



Poland @ FAIR

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FAIR: layout of facility & status

SIS100 → protons 29 GeV to U^{92+} 11 GeV/u (14 GeV C, Ca)

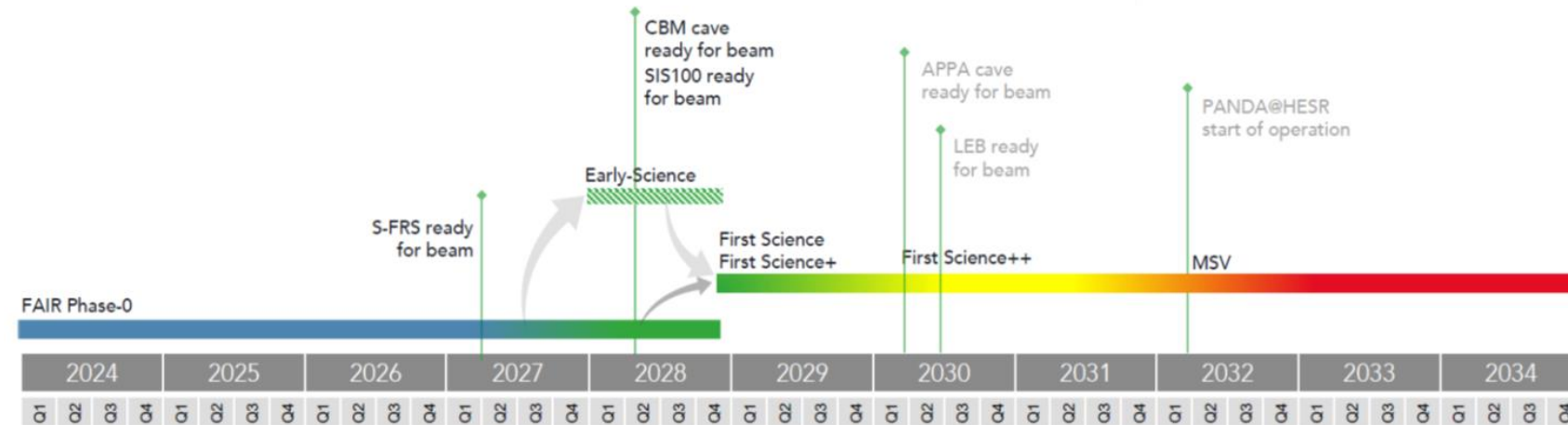
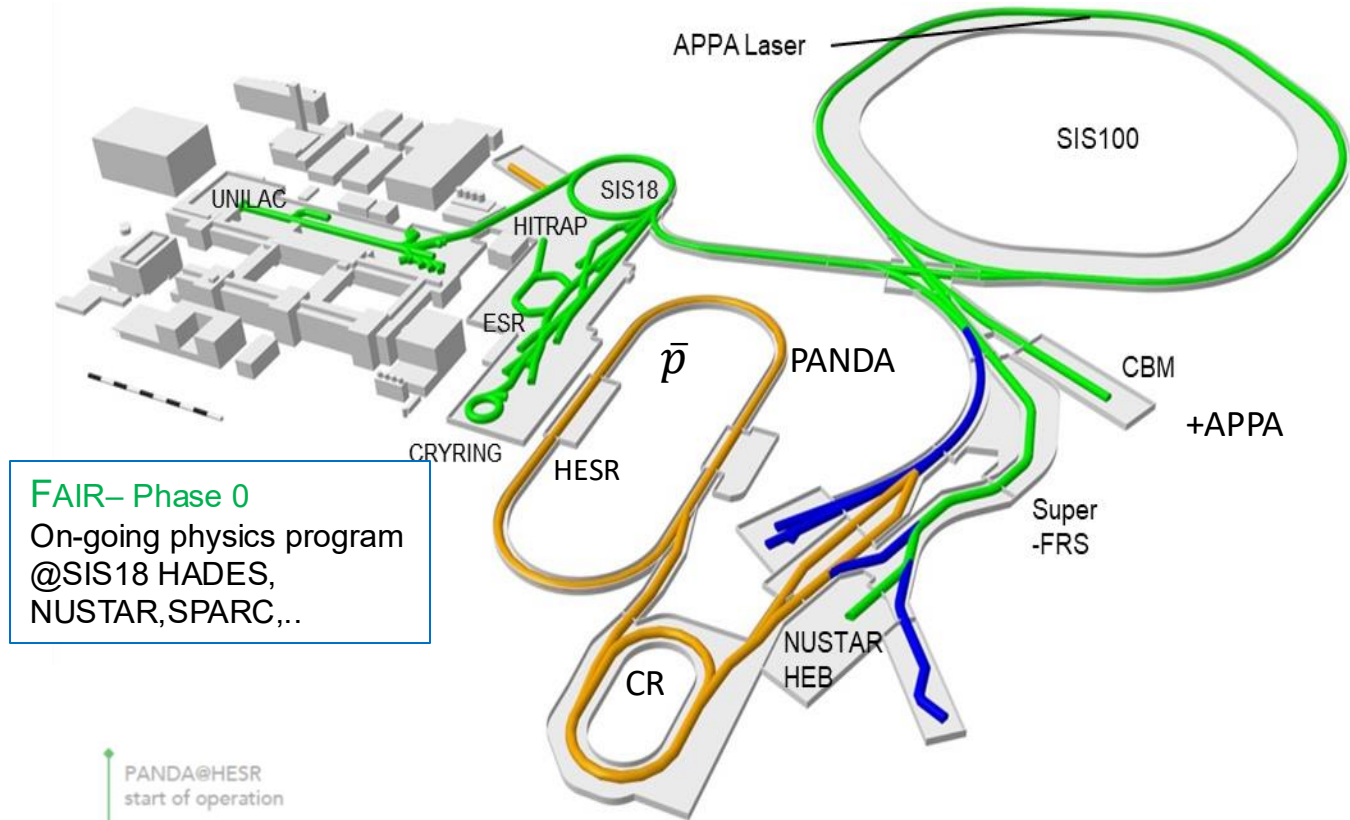
250 superc. magnets, 11 ton He, ~140 GWh Energy/year

- ✓ High Intensity beams: 5×10^{11} /s (U^{28+})->light-ions-> 2×10^{13} p/s
- ✓ High intensity radioactive beams :

Super-Fragment Separator-SFRS

HEB in construction, completion of LEB next step

- ✓ storage rings : ESR, CRYRING
- ✓ CBM on track with completion till 2028
- ✓ antiprotons (HESR), Collector Ring (CR) on hold (>2032?)



