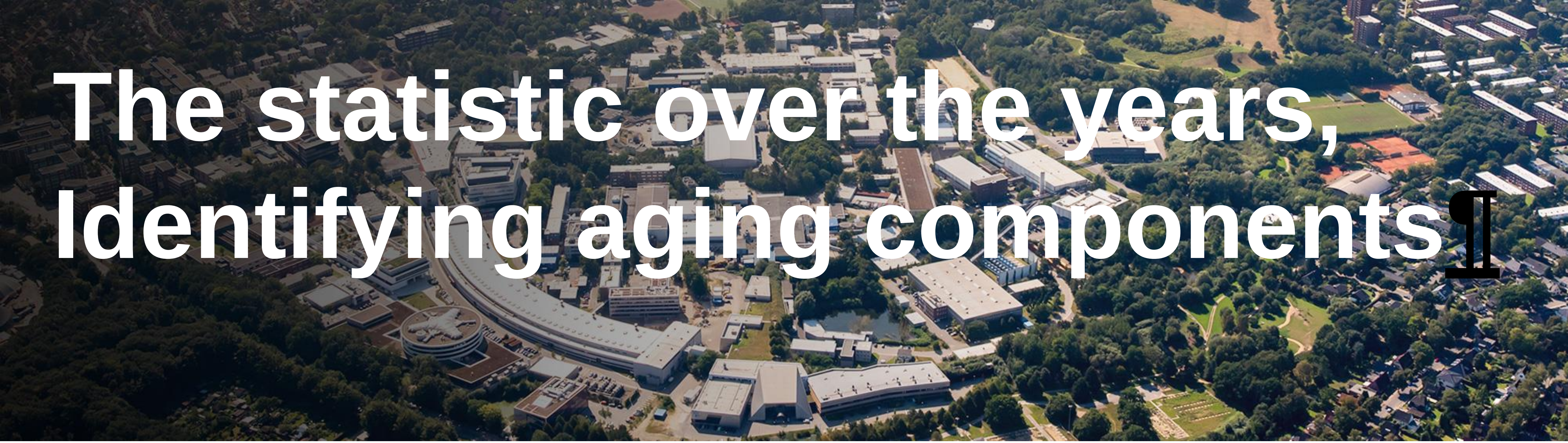


The statistic over the years, Identifying aging components¶

Joerg Eckoldt

POCPA 2023, June 1rst, 2023

HELMHOLTZ

DESY.

Why using statistical methods for failure analysis?

It is a must with large numbers of supplies

- DESY is dealing with a large number of power supplies since beginning of the 90th.
  - 1990 - 2007
    - HERA e-p + pre-accelerators 1600 ps
  - Since 2009
    - PETRA III + Extention 858 ps
  - Since 2016
    - XFEL 810 ps
    - FLASH, preaccelerators 400 ps
    - Overall more than 2000 ps in operation

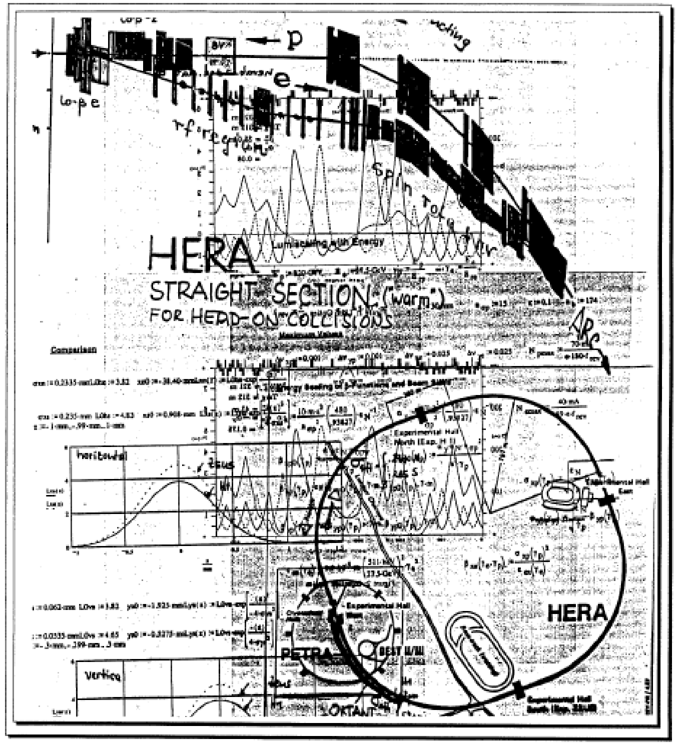
Reliability in 1995+1996

Betriebsseminar St. Englemar + ??

DESY HERA 96-05
Mai 1996

Beschleuniger Betriebsseminar 1996

St. Englmar, 28.1.-2.2.1996



DESY HERA 97-01
February 1997

HERA ´97

HERA Seminar, DESY, 1997

Reliability

Definition from the 90ths

4 STATISTICS

The availabilty of the subsystem power supply can be calculated by

$$AV = \frac{MT - (NOF * TOR)}{MT} * 100\%$$

with AV = availability
MT = machine time
NOF = number of failures
TOR = time of repair

+ magnet cycling

Definitions

Asked by Ivan

$$MTBF_{Machine} = \frac{Operation\ time}{NOF}$$

$$MTBF_{Power\ Supply} = \frac{Operation\ time\ x\ NOPS}{NOF}$$

MTBF_Power Supply: Mean time between failures
- It is a definition, what you count into it
  - is an external interlock part of the power supply failure?
  - is a power glitch part of the power supply failures?

Operation time
- definition in agreement with the machine
  - event/1000h
  - event/day
  - 1 failure/1000h corresponds to 0.024 failures/day
    - these numbers still cannot be compared since different NOPS

Definitions

Asked by Ivan

$$MTTR_{Machine} = \frac{\sum Time\ till\ Machine\ is\ up\ again}{NOF}$$

$$MTTR_{Power\ Supply} = \frac{\sum Time\ to\ repair\ the\ PS}{NOF}$$

Time
- definition in agreement with the machine
  - event/1000h
  - event/day
  - 1 failure/1000h corresponds to 0.024 failures/day
    - these numbers still cannot be compared since different NOPS

HERA Reliability

Data 1996

Table 2: Power supply failures in the machines, Mean TimeBetweenFailure, AVailability

	problems	MTBF_M hrs	AV
HERA e+p	238*	22.3	96.6%
HERA p	163	32.5	97.6%
HERA e	84	63.1	98.8%
PETRA	114	46.5	98.3%
DORIS	87	61	98.7%
DESY II / III	43	123.3	99.4%
transport lines preaccelerators	92	57.6	98.6%
entire DESY	574	9.2	91.9%
analysed period	5304 hrs		

Table 3: MTBF of the power supplies

	Number of PS	MTBF_PS overall	MTBF no external failures
HERA e+p	1166	25985	29310
PETRA	269	12515	13988
DORIS	93	5669	8968

Different counting: every failure was counted when the shift was active.
Also commissioning and testing

HERA Reliability

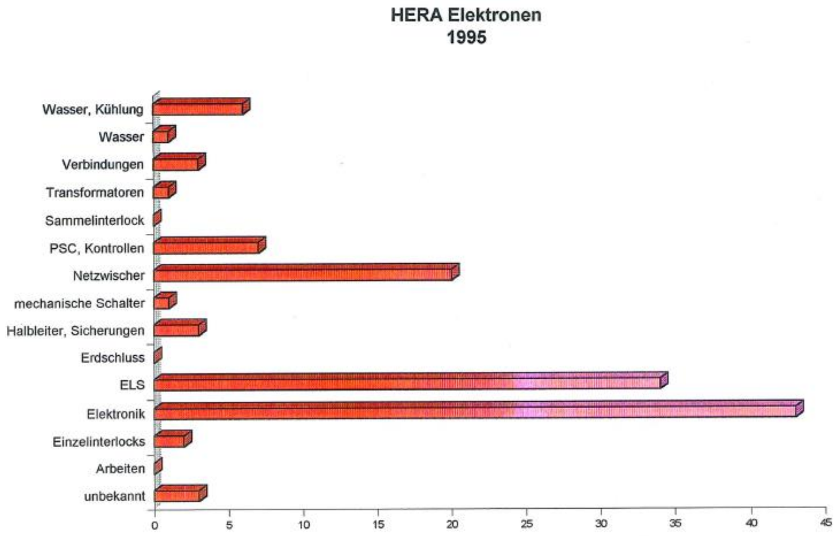
A certain number of components have a somewhat constant failure rate

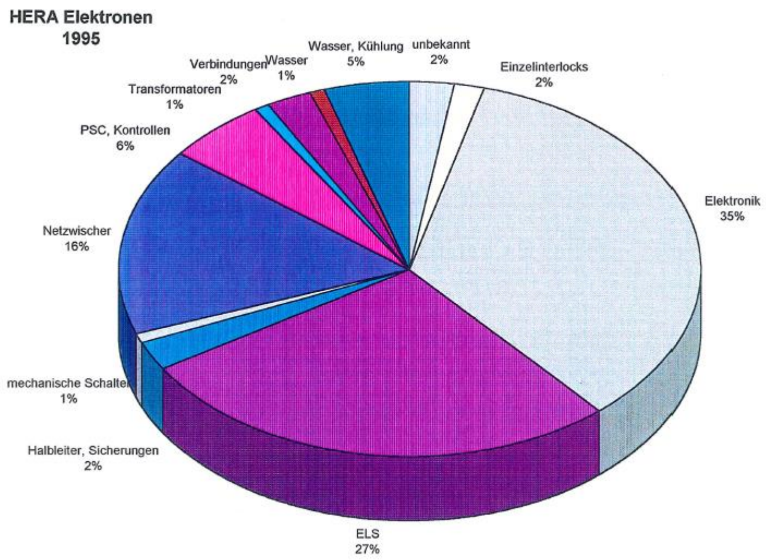
Table 1: Number of events when technical shift crew had to react.

