

HZB Facility Talk

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HGF MT ARD ST3

ST3 Annual Meeting, GSI, 03. to 05.07.2024



Today

- Our accelerator facilities at HZB
- Walk you through Bessy II, its upgrade path Bessy II+ and Bessy III,
- Take you to SEALAB: Accelerator R&D for sustainable applications like SRF R&D, water treatment and ultrafast scattering

Disclaimer

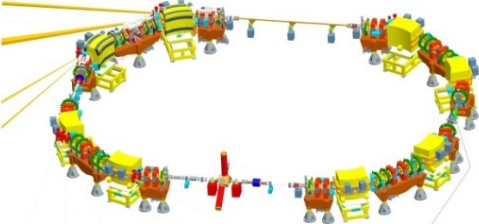
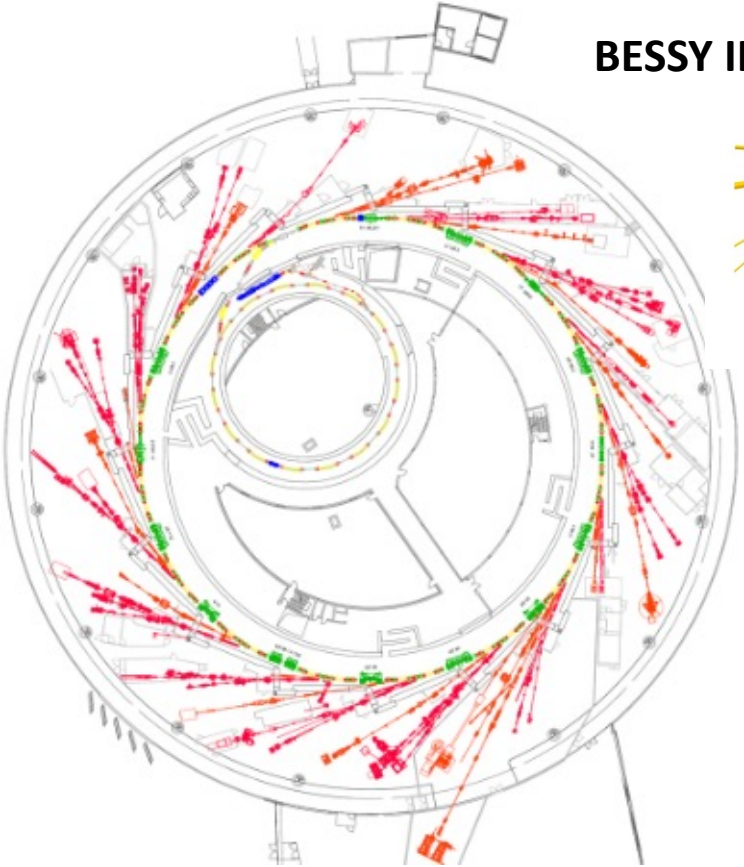
- Stay tuned for the presentation by Michael Arlandoo on Transverse Resonance Island Buckets (TRIBs) operation mode studies using Lie techniques
- Would like to thank all my colleagues at HZB and elsewhere to help with material for this presentation.



Two radiation sources – UV and Soft X-Rays for materials discovery

The goal is to develop more **sustainable methods and technology** to expand the research possibilities and allow for:

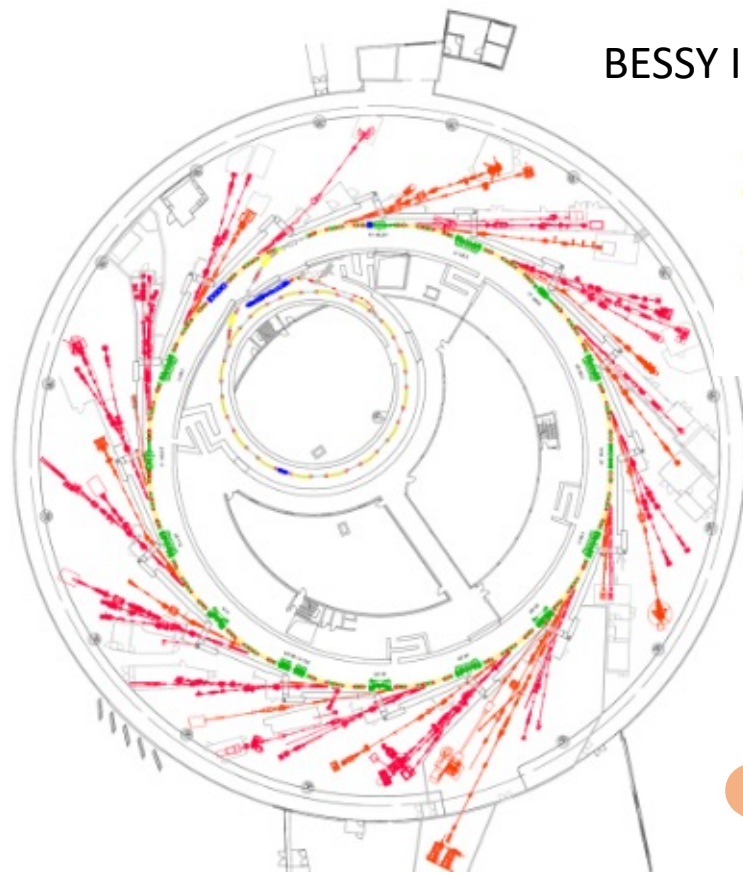
Sustainable Science



Metrology Light Source 

We develop, operate, maintain and modernize our accelerators to provide unique research opportunities

