HELMHOLTZ

RESEARCH FOR
GRAND CHALLENGES

Overview

GSI-MU Ion Facilities

Yvonne Leifels (GSI)

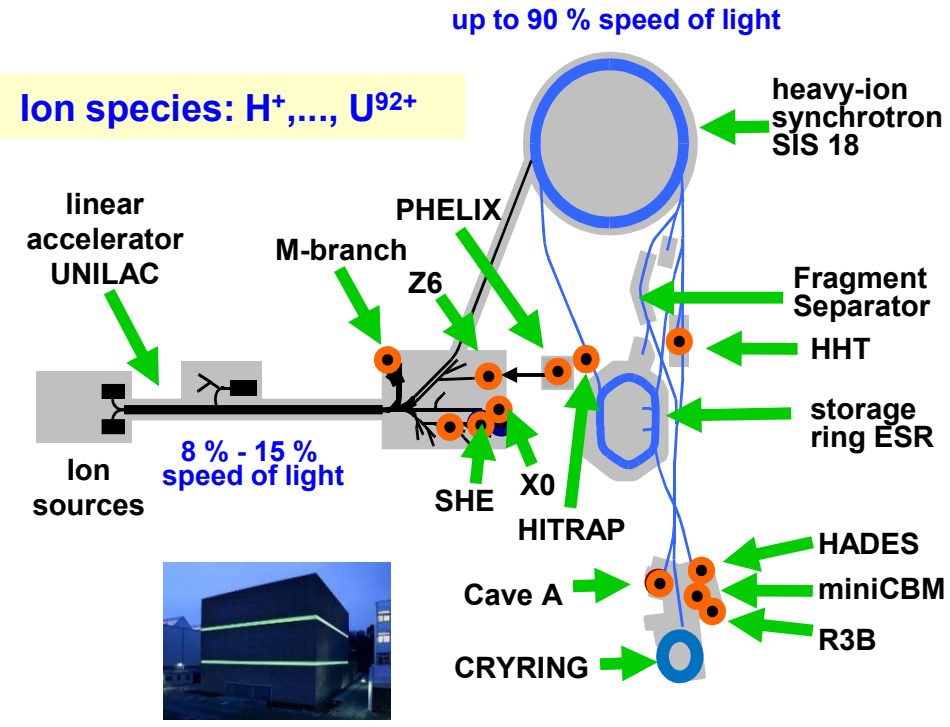
DESY. JÜLICH Forschungszentrum GSI HI JENA HELMHOLTZ Helmholtz Institute Jena HIM HELMHOLTZ Helmholtz-Institut Mainz HZB Helmholtz Zentrum Berlin HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung IPP KIT Karlsruhe Institute of Technology

GSI MU Ion Facilities towards FAIR

FAIR Phase-0 program

FAIR Phase-0 is the staged approach to FAIR science and progressive commissioning of accelerators and detectors, while :

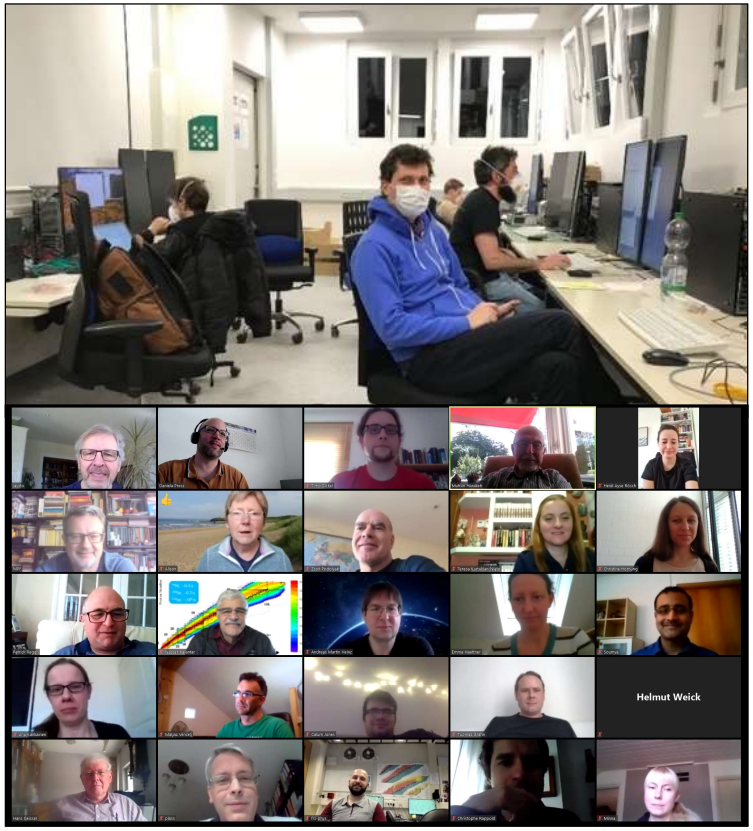
- FAIR Phase-0 started in 2018 and will continue with annual beam times of 3 months until start of FAIR
- Beam times in 2020/21 completed successfully
- Until 2024 a block of 3 months beam time per year is planned; the scheme for 2025/2026 will be developed depending on commissioning progress
- Early physics with SIS18 beam in the FAIR caves is planned from late 2025



