



# **BESSY II STATUS REPORT**

Markus Ries et al.

operation statistics

major failure events

... it is going to be a rough ride...

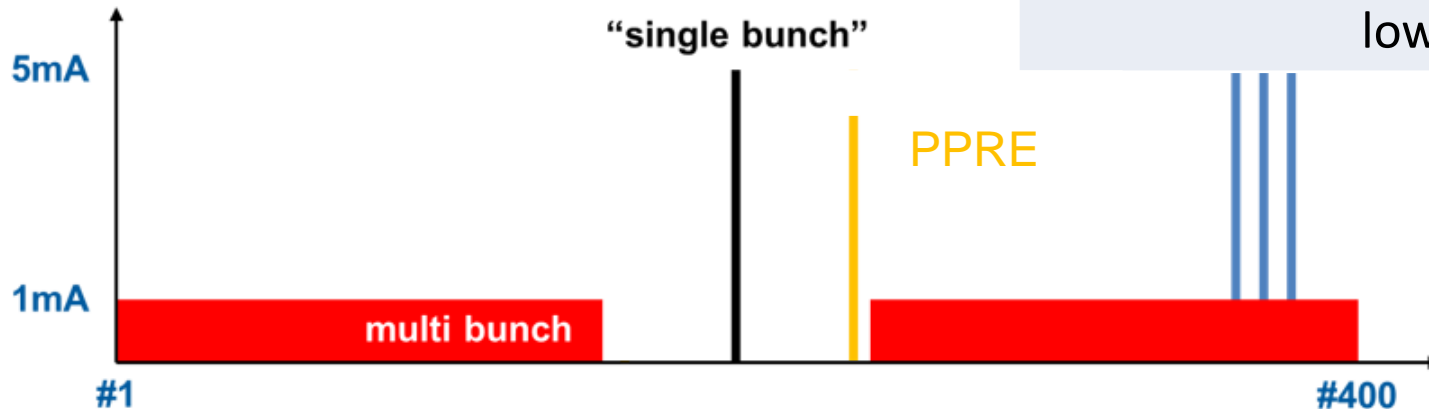
machine studies

**BESSY VSR**



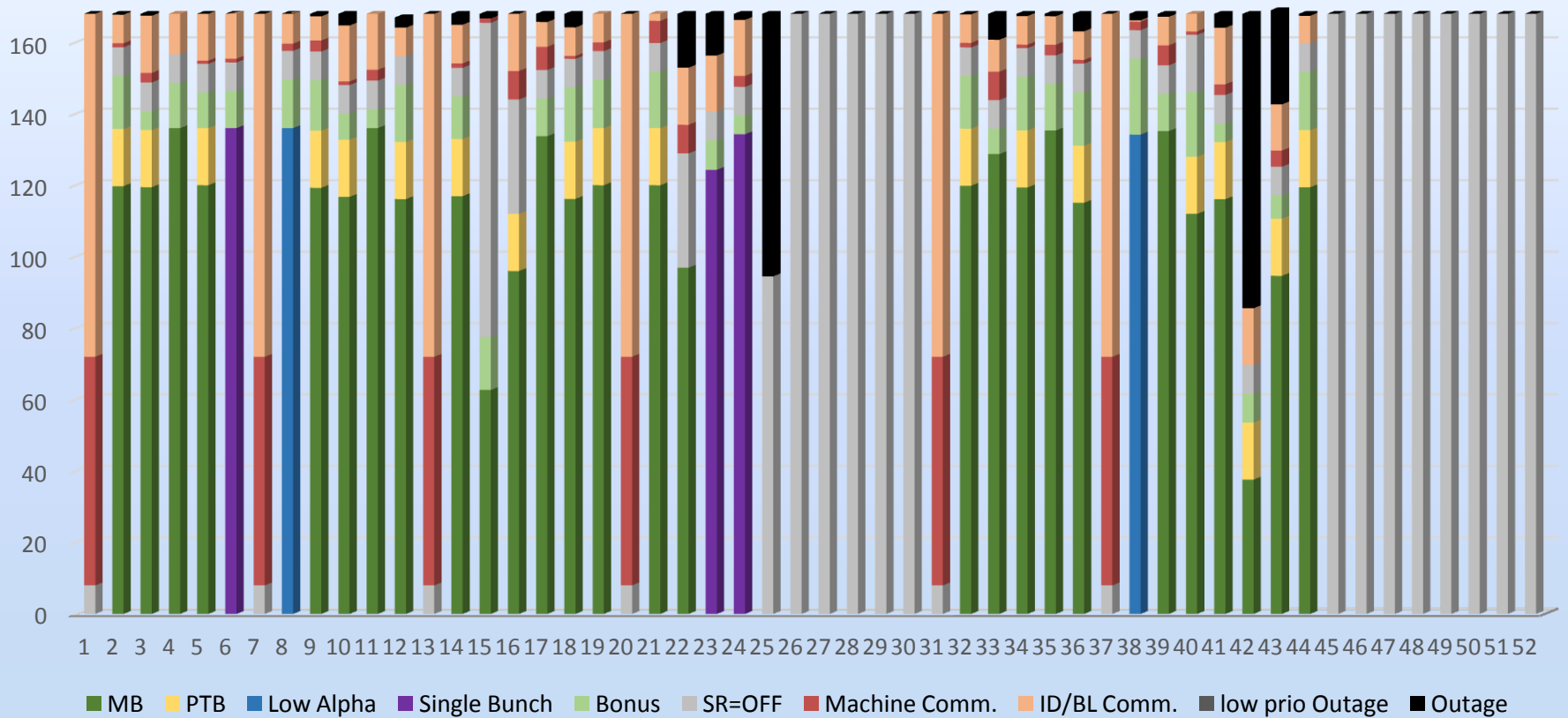
parameters	
Energy	1.7 GeV
Circumference	240 m
Horizontal emittance	5 nm rad
Beam current	300 mA
RF frequency	500 MHz
max. RF voltage	2 MV
Bunch length	15 ps
low- $\alpha$	2 ps
Mom. Comp. factor	$7.5 \times 10^{-4}$
low- $\alpha$	$3.5 \times 10^{-5}$

