European Synchrotron Light Source Workshop

HZB Helmholtz Zentrum Berlin

BESSY II Status

P. Goslawski for the BESSY II team,
Helmholtz-Zentrum Berlin

XXIII ESLS Workshop
23rd – 25th November 2015
SLS - PSI, Villigen, Switzerland

1.) Overview BESSY II

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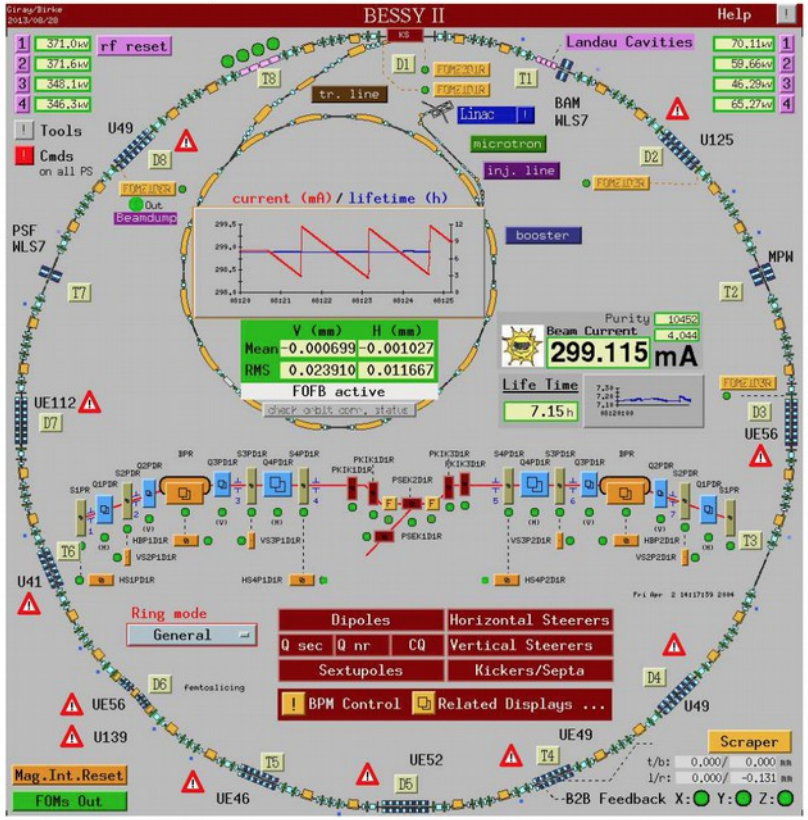
Control panel:

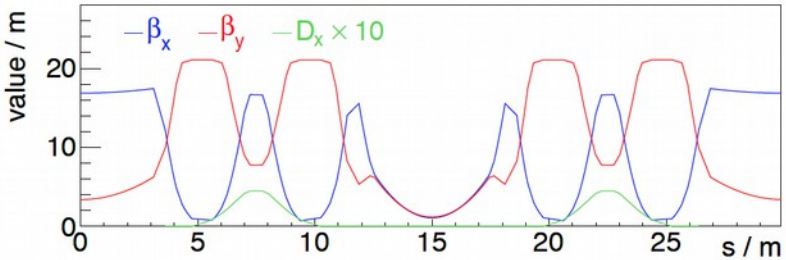


Source area: $\sigma = \sqrt{\varepsilon \cdot \beta} = 0.2\,\mathrm{mm}$

Source divergence: $\sigma' = \sqrt{\varepsilon / \beta} = 0.02\,\mathrm{mrad}$

BESSY II parameters

Magnetic lattice	DBA
Circumference	240 m
Energy	1.7 GeV
Current	300 mA
Emittance, ε	5 nm rad
Bunch length	15 ps, 5 mm
Straight sections / IDs	16 / 14
Endstations	52
First photons	1998



1.) Overview 2015

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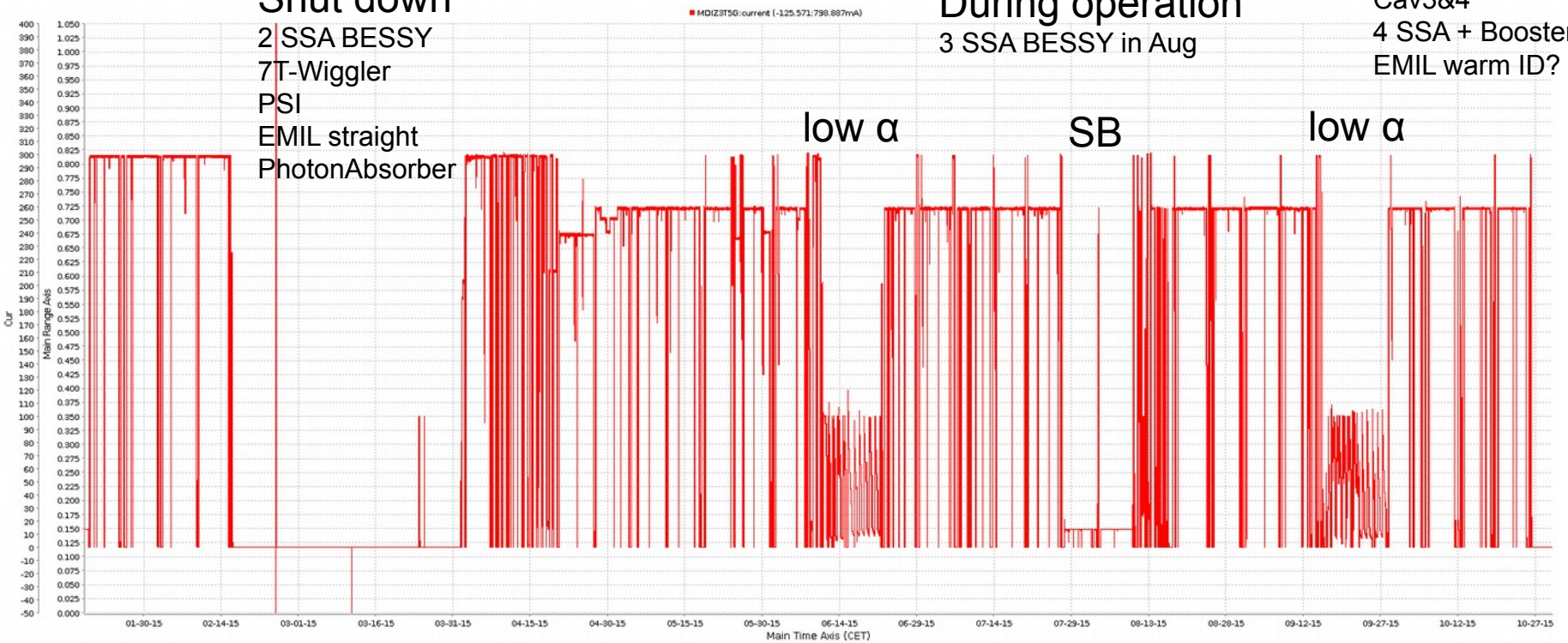
300 mA

260 mA

Shut down
2 SSA BESSY
7T-Wiggler
PSI
EMIL straight
PhotonAbsorber

During operation
3 SSA BESSY in Aug

Shut down
Cav3&4
4 SSA + Booster
EMIL warm ID?



Feb Mar Apr May Jun Jul Aug Sep Okt Nov

time

The menu

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1.) Statistics

2.) Challenges (Problems), Regeneration, Upgrades:

- bERLinPro building construction
- Vacuum, Lifetime, reduced Current
- 7T-Wiggler re-installation ✓
- Extraction Septum > induced radioactivity
- RF upgrade: Cavities and Transmitters

3.) Highlights

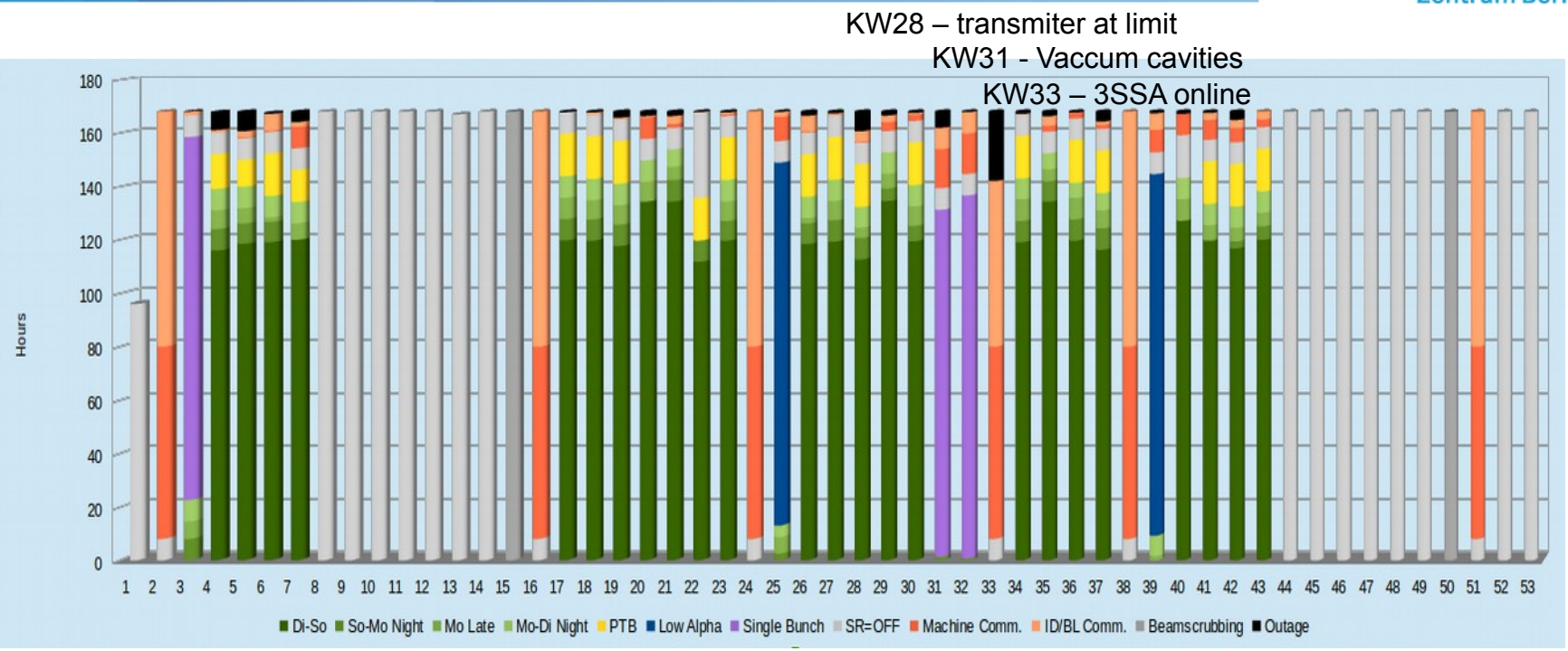
- EMIL optics
- PPRE Bunch for ARTOF ✓
- Few Bunch Mode
- Island Buckets, MultiBeam Machine