	1996	1995	1993
HERA	238	248	252
PETRA	114	165	143
DORIS	87	81	184
DESY II / III	43	113	n.n.
transport lines preaccelerators	92	131	n.n.
analysed period	5304 hrs	6720 hrs	n.n.

Statistics helps to find the best knob to turn

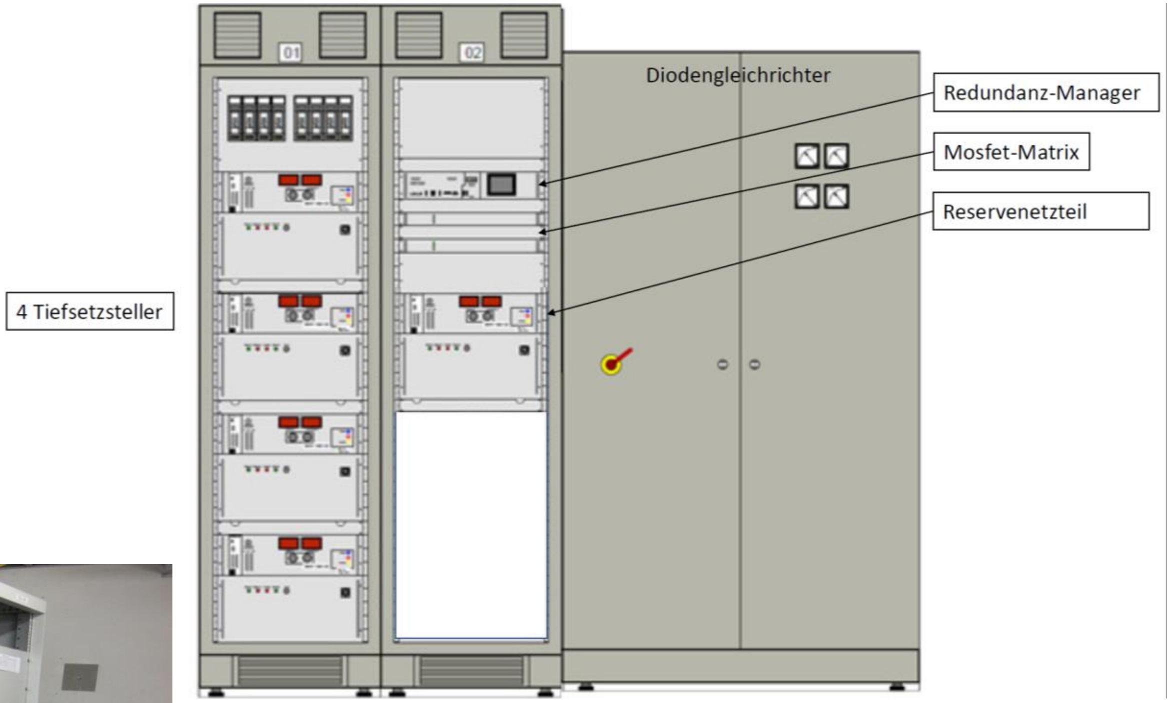
The ELS failure lead to a replacement of all semiconductor switches





Beschleuniger, Teststände und Modulatoren

PETRA III power supplies.



Number of supplies PETRA III.

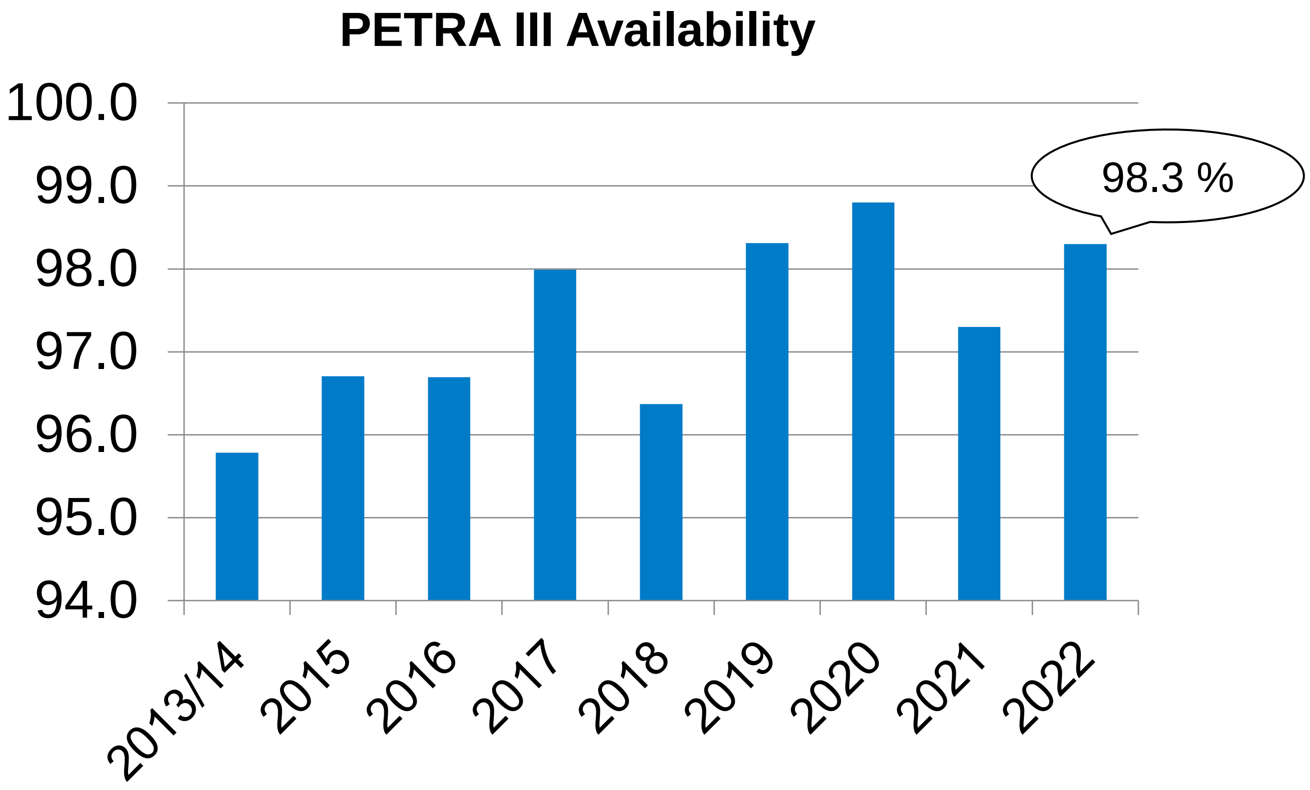
Normalconducting main magnets			
	Current	Voltage	Quantity
Switch mode supplies			
	+/- 55	60	110
	200	60	168
	600	60	96
	400	100	65
		Sum	439
SCR supplies	600	Up to 500	10
Corrector magnets			
	Current	Voltage	Quantity
	10	40	340
	5	60	70
		Sum	410

