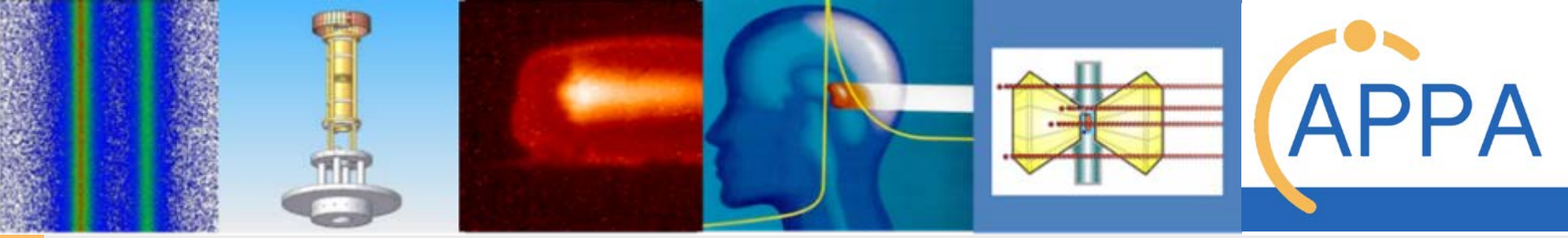


Present and future experimental GSI/FAIR facilities for material science

Research structure of FAIR

APPA

NUSTAR

CBM

Panda

Atomic physics
SPARC / FLAIR

Plasma Physics
HEDgeHOB / WDM

BIOMAT

Research structure of FAIR

BIOMAT

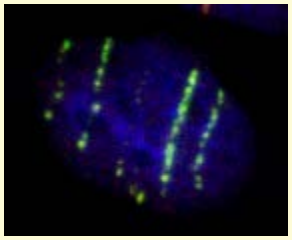
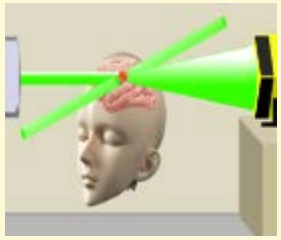
APPA | NUSTAR | CBM | Panda

Atomic physics
SPARC / FLAIR

Plasma Physics
HEDgeHOB / WDM

BIOMAT

Biophysics


- Molecular Radiobiology and Imaging
- Stem Cell Differentiation and Cytogenetics
- Immune System and Tissue Radiobiology
- Radiobiological modelling
- Treatment planning and validation
- Medical Physics
- Space Radiation Physics

