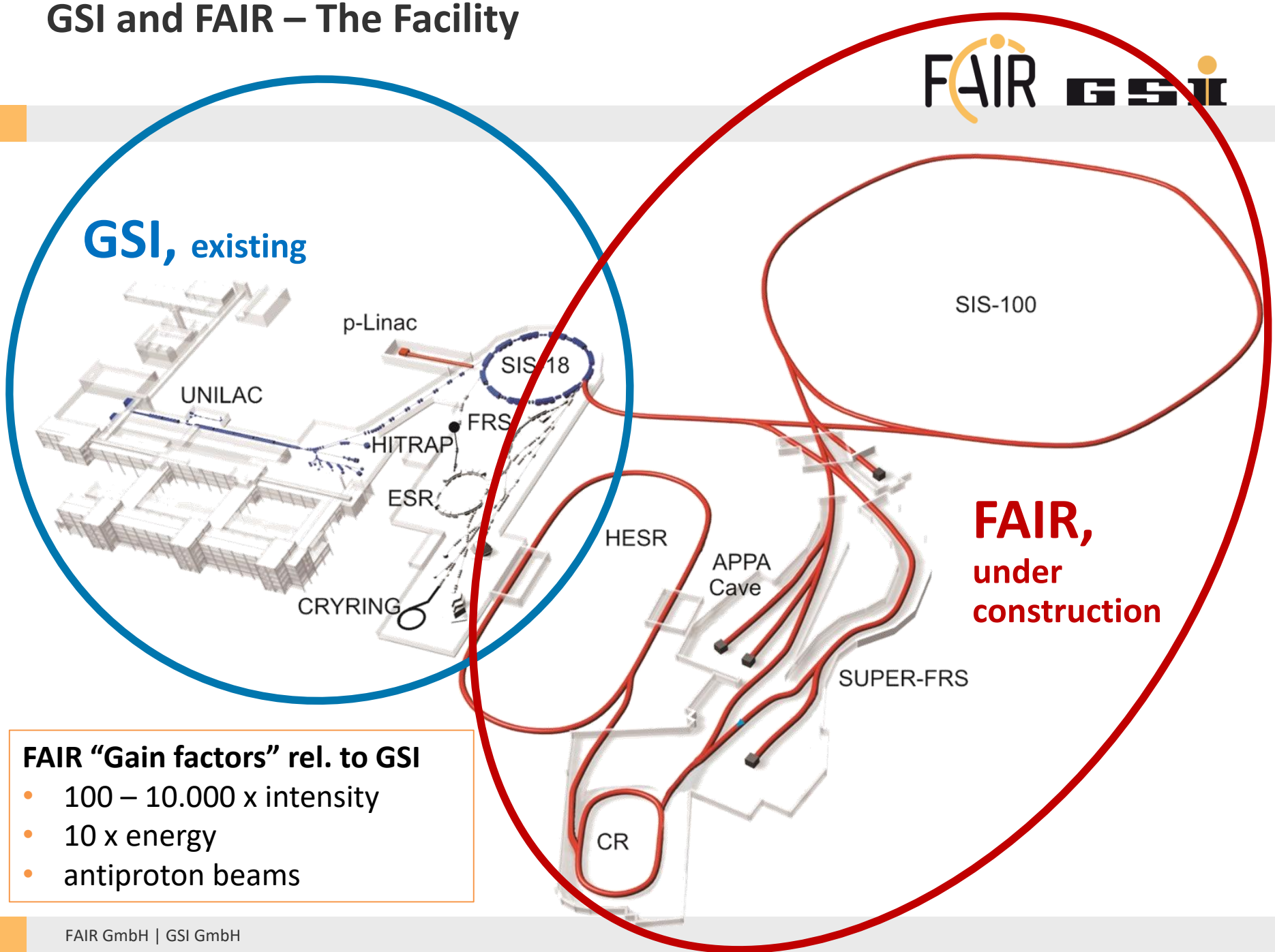
FAIR Status and News

Paolo Giubellino

GSI and FAIR – The Facility



FAIR "Gain factors" rel. to GSI

- 100 – 10.000 x intensity
- 10 x energy
- antiproton beams

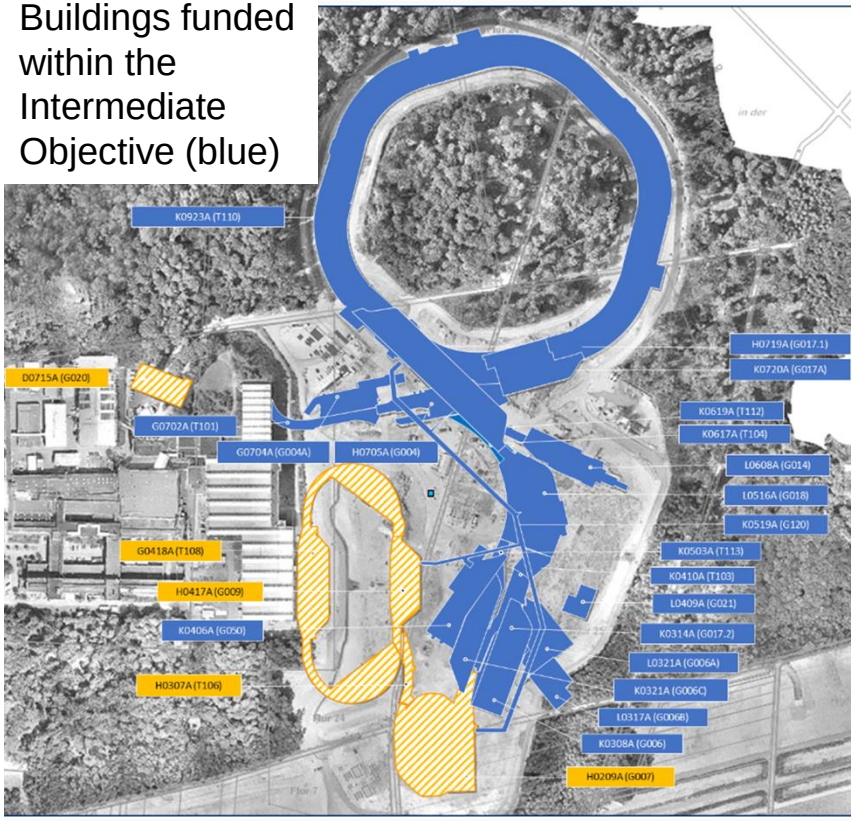
Status FAIR Project

- International Progress and Cost Review (2018/2019) confirmed:
  - scientific and technical uniqueness of FAIR promising outstanding research for decades for all four Pillars (APPA, CBM, NUSTAR, PANDA)
  - time schedule with first experiments starting in 2025
  - additional costs claimed by Management (850 M€ for completing the MSV).
- Recommendation by Review Committee to provide the needed funds plus a 10% contingency on the overall cost.
- German shareholder committed to provide its share of the additional funding.

