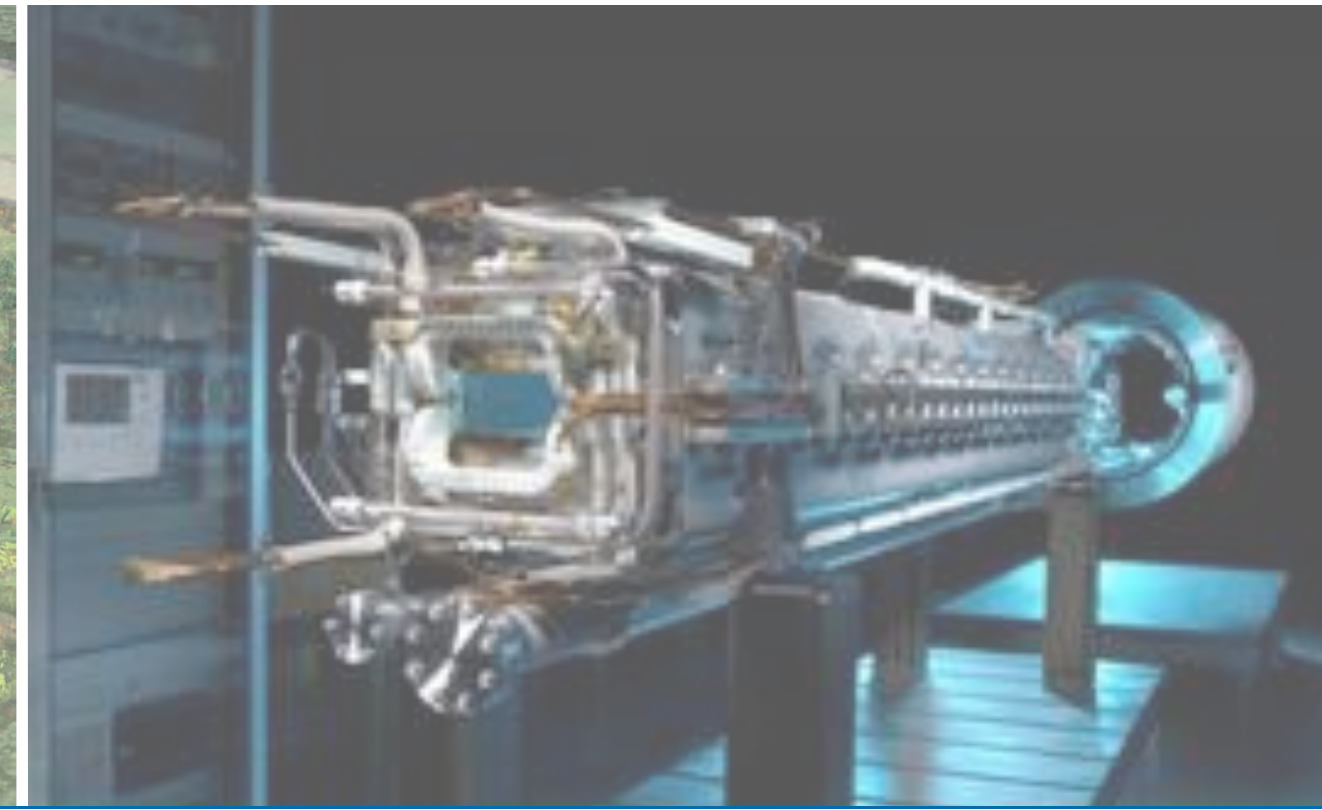




Installations for APPA cave experiments

*Stephan Neff
SPL APPA / Resource coordinator HED@FAIR*

APPA cave

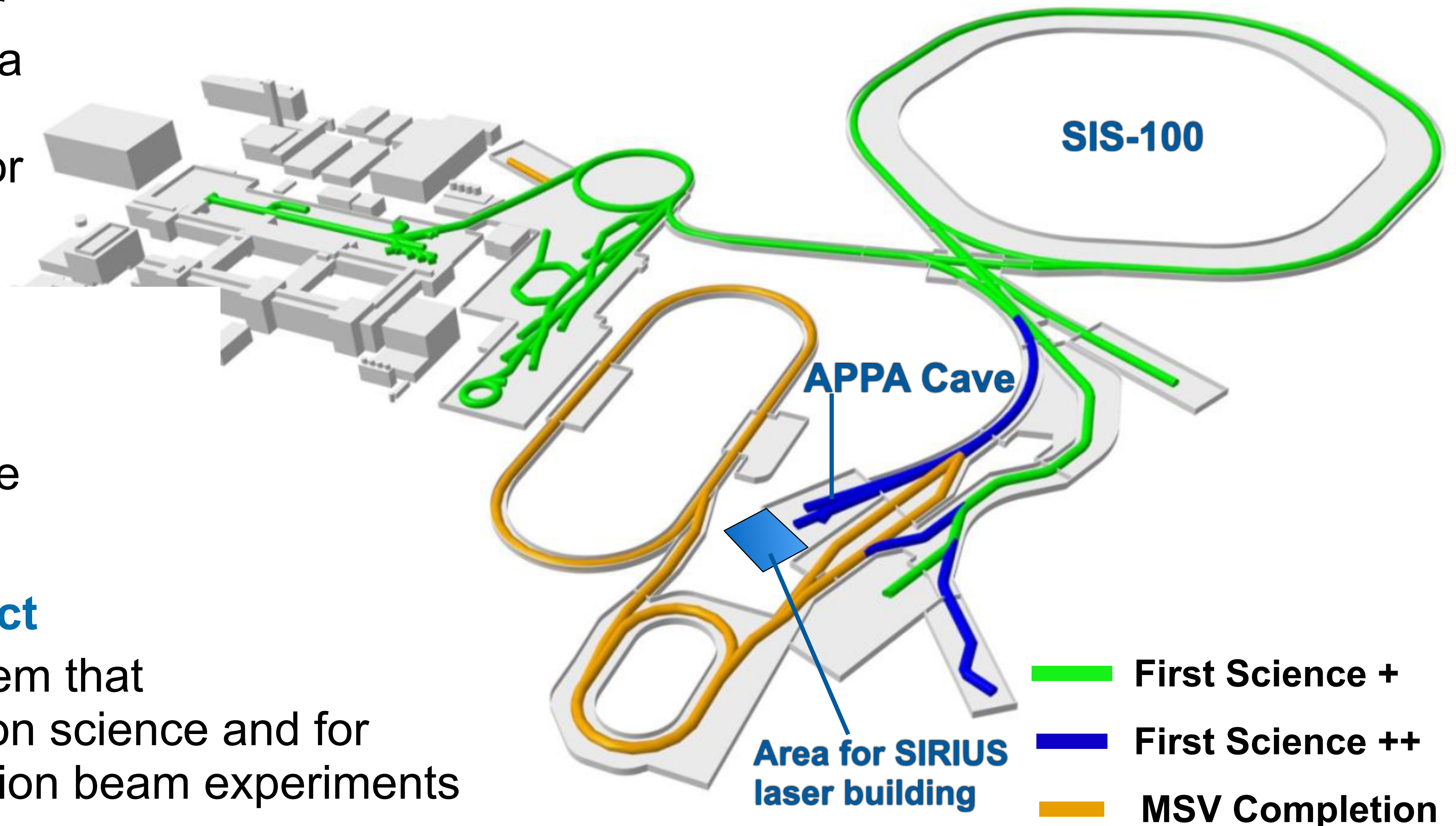
- Beam from SIS-100 or directly from SIS-18 via bypass
- Separate beamlines for HED@FAIR, BioMat and SPARC