4.) Future

- bERLinPro
- BESSY-VSR

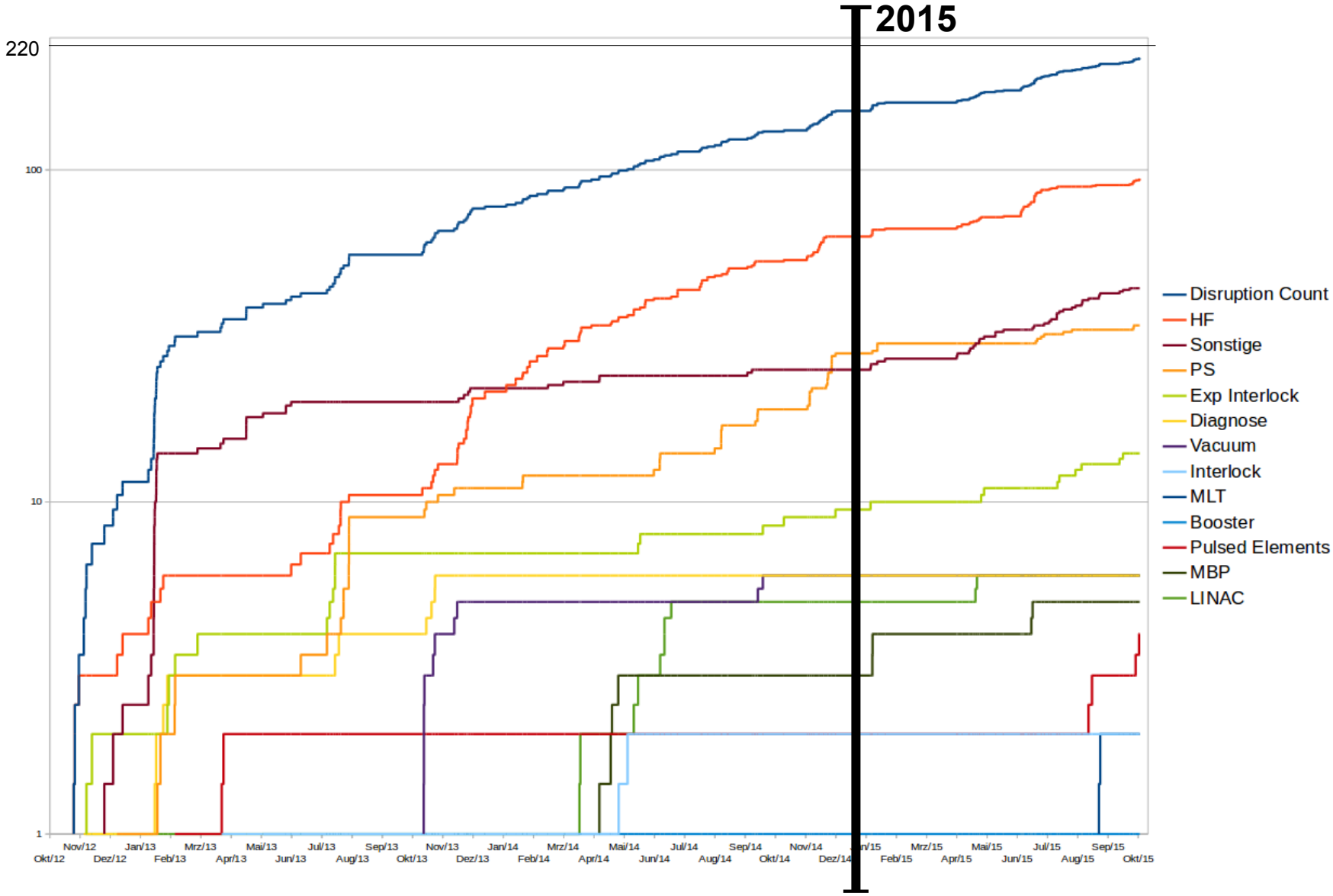
1.) Statistics

1.) Statistics - overview



Year	Outage black	MTBF	MTTR	Availability
2012	178 h	9.8 h	0.3 h	96.3 %
2013	159 h	29.7 h	0.6 h	96.7 %
2014	324 h	30.0 h	0.8 h	93.7 %
2015	**53 h**	**53.2 h**	**0.75 h**	**96.5 % (105.2%)**

1.) Statistics – error reasons



2.) Challenges (Problems), Regeneration, Upgrades

2.) bERLinPro construction & beam motion

http://www.helmholtz-berlin.de/projects/berlinpro/webcam/index_en.html

2.) bERLinPro construction & beam motion

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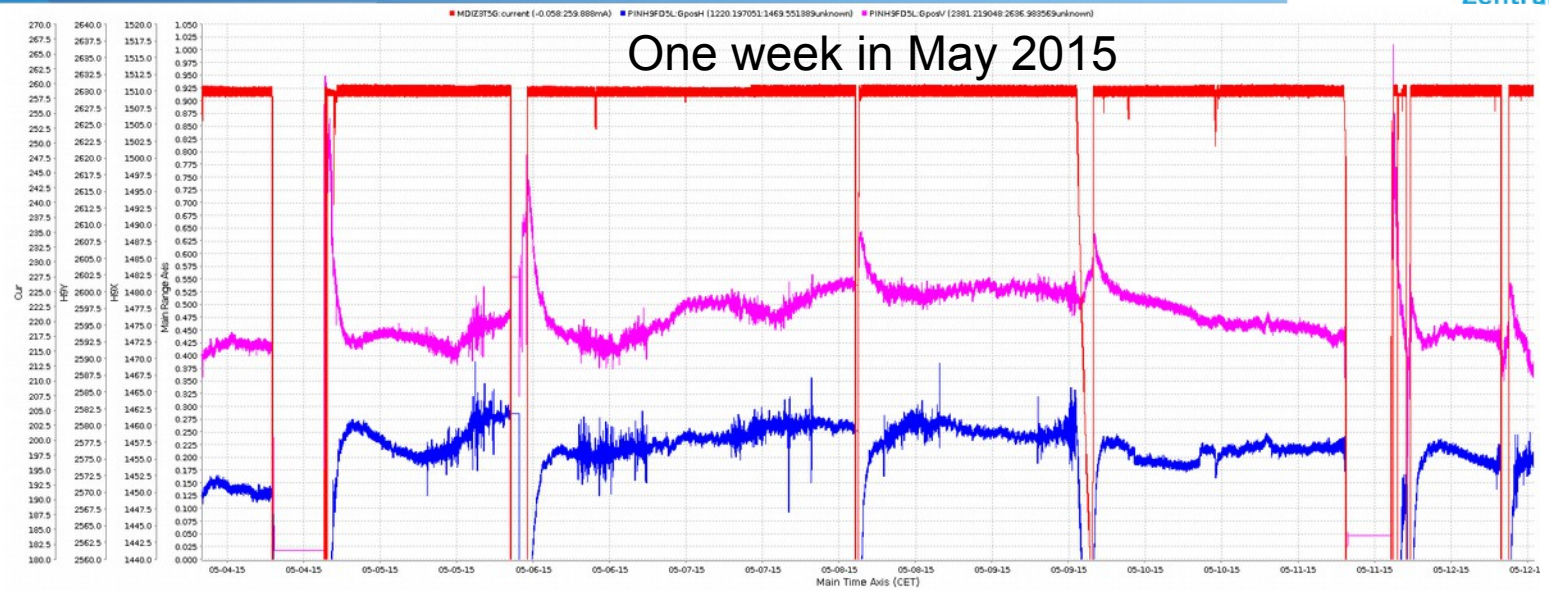
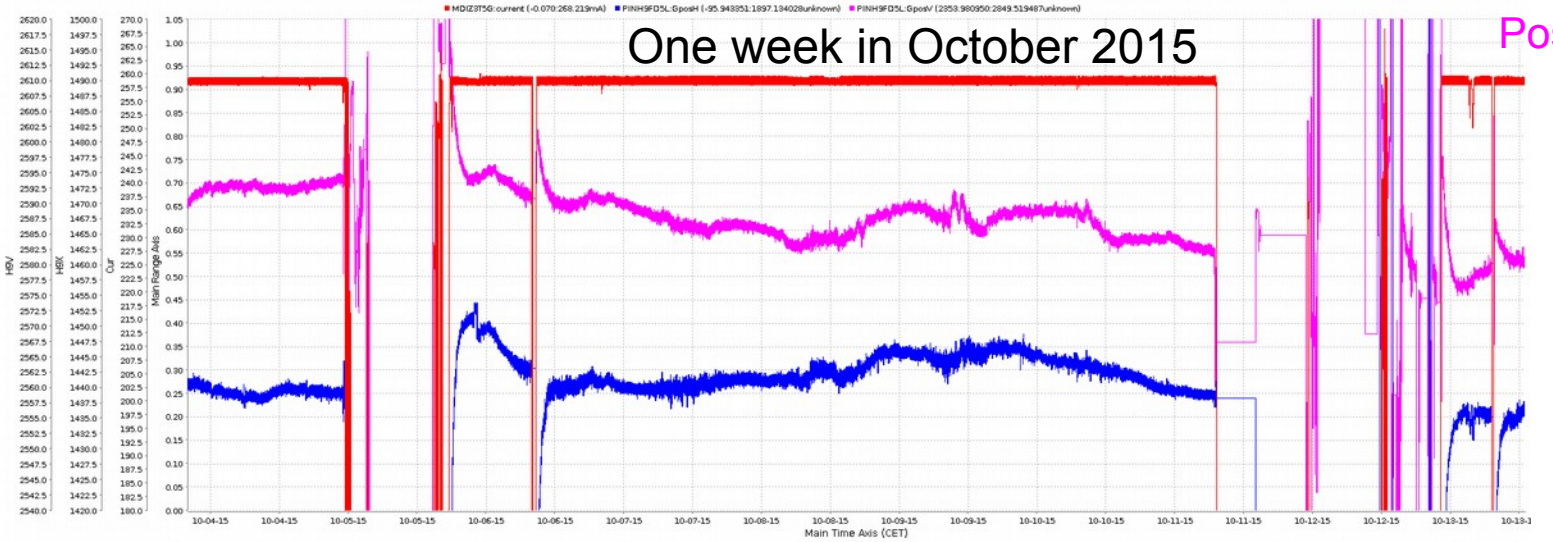
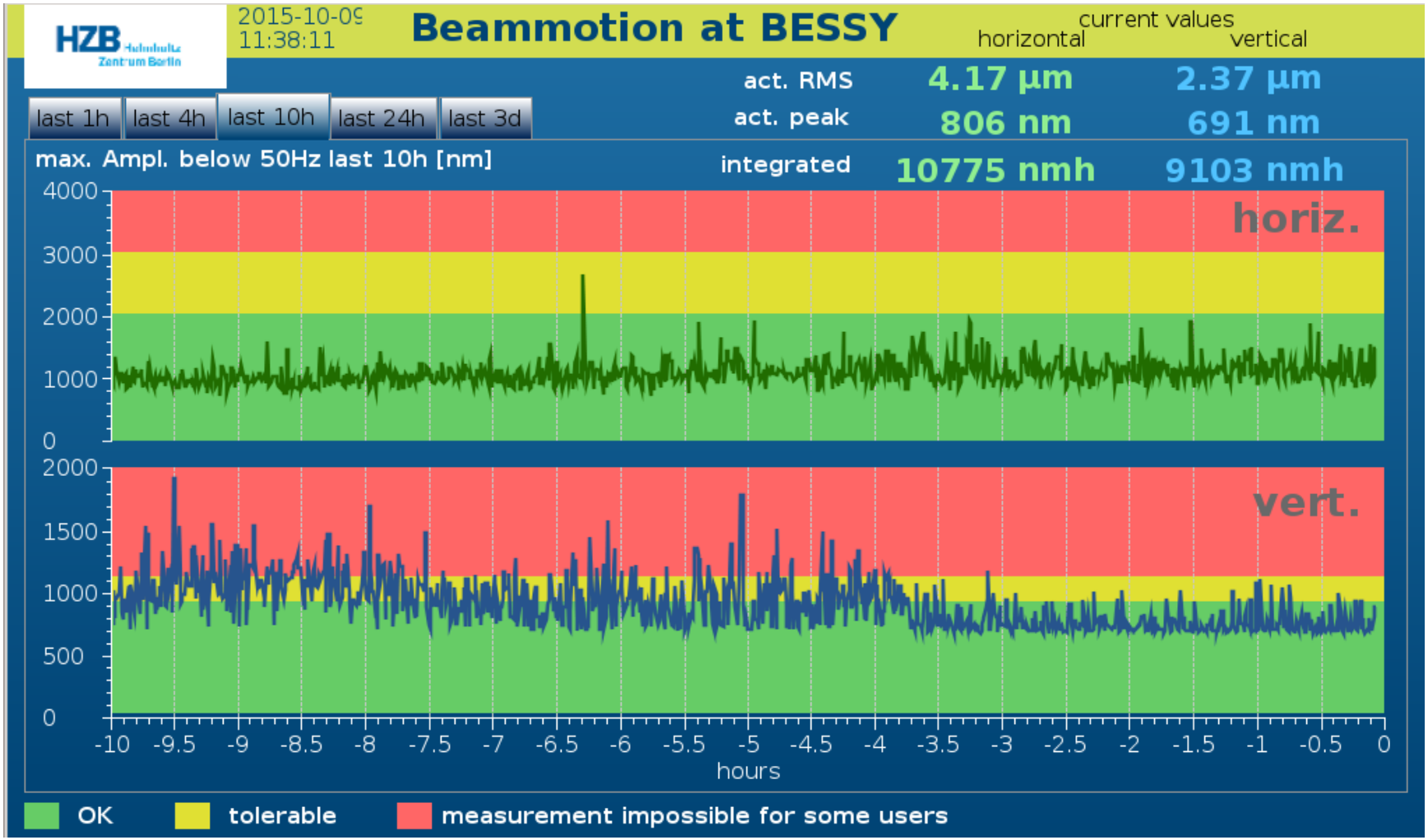