Funding Status

- Following 2018/19 Review and Germany's commitment
- With the funding available and committed so far, a so-called "FAIR Intermediate Objective" can be realized as a first step.
- The Intermediate Objective includes the buildings of SIS100, Super-FRS, APPA and CBM caves plus ***all accelerators and the part of the the experiments funded by FAIR budget.***
- FAIR Council and all FAIR shareholders remain committed to the realization of the **FAIR MSV**. Negotiations with the partner countries to commit to their shares are ongoing and promising.

Buildings funded within the Intermediate Objective (blue)



FAIR construction continues to progress...


Civil Construction – SIS100/ North Area


Components of accelerators


Civil Construction – South Area

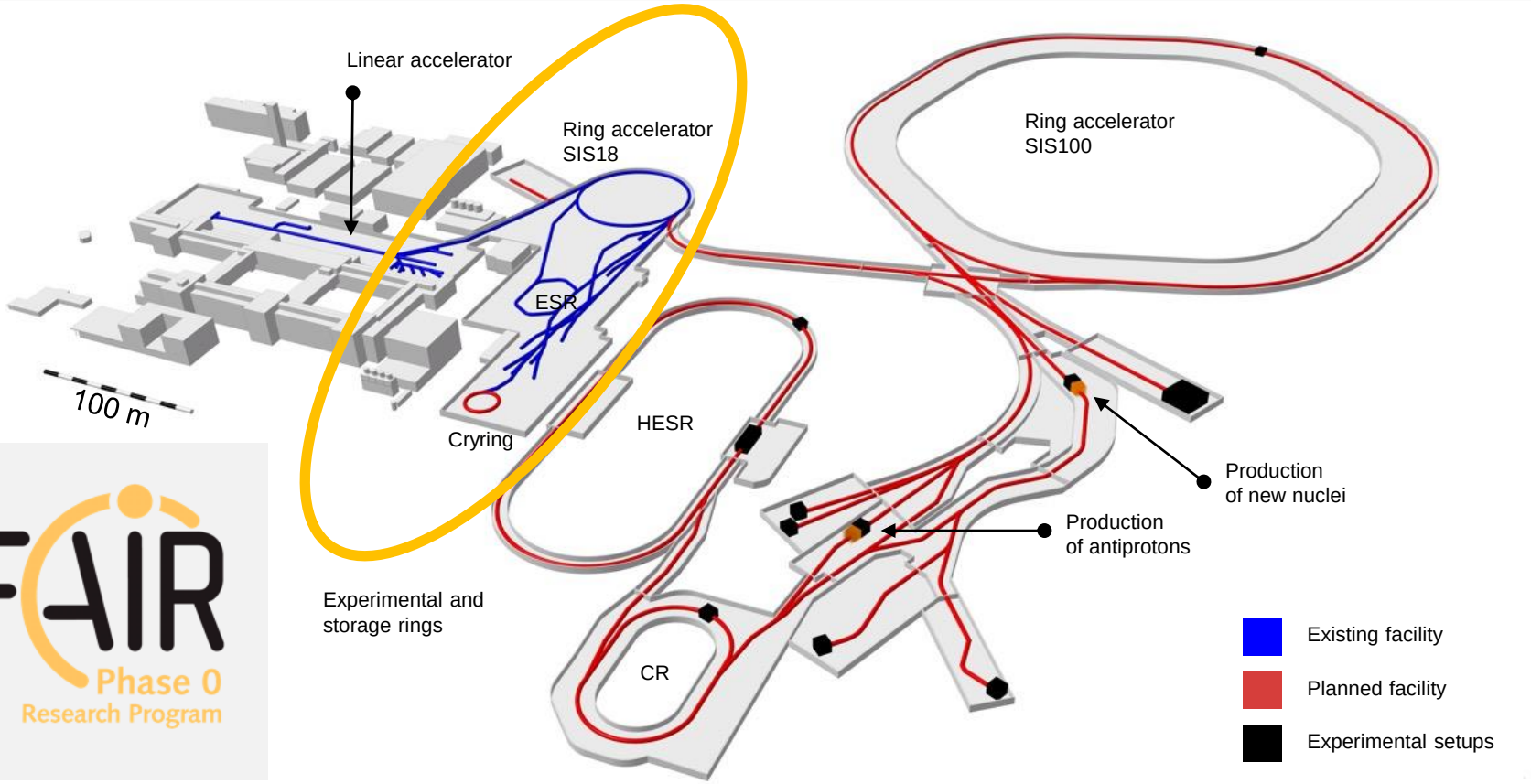

Detectors

Construction has continued without interruptions, although the COVID-19 pandemic has of course an impact, especially on some of the suppliers

Status Overview of Experiments

	Pillar	TDR	Cost [k€ 2005]	Funding	Construction	Construction completed	Test/ Commissioning
Day-1	APPA		18,421			07/2026	
	CBM		39,897			04/2025	
	NUSTAR		33,004			08/2024	
	PANDA		52,525			08/2024	
		89.0% *value weighted*	143,847	87.0% *secured*	38.0% *value weighted*		15.1% *value weighted*

Early science program FAIR-Phase 0



FAIR Phase 0 Research Program

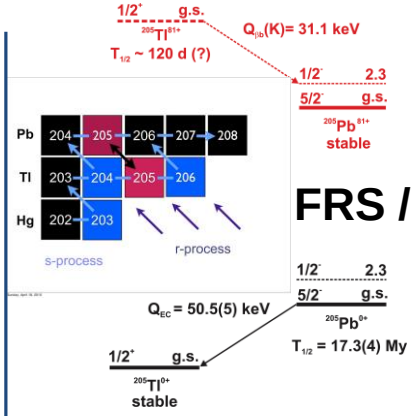
- Vital to create the know-how and human capital needed for future success of FAIR
- Develop the scientific community
- Do science while commissioning FAIR elements; unique research capabilities until start of FAIR using accelerator and detector components when they become available

