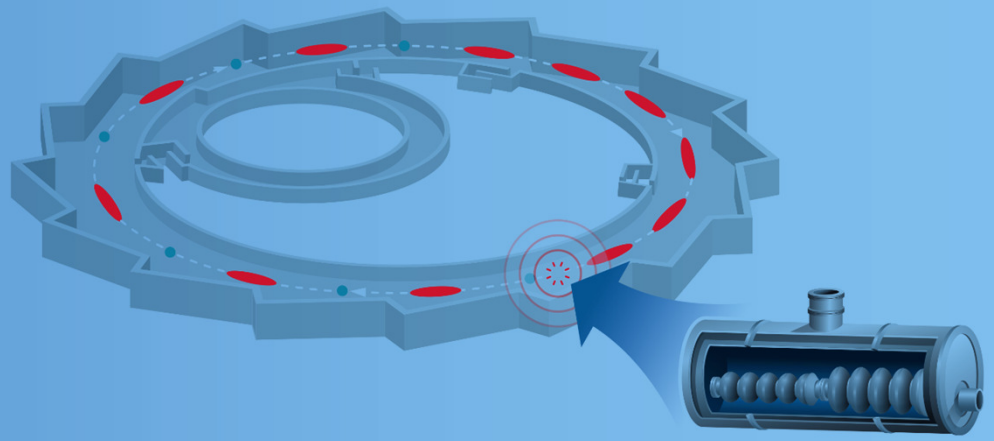
Facility Reports: HZB

Michael Abo-Bakr et al.

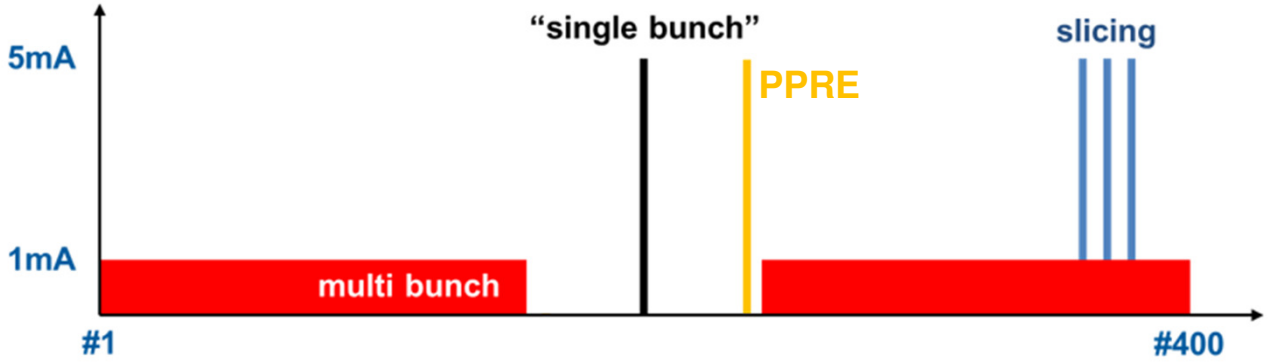
Content:

- BESSY VSR
- bERLinPro
- EMIL
- MLS



BESSY II – a third Generation Light Source

Standard BESSY II Fill Pattern:



BESSY II Standard Beam Parameters	
Energy	1.7 GeV
Circumference	240 m
Horizontal emittance	5 nm rad
max. beam current	300 mA
RF frequency	500 MHz
max. RF voltage	2 MV
Bunch length low-α	15 ps 2 ps
Mom. Comp. factor low-α	7.5×10^{-4} 3.5×10^{-5}

BESSY VSR –"The Variable pulse length Synchrotron Radiation source"

Idea: short & long SyRad light pulses from a SR

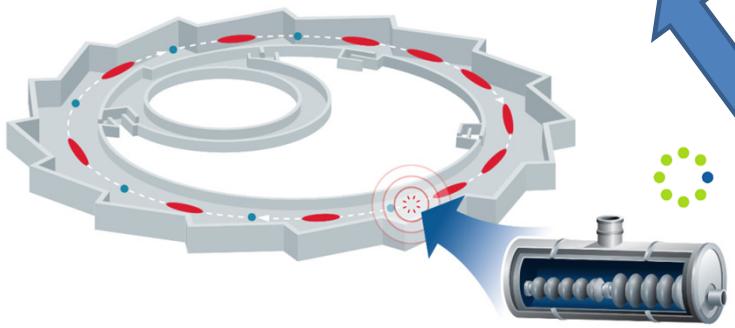
Target: intense, short x-rays with high rep rate

- **~ 1 ps zero-current bunch length (equilibrium)**
- **1.25 MHz // 250 MHz // 500 MHz**
- **no / minor changes for long pulse users**

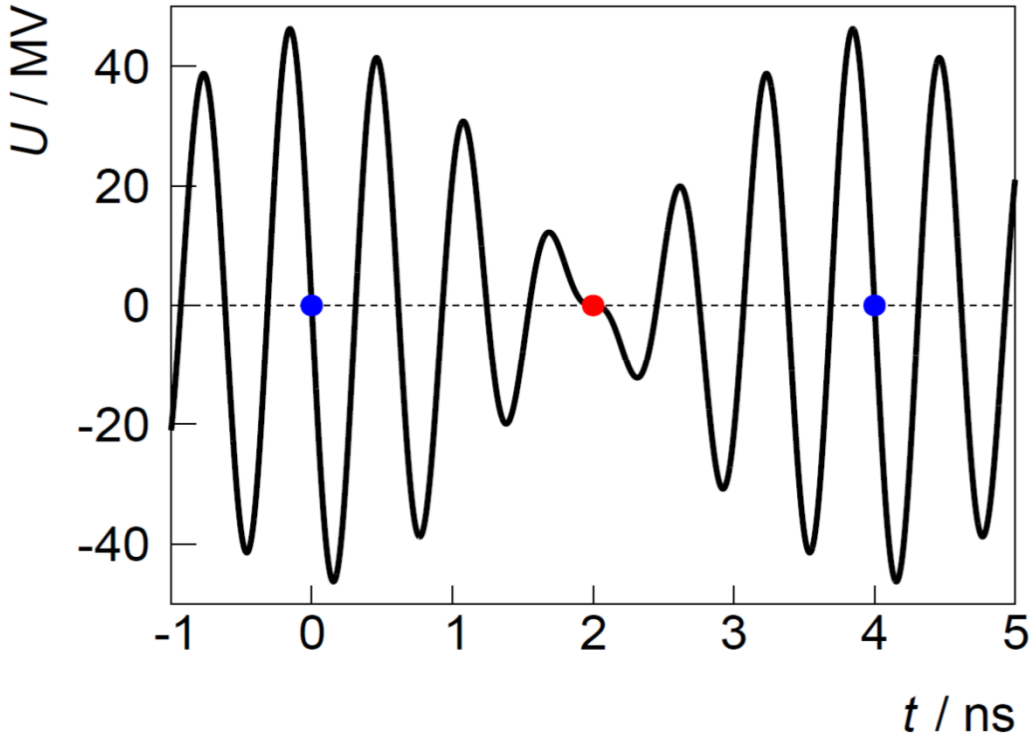
  300 mA, top-up, access to user hall (radiation safety)