$\sum$ 859

PETRA III availability, a success story

The PETRA III availability was significantly improved during the last years

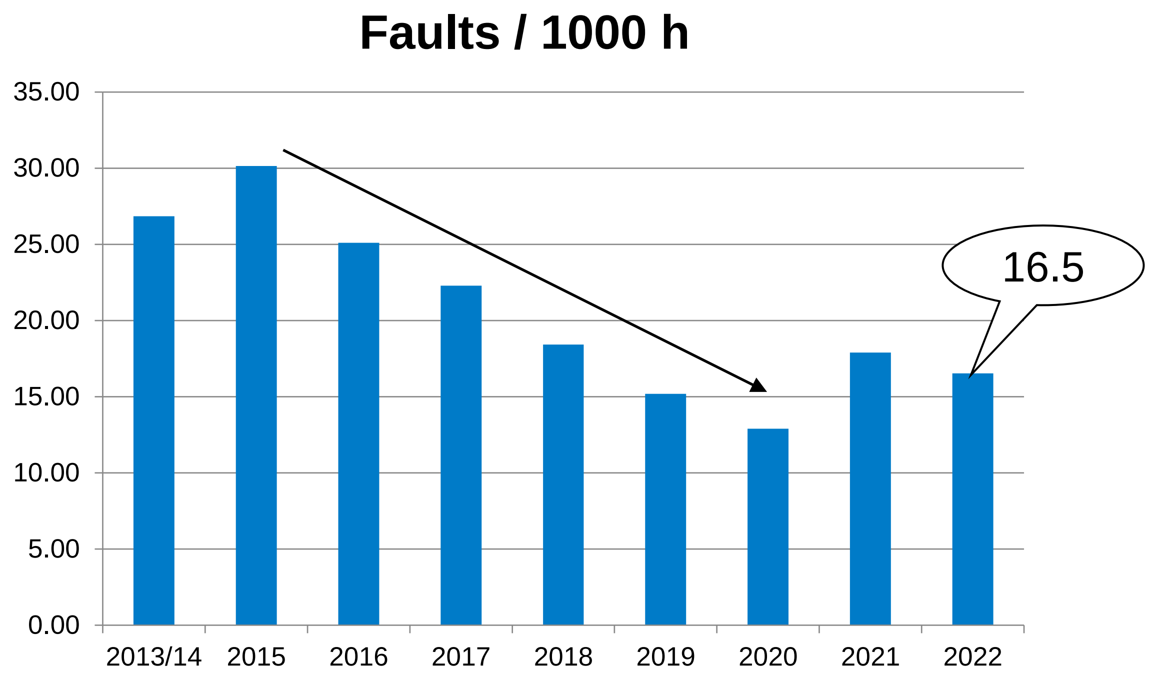
	Availab.	Faults /1000 h	MTBF
Goal 2016	97.0	16.50	57.1
2013/14	95.8	26.84	35.9
2015	96.70	30.14	32.1
2016	96.7	25.11	38.3
2017	97.99	22.30	42.9
2018	96.37	18.4	51.5
2019	98.31	15.2	61.7
2020	98.8	12.90	71.9
2021	97.30	17.9	52.9
2022	98.30	16.54	57.0