Red – current; Blue – horizontal pos.; Purple – vertical pos.

Current
PosX
PosY



2.) bERLinPro construction & beam motion



2.) Vacuum, lifetime, red. current for TopUp

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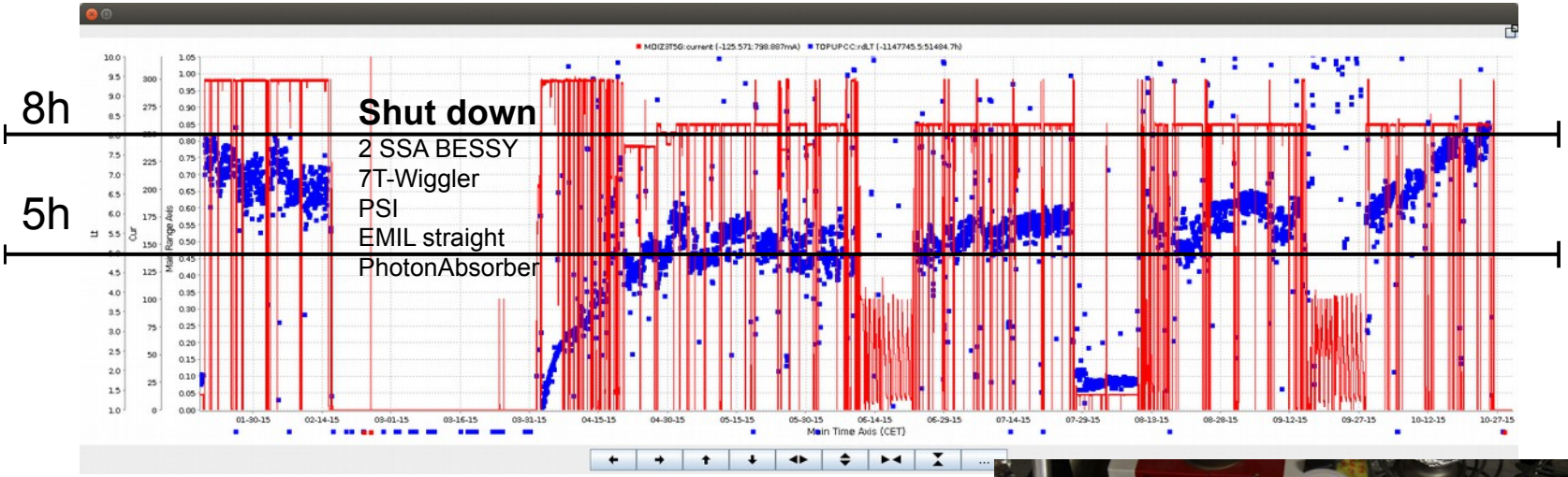

Operation with reduced current of 260mA

to fulfill TopUp conditions: InjEff > 90%, **Lt > 5h**

Lt reduced due to bad vacuum Lt

- Shift of photon absorbers; weldseam?
- Open ring? 7T-Wiggler, Cavities, EMIL
- “Dirty” 7T-Wiggler - with beam > outgassing?
- Dying pumps 10(300), half the ring checked
- New pump PS (LOCO) with starting problems
- LT increase expected!

2.) 7T-Wiggler re-installation

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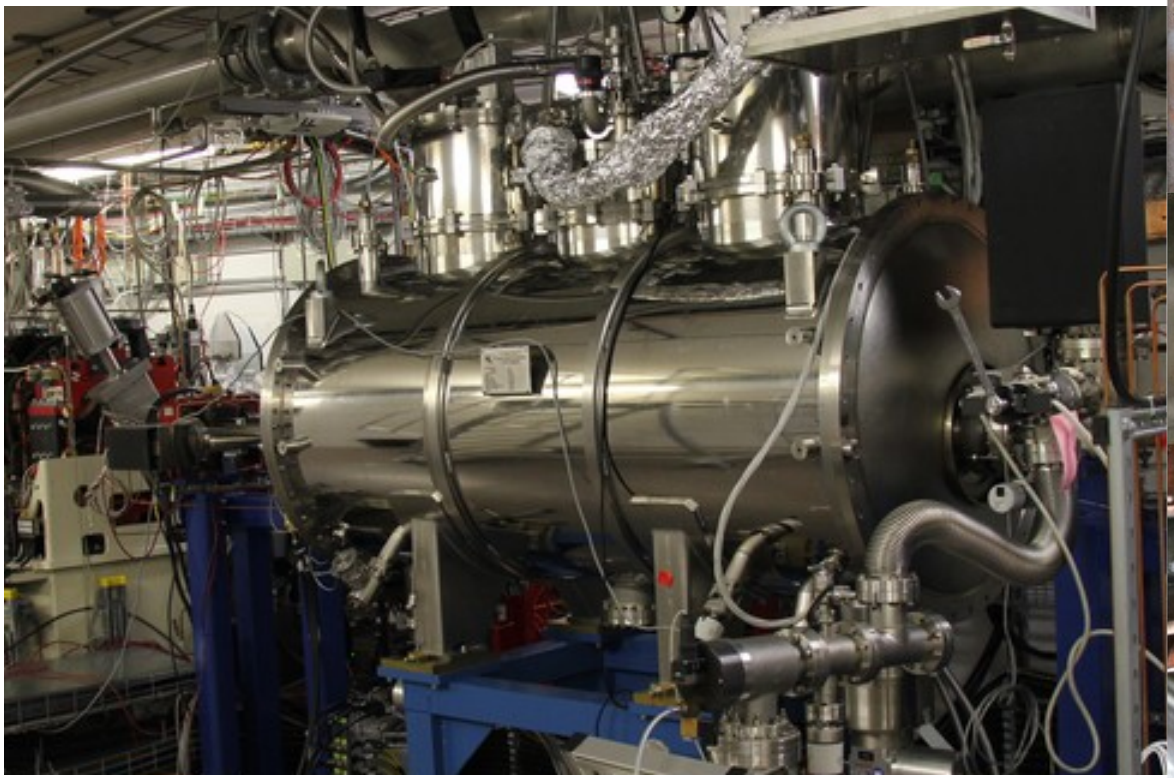
One reason for bad Lifetime

- Good bake out not easy!
- 1×10^{-7} mbar at room temperature
- With beam and radiation local outgassing
- Local very bad vacuum?