Green IT-Cube

GSI MU Ion Facilities

User operation during the Corona pandemic



- Continuous operation under strict compliance of all safety rules (distancing, masks if distancing not possible, protecting plastic walls)
  - 2/3 of planned experiments performed in 2020
- Restrictions due to COVID-19 did not allow external collaborators to travel
  - often only remote participation possible
  - less support for setting-up experiments
- Measures
  - remote operation capabilities enhanced
  - online / nearline analysis tools established
  - automated calibration procedures
  - extended support in IT tools (citrix, video conferencing etc.)

GSI MU ion facilities

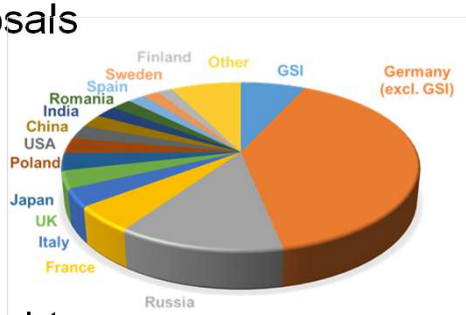
User operation – Call for proposals in 2020 for beam time in 2021/22

Total of 95 proposals submitted

Machine	Shifts requested	Shifts available
UNILAC	497 (3)	265
SIS18 / FRS	1723 (111)	421
ESR / CRYRING / HITRAP	*975 (153)*	*369*
Sum	3215 (266)	1055

number in () = shifts granted by G-PAC43
shift = 8 hours

- Following 2020 beam time
  - call opened for 2021 and 2022
- Overwhelming response to call for proposals



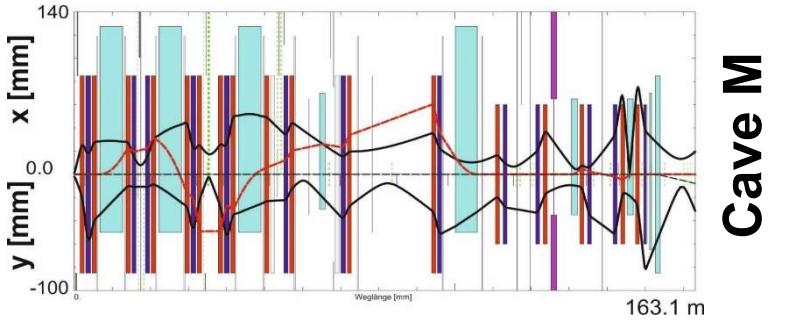
- Highlights:
  - 2 proposals connected to ERC grants
  - hadron physics program with WASA
  - extended storage ring program

GSI MU accelerator facilities

Upgrades for FAIR and FAIR Phase-0 user operation

- First-time: full chain user-operation UNILAC-SIS18-ESR-Cryring – Ag, Pb, U
- Carbon- and proton-beams at high intensity parallel operation out of one source (methane)
- Increase of the Pb-beam intensity up to 3E9/spill
- High intensity U-beam re-established
- Up to 4 ion species in parallel operation established
- New beam path SIS18-FRS-HTM commissioned

