

# FAIR status KHuK Annual Meeting

Dec 8<sup>th</sup> 2022

# **Civil Construction**



Civil Construction continues to make well progress

- Civil works of company ZÜBLIN for all experimental buildings in construction area south are progressing
  - Installation of Cryo2 and the SIS100 distribution system are progressing on schedule



BUCK RA



# Movie of the construction site as of Nov 2022

https://edms.cern.ch/file/2796608/LATEST/FAIR\*720p\*.mp4

or via www.gsi.de

## Accelerators: delivery of components continues steadily



Storage area: approx. 9.900 m<sup>2</sup>

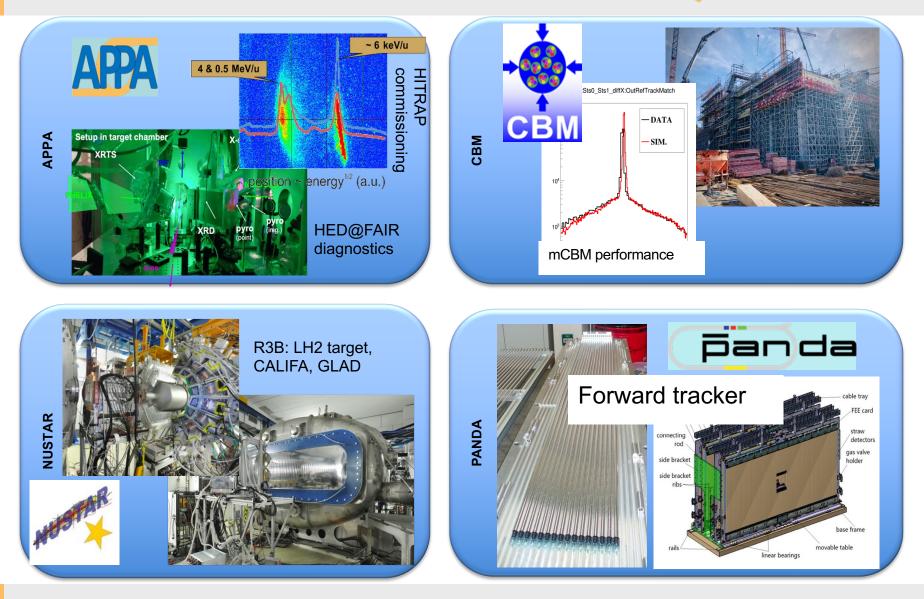
- 4.195 objects (Components, assemblies, boxes, etc.)
- > 50% of SIS100 components stored
- > 90% of HESR components stored





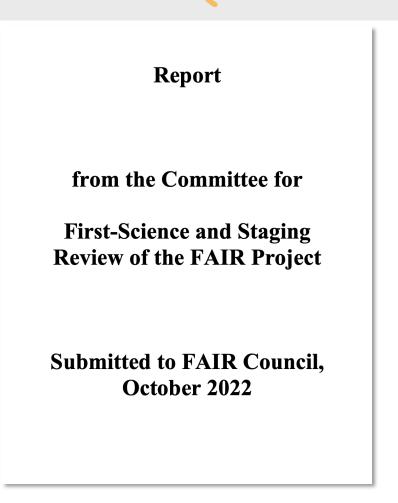
## **Experiment Construction Highlights**





# The First Science and Staging Review

- The international review panel has issued its report, which is publicly available in full on our website
- The scientific program of all four FAIR pillars is indicated as outstanding and in many cases world leading
- The competition by other facilities is strong, but FAIR has an hedge if built in a timely manner