One center, two campuses and many accelerators



BESSY II



Metrology
Light
Source 




BESSY III

& MLS2



BESSY II+



 **Operando**

- *Scientific focus: Energy, catalysis and green IT*
- *New instruments and sample environments*

 **Modernisation**

- *Stable & reliable accelerator performance*
- *Improved digitalisation, automation & remote access*
- *Lower barriers & higher instrument output*

 **Sustainability**

- *Increased self-sufficiency of energy supply*
- *Reduced energy consumption*

**Talk by
Michael Arlandoo
tomorrow**

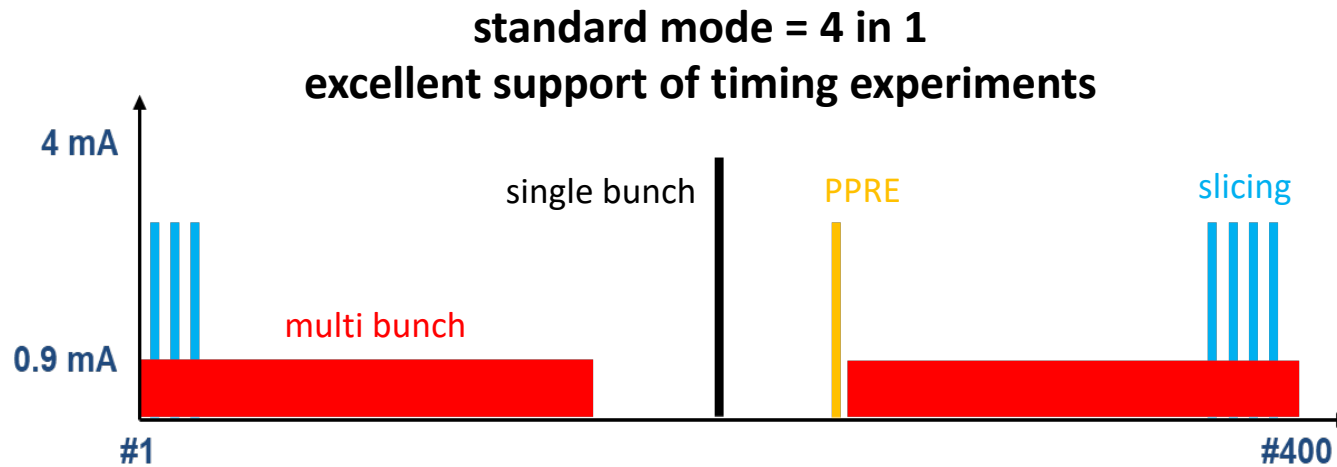
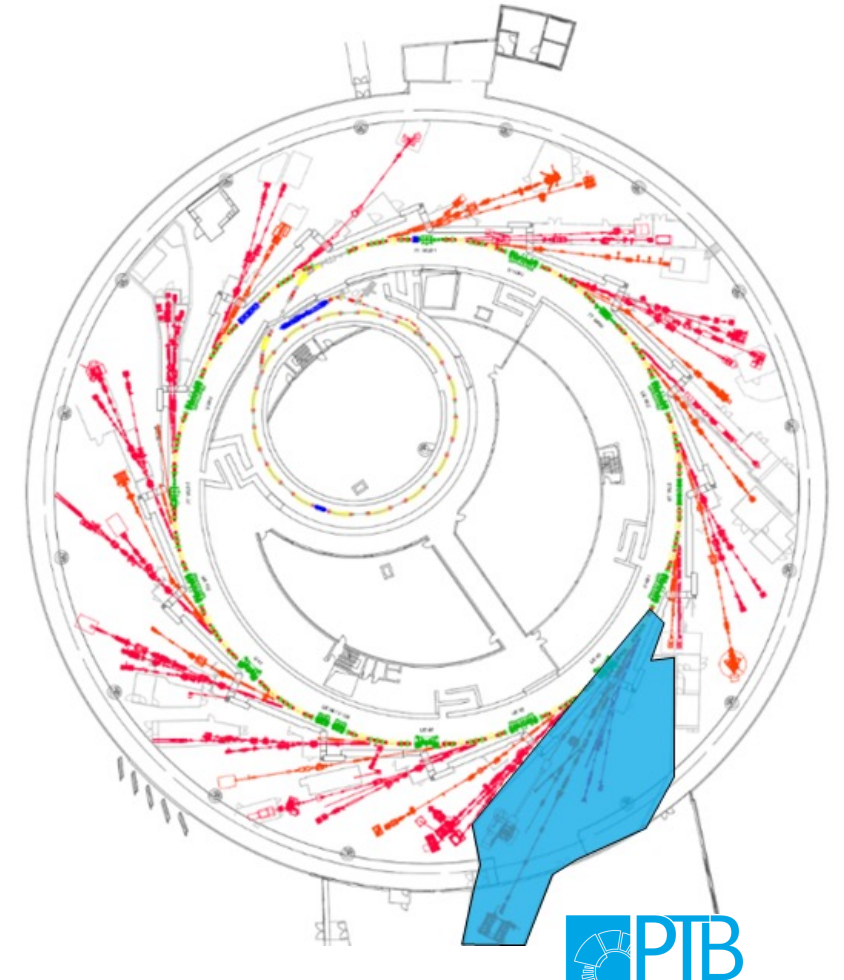
P. Gaslowski, et al., IPAC 2023 – WEPL036