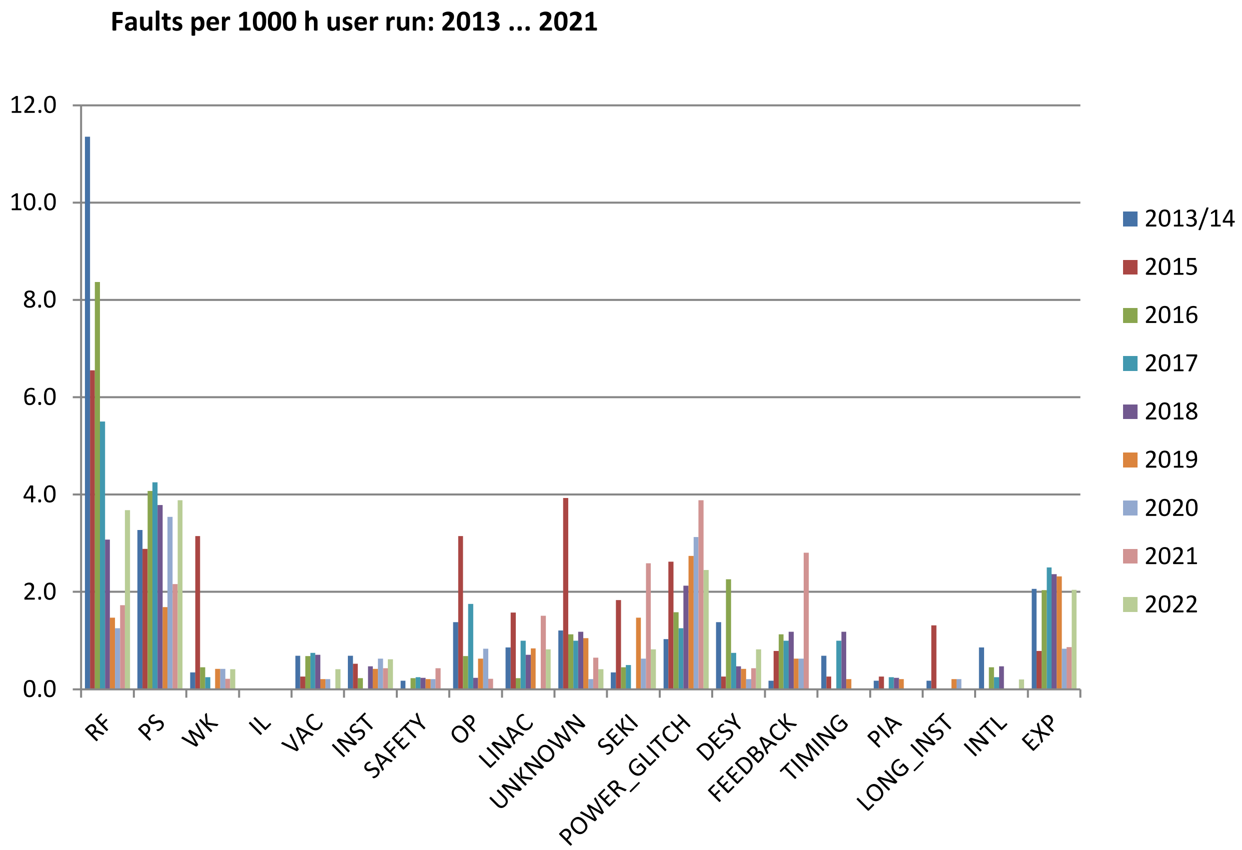


Courtesy R. Wanzenberg

PETRA III faults / 1000 h

Clear trend until 2020

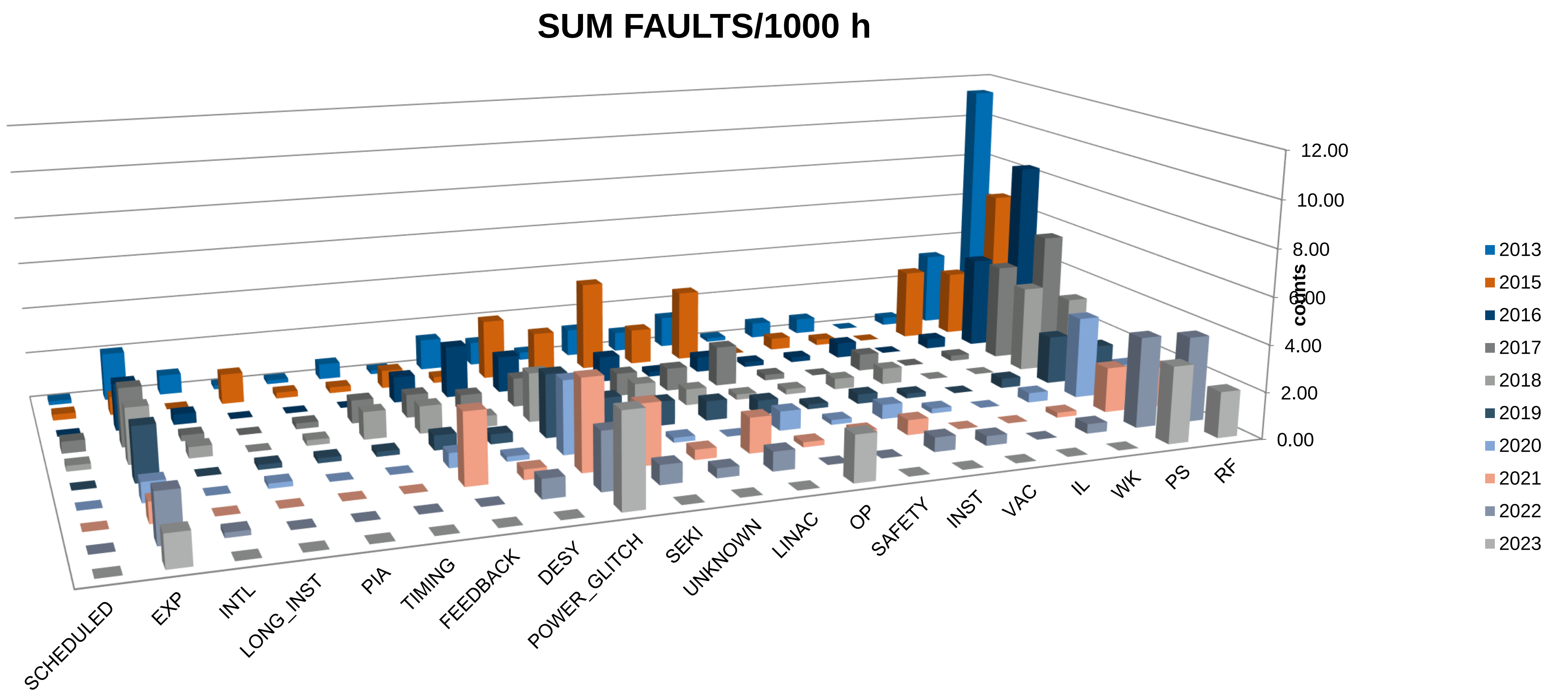




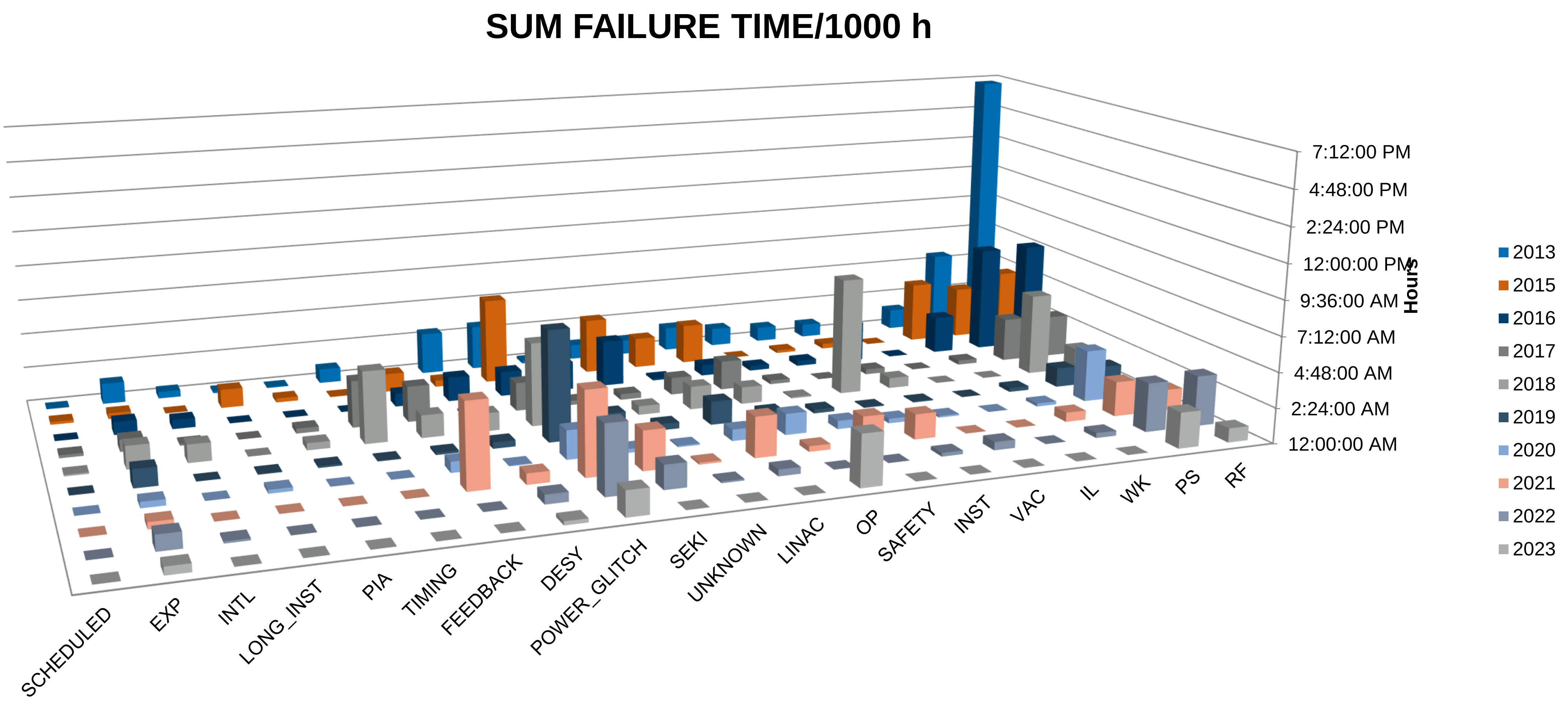
The recent value of 16.5 faults / 1000 h
is just ok, ~ 60 h MTBF

