

**27th European Synchrotron Light Source Workshop**  
November 28th, 2019



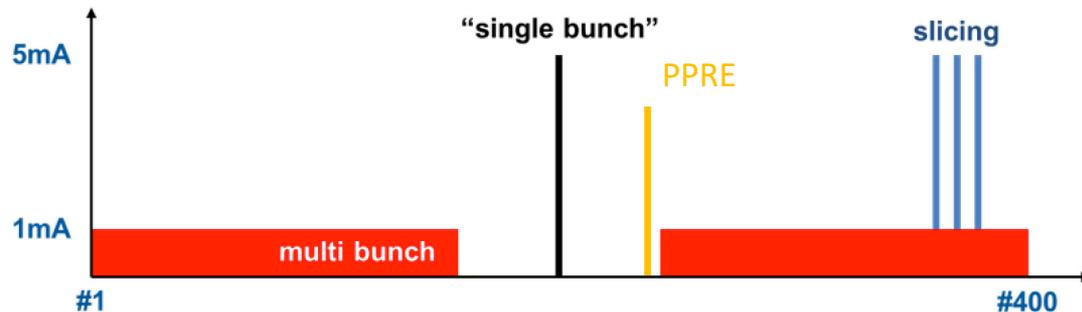
## **BESSY II – status**

Markus Ries on behalf of the machine group



Parameters	
Energy	1.7 GeV
Circumference	240 m
Horizontal emittance	7 nm rad
Beam current	300 mA
RF frequency	500 MHz
max. RF voltage	2 MV
Bunch length (zero current)	10 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 x-ray pulses and timing



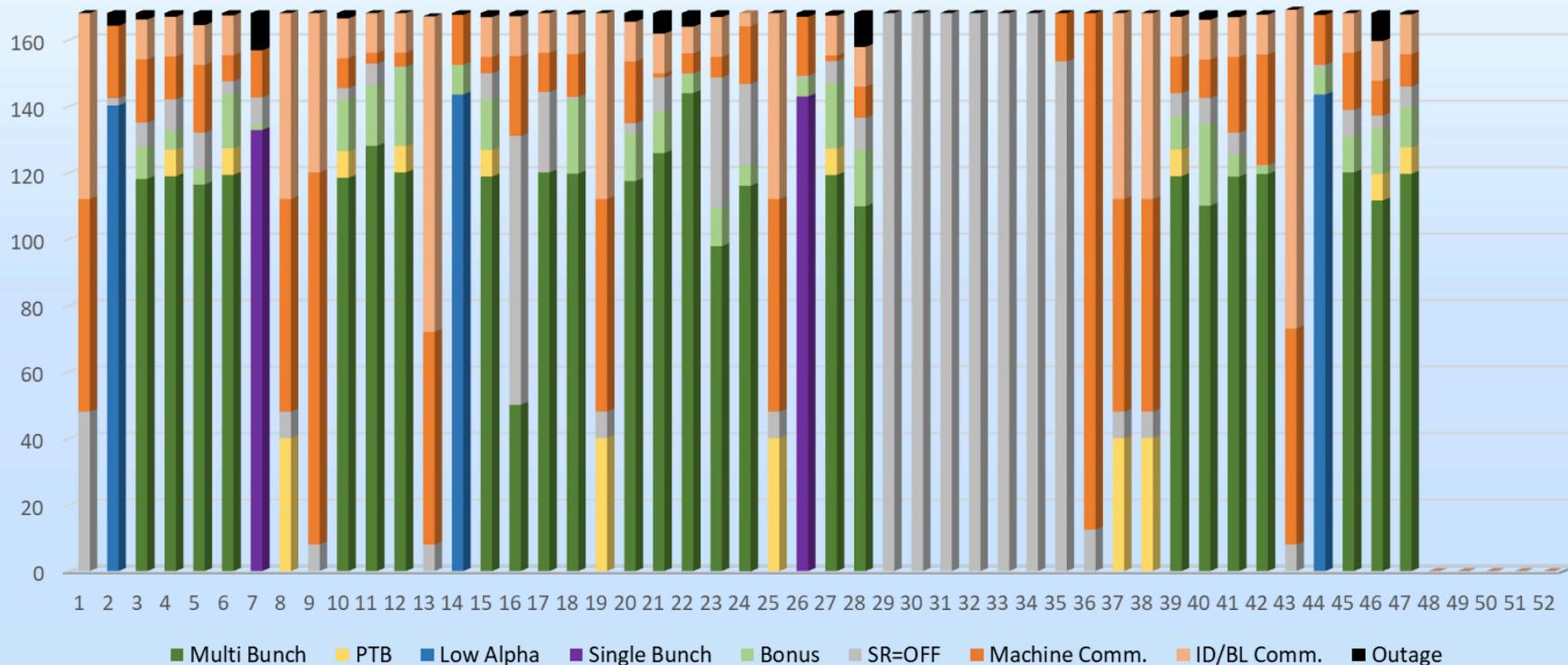
**2019 ...**

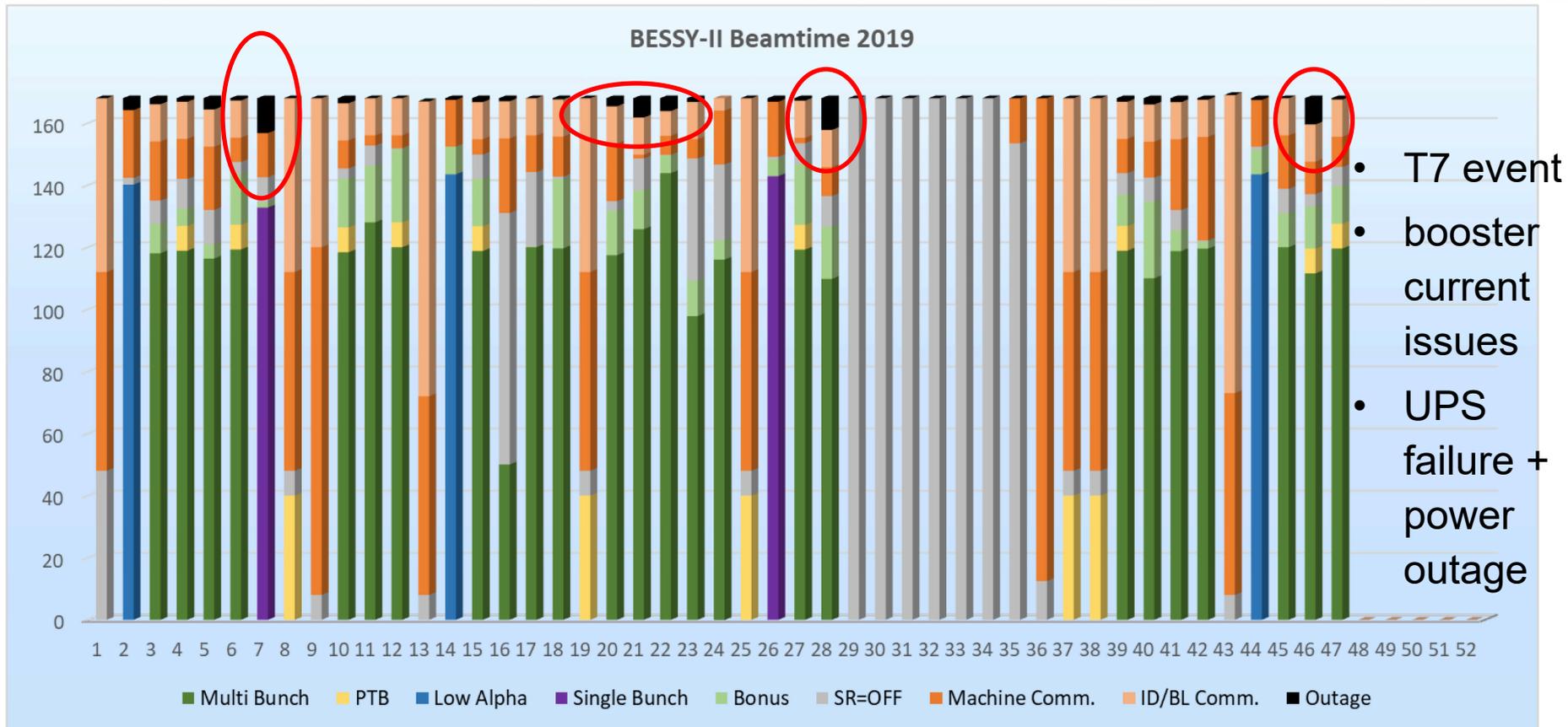
- **OPERATION STATISTICS**
- **MACHINE COMMISSIONING / EVENTS**
- **DEVELOPMENTS**
- **OUTLOOK**