$$\text{bunchlength} \sim \sqrt{\frac{\alpha}{U'}}$$

low-α



BESSY VSR

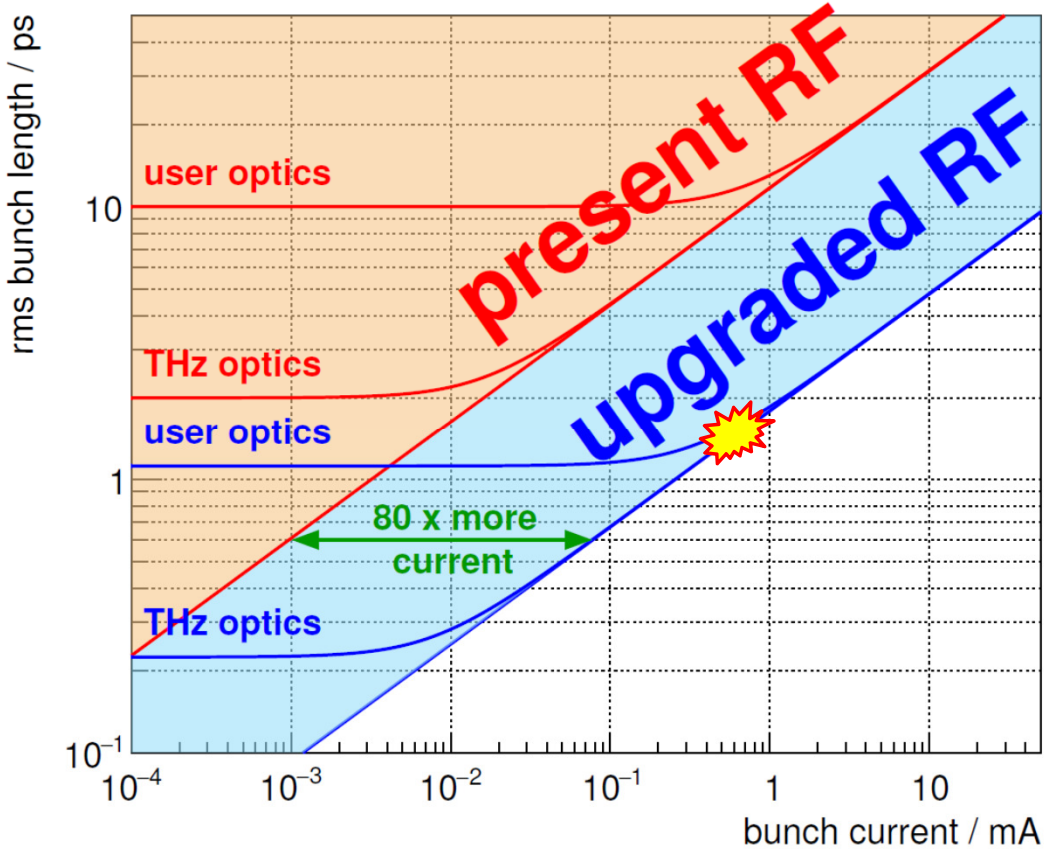


0.5 GHz NC x 4

1.5 GHz SC x 2

1.75 GHz SC x 2

BESSY VSR – CSR driven Instabilty Threshold



$$\sigma_0 \sim \sqrt{\frac{\alpha}{U'}}$$

Turbulent bunch lengthening / microwave (CSR) instability

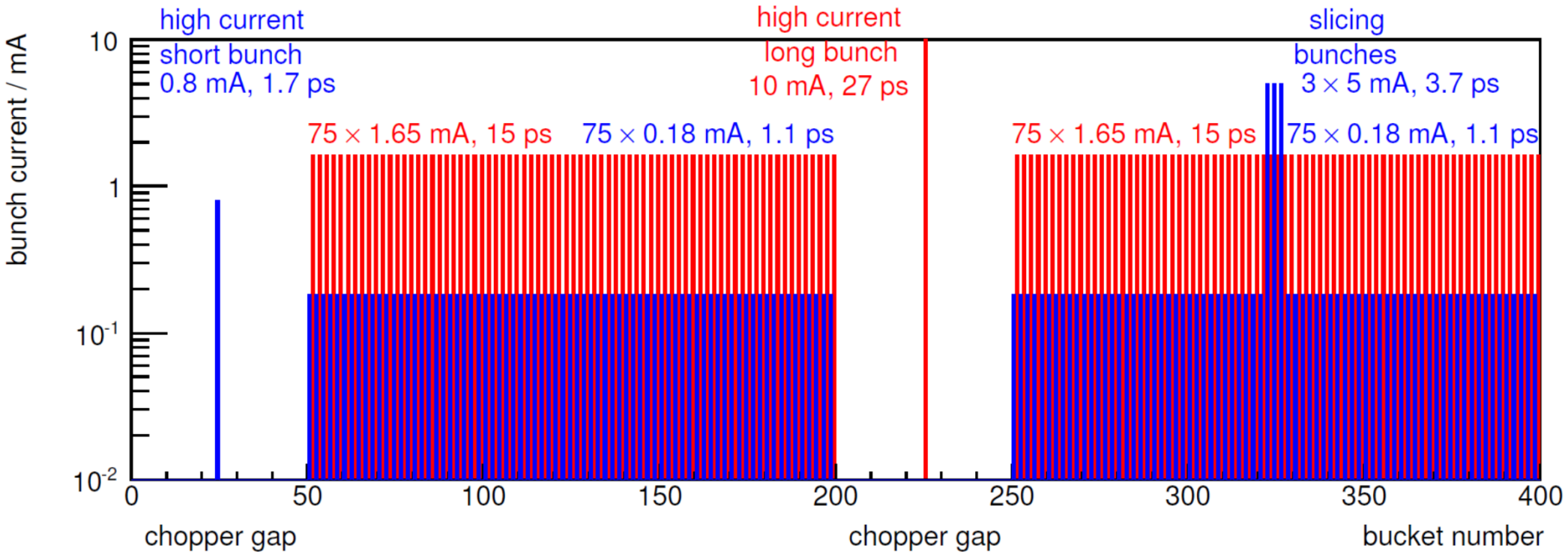
→ longitudinal instability, limiting the current in short bunches

