activities at the “day one”

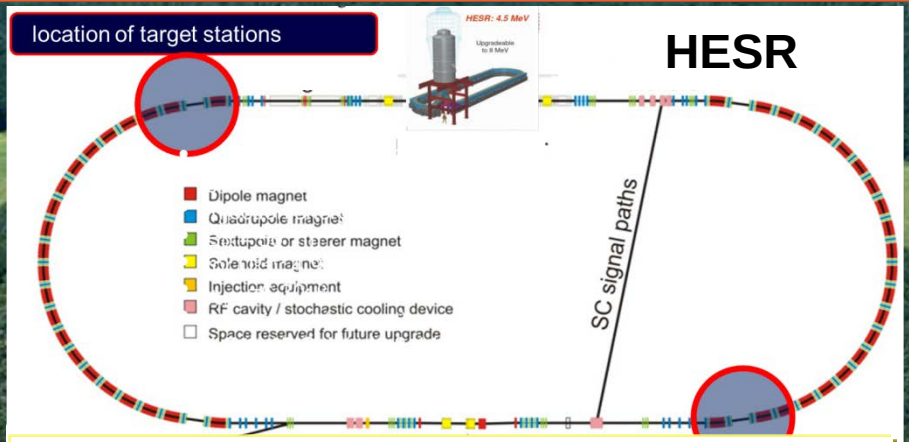
5

MSV for APPA : The Facilities

CRYRING

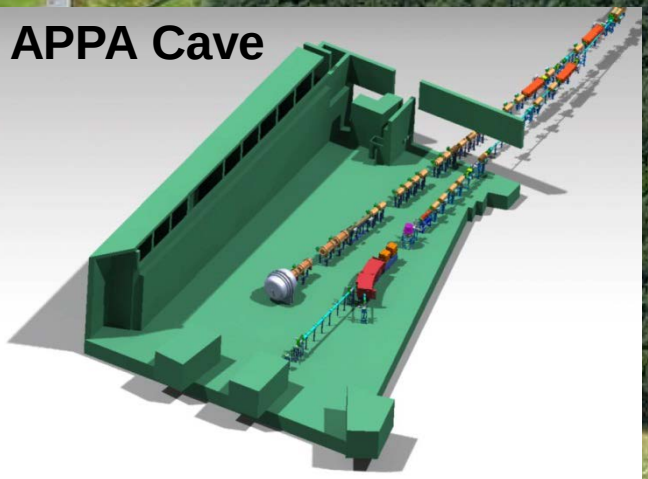


Cold Low-Energy Heavy Ions and Anti-Protons



Cold Relativistic Heavy Ions

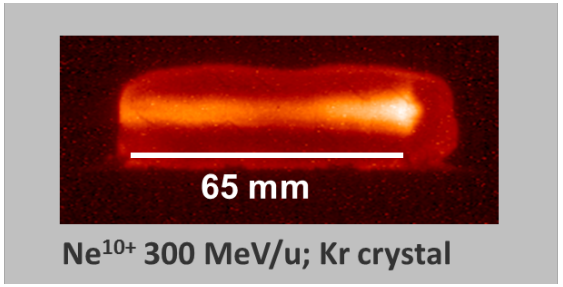
APPA Cave



Unique physics opportunities !!! ☺

Plasma Physics at FAIR

Intense HIB are excellent tool to generate extreme state of matter in reproducible conditions

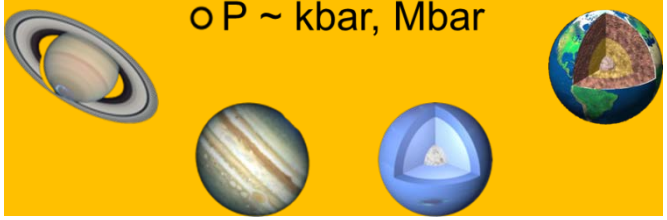


- large volume of sample (mm^3)
- fairly uniform physical conditions
- high entropy @ high densities
- high rep. rate and reproducibility
- any target material

Compared to GSI, FAIR will provide a specific intensity and energy deposition increase by a factor of 100 !