MU-MML: Transport of positron emitters (C and O) produced in FRS to medical cave



Preliminary results:

- Transmission F2-HTM ^{15}O: ~ 6%
- ^{15}O in Cave M per ^{16}O in SIS: ~ 6e-4

M. Durante, B.Franczak, H.Geissel, E.Haetter, D.Kostyleva, S.Purushothaman, C.Scheidenberger, et al.

2021 usage of positron emitters for radio therapy

MU accelerator facilities

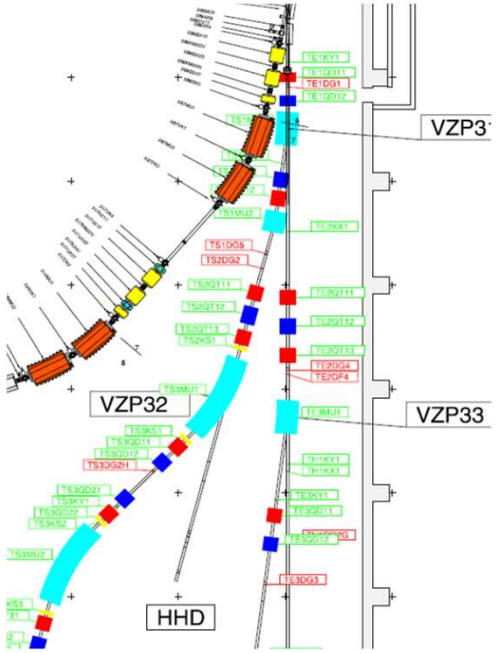
Highlights and perspectives

UNILAC post stripper upgrade: Feasibility study on integation of pulsed quadrupoles into drift tubes

drift tube before closing First of series

- first of series copper plated in-house
- magnetic field properties reached specifications

SIS18: New dipole installed



2021 replacement of UNILAC post stripper

MU Experimental facilities

Upgrade of HADES and installation of WASA at FRS

HADES:

- Enhancing physics performance under small angles
- **Goal** to measure production of and electro-magnetic decay of strange hyperons in February 2022

iTOF

TransFAIR, Jülich

- APD read-out
- Enhances trigger purity

T0

GSI, TU Darmstadt

- LGAD technology
- In-beam detector

Forward RPC

LIP Coimbra

- Based on R&D for neuLAND

STS2 + STS1

Jagiellonian Univ., TransFAIR, Jülich

- PANDA straw technology
- PANDA PASTTREC FEE chip

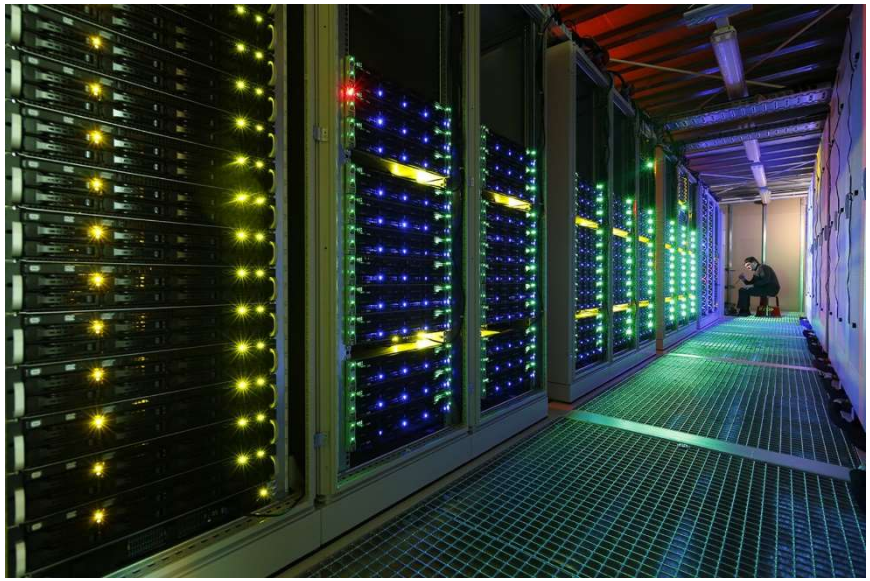
WASA@FRS:

- WASA installed in the FRS
- **Goal** to measure hypernuclei properties and eta mesic nuclei beginning of 2022

MU Computing facilities

Green-IT Cube: New compute and storage systems

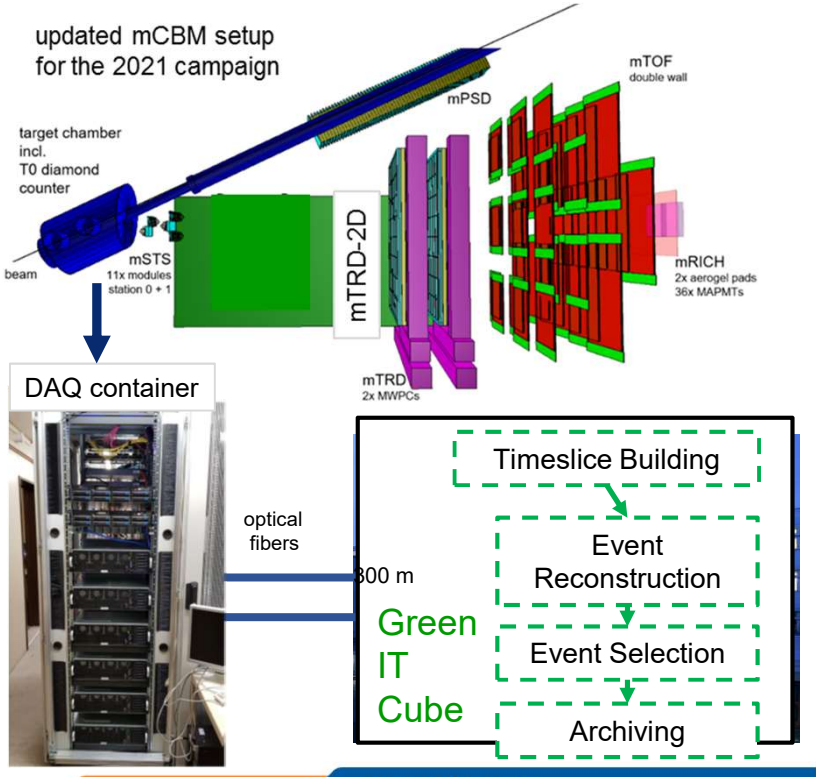
- **GPU cluster**
  400 AMD Radeon Mi100 GPUs, 8 GPUs/server, Infiniband HDR
- **High-Memory Nodes**
  50 servers with 1 TB RAM/Server, Infiniband HDR100
- **Standard Nodes**
  380 new servers, ~24.000 cores, 4 GB/RAM core, Infiniband HDR100
- **High-performance storage system (lustre) extension**
  82 new servers, ~34 PB useable space
- **Modernized Infiniband Network**
  to HDR/HDR100 (up top 200 Gb/s)



GSI MU Computing facilities

Green IT cube: Highlights and perspectives

- **Fully Integrated System**
  combining online, offline computing and HPC in one system
  with high bandwidth storage, software defined network partitioning for QoS; successfully used during beam-time for verification of the continuous read-out and event reconstruction method of CBM detector proto-types
- **Fully Virtualized System**
  all jobs running as containers, transparent for users, enabling better support of the various scientific use cases
- **Enhanced Connectivity**
  - demonstrated integration of HPC systems in Frankfurt and Mainz with the Green-IT Cube
  - Improved data access from European Open Science Cloud (EOSC) and international research partners
- **ALICE Analysis Facility**



MU Ion facilities

FAIR Phase-0

- FAIR will offer unsurpassed science opportunities
- GSI experimental and accelerator groups are working towards the completion of FAIR
- At the same time: **staged approach to FAIR science and progressive commissioning of accelerators and FAIR detectors**
- Huge progress in 2020/21 in GSI accelerator upgrades and employing FAIR detectors and concepts
- First Science at FAIR with SIS18 beam end of 2025
  - Super-FRS and APPA cave