# OPERATION STATISTICS

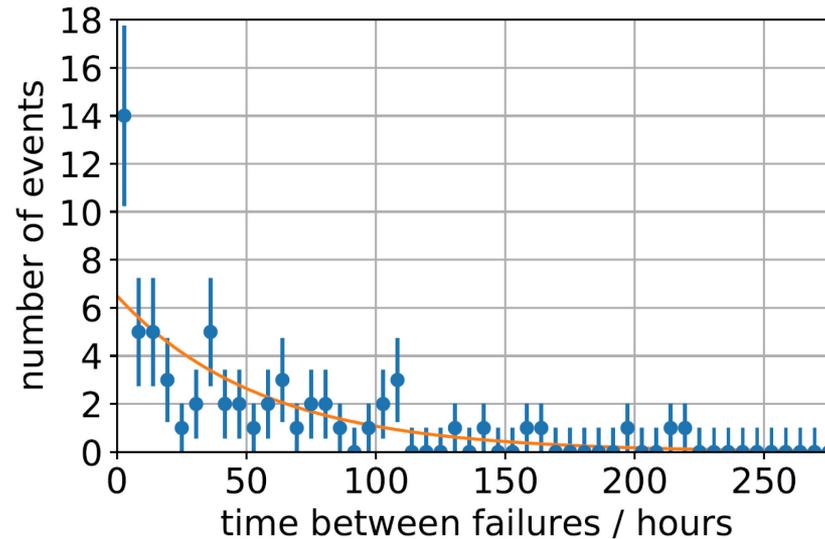
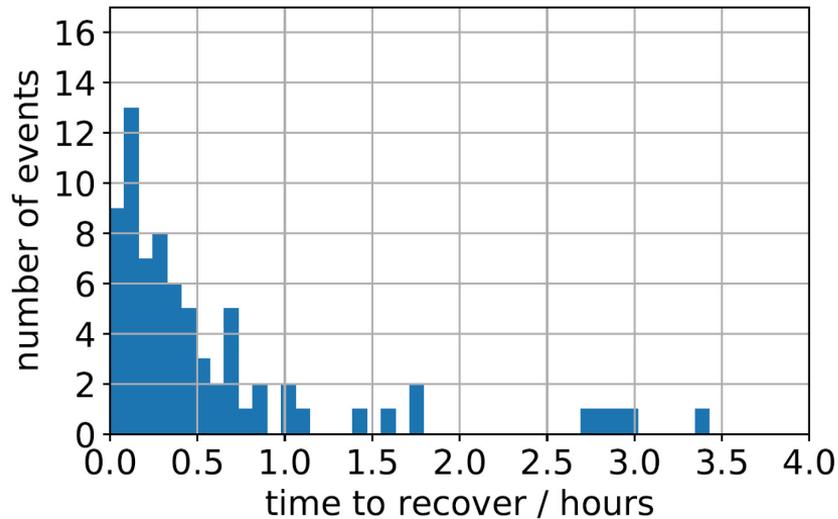


BESSY-II Beamtime 2019

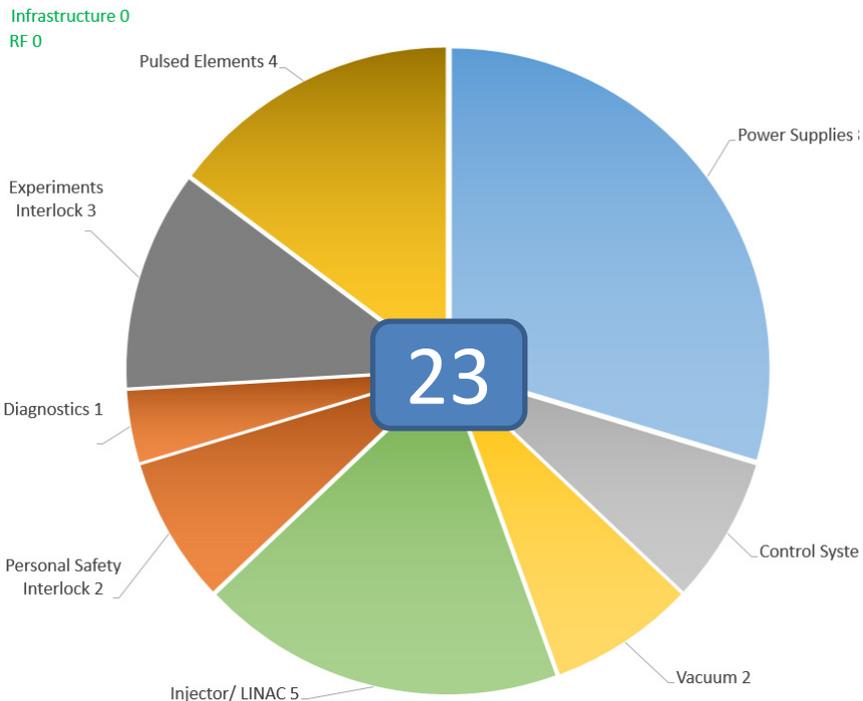




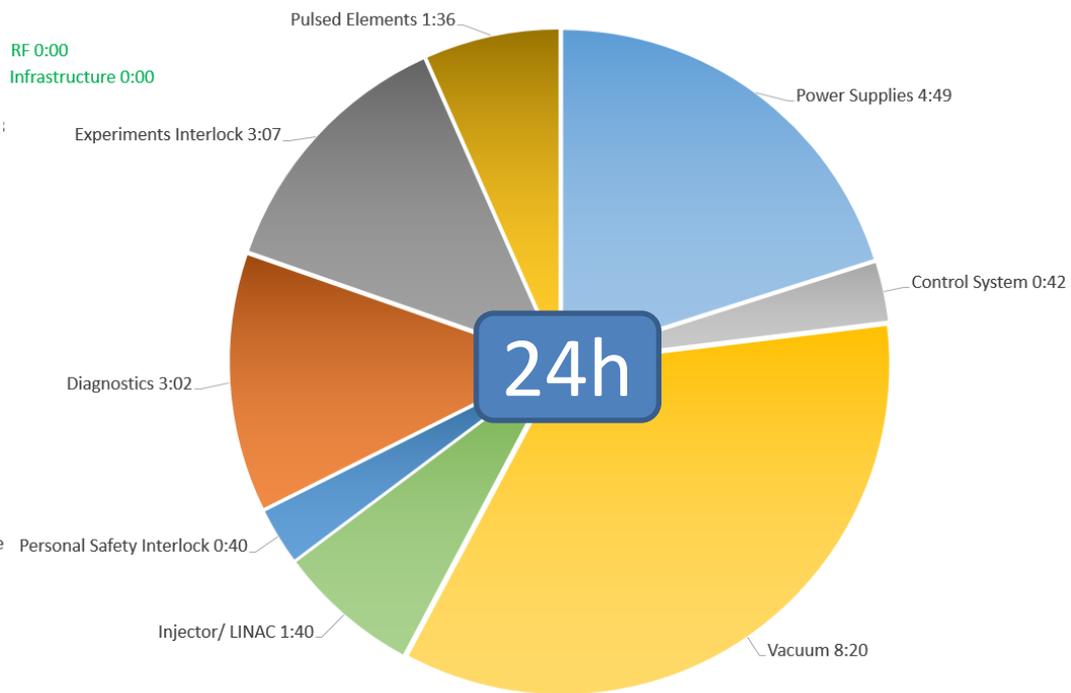
year	scheduled	downtime	bonus	# outages	availability	+bonus	MTBF	MTTR
<b>2018</b>	3578 h	28.3 h	415 h	51	99.2 %	111 %	70.2 h	0.56 h
<b>2019</b> (... cw47)	3938 h	67.7 h	322 h	67	98.3 %	107 %	58.8 h	1.0 h