FAIR @ 2025



- ✓ Civil construction completed
- ✓ 2024: Start of Installation of SIS100 and SFRS components in tunnels

Poland in FAIR



Signing of FAIR convention in Wiesbaden 2010



Jagiellonian University purchases shares (2013)

- FAIR has 9 shareholders and is controlled by **FAIR Council** (contributions from 200 Institutions and 53 countries)

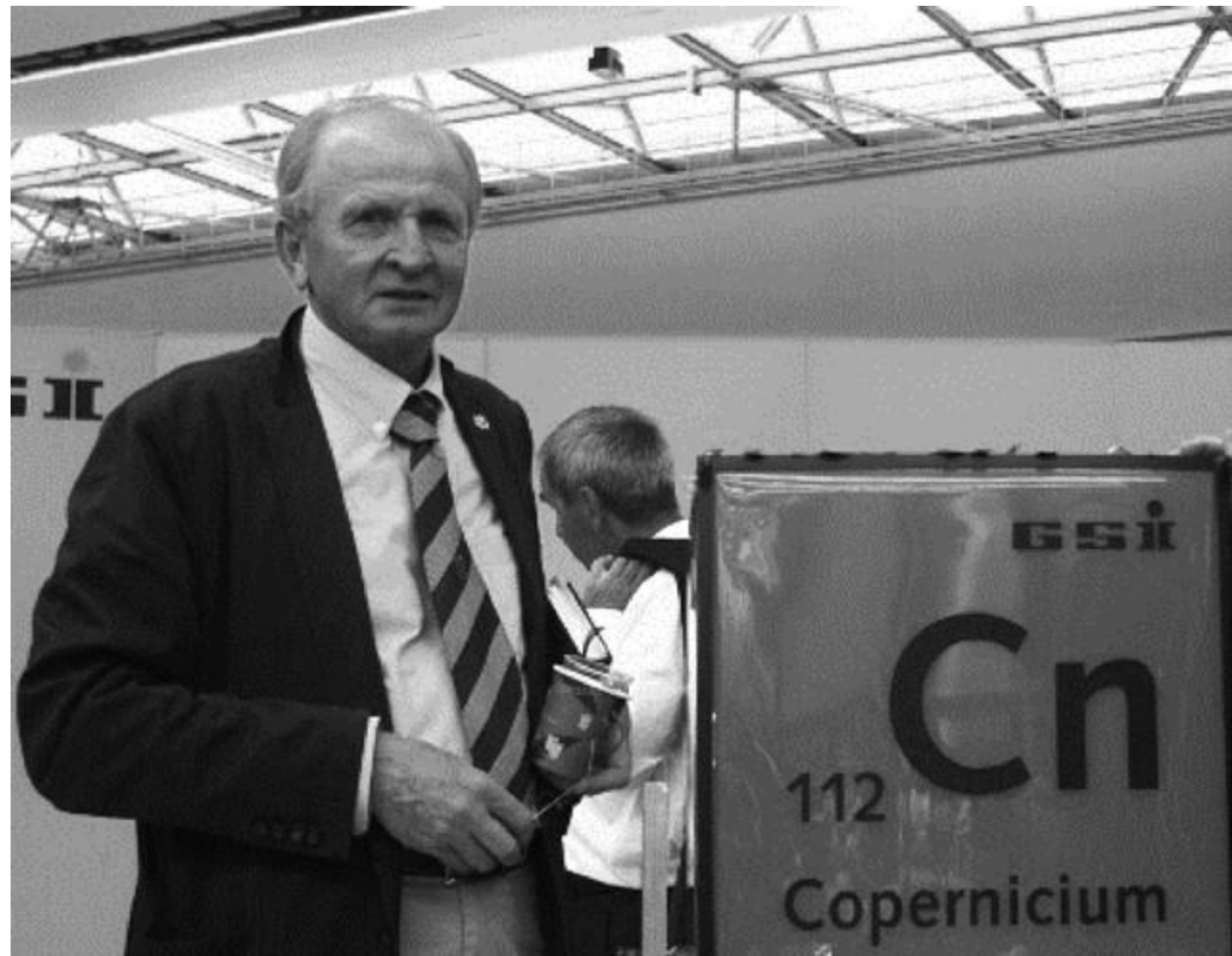


 Associated partner  aspirant country

- Poland has 2.3% of FAIR shares (~56.1 Mln Euro in 2005 prices, ~34.8 Mln Euro assigned). Contribution in form of in-kind and cash. There are 19 In-kind contributions into research infrastructure and experiments. Uniwersytet Jagielloński is coordinating polish contributions to FAIR <https://fair.uj.edu.pl/>
- Financing is provided by Ministry of Science and Education
- Krajowe Konsorcjum Femtofizyka is grouping 12 polish Institutions engaged in scientific programme at FAIR <https://fair.uj.edu.pl/konsorcjum>



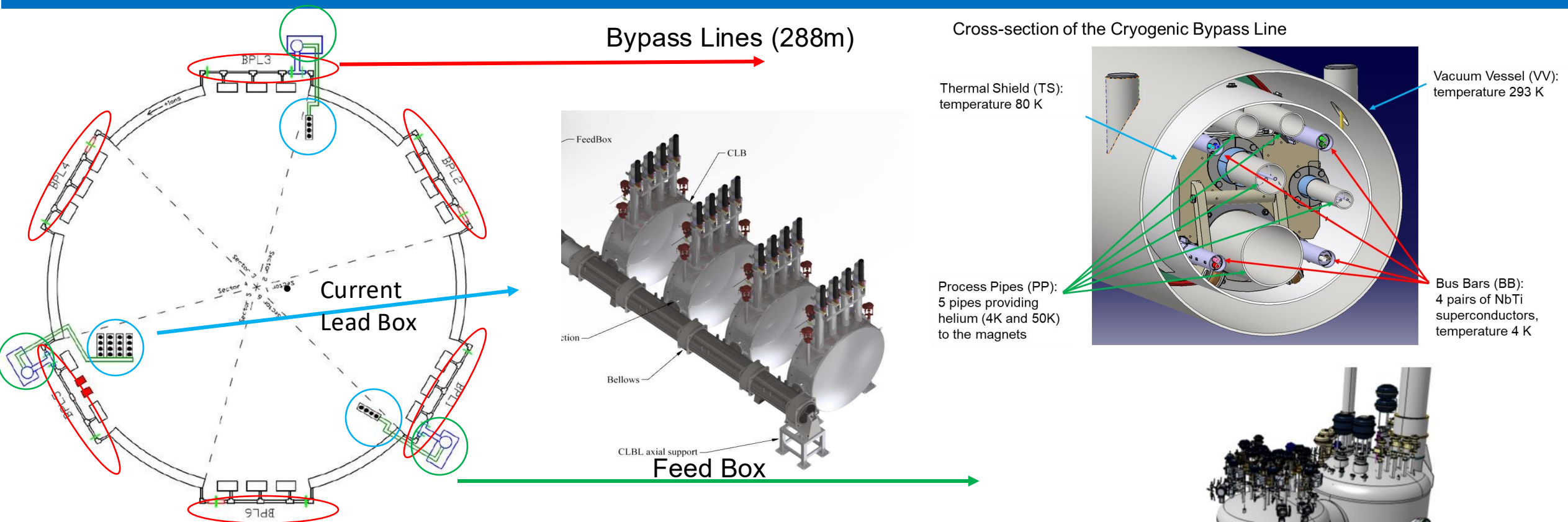
Prof. R. Kulessa signing the FAIR Memorandum of Understanding on **18.01.2005**. In the back: Dr. Schunck, Director General at Bundesministerium für Bildung und Forschung (BMBF) at that time, and Prof. Henning, then GSI scientific director.