bunch shortening:

increase U' preferred

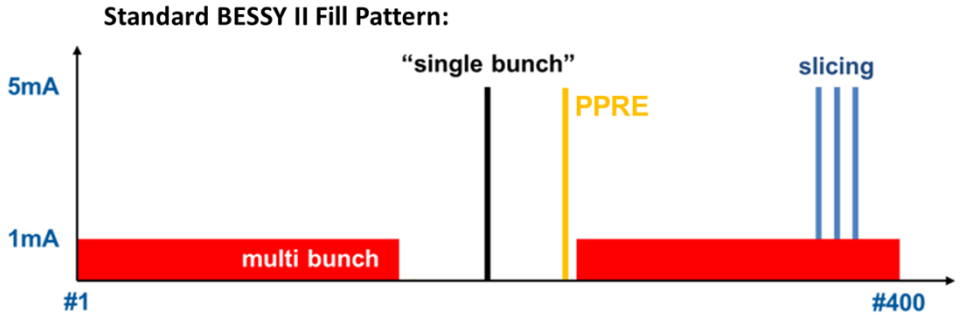
$$\sigma = \text{const.} \rightarrow I_{\text{th}} \sim \alpha$$

BESSY VSR – a fill Pattern serving many different Users



various user tailored bunch types with

- length variation ~ x 25
- charge variation ~ x 50
- charge density variation ~ x 10

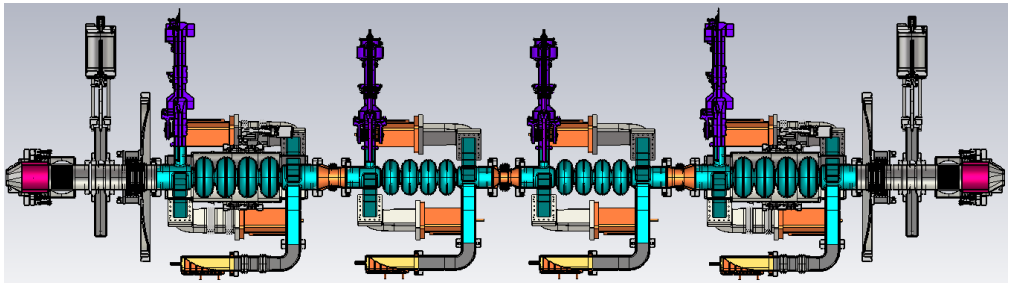


BESSY VSR – Challenges in Physics & Technology

BESSY VSR

Many challenges on the road to BESSY VSR

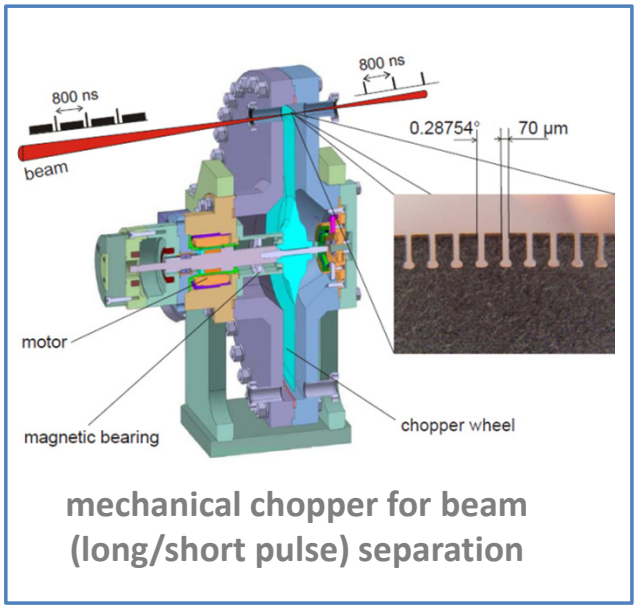
two 1.5 GHz cavities @ E_0 ~ 20 MV/m
\+ two 1.75 GHz cavities @ E_0 ~ 17 MV/m



strong SC harmonic cavities (E~20 MV/m) operated in a storage ring with high average current (300 mA)

- **beam dynamics**
- **machine integration**
- **beam separation**
- **bunch-resolved diagnostics**
- **TopUp injection**
- **…**

… a new, exciting, funded project



mechanical chopper for beam (long/short pulse) separation

BESSY VSR – Project Status & Time Line

- 200? – first ideas
- 2011 – beating scheme
- 2015 – TDS
- 2016 – related R&D projects
- 2017 – fully funded!
- 2017 – first prototype cavities in house
- 2018 – test of first critical components in ring
- 2020 – first test module in ring
- 202? – final installation / operation


MOPCH053

Proceedings of EPAC 2006, Edinburgh, Scotland

TOWARDS SUB-PICOSECOND ELECTRON BUNCHES: UPGRADING IDEAS FOR BESSY II*

J. Feikes, P. Kuske, G. Wüstefeld†, BESSY, Berlin, Germany

Abstract

Sub-picosecond electron bunches are achieved with the lengths in the user and THz optics are 13 ps and 3 ps, respectively.

THPC014

Proceedings of IPAC2011, San Sebastián, Spain

SIMULTANEOUS LONG AND SHORT ELECTRON BUNCHES IN THE BESSY II STORAGE RING

G. Wüstefeld, A. Jankowiak, J. Knobloch, M. Ries, HZB, Berlin, Germany

Abstract

We present first ideas of a scheme to develop BESSY II to alternating short and long bunches. At the high voltage gradient locations the bunches become shorter, a kind longitudinal 'rf-focusing'.