Research structure of FAIR

BIOMAT

APPA | NUSTAR | CBM | Panda

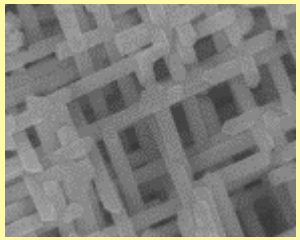
Atomic physics
SPARC / FLAIR

Plasma Physics
HEDgeHOB / WDM

BIOMAT

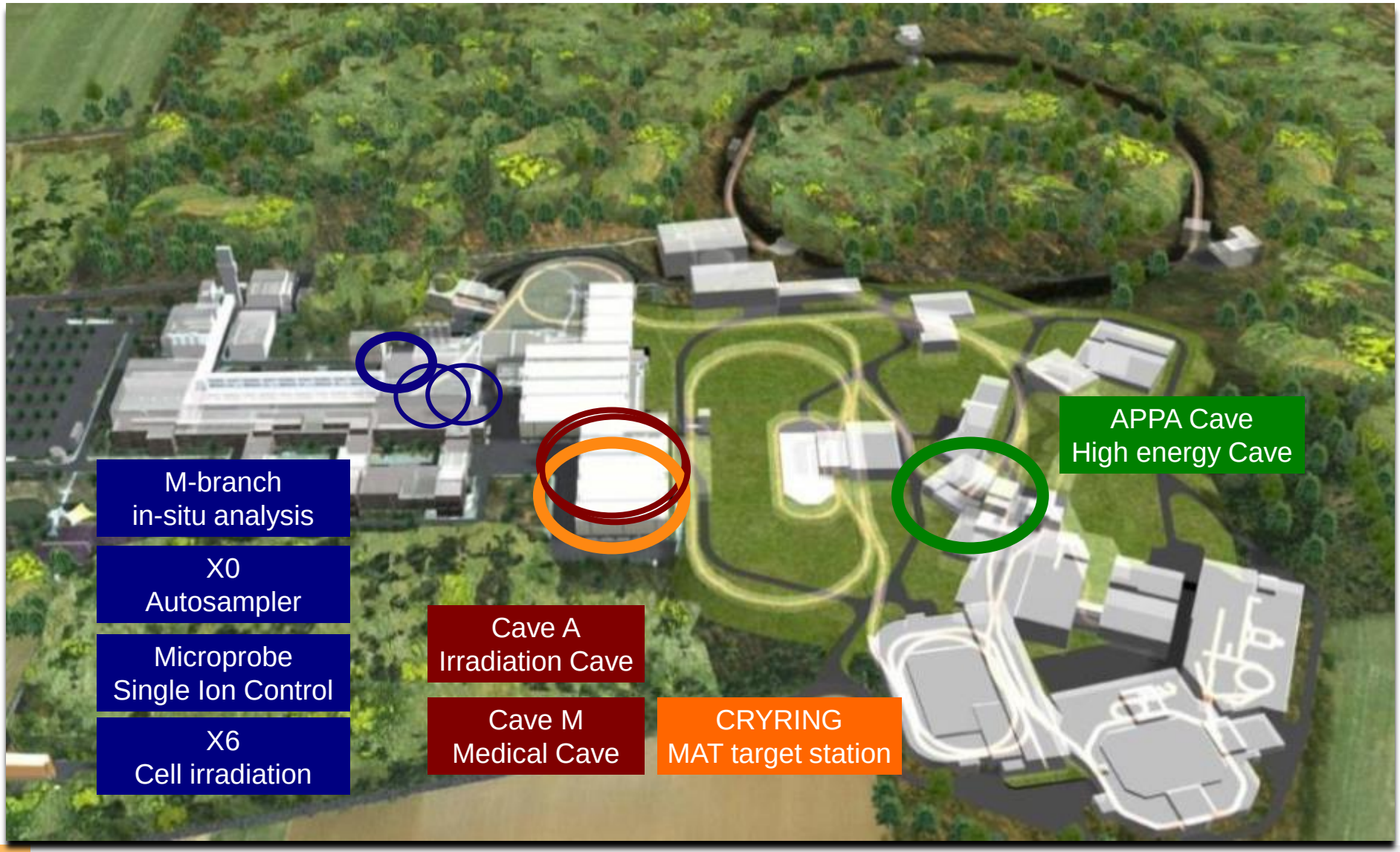
Materials Science



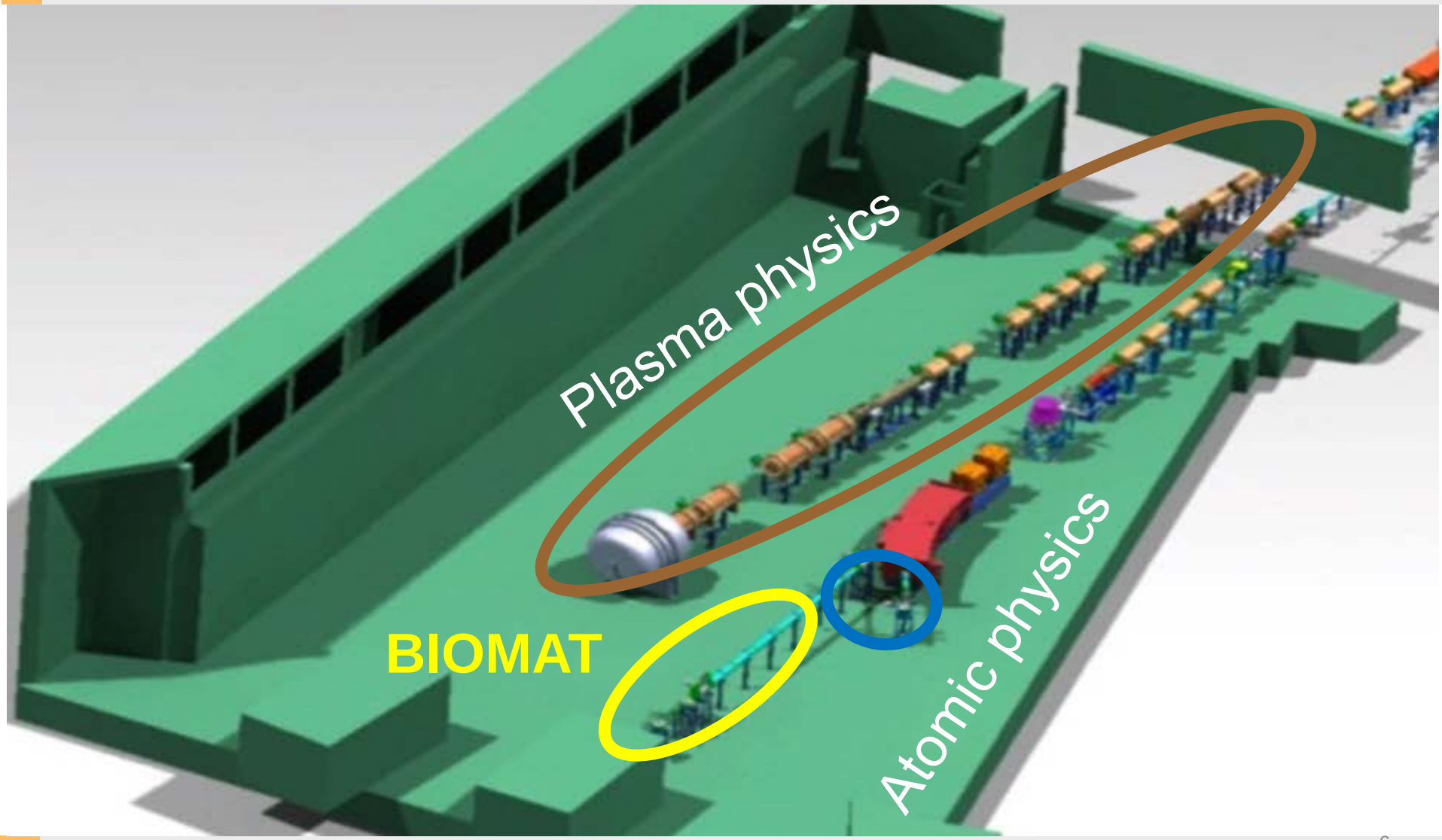


- Beam-induced damage processes
- Radiation hardness
- Materials under extreme conditions
- Irradiations under high pressure
- Ion-track based nanotechnology

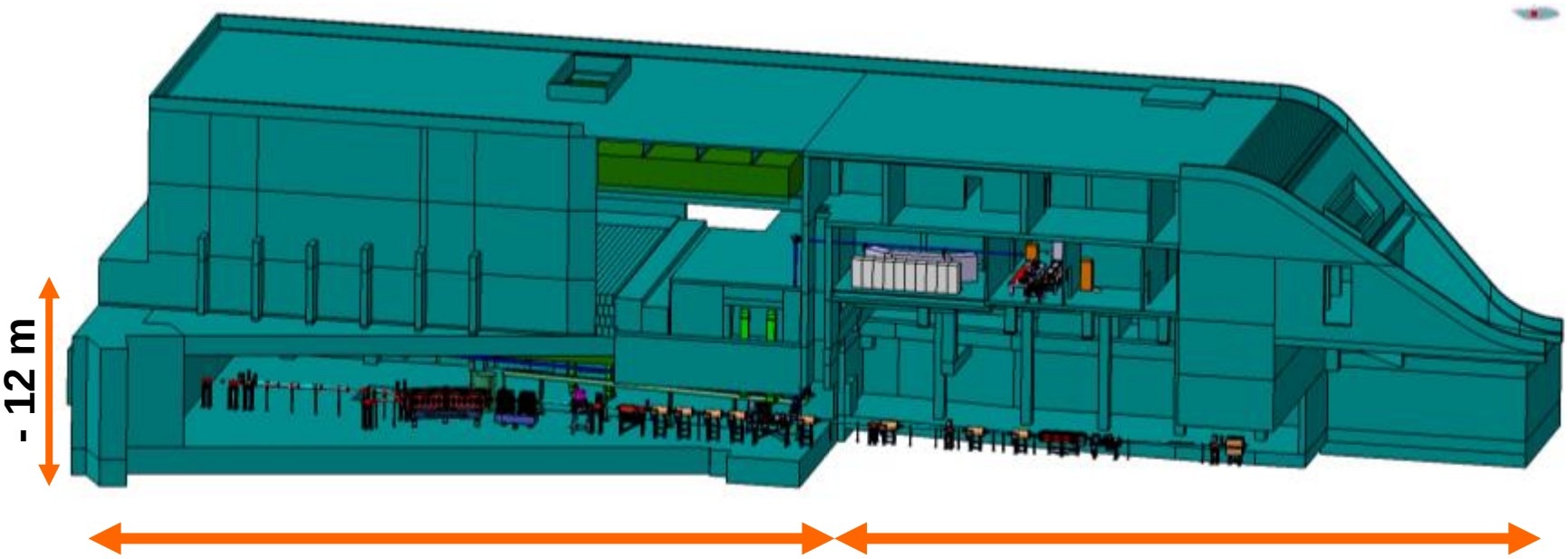
Irradiation facilities at FAIR



future APPA cave



future APPA cave



Experimental Hall ~ 50 x 23 m²

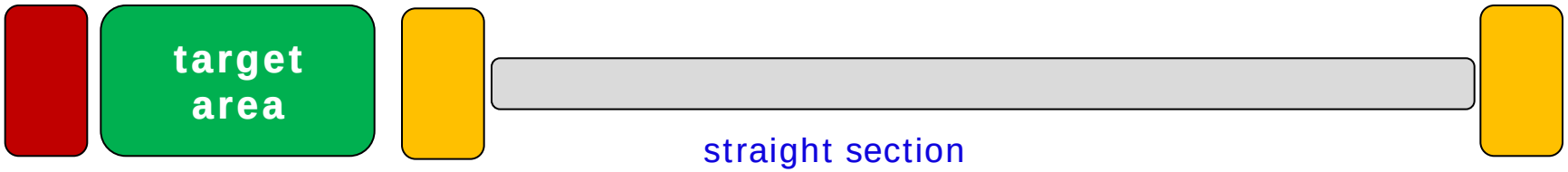
two beam lines with 5 target points

- **transfer beam line**
- **auxiliary building: laboratories , testing rooms, control rooms, meeting rooms**
- **general infrastructure: PS, media, IT, electronics for controls**

APPA Cave: BIOMAT beam line

Experiment

SIS18 / SIS100 beams



Beam dump

Beam Diagnostic II

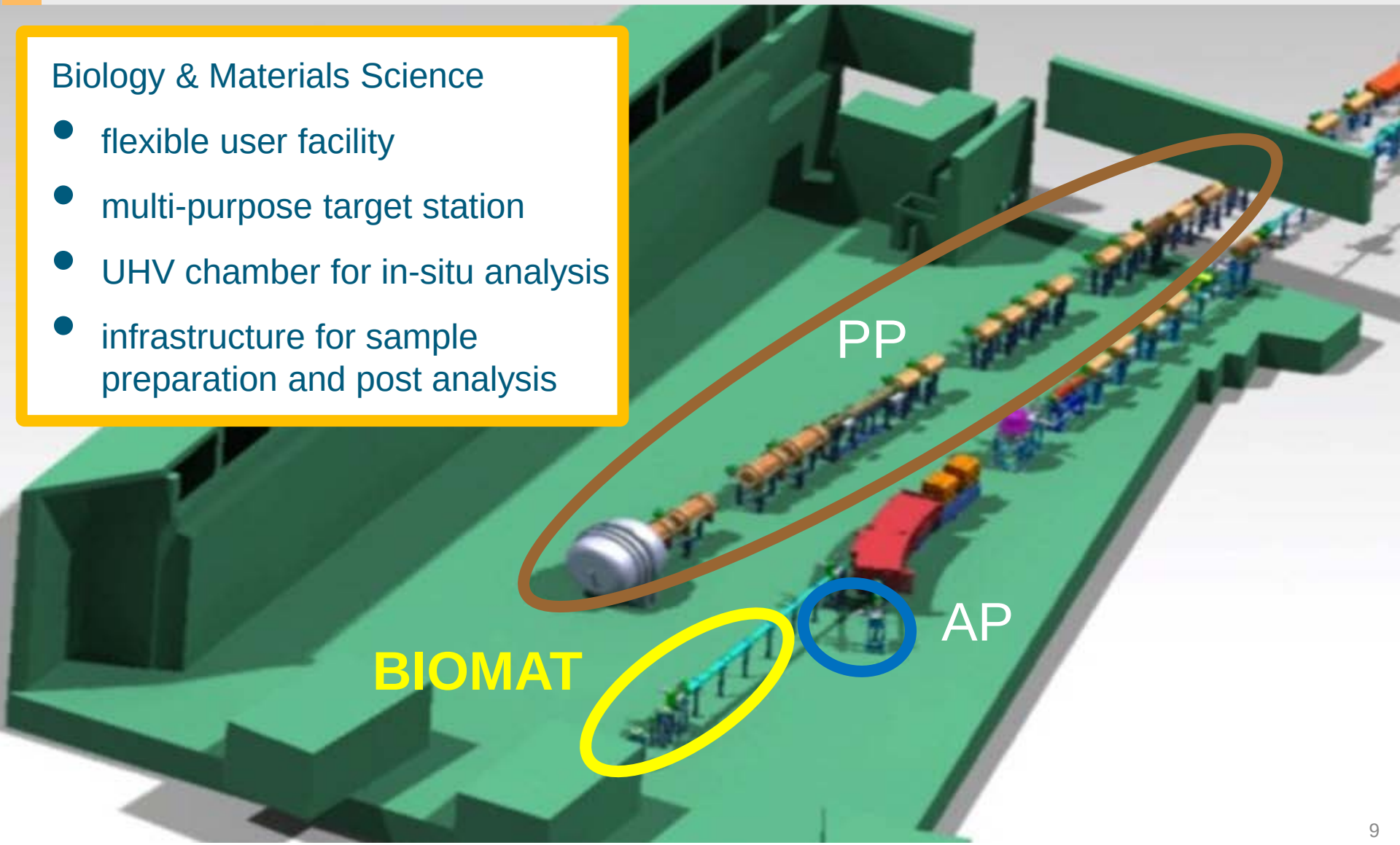
straight section
(~10m with 3 vacuum section)