Prof. Z. Majka Chair of shareholder 2013 -2024

Prof. Z. Majka at a celebration of the discovery of a new atomic nuclei, 112 Copernicium, GSI 2012.

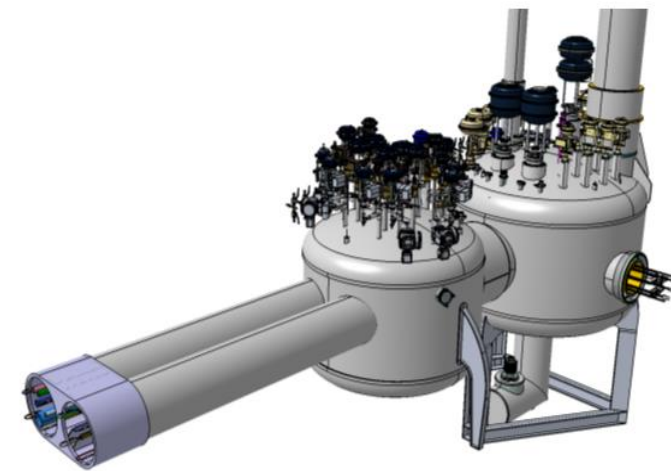
Polish in-kind contribution to SIS100



- Cryogenic and current distribution system for SIS100

Wrocław University of Science and Technology (M. Chorowski & col.): Design, production and installation **Key for First Science Physics (→ 2029)**

- Test systems for Dipole and Quadrupole magnets (Technical University, Gdańsk)
- Control system for SIS100 (UJ & S2Innovation)



Cryogenic systems for SIS100

ByPassLines: 1 (out of 6) lines@SIS100

@KRIOSYSTEM s.a



Politechnika
Wroclawska

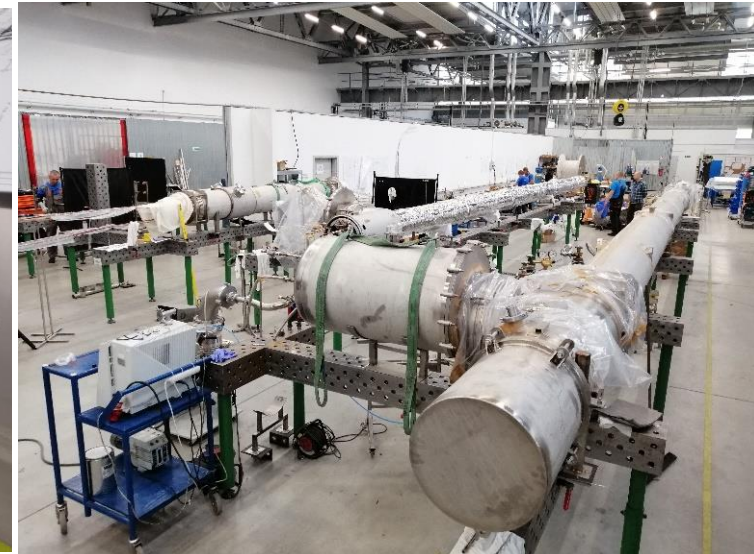


Current Lead Boxes
and links (INOX' India)

Transfer of current supply from
warm conductors to cold
superconductors

Completion scheduled on 03.2026

Feed Boxes (FB1) on 08.2026



✓ Bypass Lines production by KRIOSYSTEM
completed in 2024 installation at FAIR



IFJ-PAN (DAI) installation SIS100 (not yet in-kind)

- Installation of thermal shields between QDM and DM (07.09 – 16.09)



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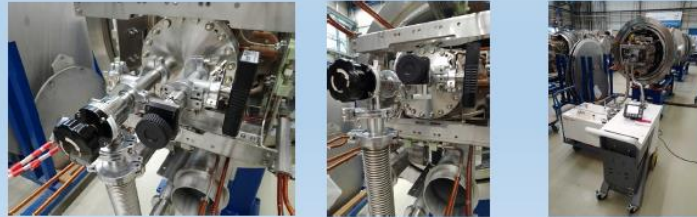
- MLI Wrapping of interconnection between QDM and DM



- Beamline interconnection between DMs (14.10)



- Connection of the vacuum eq. to the beamline at the downstream side of the DM-DM string (21.10)



- Installation of vacuum equipment on the beamline in EB (20.10)



