Challenges and Activities at the GSI Accelerator Facility

HFHF-IAP Seminar, Sankt Michael im Lungau, Österreich

Ralph W. Aßmann

25.02.2024

Mission "Accelerator Operations and Development"

- **Operation of GSI accelerators** and delivering beams for world-class heavy ion research
- Development of GSI accelerators and **preparing them step-wise for the future**
- **Supporting the FAIR project** and its completion
- Preparation and organization of **FAIR accelerator commissioning**
- **Operating** costs working group lead
- **Merging** of certain GSI/FAIR accelerator-related activities – work with **regional universities** and **international** labs
- Leadership team (see photos) and young talents in depts → excellent options for future **shaping of world-class GSI/FAIR accelerator area**

Accelerator Operations & Development

At the moment: 153 Staff *(front row and two right 2nd row: Leaders of Departments)*

29.1.2024

GSI/FAIR Organisation – Technical Sector

February 2024

Management Board

Technical Managing Director FAIR & GSI
Jörg Blaurock

ACC
Operations & Development

FAIR Project

2027
FAIR Early Science Completion

2028
FAIR First Science Completion

Project Management FAIR
J. Blaurock

Technical Integration
R. Fuchs/ O. Boine-Frankenheim

Project Management Office
E. Rosi

SIS 100 / SIS 18
P. Spiller

Super Fragment Separator
H. Simon

Commons
S. Menke

FAIR Site & Buildings **
M. Ossendorf

Site Management ****

Projektleitung ext.

****
Funktionale Berichtsline zu

Accelerator Operations & Development
R. Aßmann

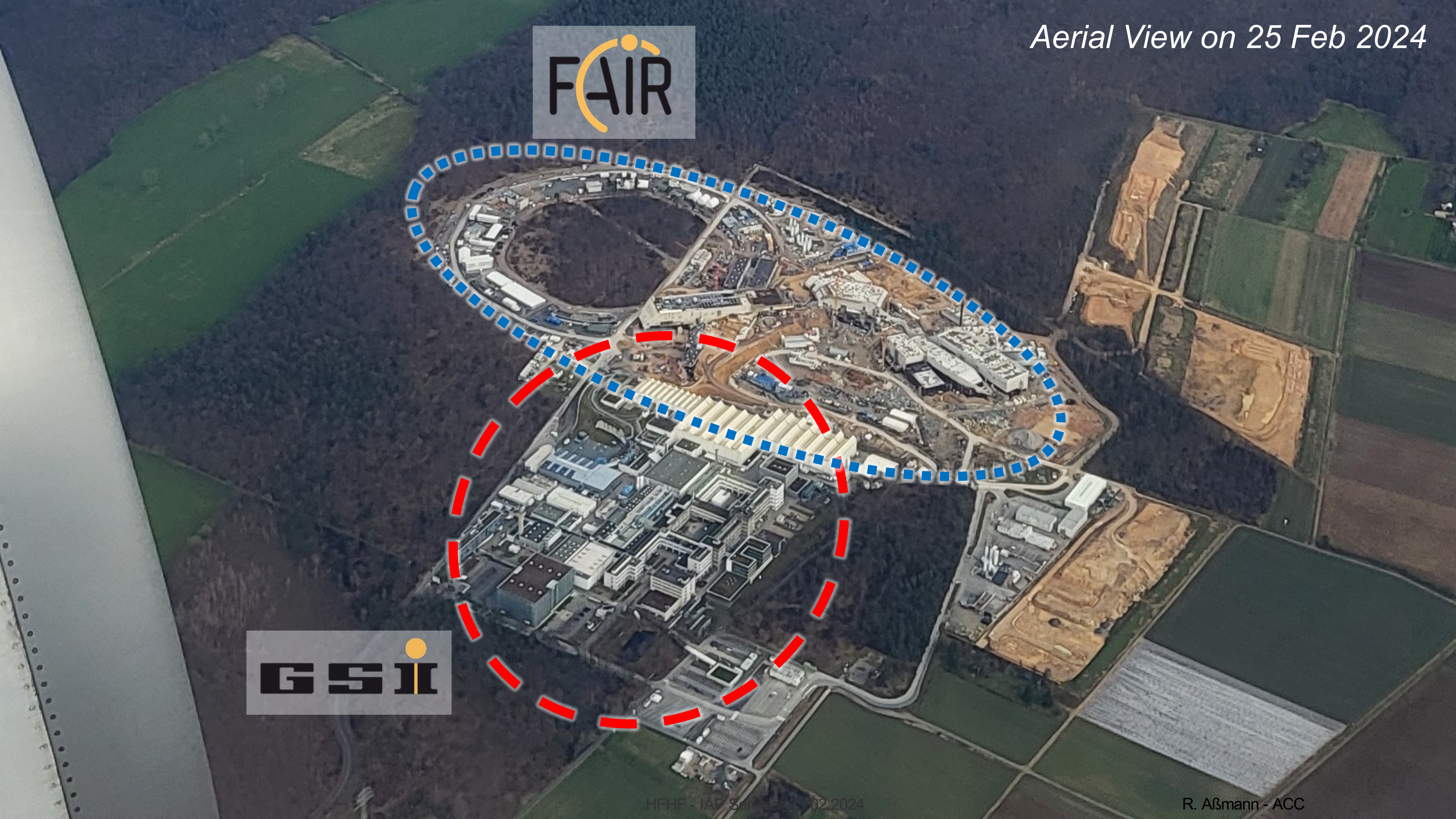
Accelerator Project Office
U. Weinrich

8 Departm.
Operations – Decelerators – Ion Sources – LINAC – LI-NAC RF – Storage Rings – Beam Cooling – UNILAC PSU

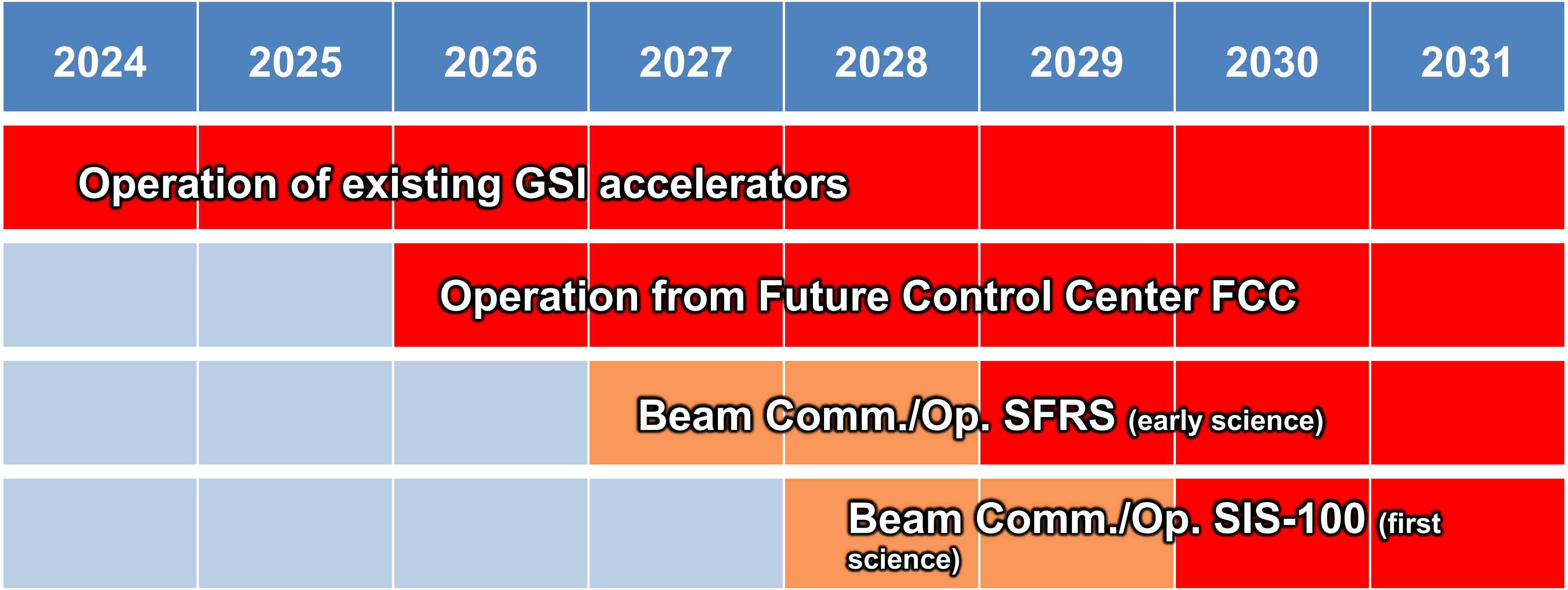
Operation Infrastructure Support
G. Walter

2 Departm.
Mechanics, Metal Working – Technology Lab.

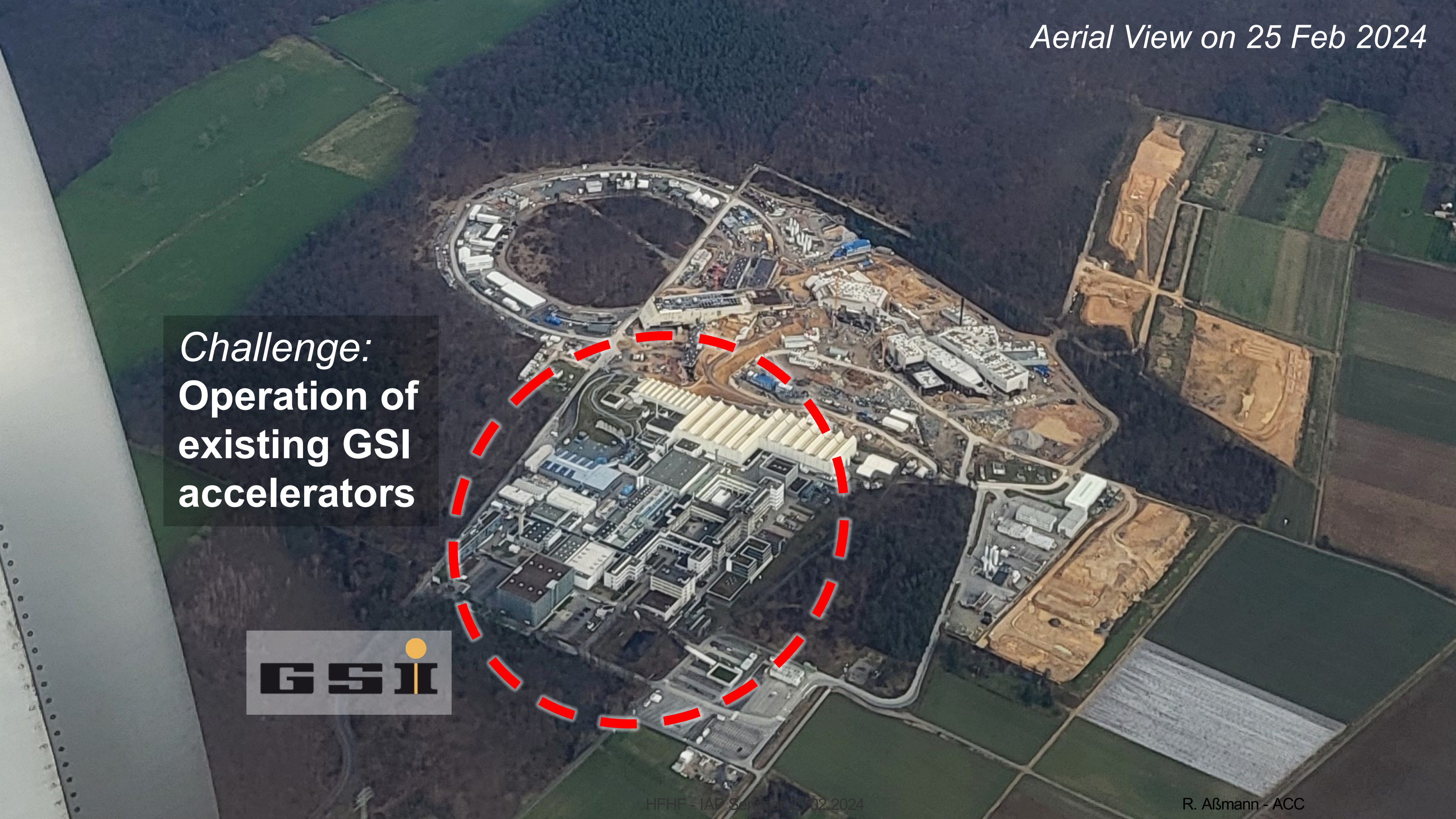
Aerial View on 25 Feb 2024



Challenges for Acceleration Operations and Developments

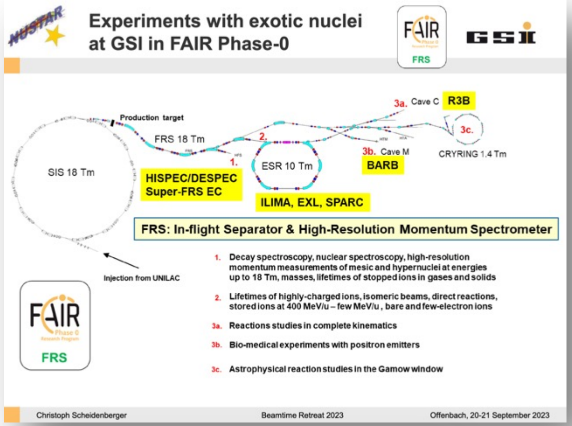


FAIR planning status Feb 2024

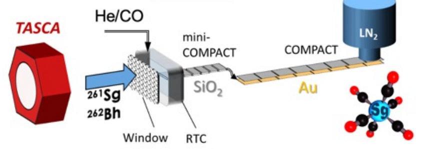

Aerial View on 25 Feb 2024
Challenge:
Operation of existing GSI accelerators
GSI

Wishes from the Experiments (SIS-18, UNILAC)