APPA support building

- Control rooms
- Technical infrastructure
- Laboratory space

The SIRIUS laser project

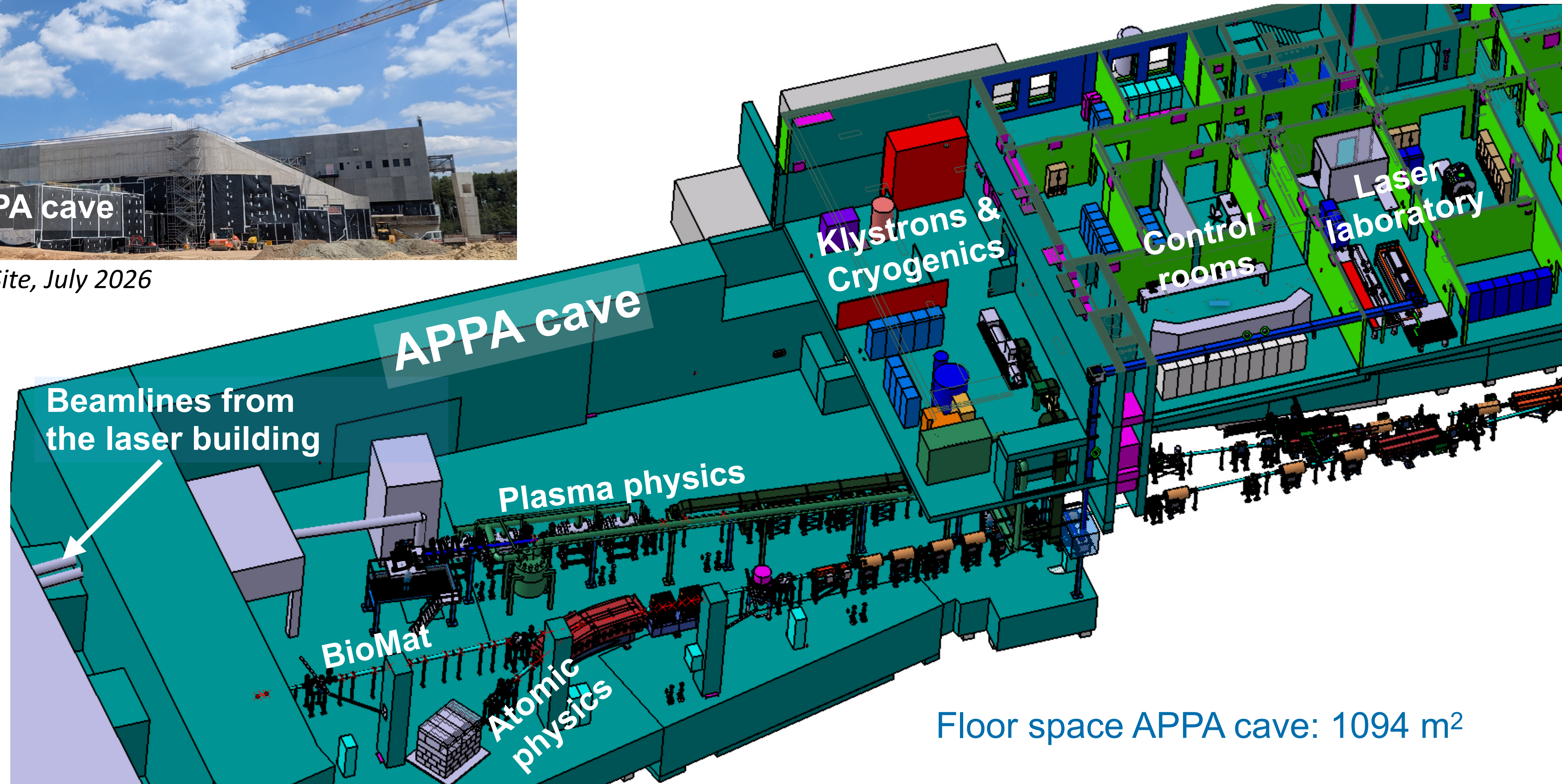
- High power laser system that could be used for fusion science and for coupled laser - heavy ion beam experiments