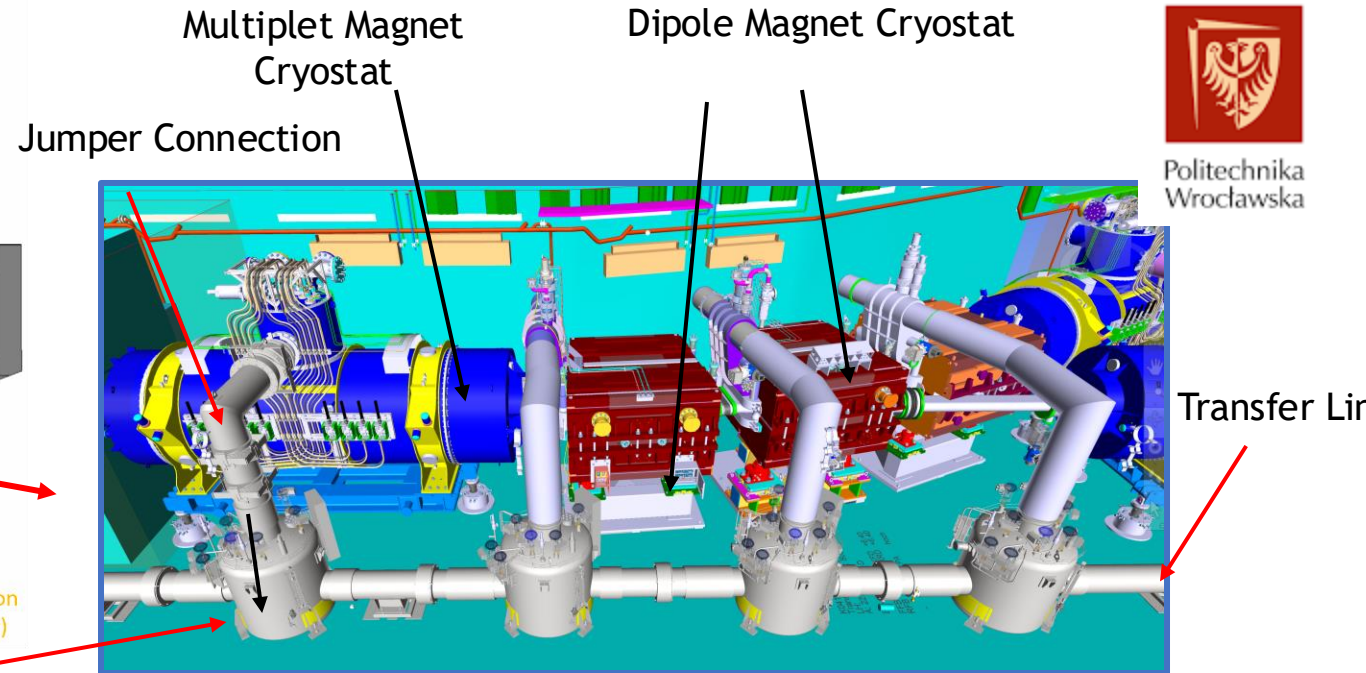
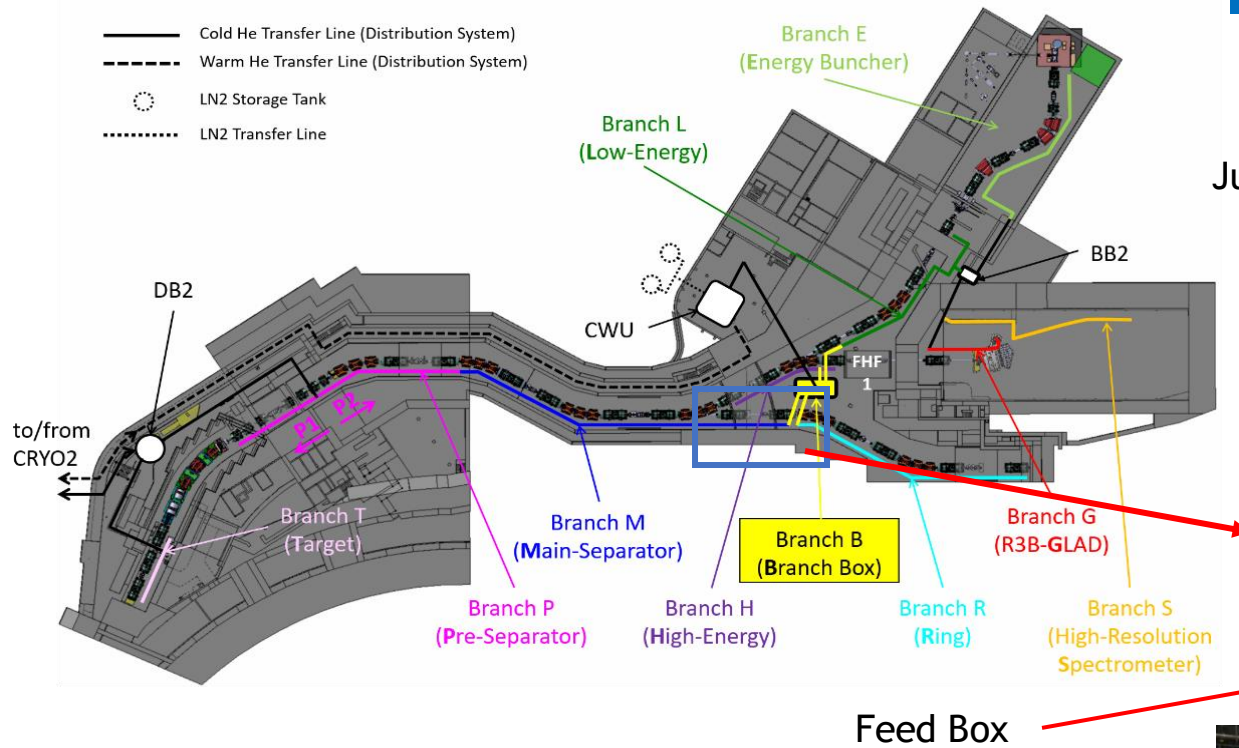
Experience gained in other Big Science projects: ESS Lund, E-XFEL, ITER-Cadarache, LHC-ATLAS,...

Activities at FAIR :

- Preparation of procedures in installation processes
- Preparation of quality control and assessment processes
- Execution of Installation

Preparation of new in-kind contribution

In-kind to SFRS



Politechnika Wroclawska

Wrocław University of Science and Technology : Design of the cryogenic system , 8 branches of SFRS, production of two branches (T,P)

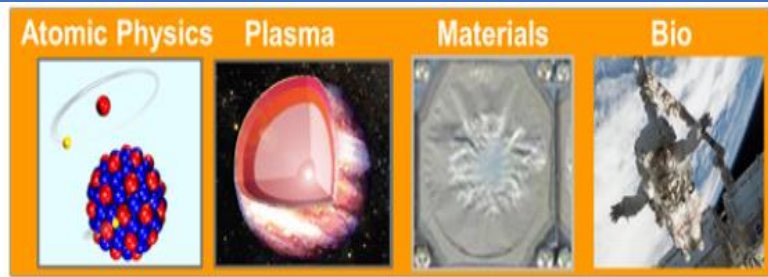
✓ First Branch produced (T) tests on-going at FAIR

Key element for for SFRS

Completion of T(2025), P (Q2.2026) –



FAIR:Research Research Pillars

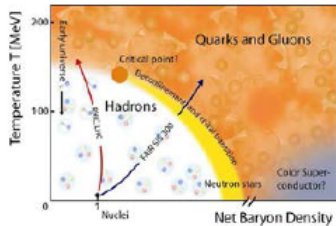


Atomic Physics, Plasma physics
and applications

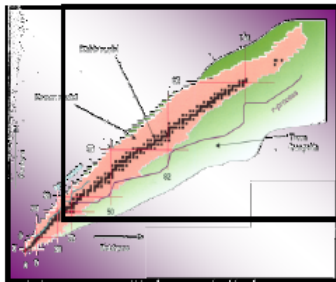
APPA

Scientists
World / Poland

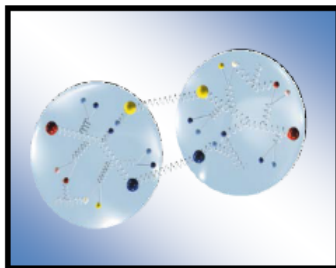
700 / 13



Compressed Baryonic Matter **CBM**



Nuclear STructure
Astrophysics and Reactions **NuSTAR**



hadron structure with Antiproton
ANihilation (at DArmstadt)

PANDA



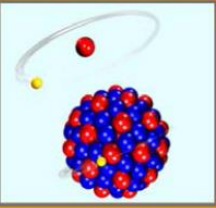
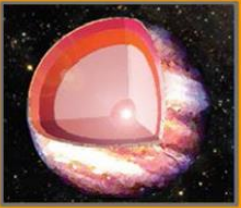
400 / 44

660 / 20

450 / 20

+ 46 scientists &
engineers contributing
to infrastructure

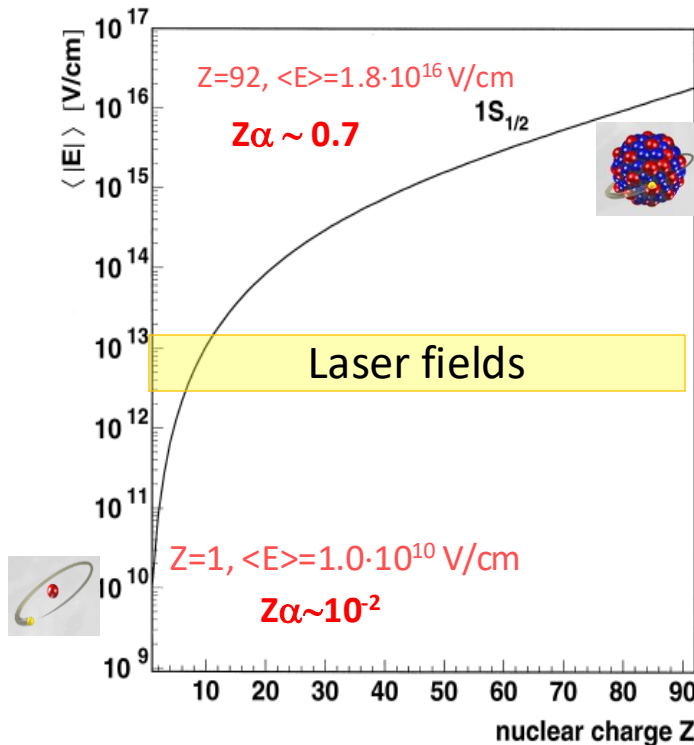
APPA (Atomic, Plasma Physics and Applied Sciences)