- NUSTAR ("Nuclear Structure, Astrophysics and Reaction")
  - Efficient use of beam-on-target time:
    - Improved **micro-spill and macro-spill structure**
  - Stay competitive on the world-wide scale:
    - **Higher beam intensity** at 1GeV/u
  - Increase duty cycle of slow-extracted SIS-18 beams:
    - Many NUSTAR exp. run with 1…2 sec. extraction time: **fast ramping up and down of SIS-18** will increase the duty factor
    - factor 2(?) higher average beam intensity on target
- SHE ("Super Heavy Elements")
  - Optimization **beam transmission** & material consumption:
    e.g. crucible lasts 4-5 days, service takes 2 days → 30% of beamtime lost
  - Timely exchange of **damaged triplet at (HLI) injector** crucial!
  - **HELIAC**: will deliver beams for **SHE during PoF V** → integration in planning for civil construction crucial!



Reaction	Product	Rate @ TASCA
$^{54}Cr + ^{208}Pb \rightarrow$	^{261}Sg 178 ms	15 atoms / d
$^{54}Cr + ^{209}Bi \rightarrow$	^{262g}Bh 135 ms	1 atom / d



Reference: Talks in Beam Retreat 2023

Wishes from the Experiments (UNILAC)

- BIOPHYSICS
  - **Mixed He-C beam**
  - **~10^{10} pps of ^{12}C**
  - Midterm needed to produce competitive therapy research: **active energy change** (GSI invented)
    - beam properties (energy, focus, intensity) requested from library
    - changing possible from spill to spill
- HiTRAP
  - **Decelerating** from 4 MeV/u to 6 keV/u (goal 10^5 ions).
  - Solve **transmission** to experiment with 20% energy spread and 180 π mm mrad
  - Around 7 days of further commissioning **time** with beams from ESR (commissioning blocks beginning of 2024&2025)

Reference: Talks in Beam Retreat 2023

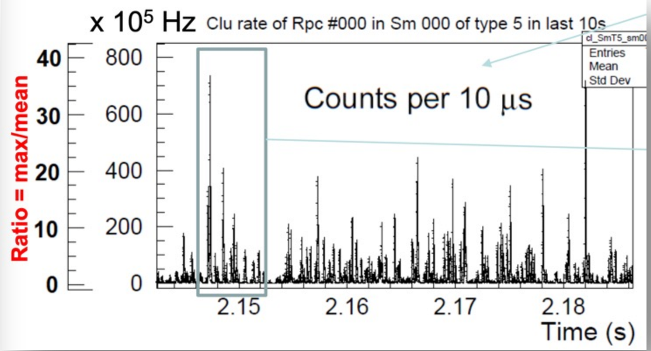
Wishes from the Experiments (CRYRING, ESR)

- SPARC
  - Storage rings **overbooked** by factor 4.5
  - **Transmission**: FRS → ESR, ESR → CRYRING, ESR → Cave A (new control system)
  - Beryllium-like 197Au75+ ions (> 5 10^6) from SIS → ESR → CRYRING
  - Accumulation, purification, electron and stochastic cooling, new target in TE, lasers, gas-jet operation, windows and detectors
  - ESR:
    - **Optimize deceleration capability** (e.g. vacuum, power supply stabilization with drift tubes)
    - accumulation of Li-like RIBs (Bi80+) with different method (ecool-stacking)
    - Ultra-slow extraction
  - CRYRING:
    - optimize/increase the intensity of soft beams (e.g. Ne3+)
    - new ion species (e.g. W14+)
  - Most equipment is stored and maintained by university groups outside the campus of GSI/FAIR. For setup assembly and testing, a **work area** outside CRYRING@ESR is an absolute necessity.

Reference: Talks in Beam Retreat 2023

Wishes from the Experiments (SIS-18, HEST)

- HADES ("High Acceptance Di-Electron Spektrometer")
  - G-22-00022 (C/Au beams)
    - Stable, well focused beam on the HADES target, beam spot diameter < 2mm (+-3sigma, 99,73%), slow extraction
    - Au ions: 0.8A – 0.2A GeV, $1.2*10^6$ ions/s (flat top)
      C ions: 0.8A–0.6A GeV, $3*10^6$ ions/s (flat top)
      Spill duration > 13 s to improve the duty factor
      Desired **micro and macro time structure** (Q<5)
    - **Beam Abort System (MP)** installed & operational, reaction time ~100 ms
  - G-22-00141 (Pion beam)
    - Fully stripped **N ions, 10^{11} ions/s**, 1.7 GeV/u, slow extraction, 1 s flat top, 80% extraction efficiency
    - **Extraction efficiency** SIS18, **enlarged apertures**, improved radiation shielding



Plus **wishes and requests from accelerator experts** for improvements, renovations and upgrades!

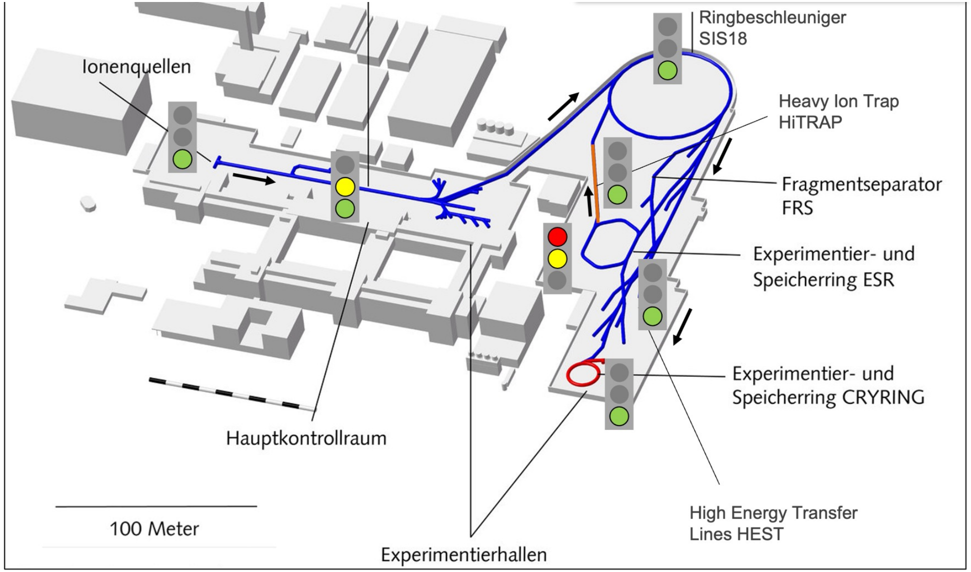
Reference: Talks in Beam Retreat 2023

Beam Retreat Presentations are Partly Addressed

- Of course, there is already a **working improvement process in place**.
- Presentations at beam time retreat and discussions.
- **Actions by the responsible machine coordinators and facility divisions** → improvements.
- Works best for shorter term improvements.
- Limited for long term actions and major investments, that require staged invests and major resource allocations → **resource-loaded technical roadmap with full coherency over the full accelerator complex**.
- Also expected from us for Helmholtz POF5 review (→ funding).
- Must include smaller and larger actions, ordered in time and with a basic plan until completion.

Example: N Beam for HADES

- This particular delivery process "tests" big parts of the accelerator complex and delivers beam for users



- **UNILAC: $^{14}N^{7+}$ 5.4 emA @11.4 MeV/u (150% of UNILAC design limit)**
  - $(N_2)^+$-acceleration at HSI to overcome space charge limitations
  - Two stripping process for max. intensity in charge state 7+

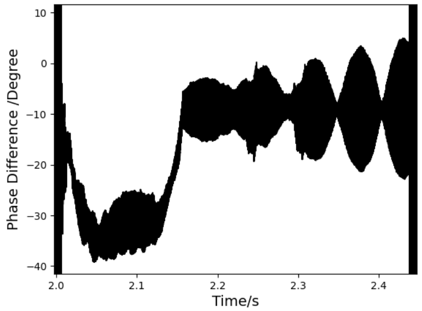
D. Lens, B. Zipfel, et al

SIS18: Test N Beam Phase Regulation

Tabelle 1: Parameter des Experiments

Pattern	SIS18_FAST_HHD_20231122_055219
Ionensorte	$^{14}N^{7+}$
Anzahl an Teilchen auf Injektion	bis zu $1 \cdot 10^{11}$
Anzahl an Teilchen auf Extraktion	ca. $5 \cdot 10^{10}$
Injektionsenergie	11,36 MeV/u
Extraktionsenergie	80,0 MeV/u
Strahlstrom auf Flattop	30 … 40 mA
Verwendete Kavität, Harmonischenzahl	S08BE2, h=4

Strahlphasenregelung aus



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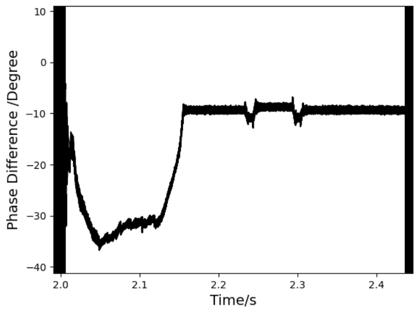
Strahlphasenregelung an



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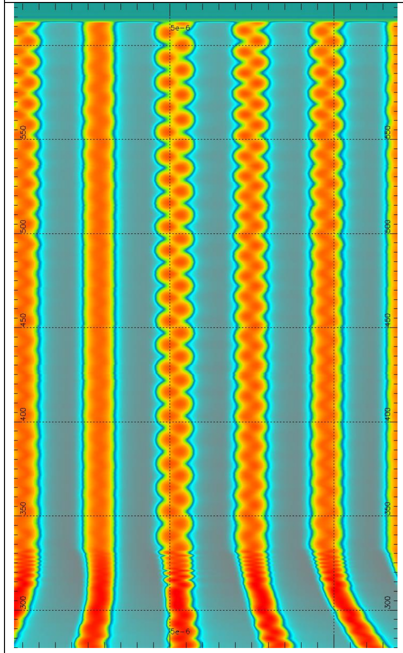
Ohne Strahlphasenregelung