## by occurrence



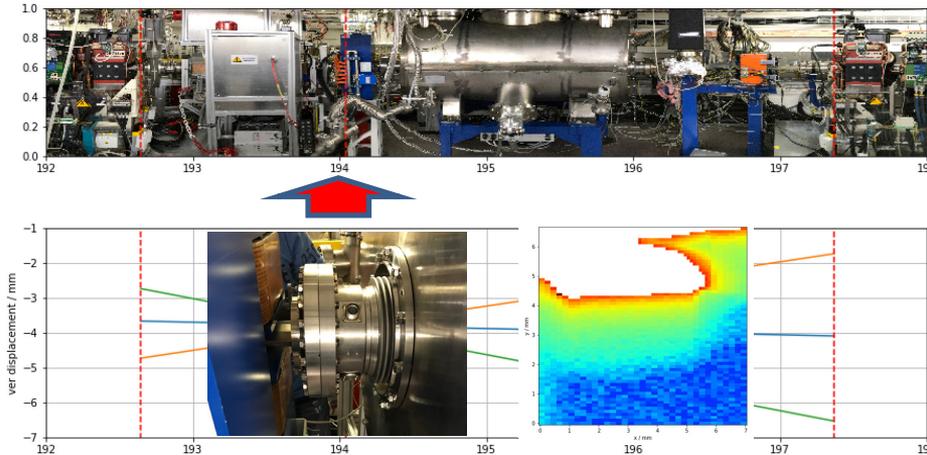
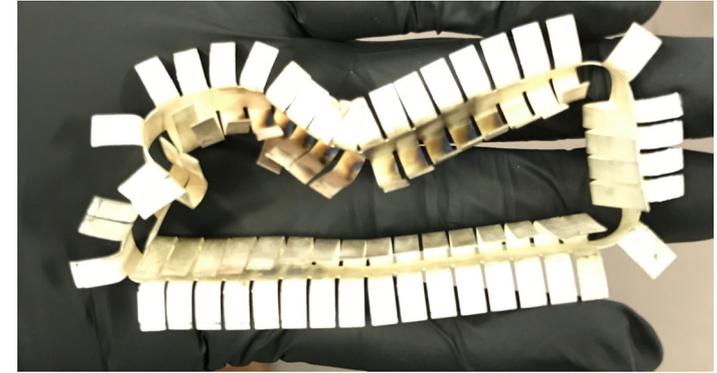
## by duration



transition: beam loss & components → outage & root cause

# MACHINE COMMISSIONING / EVENTS

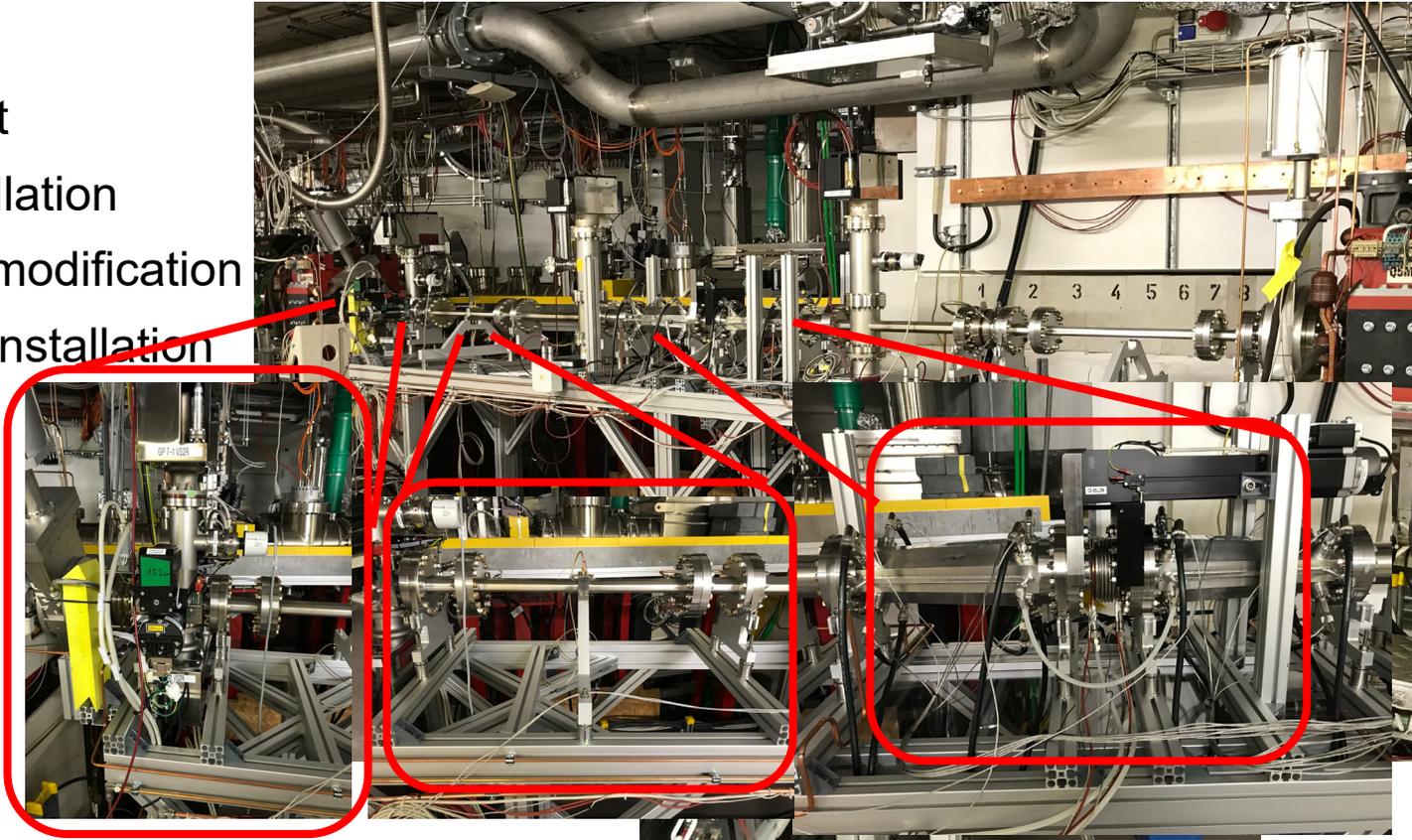
- critical event during user operation, triggered by WLS refurbishment
- Short-term recover of user operation (SB week)
- beam-based localisation  $\pm 0.2$  m
- breaking storage ring vacuum, improvising intermediate modifications



- preliminary risk mitigation strategy operation at 250 mA until shutdown
- **turnaround time 36 h**
- BAM WLS not affected
- solution implementated summer shutown → 300 mA operation recovered