Atomic Physics	Plasma	Materials	Bio
			
SPARC strong field research ... probing fundamental laws of physics	HED warm dense matter ... states of matter common in astrophysical objects	MAT/BIOMAT radiation hardness ... mechanical and electrical degradation of materials	BIO/BIOMAT space travel ..cosmic radiation risk and shielding particle therapy radioactive beams FLASH therapy

SPARC
Atomic Physics



BIOMAT
Biophysics and material science



Research areas of polish groups

- Precise tests of QED in strong em. fields (SPARC)- high precision tests in He-like Uranium atoms, radiative electron capture processes (in-kind contribution of UJK -high resolution von Hamos spectrometer)
- New methods of radiotherapy with ion beams and effects of radiation on cells (relevant for space missions) (BIOMAT)
- On-line imaging of dose induced by radioactive (^{11}C) with SciFi-Compton Camera developed at JU

NUSTAR (Nuclear Structure Astrophysics and Reactions)

Polish participation

- **Super FRS**

Production and decays of radioactive isotopes (2p radioactivity)

- **HISPEC/DESPEC:**

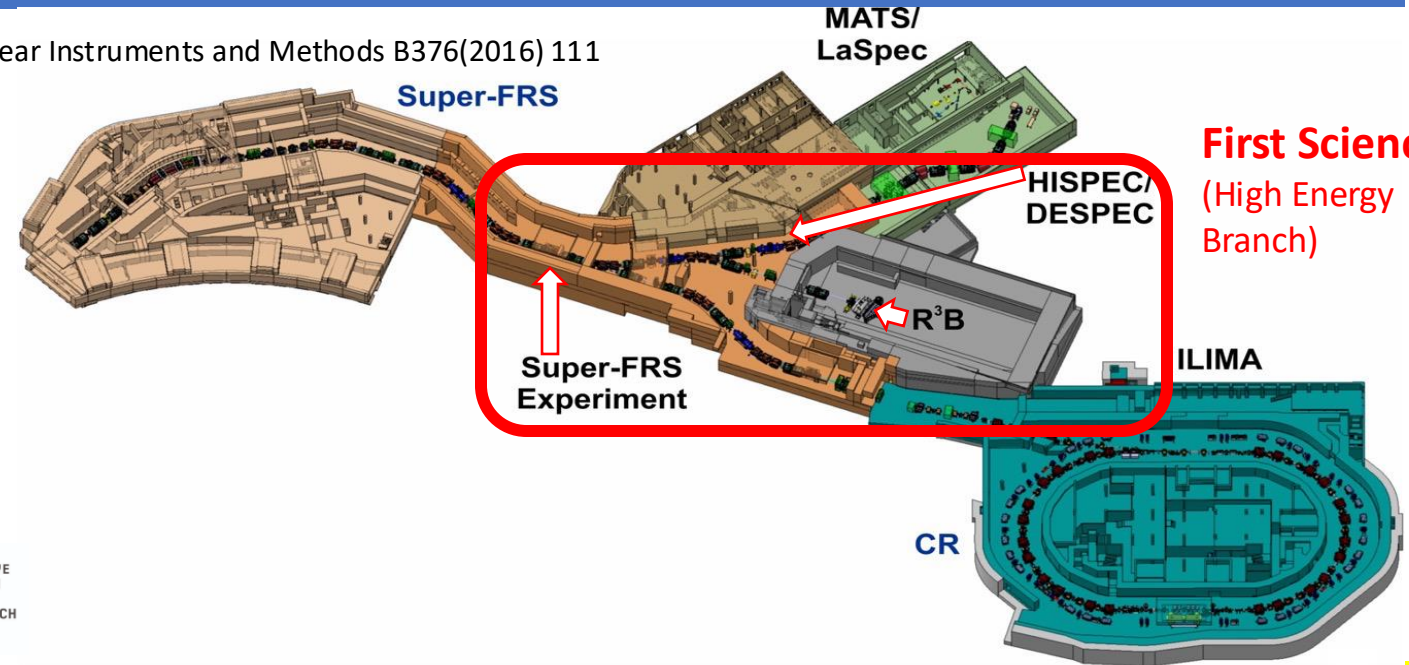
High resolution in-flight (HISPEC) and with stopped beams (DESPEC) gamma spectroscopy

- **R³B, ASY-EOS**

Reactions with Relativistic Radioactive Beams,
Equation of State (Symmetry energy, compressibility)-ASY-EOS

- **SHE:** Super-Heavy Element Research

Nuclear Instruments and Methods B376(2016) 111



Research Areas

- Limits of existence of nuclei (neutron and proton drip lines)
- Properties of proton and neutron rich nuclei (life time, deformations,...)
- Structure of their excited states (energy levels, decay modes)
- synthesis of superheavy nuclei
- origin of heavy nuclei in the universe (input to astrophysics -models)
- exotic nuclei – hipernuclei, hyperon-nucleon interactions
- Equation of State (EOS) of nuclear matter , symmetry energy (neutron stars)