Courtesy R. Wanzenberg

Failure times in PETRA III / 1000 h

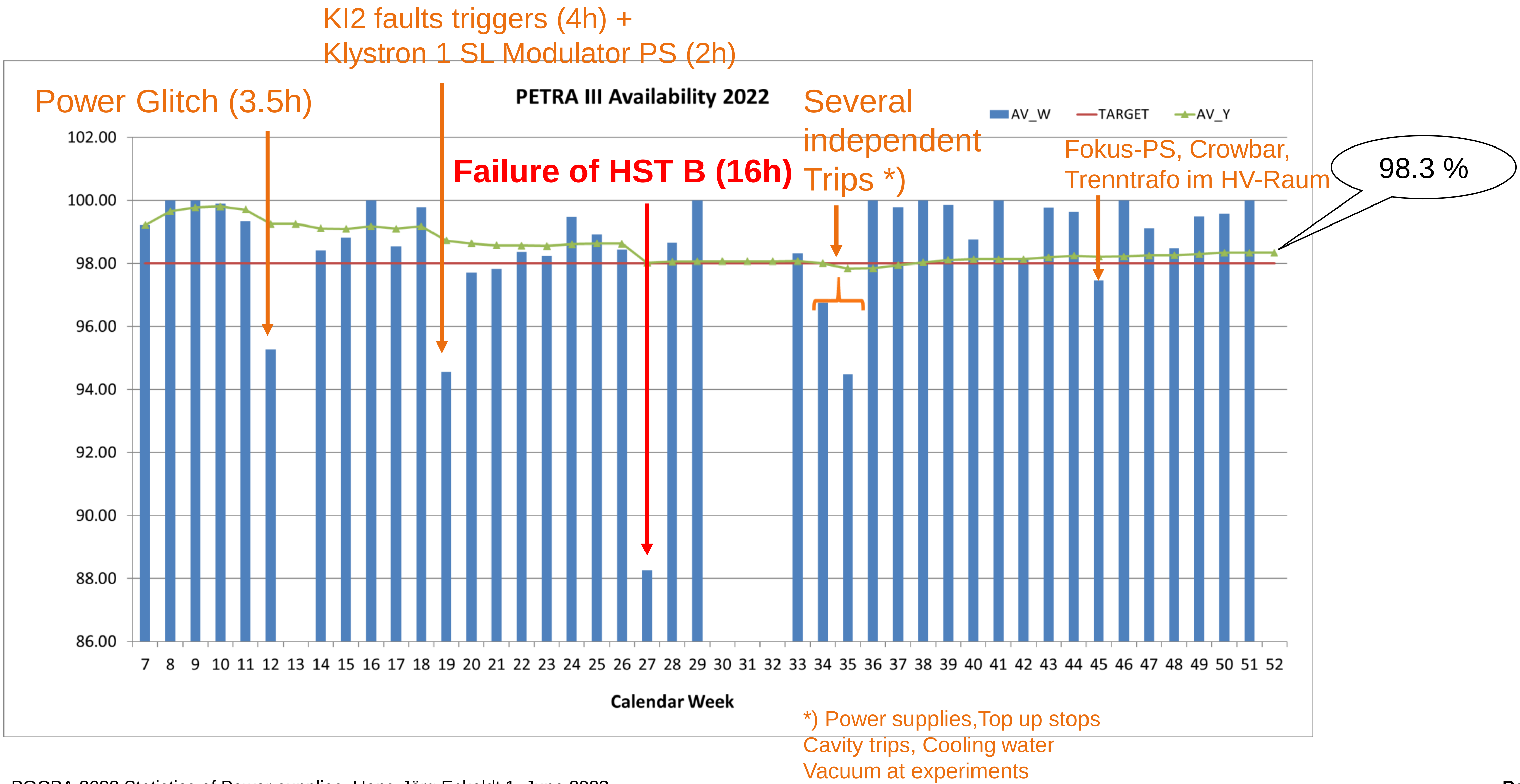


Failure times in PETRA III / 1000 h

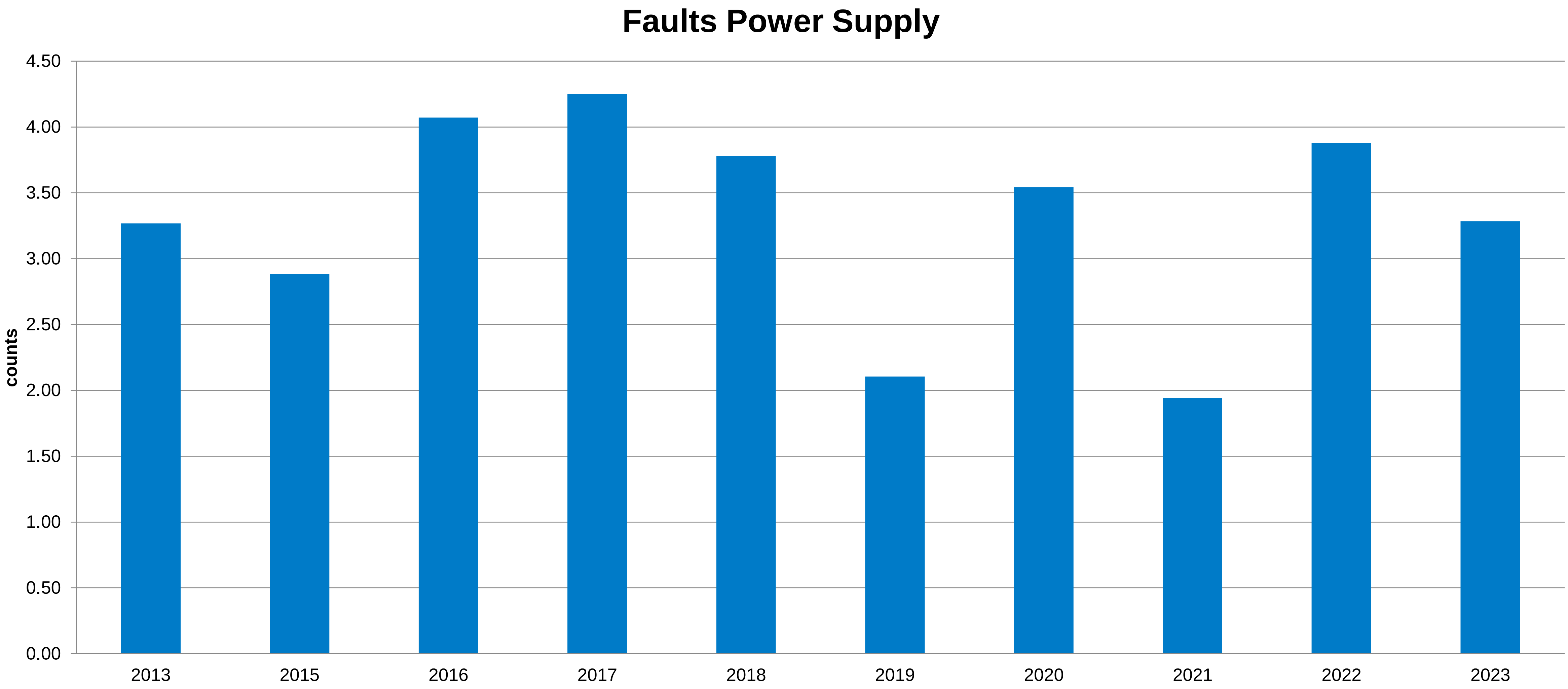


PETRA III weekly statistics in 2022

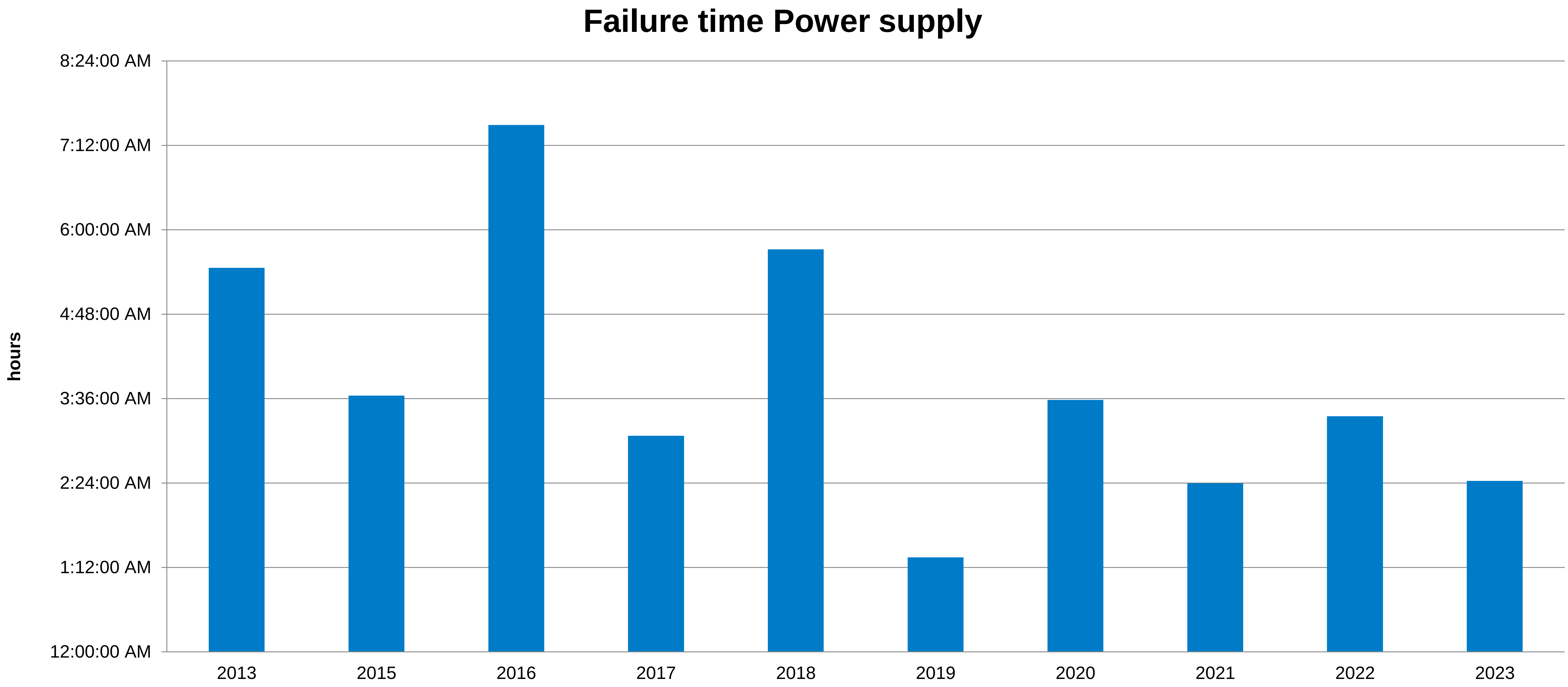
Recovery after bad weeks is possible



Faults PETRA IV power supplies/1000 h

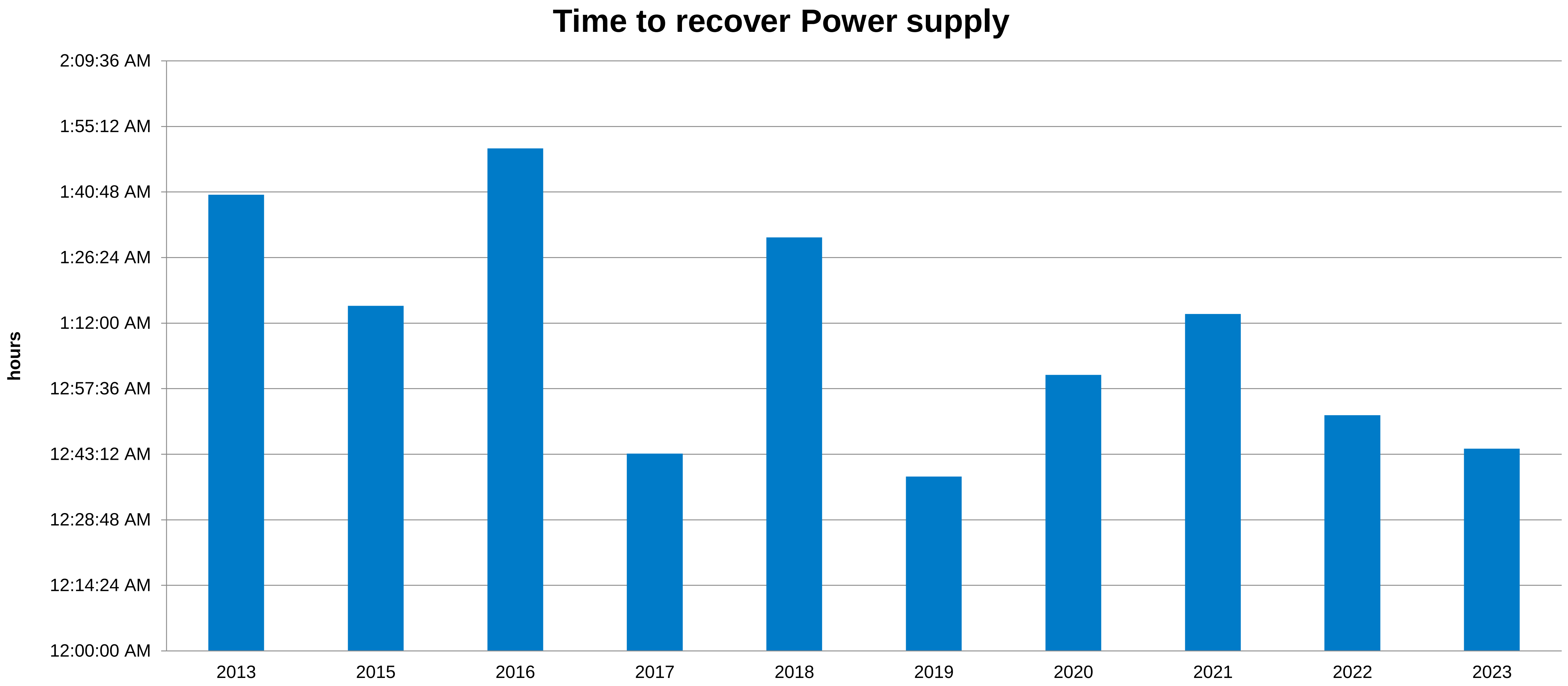


MTTR Power supplies / 1000 h