- in user operation since 1998
- diverse user community
- offering short pulses



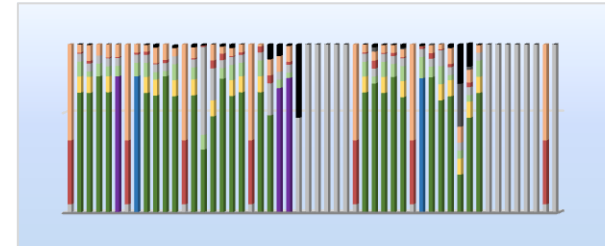
# OPERATION STATISTICS

BESSY-II Beamtime 2017



• **4+ year overview**

- 2013: shutdown extension, poor vacuum
- 2014: 3 major incidents
- 2015: 2 long shutdowns, reduced beam current
- 2016: no major incidents, EMIL optics, reduced beam current
- 2017: Cavity Vacuum and Linac-Gun problems



Year	Scheduled	Downtime	# Outages	Availability	MTBF	MTTR
2013	4505 h	159.3 h	105	96.5%	42.9 h	1.52 h
2014	5408 h	384.4 h	136	92.9%	39.8 h	2.83 h
2015	3896 h	92.5 h	90	97.6%	43.3 h	1.03 h
2016	4855 h	62.9 h	69	98.7%	70.4 h	0.91 h
2017	4299 h	249.5 h	62	94.2%	69.3 h	4.02 h

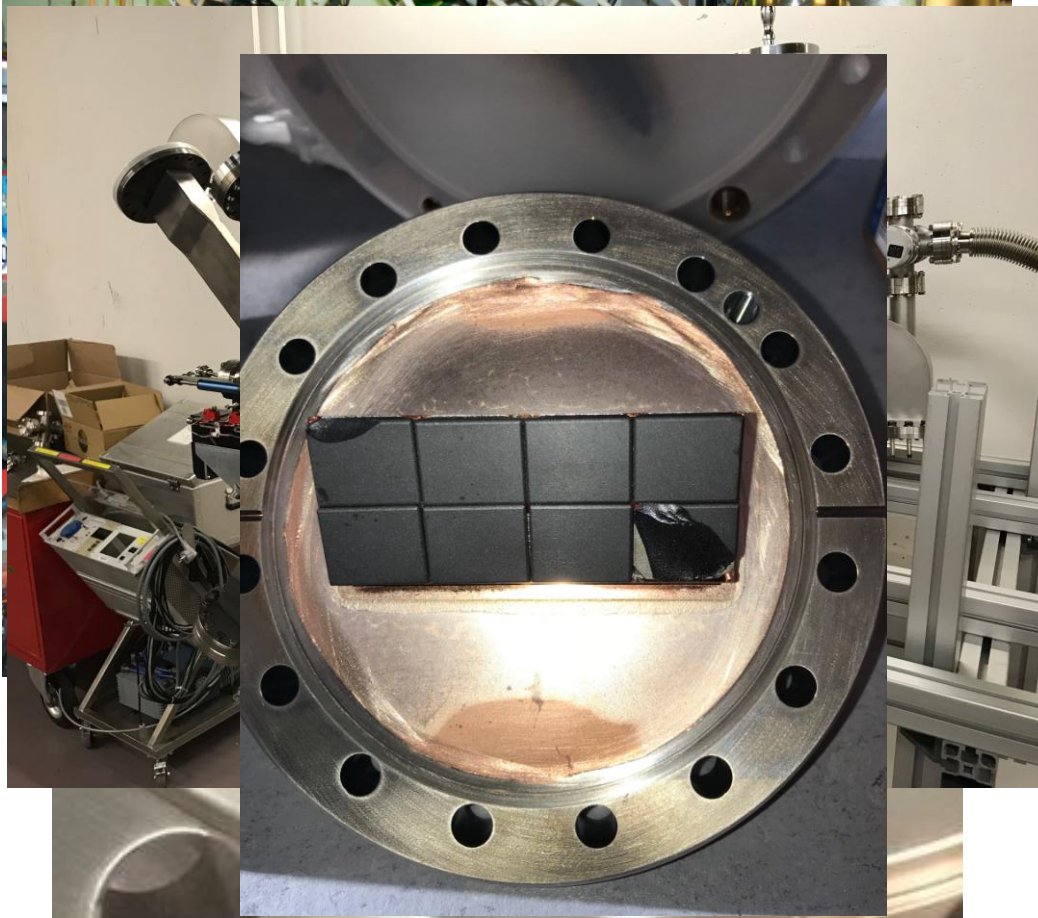
**total user time 2017 = 4049 h + 356 h (bonus time) = 4405h**

- 2017: new events due to applied metrics
    - “no beam”:  $I < 66\%$  of  $I_{nom}$  **was already** an outage in the past
    - “low beam”:  $66\%$  of  $I_{nom} < I < 90\%$  of  $I_{nom}$  **also was** an outage (but never happened!) **but in 2017 “low beam” accounts for 10 outages and 53.5 h of outage time!**
- Metrics described in “Common operation metrics for storage ring light sources”,  
 A. Lüdeke (PSI) et al., Phys. Rev. Accel. Beams 19, 082802

# CHALLENGES OF THE PAST YEAR...

... AND THE FUTURE...