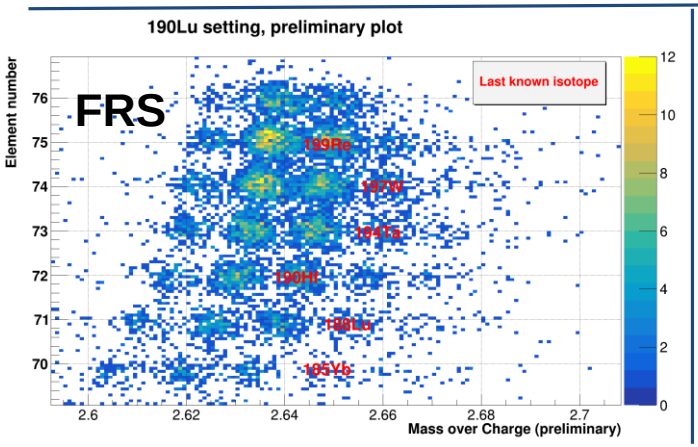
First Years of FAIR Phase-0

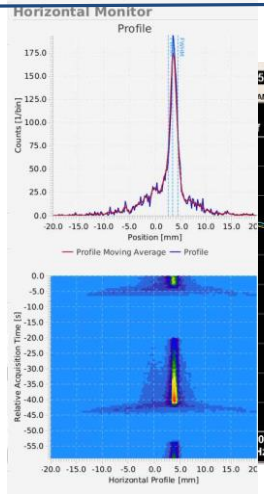
- Scientific programme and beam parameters defined taking into account scientific and technical priorities of the FAIR pillars for 3 months of beamtime per year
- 1st selection of experiments in 2017: very strong response of the scientific community, many proposals largely exceeding the offered beamtime. Selection based on scientific excellence
- Accident at UNILAC in 2018 , delivered just ~60 shifts mainly to experiments in Materials Research and Superheavy Elements
- Experiments shifted to 2019/2020: all communities were served; due to Covid-19 some experiments (about 1/3 of the ones scheduled for 2020) had to be postponed, resubmitted in the current call

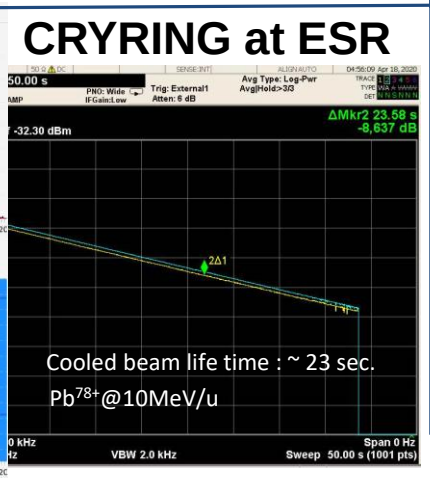
- First results from Phase 0 show the huge scientific potential which FAIR will have

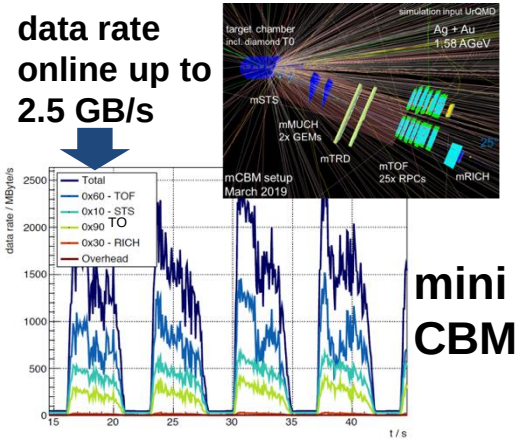
Impressions from FAIR Phase 0 in times of Covid-19



