PULPOKS 2023

Failure statistics and availability improvement of kicker systems at DESY

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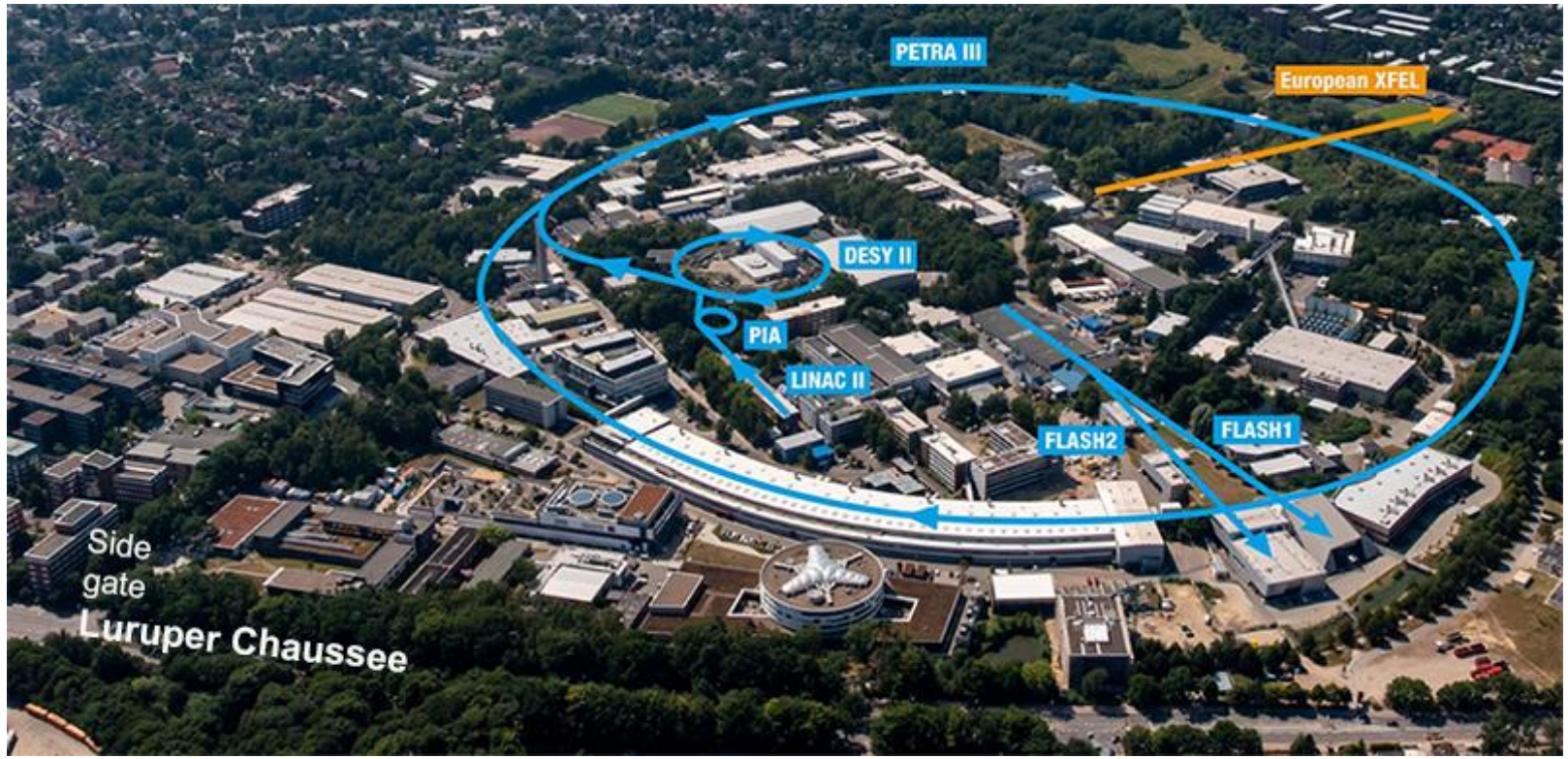
HELMHOLTZ SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

DESY.

Kicker availability

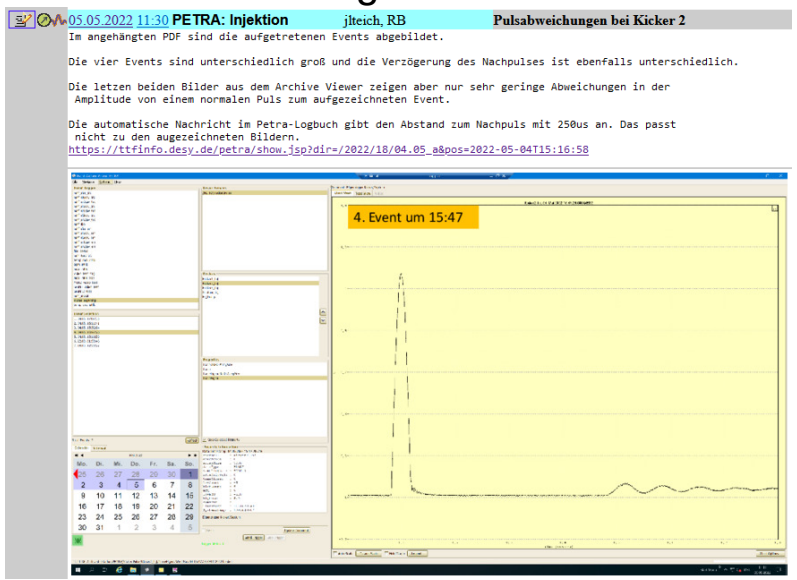
- How reliable are our kickers?
- What metric can be used to determine reliability?
- What can be done to improve reliability?
- How do you approach this topic?