## LANDAU CAVITY – VACUUM LEAK



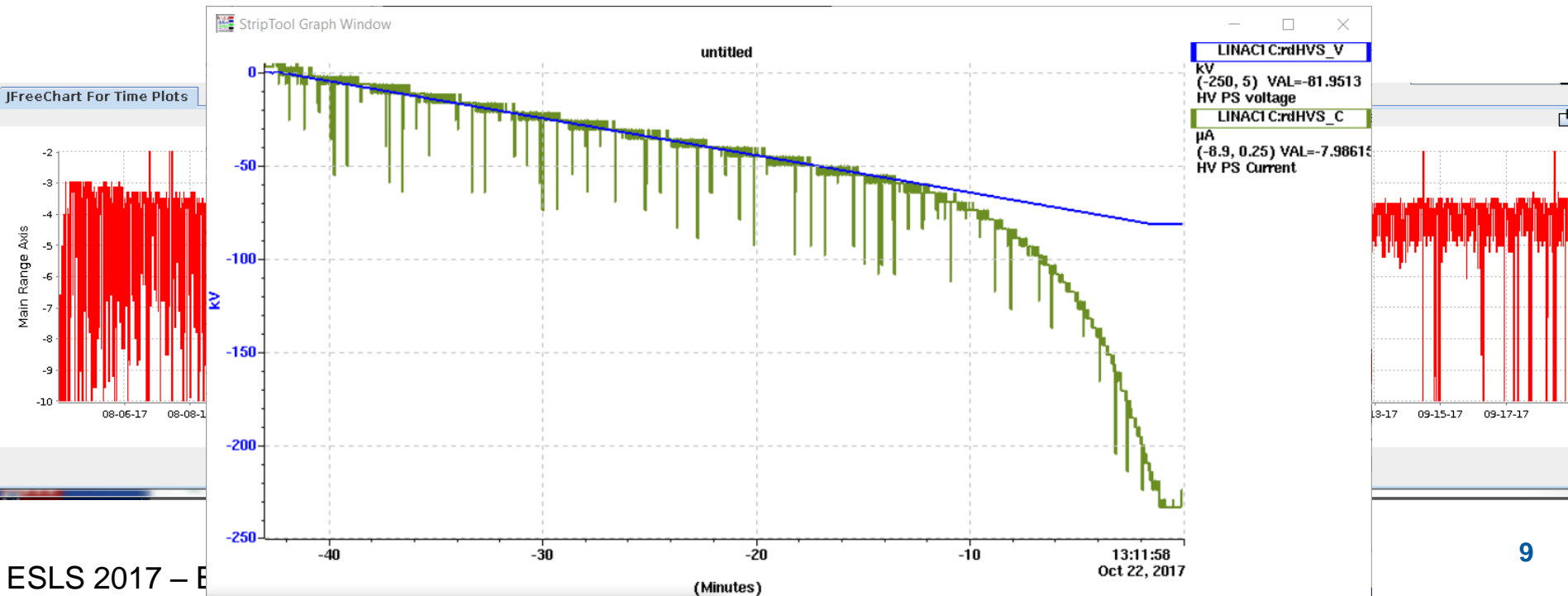
- event in 2016 leading to removal of Landaus due to increased radiation levels in user area
- HOM load ferrites broken but presumably not the source
- Vacuum leak found in Landau cavity 2 → repair not possible
- spare Landau cavity refurbished
- „knee“-design for HOM loads
- HOM load test option
- new HOM loads  
→ some didn't pass FAT, some broke → installation mid 2018
- Vacuum lifetime increased  
14 h → 20 h



## LINAC GUN – HIGH VOLTAGE TROUBLES

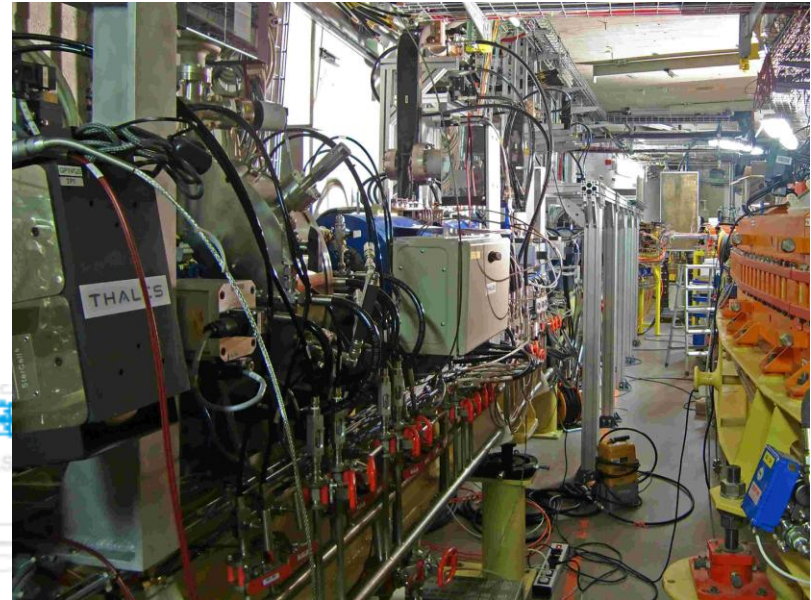
- reoccurring failure scenario since 2014
- leak current of static GUN HV behaves erratically → power supply breakdown
- so far: reproducibility is bad, phenomenology

Parameter	value
voltage (DC)	90 kV
current limit	25 $\mu$ A



## LINAC GUN – HIGH VOLTAGE TROUBLES

- Environment definitely not optimal for operating a linac  
→ temperature, humidity, radiation, space, availability for commissioning ...