## storage ring

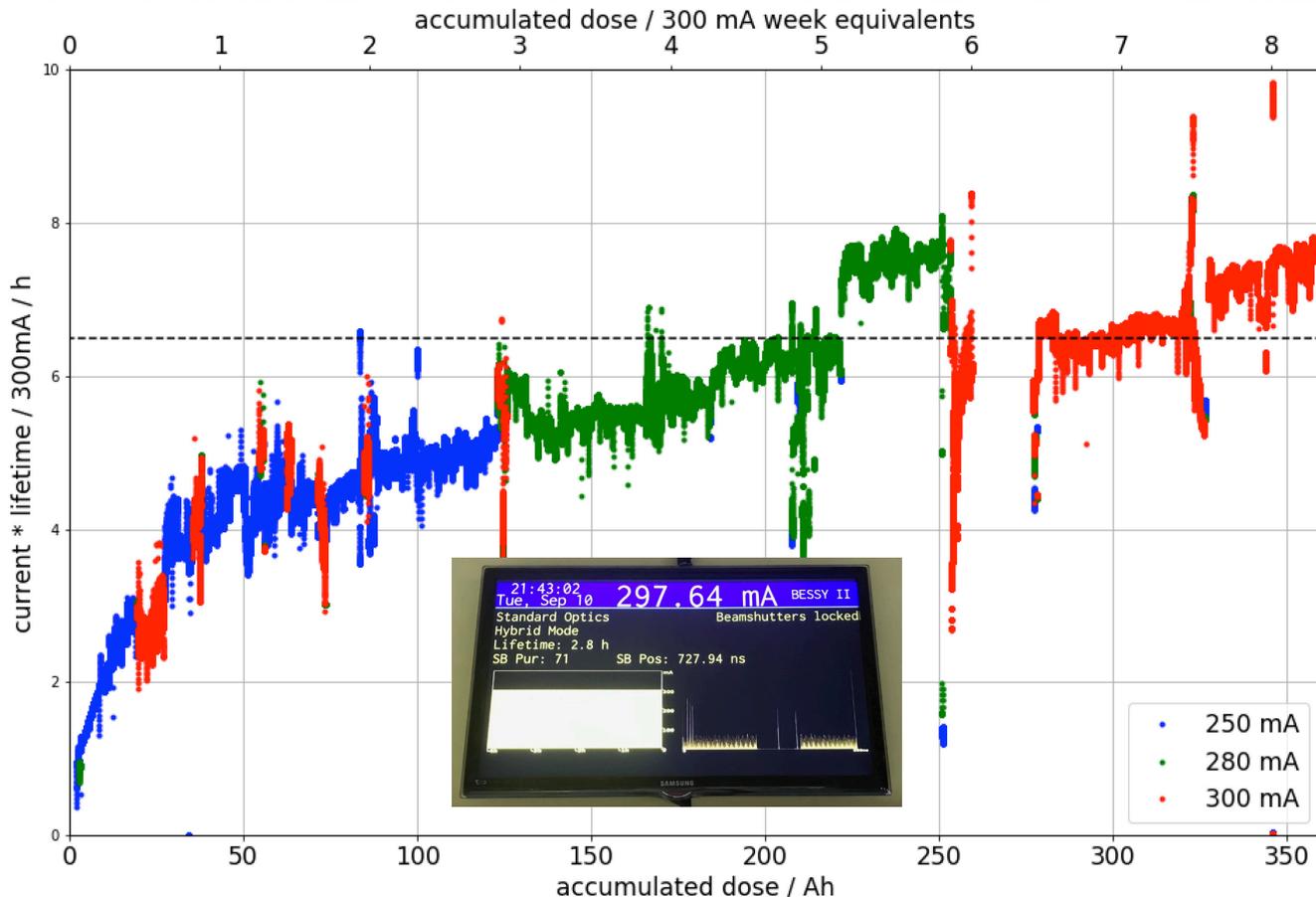
- U17 refurbishment
- BAM WLS reinstallation
- PSF WLS bellow modification
- VSR test straight installation
  - particle counter
  - new BPM
  - Shielded bellow



## injector

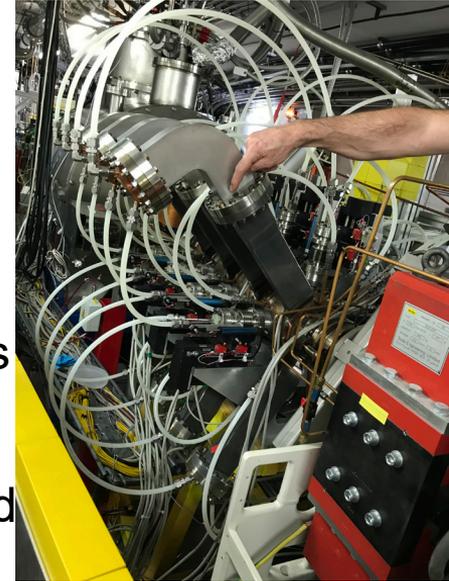
- Microtron removal
- PETRA cavities in synchrotron bunker
- Spare extraction septum in synchrotron bunker
- (re-)moved diagnostics & steerers to make room for cavity installation
- longitudinal kicker cavity installed
- bunch by bunch feedback units



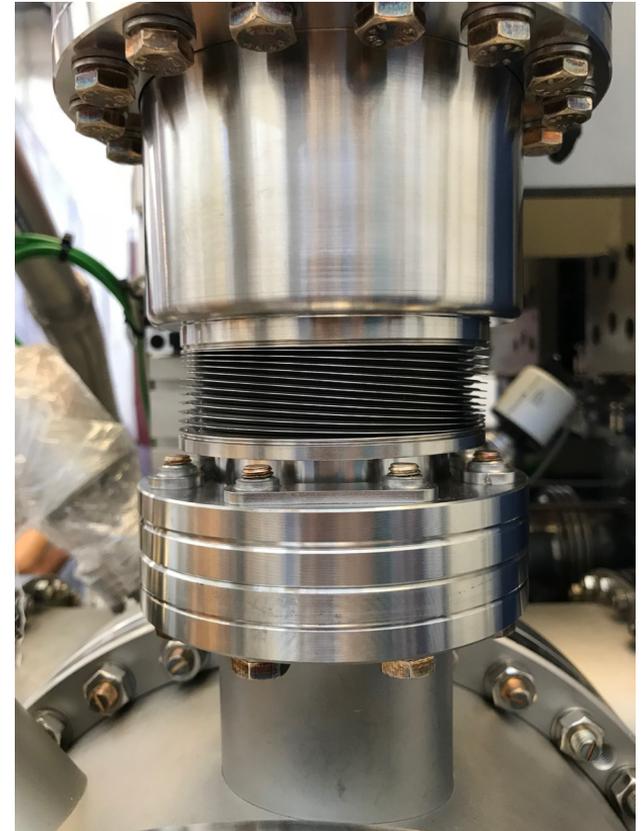


- 4 straights vented
- many elements never seen beam
- slower but acceptable recovery
- cryo cooler event
- neither beamline commissioning nor user beam time reduced

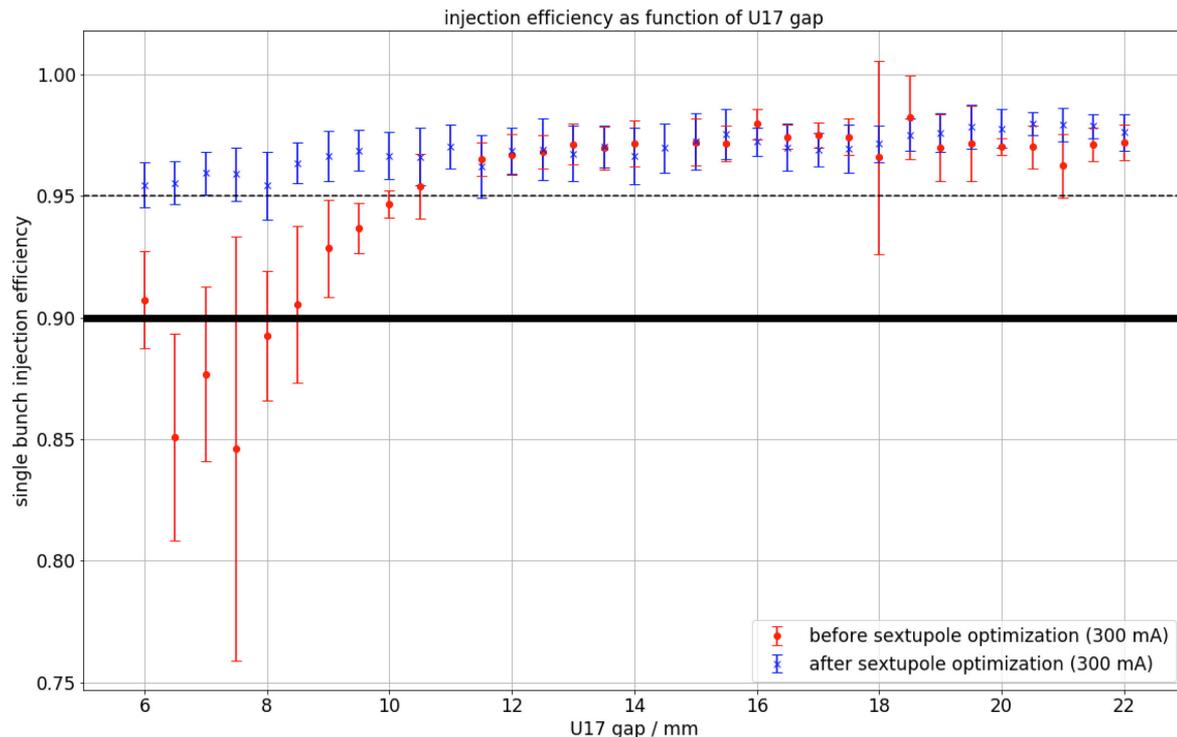
- failure in 2015/2016 → leak in cavity body
- refurbishment:
  - $\frac{1}{4}$  cavity bodies replaced
  - HOM damping antennas modified
  - HOM loads replaced
- reinstallation summer shutdown 2018
- ability to limit current reduction to handle T7 event & U17 issues
- Bremsstrahlungs levels still high → user beam line locked
- leak found in waveguides → sealed → user beam line unlocked
- repair planed in summer shutdown 2020