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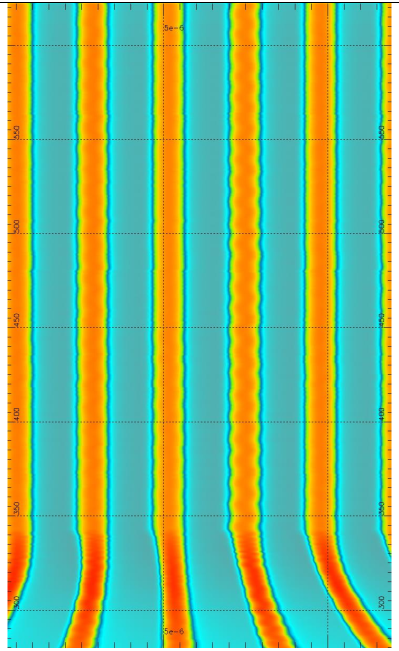
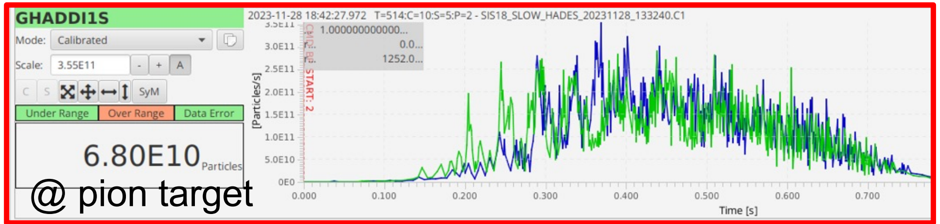
Mit Strahlphasenregelung

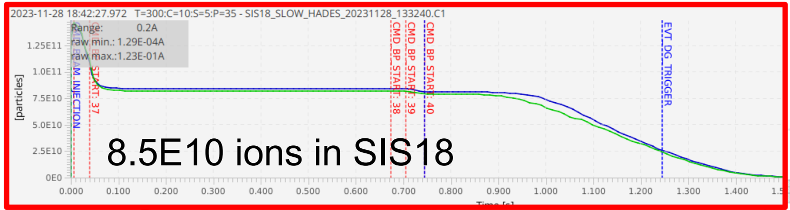


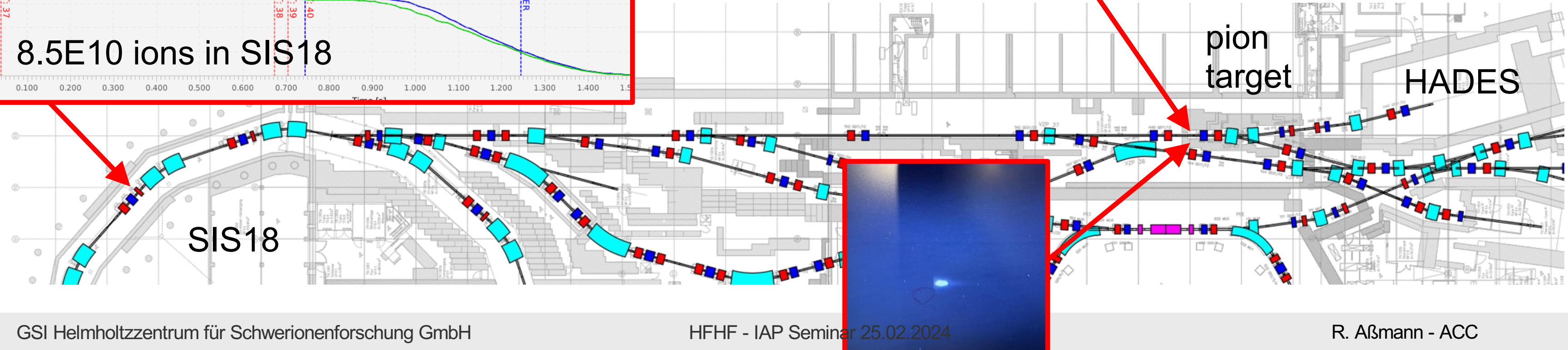
on

HEST: High-Current N Study for HADES Pion Run

- During 2014 pion run the beam intensity had to be limited due to high radiation dose levels observed in the target hall, which were caused by beam losses in the extraction region and in HEST.
- Improvements in HEST to overcome this issue:
  - Quadrupole vacuum chambers with increased apertures
  - Installation of BLMs
  - New transfer line optics for pion production
- During the high-current study the **transmission** from SIS18 to the pion production target could be significantly **increased by a factor 3-4 to 80%** (incl. extraction efficiency).
- Analysis of radiation dose data is on-going.



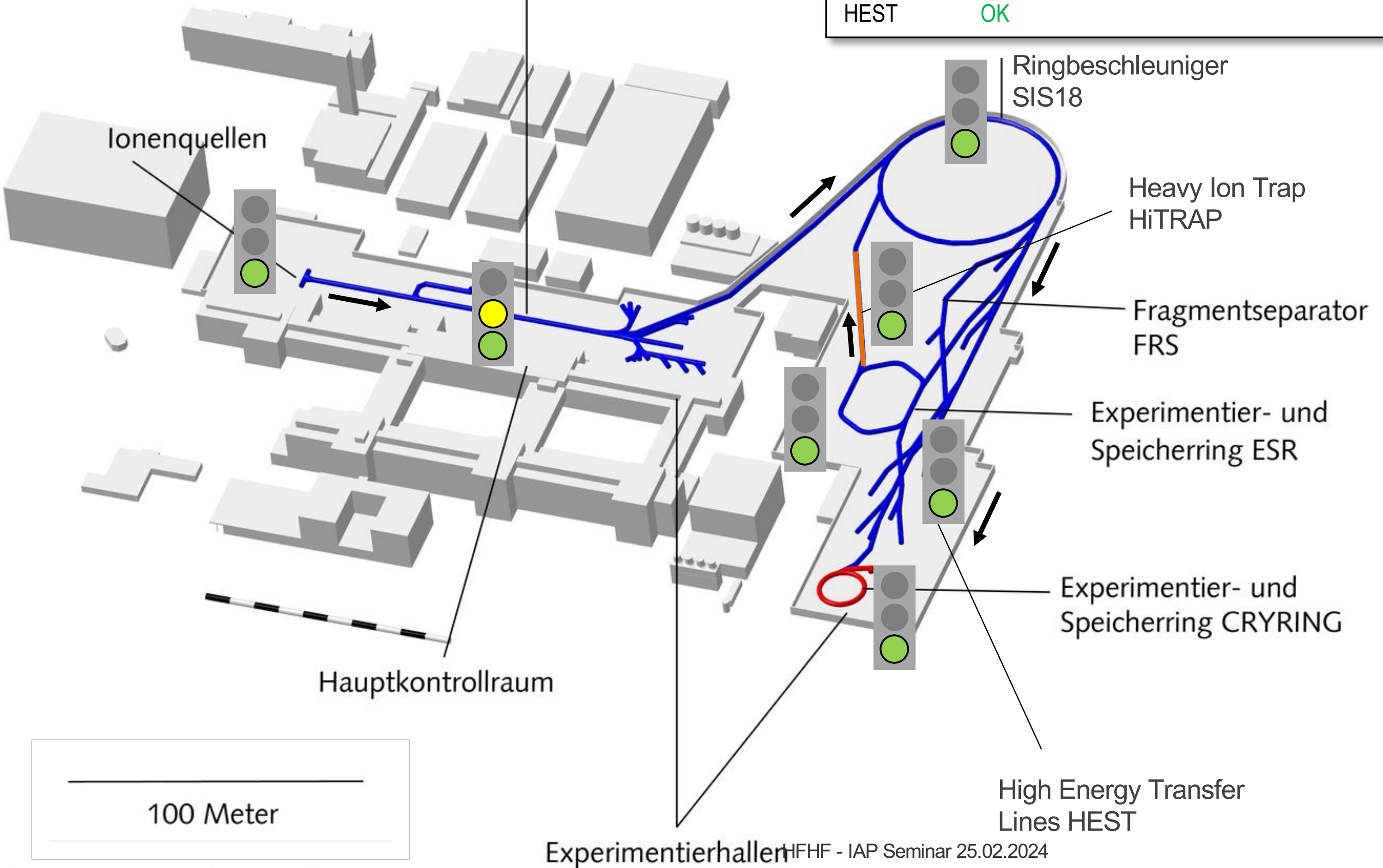




Status Accelerators

25 Feb 2024

Ionenquellen	OK	CRYRINK	OK
UNILAC	OK with risks	HiTRAP	OK
SIS18	OK	ESR	Target 19 Jan
HEST	OK		

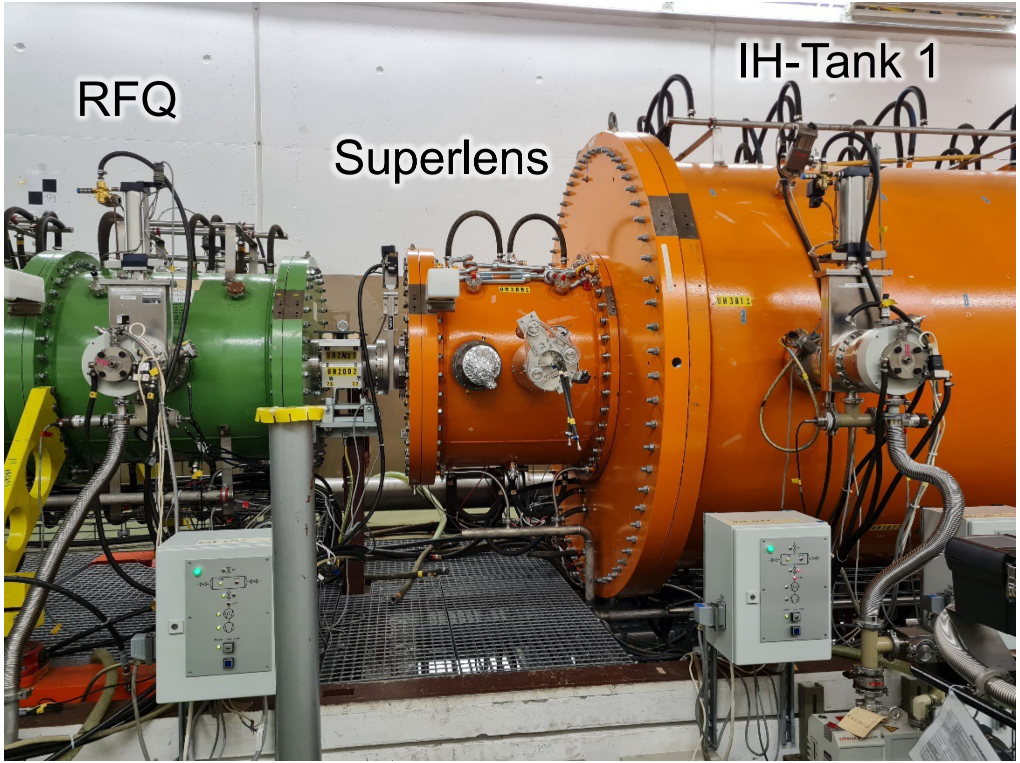


Shutdown achievements:

Modernization, upgrades and repairs. Prepare for user run but also FAIR operation. Major works done, some the 1st time in decades (e.g. ESR).

Examples: **Sources** – new ion species prepared. **UNILAC** tunnel septum magnet improved → Z line can be served again after several years. Exchange of superlens electrodes → operation back with high performance. **SIS18** new micro-spill cavity for smoother ion rate in slow extraction. **HEST** diagnostics modernized and digitized. **CRYRING** new experimental capabilities. **HiTRAP** RFQ tuned up to higher fields and software modernized to FAIR standard (ongoing). **ESR** cooling equipment repaired.