Tests of NUSTAR detectors in CCB@IFJ

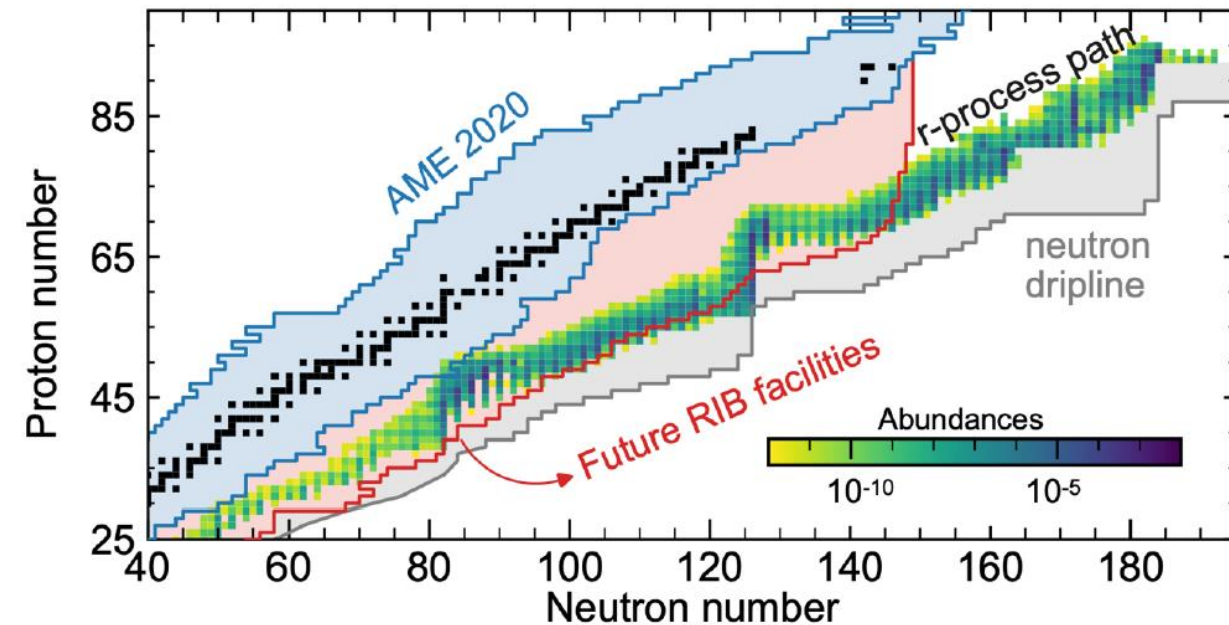
Super Fragment Separator (SFRS) @ FAIR

- Main machine for NUSTAR is SFRS FAIR will provide the most energetic and intense