Warm Dense Matter

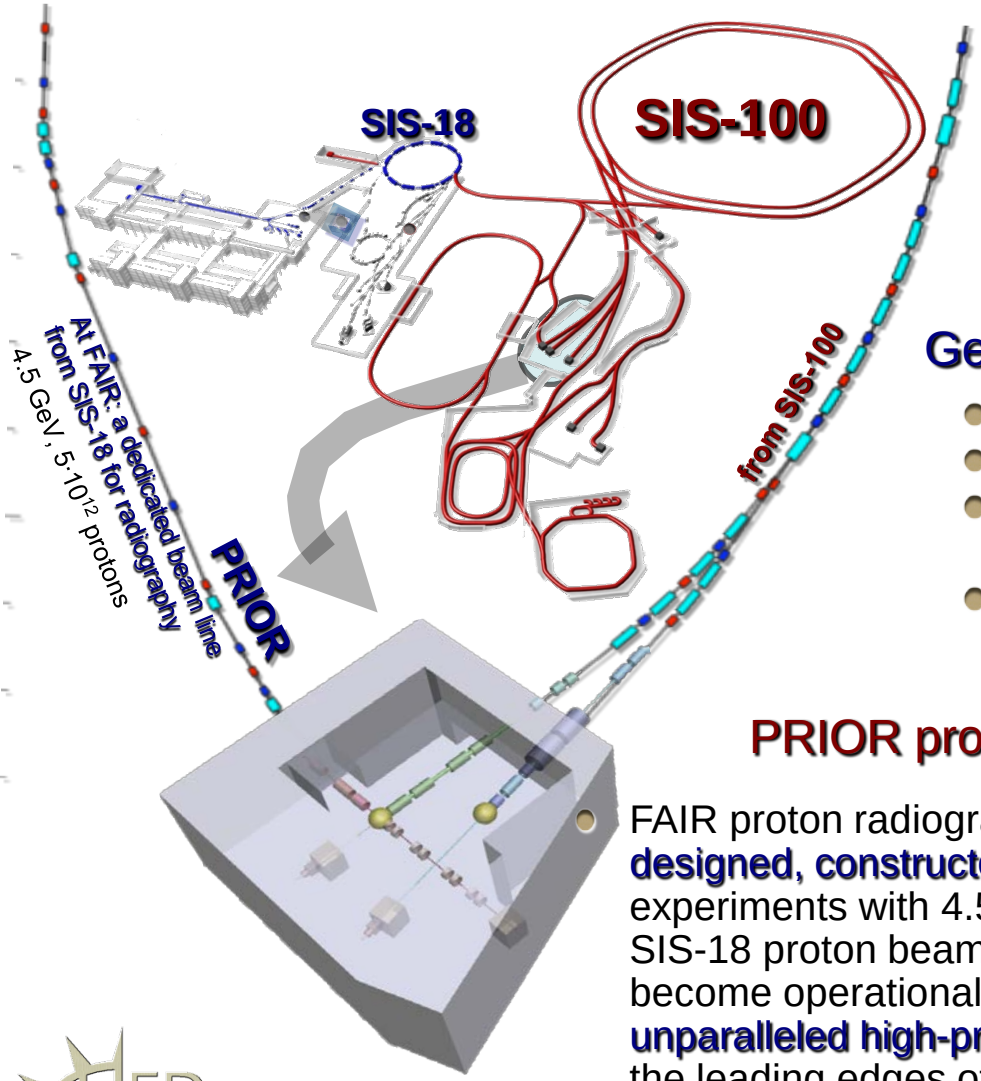
- T ~ 0.2 – 10 eV
- ρ ~ solid density
- P ~ kbar, Mbar



Interaction of ions and photons with plasmas
Equation of state, phase transitions, transport phenomena
Matter under high pressure
Coupling of intense light with matter