The experimental setups will be located in the APPA cave



FAIR Construction Site, July 2026

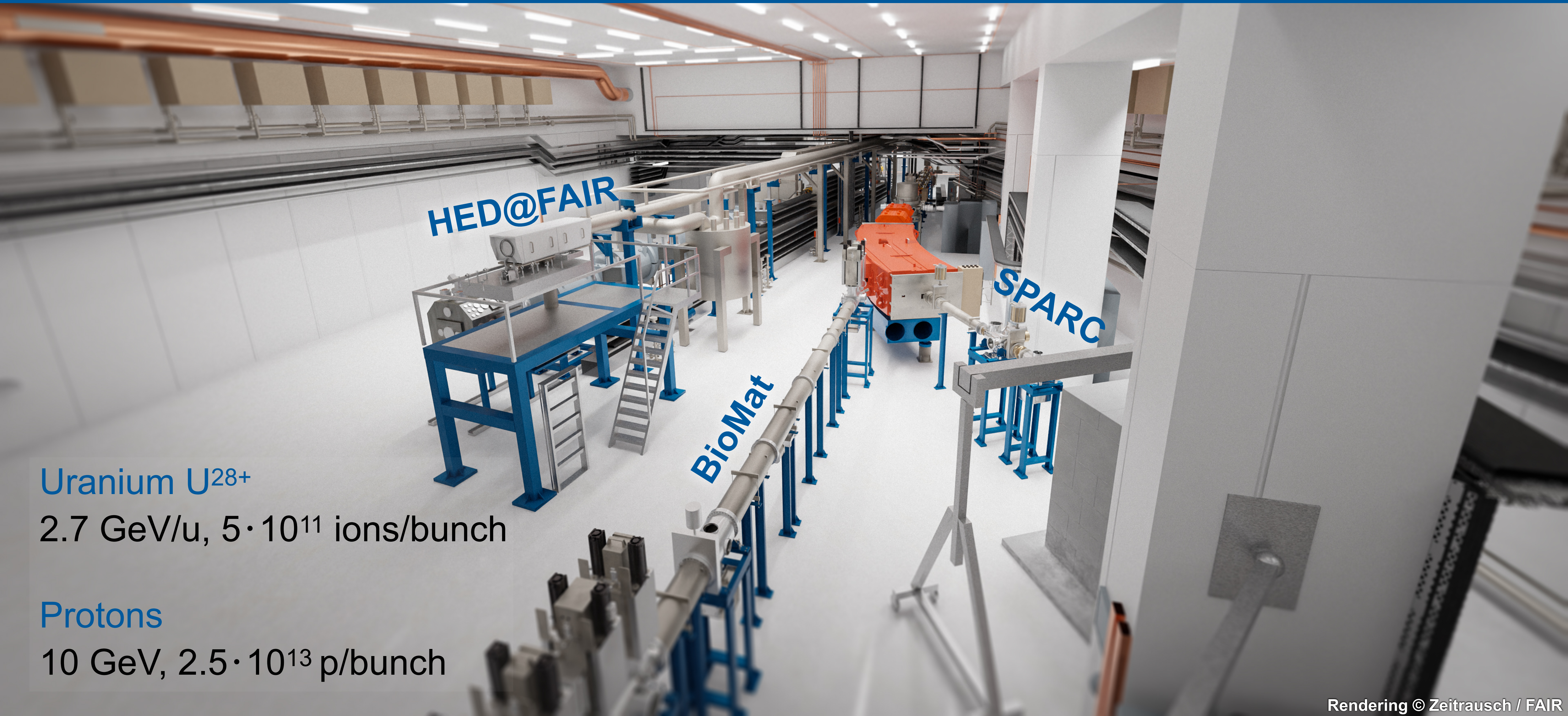


Floor space APPA cave: 1094 m²

SIS-100 will offer unique beams for experiments

	SPARC		HED@FAIR		Biophysics	Materials research	
	$U^{28+}, U^{73+}, U^{90+}, U^{91+}, U^{92+}$	Ar^{18+}	U^{28+}	Protons	Protons, He, C, Ne, Fe, Ar, Kr, Xe, U	Protons - U	Protons - U
Time structure	slow extraction		Single compressed bunch	Train of 8 bunches	slow extraction	slow extraction	fast extraction 2 Hz
Spill length / bunch length	10 s		50 ns		1 - 10 s	1 - 10 s	minimum
Number of ions per cycle	10^8	10^{10}	$5 \cdot 10^{11}$	$2 \cdot 10^{13}$	$5 \cdot 10^{10}$ (protons) $1.5 \cdot 10^{10}$ (He) $10^8 - 1.5 \cdot 10^9$ (other ions)	10^9 ($5 \cdot 10^{10}$ @ 500 MeV/u)	$5 \cdot 10^{10}$
Repetition rate	N/A		2 - 20 shots per hour		N/A		
Energy range (GeV/u)	0.1 - 10		0.4 - 2.7	3 - 10	0.1 - 10		
Ref. energy (GeV/u)	2	0.12	2	5	2		0.7