O. Schwarzkopf, et al., Eur. Phys. J. Plus (2023) 138:348

Our synchrotron radiation source Bessy II

Bessy II, a soft X-ray light source with 36 beamlines (13 undulators, 2 wave length shifters), setup from 1992 to 1998, in user operation since 1999. Constantly evolving.

Complex fill pattern supporting imaging, spectroscopy and timing experiments: low- α mode for ps beams serving CSR and THz, femto slicing for 100 fs beams for pump probe applications

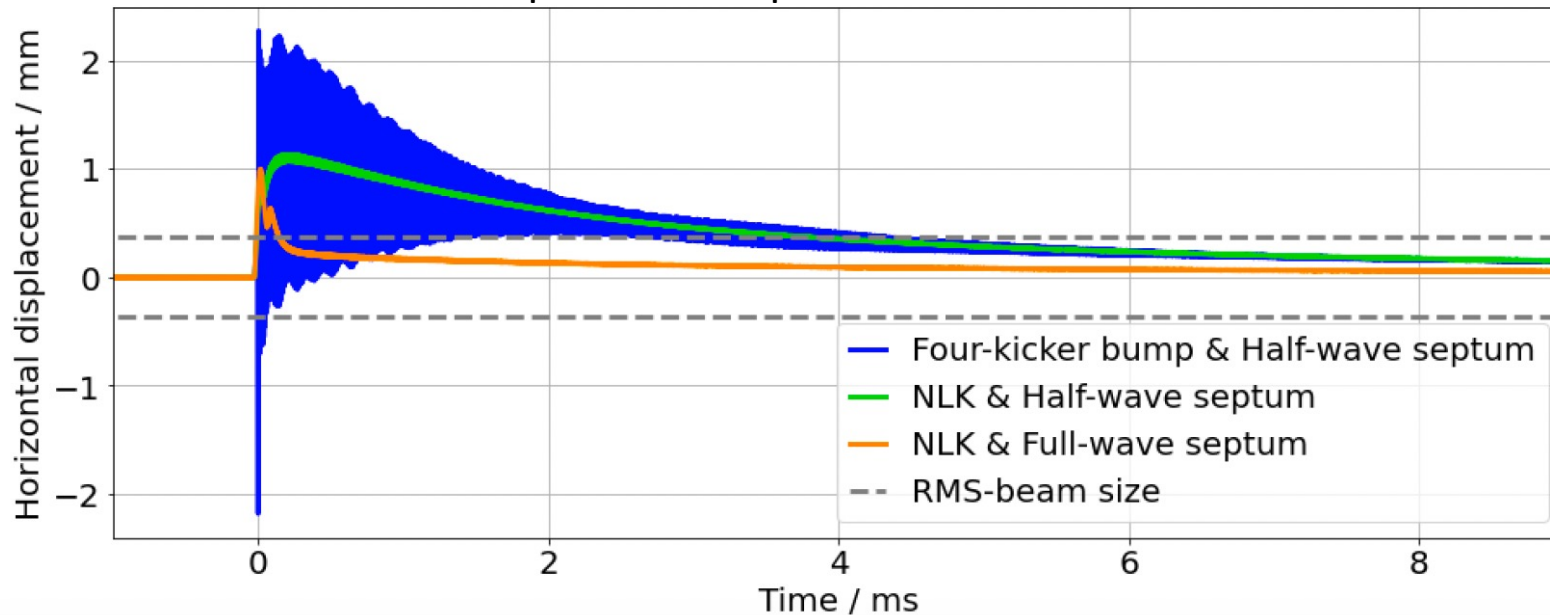


A. Jankowiak, M. Ries, A. Schälicke

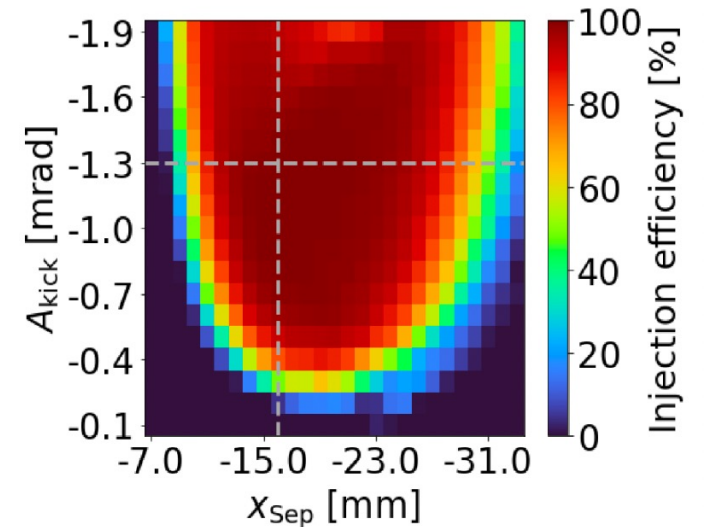