PRIOR – Proton Radiography at FAIR with 4.5 GeV proton beam

Collaboration GSI - LANL – ITEP (Moscow)



- up to ~20 g/cm^2 (Fe, Pb, Au, etc.)
- ≤10 μm spatial resolution
- 10 ns time resolution (multi-frame)
- sub-percent density resolution

GeV protons:

- large penetrating depth (high ρx)
- good detection efficiency (S/N)
- imaging, aberrations correction by magnetshigh spatial resolution (microscopy)
- high density resolution and dynamic rangemulti-frame capability for fast dynamic events

PRIOR project will accomplish two main tasks:

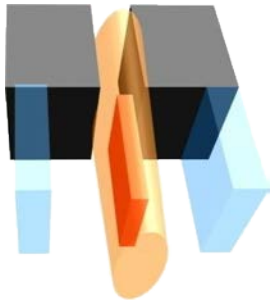
FAIR proton radiography system which a **core FAIR installation** will be **designed, constructed and commissioned** in full-scale dynamic experiments with 4.5 GeV proton beam prior to FAIR using the same SIS-18 proton beam, **a worldwide unique radiographic facility** may become operational **at GSI** that would provide a capability for **unparalleled high-precision experiments** with great discovery potential at the leading edges of **plasma physics, high energy density physics, biophysics, and materials research**

HEDgeHOB experiments

HIHEX

Heavy Ion Heating and Expansion

U^{28+}, 2 GeV, $5 \cdot 10^{11}$, SC
FFS



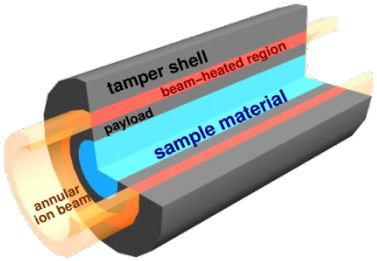
uniform quasi-isochoric heating of a large-volume dense target and isentropic expansion

numerous high-entropy HED states:
EOS and transport properties of non-ideal plasmas / WDM for various materials

LAPLAS

Laboratory Planetary Sciences

U^{28+}, 1 GeV, $5 \cdot 10^{11}$,
Wobbler



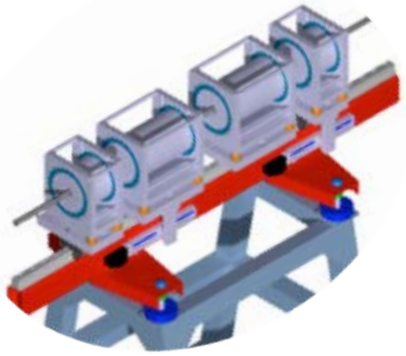
ring-shaped beam implodes a heavy tamper shell, low-entropy compression of hydrogen

Mbar pressures @ moderate temperatures:
hydrogen metallization, interior of Jupiter, Saturn or Earth

PRIOR

Proton Microscope for FAIR

p, 5–10 GeV, $2 \cdot 10^{12}$, PRIOR



worldwide unique high-energy proton microscopy setup with SIS-100 proton beam

dynamic HEDP experiments and PaNTERA, jointly with BIOMAT collaboration:
unparalleled density distribution measurements and Proton Therapy and Radiography (PaNTERA) project

Novel laser based diagnostic techniques to be used and developed :