UNILAC – Superlens Repair & Upgrade (2022/23)



Courtesy W. Barth et al

Operating issues

- Unacceptable beam losses
- Performance degradation
- Increased reflected power @high current operation

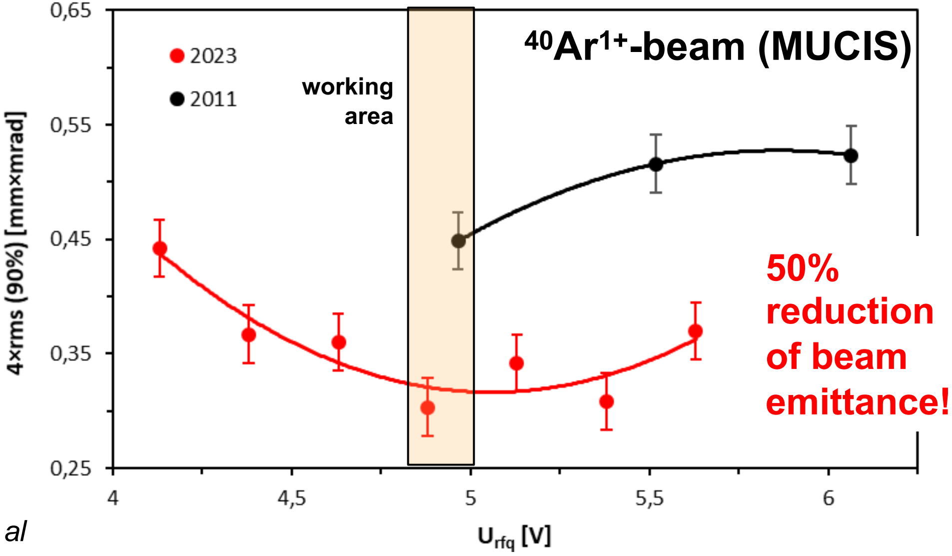
Measures

- Replacing old rods
- New rods
  - massive copper
  - galvanic copper coated
- Advanced plunger design
  - enlarged size
  - closer positioned to the girders
  - w/o tuner extensions

⇒ compensate (unwanted) shift of rf-frequency

UNILAC – Superlens Repair & Upgrade (2022/23)

- Successful rf-commissioning of SL
  - Confirmed frequency compensation
  - High power operation with advanced plunger design
  - **110% of nominal rf-level reached**



- Emittance measurement campaign behind RFQ

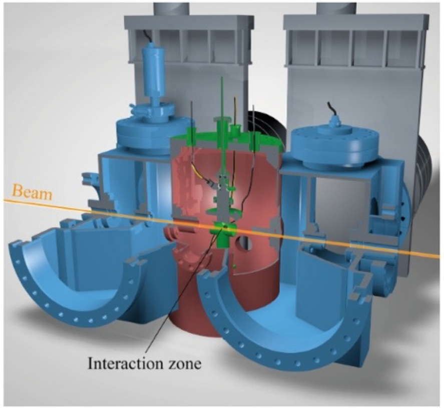
  → improved MEBT-emittance...

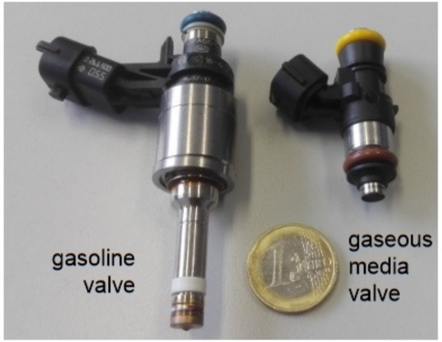
Courtesy W. Barth et al

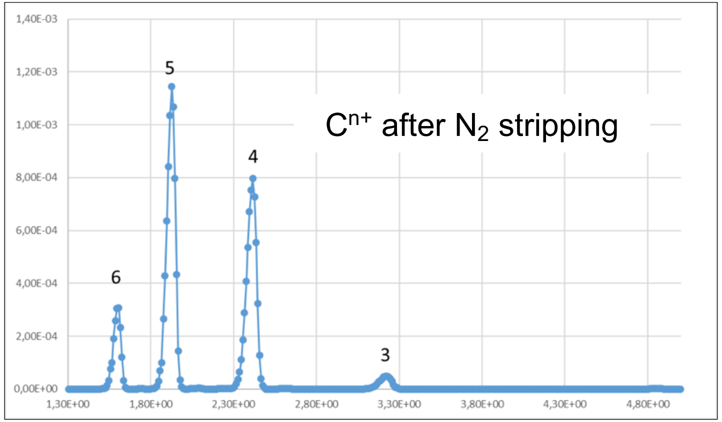
Pulsed Gaseous Stripper Operation *(temporary)*

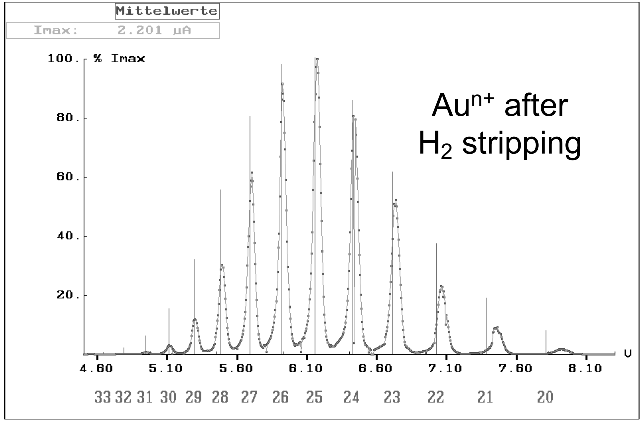
Tests in Engineering Run 2023

- Set-up operated in 2023 to collect more data on stripping **of** → **by**
- [**CH_3, Ar, Fe, Au**] → [**N_2, H_2**]
- light, inter-mediate, heavy
- eight scenarios, at different gas-pressures, pulse lengths, and repetition rates
- **U^{28+}** → **H_2** operation for further beam time in 2023 / 24



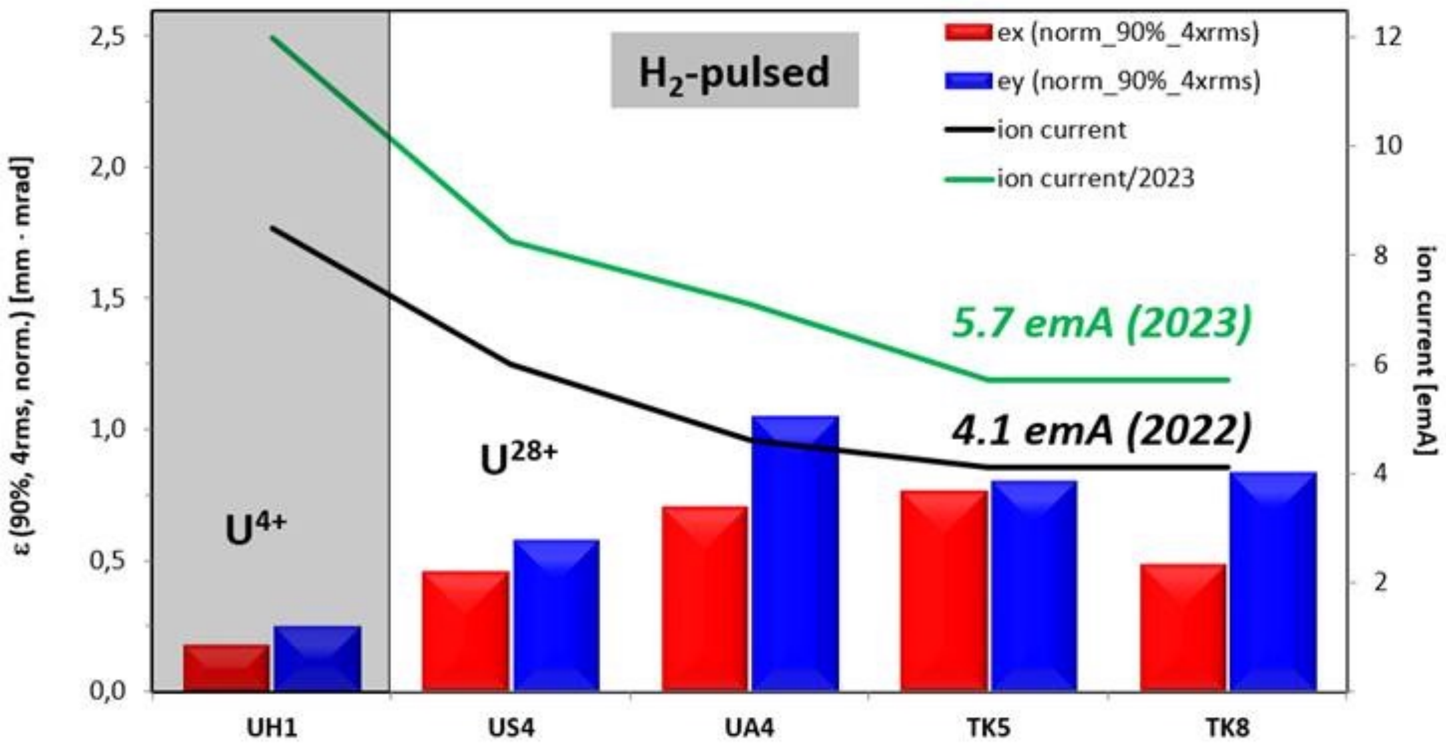






Courtesy L. Gröning et al

New U^{28+} Record at End of UNILAC



W. Barth: „40% Stromerhöhung (TK-Ende) gegenüber 2022 dank Superlinsen-upgrade – das ist die bis dato höchste erzielte U28+-Intensität“

Courtesy W. Barth et al

SIS18: Overall Status and Strategy

FAIR Phase 0 (present operation): Improvement of **spill micro-structure** with new RF structure

Improvement of **shielding** (esp. p and light ions), kicker area done recently, compatibility with construction work

FAIR Phase 1 (booster operation): Development of further technologies to **stabilize the dynamic vacuum**, esp. for U^{28+} operation

Robustness of septum wires: Improve **robustness** by adding collimators. Worry of sparking at wires. **MP** issues.

Making SIS18 fit for the future: Replacement of old **UHV pumps** (→ better vacuum).

Replacement of **power supplies**.

New **beam-based feedbacks** (profiting from completed digitilization work).

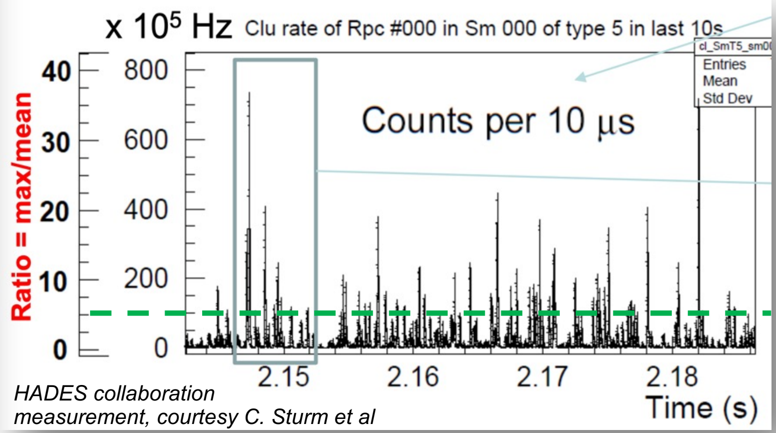
Digital Schottky system enables **active, automatic regulation** of SIS18 RF frequency to measured UNILAC beam energy

Courtesy P. Spiller et al

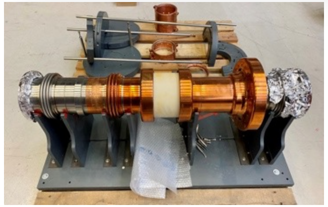
SIS18: μ-Spill Cavity for Spill Structure

Goal: Spill structure smoothing by VHF bunching

- Proof of principle experiment:
  - cavity most probably removed, depending on results
  - If positive: low impedance cavity to be developed
- Caveats:
  - The cavity may have an impact on the U^{28+} live time (will be measured).
  - High shunt impedance: cavity op. may be limited to lower beam currents. Short cut during no-use.
  - Cavity op. generates pressure bump around the Rf gap: cavity commissioned ½ day before beam time.
- Beam time 2023:
  - 1st block: Commissioning by Rf dpt. and local control of Rf parameters (no integration into control system)
  - 2nd block: **Measurement of beam micro structure (BI) with „pilot beam“ → promising results, more work needed**