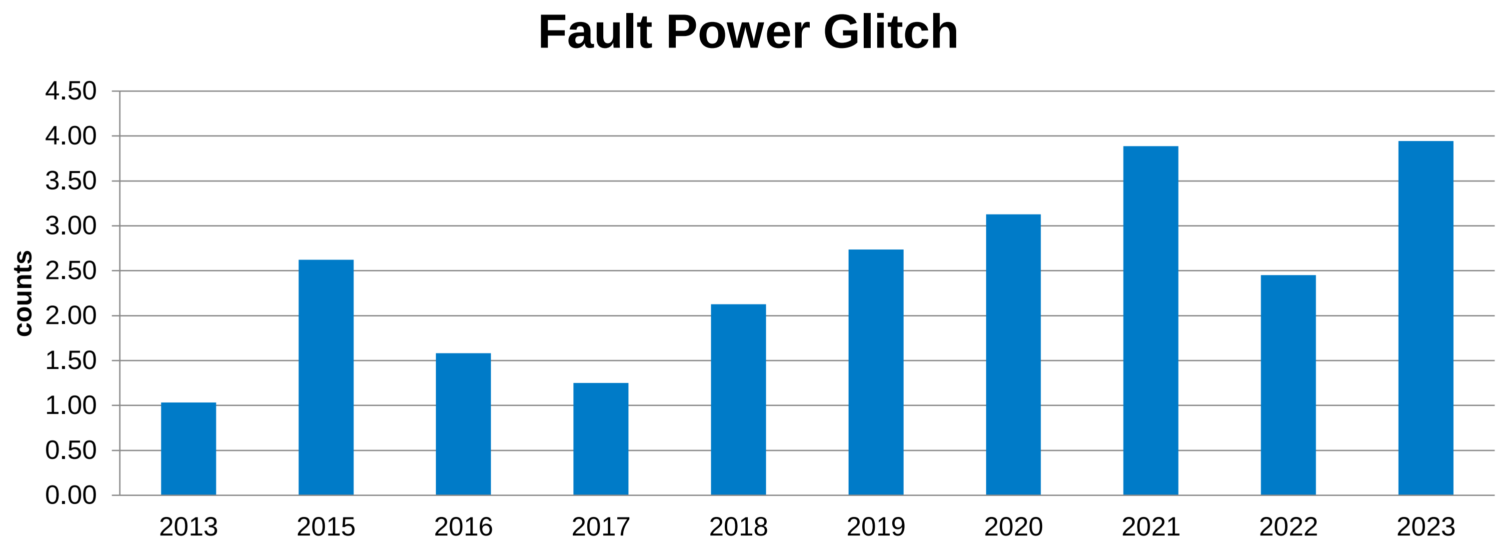
Time to recover from power supply dips / 1000 h

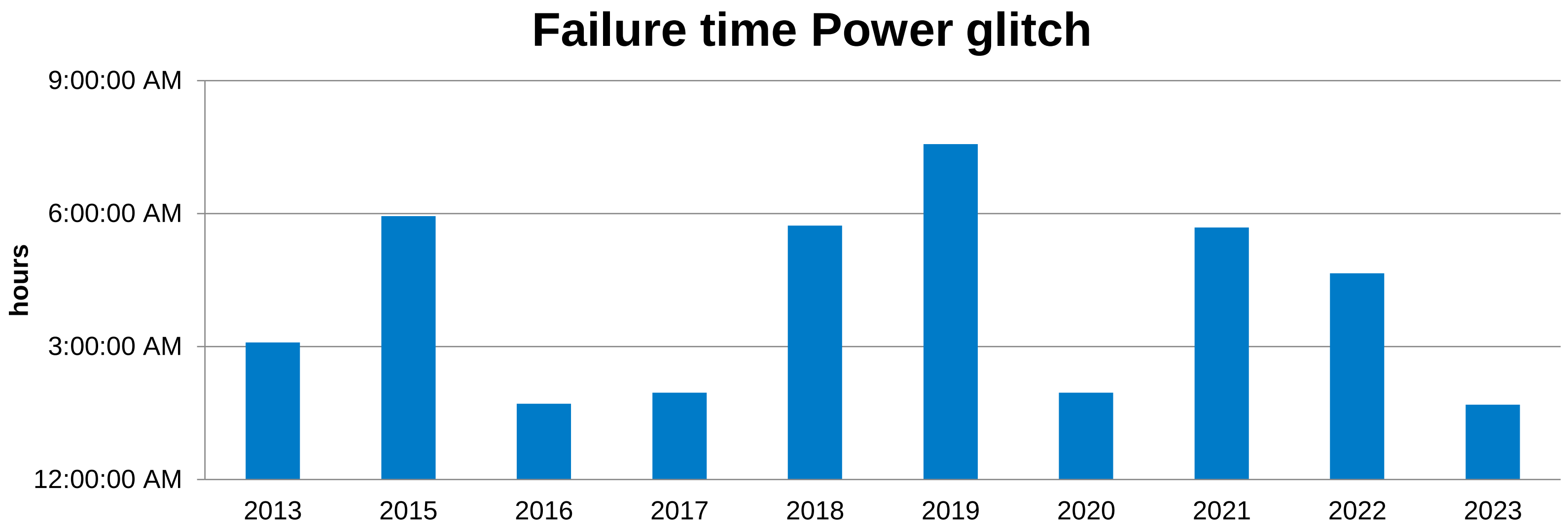
The repair becomes faster due to immediate switching to spare, 20 min magnet cycling, 30 min filling time



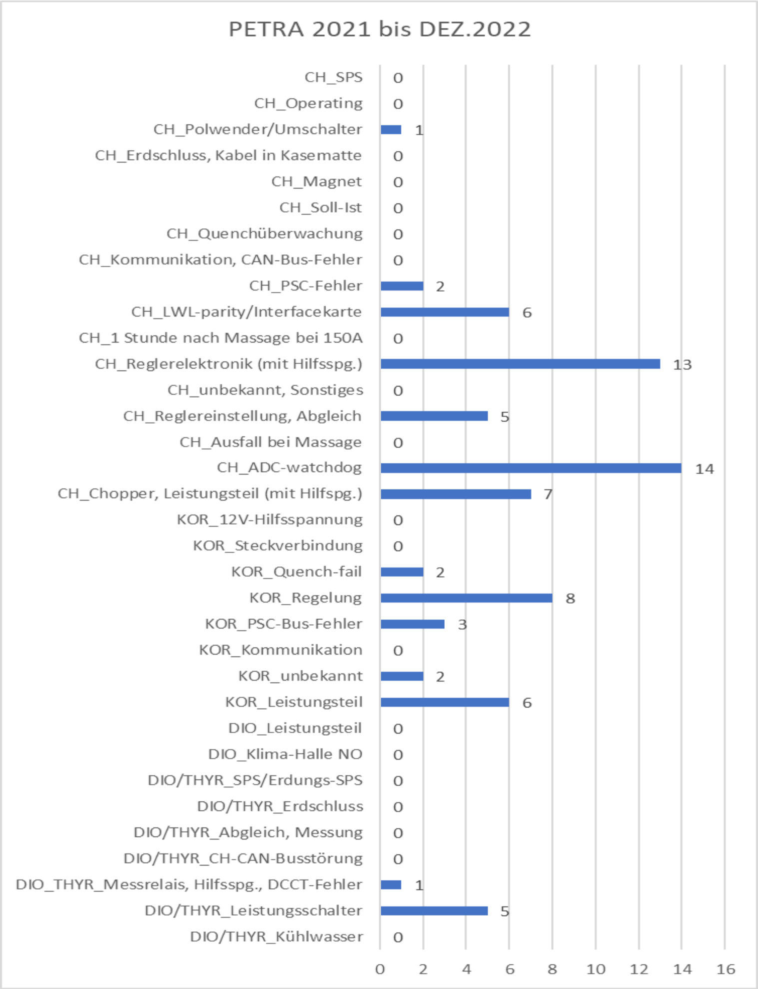
Power glitches /1000h

We see an increase over the years, but we are better in living with them





PETRA trips (2021/2022)