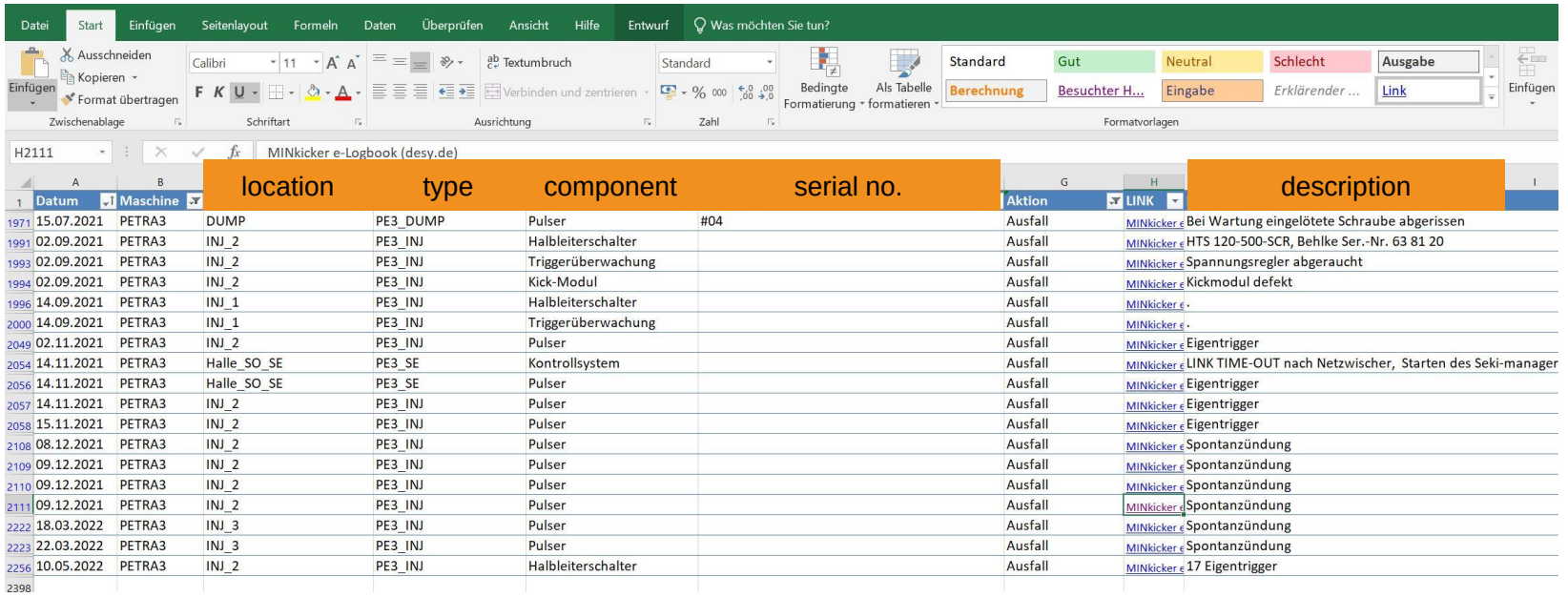


Tracking- and error list

Evaluation from 2009 to 2022

logbook

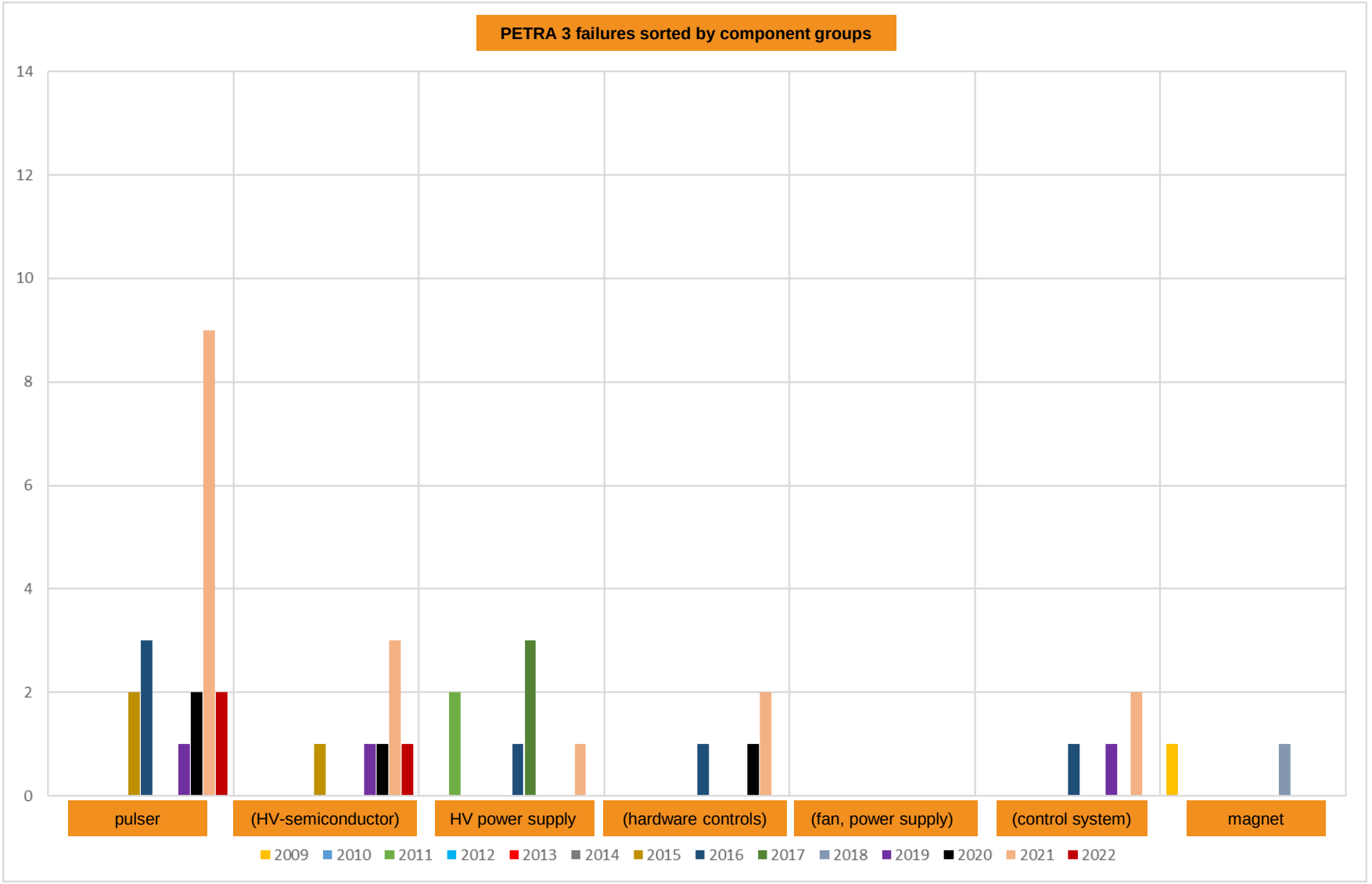




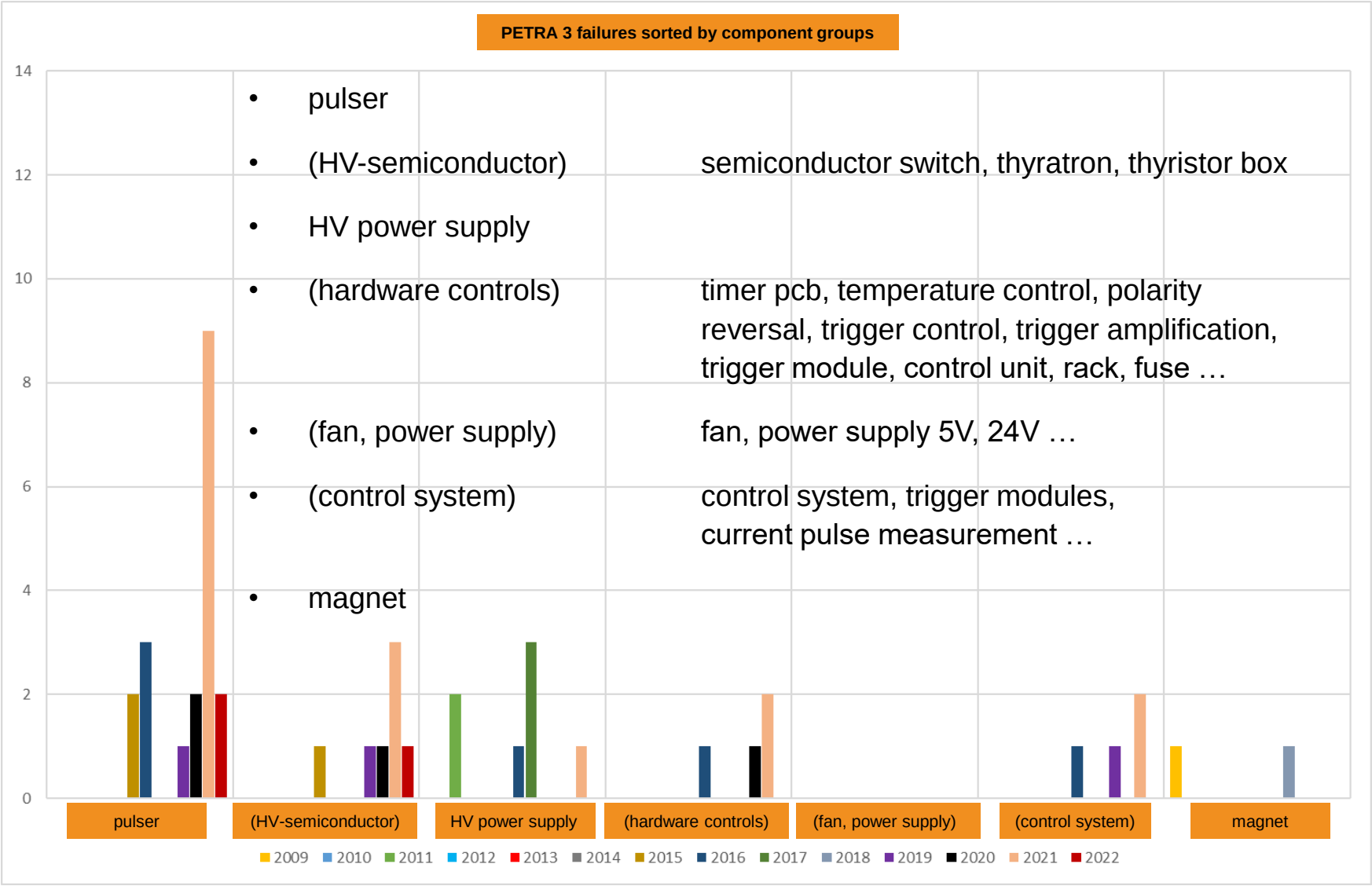
Datum	Maschine	location	type	component	serial no.	Aktion	LINK	description
15.07.2021	PETRA3	DUMP	PE3_DUMP	Pulser	#04	Ausfall	MINkicker e	Bei Wartung eingelötete Schraube abgerissen
02.09.2021	PETRA3	INJ_2	PE3_INJ	Halbleiterschalter		Ausfall	MINkicker e	HTS 120-500-SCR, Behlke Ser.-Nr. 63 81 20
02.09.2021	PETRA3	INJ_2	PE3_INJ	Triggerüberwachung		Ausfall	MINkicker e	Spannungsregler abgeraucht
02.09.2021	PETRA3	INJ_2	PE3_INJ	Kick-Modul		Ausfall	MINkicker e	Kickmodul defekt
14.09.2021	PETRA3	INJ_1	PE3_INJ	Halbleiterschalter		Ausfall	MINkicker e	.
14.09.2021	PETRA3	INJ_1	PE3_INJ	Triggerüberwachung		Ausfall	MINkicker e	.
02.11.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Eigentrigger
14.11.2021	PETRA3	Halle_SO_SE	PE3_SE	Kontrollsystem		Ausfall	MINkicker e	LINK TIME-OUT nach Netzwischer, Starten des Seki-manager
14.11.2021	PETRA3	Halle_SO_SE	PE3_SE	Pulser		Ausfall	MINkicker e	Eigentrigger
14.11.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Eigentrigger
15.11.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Eigentrigger
08.12.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
09.12.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
09.12.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
09.12.2021	PETRA3	INJ_2	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
18.03.2022	PETRA3	INJ_3	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
22.03.2022	PETRA3	INJ_3	PE3_INJ	Pulser		Ausfall	MINkicker e	Spontanzündung
10.05.2022	PETRA3	INJ_2	PE3_INJ	Halbleiterschalter		Ausfall	MINkicker e	17 Eigentrigger

- Error categories sorted by a component structure (based on DESY quality management)
- Specific errors grouped to simplify analysis
- No. of pulser installations (january 2023)
  - 26 pulser installations in the PETRAIII complex (102 in all machines)
  - 24 error categories
  - e.g. ~ 180 error entries in the logbook for the PETRA3 complex since 2009