Towards transparent injection at Bessy II

- **Transparent injection at highest efficiency** challenging for next generation lightsources because of smaller beams and smaller dynamic aperture
- Study on limits of present injection system at Bessy II with non-linear kicker (NLK)

Temporal development of orbit distortions



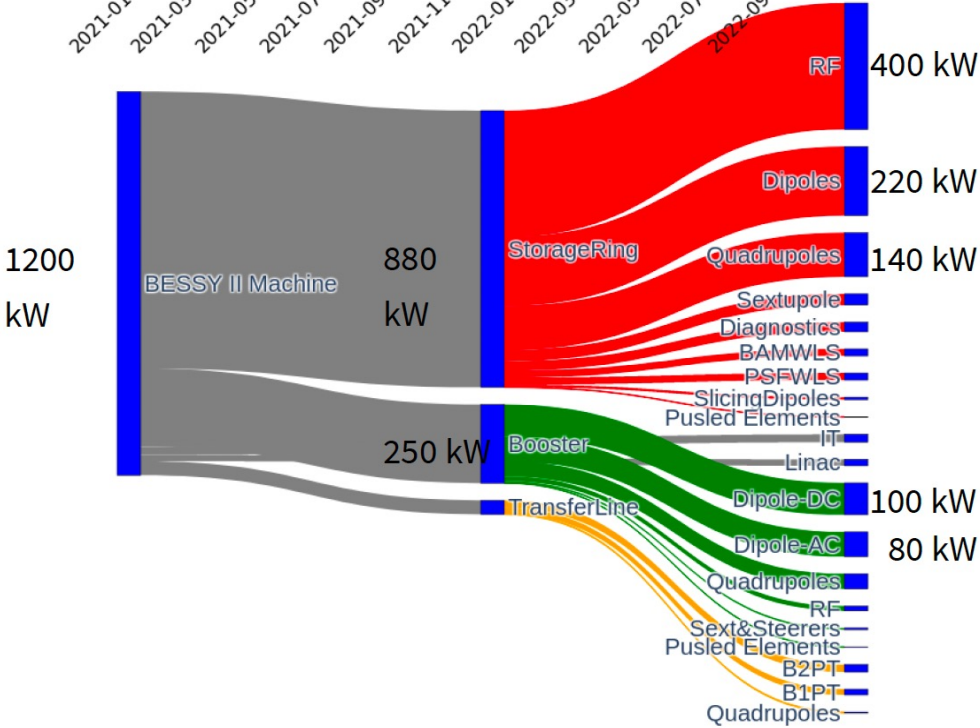
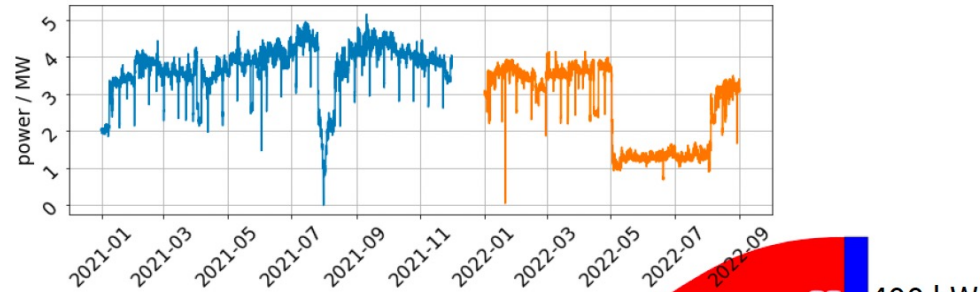
Tracking studies of injection process



- Step-wise improvement from 4-kicker bump to NLK
- **Achieved 97% injection efficiency, identified possible path for Bessy III injection design**