- since end of 2018 minimum gap limited to 10 mm
- water cooling added to taper section
- machine integration postponed to 2019
- cryocooler failed after shutdown  
→ loss of 4 days of beam scrubbing, i.e. machine commissioning

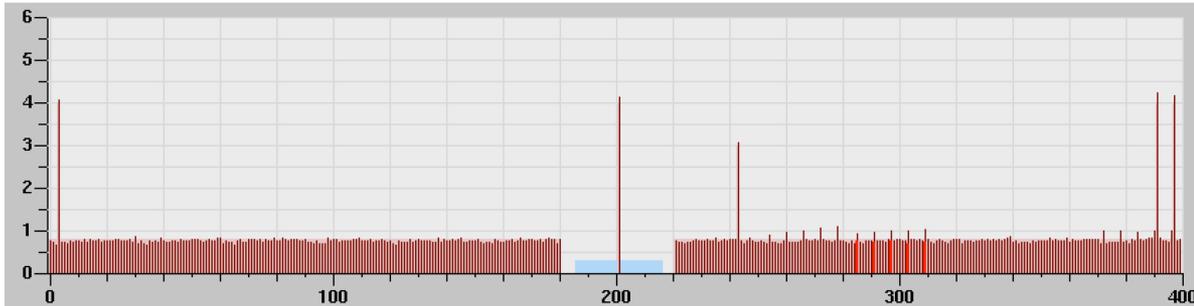
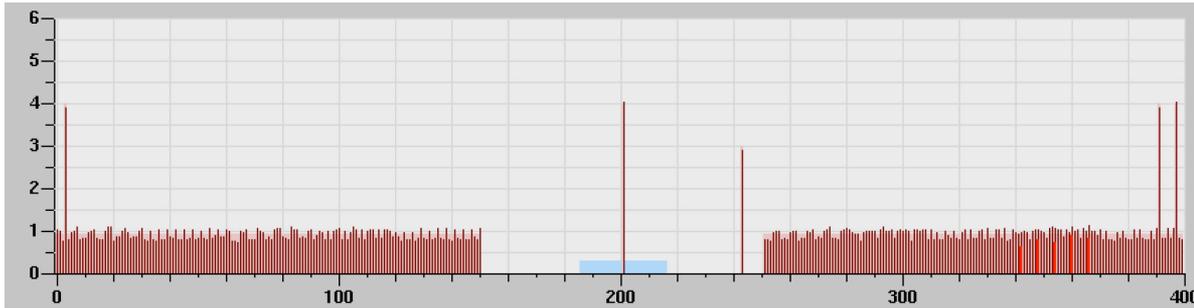


- beam based alignment
- machine protection system
- canting bump definition with beamlines
- injector optimization started
- optimization
  - kicker lifetime
  - SB inj. eff
  - Sextupoles
- Bremsstrahlung loss spot identified

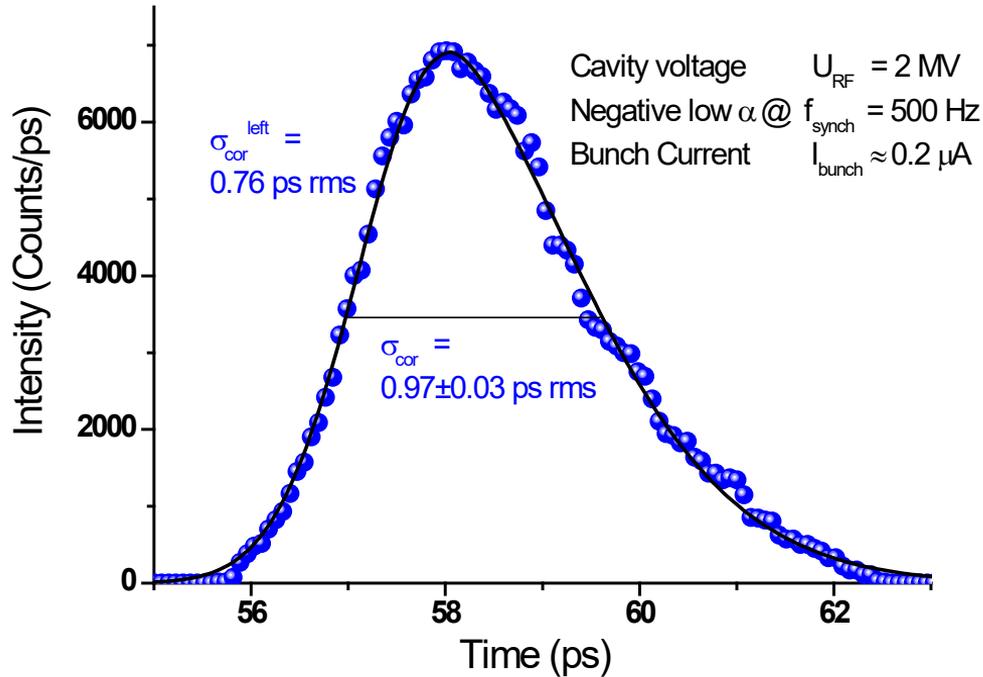


# DEVELOPMENTS

- test operation of 80ns pulse picking gap → 4 weeks in user operation

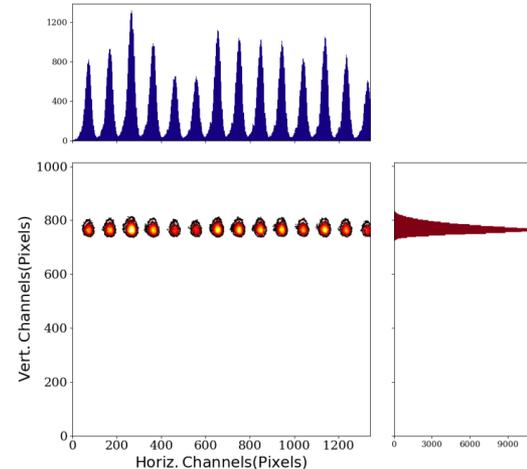


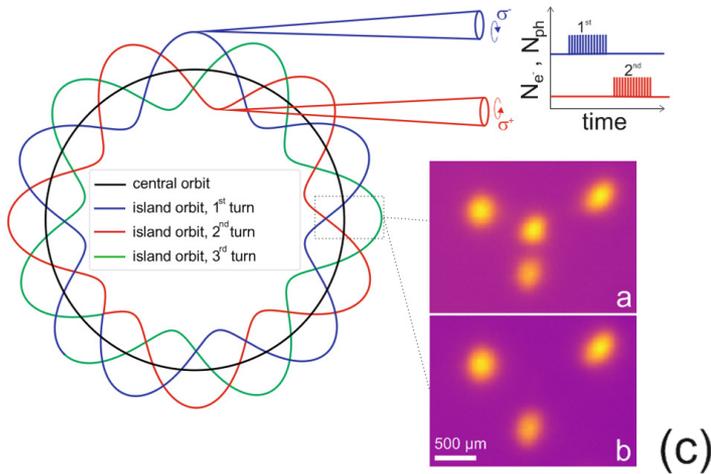
- improved Touschek lifetime (20%)
- less transient synchronous phase shift (120ps → 60ps)
- less impedance heating
- more difficult pulse picking