The APPA cave will house dedicated beamlines for HED@FAIR, BioMat and SPARC

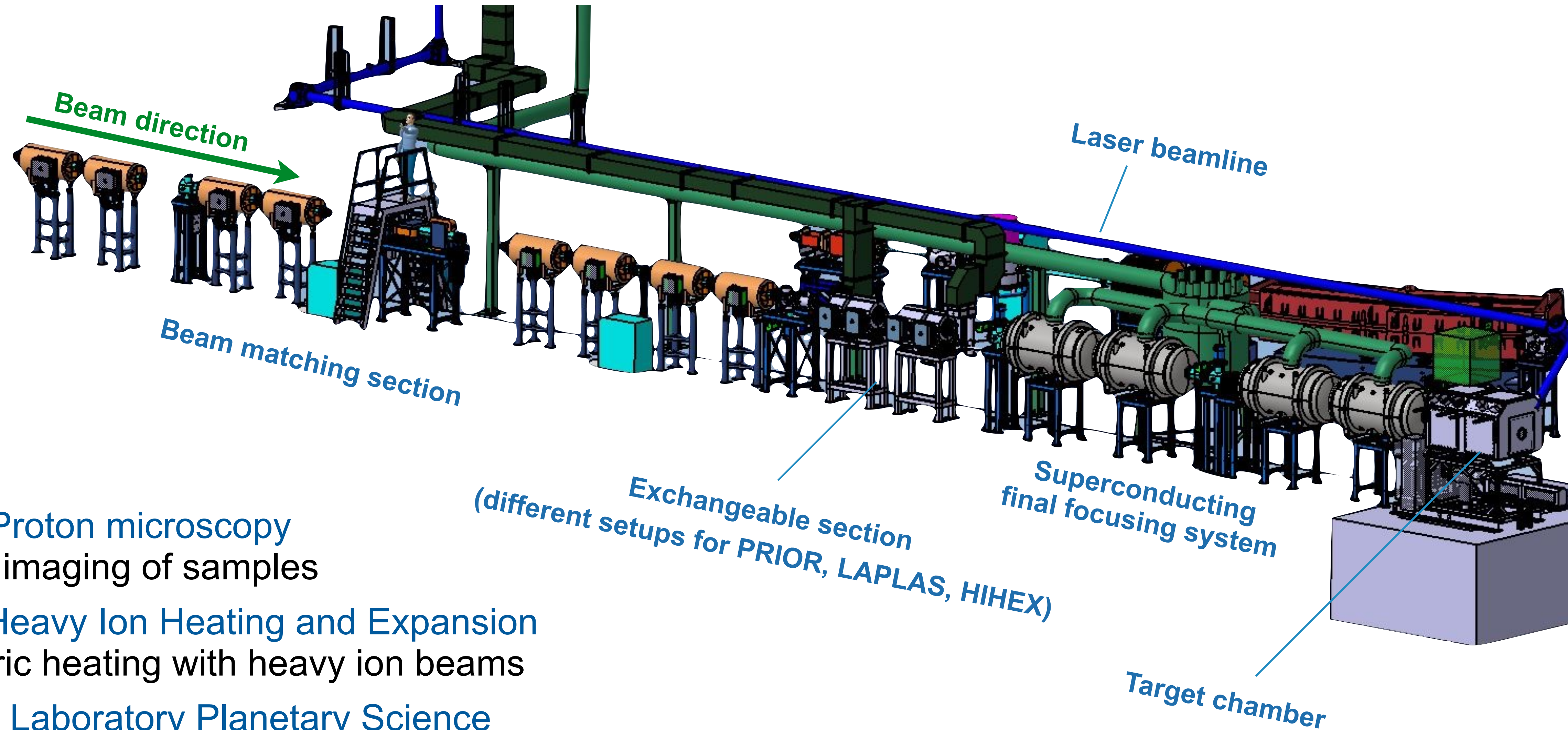


Uranium U^{28+}

2.7 GeV/u, $5 \cdot 10^{11}$ ions/bunch

Protons

10 GeV, $2.5 \cdot 10^{13}$ p/bunch



PRIOR - Proton microscopy

- Proton imaging of samples

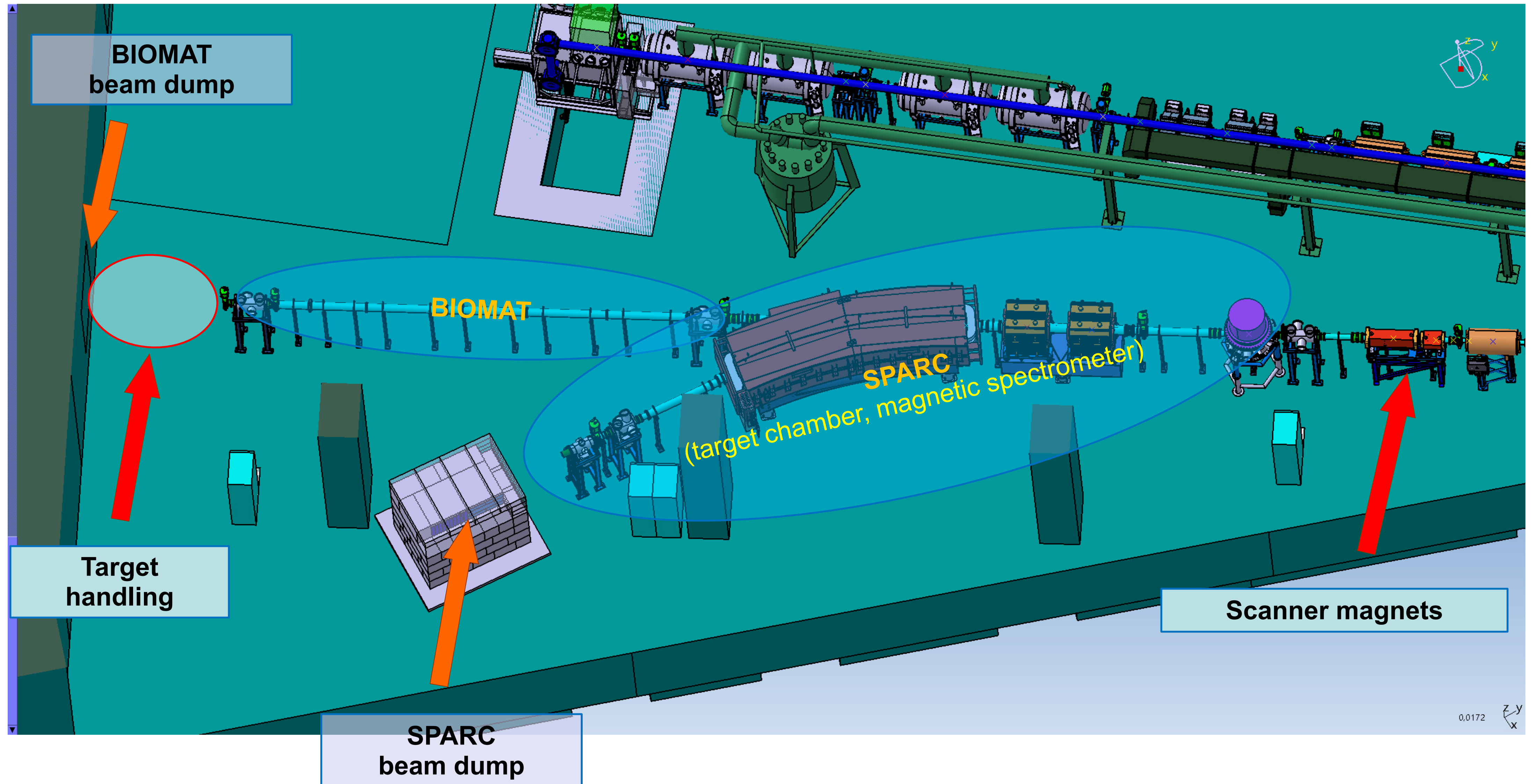
HIHEX - Heavy Ion Heating and Expansion

- Isochoric heating with heavy ion beams

LAPLAS - Laboratory Planetary Science

- Isentropic compression with heavy ion beams

A second beamline serves the BioMat and SPARC experiments



Civil construction work for FAIR First Science++ is nearly complete



Most of the basic work in the APPA cave and the support building has been completed

Essential parts of the technical basic infrastructure are being installed as part of the First Science scope:

- Basic ventilation and lighting
- Basic fire extinguishers
- Basic heating
- Basic power supplies and water
- Elevator
- Cranes
- Beam dumps (w/o graphite core)

The APPA cave and support building will be included in the final acceptance for the building permit (“Hessische Bauordnung”) for FS/FS+.



Current status of the APPA cave

The APPA building includes control rooms, laboratory space and the technological infrastructure for the experiments

Remaining infrastructure for installation

- Full fire safety system and radiation control safety, access control system
- Full air conditioning and ventilation, data connection
- Sanitary installation, technical gases
- Cabling for controls, data etc.