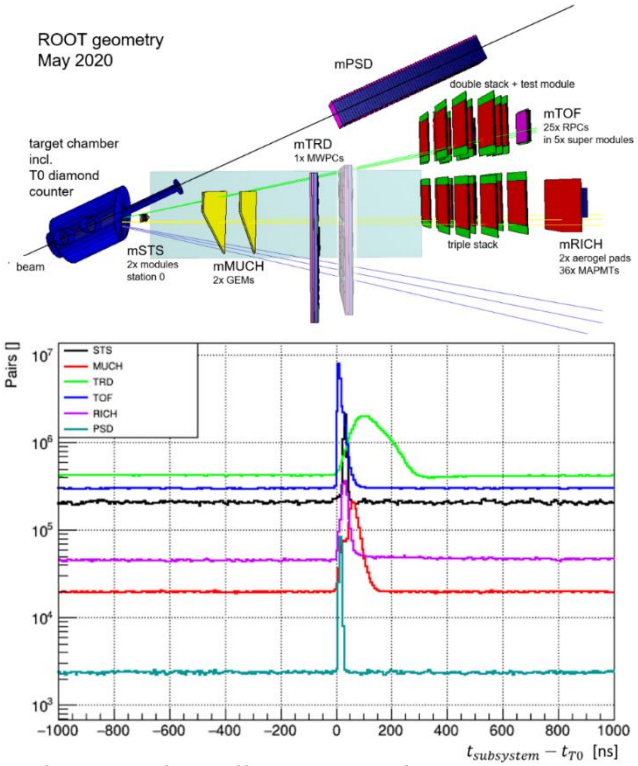




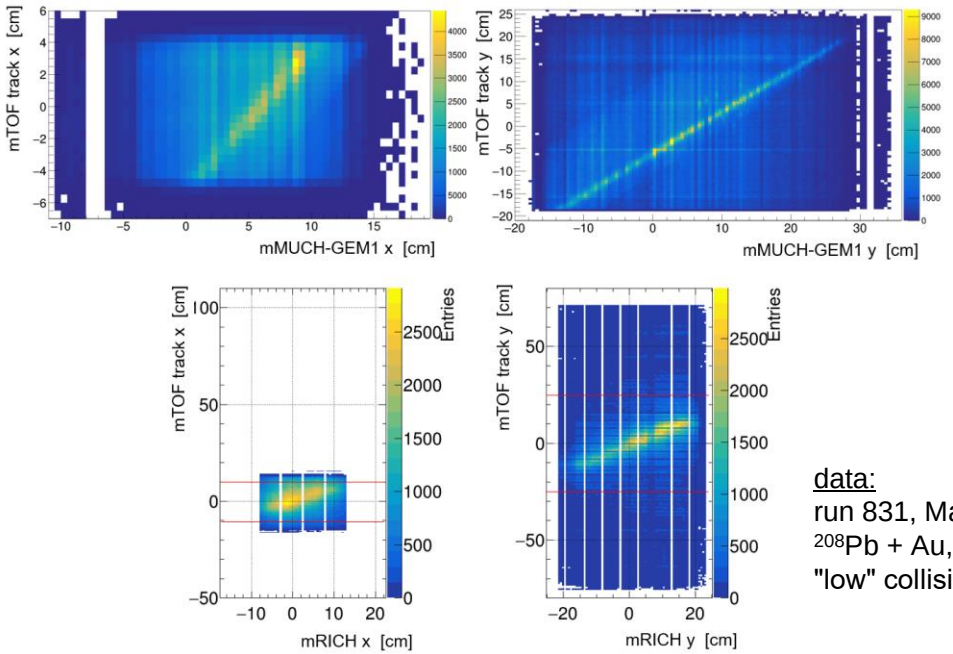




CBM: The mCBM experiment - precursor and demonstrator for CBM @ SIS100



subsystem time offset corrected

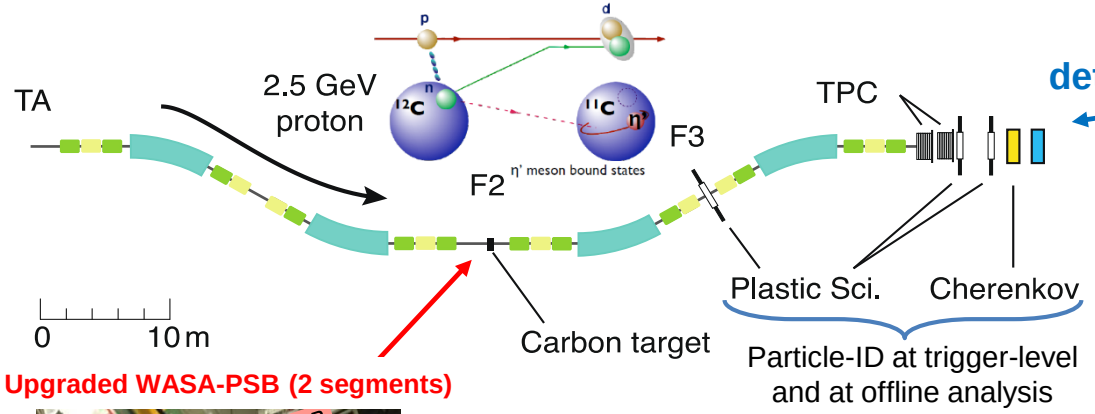


data:
run 831, May 4th, 2020
^{208}Pb + Au, 1.060 AGeV
"low" collision rate ≈ 20kHz

Observed time and spatial correlations between detector subsystems:
first steps towards verification of the triggerless-streaming DAQ system of CBM, to be verified up to the CBM design limit of 10 MHz collision rate.

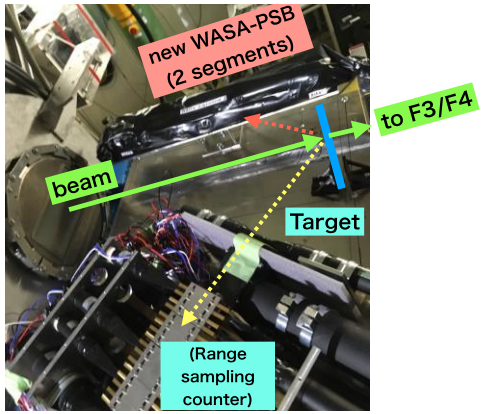
preliminary - May 2020 data

Super-FRS/FRS Experiments:
WASA test experiment with p beam (June 5-7, 2020)

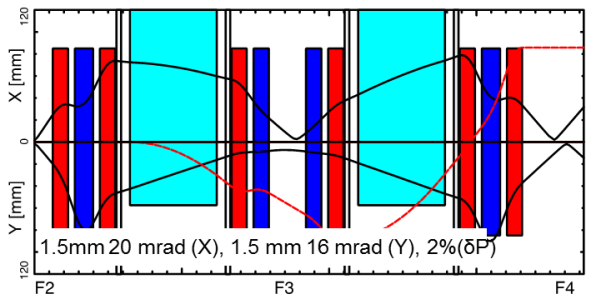


HypHI fiber detector prototype

Upgraded WASA-PSB (2 segments)



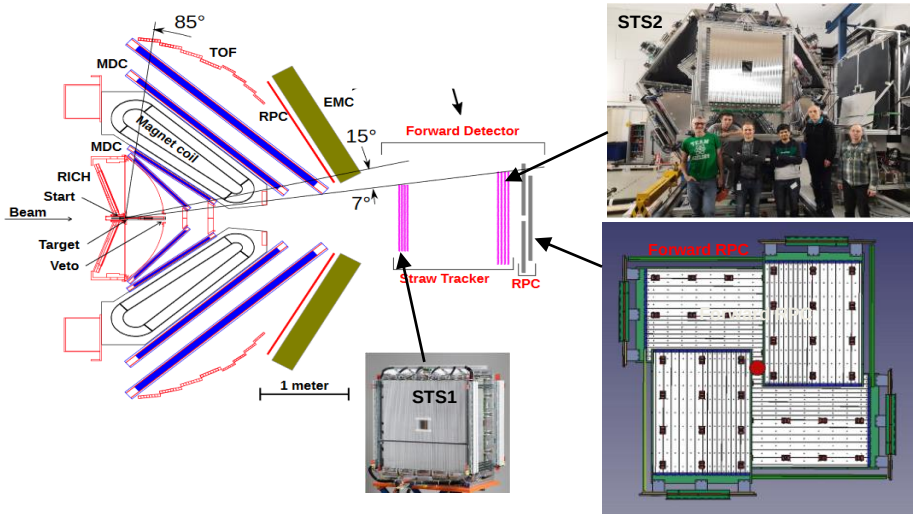
Dedicated large-acceptance ion-optical mode



- New detectors and dedicated large-acceptance ion-optical mode for WASA@FRS successfully tested under realistic kinematical and high-luminosity conditions
- Excellent particle identification in FRS (F3-F4) achieved
  - crucial for the η'-mesic nuclei experiment : Background reduction of factor 10^2 at Trigger x further factor 10^3 in Offline Analysis reached!