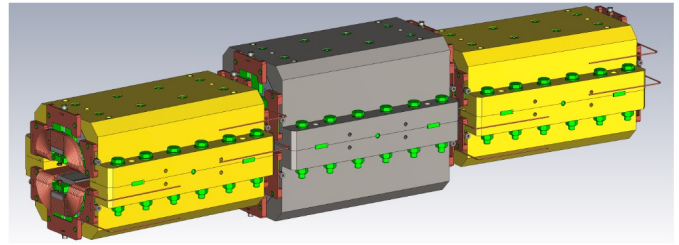
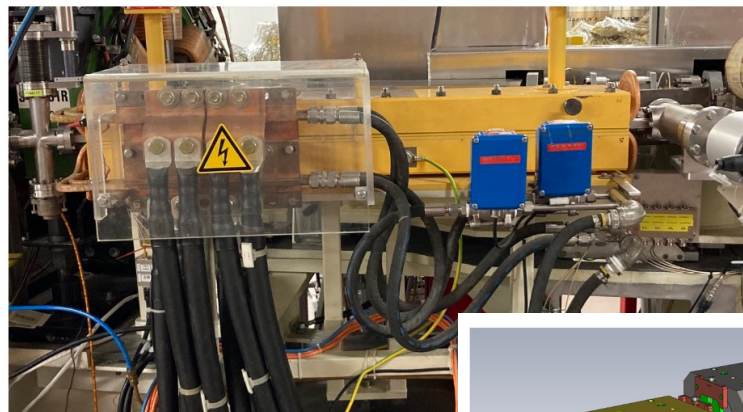
Sustainable operation of the Bessy II facility

- Establish data collection (85 monitors in control system and archiver), visualization



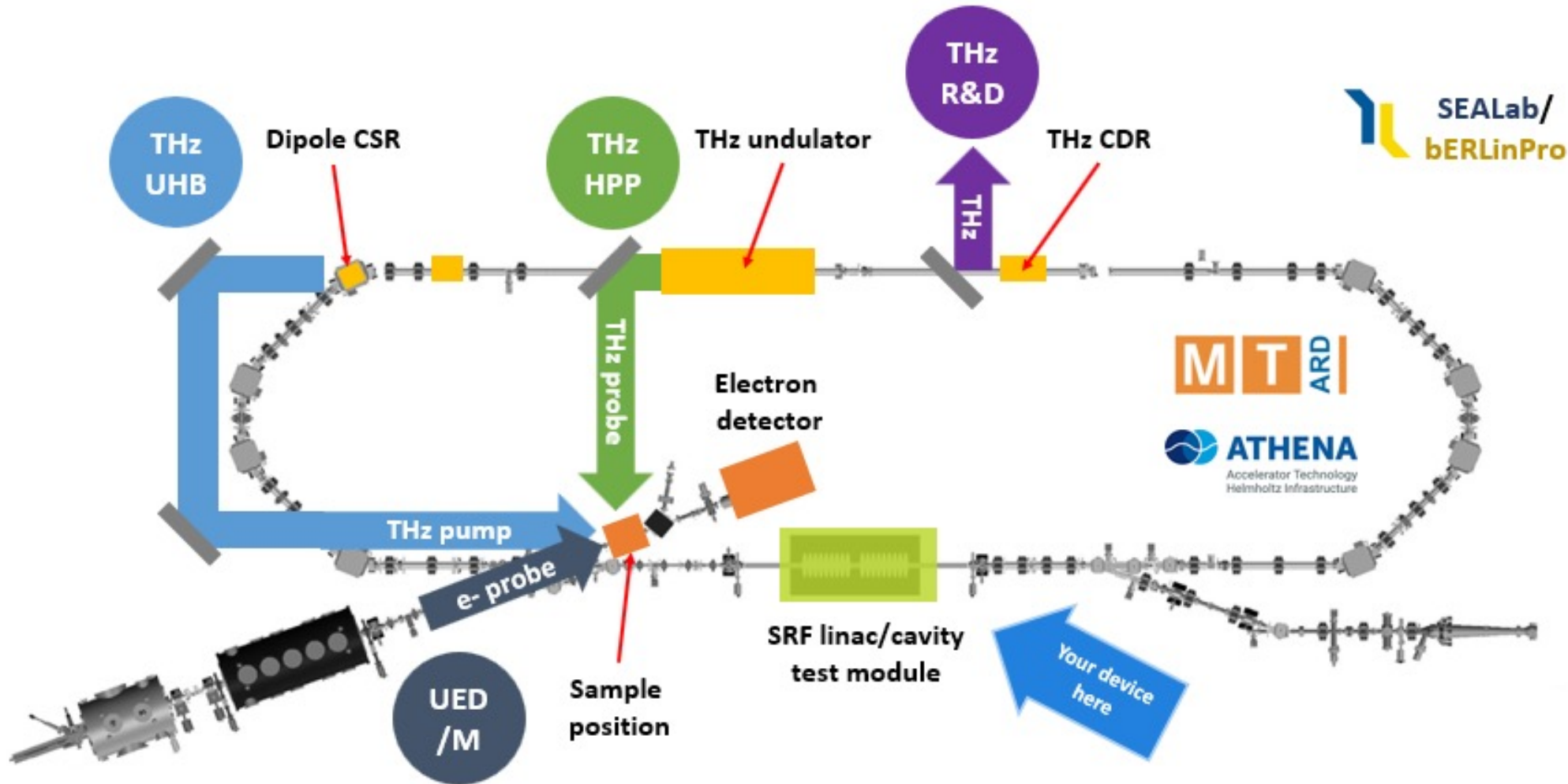
- Implement savings at Bessy II, to buildup knowhow for Bessy III