PETRA III error statistics

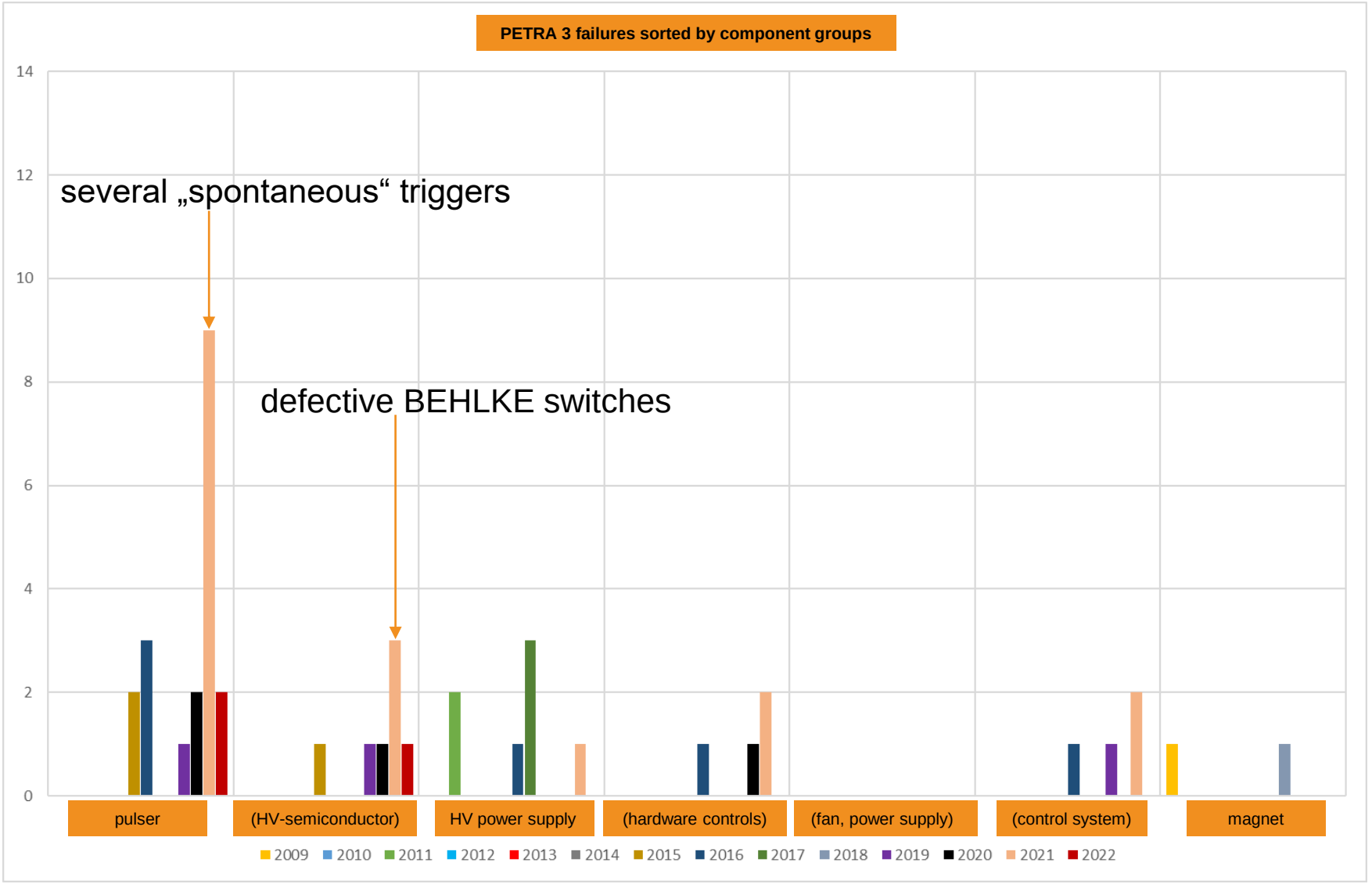


PETRA III error statistics

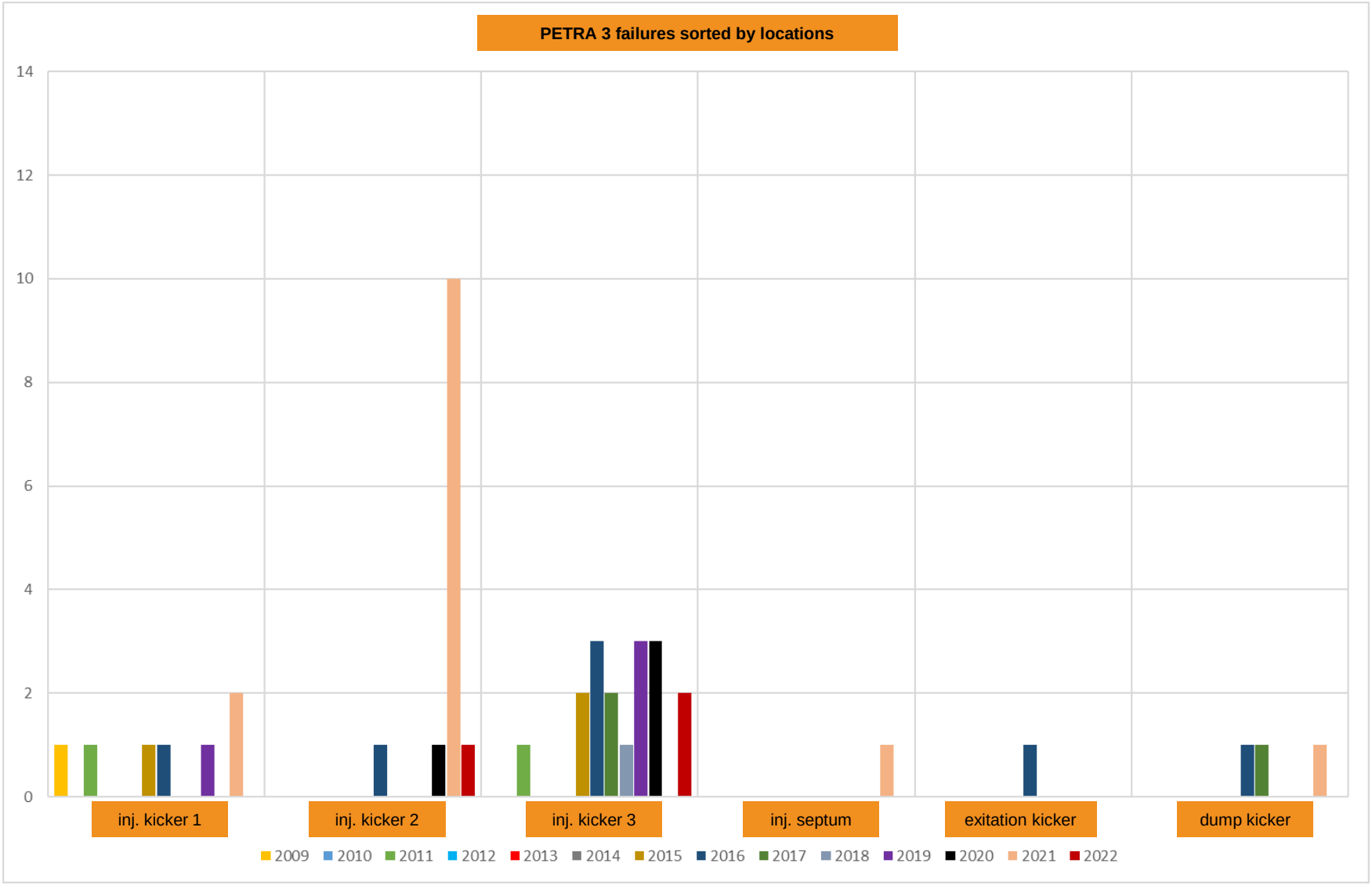


- pulser
- (HV-semiconductor) — semiconductor switch, thyratron, thyristor box
- HV power supply
- (hardware controls) — timer pcb, temperature control, polarity reversal, trigger control, trigger amplification, trigger module, control unit, rack, fuse …
- (fan, power supply) — fan, power supply 5V, 24V …
- (control system) — control system, trigger modules, current pulse measurement …
- magnet