Beam Diagnostic I

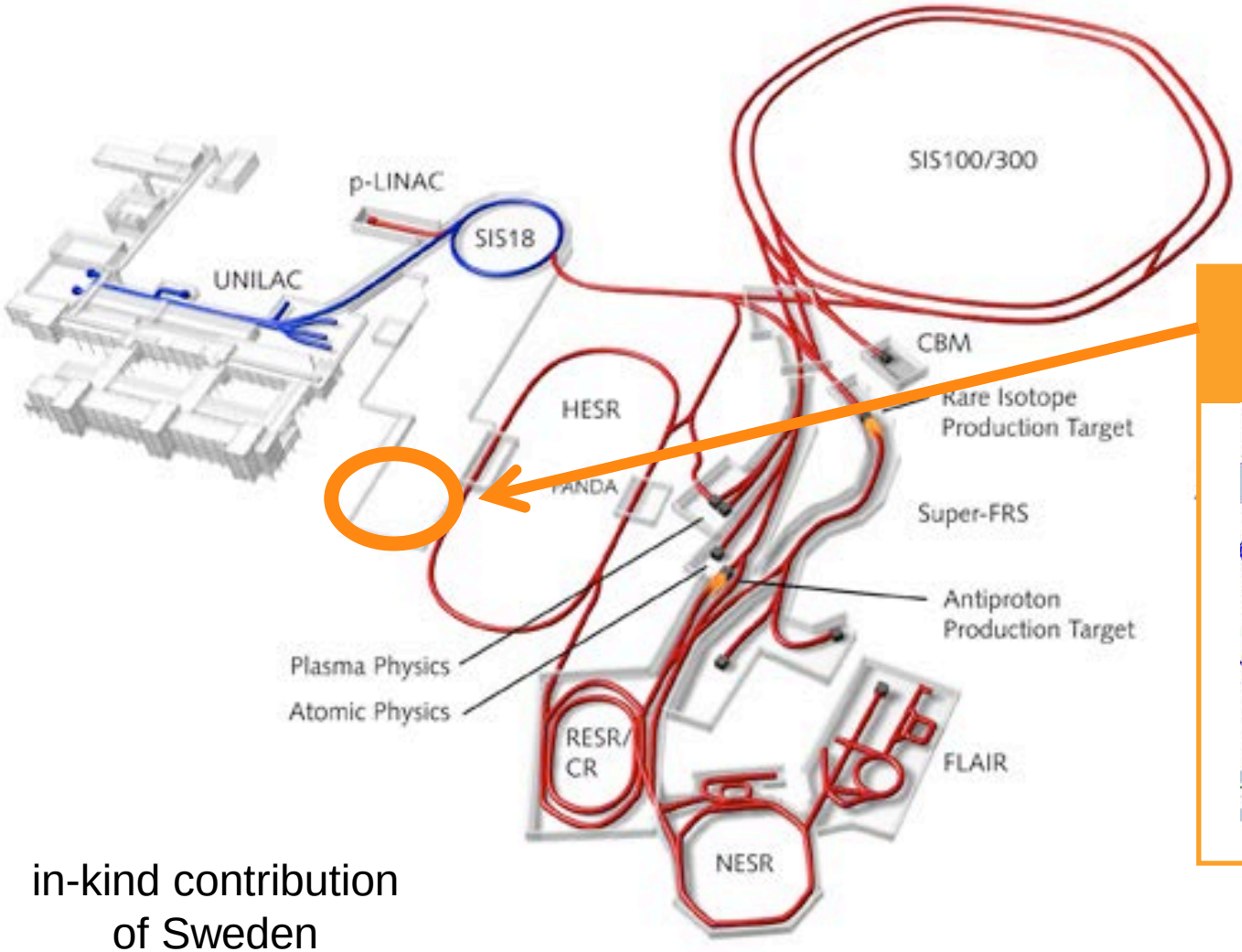
future APPA cave

Biology & Materials Science

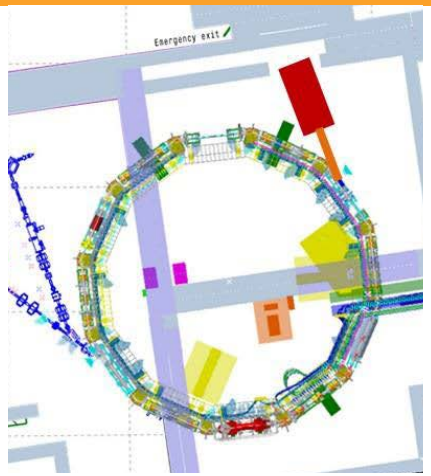
- flexible user facility
- multi-purpose target station
- UHV chamber for in-situ analysis
- infrastructure for sample preparation and post analysis