2.) Booster extraction – induced radioactivity

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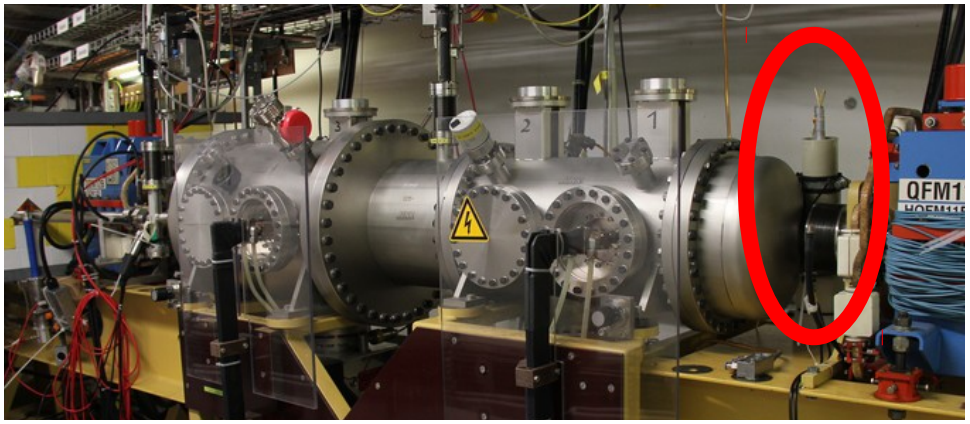
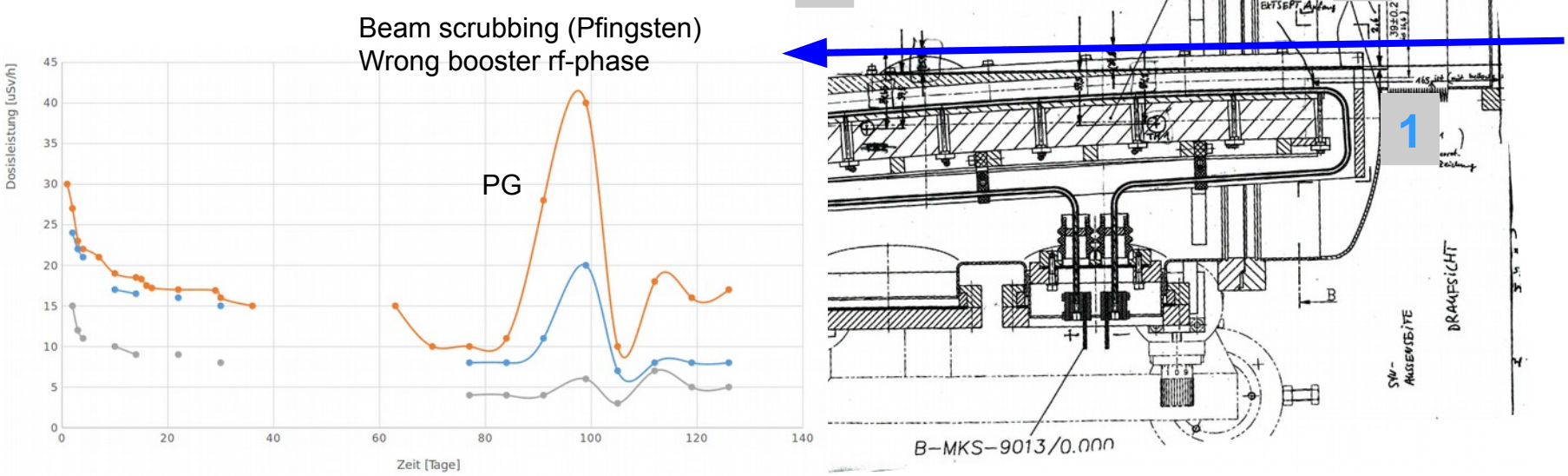
Induced radioactivity at booster extraction septum

- Narrowest point, booster aperture
- Until 2015, injection into booster with 1 Hz, (10Hz booster ramp)
- Since 2015, injection only when injecting into SR (every 2-3 min)





2.) RF-Upgrade: Cavities

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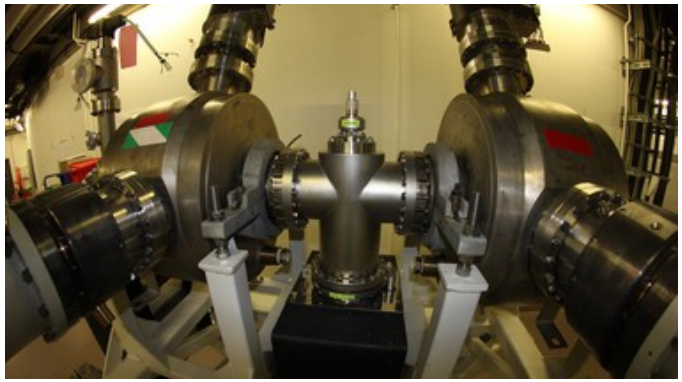
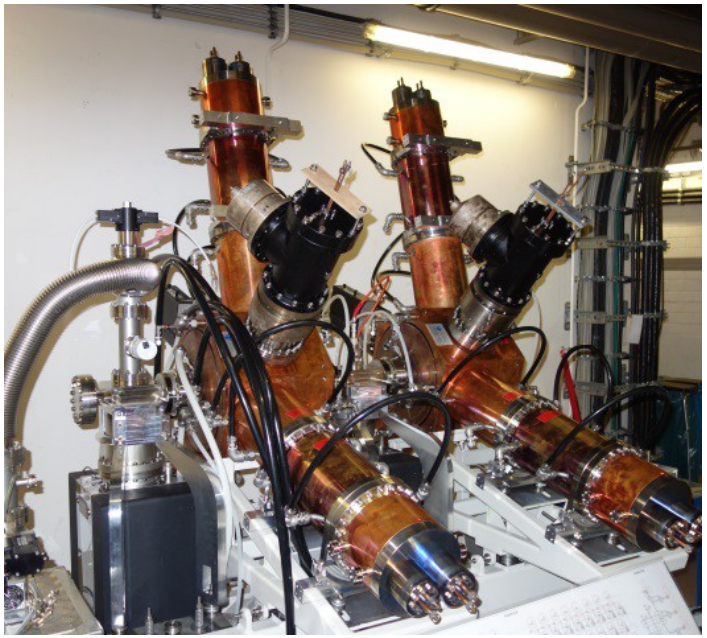
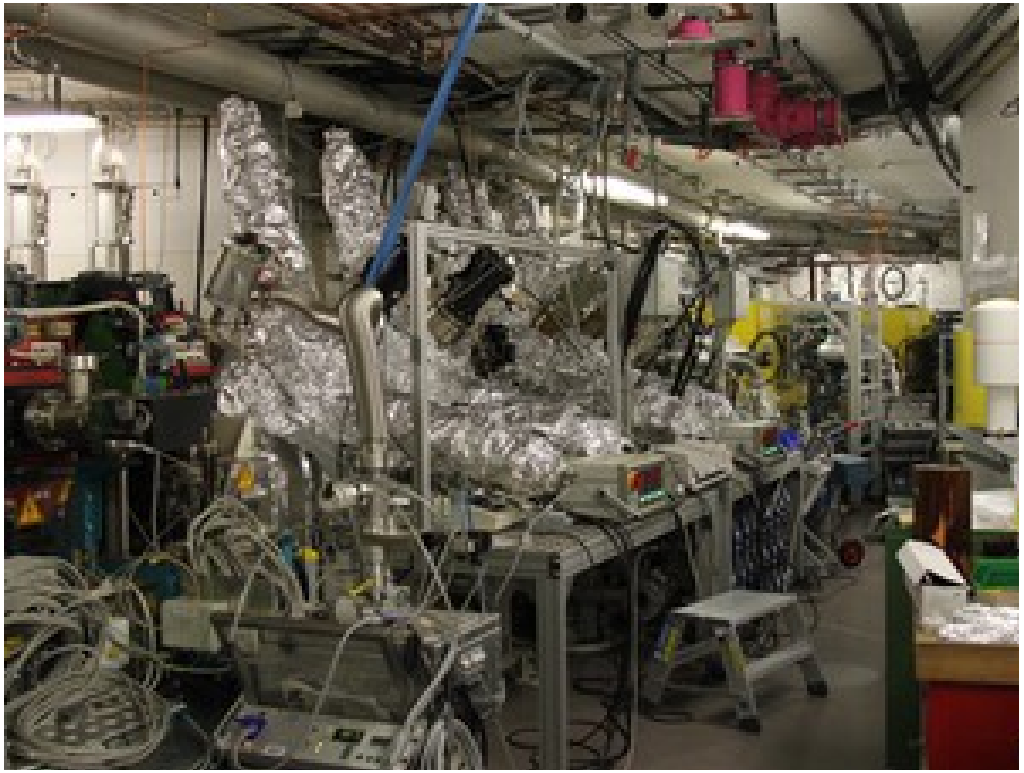


BESSY operates with 4 cavities

- Cav3&4 have been exchanged 3Q2014
- Cav1&2 exchanged now 4Q2015

All HOM damped cavities are equipped now with new SSA, instead of klystrons





2.) RF-Upgrade: Transmitters

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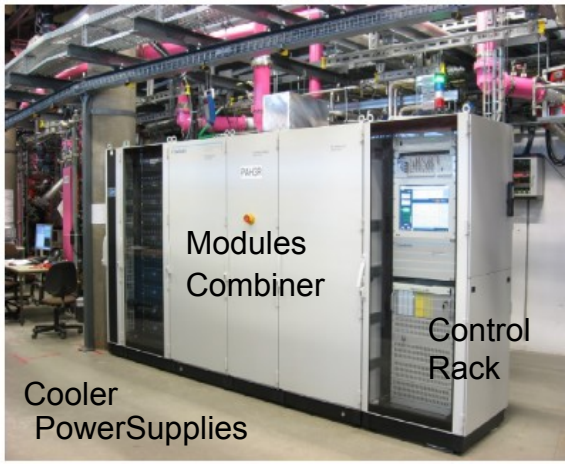
Old 75kW 500MHz klystron based RF transmitters

Old klystrons replaced by solid state (SSA) RF transmitters:

- 2 transmitters in 2014Q3
- 1 transmitter in 07/2015
- Last B2 and booster in 11/2015