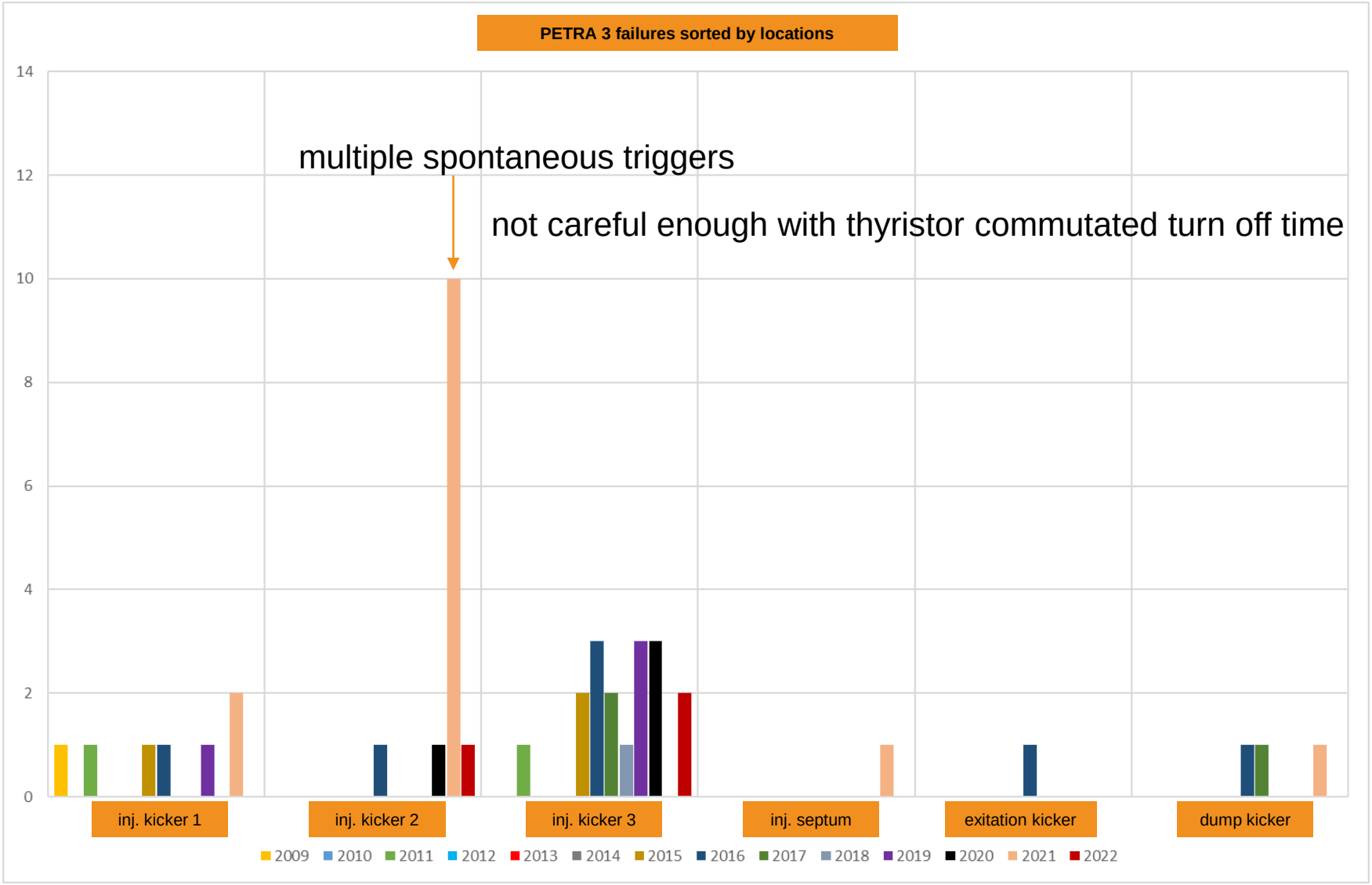
PETRA III error statistics



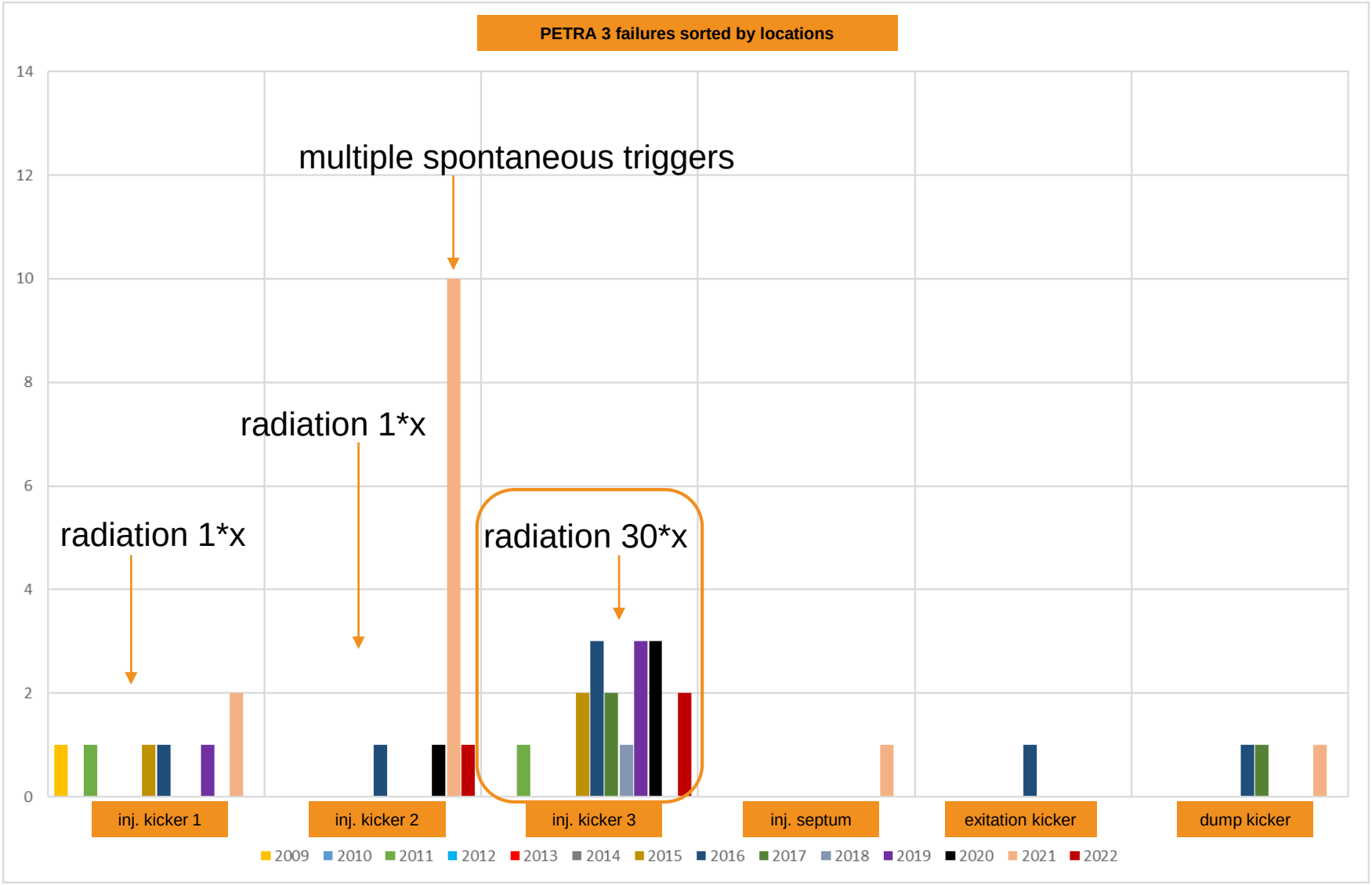
PETRA III error statistics



PETRA III error statistics

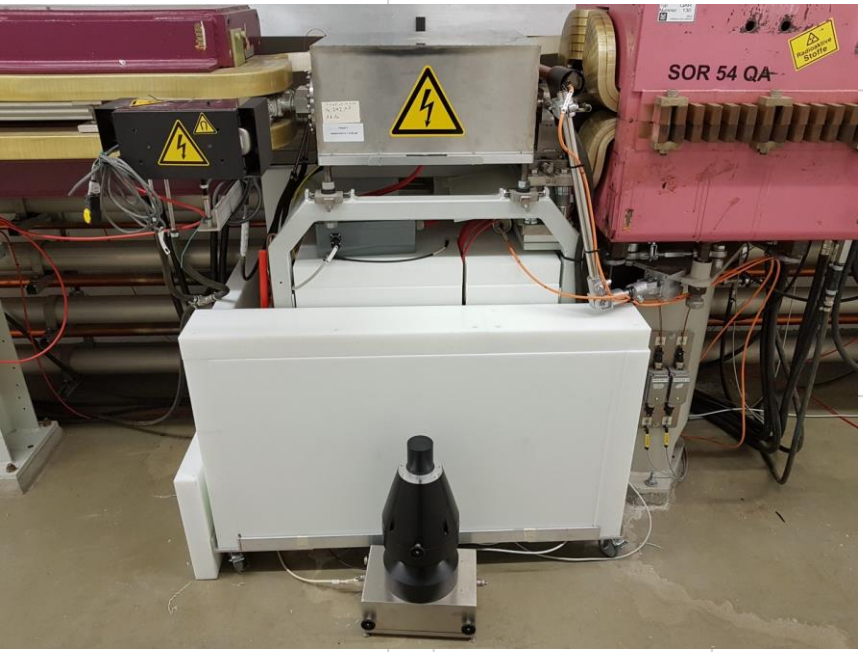


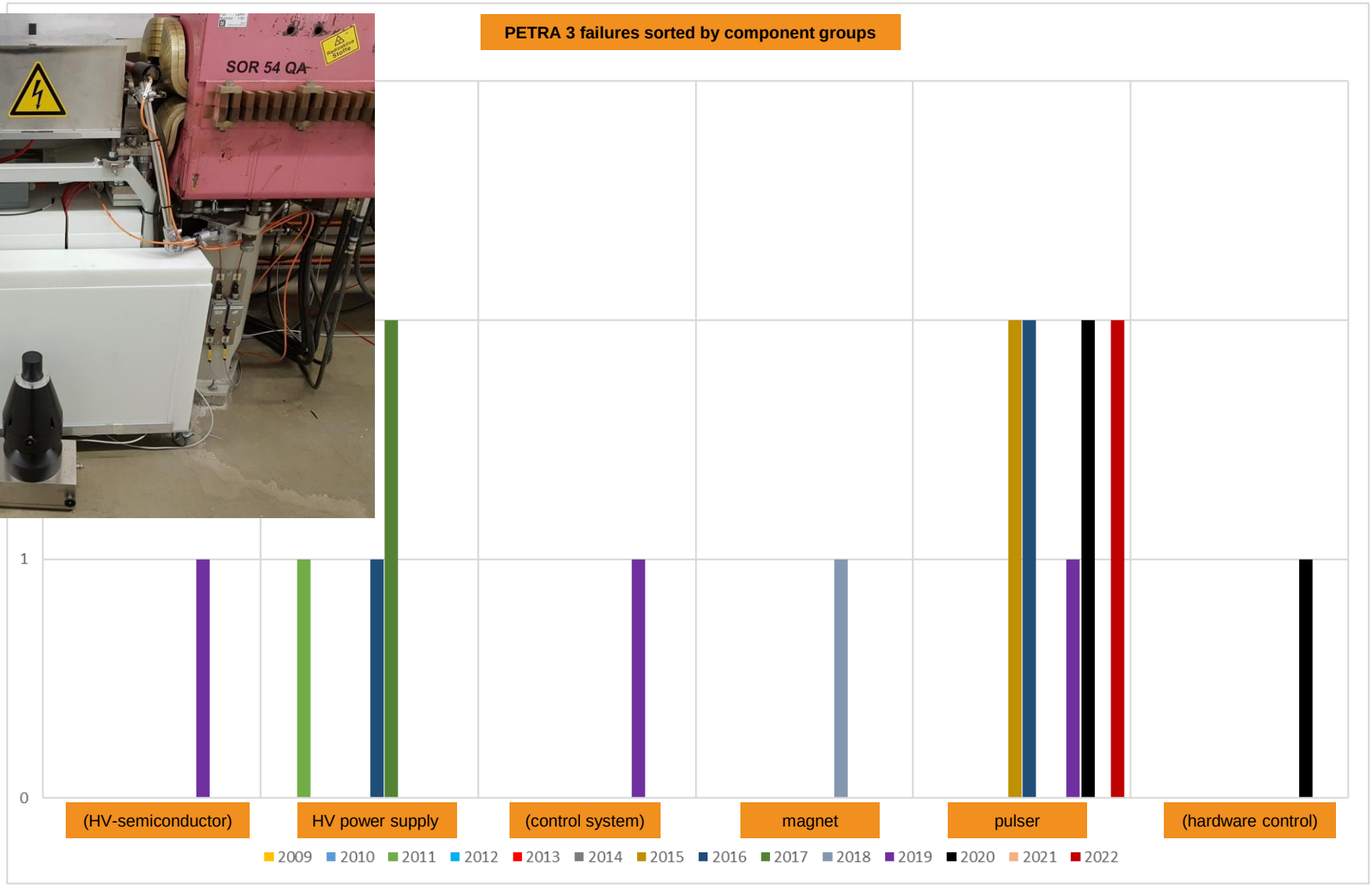
PETRA III error statistics



PETRA III error statistics

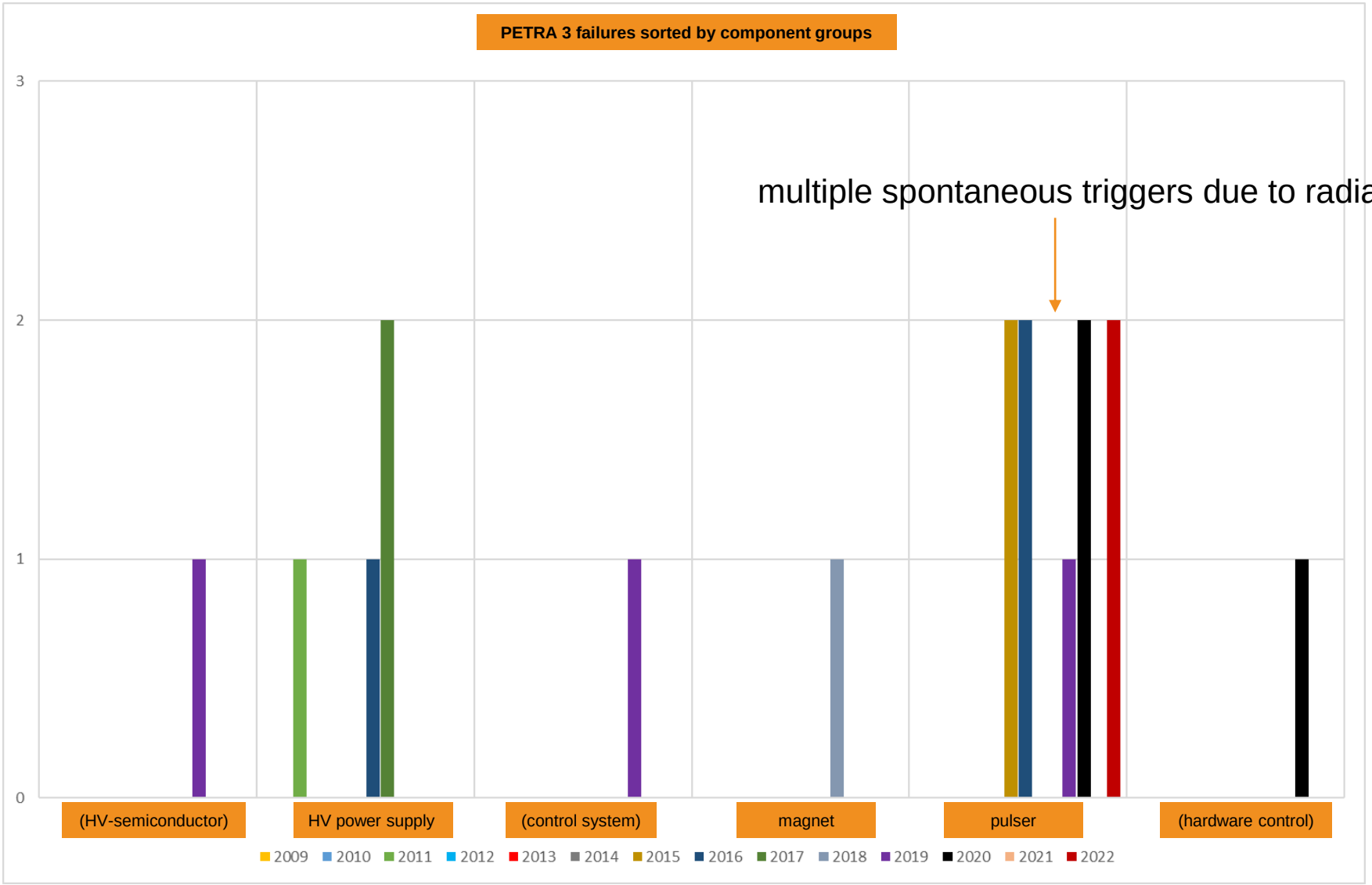