The APPA building will house essential infrastructure for the experiments

- Three control rooms for HED@FAIR, BioMat and SPARC
- Laboratories
- Klystrons, cryogenics, electronics
- Storage space
- Meeting room



▲ Laboratory

▼ BioMat control room



Media supply room ▼



The SIRIUS project would provide a high-power laser for fusion science and for coupled laser - heavy ion beam experiments

Four beamlines

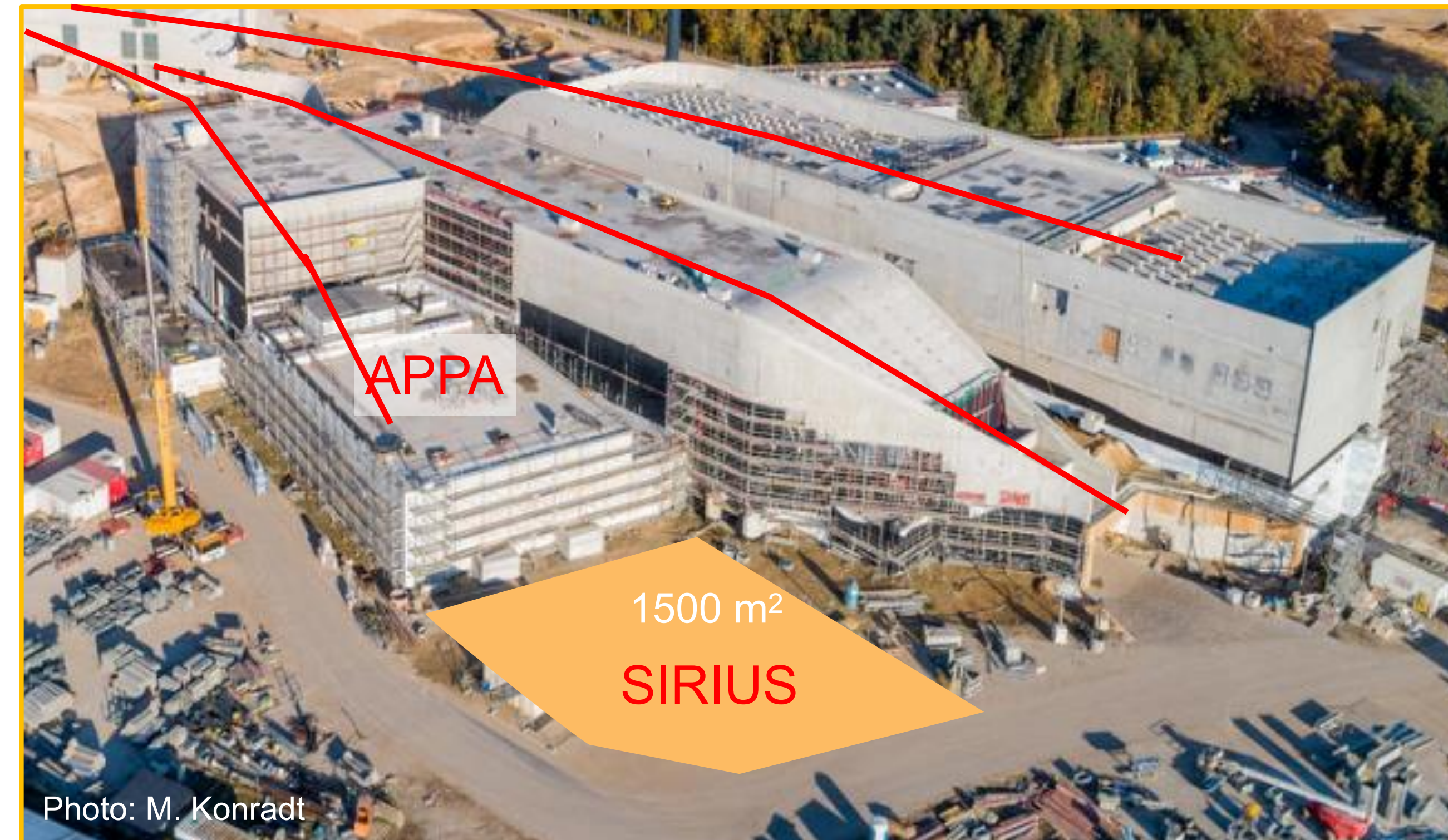
- kJ ns pulses
- Option for short-pulse operation

Two target stations

- Target chamber in APPA cave for coupled experiments
- Target chamber in the laser building for laser-only experiments