BESSY VSR – Project Status & Time Line

BESSY VSR

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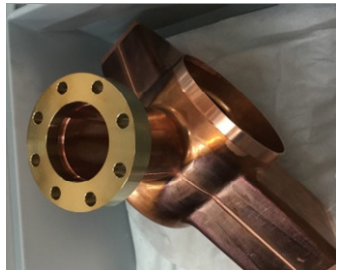
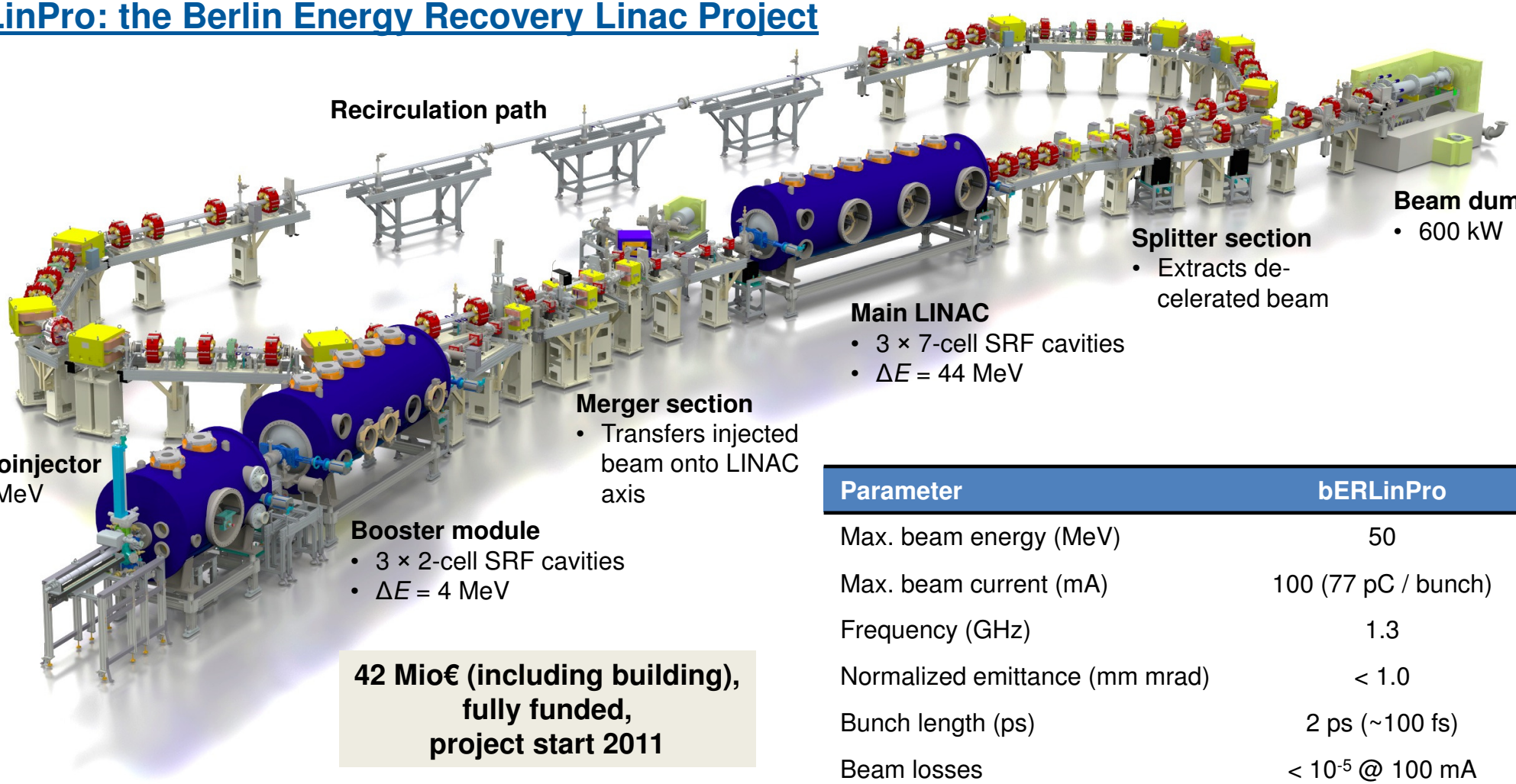


bERLinPro: an ERL R&D facility

bERLinPro: the Berlin Energy Recovery Linac Project



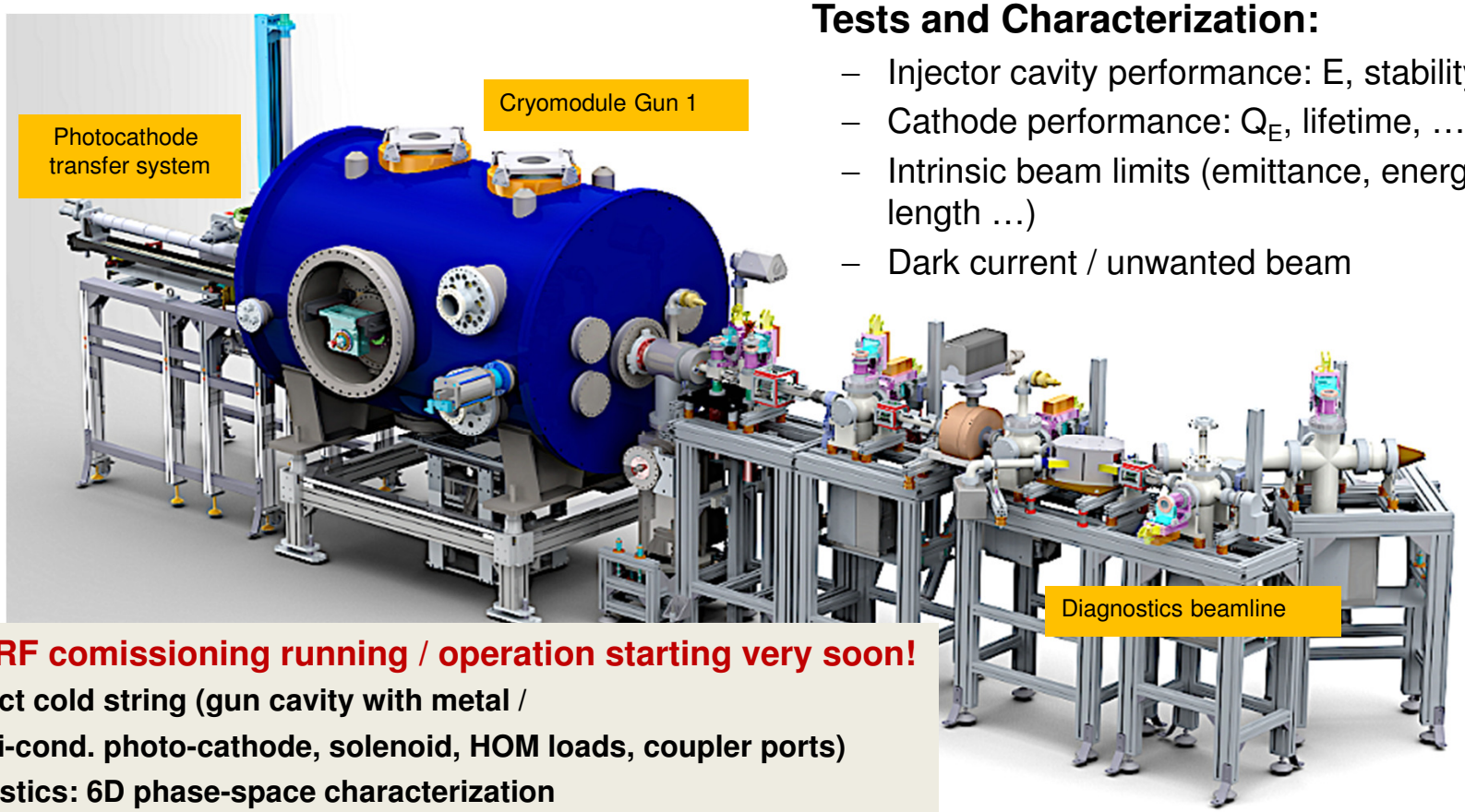
42 Mio€ (including building), fully funded, project start 2011