Fast Streak Camera (HAMAMATSU) with

- t vs x mode
- improved toroidal mirror
- improved 125 MHz generation (OPTRONIS)

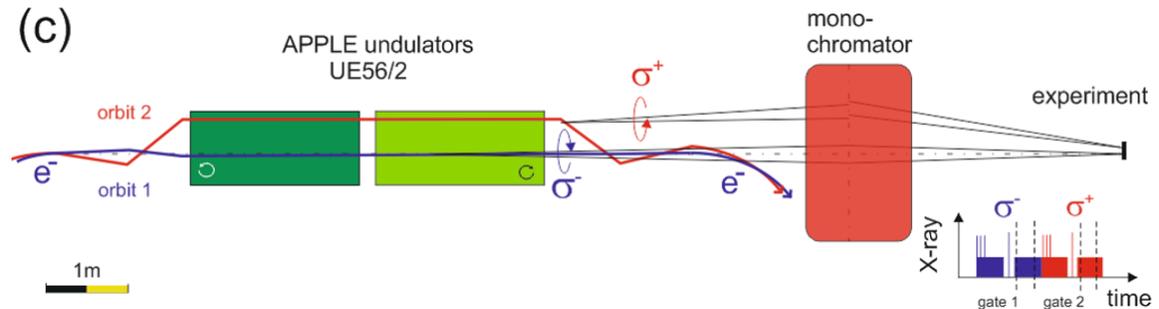




K. Holldack, C. Schüßler-Langeheine, P. Goslawski, N. Pontius, T. Kachel, F. Armbrorst, M. Ries, A. Schällicke, M. Scheer, W. Frentrup and J. Bahrtd

**Flipping helicity of X-rays from an undulator at unprecedented speed, submitted, under review.**

- 2 full days spent in July 2019 for a pioneering experiment at UE56/2
- XMCD detection used as probe to detect turn-by-turn helicity reversal of circular X-rays
- tricky combination of stable TRIBs settings in machine and UE56/2 twin undulator at special setting
- first two TRIBs orbits accepted by beamline



## operation schedule

Early	7 - 11 h
	11 - 13 h
	13 - 15 h
Late	15 - 19 h
	19 - 23 h
Night	23 - 7 h

## Normal week

## 120 h beam time

Mon.	Thu.	Wed.	Thu.	Fri.	Sat.	Sun.
SD*	MC -> BLC	MB	MB	MB	MB	MB
MC	BLC					MB
MC	MB	MB	MB	MB	MB	
MC	MB	MB	MB	MB	MB	MC

motivation:

increase available user/commissioning time and reliability by minimizing transient machine states

→ successful

→ take it one step further?

## operation schedule

	7 - 11 h
Early	11 - 13 h
	13 - 15 h
Late	15 - 19 h
	19 - 23 h
Night	23 - 7 h

## Week 1

125 h beam time

Mon.	Thu.	Wed.	Thu.	Fri.	Sat.	Sun.
SD*	MC -> BLC	MB	MB	MB	MB	MB
MC	BLC					
MC	MB	MB	MB	MB	MB	MB
MC	MB	MB	MB	MB	MB	MB

## operation schedule

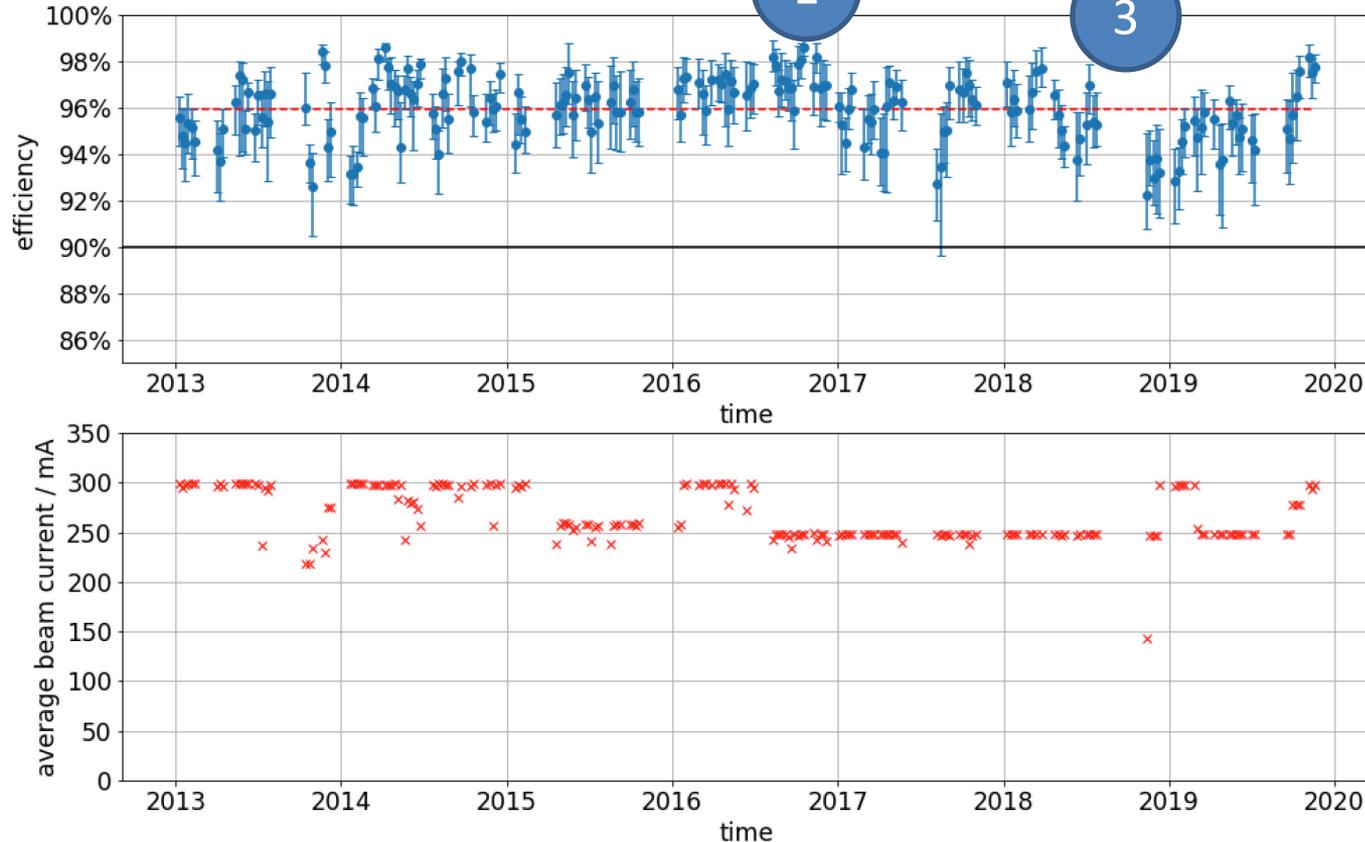
	7 - 11 h
Early	11 - 13 h
	13 - 15 h
Late	15 - 19 h
	19 - 23 h
Night	23 - 7 h

## Week 2

163 h beam time

Mon.	Thu.	Wed.	Thu.	Fri.	Sat.	Sun.
MB						
MB						
MB	MB	MB	MB	MB	MB	MC

- 20% more user time
- more commissioning weeks
- 1<sup>st</sup> test week revealed no significant trouble
- Only very few facilities do a two week rhythm → Is it worth trying?