Radiation sources with photon energies > 1MeV

e- beams with energies >20 MeV

P+ beams with energies > 100 MeV

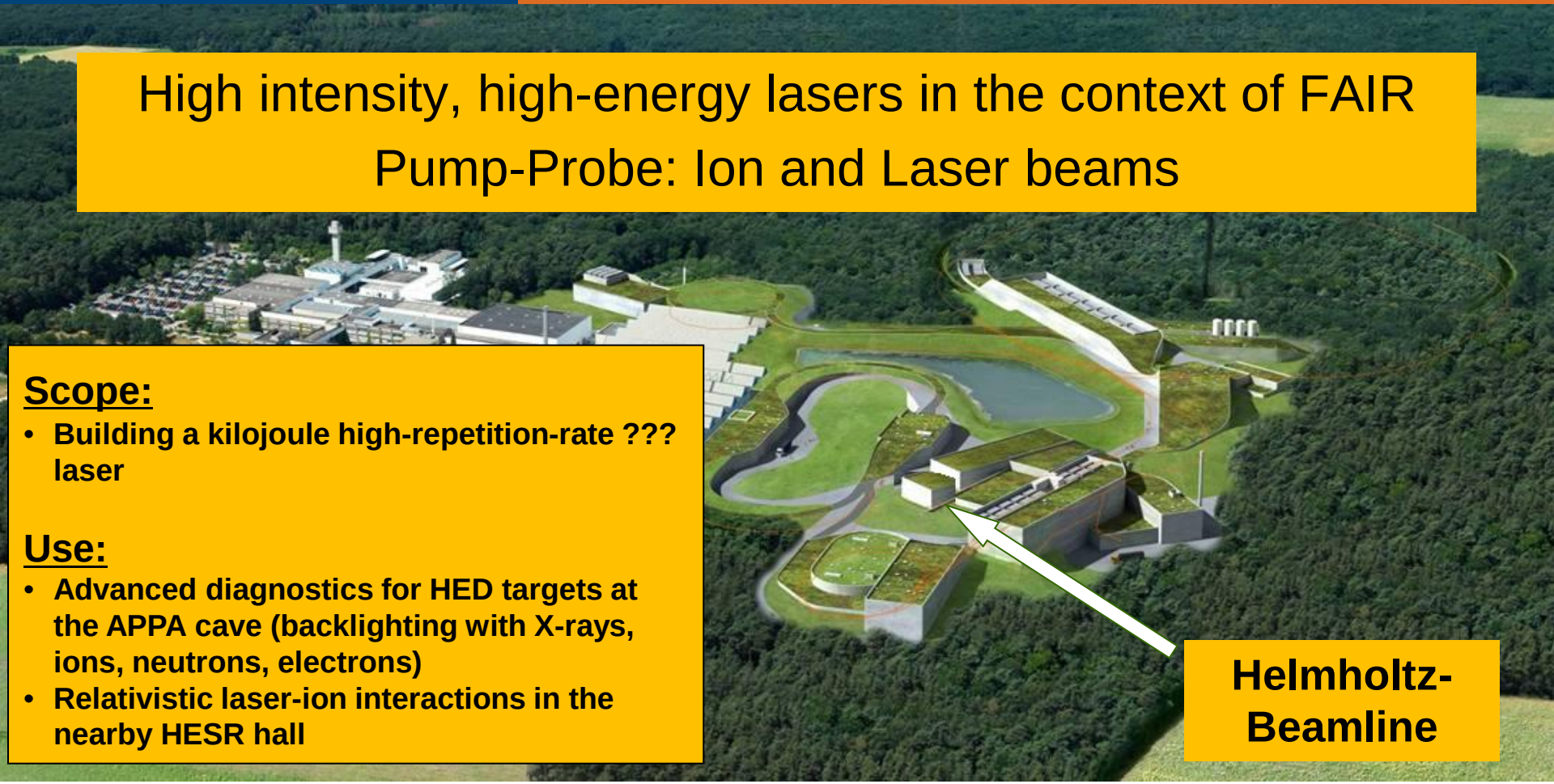
High brilliance pulsed n_0 beam sources

Requirements defined by macroscopic sizes of HIB heated samples of high Z elements

Helmholtz Beamline project (2016- 2019)

High intensity, high-energy lasers in the context of FAIR

Pump-Probe: Ion and Laser beams



Scope:

- **Building a kilojoule high-repetition-rate ??? laser**

Use:

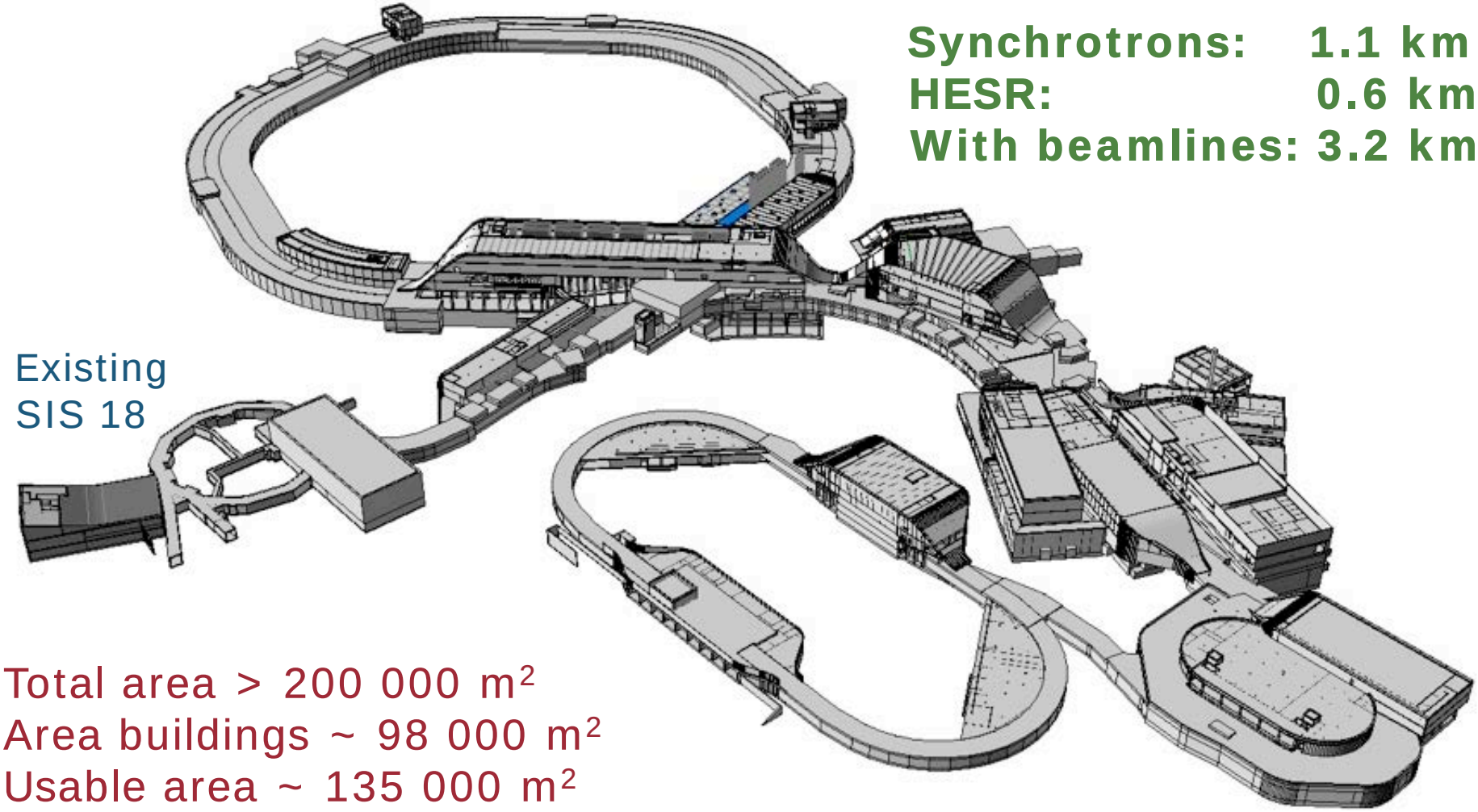
- **Advanced diagnostics for HED targets at the APPA cave (backlighting with X-rays, ions, neutrons, electrons)**
- **Relativistic laser-ion interactions in the nearby HESR hall**

Helmholtz-Beamline

Initiative of the Helmholtz Center HZDR in close collaboration with HI-Jena.