Parameter	bERLinPro
Max. beam energy (MeV)	50
Max. beam current (mA)	100 (77 pC / bunch)
Frequency (GHz)	1.3
Normalized emittance (mm mrad)	< 1.0
Bunch length (ps)	2 ps (~100 fs)
Beam losses	$< 10^{-5}$ @ 100 mA

bERLinPro: an ERL R&D facility

bERLinPro: a staged approach

Stage 1 – "GunLab": high-brightness beam from an SRF Injector



Tests and Characterization:

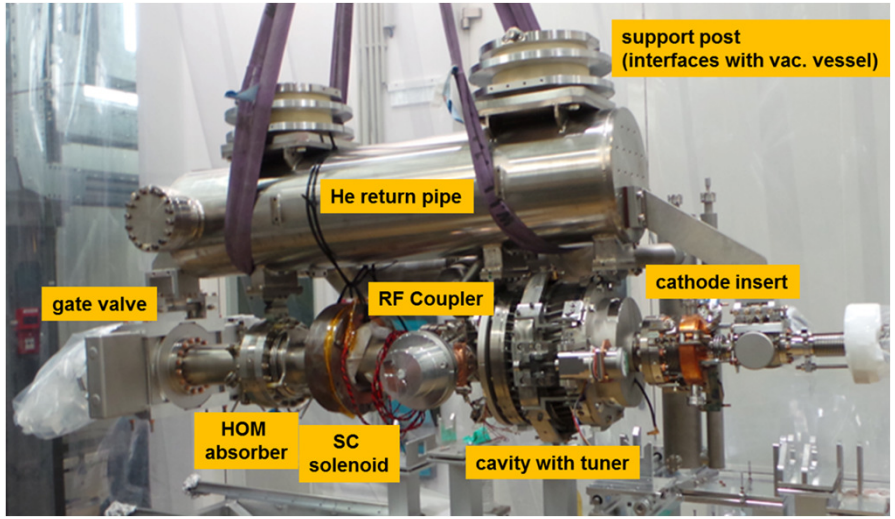
- Injector cavity performance: E, stability, …
- Cathode performance: Q_E, lifetime, …
- Intrinsic beam limits (emittance, energy spread, bunch length …)
- Dark current / unwanted beam

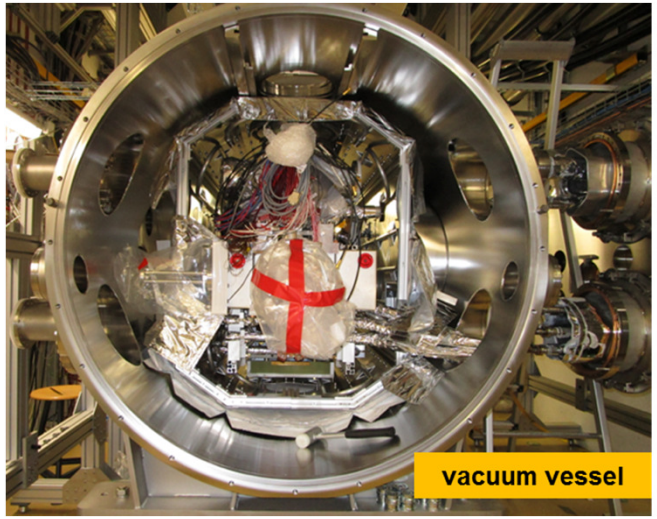
GunLab RF comissioning running / operation starting very soon!

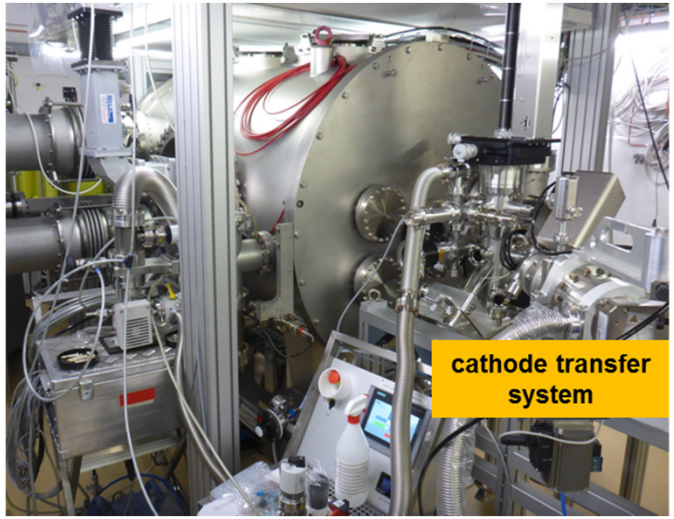
- **compact cold string (gun cavity with metal / semi-cond. photo-cathode, solenoid, HOM loads, coupler ports)**
- **diagnostics: 6D phase-space characterization**
- **full charge @ low average current (5 µA, radiation limit)**