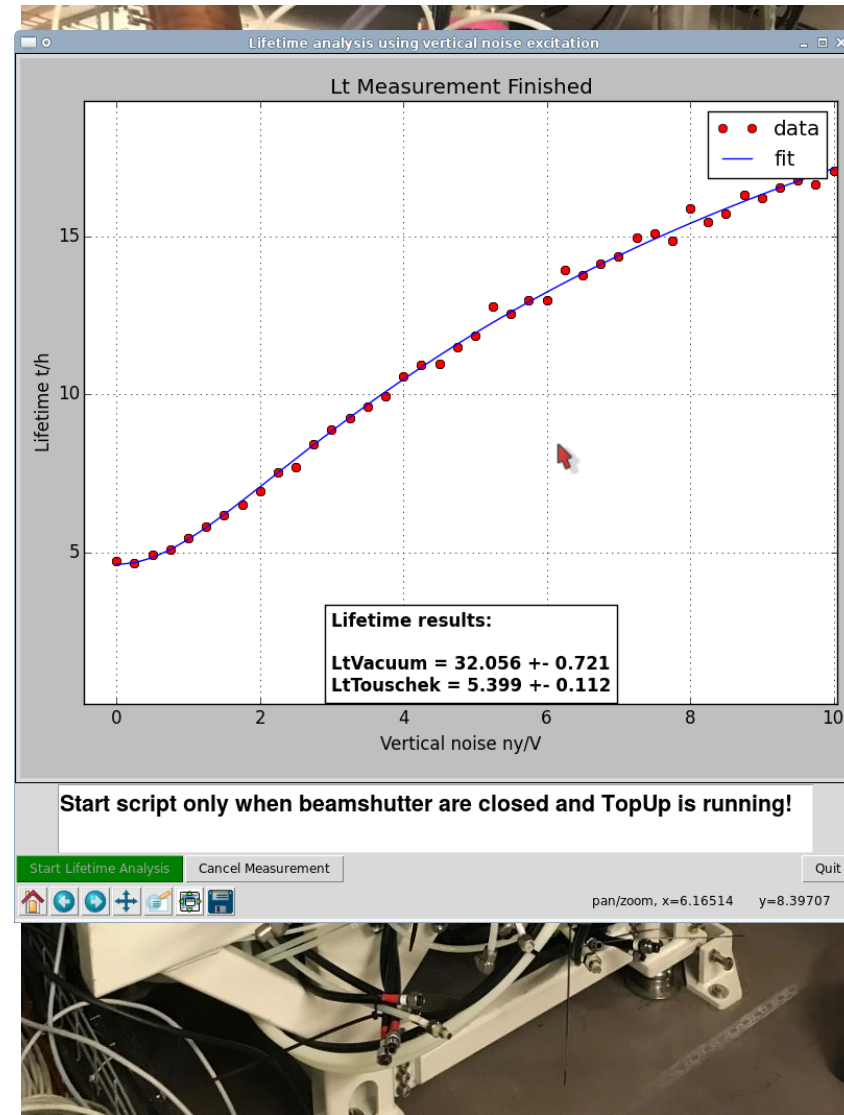


efforts

- test stand
- collaboration
- shielding

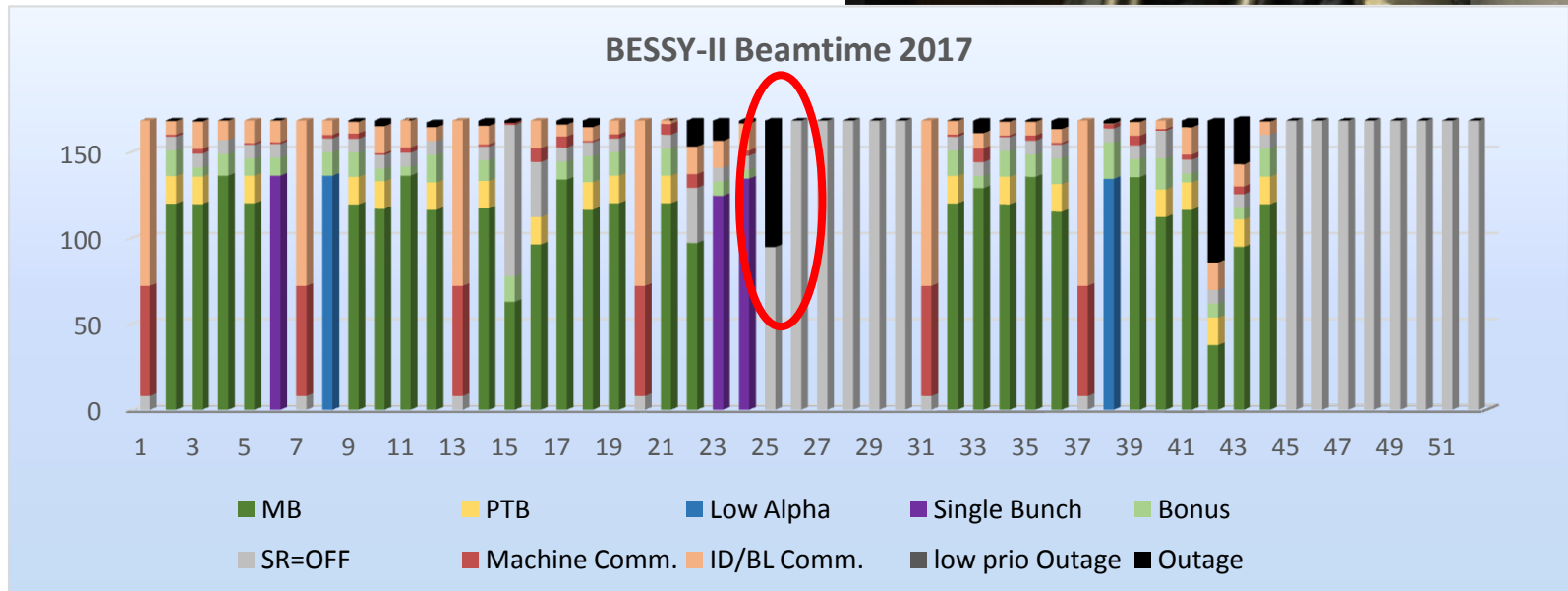
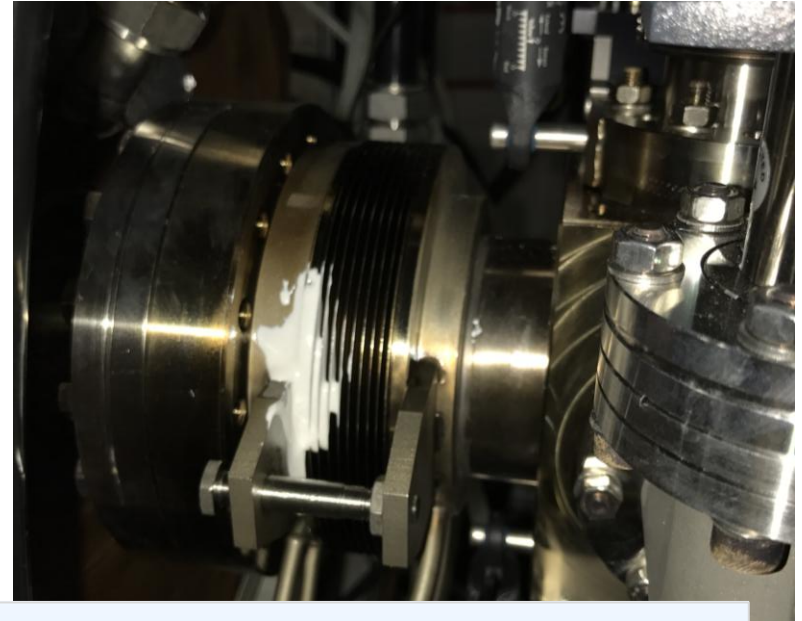
## VACUUM LEAK: RF CAVITIES

- systematic weakness found in the 500 MHz cavities  
→ more details will be reported by Ji Li (see MLS status talk)
- fix applied in a matter of weeks (based on the ALBA design)
- vacuum lifetime dramatically increased  
20 h → 35h
- no side effects observed so far