CRYRING – storage ring



Cryring
MAT target station

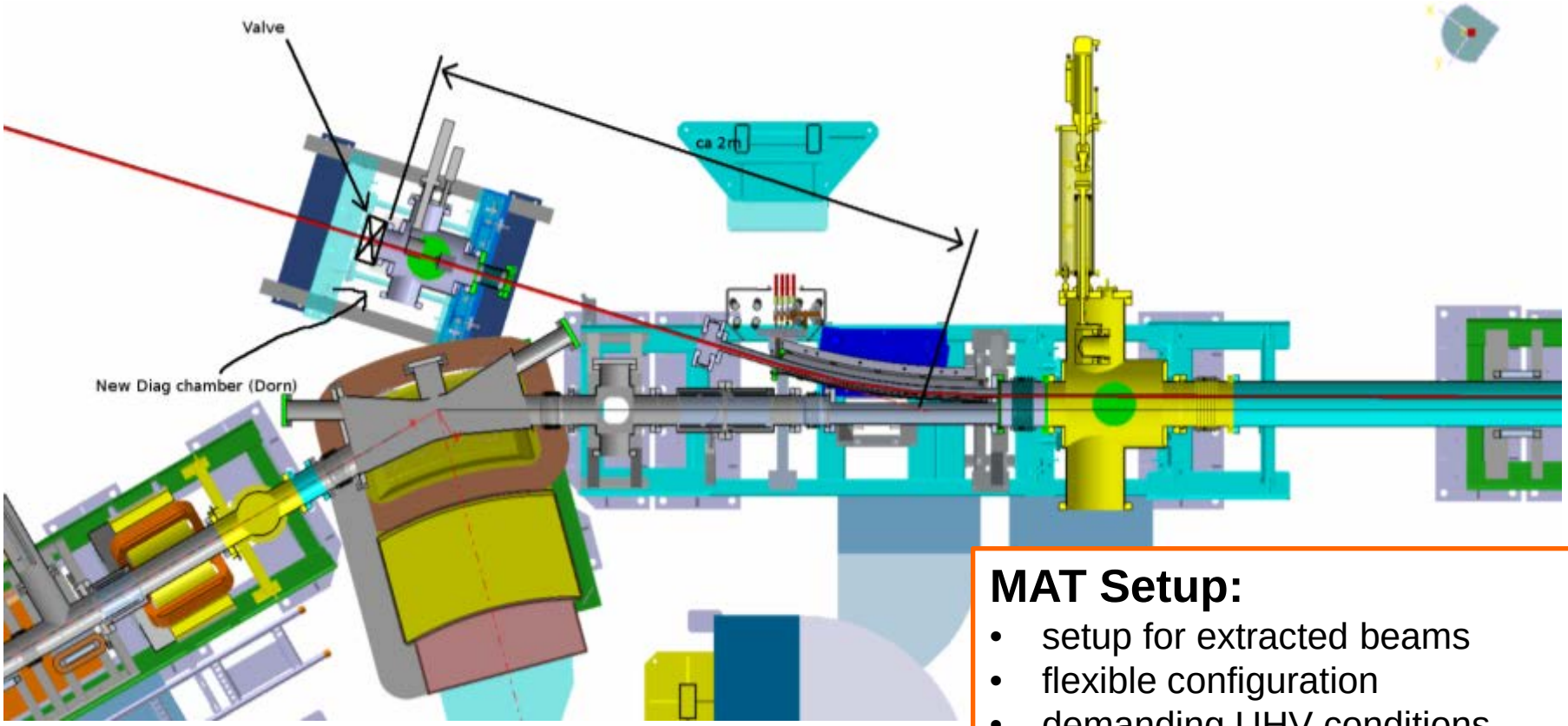


in-kind contribution
of Sweden

CRYRING – storage ring

- protons – U ions via UNILAC + SIS18 + ESR
- stand alone operation possible
- up to 13 MeV/u + high charge states (U^{92+})
- typical intensity 1e7 /spill

CRYRING: MAT target station



MAT Setup:

- setup for extracted beams
- flexible configuration
- demanding UHV conditions

Instrumentation:

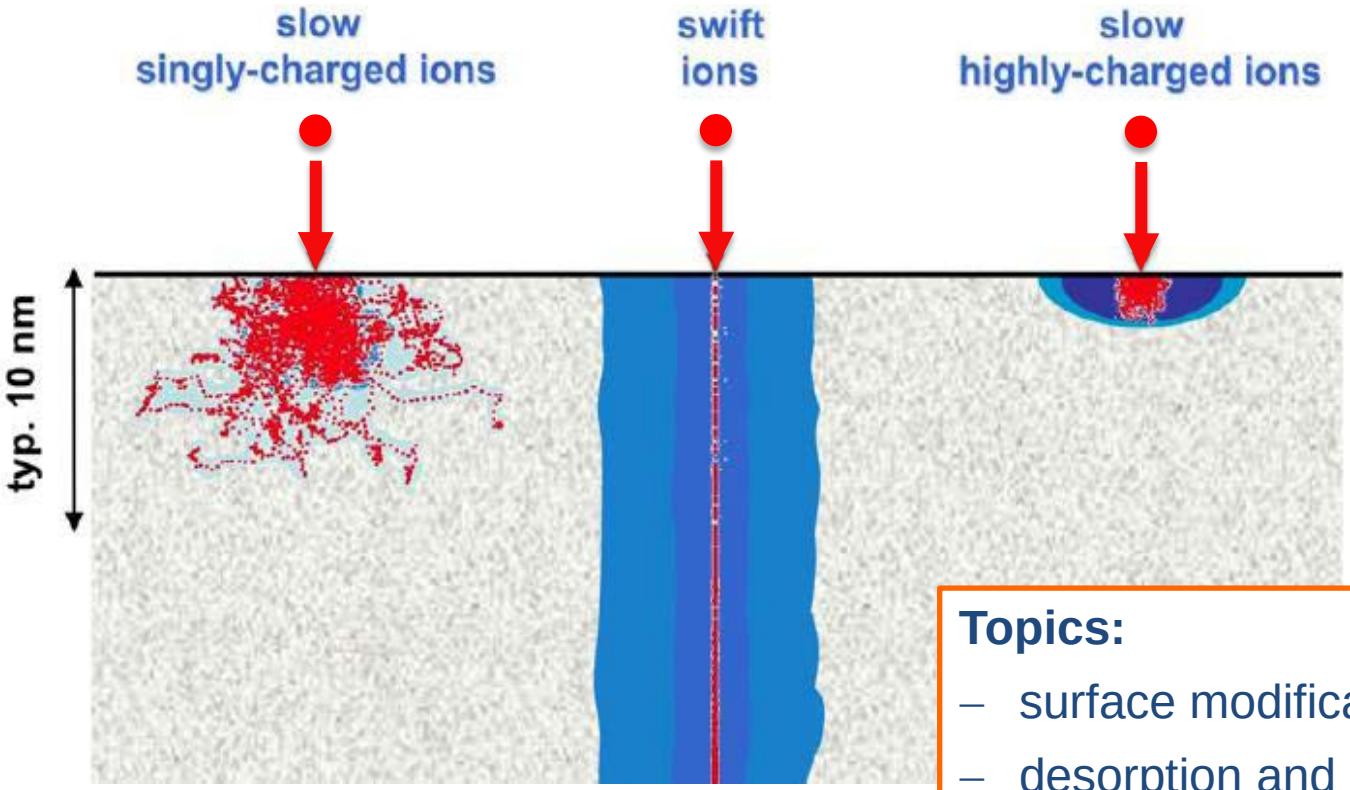
- beam line equipment
- irradiation chamber
- in-situ analysis

CRYRING: MAT target station

E_{kin}: keV
elastic collisions

E_{kin}: MeV
electronic ionization

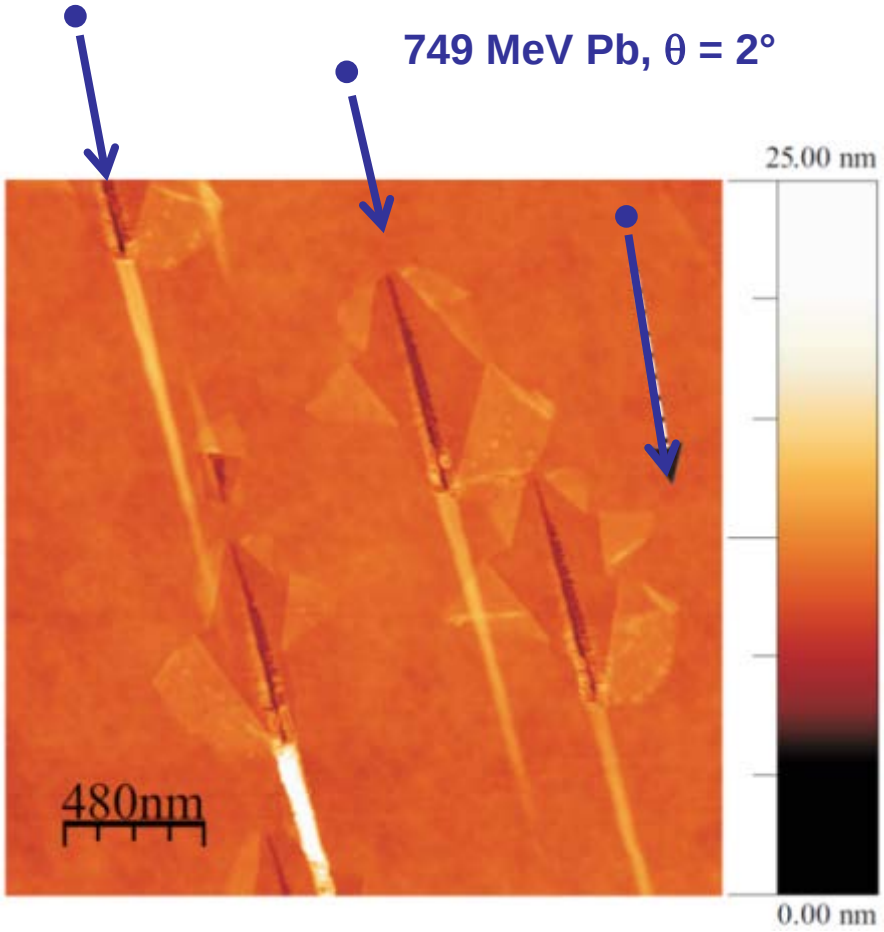
E_{pot}: keV & q
collisions & ionization