HADES collaboration measurement, courtesy C. Sturm et al



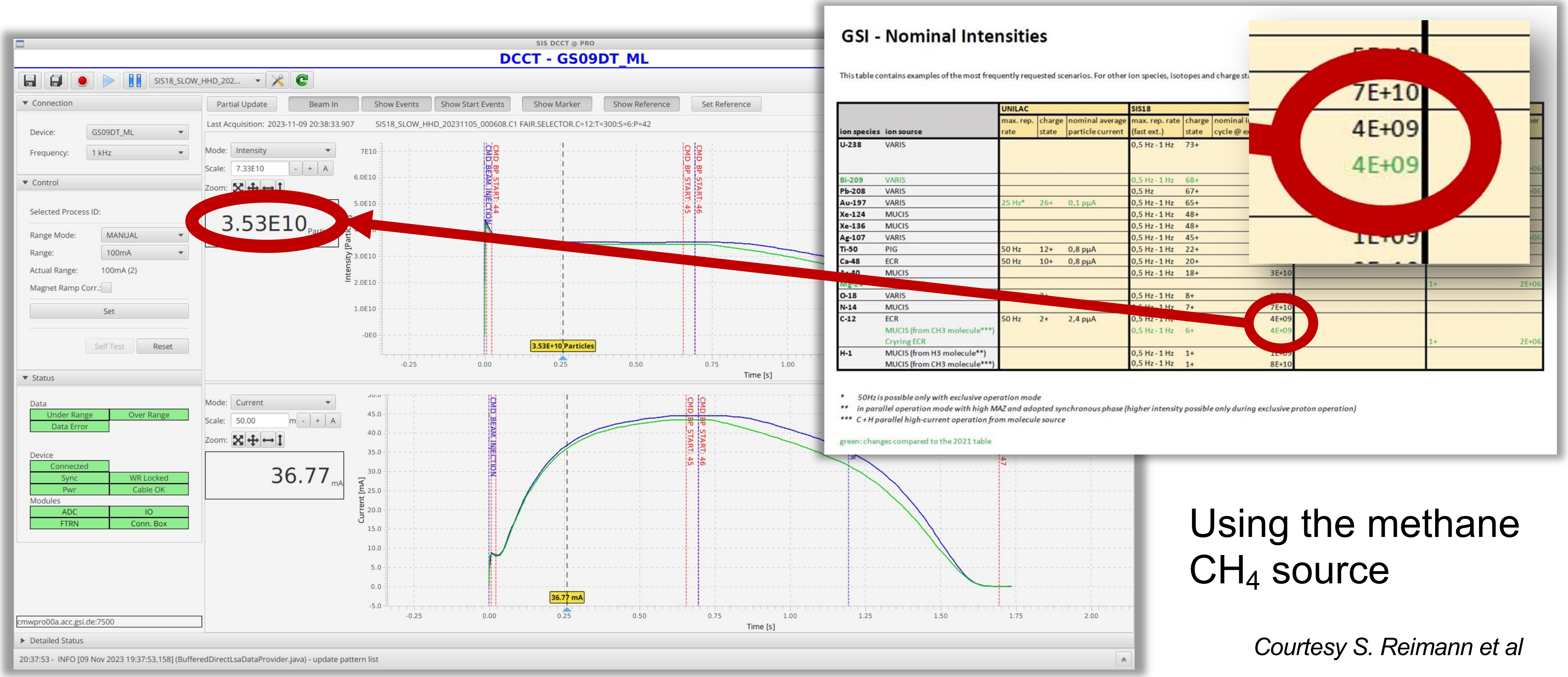
Rf gap produced twice because of insufficient properties of gap ceramics (Rf energy dissipation)

Cavity at installation in SIS18

Courtesy P. Spiller et al

SIS18: Intensity C Beam for Users → Factor 10 Better

Vacuum Upgrade Program



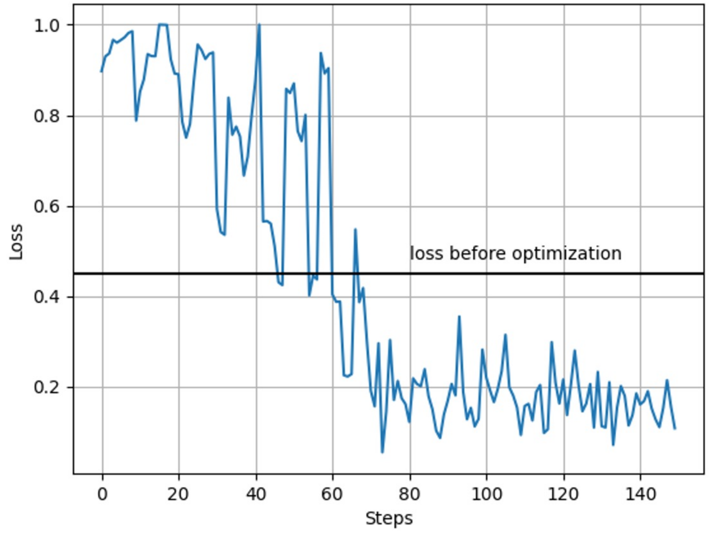
Using the methane CH_4 source

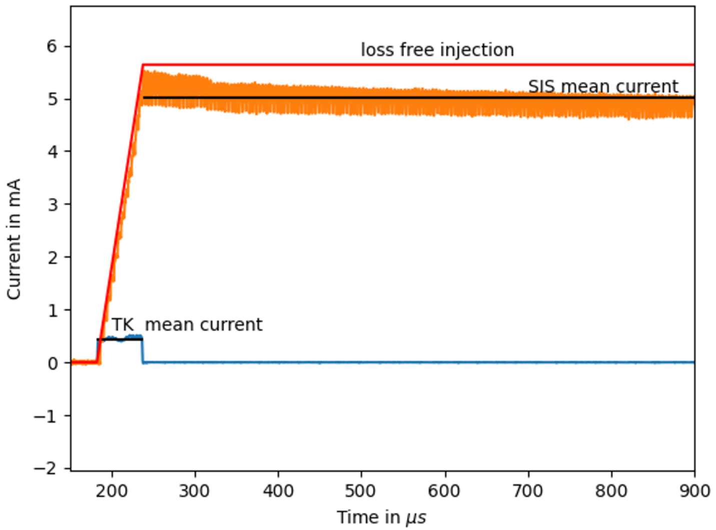
Courtesy S. Reimann et al

S. Appel, O. Boine-Frankenheim et al

First automated SIS18 injection optimization

- With the **python bridge fully automated multi-turn injection optimization** can be performed in about 15-20 min
- The loss could be reduced from 40% to 10% using five optimization parameter
- Potentially further improvements using more optimization parameters and other optimization algorithms





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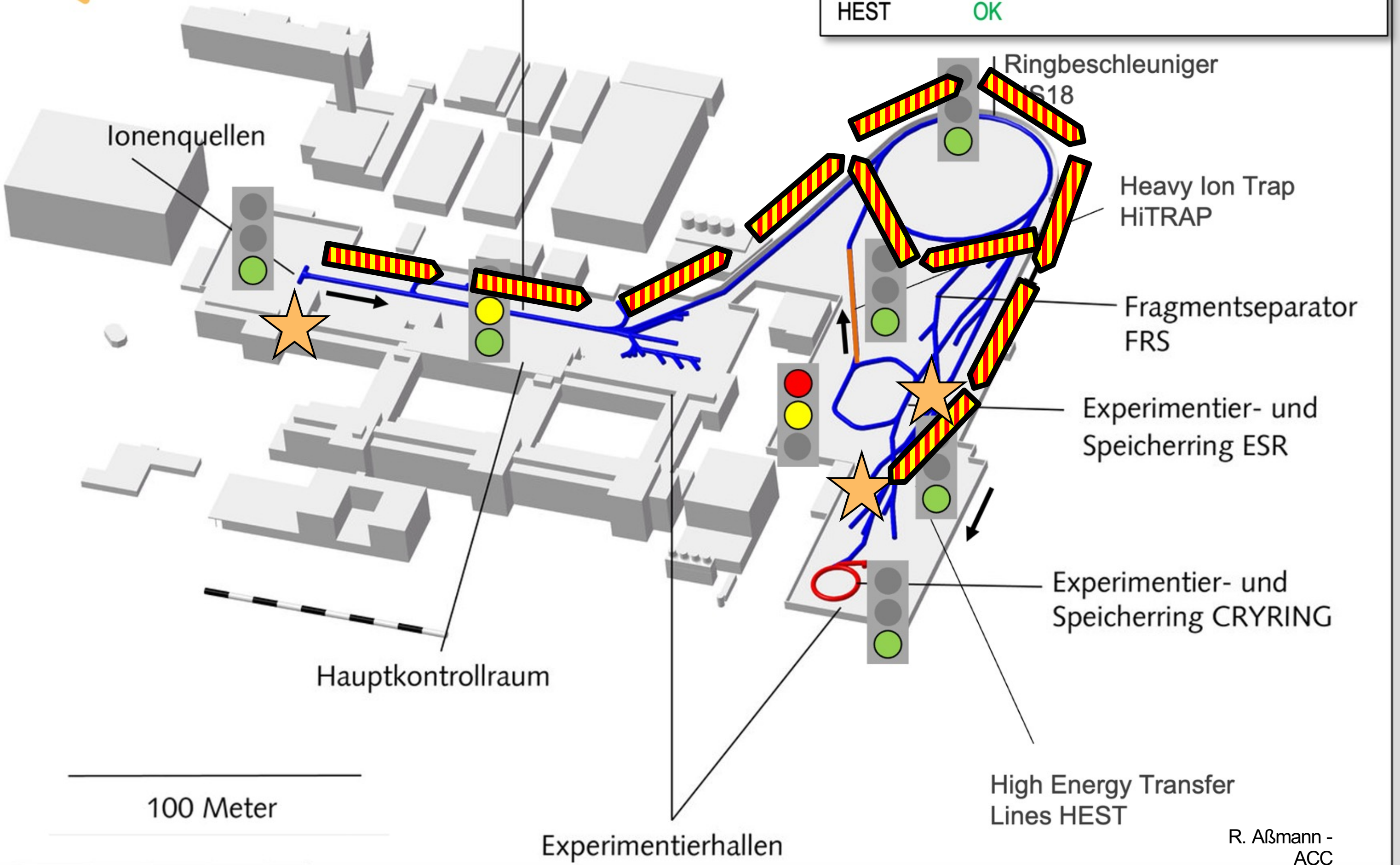


Courtesy F. Maimone et al

Dual Ion Beam for Tumor Therapy *(world-wide first)*

Carbon used for tumor irradiation. Helium penetrates through body and is used for real time imaging.

▪ **Ion mass**	He + C (5-20% He)
▪ **Ion charges**	$^{4}He^{+}$ und $^{12}C^{3+}$ from CH_4
▪ **Energy**	225 MeV/u
▪ **Beam intensity**	10^8, Slow extraction
▪ **Stability**	No variation of He, C and O
▪ **Contamination of $^{16}O^{4+}$**	As low as possible

Possible contrast at low-density differences

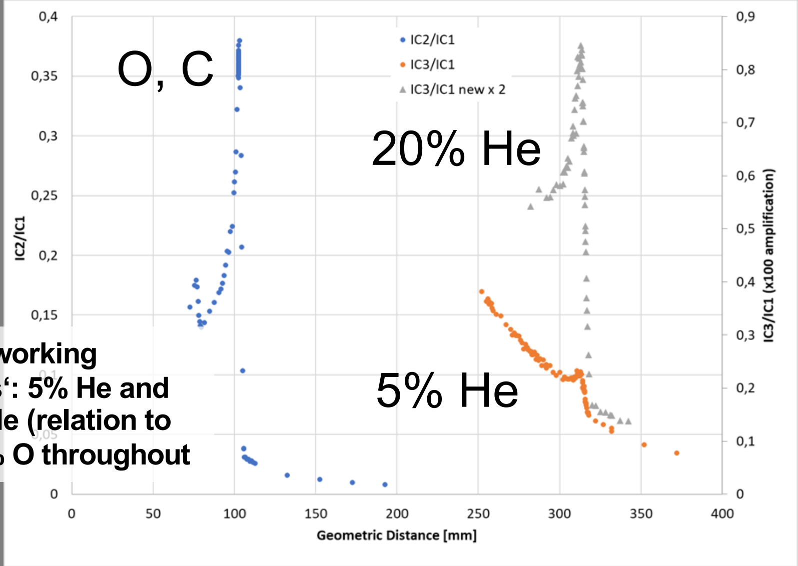
A gummy bear in addition to other density calibration targets in a gelatin block (edge length 6 cm), can be imaged exclusively with the helium portion of the beam.