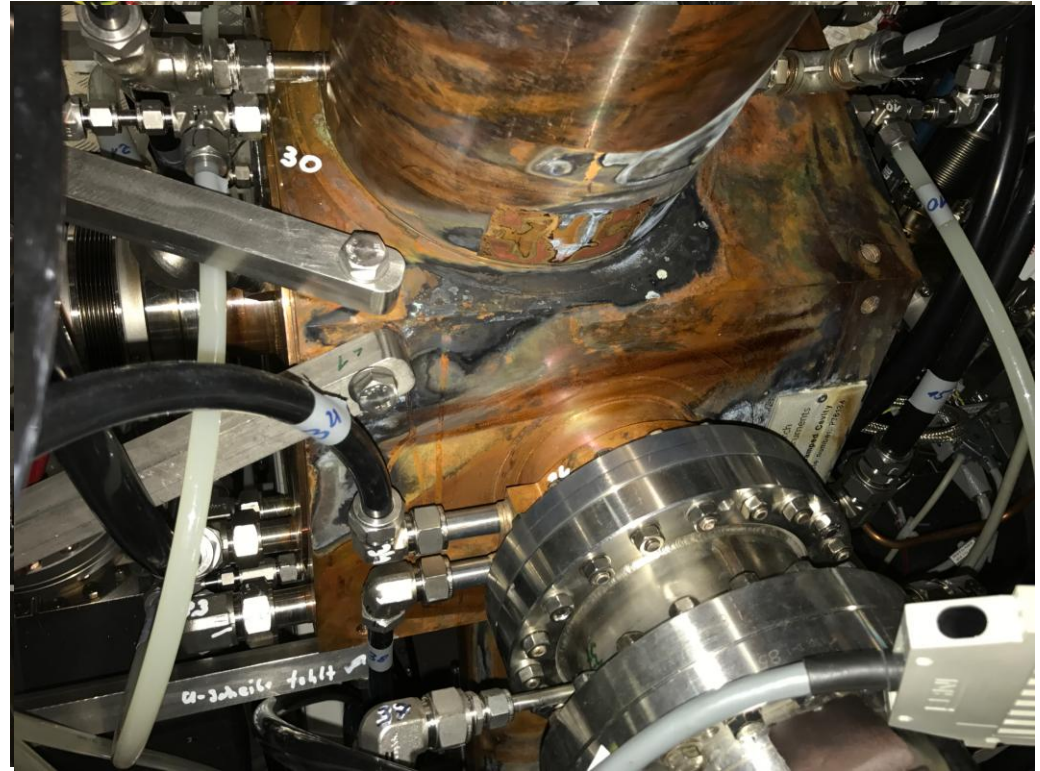
## VACUUM LEAK: BELLOW

- significant pressure increase
- → lifetime drops
- → TopUp conditions violated
- → enforced early shutdown

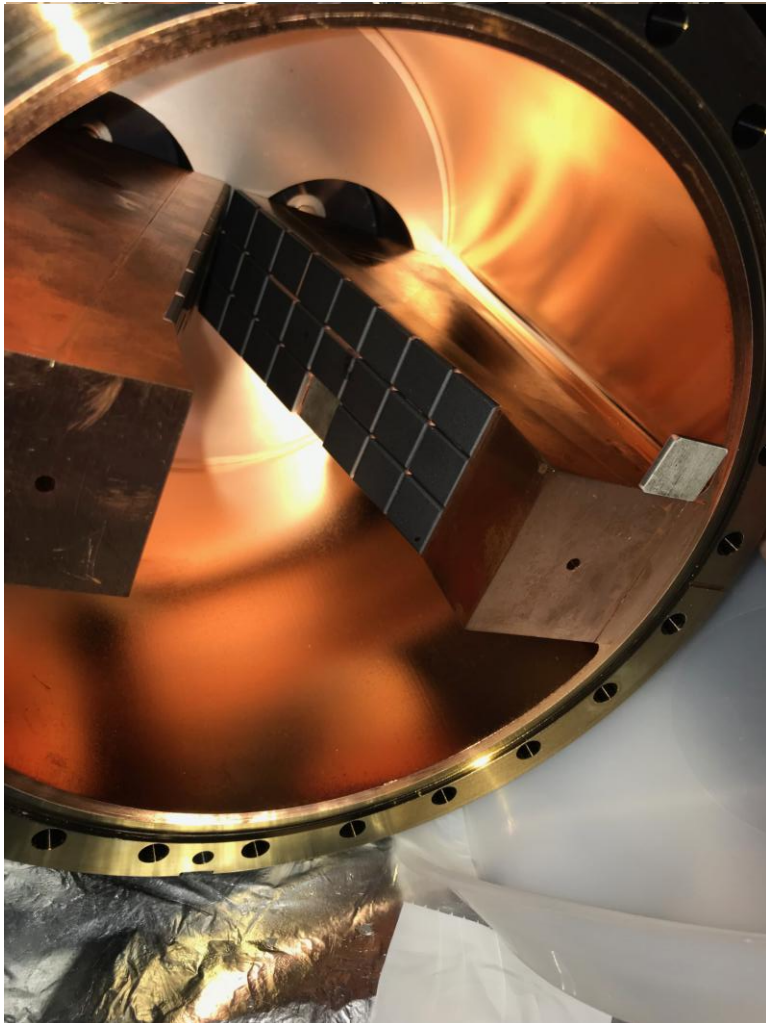


## RF CAVITY UNSTABLE OPERATION

- phase noise & vacuum response observed at RF voltages of > 100 kV
- no significant loss of beamtime
- operational risk increased
- presumably heating malfunction
- presently being replaced