HADES
Test of forward detectors with protons

Forward Detector to track charged hadrons at θ < 7°



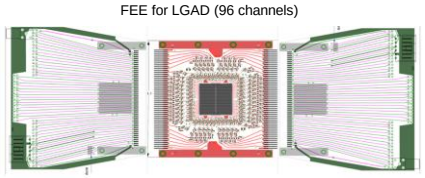
Feasibility studies for S518 experiment published:
HADES and PANDA Collaborations,arXiv:2010.06961

Project status:
- STS1 – installation in November 2020
- STS2 – installed, ready for beam
- Forward RPC – installation in Q1 2021

Participating institutes:
FZ Jülich, JU Kraków, IPNO Orsay, LIP Portugal

Start detector system based on Low Gain Avalanche Detector Technology
EPJA 56 (2020) 183

T0 detector key requirements:
- Time precision below 50 ps
- Rate capability of 100 MHz / cm^2
- Vacuum operation



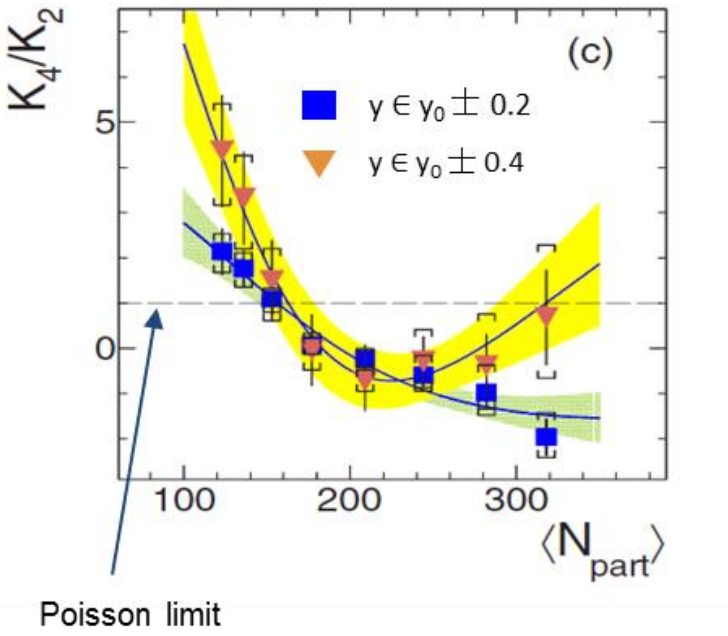
Project status:
- Readout system readiness in Q4 2020
- Sensor production at FBK started, delivery in 06/07 2021

Participating institutes:
GSI, TU Darmstadt
Part of the “High-D” Consortium ErUM BMBF
Collaboration with Fondazione Bruno Kessler (FBK, Trento, Italy), INFN Torino, Italy

HADES Highlight
Proton number fluctuations in Au+Au @ 1.23 GeV/u

- Many observables to characterize fluctuations
  - factorial moments, cumulants
- Ratios of the cumulants are intensive quantities i.e. they do not depend on the mean volume
- Sophisticated corrections methods needed

- Clear deviation from the Poisson limit
- Non-trivial N_{part} dependence



HADES, Phys.Rev.C 102 (2020) 2, 024914
(Editor's highlight)

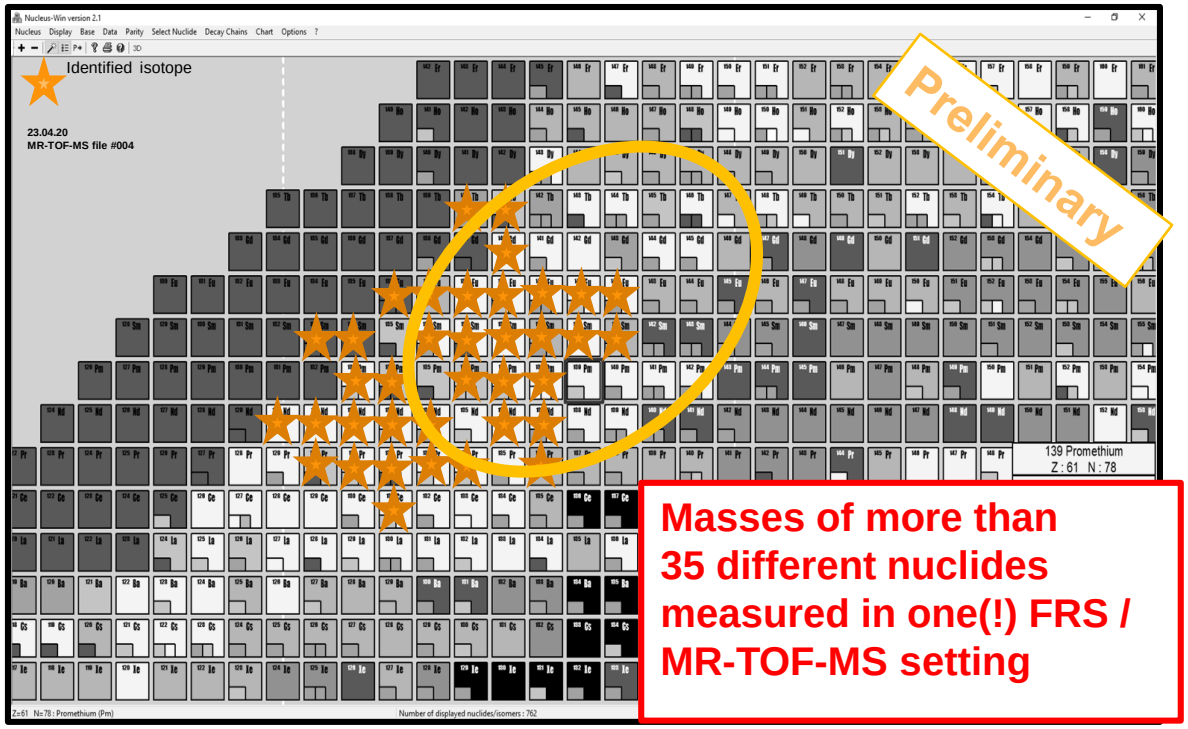
Highlights of S468
New isotope search, masses, $T_{1/2}$

Experiment

- Ion optical method to stop many different species simultaneously in an active stopper
  → efficient data taking
- Region of interest: n-deficient lanthanides
- Successful mass excess tagging of $^{143\text{-}144}$Ta with the MR-TOF-MS