Measured ion contributions to image:
12C^{6+}: 0.167%
4He^{2+}: 99.833%

Two 'working points': 5% He and 20% He (relation to C), 7% O throughout

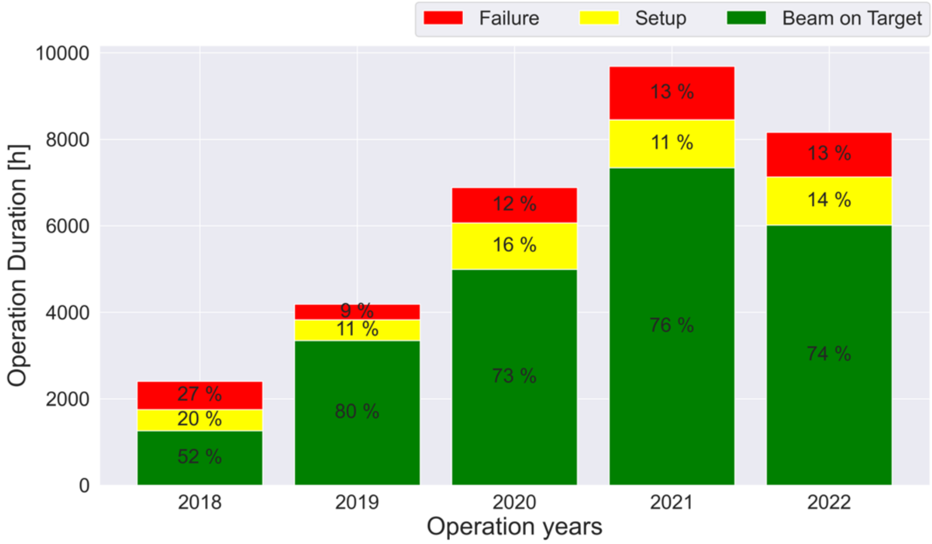
Measurements with a matrix IC detector (also time-resolved) and films providing location information collected as well.

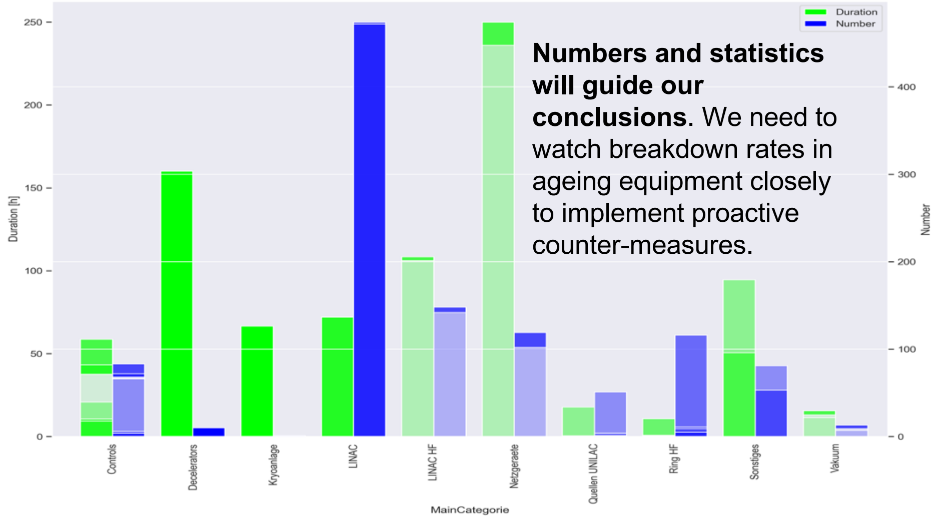
Integrals over one spill for the depth dose



- IC2: front chamber with O and C peak
- IC3 : back chamber with 5% He concentration
- IC3 : back chamber with 20% He concentration

Availability 2018-2022 → 2023?



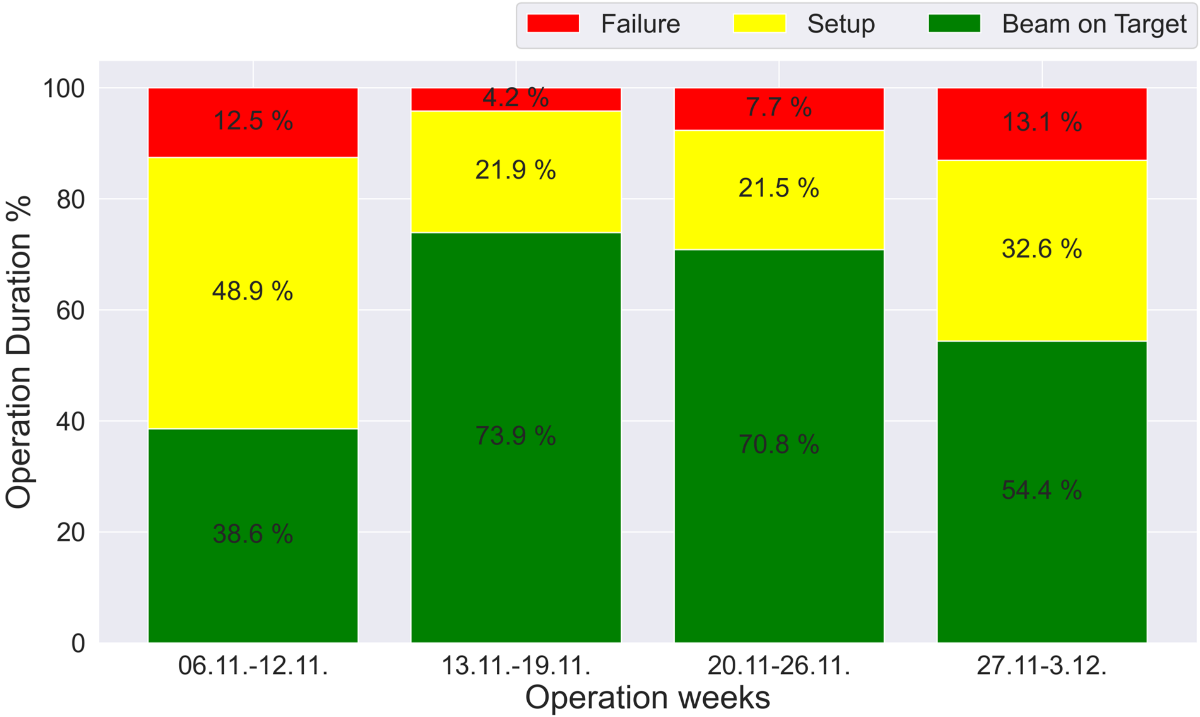


Numbers and statistics will guide our conclusions. We need to watch breakdown rates in ageing equipment closely to implement proactive counter-measures.

Performance committee will track accelerator performance and work out a coordinated technical roadmap / action plan across the accelerator complex

→ Oksana Geithner will act as committee manager

Overall Accelerator Chain Availability During Engineering-Run 2023 (first 4 weeks)



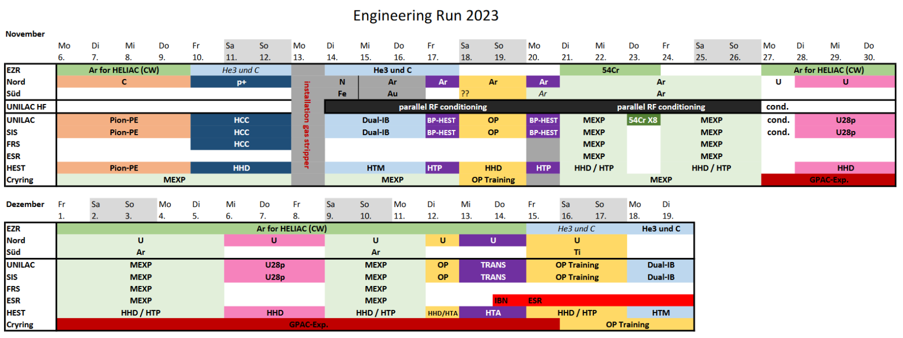
Courtesy O. Geithner et al

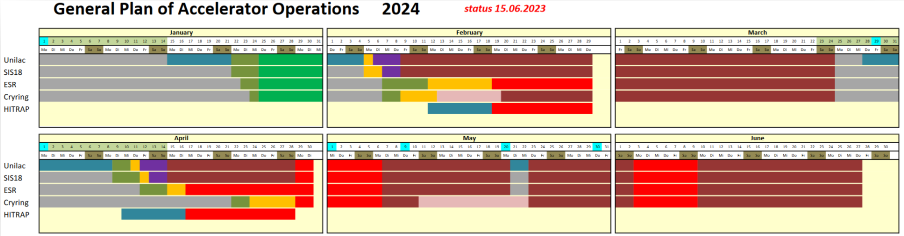
Availability Goal (Setup + BoT) is > 90% during half the run (so far)

So far very (exceptionally) good

* The distinction between setup and beam on target is rather arbitrary during an engineering run. The decisive factor is the failure rate.

Ongoing: User Beam Time 2024





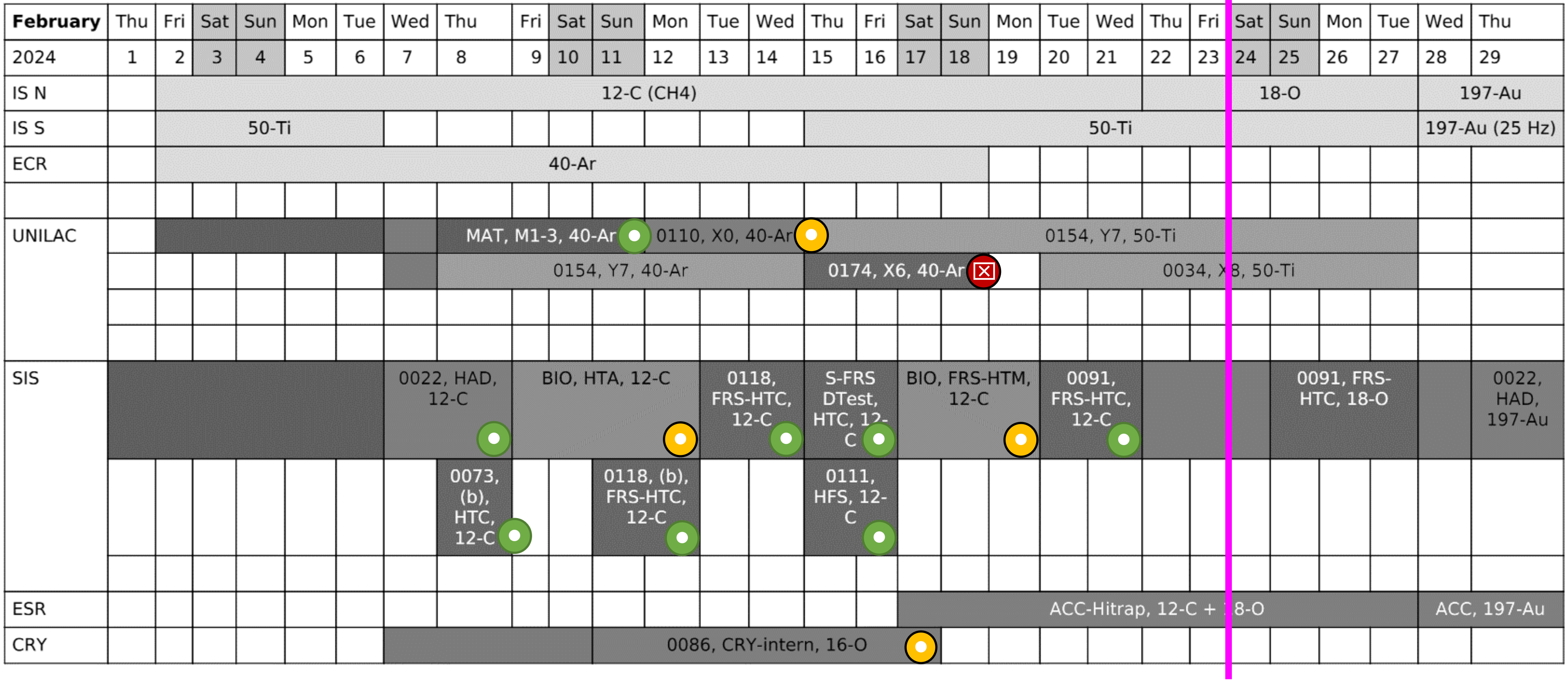
Coordinated by S. Reimann

- **Engineering run** (6 Nov – 19 Dec 2023):
  - Recommissioning and performance testing to **ensure operational capability**
  - 5 campaigns for further development of **operating modes for GSI/FAIR users**
  - **78 registered proposals** for machine studies & detector tests for FAIR and GSI
- **User beam time** (9 Feb – 27 Jun 2024):
  - **102 days of physics beam time for GSI/FAIR users**
  - 15 days for machine development
  - 22 days for HITRAP commissioning