## RF CAVITY – HOM ABSORBER



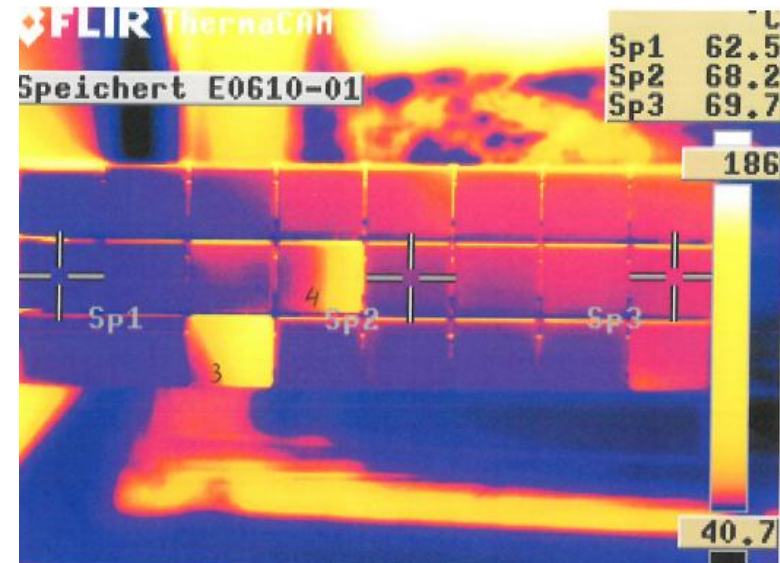
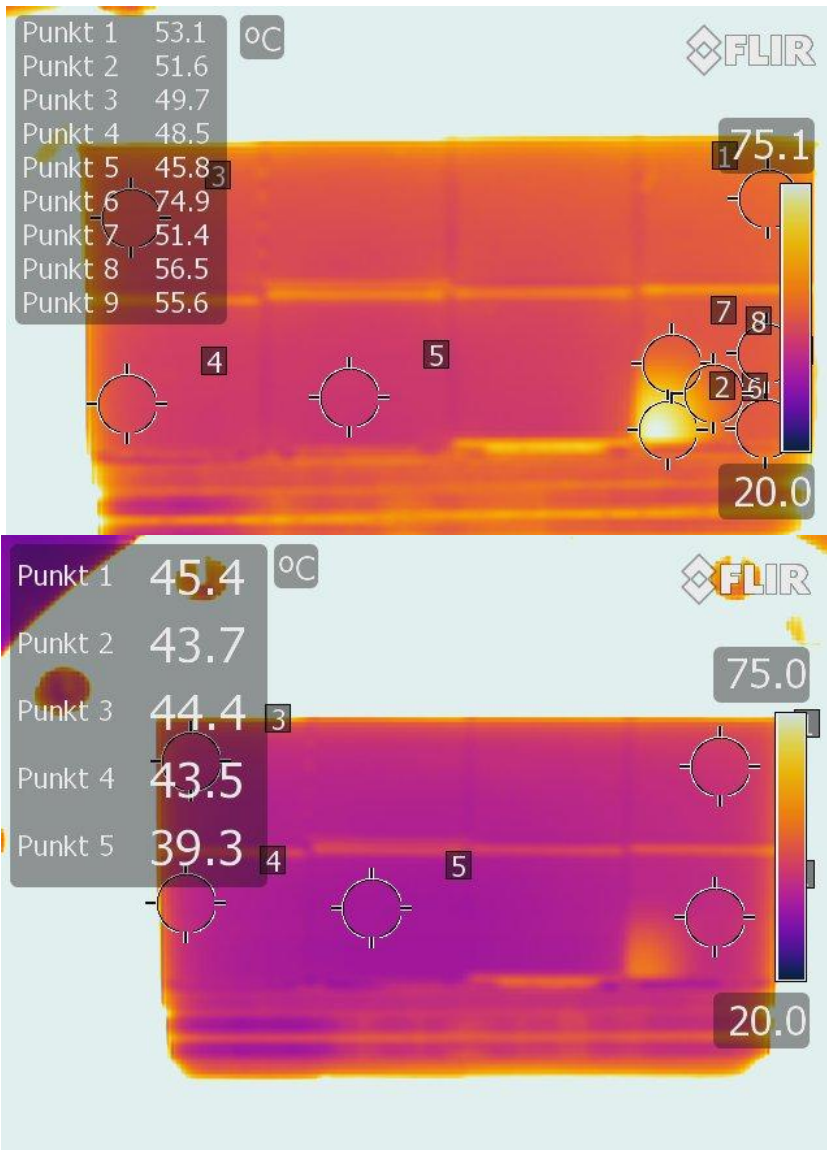
### HOM absorbers (soft)soldering issues

- loose ferrite plates
- full batch affected → 12 absorbers
- re-assessing our FAT
- enough spares to fix this shutdown

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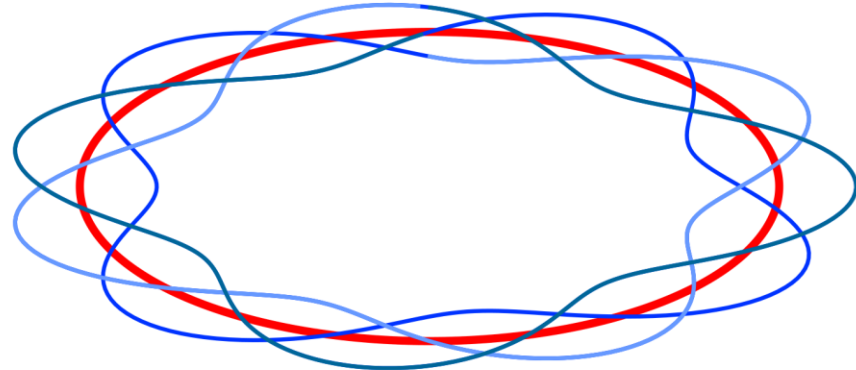
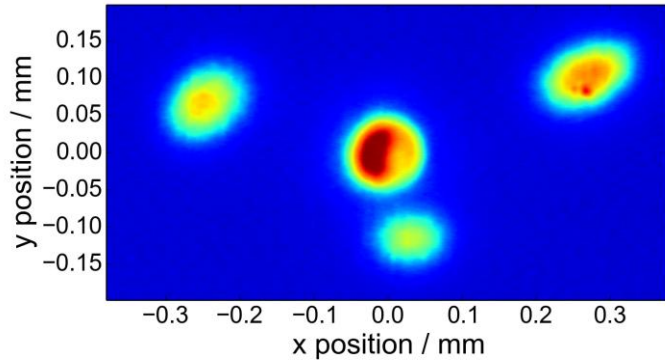
- loose ferrite plates
- full batch affected → 12 absorbers
- re-assessing our FAT
- enough spares to fix this shutdown
- new spares will be ordered
- systematics are being investigated





## **MACHINE STUDIES**

# TRIB STUDIES



	Access - no beam	Accelerator Start-up	Few Bunch Mode user shift	Low-alpha user shift	Multi bunch user shift	IC																					
Beamtime	2017 / 2																										
Month	January																										
Week	1 *		2 *		3																						
operation-mode	MC		MB		MB																						
Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
early shift (7:00-15:00)																											
late shift (15:00-23:00)																											
night shift (23:00-7:00)																											
Beamtime	2017 / 2															2018 / 1											
Month	February																										
Week	5					6 *					7 *						8 *						M				
operation-mode	MB					SB					MC						TO						M				
Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
early shift (7:00-15:00)																											
late shift (15:00-23:00)																											
night shift (23:00-7:00)																											

- scheme first investigated at MLS
- now being implemented at BESSY II
- TopUp conditions reached!!
- user test week scheduled
- BESSY VSR potential to be investigated