injection kicker 3





PETRA III failure statistics

injection kicker 3



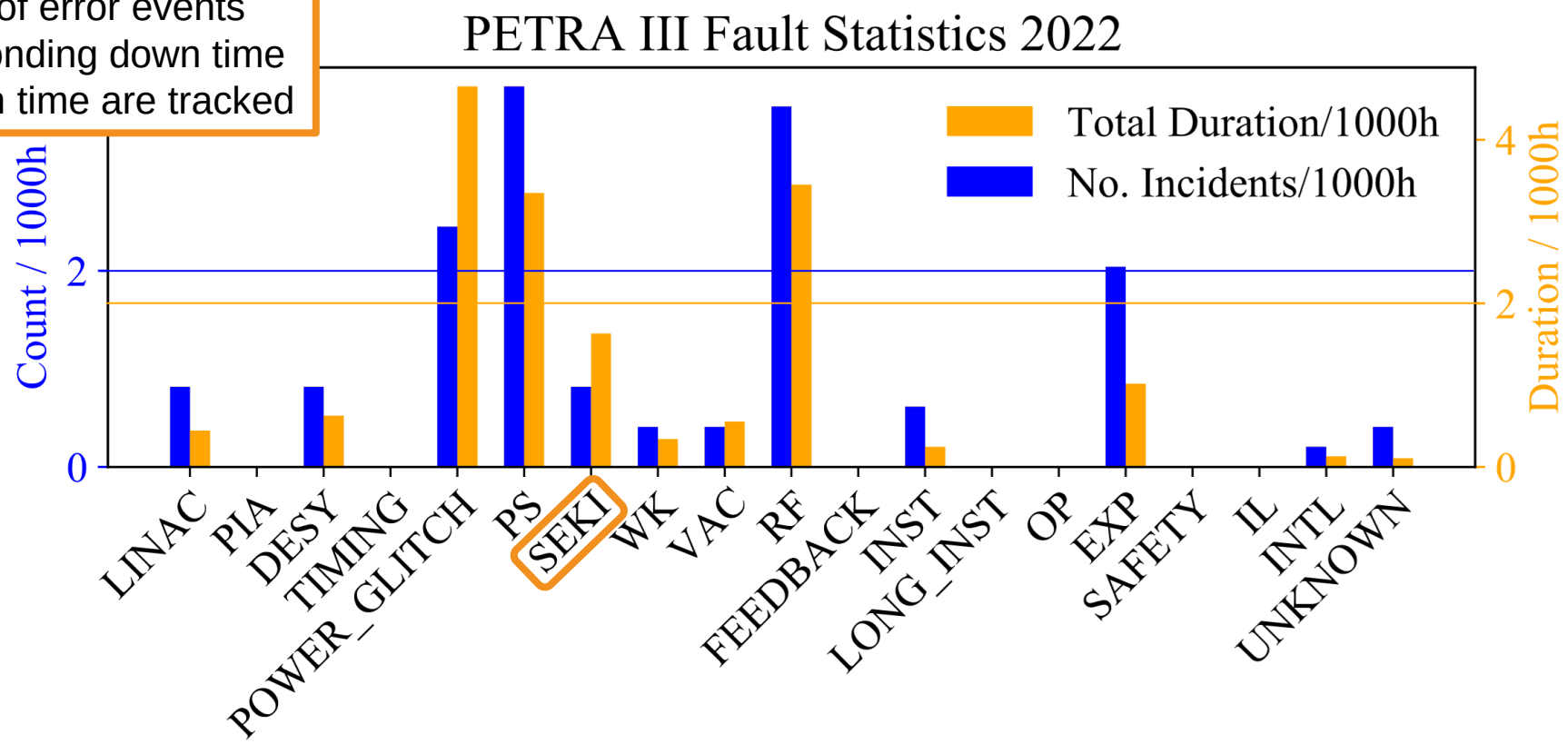
PETRA III failure statistics

Power Glitches caused longest Downtime

Highest No. of Incidents due to Power Supplies & RF

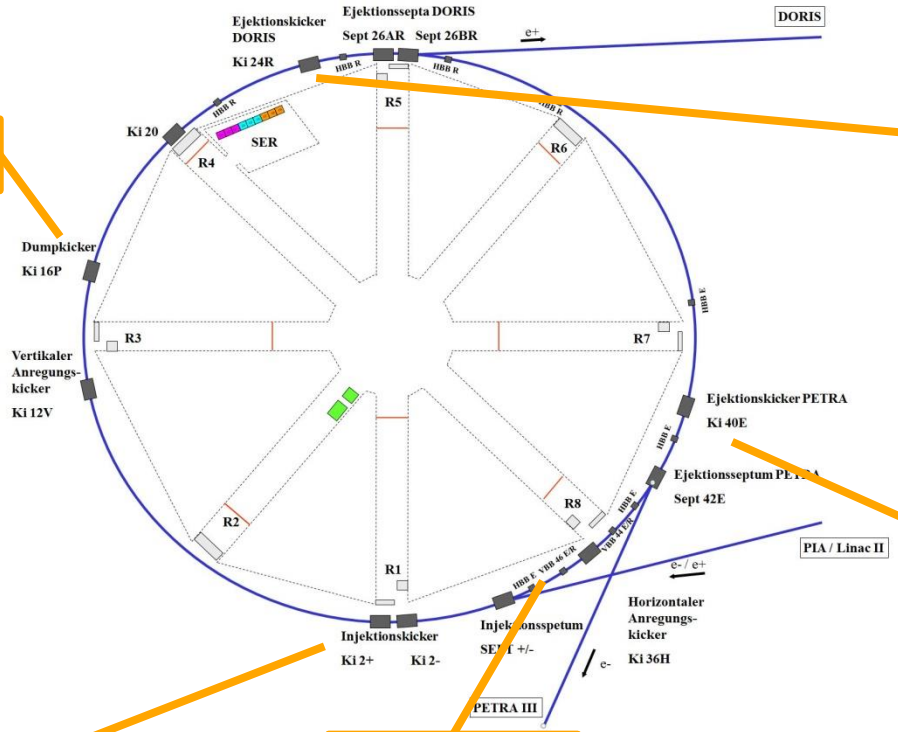
Total	No. of Incidents	Duration
USER Run	81	81 h