New SSA 1x40kW for booster and 4x80kW for storage ring

SSA from Cryoelectra

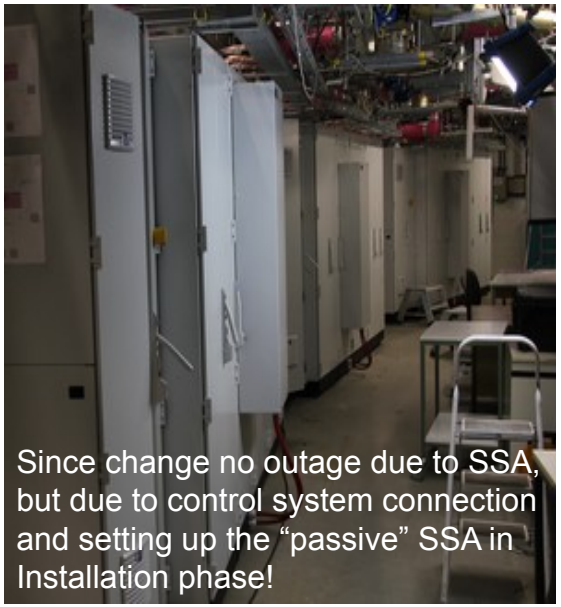
> excellent service

17M from order to first transmitter

6M debugging prototyp

11M to first beam

9M installation phase for 5 transmitters



2.) RF-Upgrade: Results long. beam dynamics

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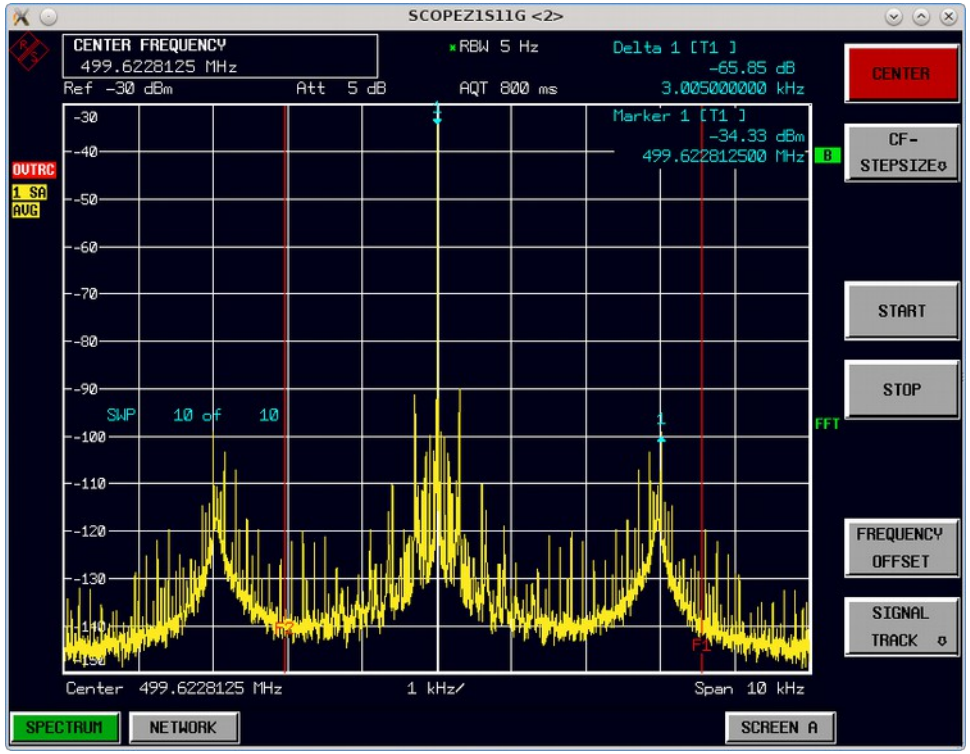
Longitudinal BeamDynamics for different RF systems (cavity and transmitter) (3mA)

- **Cav1: HOM + Klystron**
  - A lot of noise
  - 300, 600, 900 kHz



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- **Cav2: HOM + SSA**
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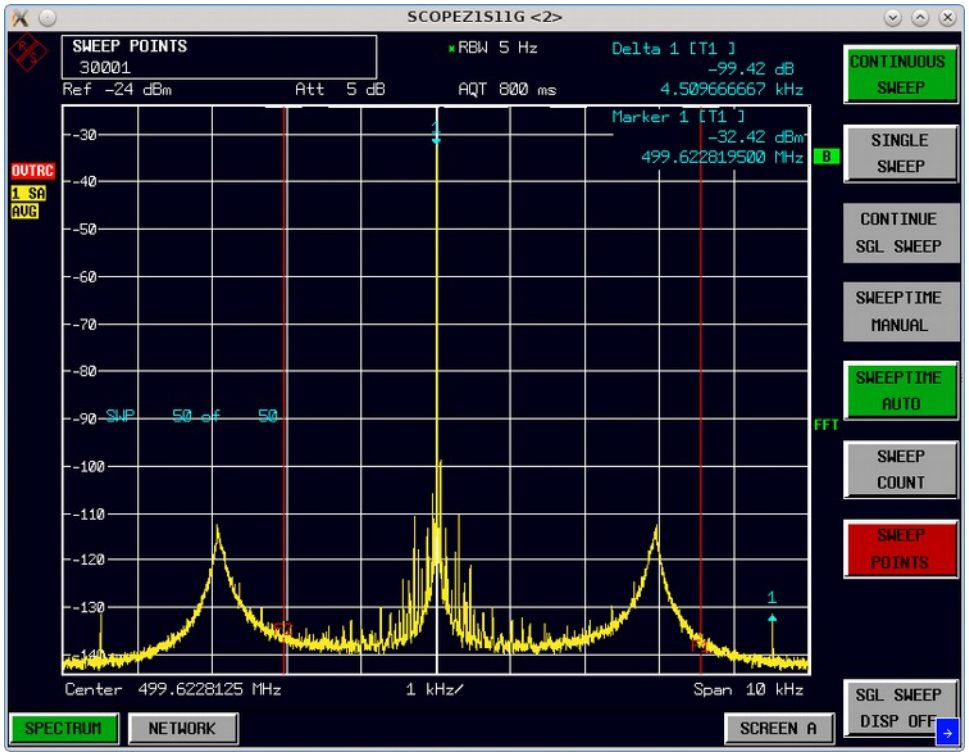
  - 50Hz and hh



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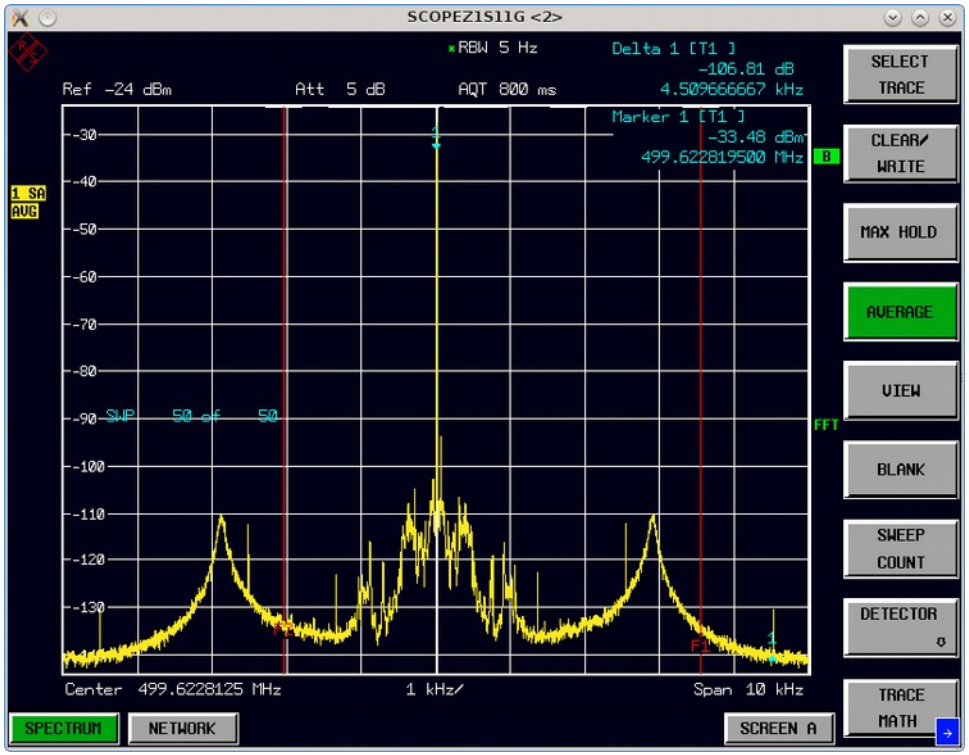
- **Cav3: Doris + SSA**
  - Noise below 1kHz, otherwise clean
  - Wide 900Hz line
  - Plateau below 500Hz



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  - Wide 900Hz line
  - Plateau below 500Hz
- **Cav4 similar to Cav3**

Very promising! Looking forward to next low alpha week (end of February) >> Produce short bunches!

3.) Highlights

3.) EMIL – Energy Materials In-situ Laboratory

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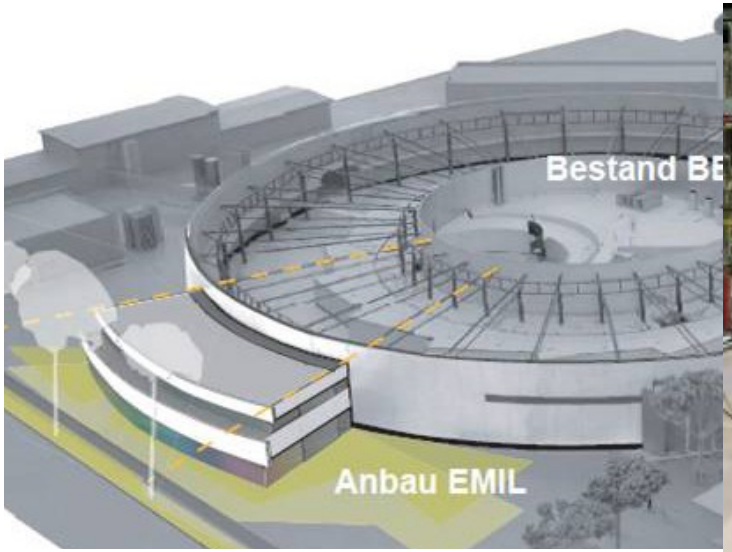
EMIL at BESSY II

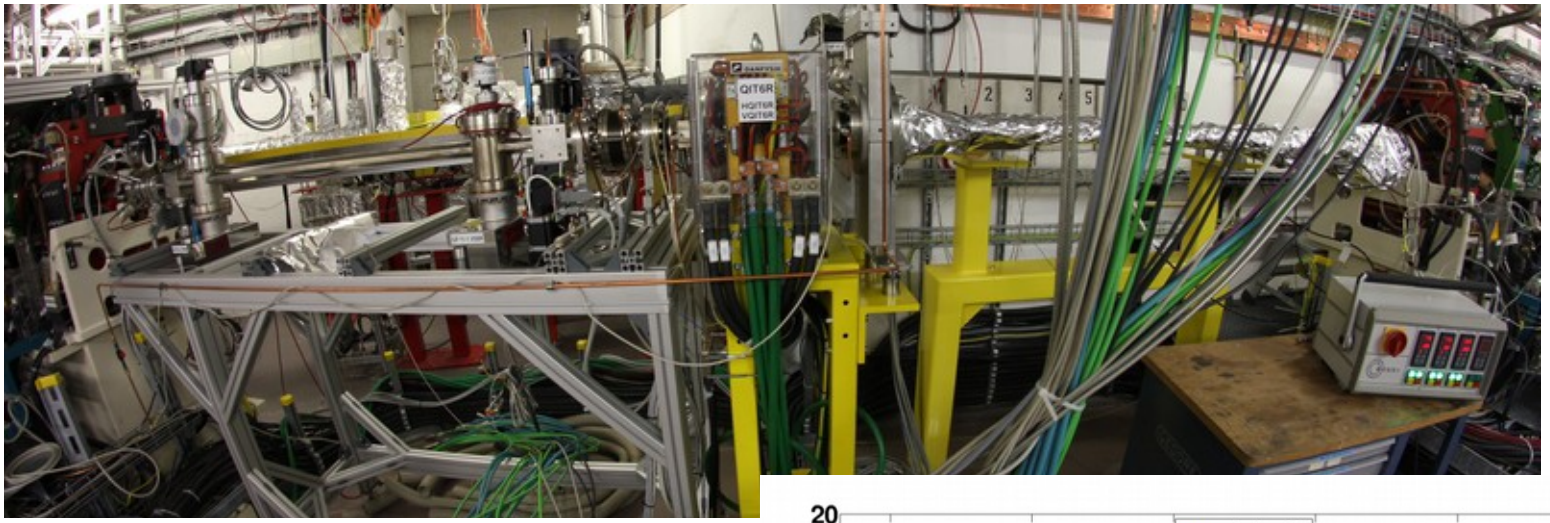
combines X-ray analysis methods and deposition tools, partially with industry related technologies.