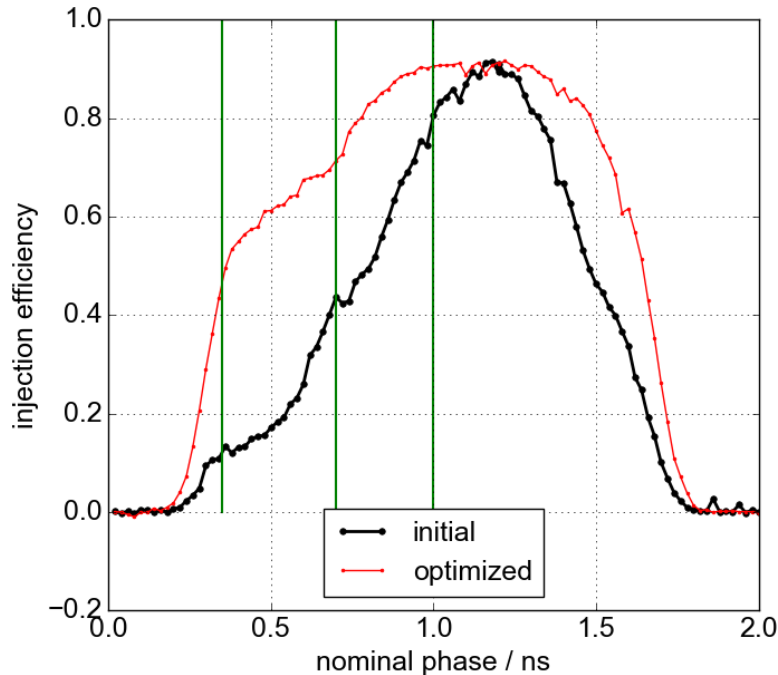
reference: Paul Goslawski, Markus Ries

# IMPROVING MOMENTUM ACCEPTANCE



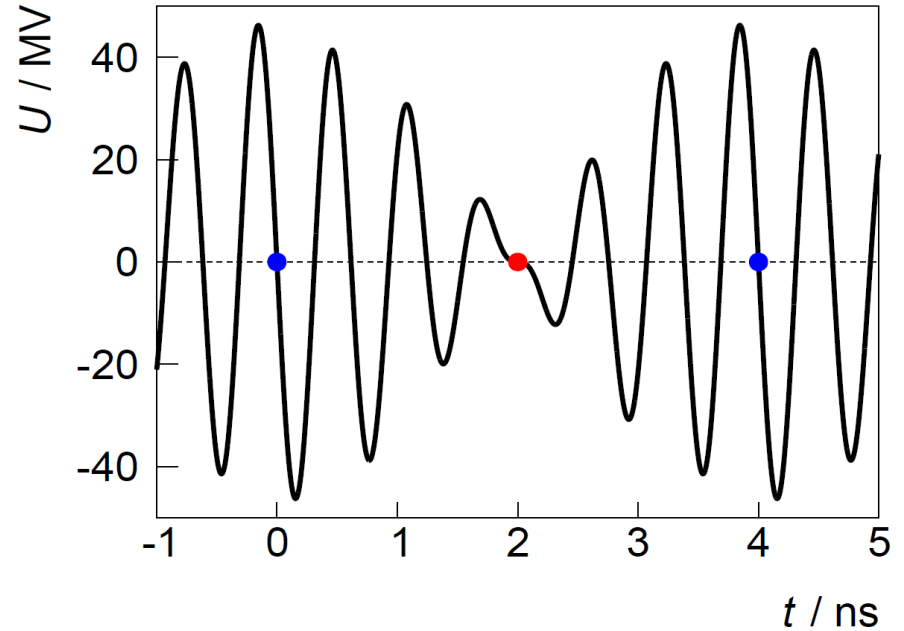
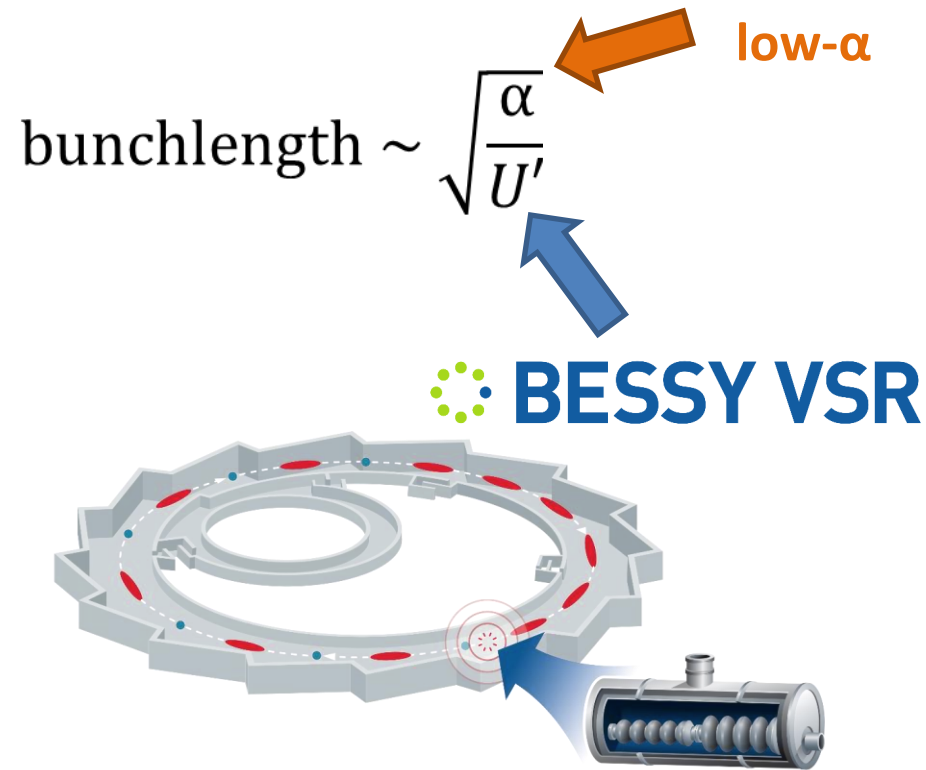
optimizing momentum acceptance