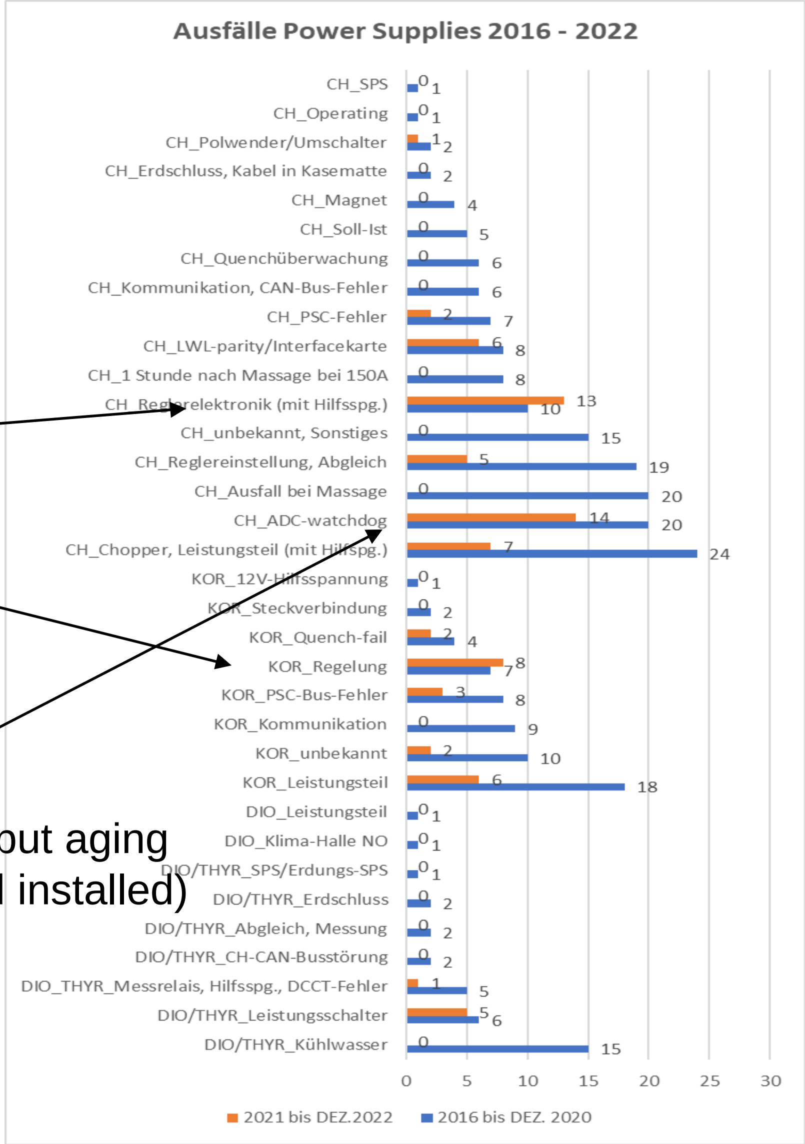
Dioden- and SCR-Units:
- Circuit breaker (when tuning on)
- Water cooling
- Measurement relais

Chopper:
-ADC-Watchdog
-Regelation electronic (with auxiliary power supply)
-Chopper, power part (with auxiliary power supply)
-LWL-parity/Interfacekarte
-Adjustment

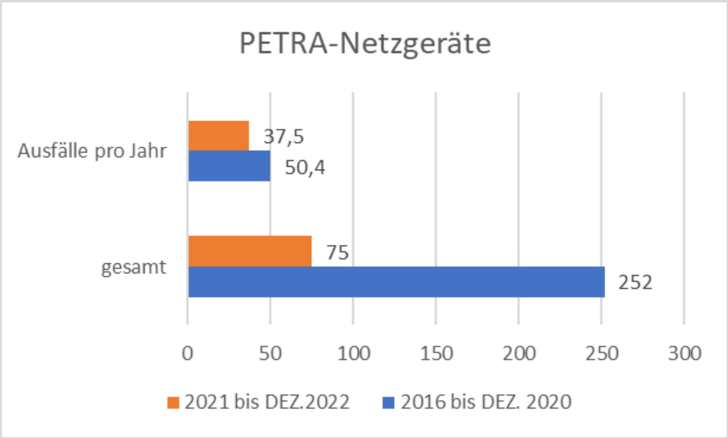
Corrector:
-regulation electronic
-power part defect
-PSC-Bus error
-Quench-fail/Impedance measurement

PETRA: Trips 2016 - 2022

Auxiliary power supplies



Failure decreased but aging effect (work around installed)

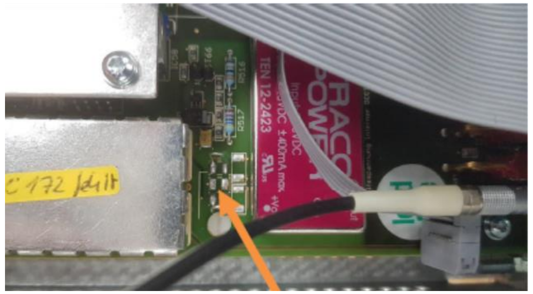


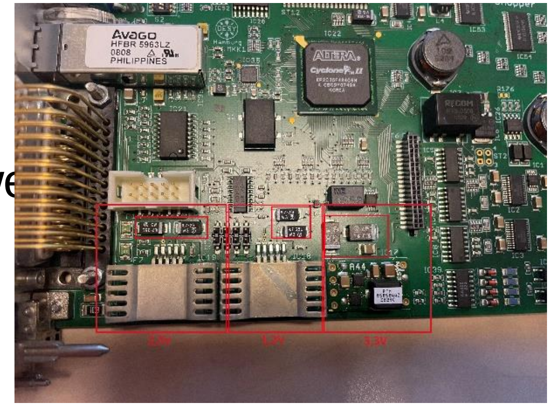
PETRA power supply failures were reuced by 25% in the years, compared to the years 2016-2020

Auxiliary power supplies

Often source for trouble

- In corrector power supply PETRA
  - One lot wrong equipment at the start. 3 A instead of 6A (average current 2A)
    - Strong aging, had to be replaced
  - After 5 years again strong aging are replaced in the moment
    - Same type of supply, reequipped with a longer life time capacitor
  - Regulation electronic
    - In the housing of the regulation electronic space is less an issue.
    - Here the auxiliary supply will be replaced with standard ring core topology.



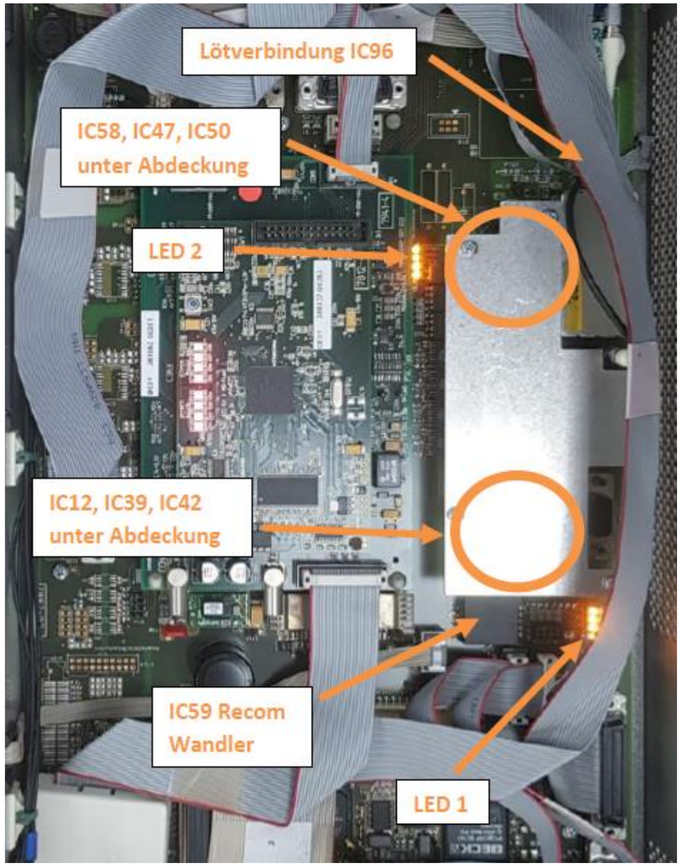


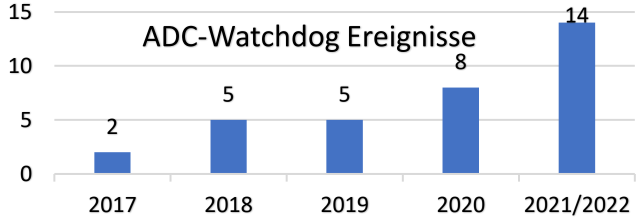
- Overcurrent measurement relays or phase detectors have their own auxiliary powe
  - We detected these burnt after a period of 2 – 4 years. The built in print transformers were detected as trouble source. These overheated regularly.
  - A new auxiliary supply was designed. Problem solved
- It seems that typical commercially available 12 V units have a lifetime of appr. 5 years
- DCCT auxiliaries fail very seldom