Preliminary results

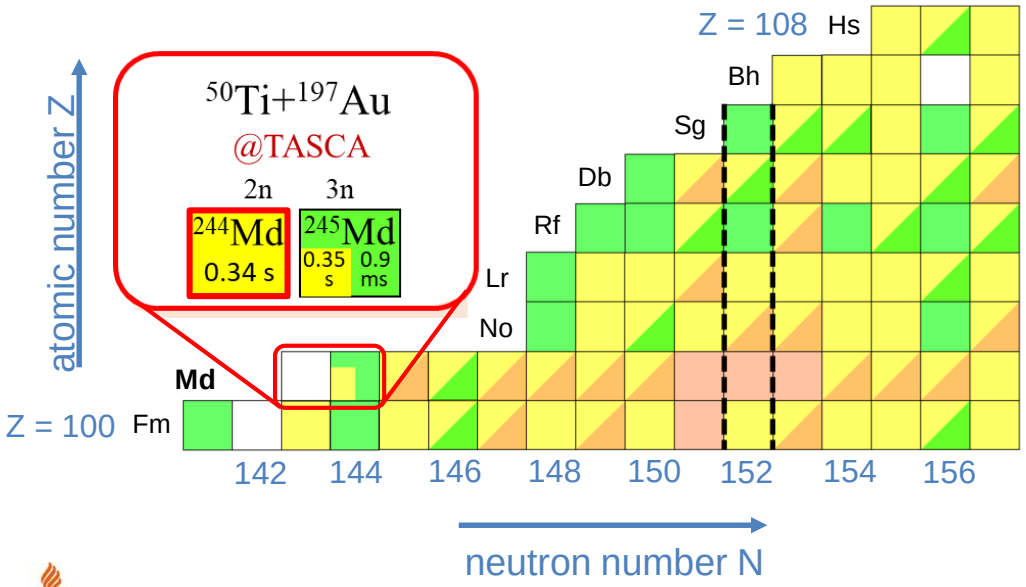
- 12 new masses
- 10 improved masses
- several new half-life measurements
- several NEW ISOTOPES identified



Highlights Super Heavy Elements
^{244}Md: a new isotope from TASCA

- Alpha, CE and SF decays in the neutron-deficient region of Md, No and Rf isotopes

  - Large-size focal plane detector studies at TASCA – high transmission
  - "Triggerless" conversion electron measurements
    – highly efficient for isomeric state id.



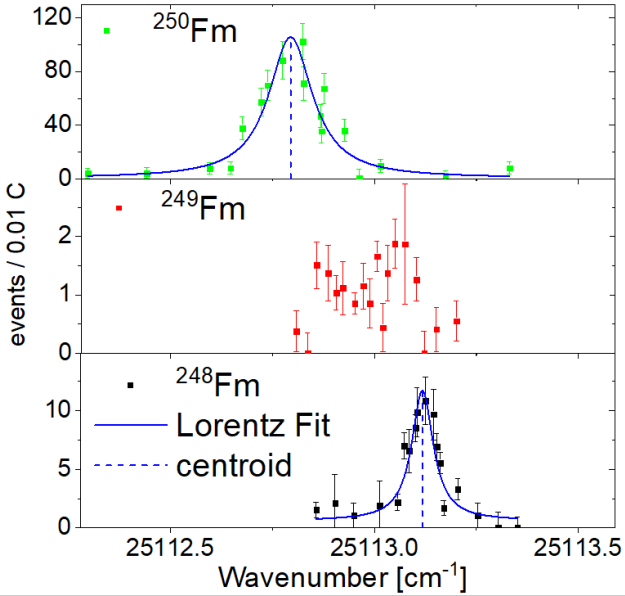
FAIR Phase 0 Research Program TASCA 2018/20

HIM JG|U GSI + Int. partners: UNIVERSITY OF JYVÄSKYLÄ

J. Khuyagbaatar *et al.*, Phys. Rev. Lett. (accepted)

Highlights Super Heavy Elements
Laser Spectroscopy of Heavy Elements

- Elements 100-103 (Fm-Lr)
  - **Heaviest elements studied by laser spectroscopy**
  - Atomic and nuclear properties of the heaviest elements
  - GSI-unique: presently no comparable setup operational worldwide



FAIR Phase 0 Research Program
SHIP
2019/20

HIM JG|U GSI TECHNISCHE UNIVERSITÄT DARMSTADT

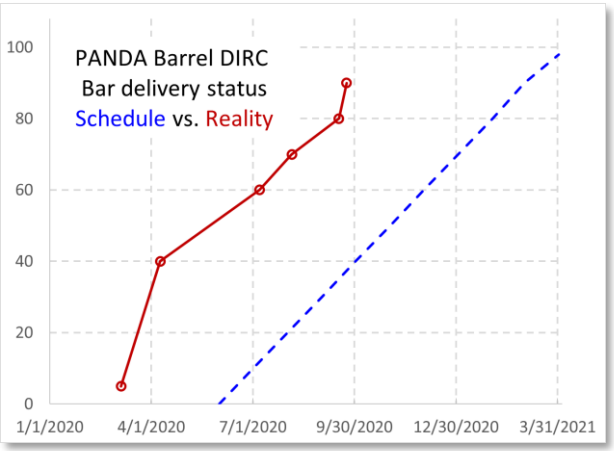
+ Int. partners: KU LEUVEN UNIVERSITY OF LIVERPOOL cea GANIL TRIUMF

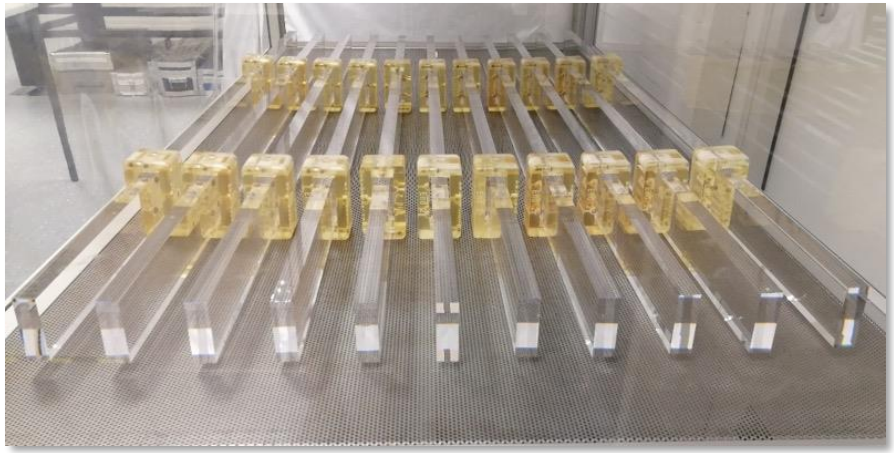
Exp: S. Raeder *et al*.