Already part of the Helmholtz roadmap for new research infrastructures !

Civil Construction



Synchrotrons: 1.1 km
HESR: 0.6 km
With beamlines: 3.2 km

Existing
SIS 18

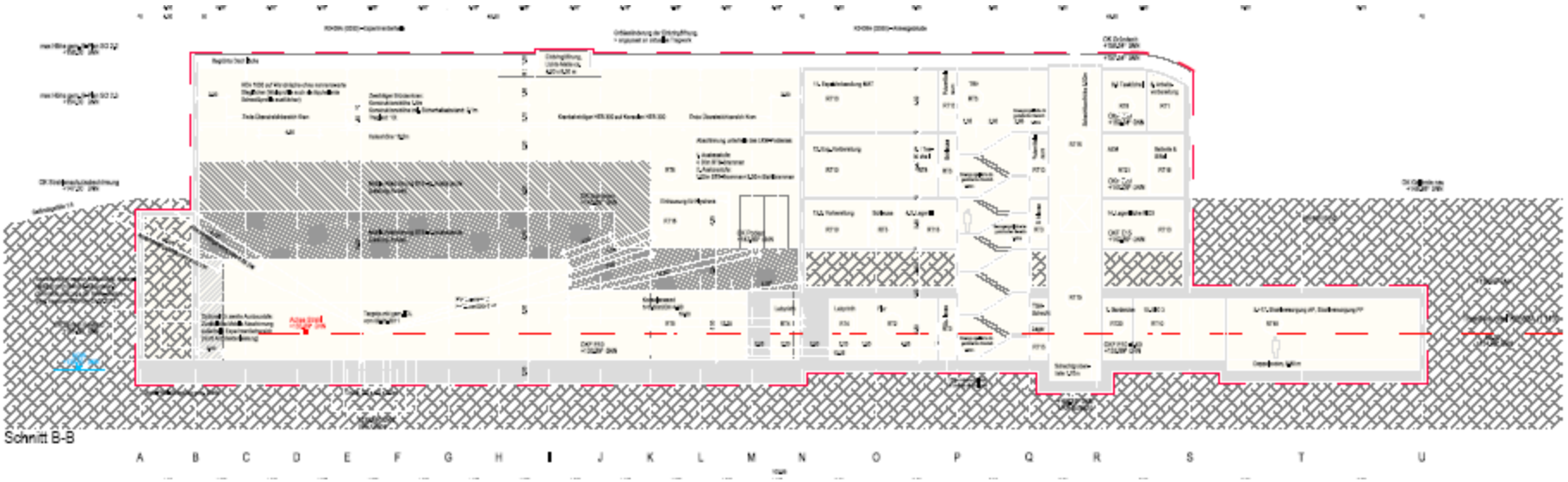
Total area > 200 000 m²
Area buildings ~ 98 000 m²
Usable area ~ 135 000 m²
Volume of buildings ~ 1 049 000 m³
Substructure: ~ 1500 pillars, up to 65 m deep

FAIR Construction Side

APPA Experimental Area

Green Paper:
include to the scope of the Modularized Start Version a multipurpose hall to ensure atomic physiscs, plasma physics and bio physics to start

A multifunctional hall was designed togehter with users:
- Experimental area for experiments 850 sqm
- total area of hall 1160 sqm
- Vertical hight 18,50 m
- Additional 3 story service building (2000 sqm)



Summary

FAIR Project is well in progress: construction of the facility started;

Plasma Physics within APPA research pillar is on a safe side;