bERLinPro: a staged approach

bERLinPro





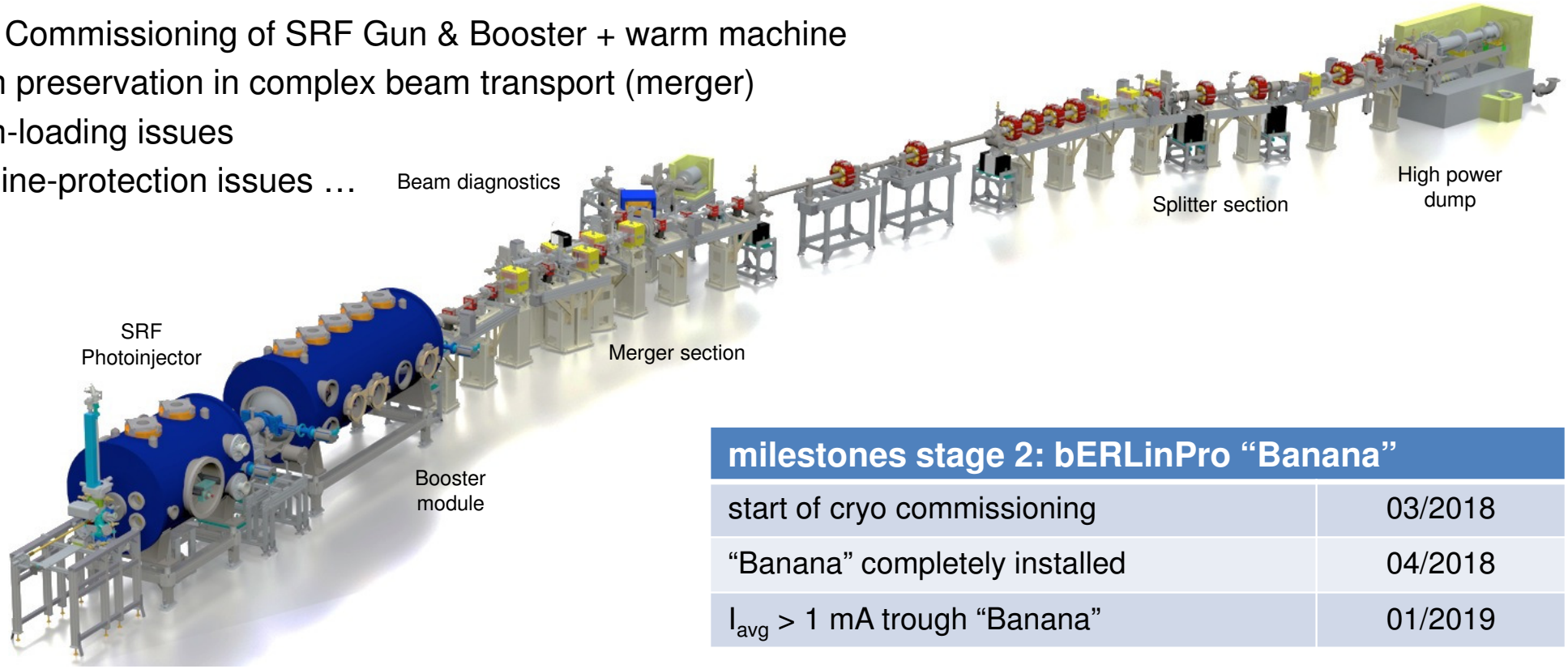


bERLinPro: a staged approach

Stage 2 – “Banana”: medium-power beam transport at low energy

Gun1 with 2 adjustable TTF3 couplers; power limited to ~ 20 kW

- (Re-) Commissioning of SRF Gun & Booster + warm machine
- Beam preservation in complex beam transport (merger)
- Beam-loading issues
- Machine-protection issues …



milestones stage 2: bERLinPro “Banana”	
start of cryo commissioning	03/2018
“Banana” completely installed	04/2018
I_{avg} > 1 mA trough “Banana”	01/2019

bERLinPro: a staged approach


accelerator hall (June 2017)


diagnostics & vacuum racks
technical infrastructure hall (June 2017)