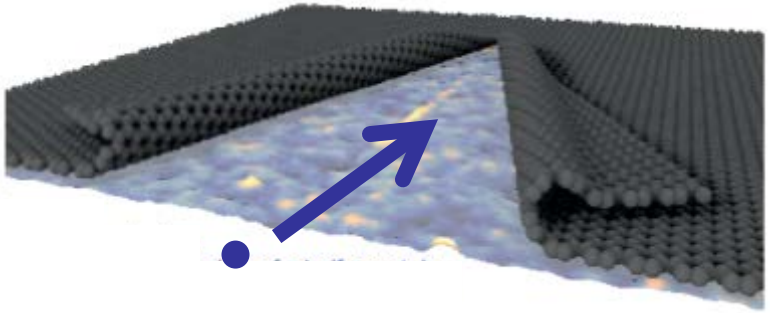


Topics:

- surface modification
- desorption and sputtering processes
- luminescence

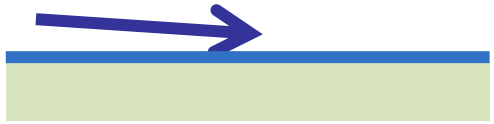
CRYRING: MAT target station





“unzipping graphene

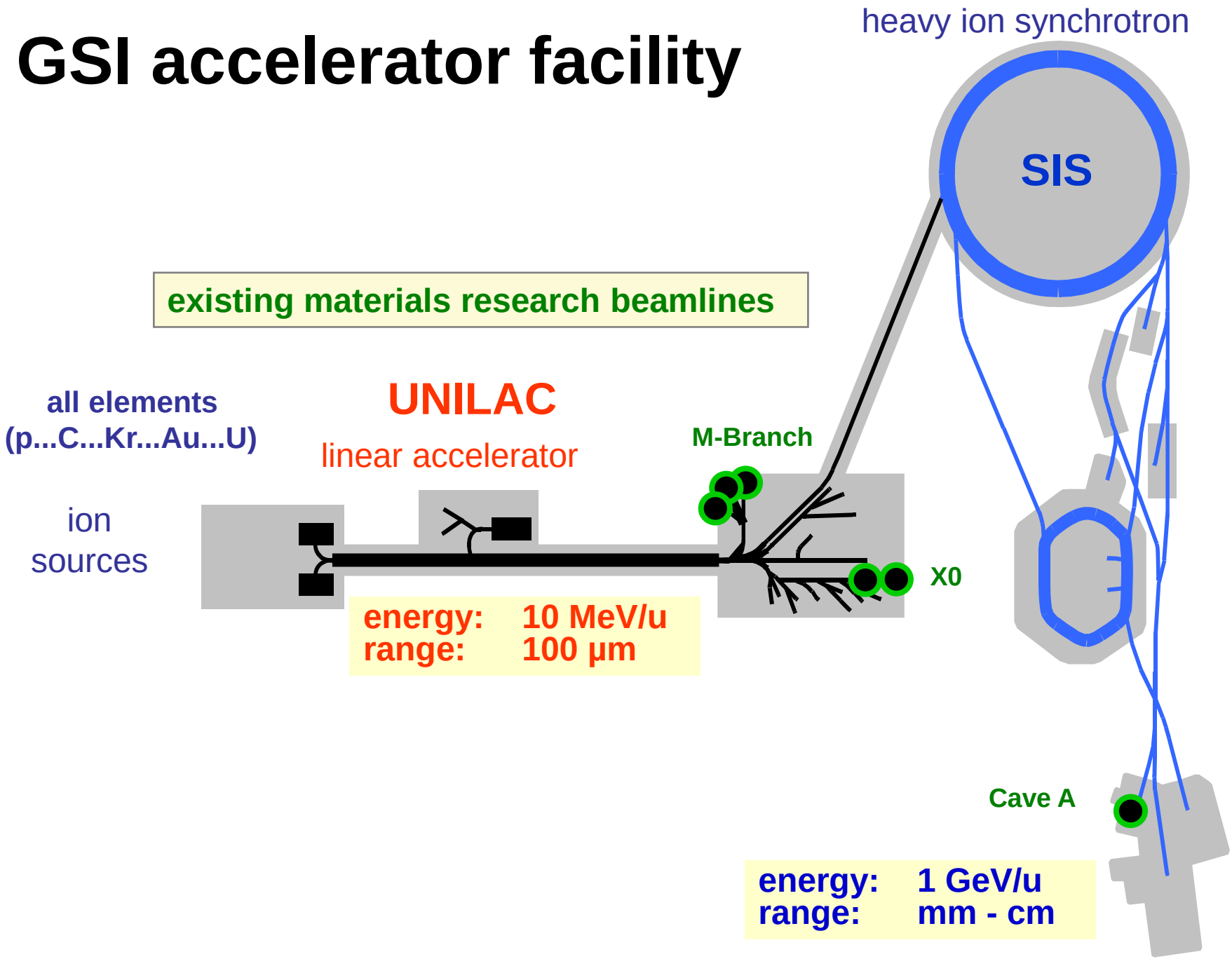
Ion irradiation under glancing incidence (θ = 2°)



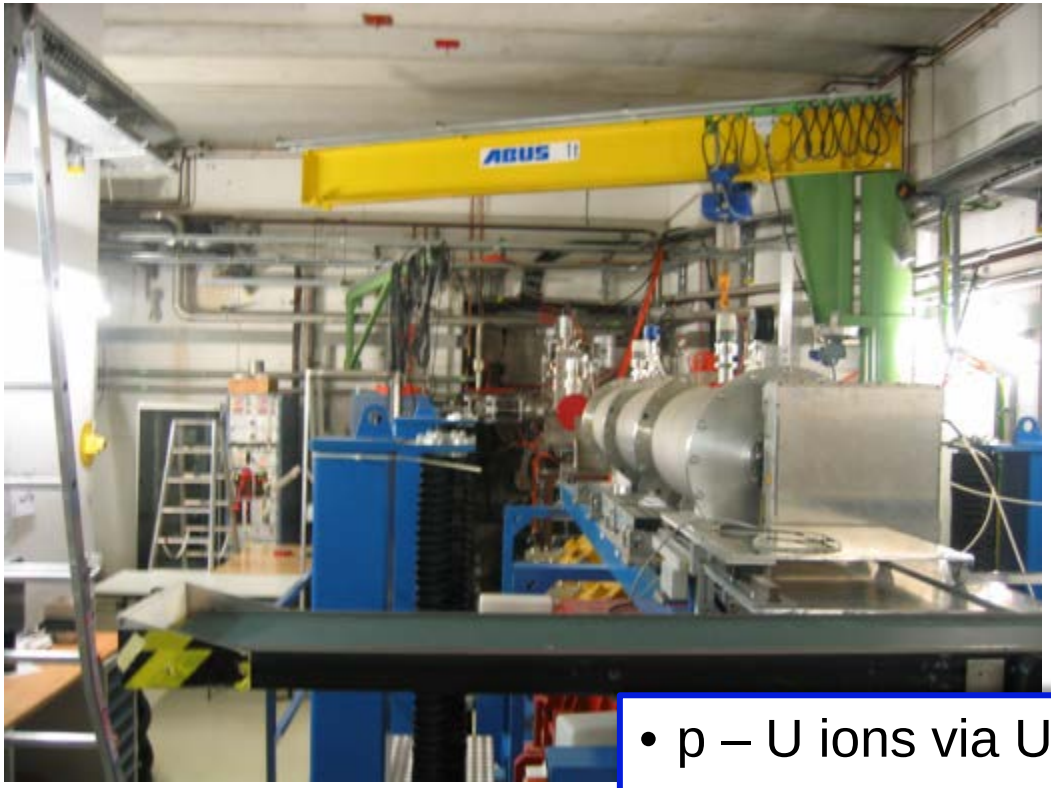
single graphene layer
on PMMA

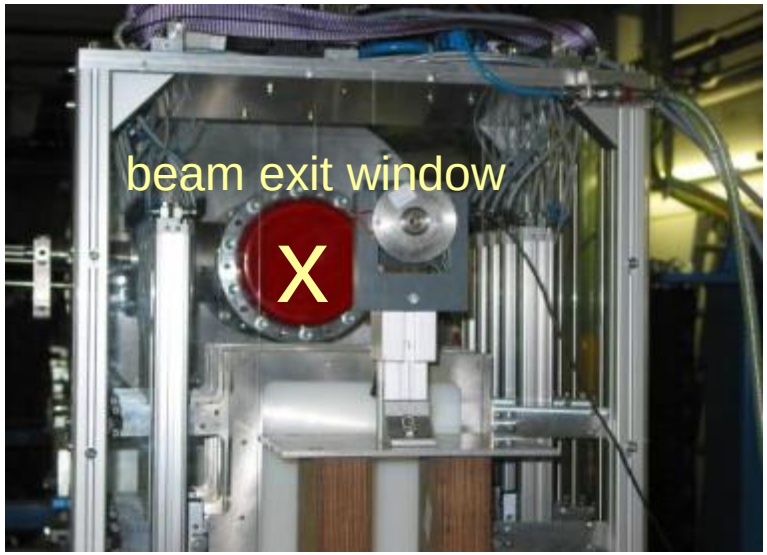
University of Duisburg-Essen, Prof. M. Schleberger