- maschine point of view:
  - number of error events
  - corresponding down time
- only events that lead to down time are tracked

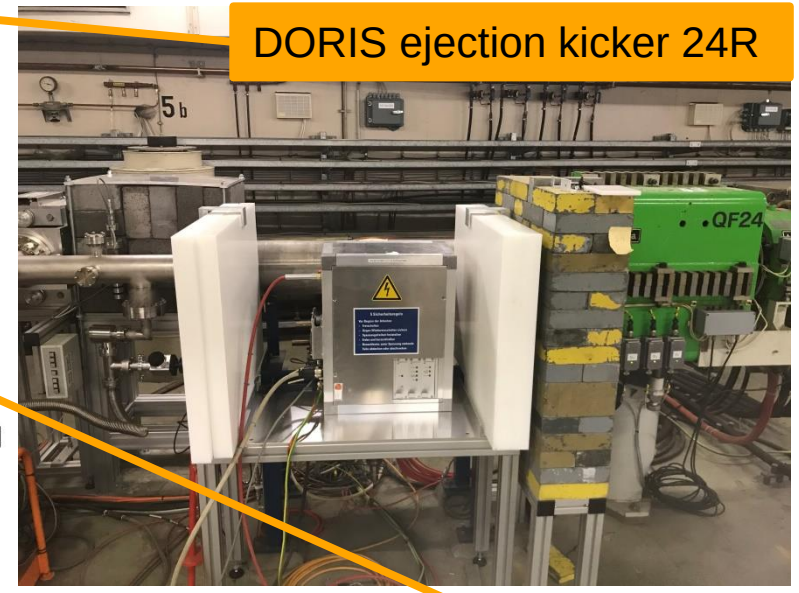


DESY II

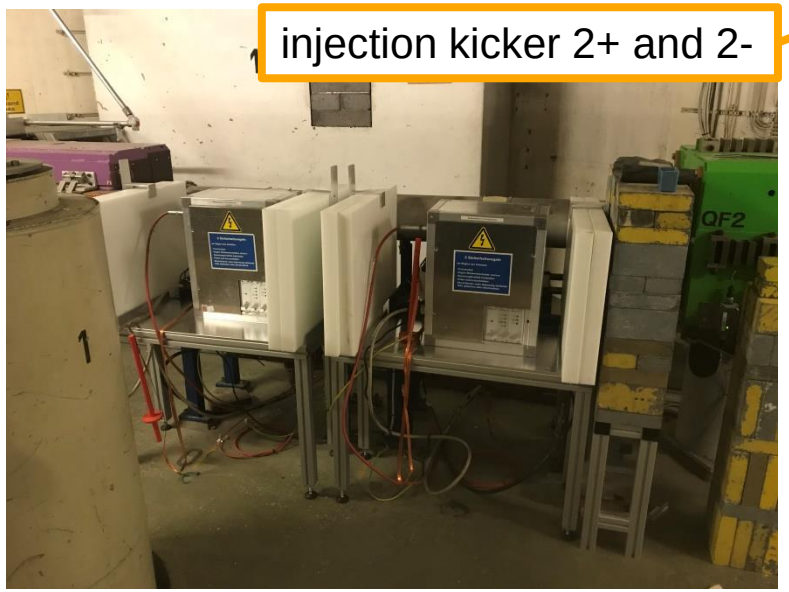
dump kicker 16P



DORIS ejection kicker 24R



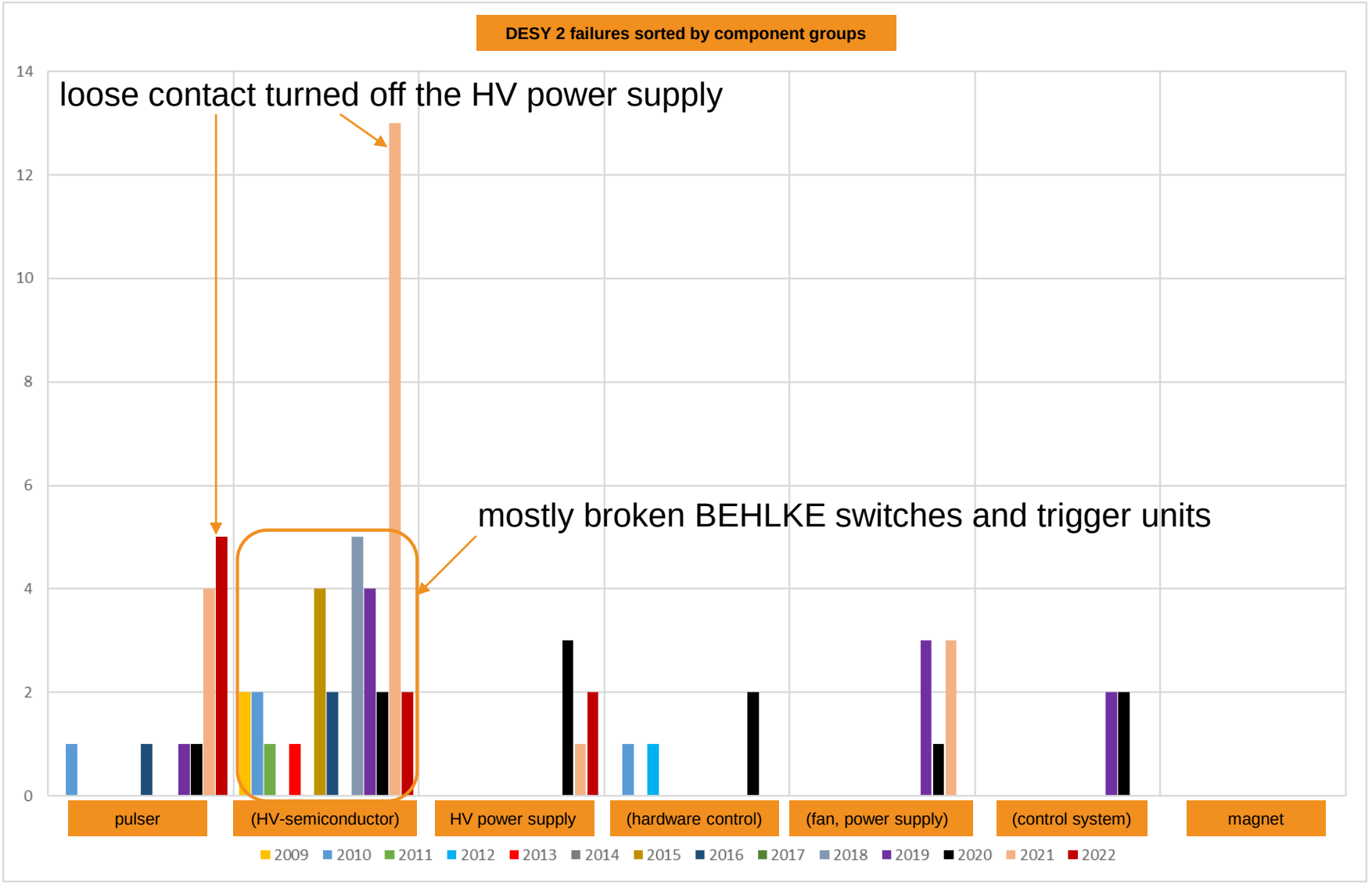
injection kicker 2+ and 2-



Kicker 46H

PETRA ejection kicker 40E

DESY II failure statistics



New BEHLKE trigger module

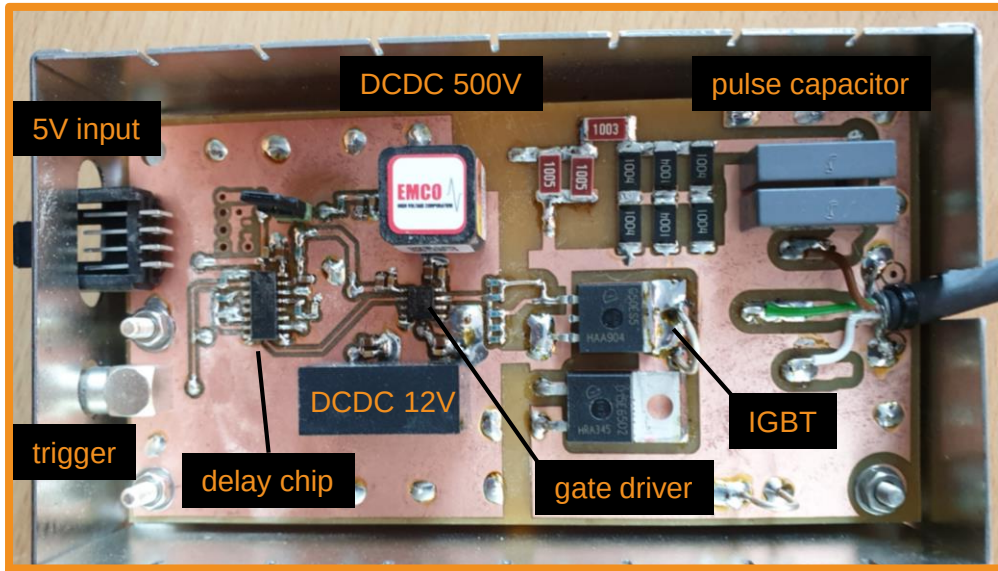
Frequently broken BEHLKE thyristor switches