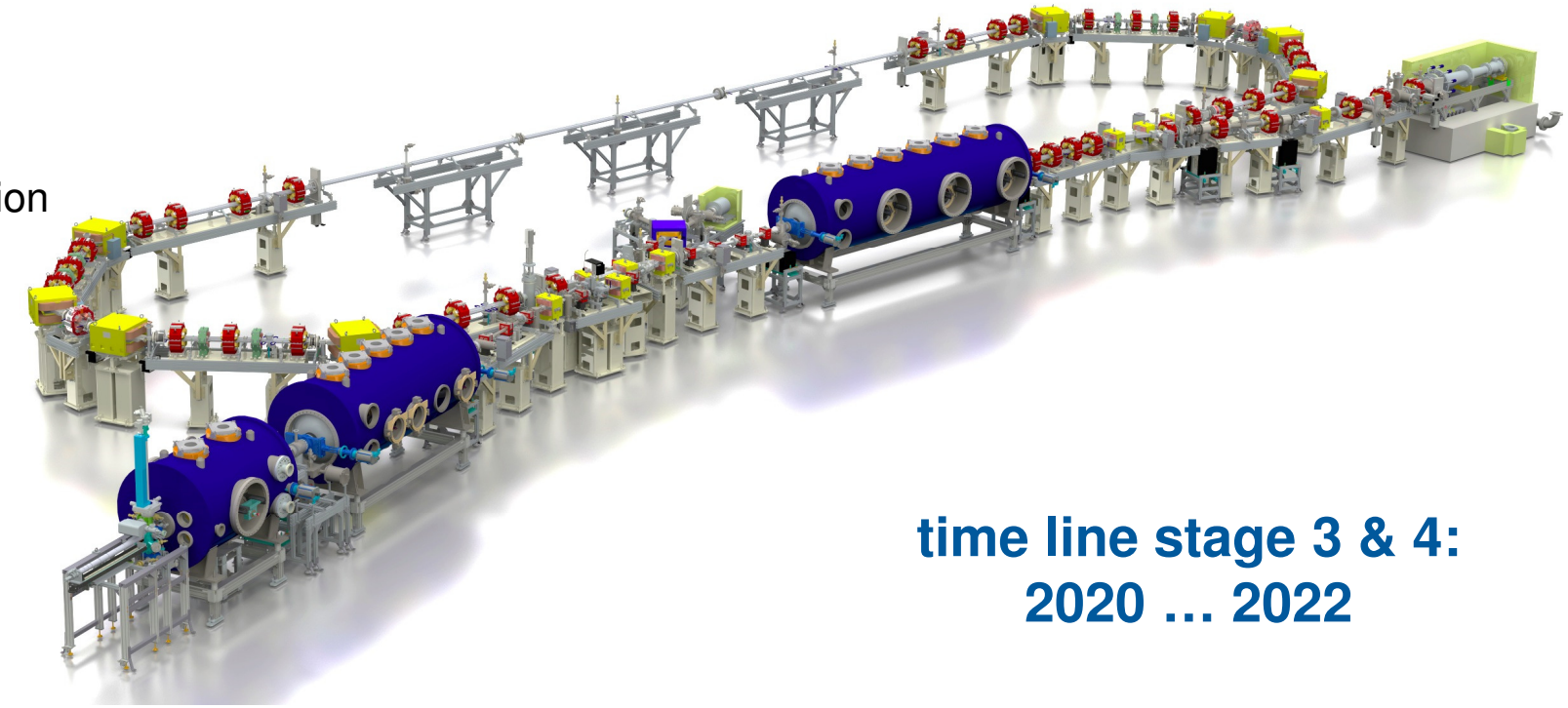

girder & magnet installation in the accelerator hall (Feb/March 2017)

bERLinPro: a staged approach

bERLinPro

Stage 3 – recirculation: medium power, high energy transport of a high-brightness beam

- LINAC performance
- Recovery efficiency
- Bunch compression
- Beam quality preservation



time line stage 3 & 4:
2020 … 2022

Stage 4 – complete machine: high-power recirculation

- "Putting it all together"
- High-current operation of gun (Gun2)
- Beam loss, reliable transport to dump
- Machine protection, reliability

EMIL – A novel research platform for energy materials

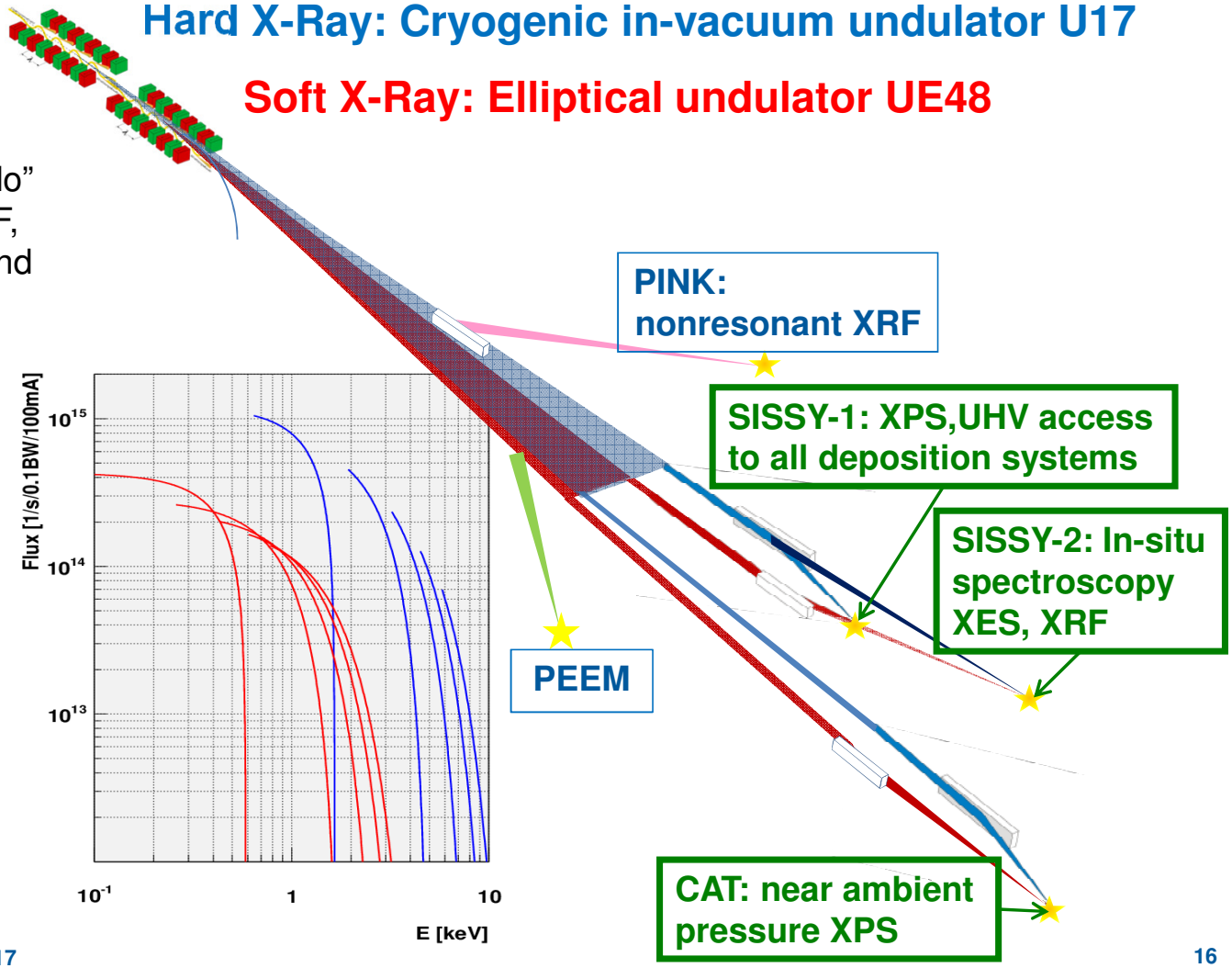
EMIL: the Energy Materials In-situ Laboratory at BESSY II

state-of-the art surface and interface analysis laboratory: "in-system", "in-situ" and "in-operando" X-ray analysis (PES, PEEM, HAXPES, XES, XRF, XRD, ambient-pressure-HAXPES) of materials and devices under realistic sample environments

focus on energy conversion, storage & efficiency

two ID's → 5 experimental end-stations:

- 3 with **simultaneous access to soft & hard X-rays** (80 eV – 10 keV)