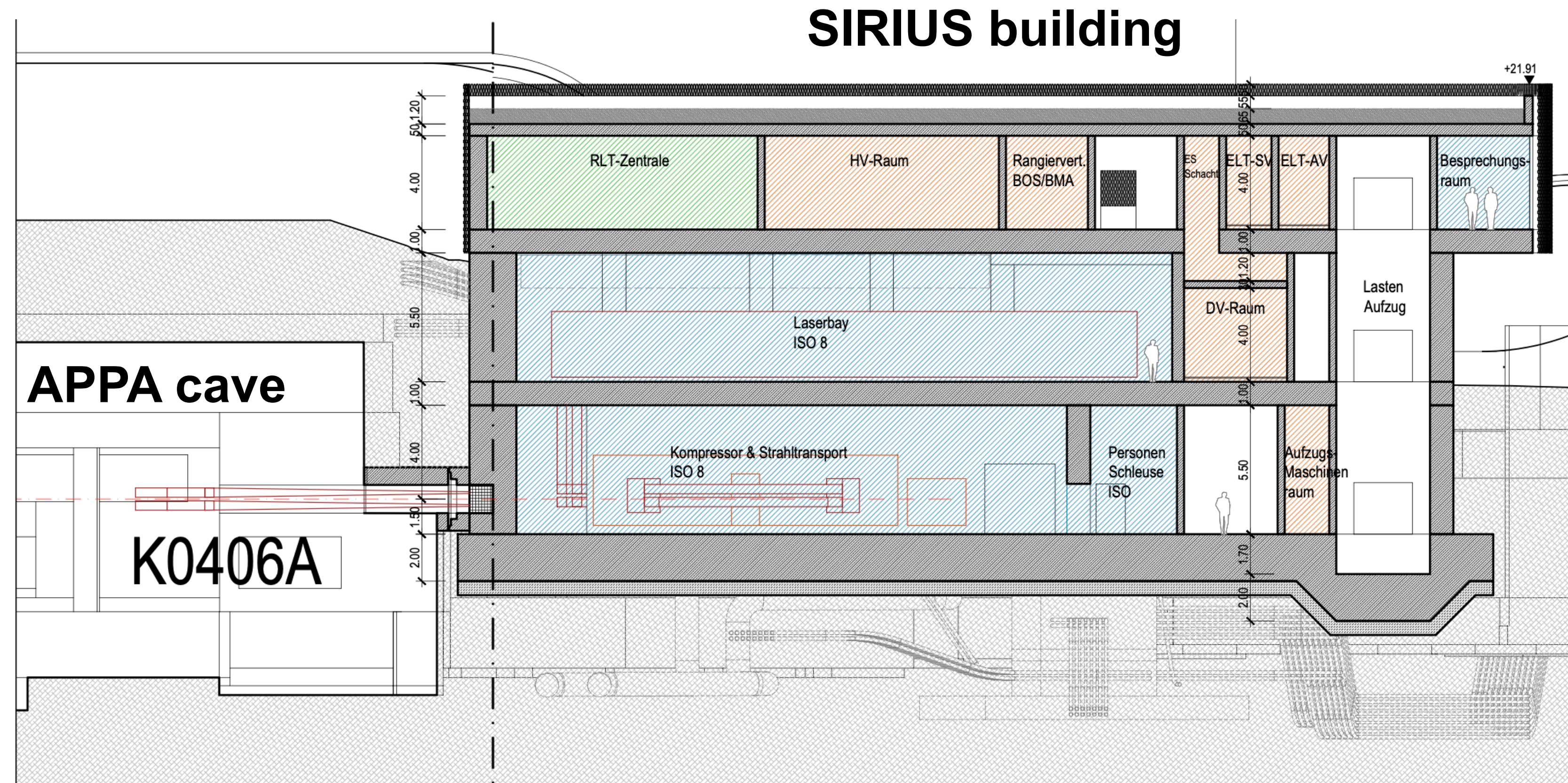
Next steps

- A conceptual design report for the laser is in preparation as part of the European THRILL project
- A proposal for the inclusion in the German roadmap for research infrastructures is in preparation
- It is planned to apply for funding in the framework of the German fusion science initiative



For details about the laser system, see the talk by V. Bagnoud

- Building will be connected to the FAIR media supplies (power, cooling water, etc.)
- The CAD model of the building has been added to the FAIR building database to reserve the needed space