FAIR Phase-0 goals

- Forefront research by employing and testing new FAIR detectors
- Exploiting upgraded GSI accelerator facilities
- Education of young scientists
- Maintain and extend skills and expertise
- Serve national and international user community

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Backup slide

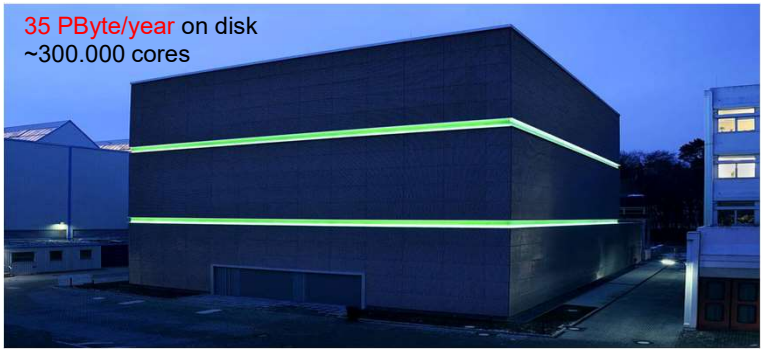
Have this one ready to show – the recommendation will be on the topic level

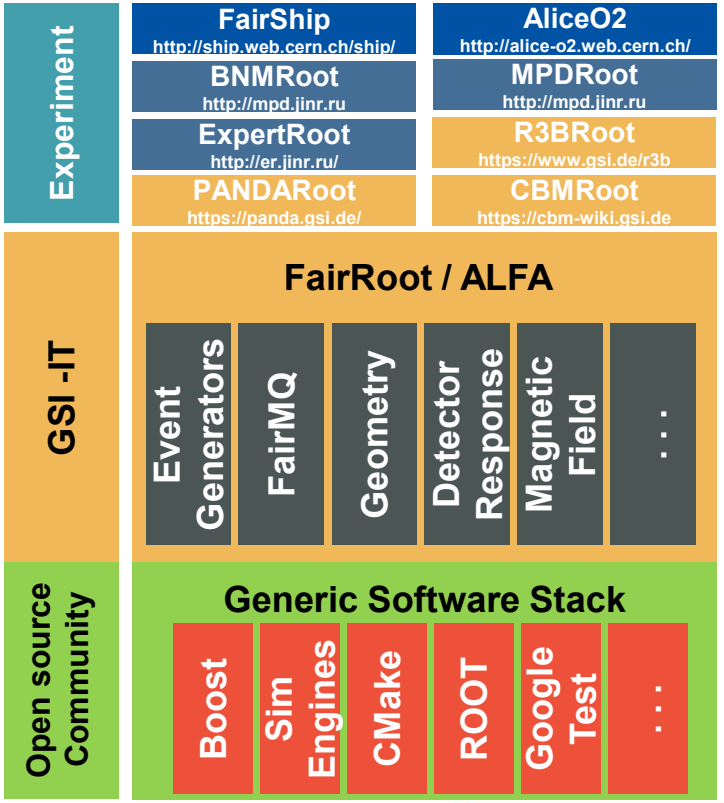
Computing at GSI/FAIR:
Maximize the synergy between partners on software and hardware usage

Dynamically allocated resources for exclusive usage and limited time (online clusters)

Generic batch farm for GSI/FAIR Users

Analysis Facilities (Grid Tier2)





MU accelerator facilities

Highlights and perspectives

UNILAC post stripper upgrade: Feasibility study on integation of pulsed quadrupoles into drift tubes

drift tube before closing

First of series

- magnetic field properties reached specifications

L. Groening et al.

2021 replacement of UNILAC post stripper

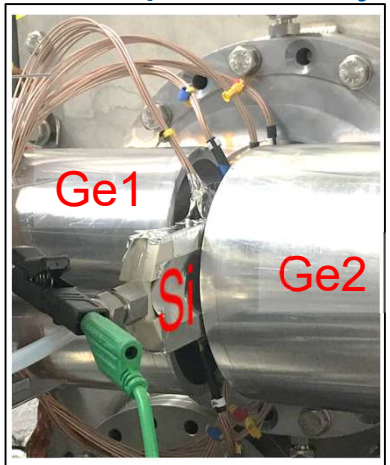
SIS18 septum: New power supply

- voltage increased close to nominal value
- reached nominal extraction angle
- less losses during extraction