- Improving efficiency of RF transmitters
- Permanent magnet design and operation
- Thermal stability -> heating and cooling
- EU Research Facility 2.0 project



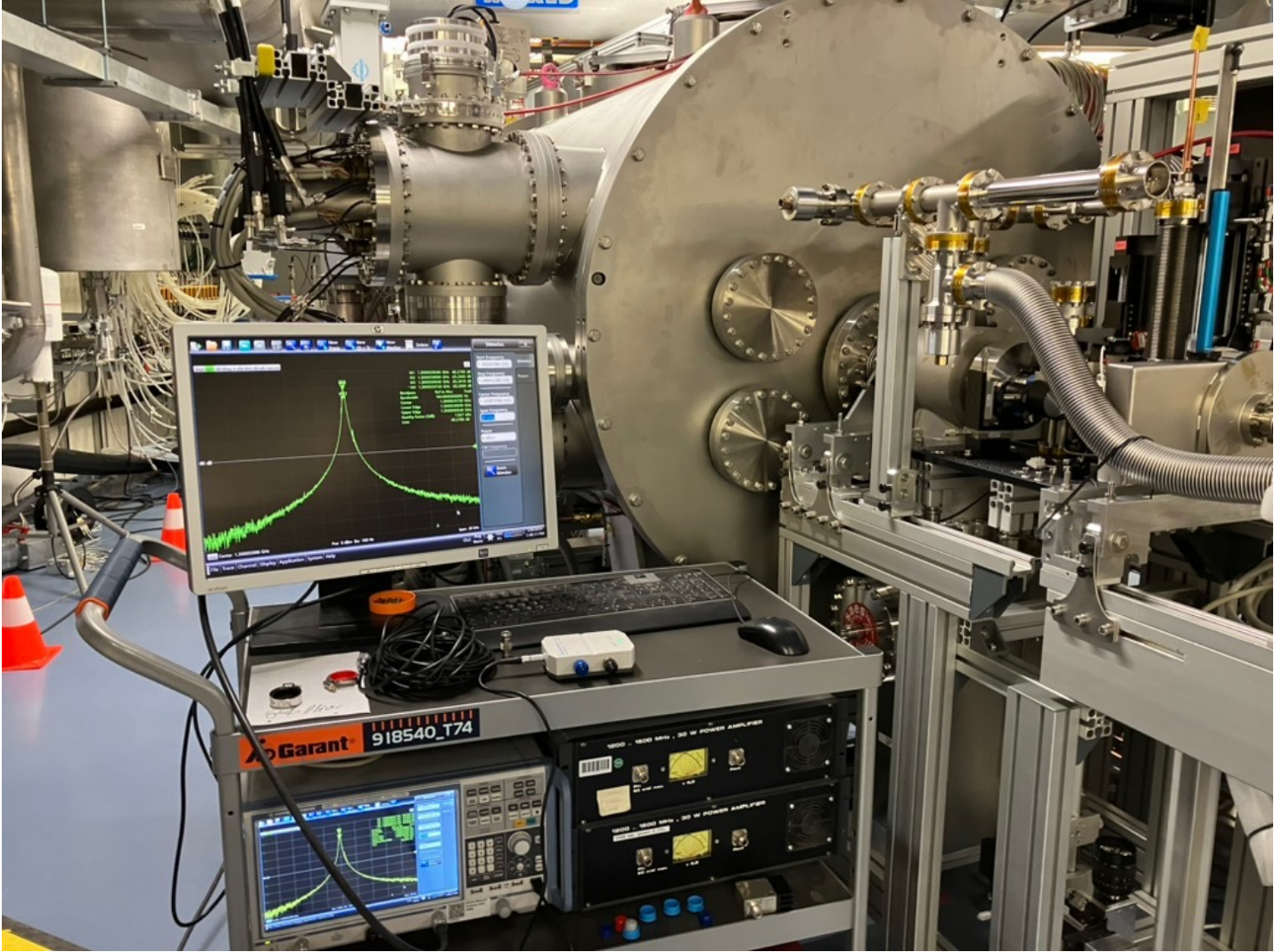
J. Völker, IPAC 2023-WEPM131

Developing SEALAB towards a multi-science facility

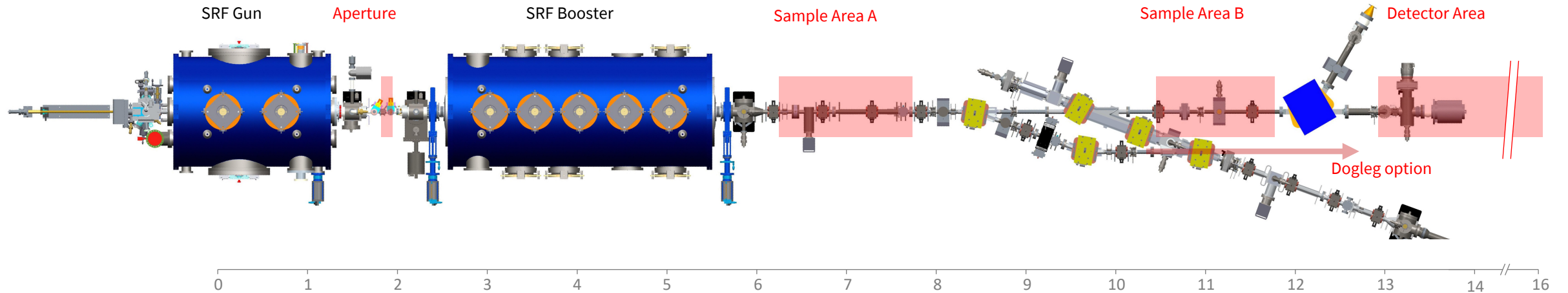


- [1] TK et al., arXiv:1910.00881v2 [physics.acc-ph] 8 Jan 2020
- [2] J.-G. Hwang et al., J. Korean Phys. Soc. 77, 337–343 (2020).
- [3] TK et al., IPAC 2023

Status of the SRF photoinjector of SEALAB



Ultrafast scattering modalities with the SRF photoinjector of SEALAB



Capabilities of the photoinjector:

1 to 3.5 MeV beam energy with **variable** bunch charge (1 fC to 100 pC), pulse length (10 fs to 6 ps) and spot size (10 to 100s μm), **high stability at MHz repetition rate**.

Very **flexible accelerator/lens system**: one gun cavity and three booster cavities, many quadrupoles, done optimization for bunching/diffraction/imaging schemes,

Ultrafast science drivers:

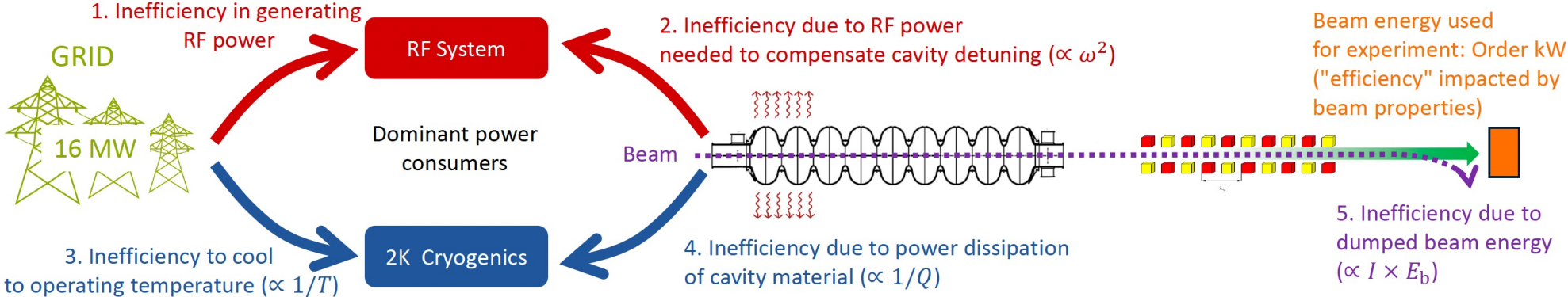
fs thermometer for the lattice – study of quantum and functional materials, transistors, solar cells...

A perfect R&D test suite for beam dynamics, instrumentation, controls, synchronisation. Fits ideally the envelope of ST3.