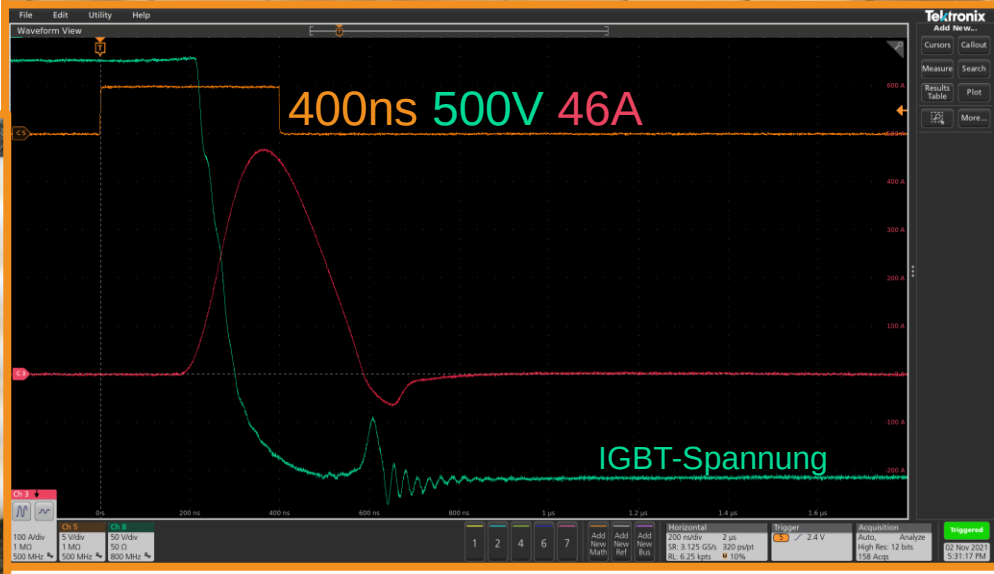
- frequently broken BEHLKE switches
- root cause radiation
- old switches had trigger module integrated in HV-module
- we ordered seperate trigger and HV-modules
- 90% of the time the trigger unit failed
- our own trigger module design never failed to this day

- disadvantages:
  - some pulsers need changes to use new trigger module
  - not applicable with old switches with integrated trigger module

- BEHLKE has apparently fixed the problem with the 12kV switches
  we prefer to buy the trigger modules:
  - saves time
  - actually cheaper to buy from BEHLKE

prototype of a trigger module developed by reverse engineering

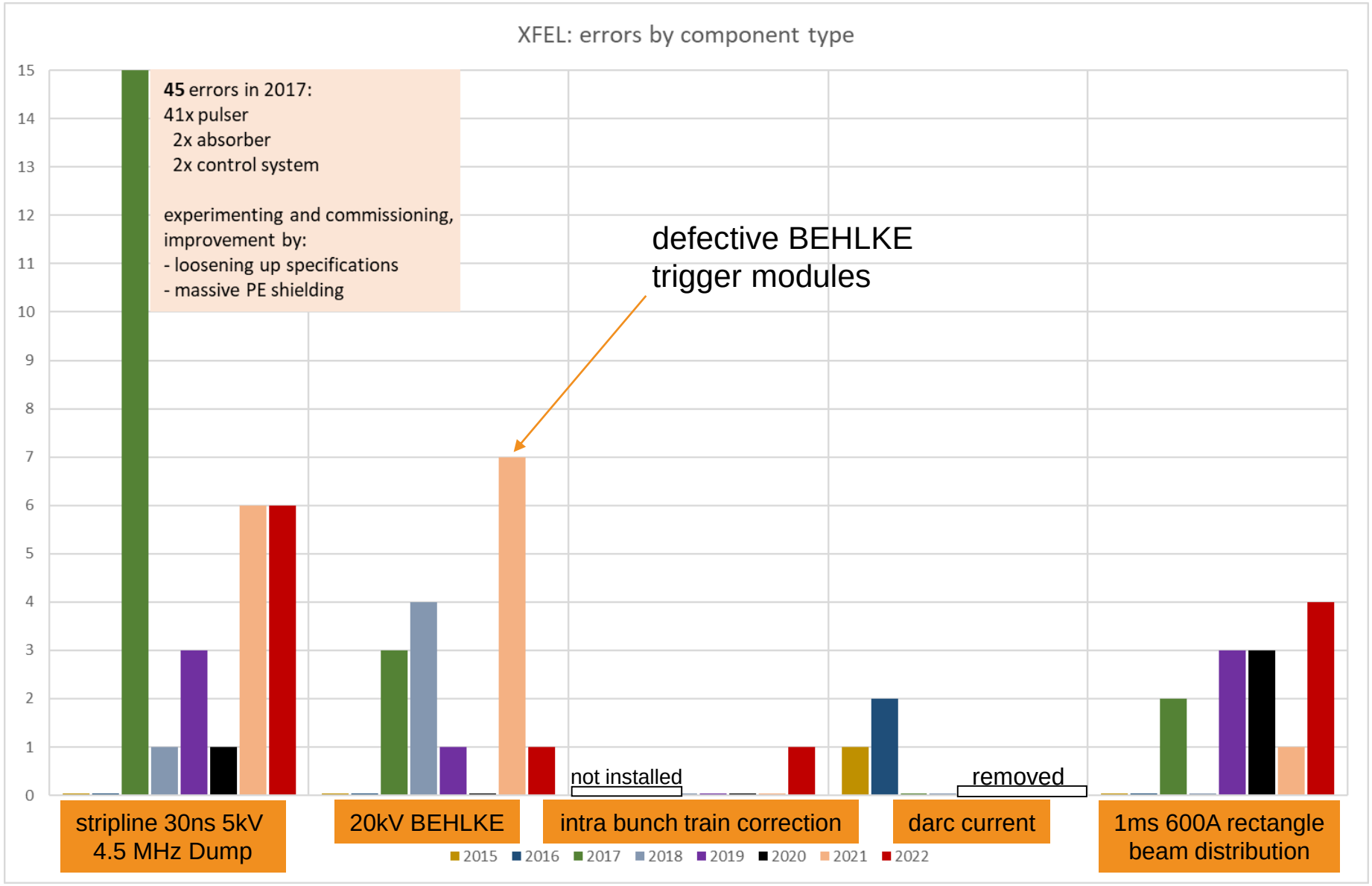




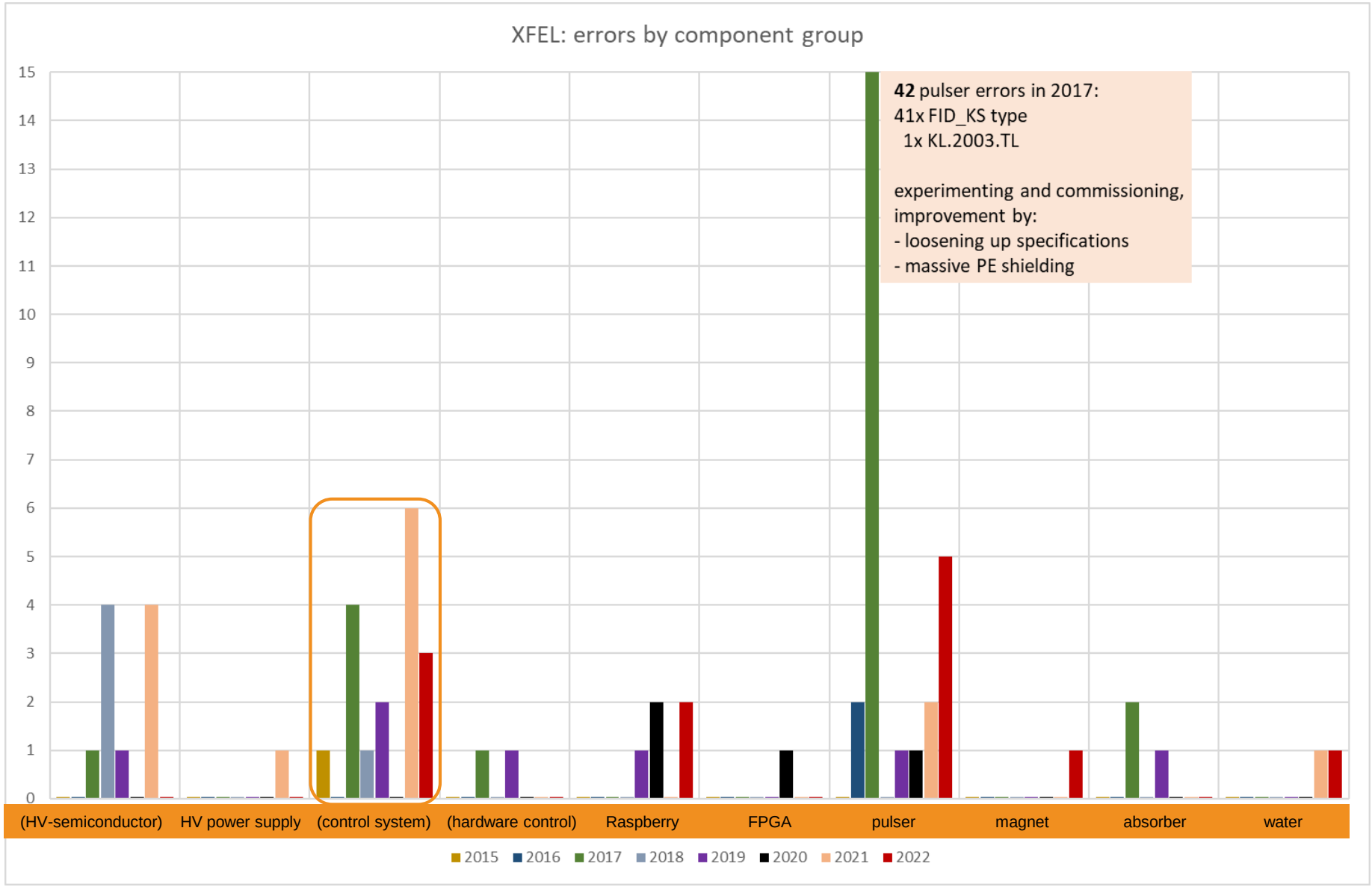
HTS 120-500-SCR
old switch with integrated trigger module