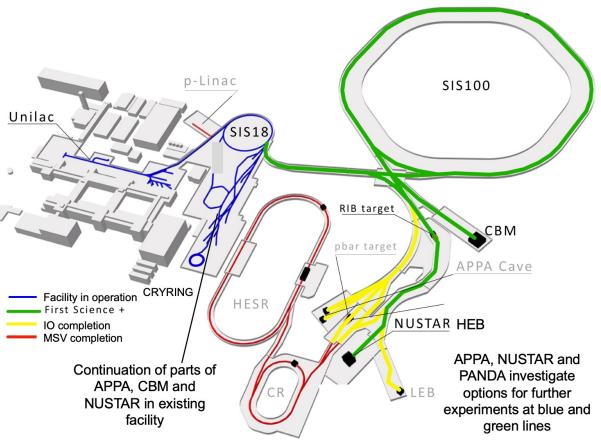
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 Given the financial constraints, a start configuration including SIS 100, SFRS with the High Energy cave and CBM is recommended FAIR First Science and Staging Review : Council response

In October 2022 FAIR Council decided to:

follow the recommendation of the review that scenario #3 (SIS100, Super-FRS-HEB and CBM) would be the most appropriate starting scenario to achieve world leading science

 consider this as the basis for the further FAIR execution.





# A stepwise realization



- Provided funding allocation, will be realizing FAIR in steps:
  - The low energy storage rings ESR, CRYRING and HITRAP are already realized, they will be used in the coming years as part of FAIR Phase-0, which will continue approximately at the current level, while progressively reaching their design performance.
  - The Super-FRS and SIS100 will be realized and commissioned with just the caves for the NUSTAR High-Energy Branch and CBM
  - Next, the APPA cave will be put into operation, followed by the NUSTAR Low-Energy Branch
  - Finally, the storage rings CR and HESR and the antiproton production chain (p-linac, antiproton target and beamlines) will complete the MSV



- Up to 2025 we continue with FAIR Phase-0, from 2026 onwards we enter the mixed-mode with the commissioning of the new beamlines.
- "First Science+" includes all the facilities on the GSI campus plus the Super-FRS with the High Energy Branch, SIS100 and the CBM cave.
- Some experiments will start already in 2027 at the Super-FRS using SIS18 beams ("Early Science")
  - The amount of beam time to the new cave during Early Science will depend on the physics case, which should now be updated and detailed.
- We will try to keep a broad research program on campus, which will also serve the long-term goals of FAIR.

### FAIR in 2028



- So, the "FAIR2028" science program will include:
  - APPA experiments at the low-energy rings, at the caves at SIS18 and UNILAC, PHELIX and a limited set of experiments which could be hosted at the SIS100 caves
  - NUSTAR at the SFRS with SIS100 beams, plus SHE experiments at UNILAC and ILIMA at the low-energy rings
  - CBM at the new cave with SIS100 beams, and HADES at SIS18
- We will optimize our efforts towards optimum use of our resources and of the space in the new caves for these goals.
- For activities which will have beam only at a later stage, such as PANDA, suitable programs are being developed, when possible using the caves and beams available at GSI/FAIR.



# Situation

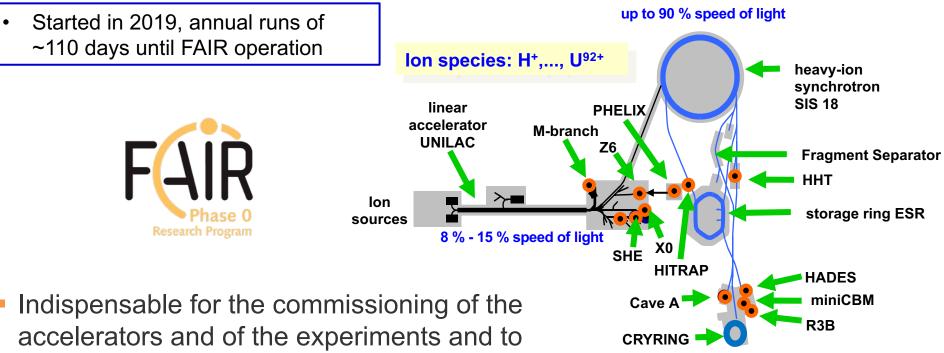
- Significant cost increases for electricity and gas (heating)
- Cost increases for building materials and other technical trades
- Expecting rising personnel costs
- Tightening of regulatory requirements (fire protection, drinking water protection etc.) making new construction measures more expensive