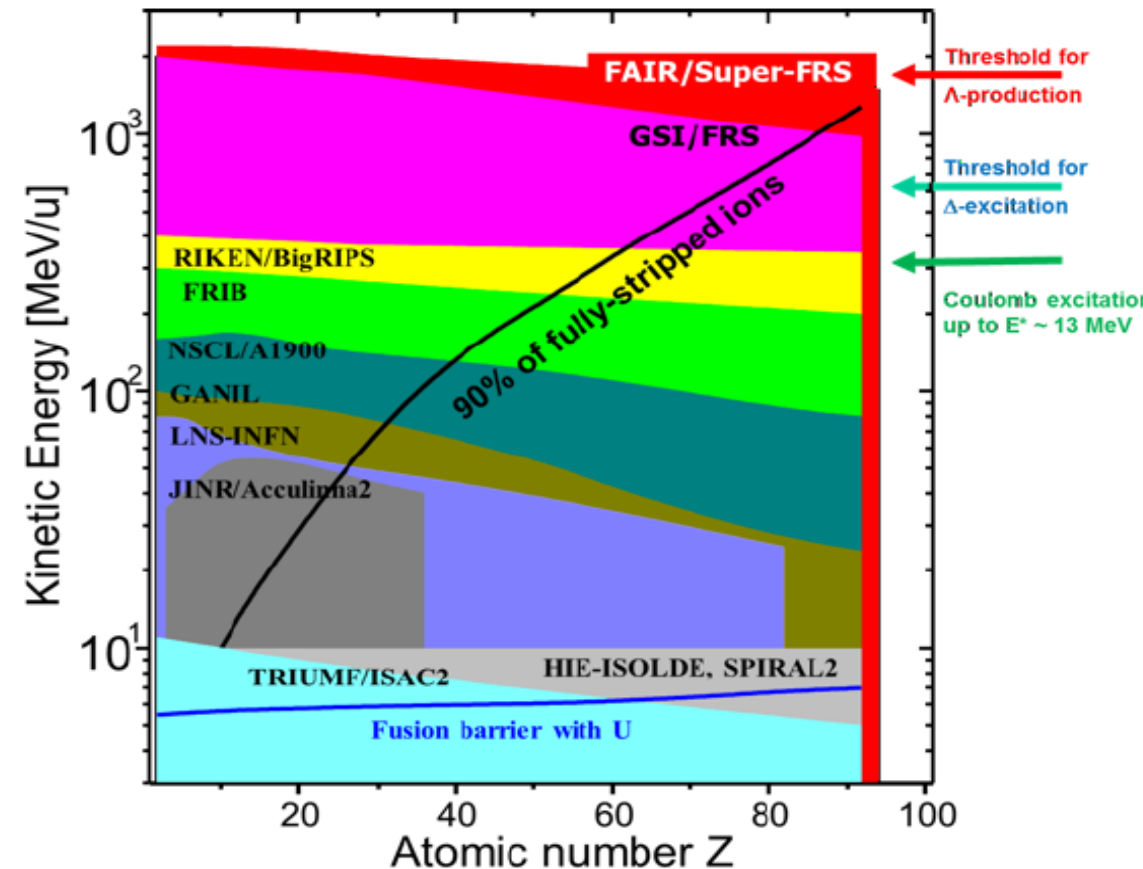
Radioactive Ion Beam facility in world

Isotopes accessible with SFRS

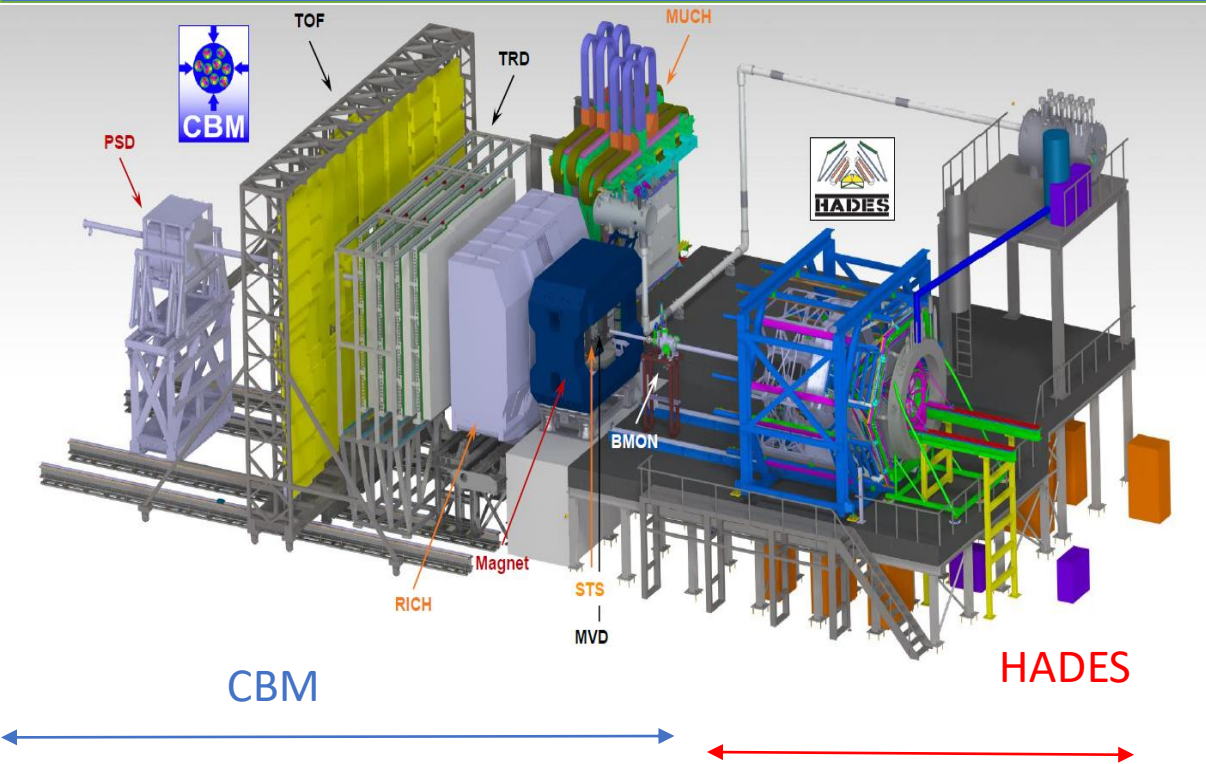
NUPECC Long Range Plan'2024



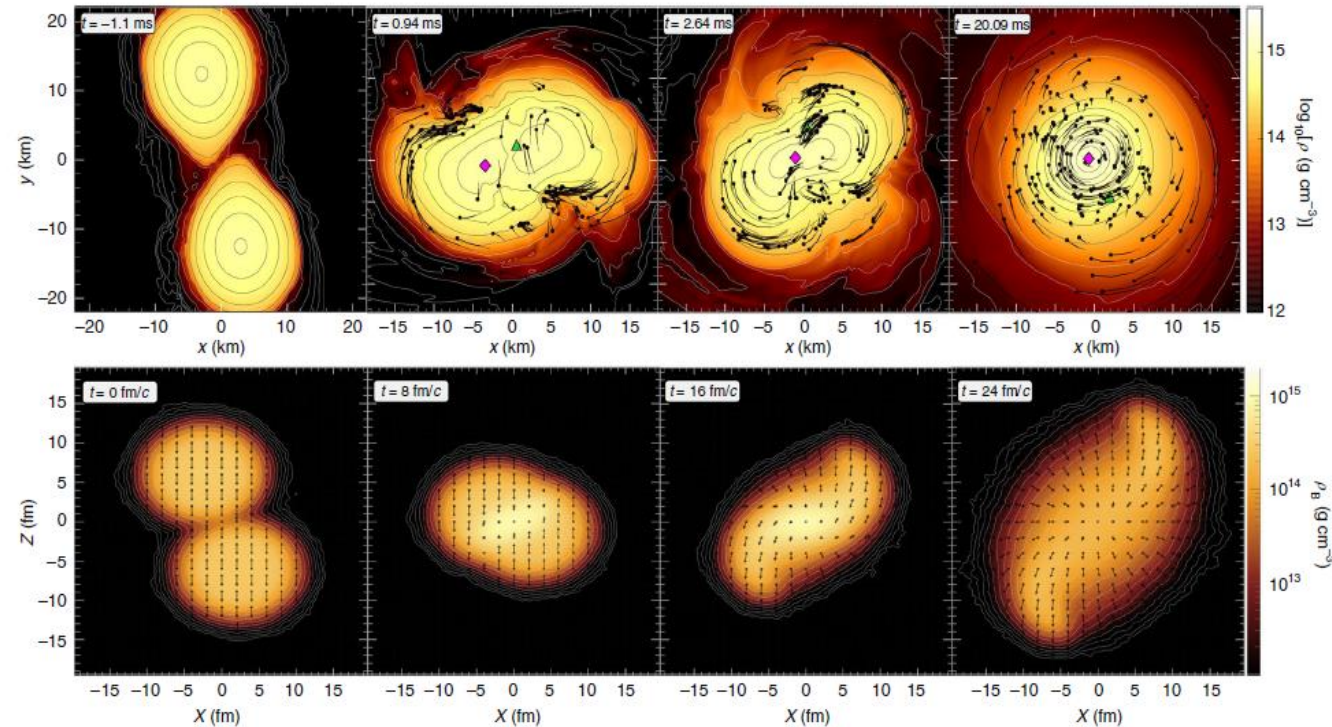
SFRS@ FAIR Access to heavy ($Z > 90$) radioactive beams
(also short lived isotopes- (ns- μ s) !



CBM & HADES at SIS100

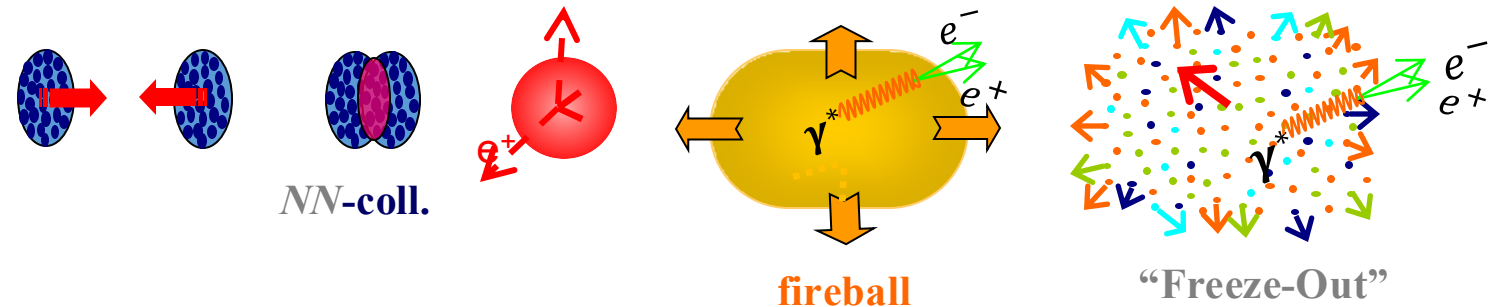


Neutron STAR merger



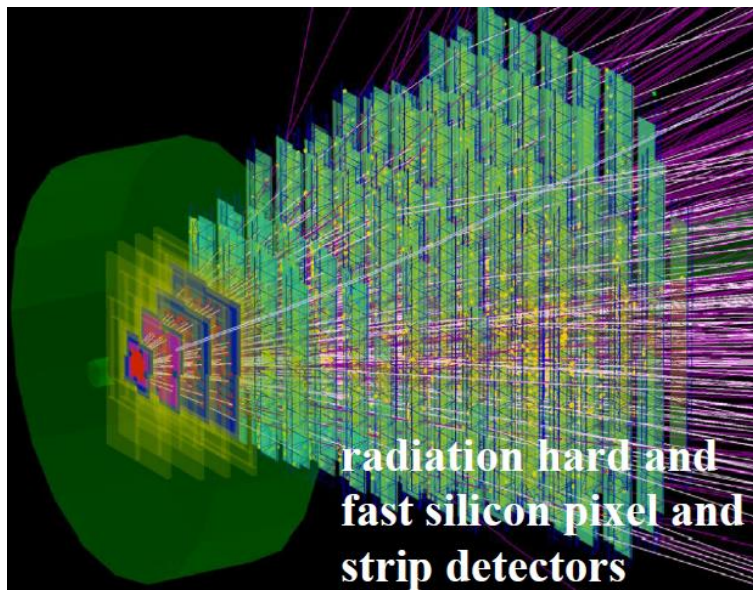
Au+Au collision

At FAIR energies (1-10 AGeV) compressed baryonic matter is created with similar density and temperature ($\sim 70\text{-}80 \text{ MeV}$) as in Neutron Star mergers