12kV 5000A

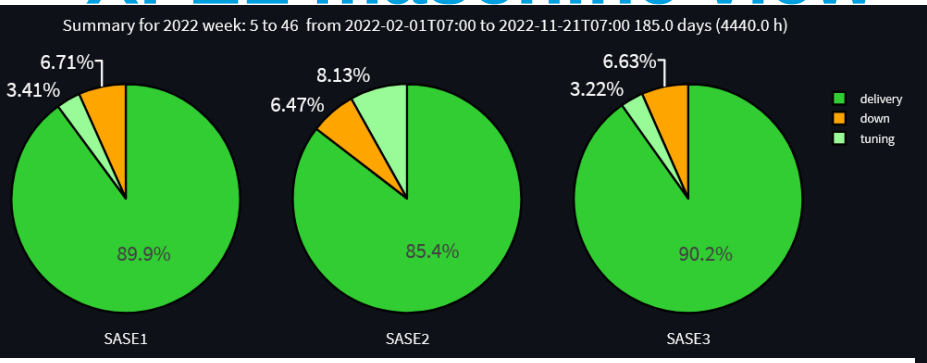
XFEL failure statistics



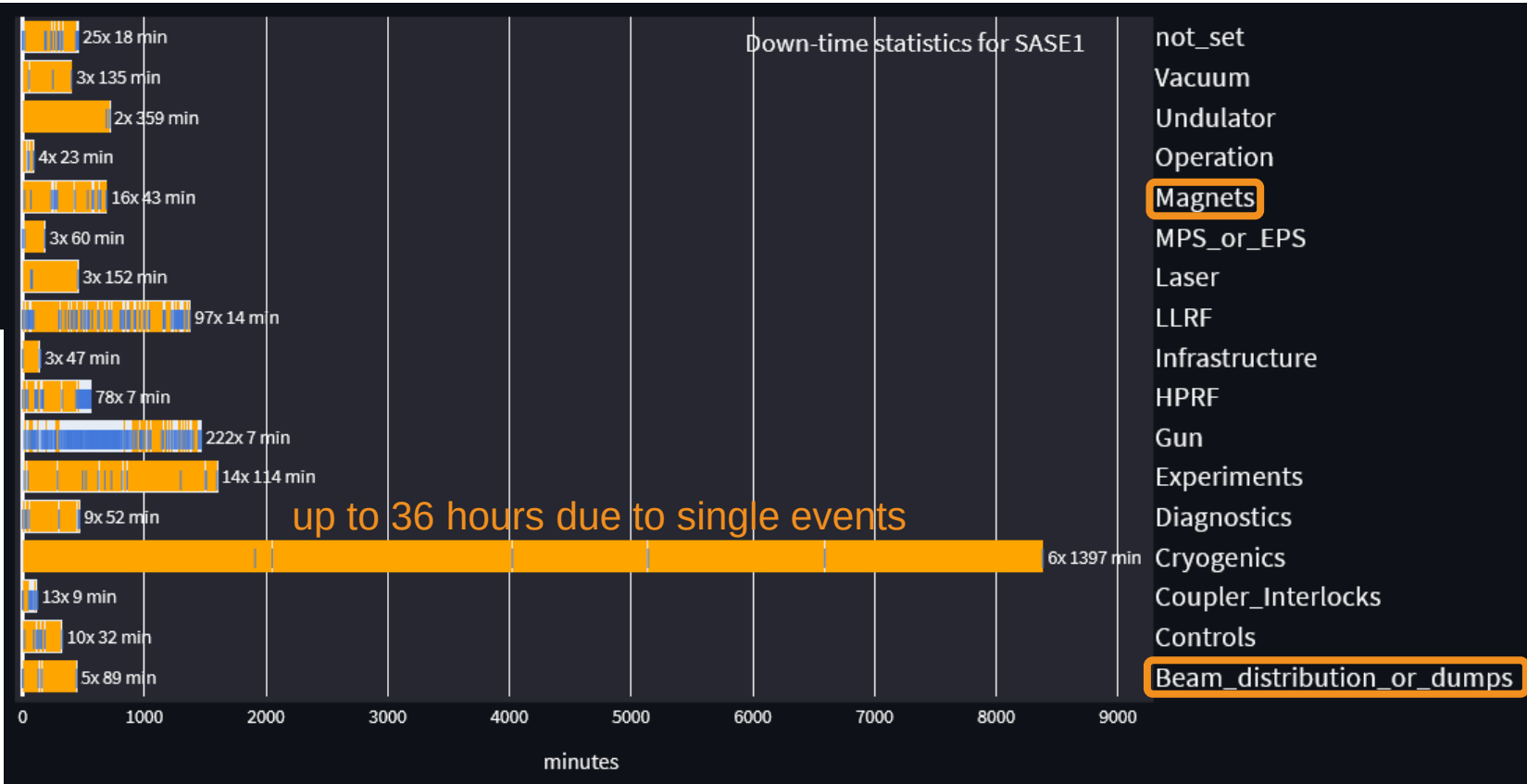
XFEL failure statistics

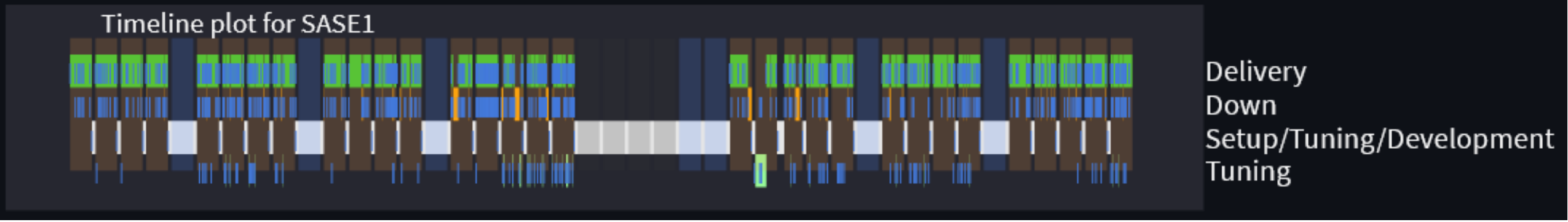


XFEL maschine view



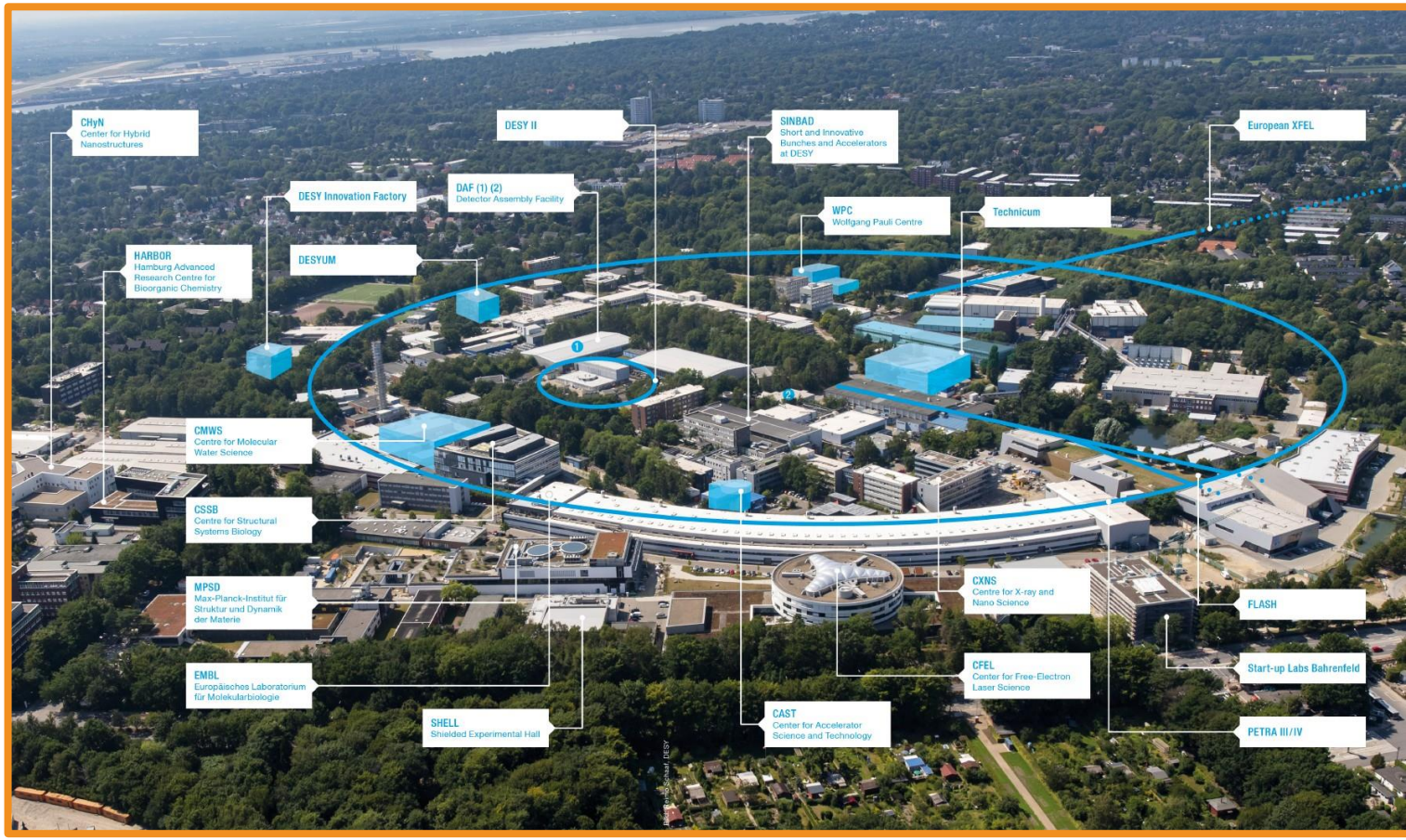
- depending on the operator we are
  - „magnets“
  - „beam_distribution_or_dumps“
- sometimes statistics aren´t conclusive





Summary

- With an increasing demand for availibility and reliability we started to do more statistics
- The high number of components demands good documentation
- What can be done to improve reliability?
- How do you approach this topic?



Thank you for your attention!

Kontakt

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Data extracted from our log book by Ralph Keute and graphical representation by Jens Wortmann