S. Reimann
M. Vossberg

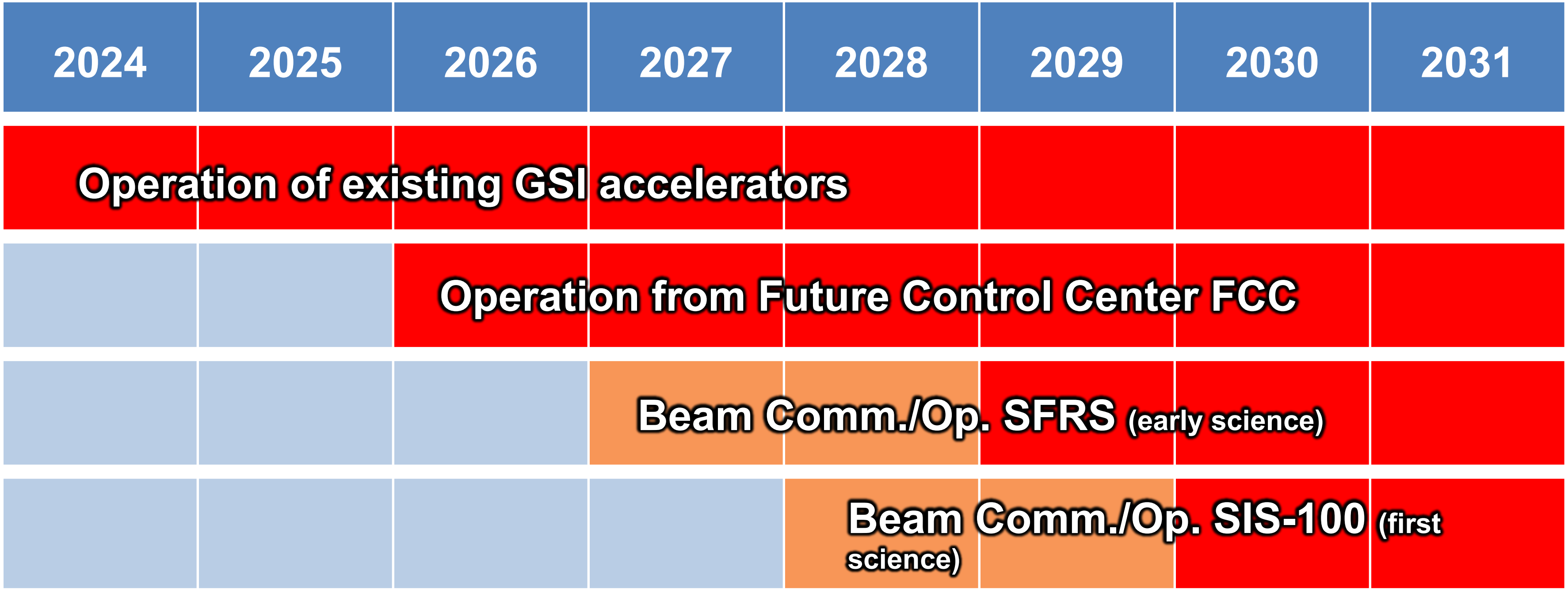
- experiment finished (>80% machine availability/performance = nominal) 8
- experiment finished (>60% machine availability/performance = sufficient) 4
- experiment failed or < 60% machine availability/performance = insufficient 0

Status 23.02.




Aerial View on 25 Feb 2024
FAIR
Challenge: **Beam Commissioning & Operation of FAIR**
GSI

Timeline



FAIR planning status Feb 2024

Early Science, First Science, First Science +

#	From	To	Particles species	Rigidity range [Tm]	max. hor. acceptance [mm mrad]	max. vert. acceptance [mm mrad]	at momentum offset: [± ‰]
Early Science	SIS18	SFRS Target	Ions	9-18	45	23	3
First Science	SIS18	SIS100	Ions, protons	9-18	90	42	3
	SIS100	SFRS Target	Ions	27-100	43	30	10

- UNILAC
  U4+ is produced in the VARIS source
  U28+ is produced in the UNILAC gas stripper at 1.4 MeV/u
  Accelerated in UNILAC to 11.4 MeV/u
  4 pulses of uranium beam are produced in 1.11 s (2.7 Hz)
- SIS18
  Each pulse is accelerated at harmonic number h=2 to 200 MeV/u
  Acc. of 4x2 bunches requires 1.6 s in total including pre- and post-processing
- SIS100
  Duration of injection into SIS100 is 1.11 s
  Acceleration to 1.5 GeV/u

Reference: "FAIR Operation Modes“, EDMS.

NUSTAR Requirements

in LEB and HEB will receive the primary beam from SIS100 with slow extraction

Requirements for the primary beam in front of the Super-FRS target

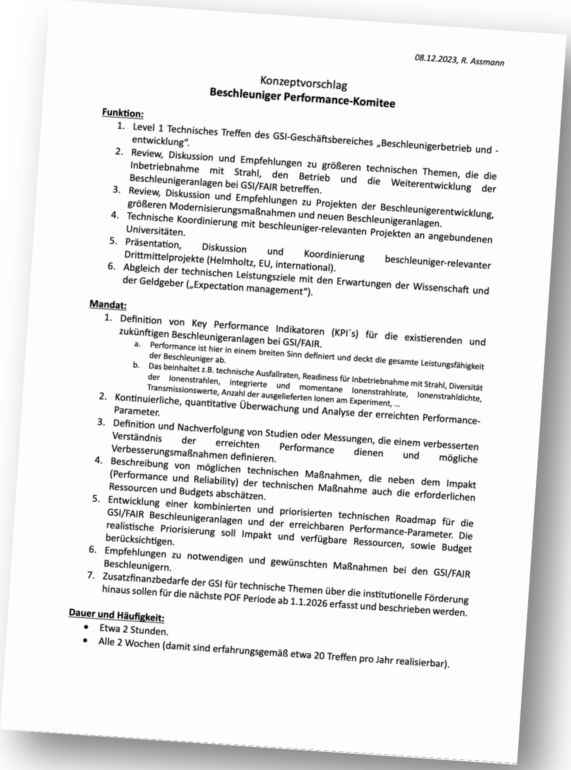
Requirement of NUSTAR Experiments in HEB and LEB

Beam Parameters	Ion type									
	Ref. Ion: U^{28+}	Bi^{26+}, Pb^{26+}, Au^{25+}	Xe^{21+}, Kr^{16+}	Ar^{10+}	p	Ref. Ion: U^{28+}	Bi^{26+}, Pb^{26+}, Au^{25+}	Xe^{21+}, Kr^{16+}	Ar^{10+}	p
	Commissioning					Operation in MSV				
Spill length [s]	1-10									
Number of ions per cycle	2×10^{10}	3×10^9	7×10^9	8×10^{10}		10^{11}	5×10^{11}	7×10^{11}		5×10^{12}
Energy Range [GeV/u]	0.4-2.7									
Ref. energy [GeV/u]	1.5					2.5	1.5			2.5
Momentum spread (2σ)	$\leq 10^3$									
Transverse emittance (2σ) [mm mrad]	2(h) x 5(v)									
Beam spot radius on target [mm]	1(h) x 2(v)									

Reference: "FAIR Operation Modes“, EDMS.

Performance Committee: Concept

- Concept paper (3 pages) finalized and internally presented
- Committee will bring together the leaders in accelerator science and technology across GSI and FAIR every 2 weeks
- It will include representatives from collaborating universities and experiments
- We will discuss and define together the **GSI/FAIR technical roadmap** with prioritization (taking into account performance, resources, budget):
  - What performance when → **expectation management** of GSI/FAIR performance
  - **Common strategy and plan** on improvements, upgrade and new facility projects in the accelerator domain
- The committee complements line management that remains responsible for final decision, resources and implementation.



08.12.2023, R. Assmann

Konzeptvorschlag
Beschleuniger Performance-Komitee

Funktion:

1. Level 1 Technisches Treffen des GSI-Geschäftsbereiches „Beschleunigerbetrieb und -entwicklung".
2. Review, Diskussion und Empfehlungen zu größeren technischen Themen, die die Inbetriebnahme mit Strahl, den Betrieb und die Weiterentwicklung der Beschleunigeranlagen bei GSI/FAIR betreffen.
3. Review, Diskussion und Empfehlungen zu Projekten der Beschleunigerentwicklung, größeren Modernisierungsmaßnahmen und neuen Beschleunigeranlagen.
4. Technische Koordinierung mit beschleuniger-relevanten Projekten an angebundenen Universitäten.
5. Präsentation, Diskussion und Koordinierung beschleuniger-relevanter Drittmittelprojekte (Helmholtz, EU, international).
6. Abgleich der technischen Leistungsziele mit den Erwartungen der Wissenschaft und der Geldgeber („Expectation management").

Mandat:

1. Definition von Key Performance Indikatoren (KPI´s) für die existierenden und zukünftigen Beschleunigeranlagen bei GSI/FAIR.
   a. Performance ist hier in einem breiten Sinn definiert und deckt die gesamte Leistungsfähigkeit der Beschleuniger ab.
   b. Das beinhaltet z.B. technische Ausfallraten, Readiness für Inbetriebnahme mit Strahl, Diversität der Ionenstrahlen, integrierte und momentane Ionenstrahlrate, Ionenstrahldichte, Transmissionswerte, Anzahl der ausgelieferten Ionen am Experiment, …
2. Kontinuierliche, quantitative Überwachung und Analyse der erreichten Performance-Parameter.
3. Definition und Nachverfolgung von Studien oder Messungen, die einem verbesserten Verständnis der erreichten Performance dienen und mögliche Verbesserungsmaßnahmen definieren.
4. Beschreibung von möglichen technischen Maßnahmen, die neben dem Impakt (Performance und Reliability) der technischen Maßnahme auch die erforderlichen Ressourcen und Budgets abschätzen.
5. Entwicklung einer kombinierten und priorisierten technischen Roadmap für die GSI/FAIR Beschleunigeranlagen und der erreichbaren Performance-Parameter. Die realistische Priorisierung soll Impakt und verfügbare Ressourcen, sowie Budget berücksichtigen.
6. Empfehlungen zu notwendigen und gewünschten Maßnahmen bei den GSI/FAIR Beschleunigern.
7. Zusatzfinanzbedarfe der GSI für technische Themen über die institutionelle Förderung hinaus sollen für die nächste POF Periode ab 1.1.2026 erfasst und beschrieben werden.

Dauer und Häufigkeit:

- Etwa 2 Stunden.
- Alle 2 Wochen (damit sind erfahrungsgemäß etwa 20 Treffen pro Jahr realisierbar).