Theory: A. Borschevsky V. Dzuba, S.Fritzsche, B. Schütrumpf *et al.*

PANDA Barrel DIRC radiator fabrication progress

- Fabrication of DIRC bars at Nikon Corp, Japan progressing well
  - Received 90 of 98 ordered bars, ~5 months ahead of schedule
- All bars meet fabrication specs, performing detailed QA in GSI DIRC lab
- Procurement of 8-14 additional bars in preparation





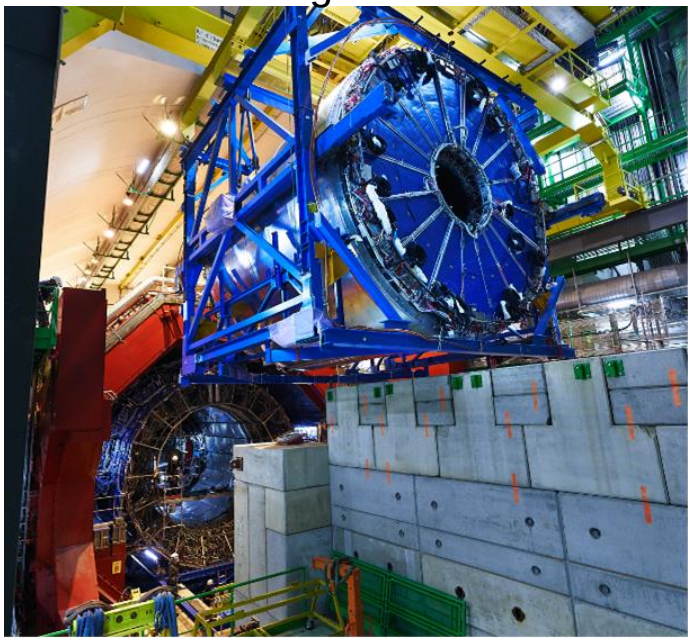
New bars in GSI DIRC lab

ALICE Highlight
The ALICE TPC returns to the cavern

Wrapped, towards the shaft

Down to the cavern
August 5

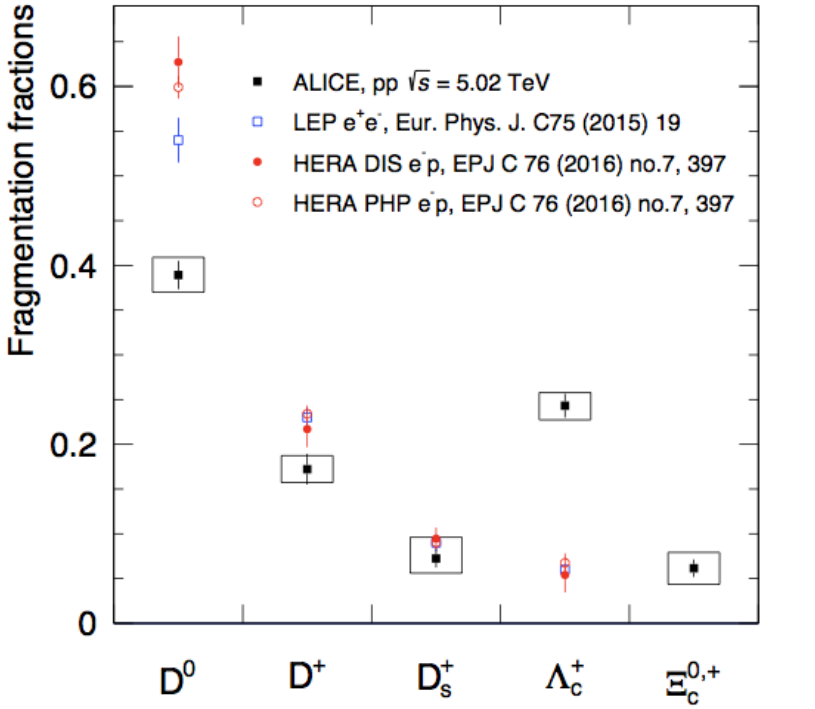
Ready, in front of the L3 magnet
August 6



ALICE Highlight
Charm production in pp collisions

- First measurements of charm quark **fragmentation fractions** into the different hadron species in hadronic collisions
- Enhanced production of charm baryons in comparison to **LEP** (ee) and **HERA** (ep)measurements
- Higher charm cross section than pQCD calculation (**FONLL**) at the LHC

- Strong **synergy with CBM Collaboration** in KFParticle usage and Machine Learning application development



Phase-0 Beamtime 2021-22

- Following 2020 beam time (2/3 experiments despite Covid-19)
  - Call opened for 2021 and 2022
- Overwhelming response to call for proposals
  - 173 proposals requesting 4,253 shifts

Call for FAIR Phase-0 beamtime in 2021 and 2022 Number of shifts in total[1]	**UNILAC**	**SIS18**	**ESR/ CRYRING/ HITRAP**
Requested in proposals received	807	1,942	1,037
Ranked “A” by PACs (additional proposals ranked “A-” not included)	413	614	463

- Beam time schedule for 2021 and 2022 accommodates the approved experiments while taking into account resources and works on campus
- Measures are being developed to mitigate issues due to the continuing pandemic.