7 years of TopUp

- 96% weekly avg. eff.
- 250 mA / 300 mA

1. EMIL optics
2. MPW removal
3. CPMU17 installation

# OUTLOOK

- good operational performance and reliability in 2019
- 300 mA user operation recovered
- RF spring event handled with short turn around time of 36h
- U17 implemented and in full beamline commissioning / user operation
- shielded bellow acceptable for user operation & studies so far
- landau cavity refurbishment, workaround in operation
- TRIBs XMCD experiment

- shielded bellow – single bunch user operation capability & studies
- landau cavity repair
- particle counter removal
  
- integration of radiation protection dosimetry data to control system
  
- suppression of collective effects in booster synchrotron
- further U17-integration optimization loops
  
- push development for TRIBs user operation
- Booster refurbishment & upgrade
- BESSY VSR studies

Michael Abo-Bakr, Wolfgang Anders, Felix Andreas, Felix Armborst, Terry Atkinson, Joachim Bartilla, Yvonne Bergmann, Thomas Birke, Daniel Böhlick, Anne Bundels, Markus Bürger, Rober Burneleit, Emanuel Cambas, Mathias Diehn, Marc Dirsat, Olaf Dreßler, Michael Edling, Silvio Ehlert, Dan Eichel, Volker Dürr, Pablo Echevarria, Hartmut Ehmler, Fjodor Falkenstern, Jörg Feikes, Nadine Fischer, Roland Fleischhauer, Thomas Flisgen, Andre Frahm, Benjamin Franksen, Sabine Giray, Holger Glass, Hans-Walter Glock, Felix Glöckner, Anny Gora, Rainer Görgen, Paul Goslawski, Mario Haucke, Jochen Heinrich, Svenja Heling, Andreas Heugel, Harry Hoffmann, Falk Hoffmann, Karsten Holldack, Holger Huck, Ji-Gwang Hwang, Andreas Jankowiak, Christian Jung, Christian Kalus, Jens Knobloch, Jörg Kolbe, Marten Koopmans, Bernhard Kuner, Jens Kuszynski, Victoria Laux, Nicole Leuschner, Ji Li, Klaus Ludwig, Michael Markert, Aleksandr Matveenکو, Meghan McAteer, Tom Mertens, Gert Meyer, Gregor Mielczareck, Ingo Müller, Roland Müller, Christian Nass, Klaus Ott, Fabian Pflocksch, Lutz Pichl, Henry Plötz, Joachim Rahn, Markus Ries, Stefan Rotterdam, Roswitha Schabardin, Andreas Schällicke, Tobias Schneegans, Ines von Scheibner, Günter Schindhelm, Ines Seiler, Gregor Schiwietz, Bernhard Schriefer, Thomas Schröter, Michael Schuster, Dirk Schüler, Hannes Stein, Tom Struppert, Ervis Suljoti, Yegor Tamashevich, Michael Ulrich, Stefan Wiese, Daniel Wolk, Antje Vollmer, Sven Wrede, Nora Wunderer ... and many more



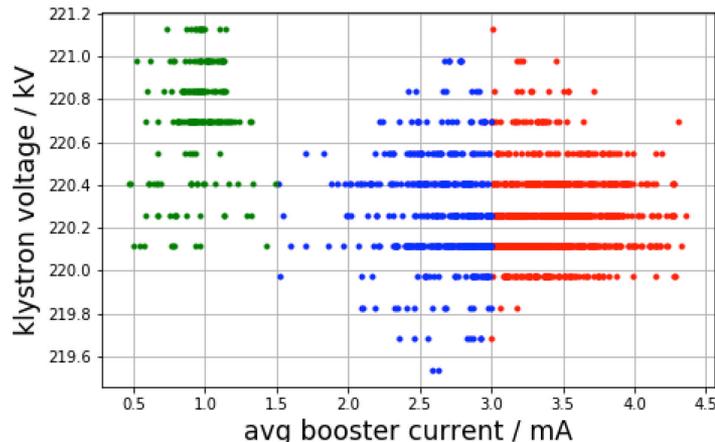
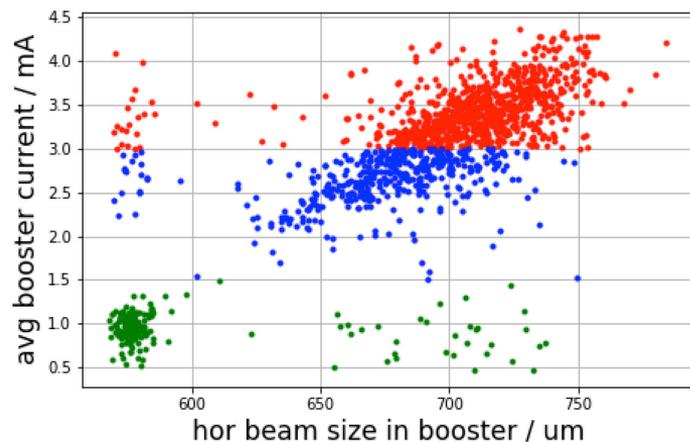
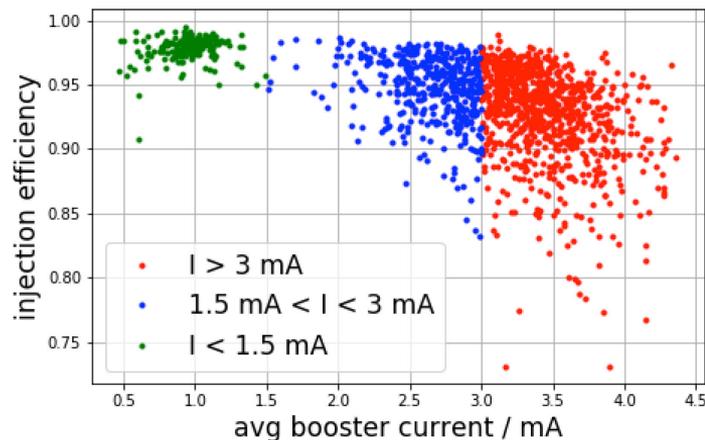
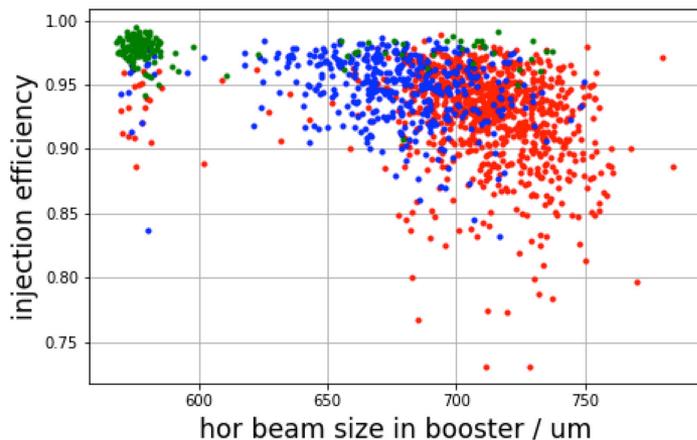
# BACKUP