- Materials and device concepts for solar energy (SISSY) and catalysis application (CAT)
- Joint project between HZB and Max-Planck
- Double undulator X-ray beamline from 80eV to 10keV for 5 interaction points
- More infos
  Homepage:



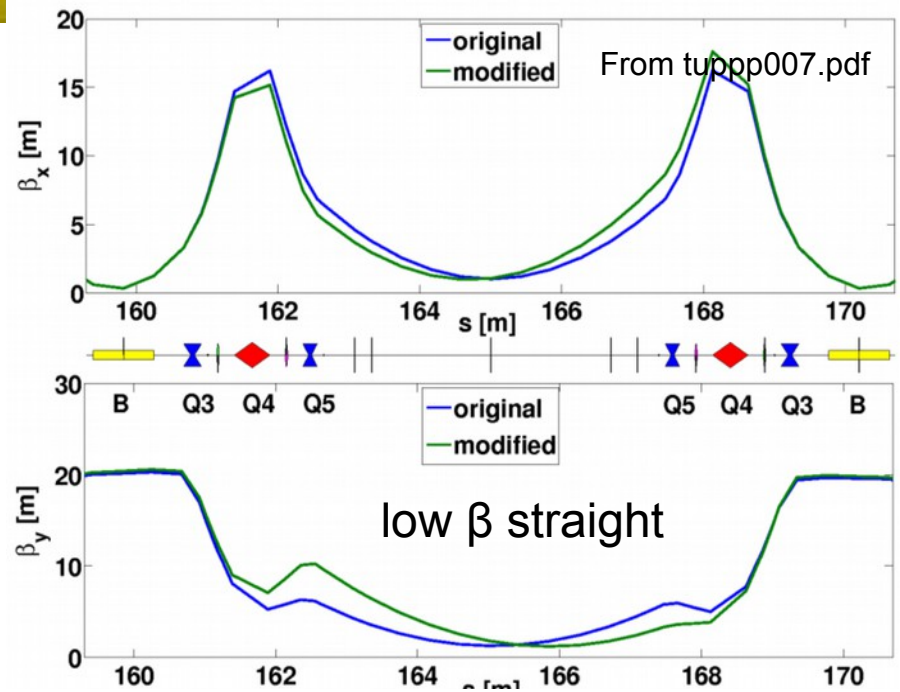
http://www.helmholtz-berlin.de/forschung/zukunftsprojekte/emil_en.html

3.) EMIL – Optics



EMIL at BESSY II

- Waiting for APPLE II undulator, installation in 2015? (80eV-2keV) We are prepared and ready!
- Start with optic adaption in 2015, because of very small vertical aperture – ID gap down to 5mm
- Previous work by P. Schmid, P. Kuske, G.Wüstefeld



3.) PPRE Bunch for ARTOF (γe⁻ spectroscopy)

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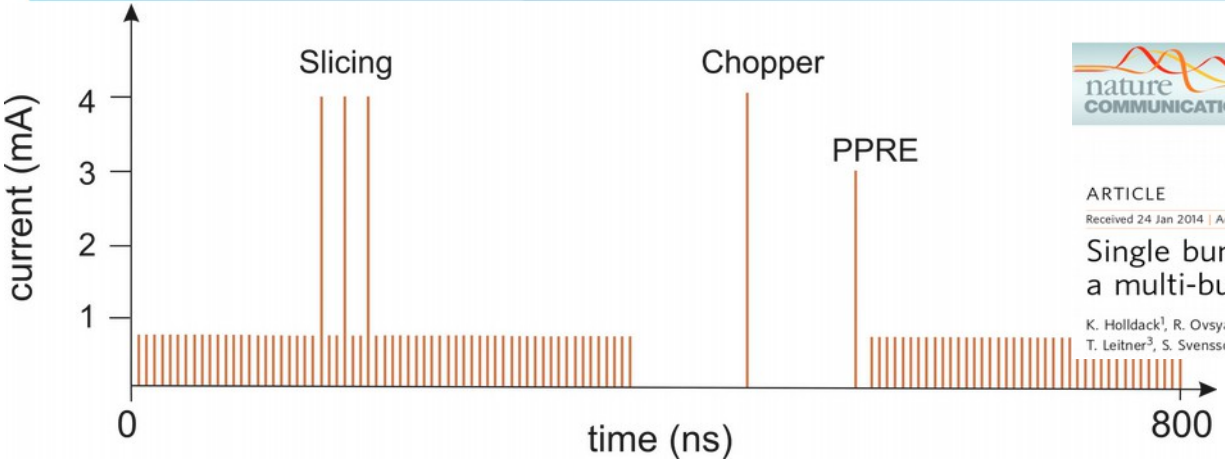
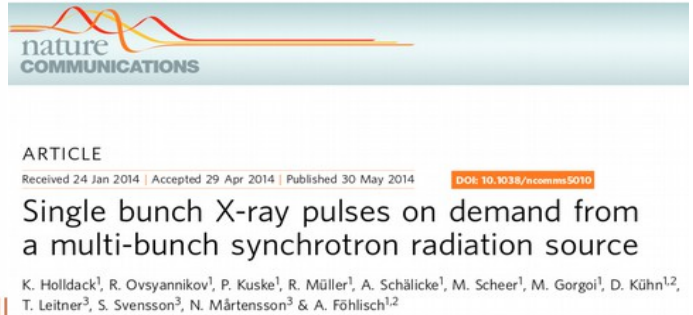



nature COMMUNICATIONS

ARTICLE

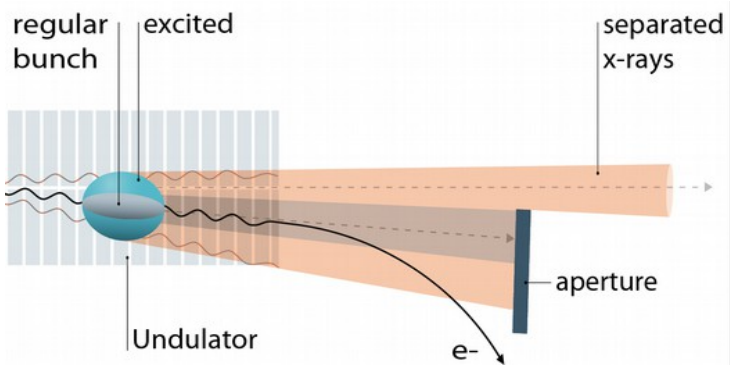
Received 24 Jan 2014 | Accepted 29 Apr 2014 | Published 30 May 2014 DOI: 10.1038/ncomms5010

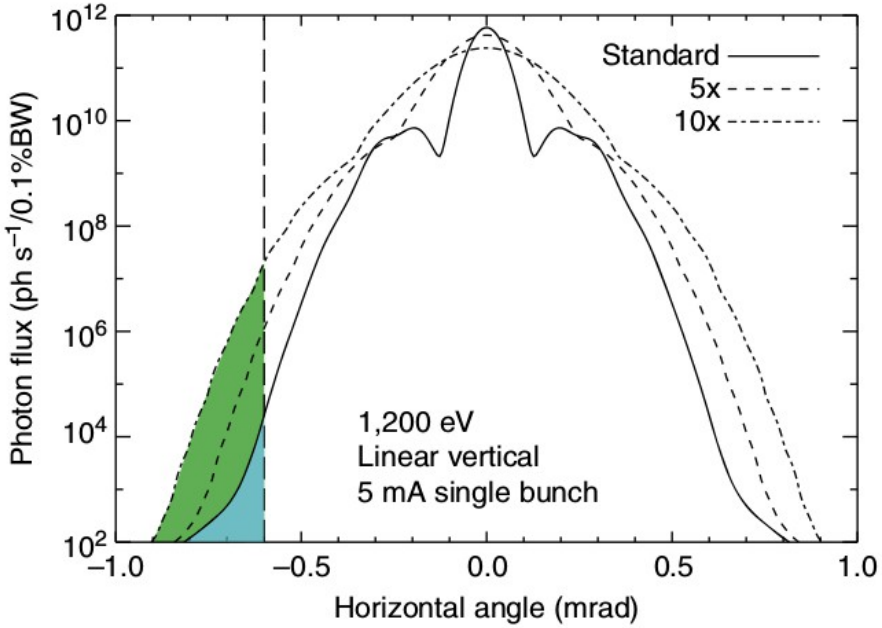
Single bunch X-ray pulses on demand from a multi-bunch synchrotron radiation source

K. Holldack[1], R. Ovsyannikov[1], P. Kuske[1], R. Müller[1], A. Schälicke[1], M. Scheer[1], M. Gorgoi[1], D. Kühn[1,2], T. Leitner[3], S. Svensson[3], N. Mårtensson[3] & A. Föhlisch[1,2]

PPRE = Pulse Picking by Resonant Excitation

- IDEA: Time resolved exps like in pure single bunch
- Excitation, bump and aperture





3.) Few bunch mode, starting point

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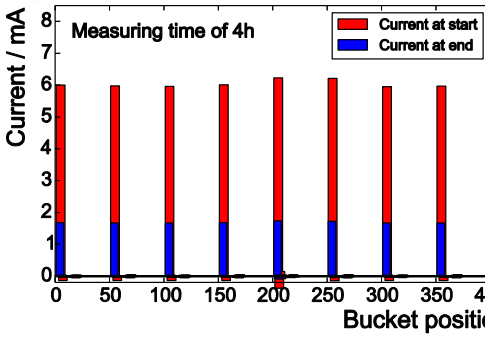
Other machines:
PETRA, ESRF, etc.