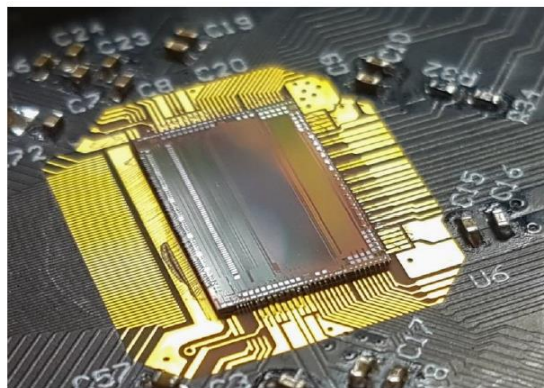


In-Kind contributions to CBM/HADES

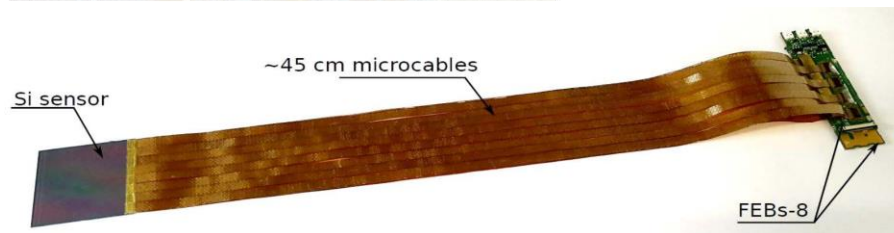
Detectors, dedicated read-out electronics (ASIC, FPGA) and read-out firmware, control systems for target



ASIC "STS-XYTER", radiation hard, 5ns resolution, 5 bit ADC



AGH University of Kraków



½ ladder with read-out



CBM : Silicon Trackin Stations(STS) -4 IK contracts

Sensors 1.8 mln channels, development and production of ASIC "STS-XYTER", front-end boards

- ✓ Sensors and ASIC production completed – on going tests of modules with integrated read-out
- ✓ Read-out firmware and on-line computing

HADES : Electromagnetic Calorimeter – Main frame IK

Straw tube tracker



Politechnika
Warszawska



In-Kind contributions to PANDA

Detectors, dedicated read-out electronics (ASIC, FPGA) and read-out firmware, control systems for target

PANDA : 3 IK contributions ,

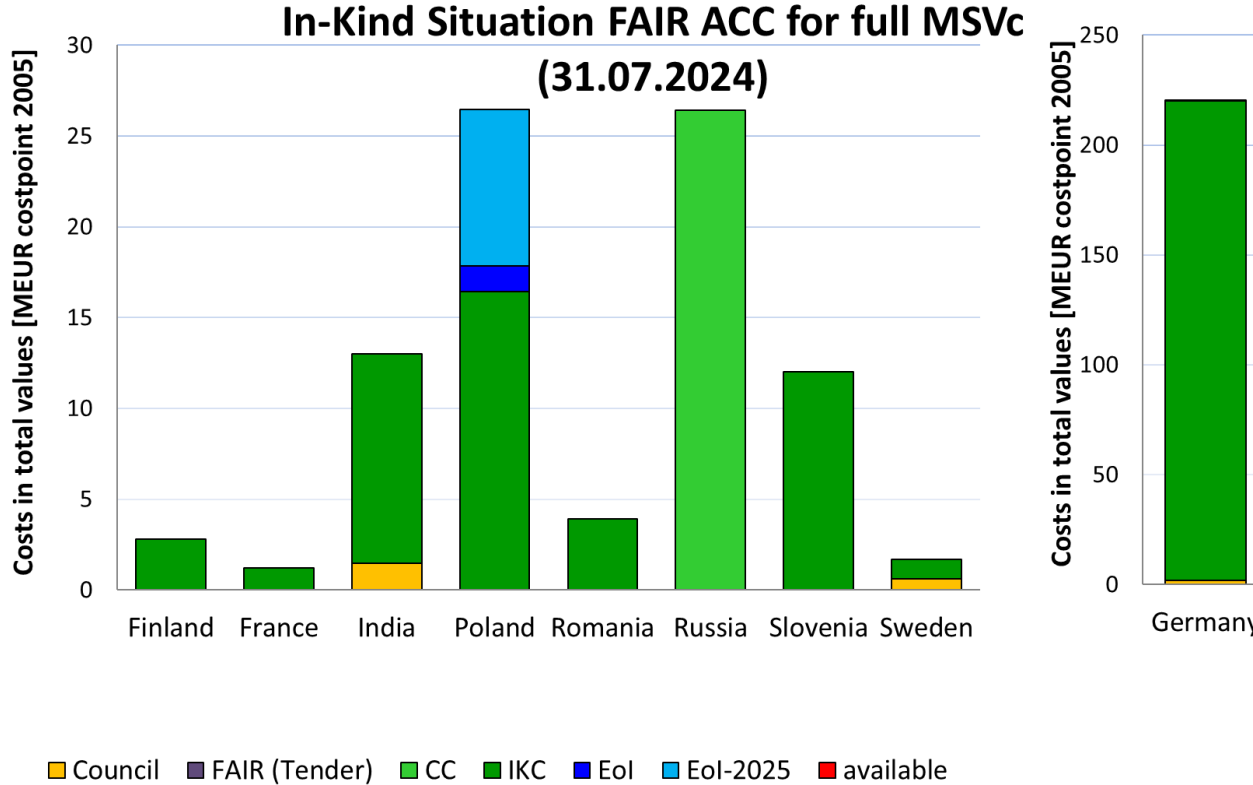
- ✓ Straw Tube Tracker in Forward Detector about 12k straws (50% completed)
- ✓ Read-out ASIC „PASTTREC”, (completed) ,
- ✓ read-out boards (TDC) and data processing –on going
- ✓ Control system for cluster target

Jagiellonian University, AGH University Kraków



Some modules with readout already in use in
HADES experiment in FAIR-Phase0

In-kind contributions to FAIR



Poland : 3'd country with largest In-Kind contributions to FAIR (above 95% of resources allocated to IK):
8 - infrastructure
11 - experiments

- 15 in realization (5 completed)
- 4 contracts in preparation
- 2 Expression of Interest : IFJ PAN- installation SIS100/SFRS and PWr Feed Box (2,3)

Summary

- FAIR is a unique project on a European landscape of that opens new possibilities for research in atomic, nuclear and materials physics and their applications.
- FAIR is now in installation and integration phase aiming in completion of the new SIS100 accelerator, Super Fragment Separator (SFRS) and NUSTAR and CBM detectors by end of 2028.
- Polish in kind contributions are of large importance for timely completion of the FirstScience (+) configuration
- Polish research groups actively participate in FAIR's research pillars. The challenge is to maintain their potential and extend polish participation , particularly among young researches.

<https://fair.uj.edu.pl/>

FAIR-Phase0 program

A path towards science at FAIR after completion of SIS100 and SFRS since 2016..

Successful beam campaigns for all pillars. 2022-2024 about 124 proposals submitted to PAC, 65 granted with beams

Continuation during construction of FAIR

Active role of polish groups (HADES, SPARC, NUSTAR) with several important contributions –(next slides)