2021 improves conditions for experiments

MU experimental facilities

Super-heavy elements



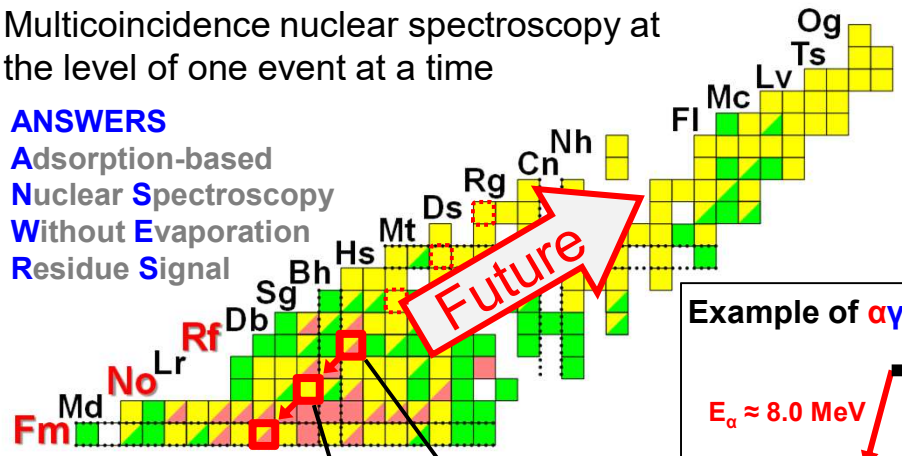
ANSWERS with its assembly of Si- and Ge-detectors at the focal plane of ***TASCA***.

Photo (J. Khuyagbaatar, GSI)

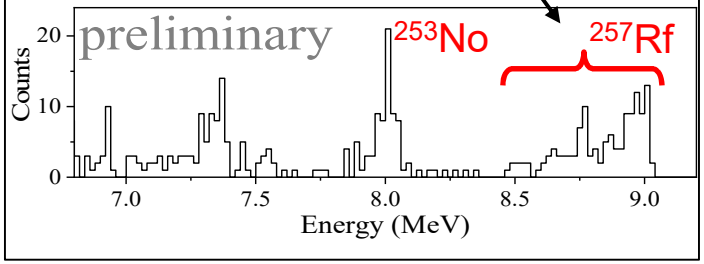
Multicoincidence nuclear spectroscopy at the level of one event at a time

J. Khuyagbaatar et al. (GSI)

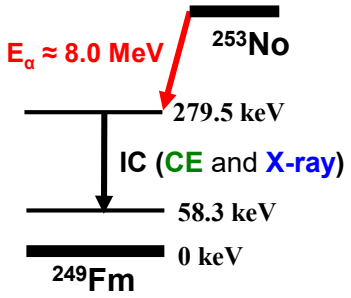
ANSWERS
Adsorption-based
Nuclear **S**pectroscopy
Without **E**vaporation
Residue **S**ignal



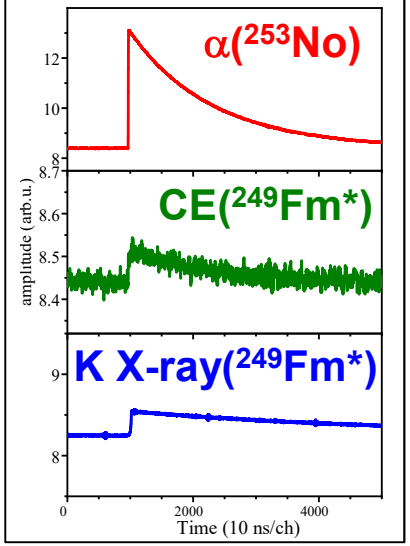
ANSWERS
Alpha-energy spectrum of strip 0



Example of αγe event



Digital traces (signals)



Final commissioning provides new data along the ^{257}Rf decay chain and paves the way for studies of superheavy elements