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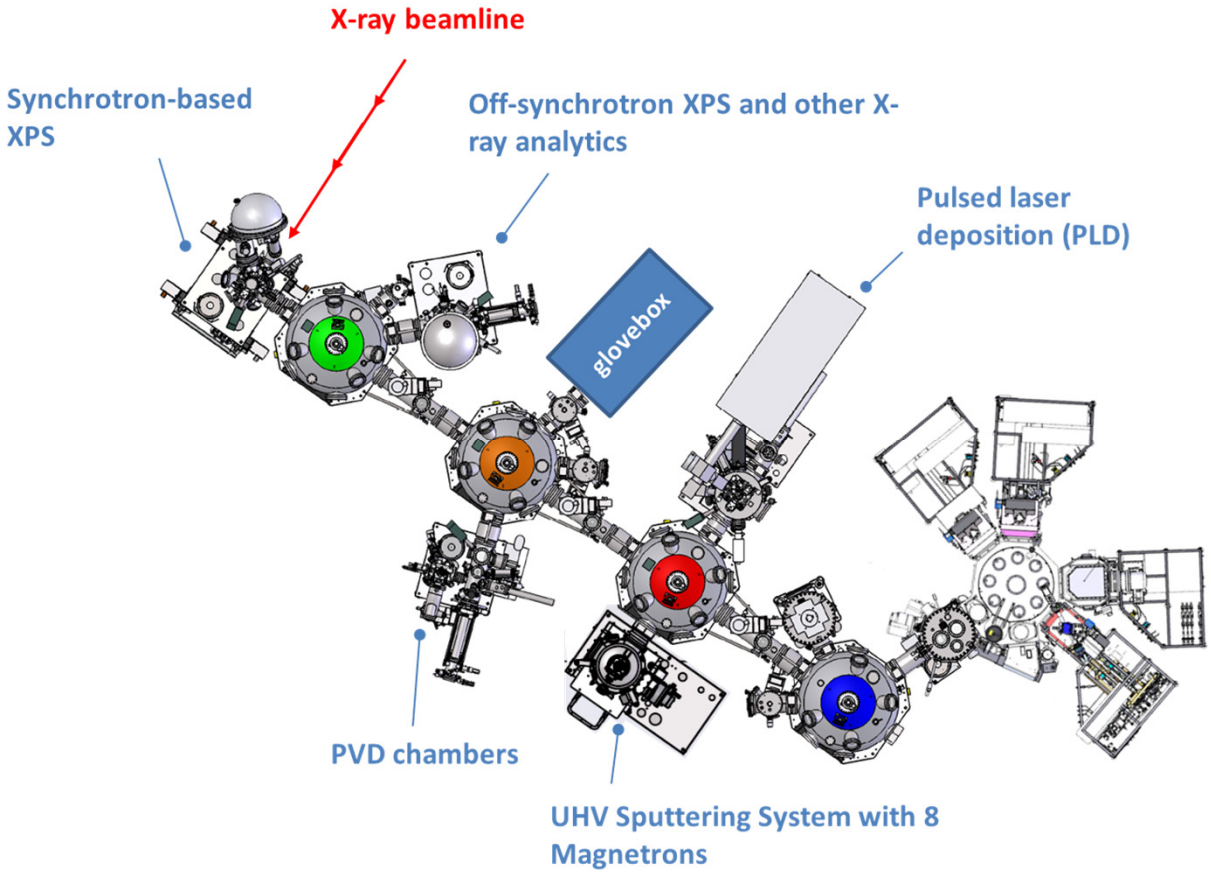
focus on energy conversion, storage & efficiency

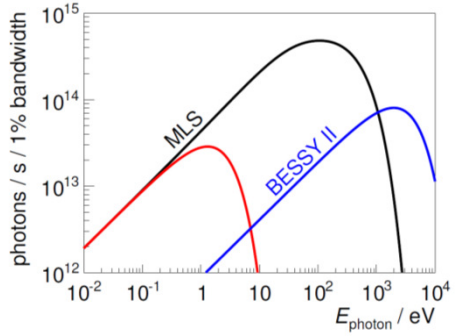
two ID’s → 5 experimental end-stations:

- 3 with **simultaneous access to soft & hard X-rays** (80 eV – 10 keV)
- SISSY-Lab comprises a variety of deposition & characterization facilities in one integrated UHV system.

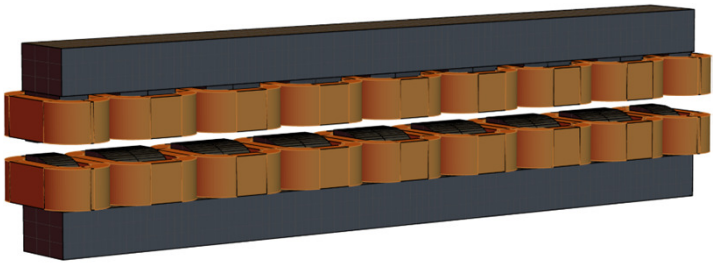


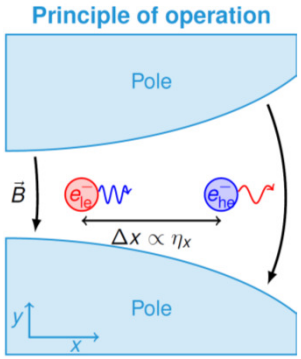
MLS: the METROLOGY LIGHT SOURCE

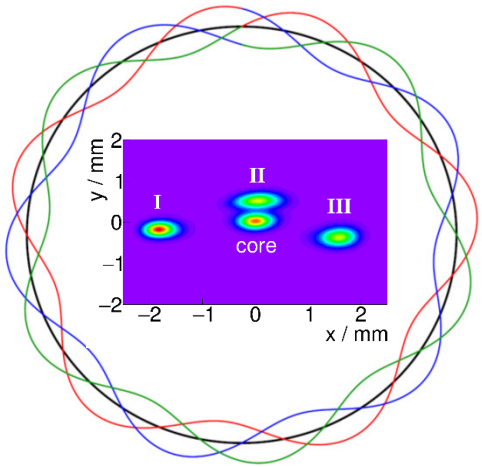
- facility of Physikalisch-Technische Bundesanstalt (PTB) designed and operated by HZB
- user facility, low-α, low-ε
- highly automated operation, ramped
- 2017: new RF cavity (HOM damped EU)
- ideal test environment for accelerator physics
  e.g. TRIBs: transverse resonance island buckets (BESSY-VSR)
  e.g. negative low-α
- R&D project: Robinson Wiggler



parameters	
Energy	50 … 630 MeV
Circumference	48 m
Horizontal emittance	100 nm rad
Beam current	200 mA
RF frequency	500 MHz
max. RF voltage	0.5 MV
Bunch length low-α	20 ps 1 ps
Mom. Comp. low-α	$(-3 \ldots 7) \times 10^{-2}$ 1.3×10^{-4}







Thank you for your attention!