GSI accelerator facility



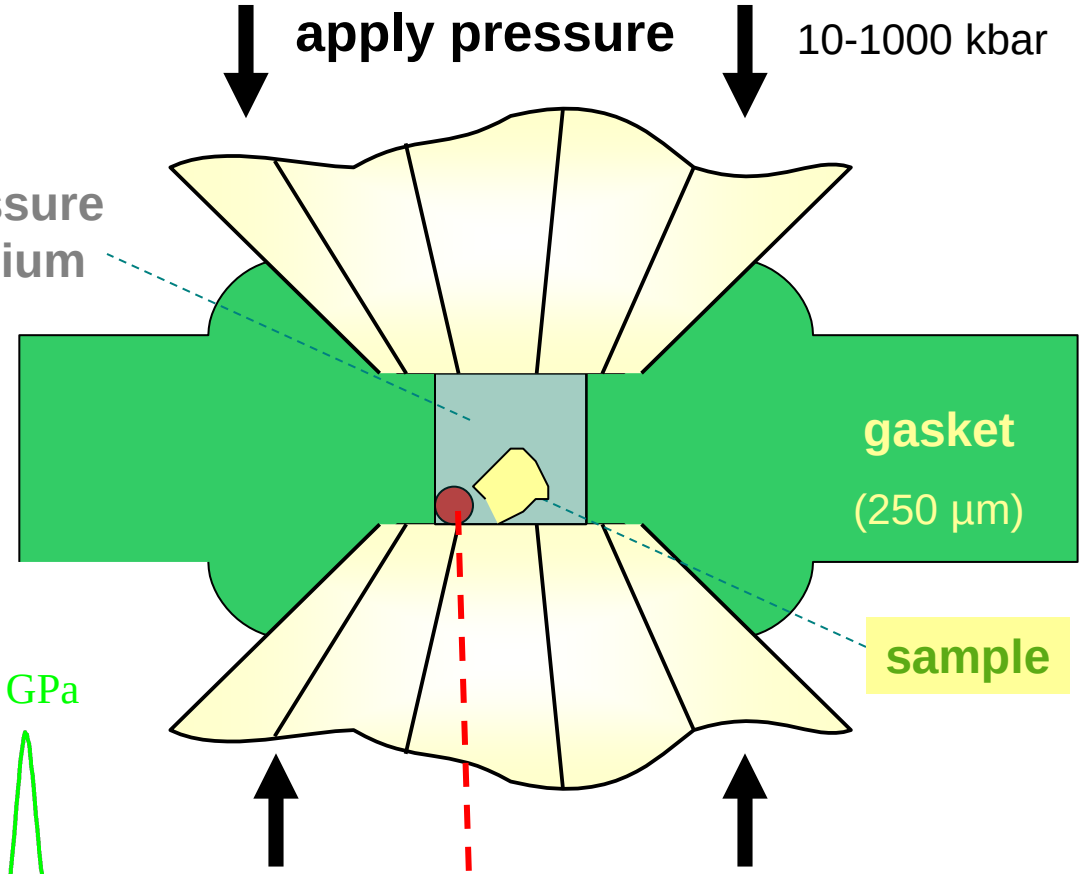
SIS18: Cave A

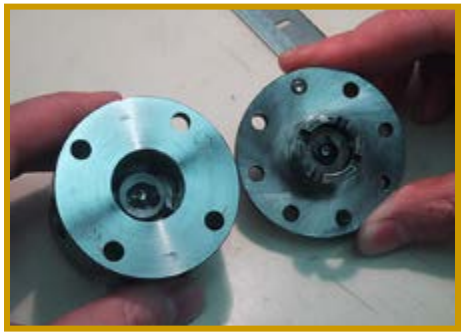


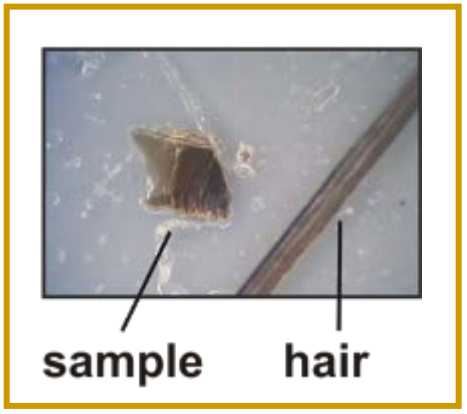


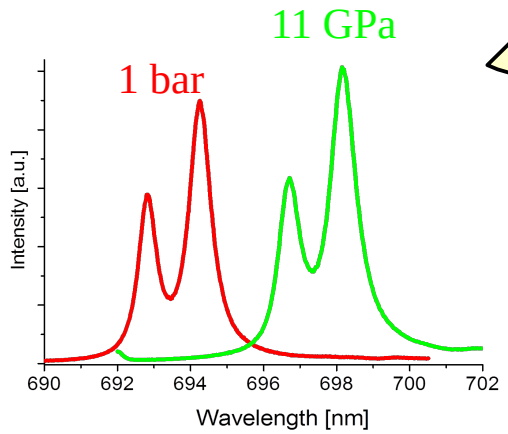
- p – U ions via UNILAC + SIS18
- up to 1 GeV/u
- typical intensity 1e9 /spill
- multi purpose sample positioning system
- beam scanning system

Irradiation under pressure: Diamond anvil cell (DAC)