In contrast to other machines,
there is no few bunch mode at BESSY (10MHz)

One test during MachineCommissioning sunday (3h)

- 8 bunches with 100ns spacing = 10Mhz repetition,
  each bunch 7.5 mA, total = 60 mA in decay mode
  > TopUp defined only for MB and SB
- Stable operation and two happy user groups!



Schönhense, Elmers, Tusche, etc. (Mainz)

- 8x more statistics and better SNR,
  > 3D spin filtered band mapping within <1h

Paper in preparation

Doerner (Frankfurt)

- COLTRIMS based on TOF,
  4x more statistic and 2x better signal to noise

> Some inhouse users/beamline scientists also very interested!

3.) MultiBeam Machine - Resonant Island Buckets

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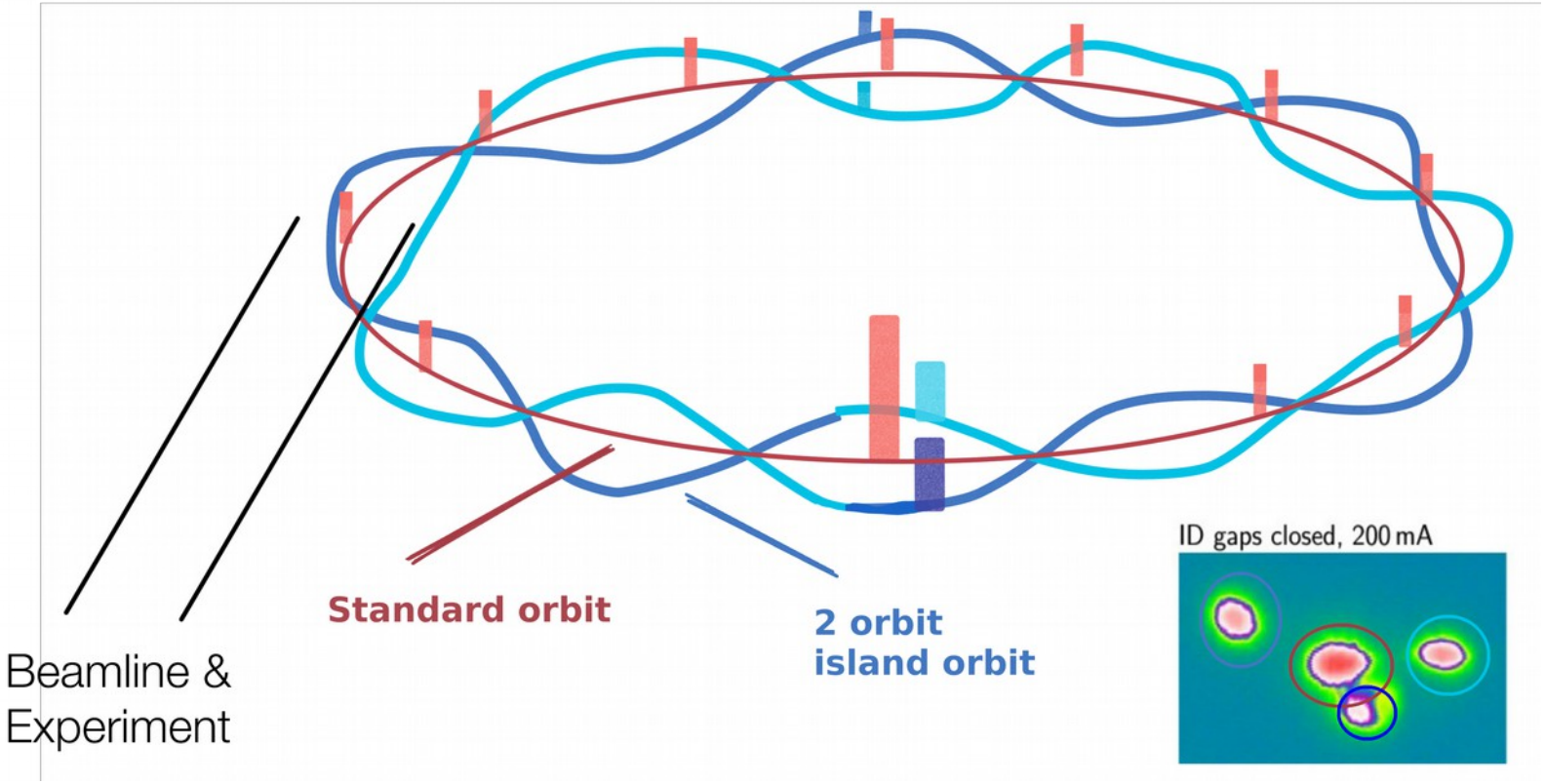
2nd orbit or lane for electron bunches



Talks tomorrow

- Operation modes of the Metrology Light Source
- Bunch separation by transverse resonance island buckets triggered by BESSY VSR

4.) Future

4.) bERLinPro

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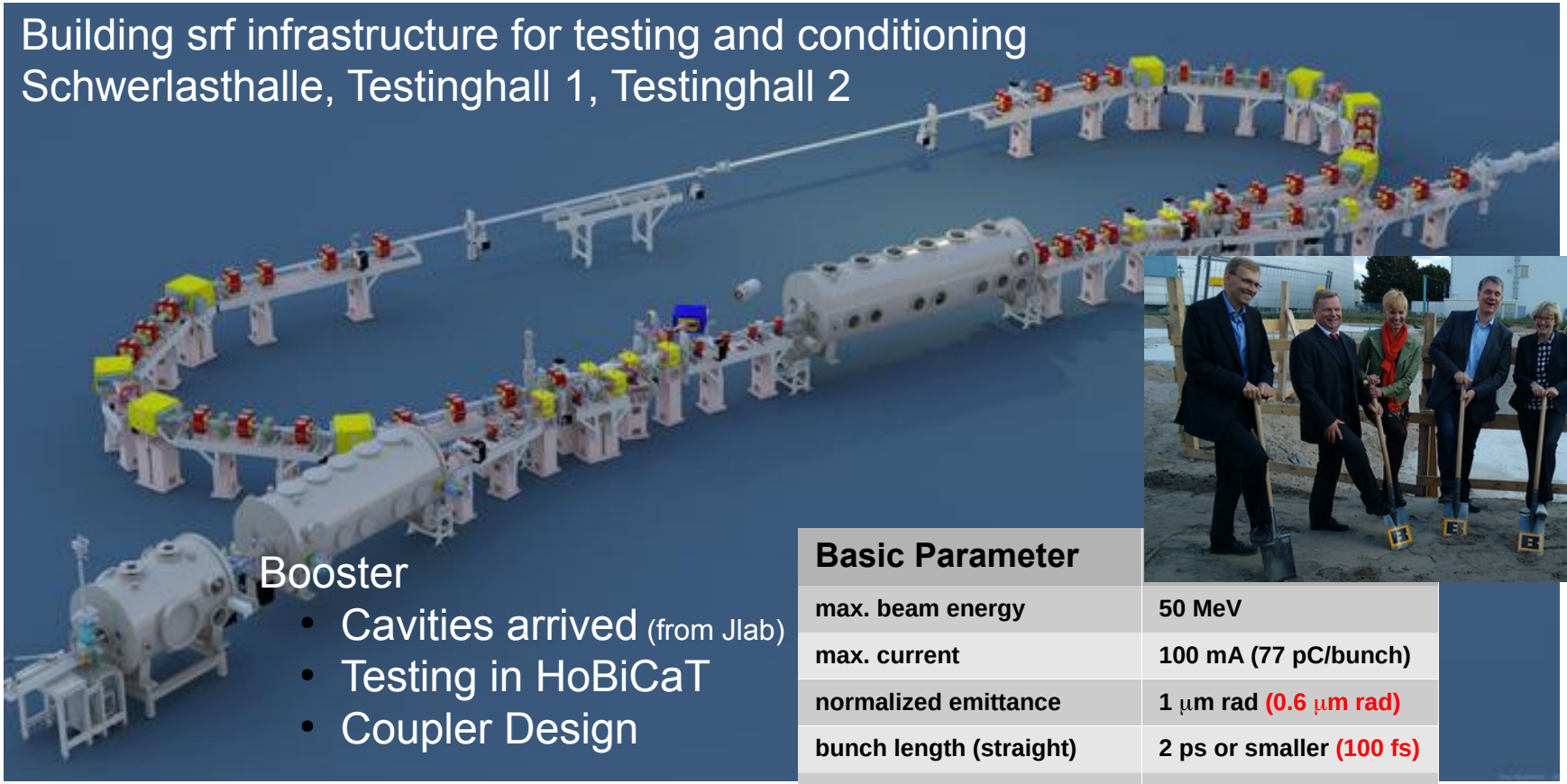
Electron Gun (Prototype BPro)
- Cryomodule ready
- Cavity ready
- Cold String

Banana ordered
- Source, Dump
- Straight, no Linac

LINACModule
- Finalizing Design
- out coupling HOMs
- Kryo-design

Building srf infrastructure for testing and conditioning
Schwerlasthalle, Testinghall 1, Testinghall 2



Booster
- Cavities arrived (from Jlab)
- Testing in HoBiCaT
- Coupler Design

Basic Parameter	
max. beam energy	50 MeV
max. current	100 mA (77 pC/bunch)
normalized emittance	1 μm rad (0.6 μm rad)
bunch length (straight)	2 ps or smaller (100 fs)
rep. rate	1.3 GHz
losses	< 10-5