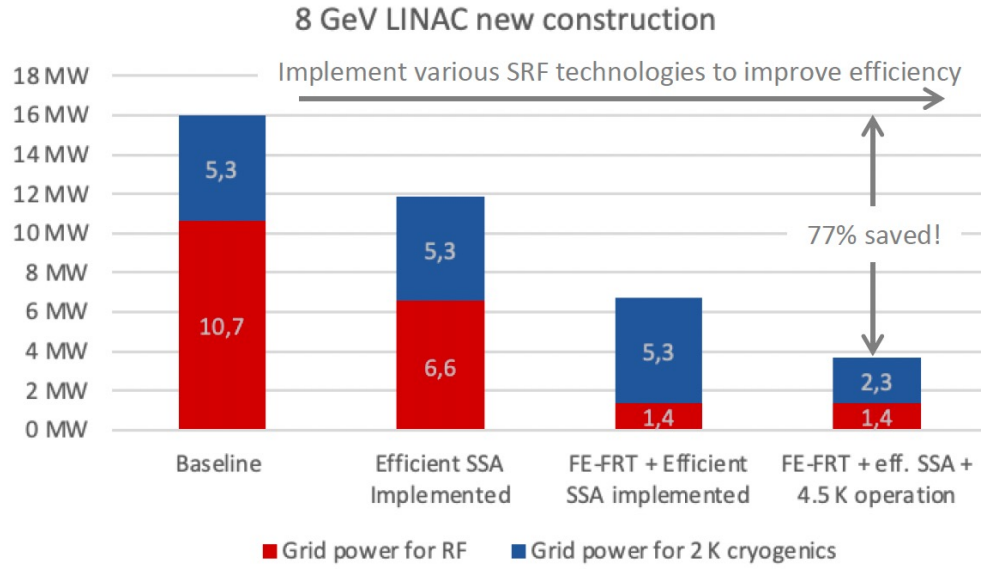
see talk by Raffael Niemczyk



Tackle the main inefficiencies from grid to dump for SRF accelerators

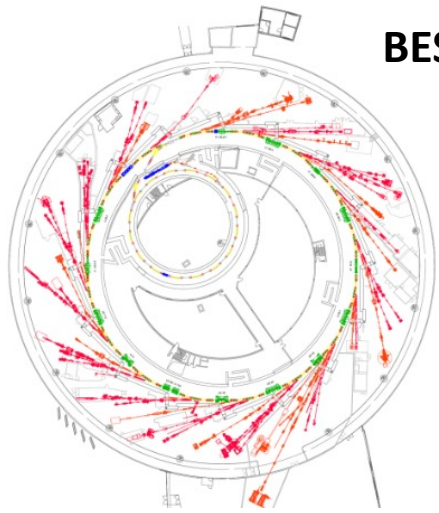


Kick off: <https://indico.ijclab.in2p3.fr/event/10302/>

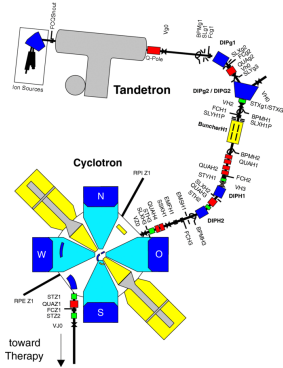


J. d'Hondt, J. Knobloch, A. Neumann

One center, two campuses and many accelerators



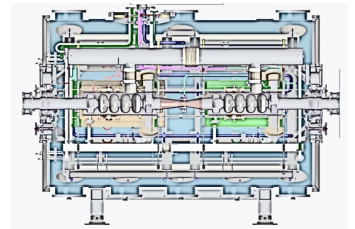
BESSY II/II+



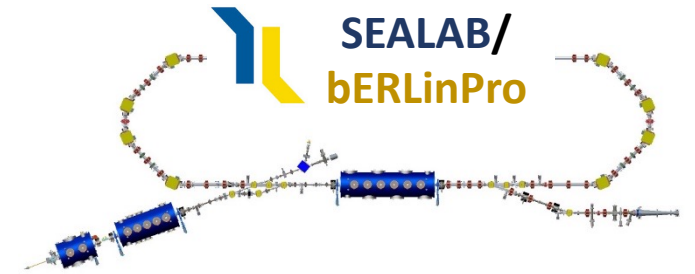
Cyclotron and proton therapy complex



VSR DEMO



**Metrology
Light
Source**



We develop, operate, maintain and modernize our accelerators to provide unique research opportunities

Summary

HZB operates and develops large scale user **facilities - synchrotron radiation sources, proton therapy - and accelerator R&D Infrastructures like SEALAB**



We advance **fundamental and applied accelerator science and forefront technologies** for the continuous improvement of these facilities and to develop state-of-the-art accelerator concepts and novel disruptive methods and paradigms to provide perfect experimental opportunities for HZB's present and future users/partners.

Our strategy is to **maintain Bessy II at the forefront by an ambitious R&D program** (Bessy II+), which is strongly **linked to our new facility Bessy III**.

ARD is crucial to our success, especially here in ST3 where we look at ultra-short pulse generation and diagnostics with SRF photoinjectors, innovative schemes for storage ring based FELs (SSMB) and proton therapy modalities → control of the complete 6D phase space for every bunch to enable innovative modalities for FEL, SR and ultrafast applications. Energy-efficiency stability and reliability during all phases of the accelerator lifecycle.