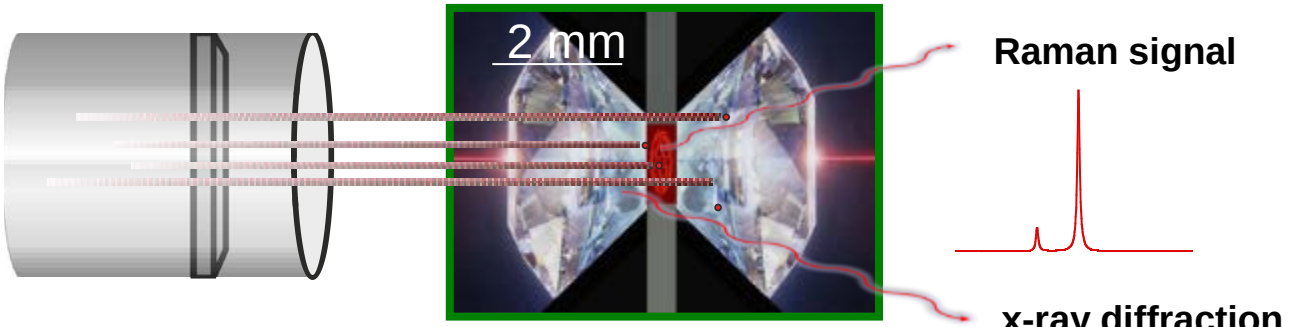




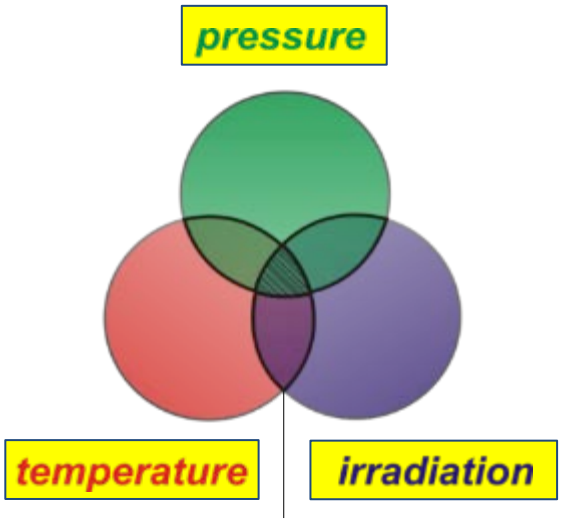


SIS18 Cave A - High pressure irradiation

high energy
Au, Pb, U ions



diamond anvil cell
10-1000 kbar

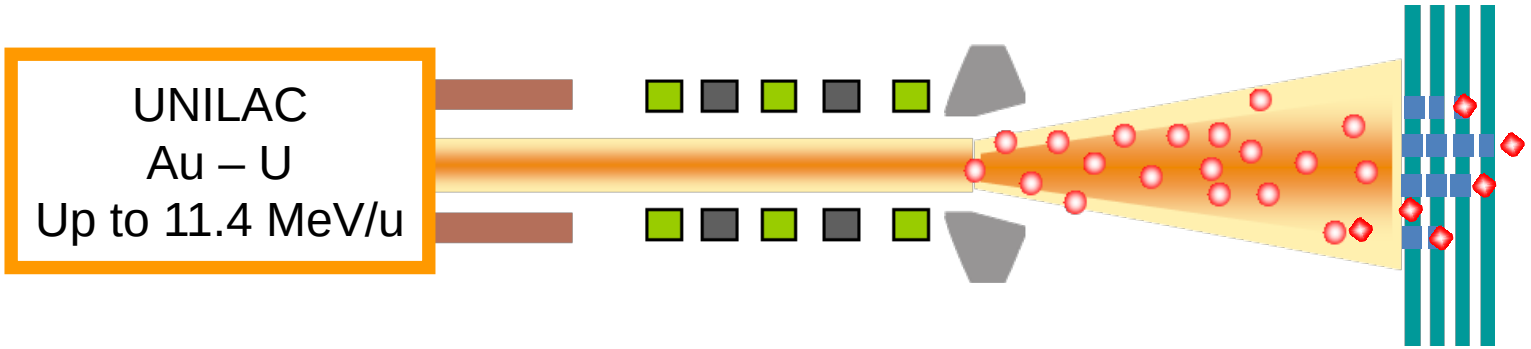


Extreme Environments

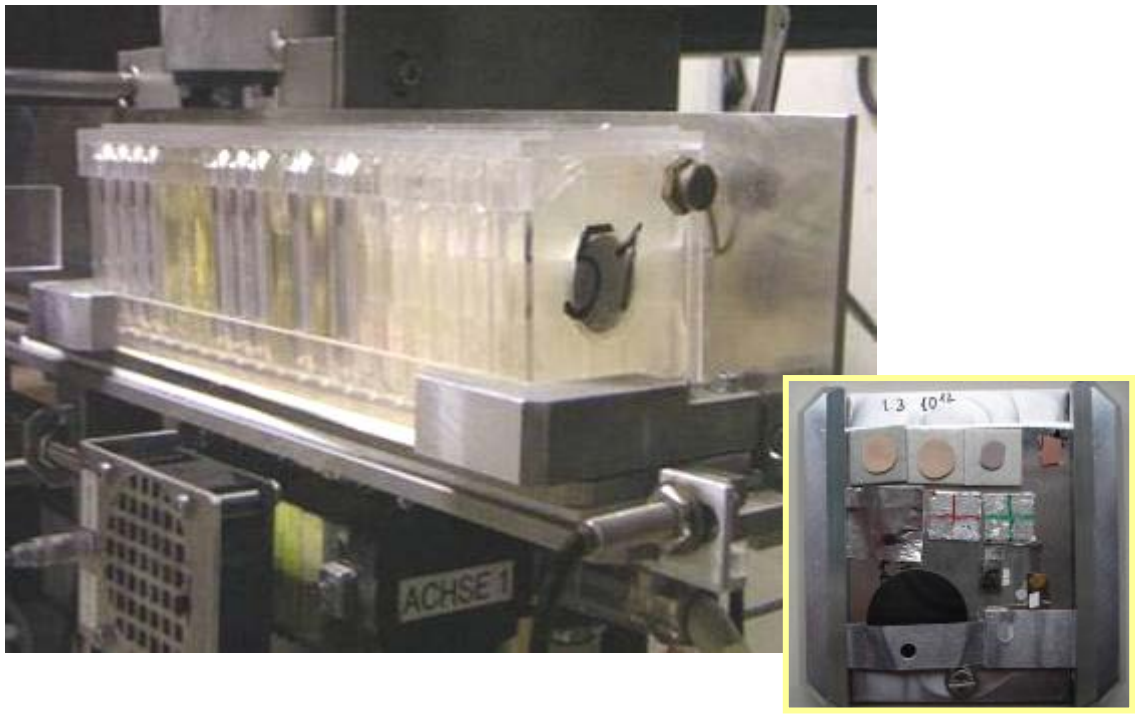
- synthesis and stabilization of new materials
- nanoscale manipulation of materials properties
- recover exotic high-pressure phases
- simulate radioactivity effects within Earth's interior

FAIR benefit:
higher beam intensities

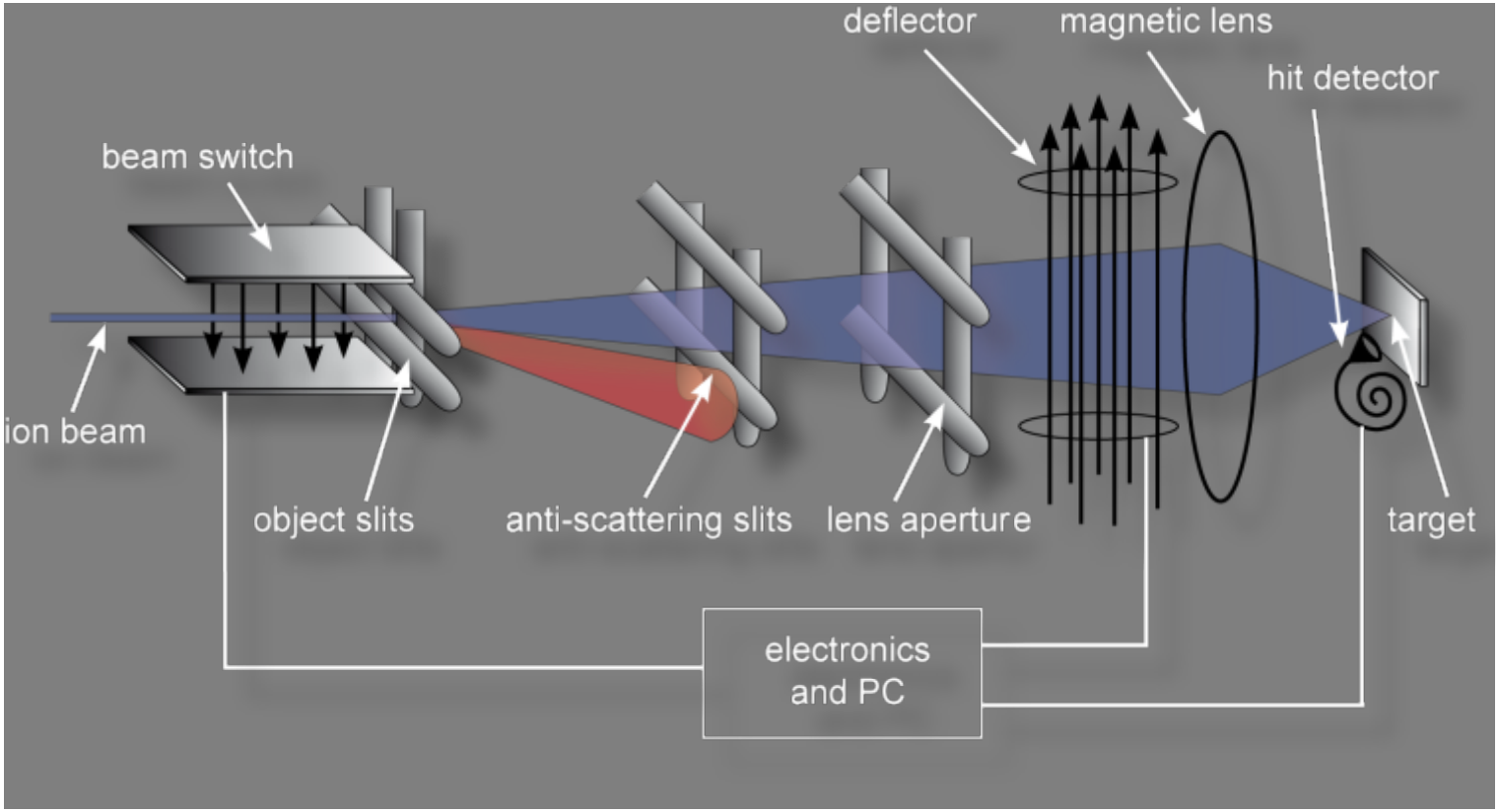
UNILAC: X0 standard sample irradiation

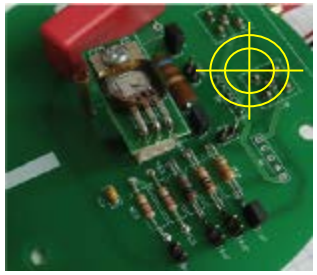


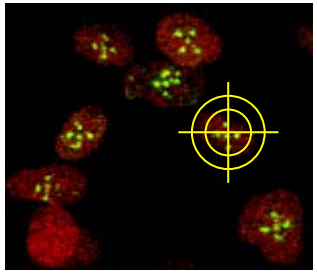
- Automatic load-lock system
- Defocused beam (5x5cm^2)
- Fluence regime:
  1 – 1E13 ions/cm^2
- Single ion irradiation
- 50 samples per hour