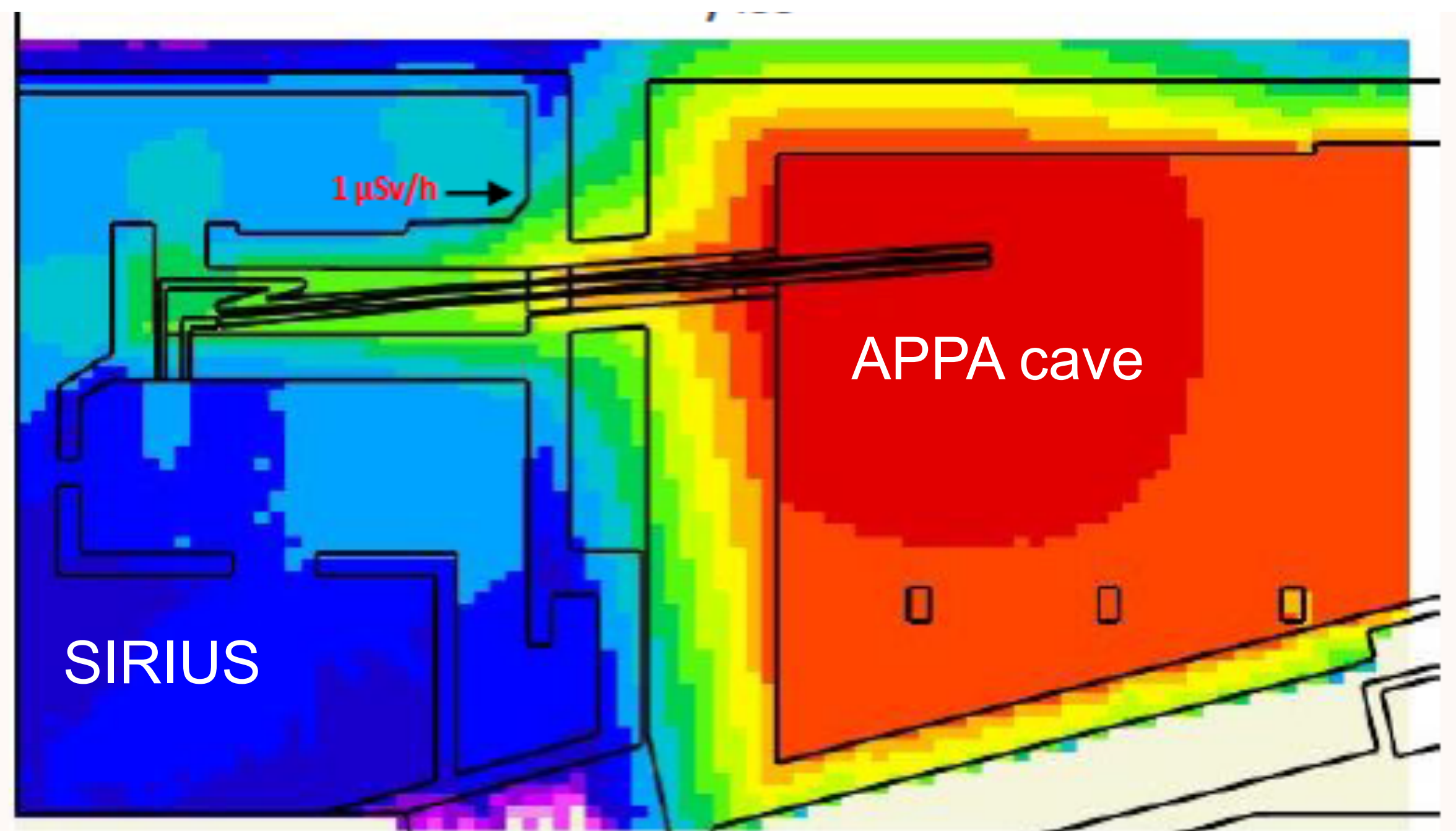


Radiation safety calculations show sufficient shielding of the laser building from ion beam induced radiation in the APPA cave

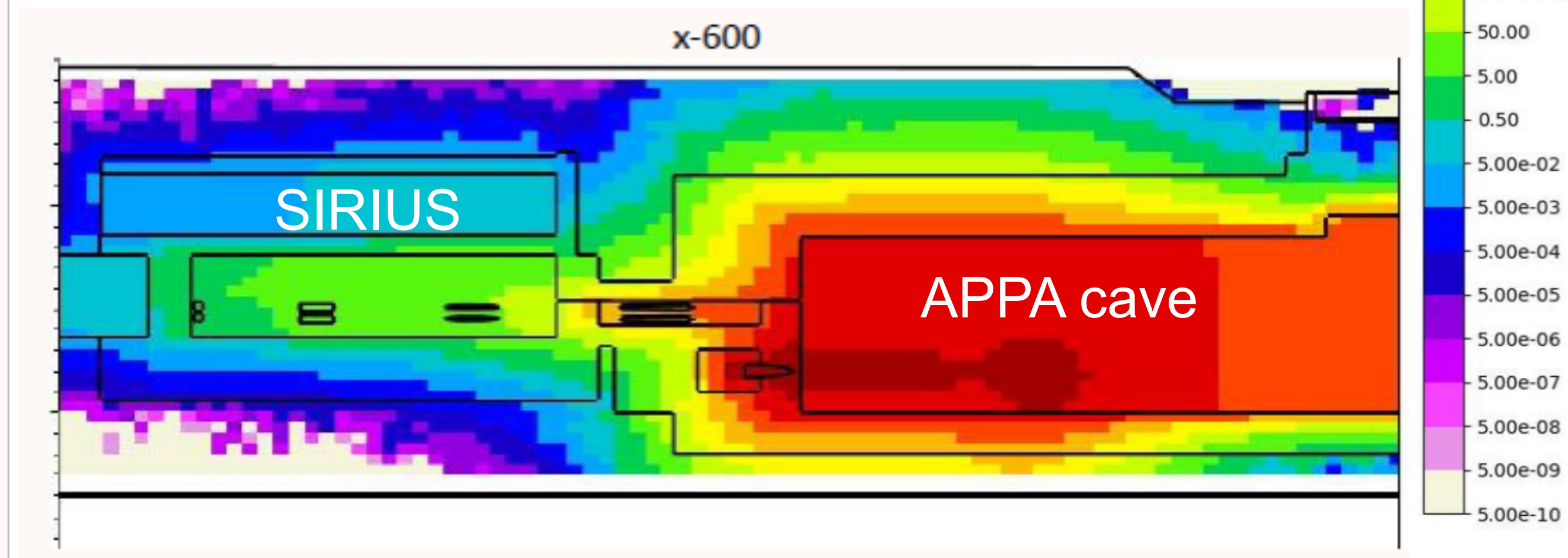
During operation in APPA cave – residual radiation exists in the transfer tunnel

- Access restriction
- Ventilation of the transfer tunnel through the system for the APPA cave

radiation in basement (top view)



radiation in building (side view)



We are looking forward to the realisation of the experiments in the APPA cave

- FAIR will offer unique beam parameters for experiments
- Dedicated beamlines for HED@FAIR, BioMat and SPARC allow for a fast switch between experimental campaigns

The APPA cave is ready for installation once funding is available

- The civil construction is finished
- Essential parts of the technical basic infrastructure are currently being installed
- Tendering for the remaining infrastructure can begin once funding is available
- Necessary installations for experiments include the beam transport line to the APPA cave

Other activities could help bridge the time gap until the APPA cave is available

- BioMat has proposed to carry out experiments at the S-FRS and in the CBM cave
- The SIRIUS laser project would provide fusion science opportunities and could later be used for coupled laser - heavy ion beam experiments

Thank you for our attention