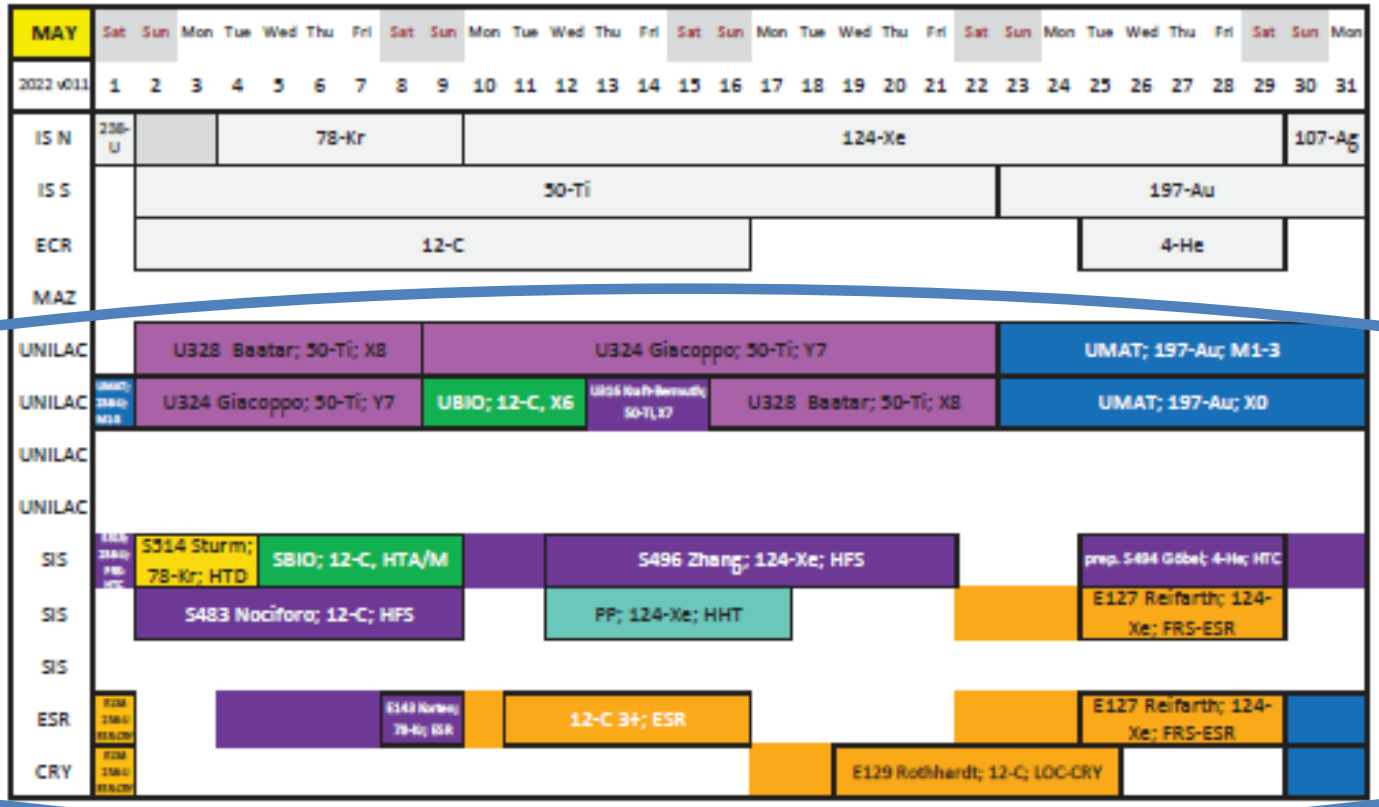
Phase-0 Beamtime 2021-22

- Distribution of proposals and results of the consultations in the GPAC (APPA/SPARC; HADES/CBM; NUSTAR)

Collaboration	Shifts requested	Recommendation	
	Total+(sec+para)/10	A	A-
APPA / SPARC	927 (153)	400	136
HADES / CBM	574.7 (0)	119	49
NUSTAR / R3B	300.8 (23)	136	28
NUSTAR / S-FRS-EX	394 (29)	122	26
NUSTAR / DESPEC	503.2 (59)	145	22
NUSTAR / SHE	447.6 (0)	247	57
NUSTAR / ILIMA	68 (0)	18	0
Sum	3215.3 (266)	1187	318

FAIR Phase-0: Beamtime schedule 2021

- Beamtime spread over 6 months (February until July) with several breaks. Example of MAY (full schedule in Backup)



Parallel multi-user operation!

FAIR-Phase 0 future

- Participation in call 2021/22 confirms the very strong interest of the scientific community
- Operational experience gained demonstrates the importance for the future of operation of FAIR
- Will continue with regular beam time allocation until FAIR operations starts
- If exceptionally beamtime becomes available, for example because an experiment is unable to use it, the GPAC will be consulted on its allocation
- Next general call in two years time
- We develop an integrated plan of successive improvements to the accelerator complex to expand the scientific reach of the program

FAIR Phase 0 Research Program

The Campus develops

FAIR control center

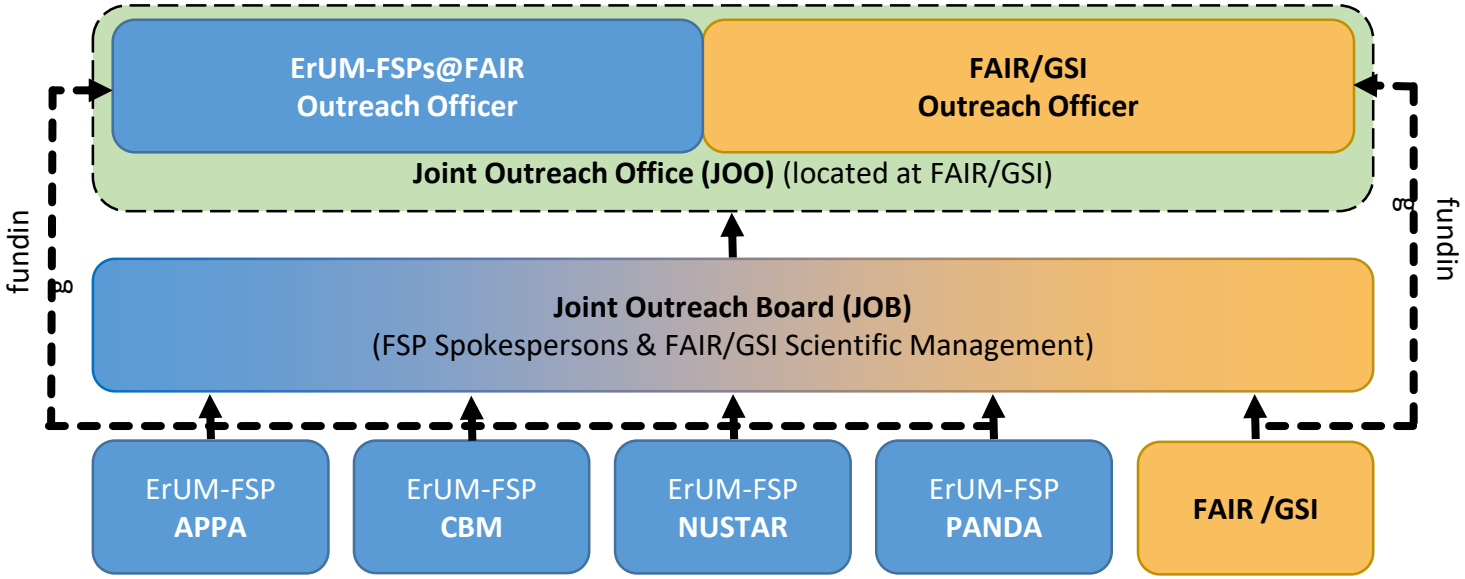
- hosting main control room
- 200 working places
- operational 2024

Parking garage

- providing space for 800 cars
- completed in Q1 2021

Education, Outreach

- The University groups of the FAIR pillars and FAIR/GSI propose to join forces
  - ErUM FSPs T05 ... T08 are associated with the four FAIR research pillars
- Proposed to establish a **Joint Outreach Office** on the FAIR/GSI campus
  - One person for the 4 pillars matched by a further person paid by FAIR/GSI
  - Ensure sustainability by professionalization and a long-term perspective



Thank you!!