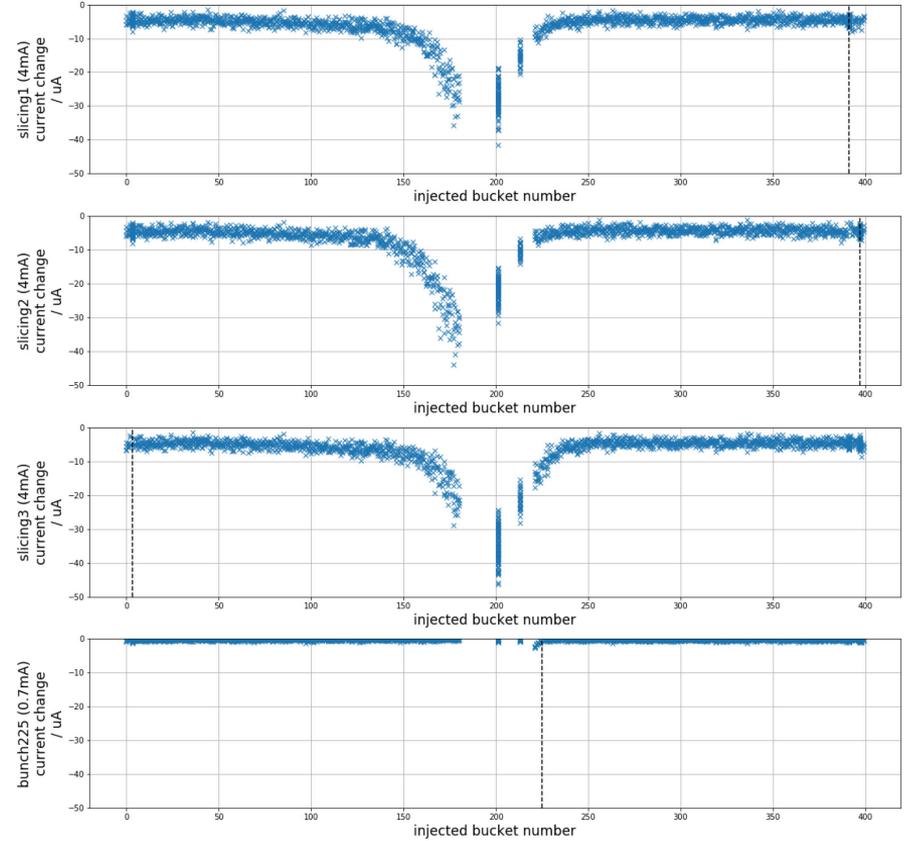
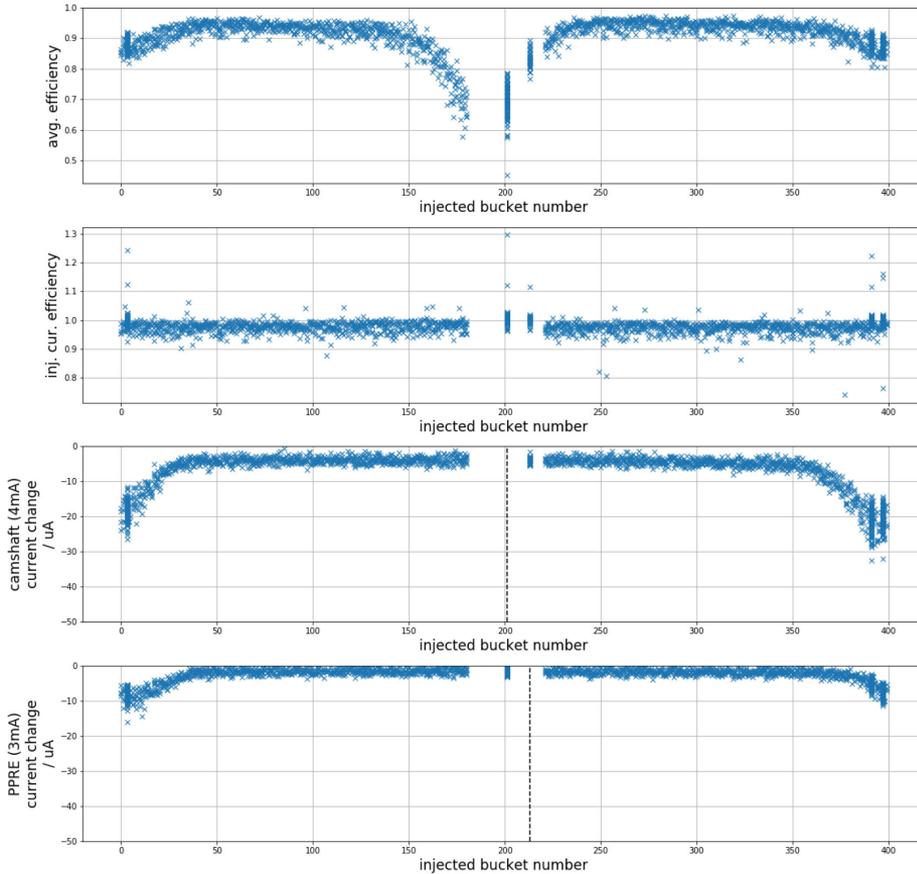
... the wheels start to spin

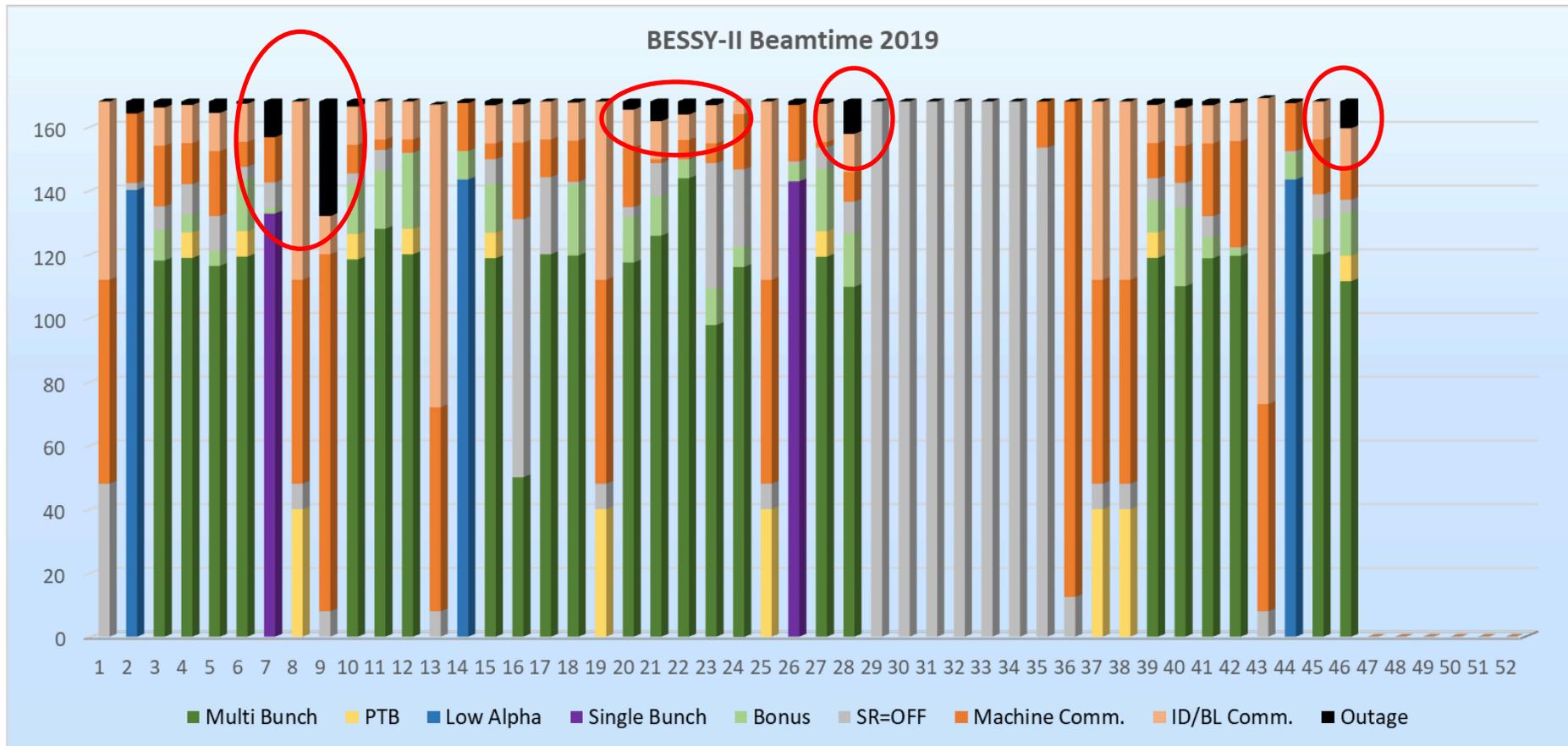
... fueled by the appointment of our new “photon science” director Jan Lüning

- storage ring based light source
- soft & tender x-rays
- DLSR approach following directions of SOLEIL / SLS / ELETTRA...  
target emittance in the order of  $\approx 200$  pm rad
- electron energy  $\approx (2.0 \dots 2.5)$  GeV
- green field approach is investigated ( $C \approx 350\text{m}$ ) as well as in-facility ( $C \approx 240\text{m}$ )
- $\approx 2030$
  
- CDR-Phase started – CDR expected 2022
- Science Case will be worked out during the next year  
→ Workshops with Science Expert Groups
- Investigation of short-pulses, need for time-resolved experiment under way
- Possible site for BESSY III facility in Berlin-Adlershof has been reserved









year	scheduled	downtime	bonus	# outages	availability	+bonus	MTBF	MTTR
<b>2018</b>	3578 h	28.3 h	415 h	51	99.2 %	111 %	70.2 h	0.56 h
<b>2019</b> (... cw46)	3846 h	103.3 h	310 h	67	97.3 %	105 %	57.4 h	1.5 h