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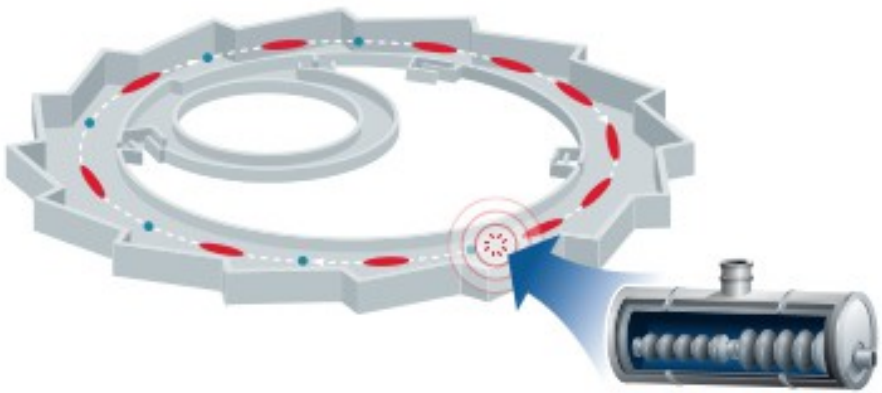
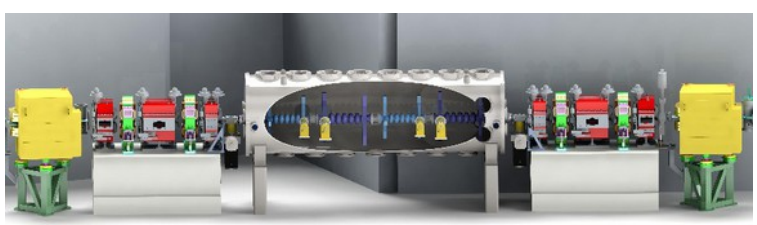
BESSY VSR objectives

- Add short pulse operation at all beamlines in parallel
- Conserving photon brilliance (emittance) for all users

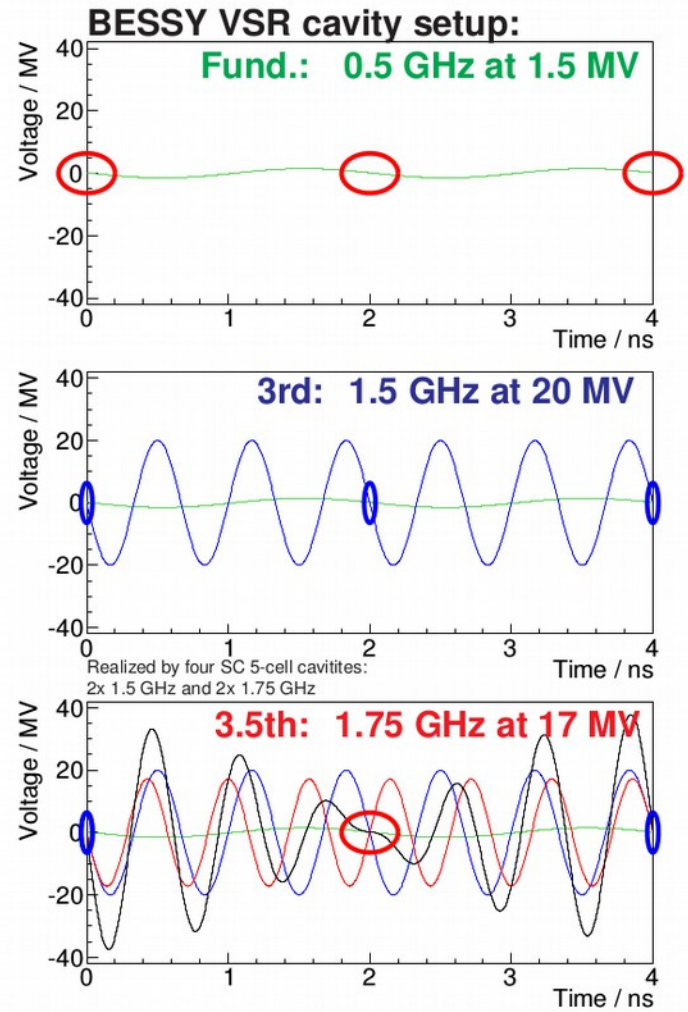
→ **V**ariable pulse length **S**torage **R**ing



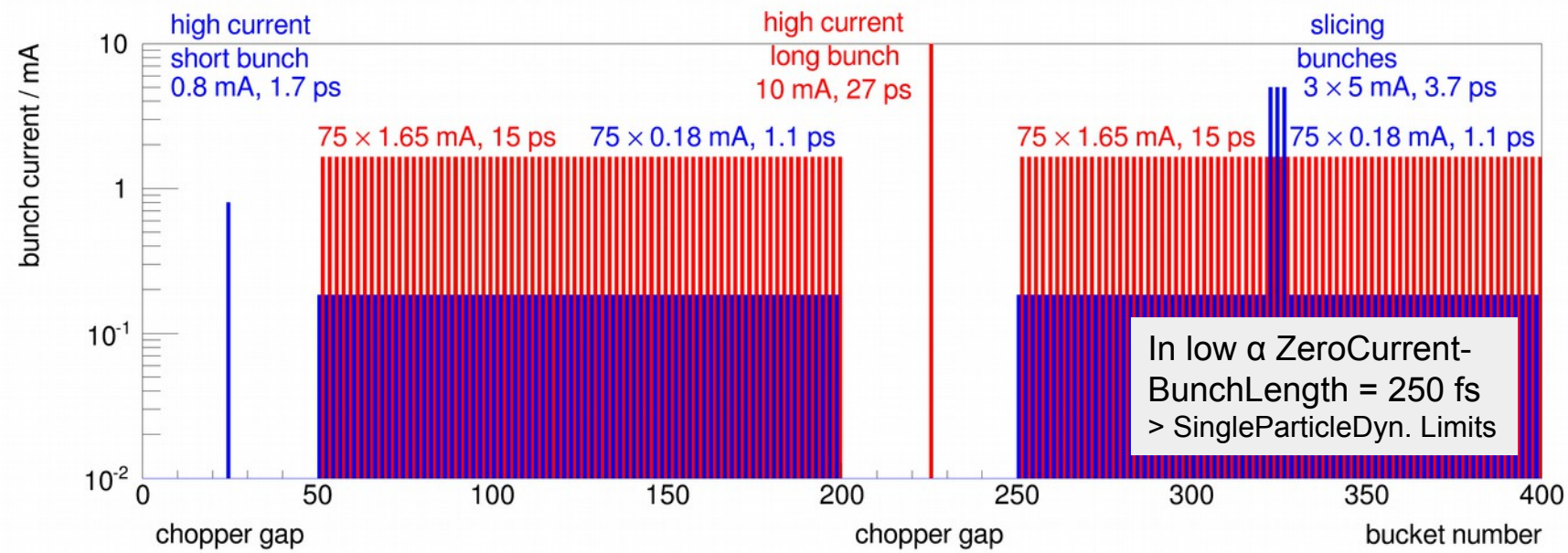


Short and Long Pulses

Shaping the longitudinal focusing U' and phase space by introducing voltage beating:



4.) BESSY VSR upgrade for BESSY II



2011 First idea G. Wüstefeld et al.
2013 VSR Science Workshop, strong support of community
2014 Positive POF III evaluation
03/2015 TDS finished and reviewed
04/2015 Positive BESSY II MAC
06/2015 Application to Helmholtz
2016 Decision about founding
2018 First money (if successful)

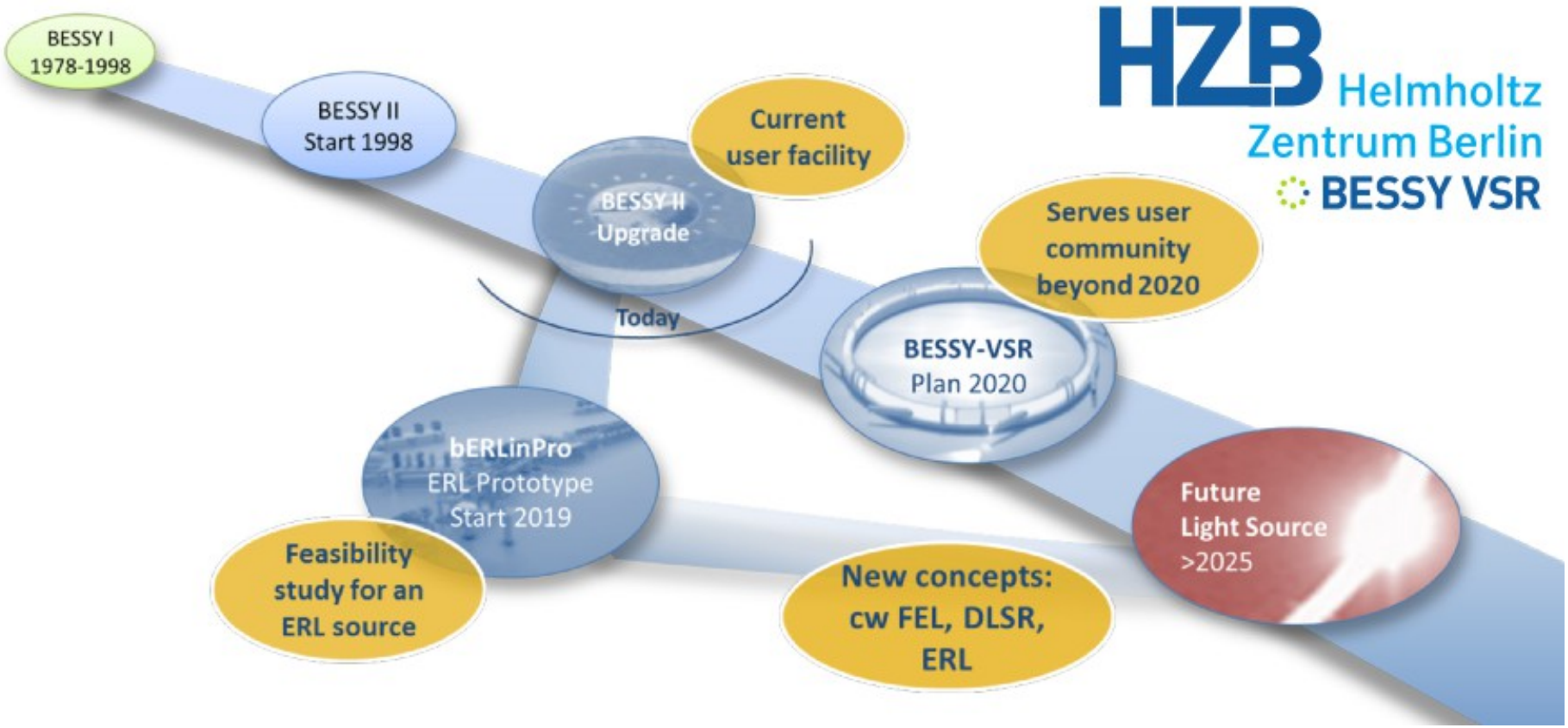
doi:10.5442/R0001

Start prep. phase in advance (now)

2015 Experiments (MC time), i.e. IB
Now 2 ARD Projects in total 3M€
- SRF: 1.5GHz cavities qualification
- Diag.: B2B QPD, Orbit, BeamProbe

2018+ Preparatory phase (7w dt)
2020+ Full VSR installation (22w dt)

Thank you for your attention



Title