# Proposed action plan

- Shifting of beam time from last quarter of 23 to beginning of 24.
  - Engineering run in 2023, with possibility of limited experimental program
- Containement of fix costs
- Reduction of running costs and invest
- Partial compensation of rise of personnel costs
  - effective reduction of personnel

### Early science program FAIR Phase-0

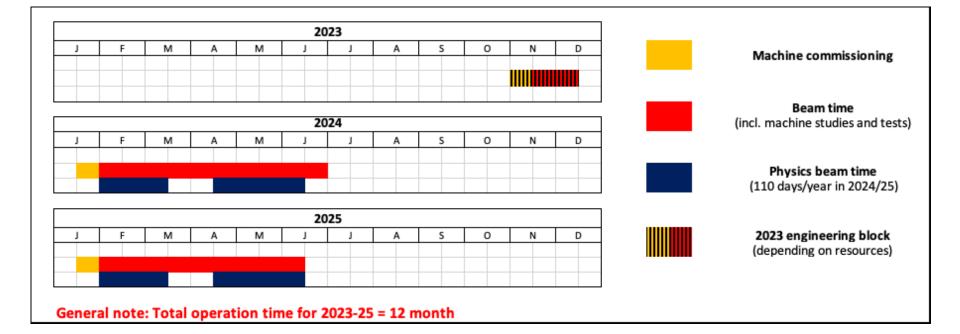




- develop the know-how for their operation
- Science while commissioning FAIR
  - 2021 and 2022 runs completed as planned
  - Following the call for the next runs, the PACs, composed of international experts, evaluated the proposals in Sept 2022

### Beam time 2023/2024/2025

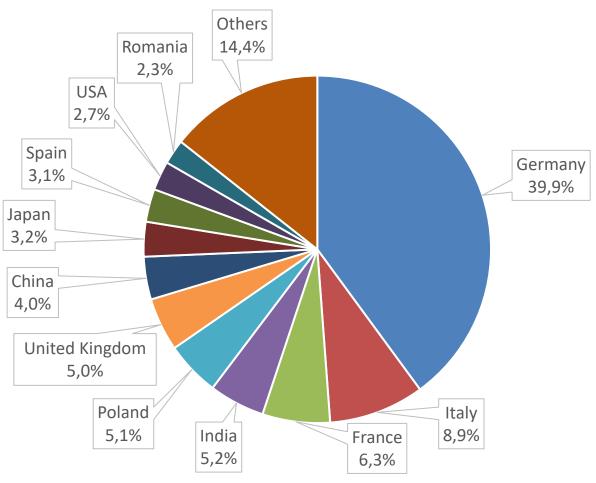




This plan allows to honor all the beamtime offered in the current call

# Beamtime Proposals 2022 for the next two periods

- 124 proposals submitted (to all 4 PACs: G-PAC, Mat-PAC, Bio-PAC and PPAC)
- 1729 participants of proposals
- From institutes in 45 countries (15% internal users)
- Committee evaluation took place in September 2022
- Beamtime granted in October 2022



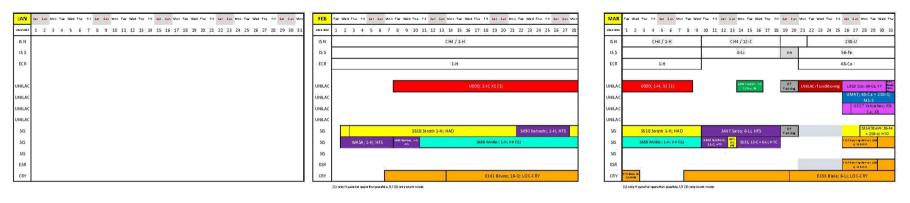
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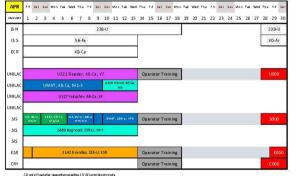




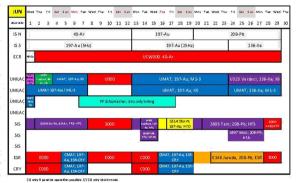
### Performed beam time in 2022

### Feb – June 2022





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Daniel Severin; diseverin@gsi.de; 2715 2022 v042