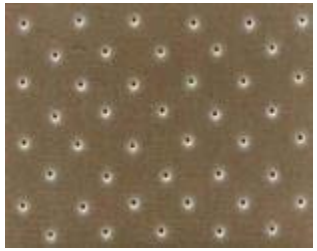


UNILAC: X0 Microprobe



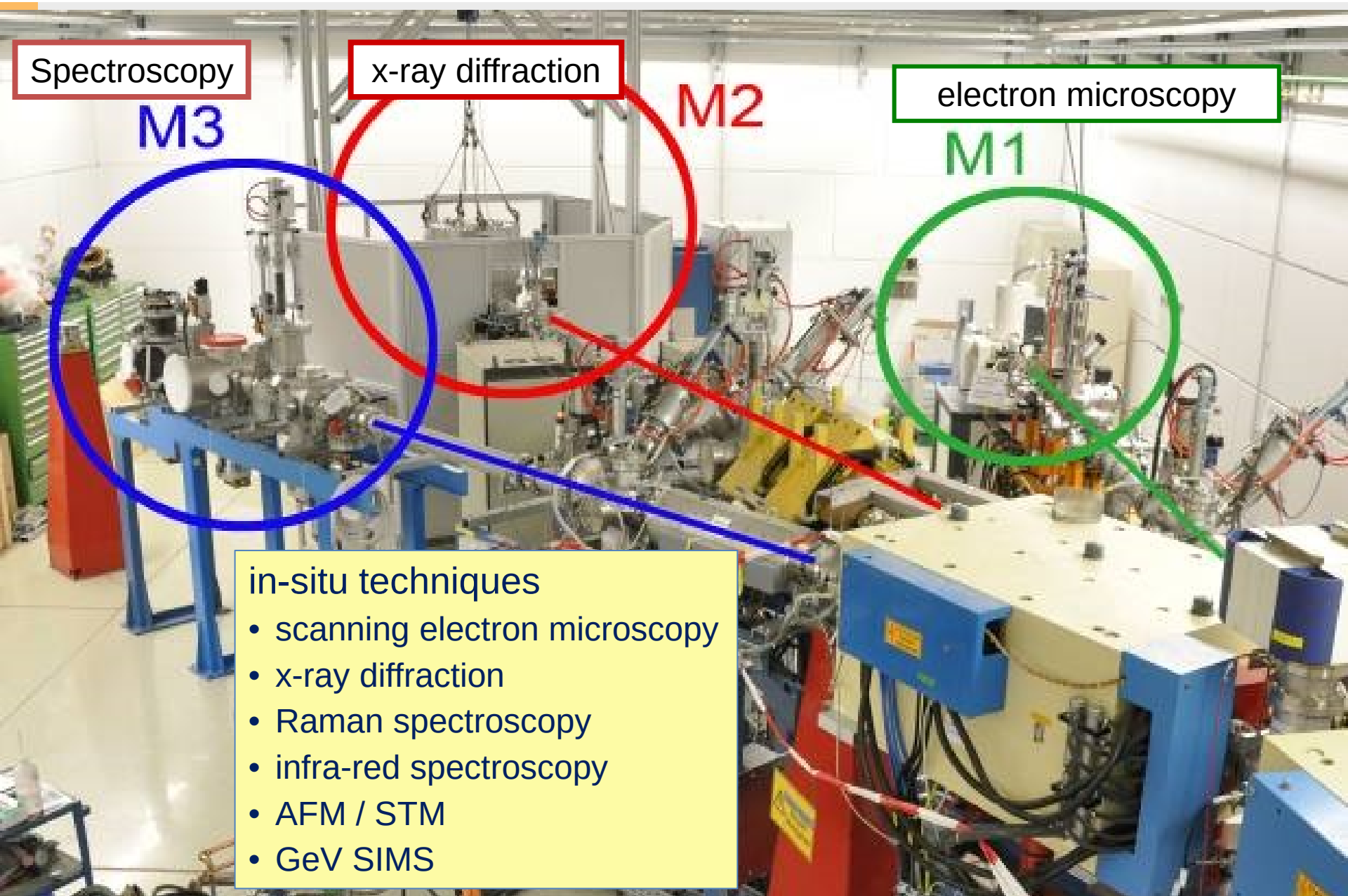






- **protons – U ions**
- **E_{max} 11.4 MeV/u**
- **absolute targeting accuracy < 1µm**
- **targeting rate 1000 *ions/s***

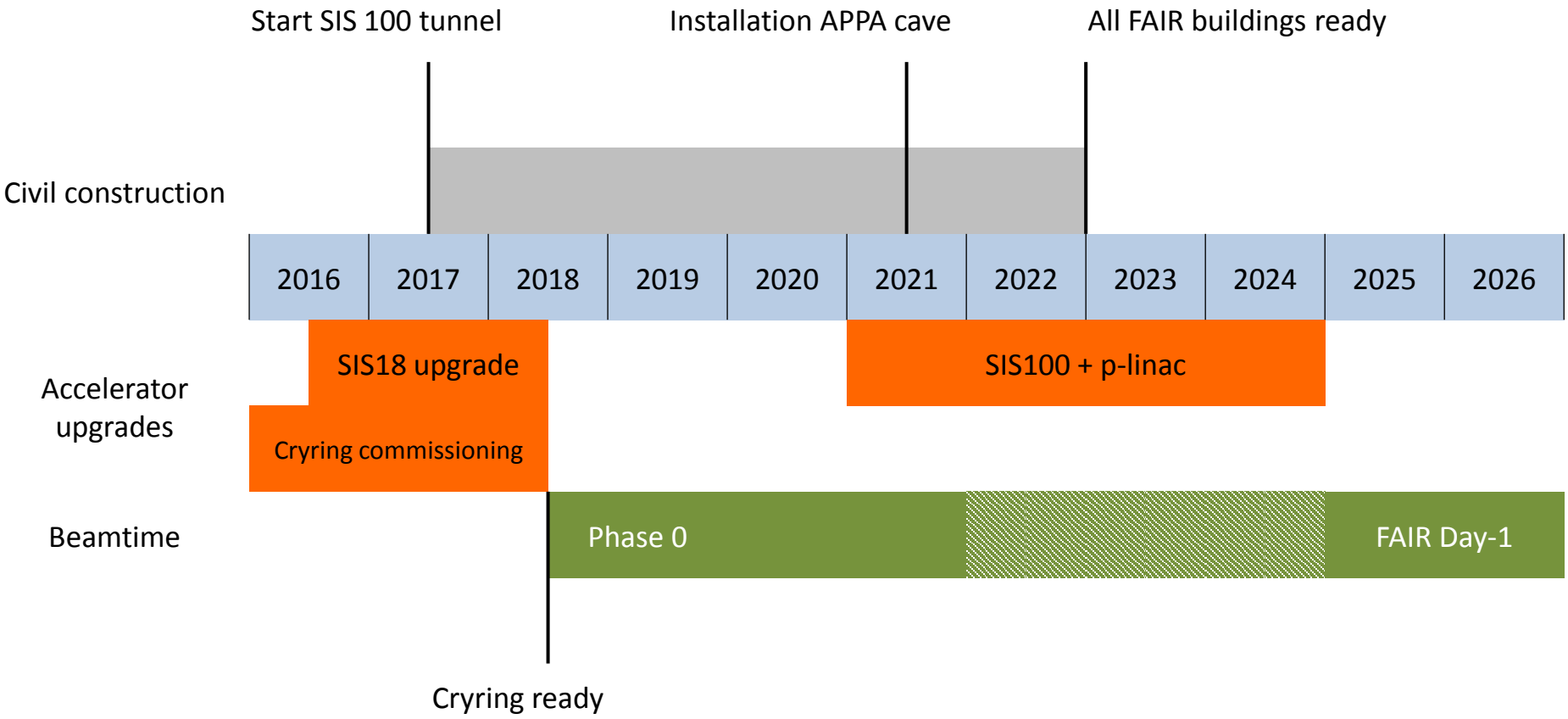
M-branch - UNILAC



in-situ techniques

- scanning electron microscopy
- x-ray diffraction
- Raman spectroscopy
- infra-red spectroscopy
- AFM / STM
- GeV SIMS

Timeline



UNILAC and SIS-18 beam time available ≥ 2018
call for proposal: deadline extended to June 19, 2017