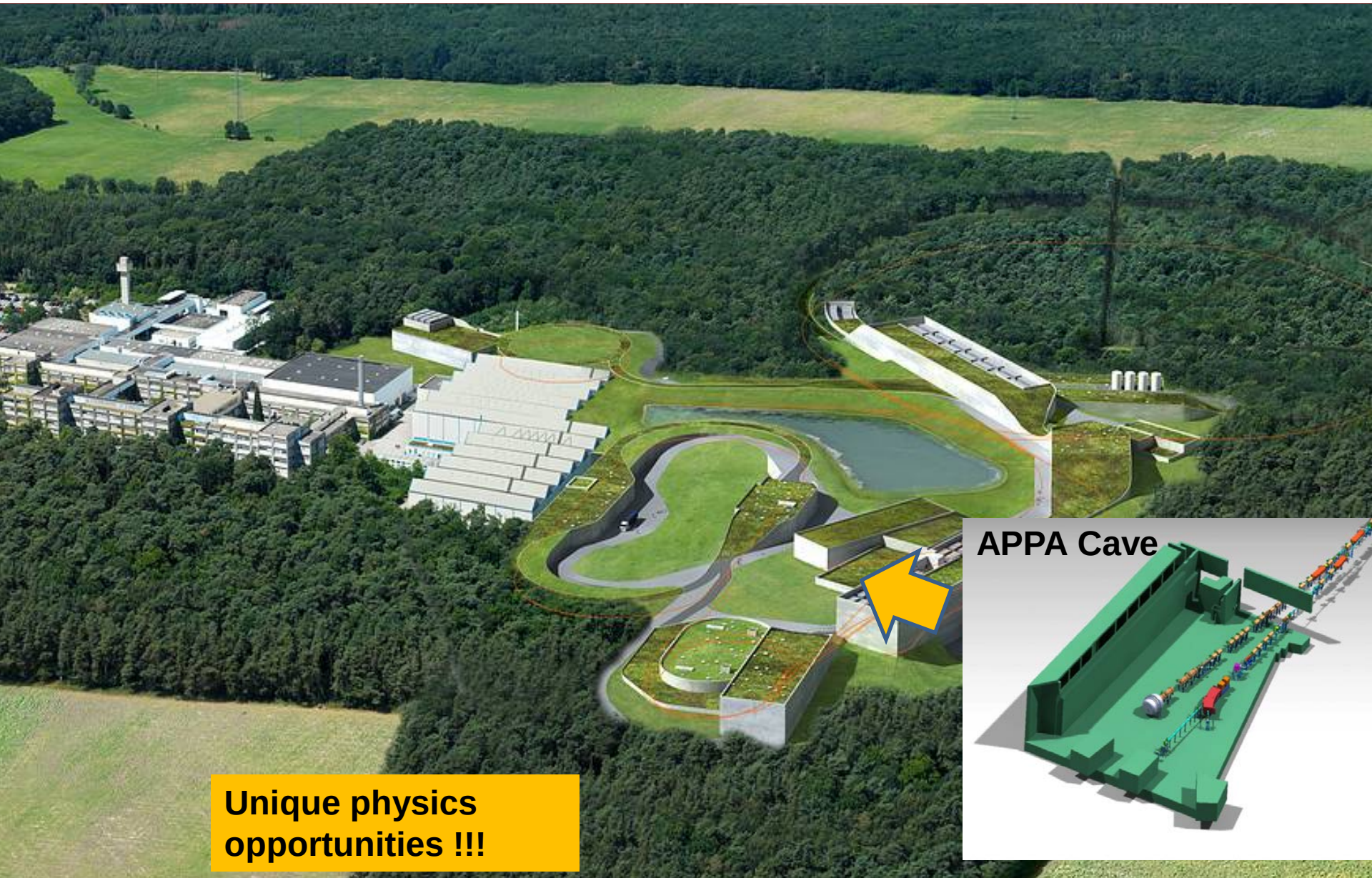
Research collaborations are creative in finding new solutions for the use of capabilities of the FAIR MSV;

From TDRs to contracting phase for hardware of PP experiments;

Full support from FAIR in bridging the “shot down” gap

Activities on construction site

FAIR 2018+



Unique physics opportunities !!!