Performance Committee: Mandate

1. Definition OF **Key Performance Indicators** (KPI´s) for the existing and future accelerators at GSI/FAIR.
    a. Performance is defined in aborad sense and covers the full performance capability and issues of the accelerators
    b. This includes technical failure rates, readiness for beam commissioning, diversity of ion beams, integrated and peak ion delivery rates, density of ion beams (emittance), transmission rates, number ions delivered at various experiments, …
2. Continuous and **quantitative surveillance** of delivered KPI's
3. Definition and follow-up of **studies, measurement campaigns and R&D efforts**, that are required for an improved understanding of the obtained performance and for the definition of possible improvement measures
4. Description of possible **technical measures,** including impact (performance reliability), required resources and budget.
5. Development of a **combined and prioritized technical roadmap for the GSI/FAIR accelerator complex** and the realistically reachable performance indicators. The realistic prioritization shall include impact, available resources and budget.
6. **Recommendations on necessary and favored actions** on the GSI/FAIR accelerators.
7. Collection and description of additional **financial needs at GSI for technical work during the next POF period**, beyond the institutional funding from 1.1.2026 onwards.

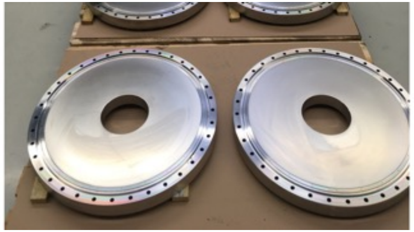
Performance Committee: Milestones

01/2024	Kickoff meeting
03/2024	Definition of KPI´s
09/2024	Overview table on the present status and future expectations (goals)
10/2024	Preliminary list of additional financial needs at GSI for technical work during the next POF period
12/2024	Combined and prioritized technical roadmap for the GSI/FAIR accelerator complex and the realistically reachable performance indicators, including a first estimate on resources and cost for eventual actions.

Future Upgrade: UNILAC Post-Stripper Upgrade

- **Cavity** series production

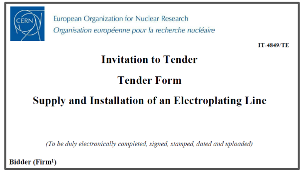

- **Small parts** series production




Project **on schedule and on budget**

- Drift tube **production**
  - first prototype successfully tested
  - tubes for first cavity ordered
  - tubes for second cavity to be ordered in Dec.
  - council recently approved the funding application for all tubes to be considered in 2024 council

- Plating of **177 drift tubes** → CERN
  - CERN's new plating shop will be equipped with dedicated set-up for GSI



European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

IT-4849/TE

Invitation to Tender

Tender Form

Supply and Installation of an Electroplating Line

(To be duly electronically completed, signed, stamped, dated and uploaded)

Bidder (Firm)

ADDENDUM 18 KR5656/TE

TO

COLLABORATION AGREEMENT K 1727/DG (THE "AGREEMENT")

BETWEEN: THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN"), an Intergovernmental Organization having its seat in Geneva, Switzerland, duly represented by its Head of Industry, Procurement and Knowledge Transfer Department, Christopher Hartley, its Head of Procurement and Industrial Services Group, Cristina Lara-Arnaud, and its Head of Technology Department, Jose Miguel Jimenez,

AND: GSI HELMHOLTZZENTRUM FÜR SCHWERIONENFORSCHUNG GMBH ("GSI"), established in Darmstadt, Germany, represented by its Managing Directors, Paolo Giubellino and Jörg Blaurock,

Hereinafter each individually referred to as a "Party" and collectively as the "Parties".

  - Contract with CERN signed and in place (11 Dec).

Courtesy L. Gröning et al

Collaboration & Scientific Exchange are Crucial

HFHF

Welcome to the HFHF IAP – GSI Winter Seminar

St. Michael im Lungau, Austria

25.2 – 2.3. 2024

Organisation

H. Podlech

R. Hollinger

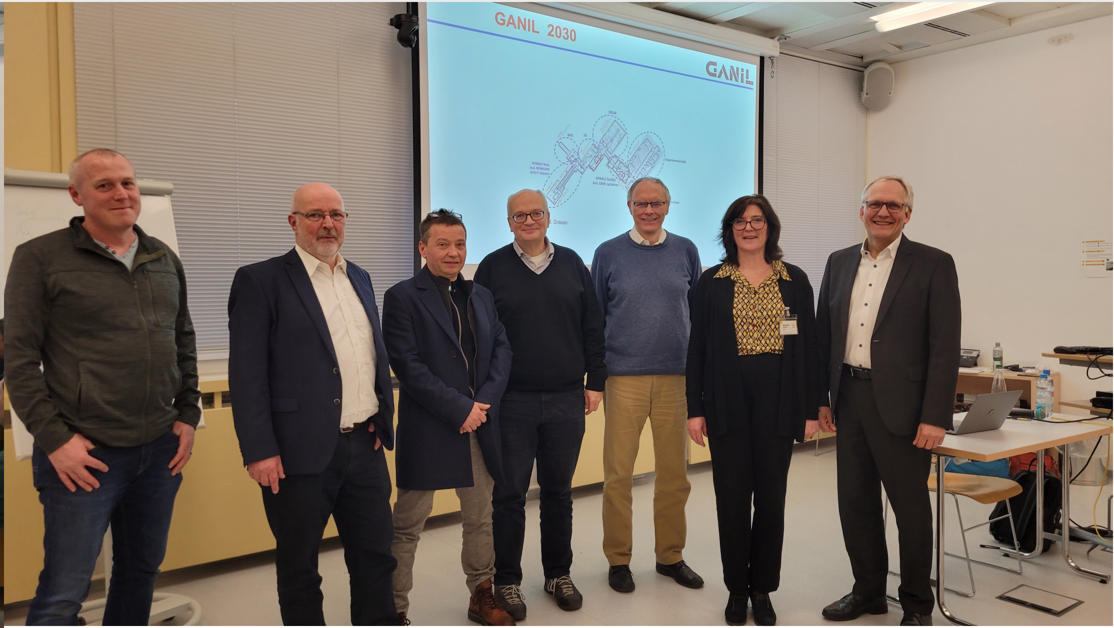
F. Maimone

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

IAP Institut für Angewandte Physik

Thanks for organizing this – looking very much forward to our discussions on our fascinating accelerator science!

Collaboration & Scientific Exchange are Crucial



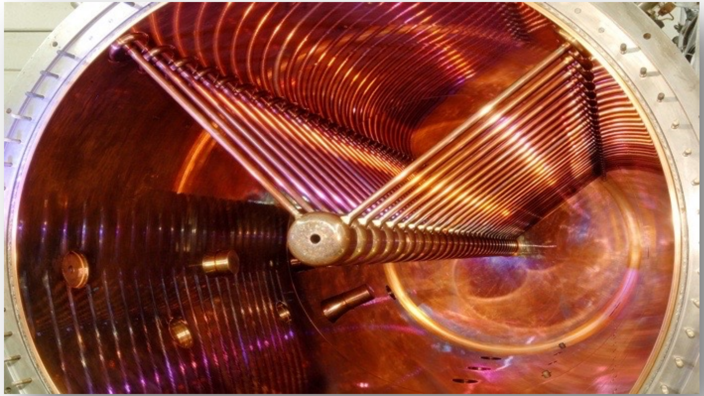
GSI Accelerator Seminar Series

Last week in person → 40– 50 participants

Budget reserved for this

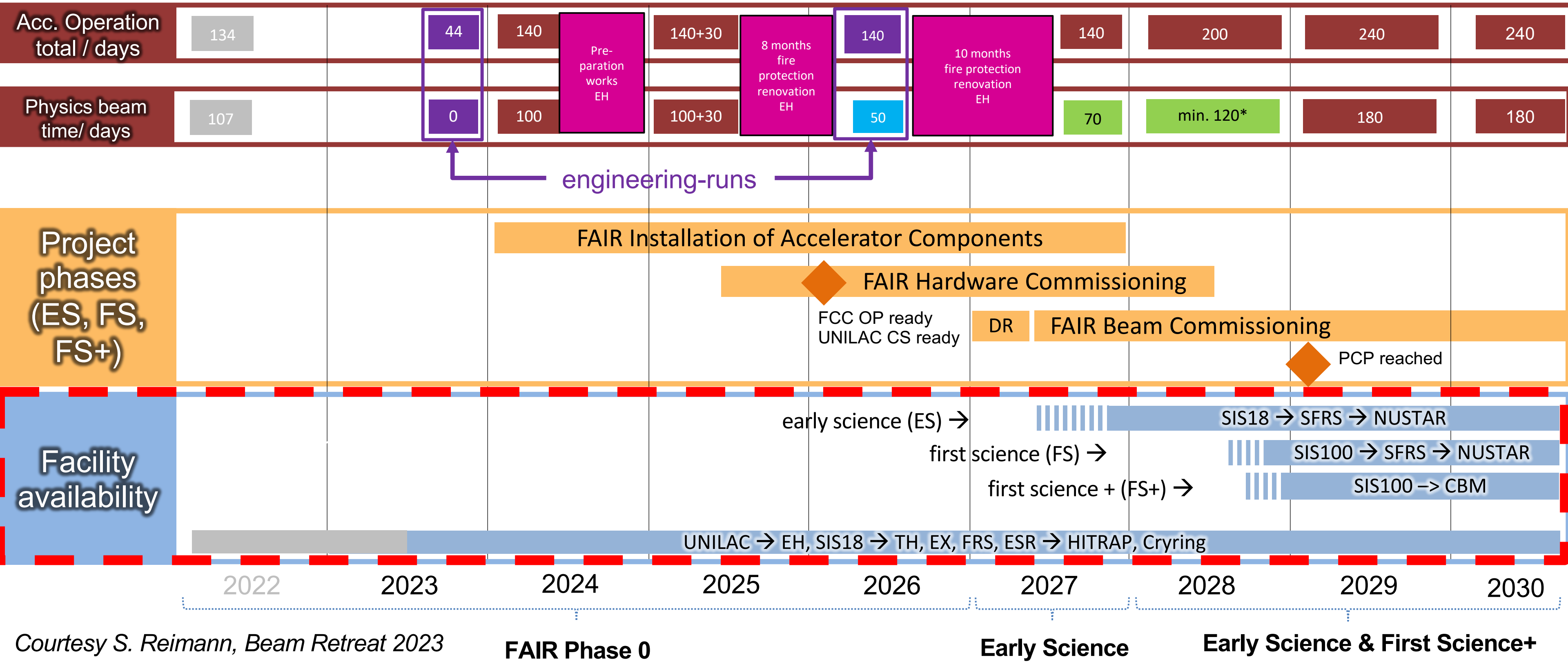
Conclusion and Outlook

- Long shutdown 2022 → 2023: **completed**
- Engineering run **successful,** now in **physics run**
- Next years: about 6 months **user runs** and shorter yearly shutdowns (repairs, smaller upgrades) foreseen
- FAIR installation and **preparing FAIR operation:**
  - Hiring personnel with mixed GSI/FAIR duties in ACC
  - Merging of some accelerator-related activities to be considered
- Stronger links to **universities** & international **labs**
- New **committee will define performance indicators**: prepare optimized accelerator actions across GSI/FAIR
- **GSI/FAIR technical roadmap** with prioritization (taking into account performance, resources, budget) to be prepared together until 12/2024.



Thank You for Your Attention

FAIR/GSI Strategic Operation Scenario towards FS+



Courtesy S. Reimann, Beam Retreat 2023

SIS18: UHV System Refurbishment

Courtesy P. Spiller et al

- Baseline UHV puming system has an age of about 35 years!
  - (Initial) static residual gas pressure especially important for U^{28+} (booster) operation.
  - High pumping power → stabilize dynamic vacuum under influence of ion induced gas desorption.
- Actions 2022 - 2023:
  - IZ pumps and NEG pumps procured for replacing part of the old pumps.
  - Shut down, sector S03-S05: all IZ pumps renewed, all Ti-pumps exchanged by CapaciTorr-NEG pumps
- Static UHV pressure has been improved in upgraded sections **from 5×10^{11} to 1×10^{11}**.
- U^{28+} -operation:
  - beam lifetime may be affected by each short section with poor pressure.
  - **Lifetime improvements with standard ions and U^{28+} ions will be measured in 2023 beam time.**
- Outlook:
  - In 2024, + vacuum sector S01 (S11-S02) will be opened for installation of first cryognic insert. Used for replacing all pumps in this sector. Urgent improvements needed in sector 5 and 6 incl. NEG activation.