- phase acceptance used as figure of merit while optimizing sextupole magnet strengths
- small gaps for certain IDs have significant impact  
→ include to optimization  
→ no linear superposition
- optimization algorithm:
  - by hand
  - particle swarm
  - try RCDS?
- on energy injection studies
- strong impact → BESSY VSR injection to short bunches



reference: Peter Kuske, Ji Li

## **BESSY II MODIFICATIONS**



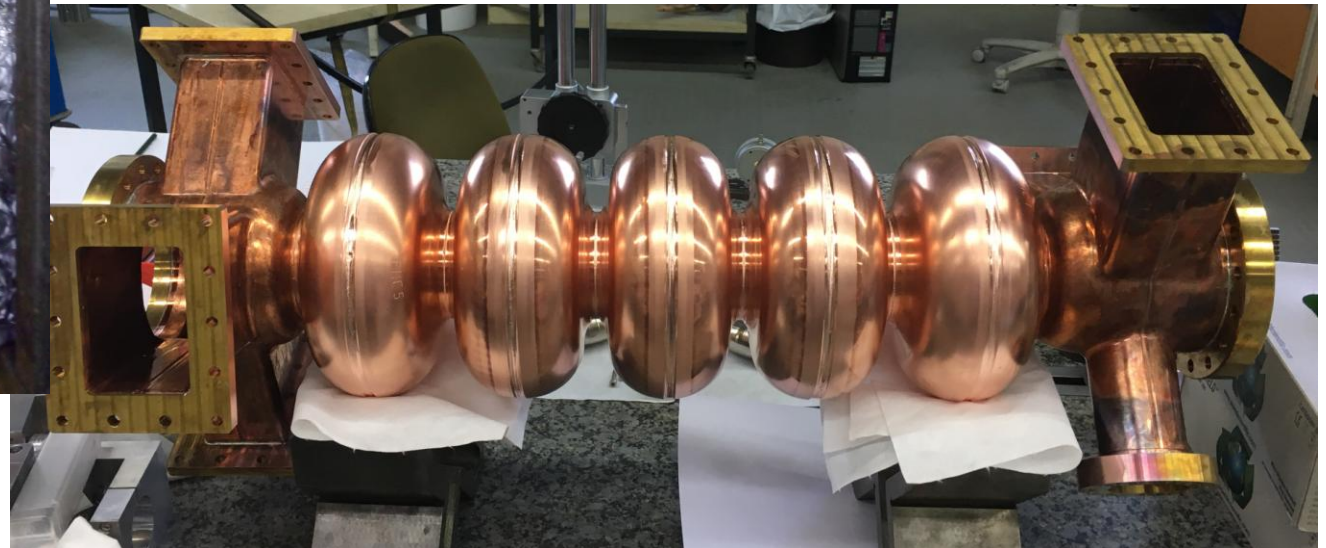
**0.5 GHz NC x 4**

**1.5 GHz SC x 2**

**1.75 GHz SC x 2**



- fully funded project !!
- normal conducting multi-cell cavity on site
- superconducting single-cell cavity on site
- 15 MV / m reached in vertical test stand (single cell)



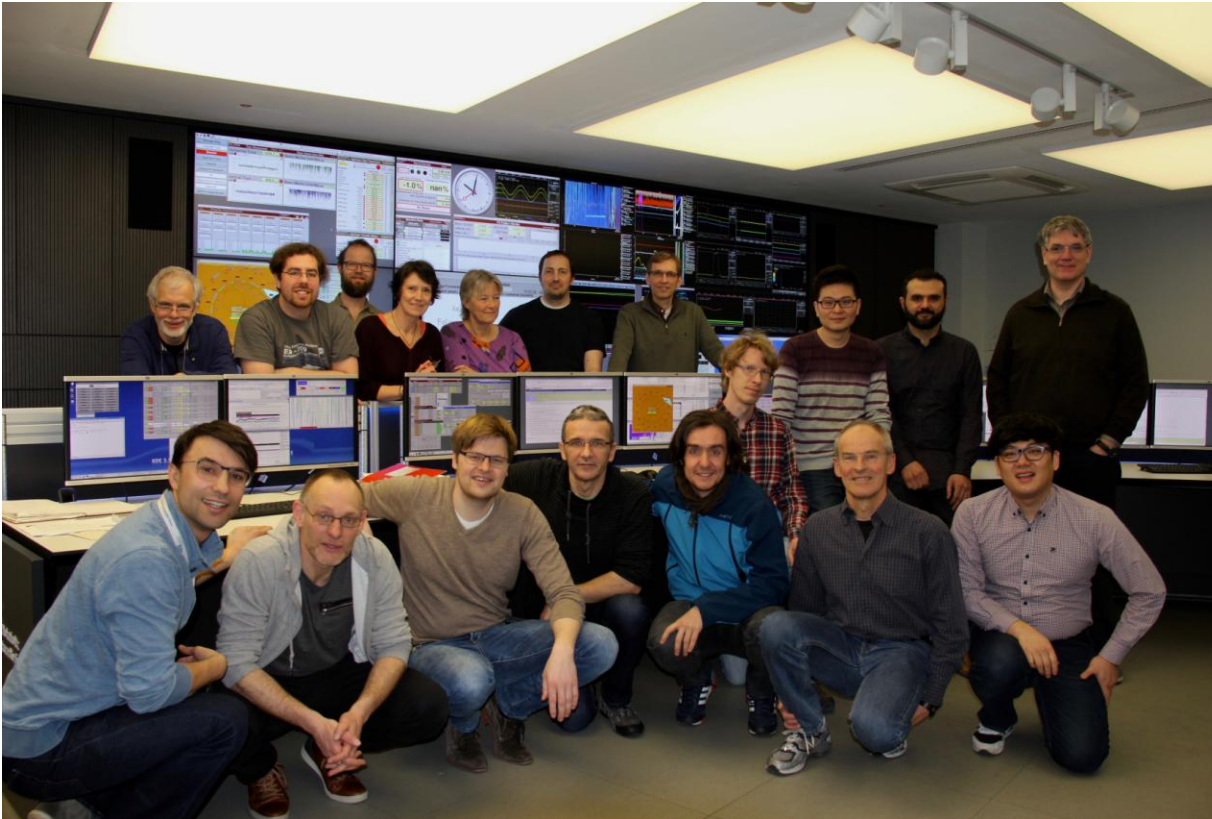
## UPCOMING BESSY II UPGRADES & MODIFICATIONS IN 2018

- reinstall Landau cavities
- optical diagnostics beamline
- wavelength shifter refurbishment
- complete EMIL straight → install CPMU17
- multipole wiggler taken out of the ring
- first test installations for BESSY VSR (synchrotron radiation absorbers)

- standard user operation running smooth in general
- operation statistics in 2017 dominated by rare events with high MTBF and high MTTR
- injector reliability needs to be increased
- HOM load soldering seem to be a cause of trouble
- experience with solid state amplifiers is well so far
- BESSY VSR is fully funded and progressing
  - first module scheduled to enter the ring in 2020
- Ji Li will report on operation of the Metrology Light Source (MLS)



## THANKS TO ALL PEOPLE INVOLVED IN BESSY II OPERATION



... and many more ...

# THANK YOU FOR YOUR ATTENTION