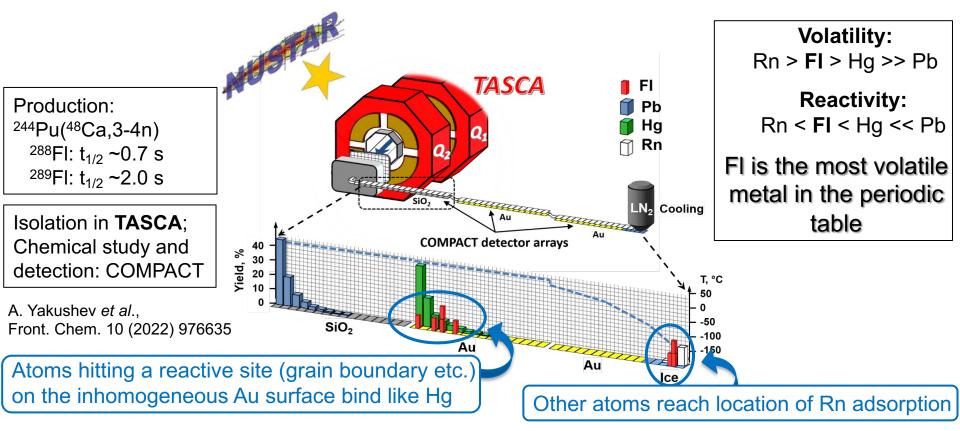
### Performed beam time in 2022: experiments



Beams	Асс	Main experiments	Parallel experiments
light ion-beams block (1-H, 6-Li, and 12-C)	SIS18	WASA (1-H, 6-Li) HADES (1-H)	PRIOR SFRS/EX mCBM R3B
48-Ca, 238-U, and 56- Fe beams	UNILAC	SHIP (48-Ca) TASCA (48-Ca)	Materials Science
	SIS18	mCBM(56-Fe, 238U) Biophysics including ESA Materials Science	Plasmaphyscs 238-U for HIHEX
	ESR	Atomic physcis (238-U) cancelled Atomic physics (229-Th)	
208-Pb, 209-Bi, 48-Ca and 18-O, 58-Ni beams	UNILAC	Materials Science (48-Ca, 209-Bi) SHIP (48-Ca)	SHIP (48-Ca) Detector tests CBM (48-Ca) Materials Science (209-Bi)
	SIS18	Nuclear spectroscopy (208-PB) R3B (16-C) mCBM (58-Ni)	HIHEX (HHT)
	ESR	HITRAP commissioning	
40-Ar,197-Au, 208-Pb, 136-Xe	UNILAC	Materials science (197-Au), Multi-nucleon transfer (136- Xe)	
	SIS18	R3B (40-AR) Nuclear spectroscopy (208-Pb)	
	ESR	Materials science at CRYRING (197-Au) Neutron induced reaction cross sections (208-Pb)	
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# Chemical properties of element 114, flerovium elucidated at GSI/FAIR

- Flerovium: heaviest element with experimentally studied chemical properties
- Eight registered atoms in three beamtimes of total 2.5 months duration







# Successful beam time: 42 B events collected !

- Promising online results
- New detector systems performed very well: STS forward tracker stations (PANDA), forward RPC (HADES) photon camera (CBM), inner TOF (FAIR-NRW), LGAD T0 (HADES)
- 7 new institutes joined HADES (Sweden, Poland, Germany)



HADES Beam time S518

Production and electromagnetic decay of

Integrated statistics

01 03 05 07 09 11 13 15 17 19 21 23 25 27 01 03 05 07 09

Feb/Mar 2022

Beamtime

p+p @ 4.5 GeV

Anticipated Events

Recorded Events

45000

40000

35000

30000

25000

20000 15000

10000

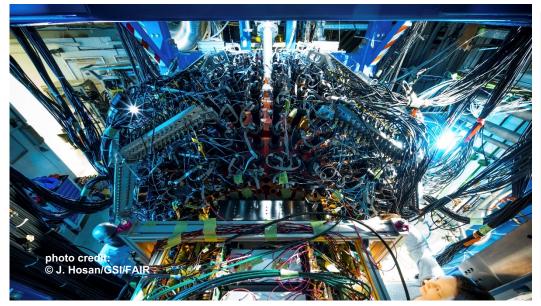
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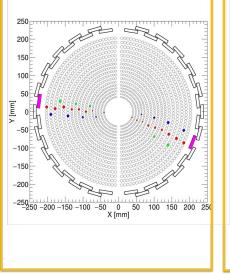
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### WASA @ FRS









#### WASA detector:

- 18 tons of weight
- s.c. solenoid magnet (700 A, 1.0 Tesla)
- ≈10,000 electronic channels
- installation work: July 2021 January 2022

#### Data stream:

- up to 300 MB/second
- 50 TB recorded in 1 week of beamtime

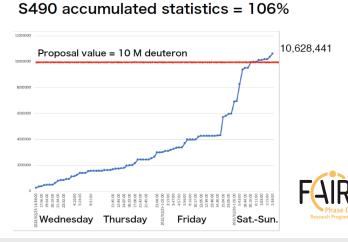
#### Main detectors:

- Scintillator barrel
- Mini Drift Chambers
- CsI calorimeter
- Fiber tracking detectors

- Novel spectroscopic techniques are explored to study exotic nuclei and exotic atoms
- For the first time a calorimeter is coupled to a highresolution spectrometer for relativistic beams

### **Experiments:**

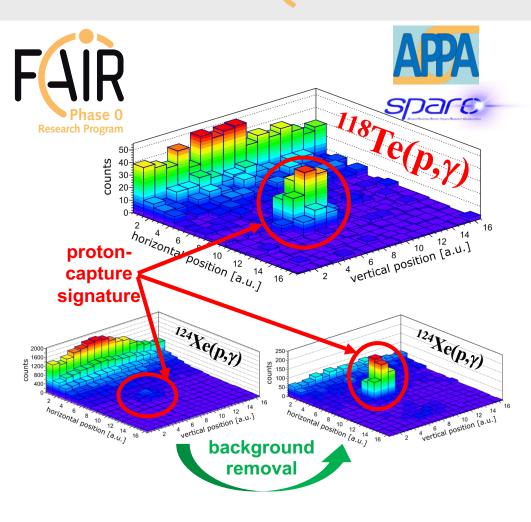
- Search for eta'-mesic nuclei (S490, K. Itahashi et al.)
- Hypernuclei spectroscopy (S447, T. Saito et al.)



# Ground-breaking experiment opening way for nuclear astrophysics experiments at FAIR with ESR FAIR = 1

- E127: Proton-capture rates for nuclear astrophysics:
  First reaction study on stored radio-beam at low energies
- Study of radioactive <sup>118</sup>Te (6 days half-life)
  - production, storage, accumulation and deceleration in FRS-ESR
  - proton-capture measurements realized at 7 MeV/u and 6 MeV/u
- New background-free detection method demonstrated

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Jan Glorius et al.

### E142: Laser Excitation of the <sup>229</sup>Th Nucleus Using Nuclear Hyperfine Mixing (NHM)

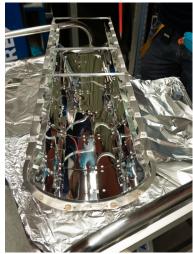






#### Redesign of in-ring VUV fluorescense detection system

MgF<sub>2</sub>-coated Al-mirrors for the detection of photons bellow 115nm (Collaboration Fraunhofer IOF, Jena)



#### Foto: C. Brandau

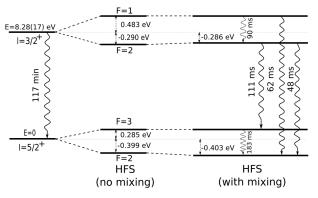
#### Achievements:

- 2\*10<sup>4</sup> bunched <sup>229</sup>Th<sup>89+</sup> in ESR per 10<sup>9</sup> <sup>238</sup>U ions in SIS (future upgrade path identitfied)
- Issue-free 30Hz high-intensity laser operation @320nm
- Experiment detailing (signal/background): ~10 fold sensitivity enhancement
- Short ion bunches (~5ns): refined experiment timing
- New "background-free", low beamintensity bunch-length measurements (recombi-nation in cooler + particle detectors)

#### Feasibility of the measurement method was demonstrated !

(but due to restrictions only 15-20% of targeted scan range covered)





V. M. Shabaev, ..., C. Brandau et al., PRL. 128, 043001 (2022)

**Drastic changes of nuclear life time Excitation:** ~10<sup>6</sup> more probable **and:** ~10<sup>6</sup> more decay γ's

Laser Spectroscopy at ESR:

An intense "10 eV"-laser exploiting the Doppler Shift C. Brandau, W. Nörthershäuser et al., JLU Gießen, TU DA, GSI

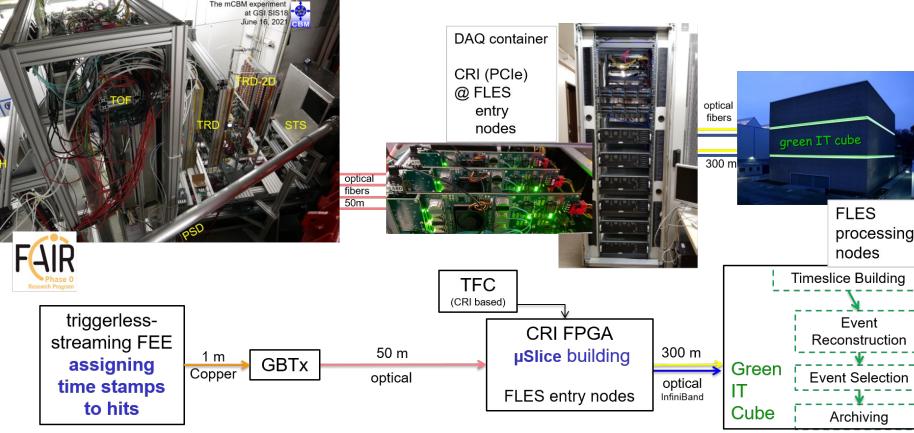
# highest collision rates available in FAIR Phase-0

 Customised chain of electronics to process and transfer the data of all subsystems to the final data processing proven its capability

During the last campaign, mCBM was successfully tested with the

# CBM in Phase-0: mCBM

FAIR GmbH | GSI GmbH



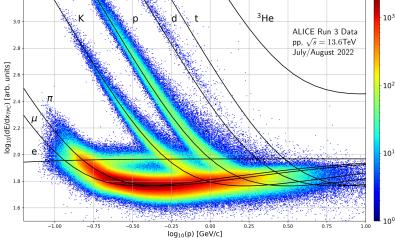


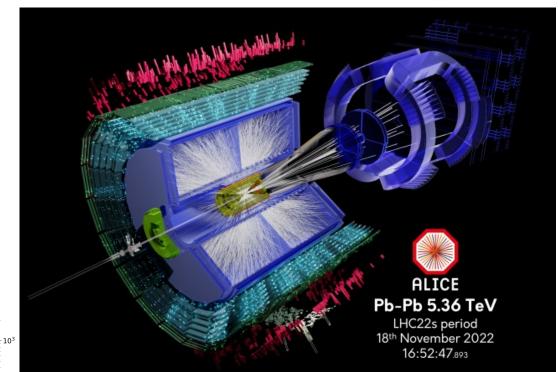


### **ALICE LHC Run 3**



LHC at CERN: operation restarted on July 5, 2023 Proton-proton collisions at 13.6 TeV Pb-Pb collisions at 5.36 TeV on Nov 18th





### **Upgraded Time Projection Chamber**

- <sup>101</sup> Continuous readout
  - Particle identification
  - Readout concept similar to the one of CBM and PANDA

#### FAIR GmbH | GSI GmbH



# **Thank You!**

With

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