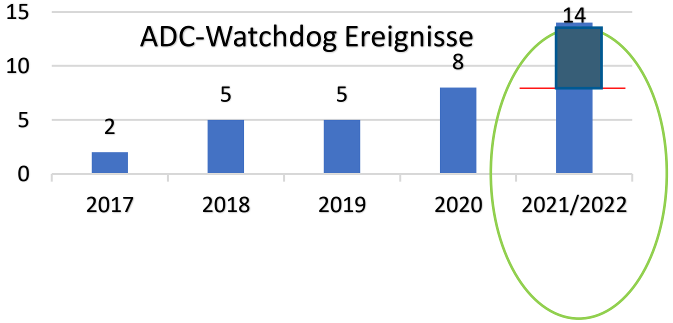
ADC Watchdog

Check of functionality of measurement ADC

- Failure due to a DCDC converter of the current measurement ADC
  - The measurement shows spikes or 0-current. An interlock stopped the supply
  - In case of a watchdog interlock, the power supply will be immediately exchanged
  - So far, a work around was found with via a software. The software prevents the unwanted reaction of the regulation for a short time. Additionally a warning message indicates the malfunction. The power supply will then be exchanged at the next maintenance day
  - The exchange of the device is very complex (SMD-soldering)



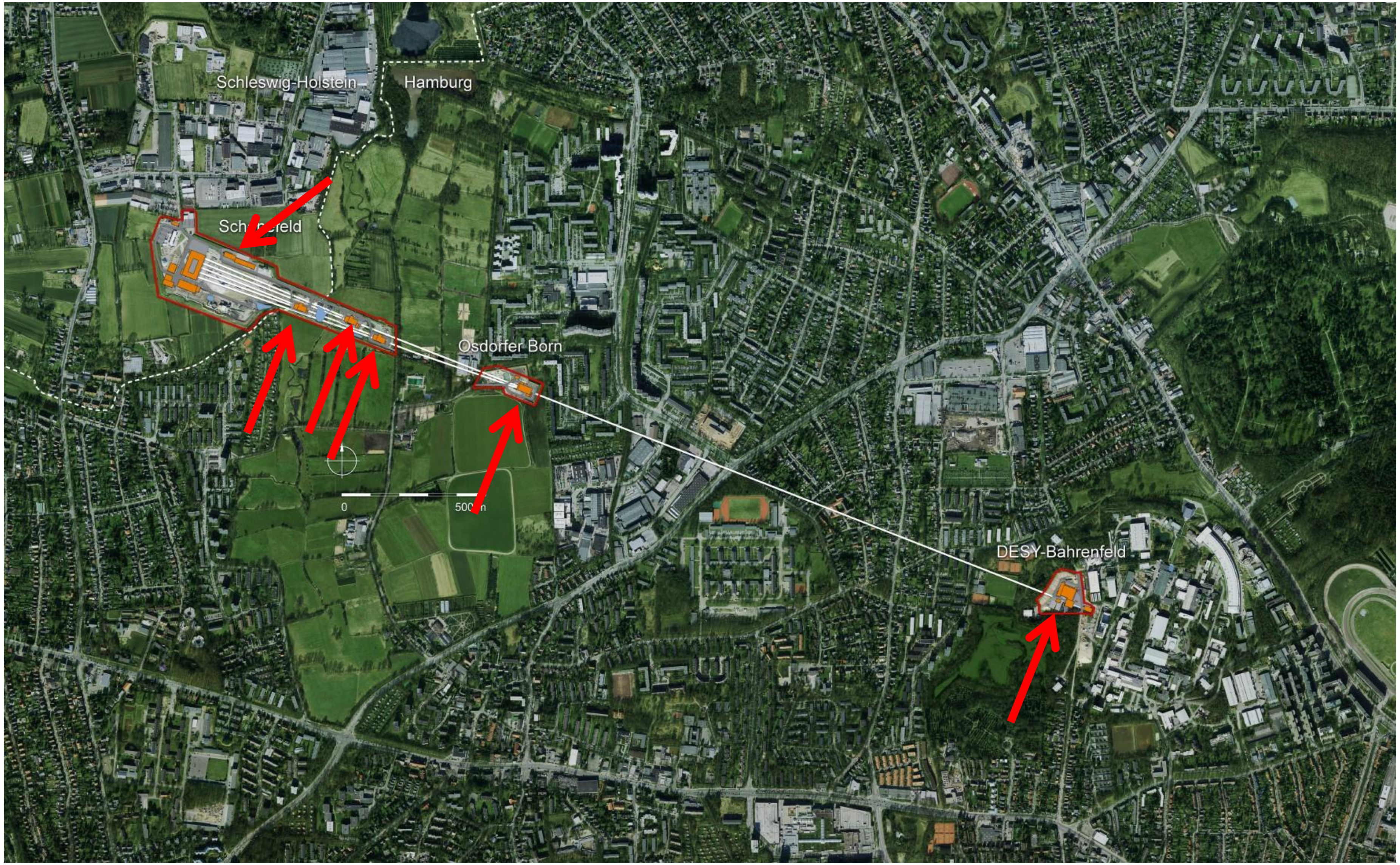




XFEL

XFEL.

Location of magnet power supplies



Injector complex.

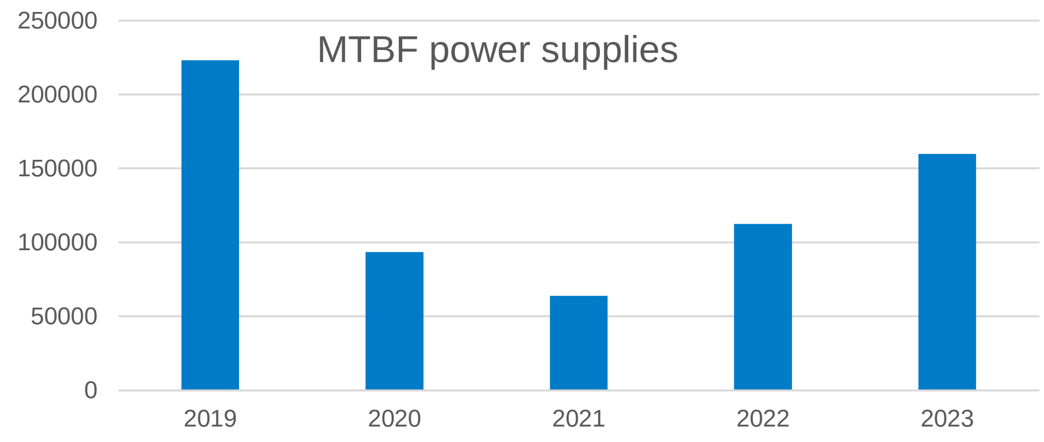
Number of supplies.

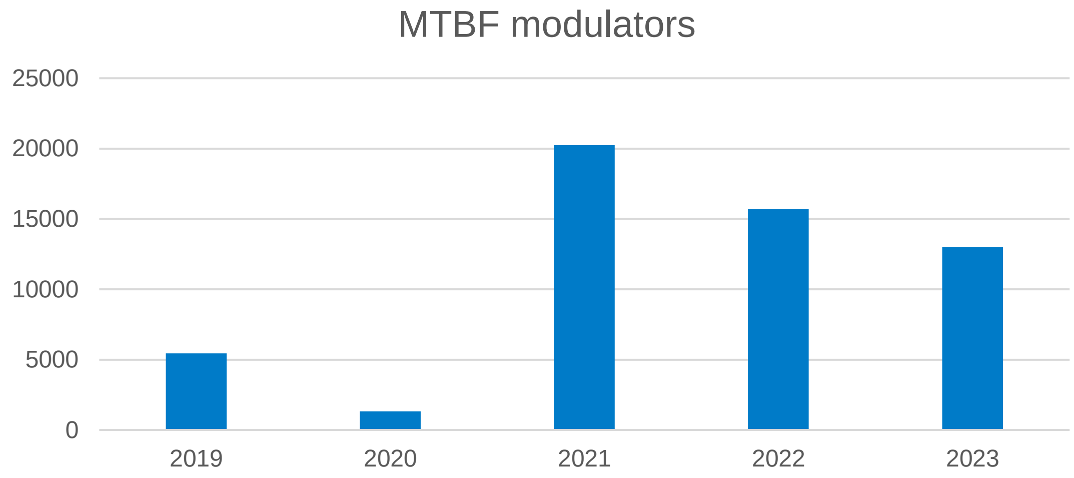
Normal conducting main magnets			
	Current	Voltage	Quantity
	15	40	53
	200	60	164
	200	120	48
	200	400	2
	600	200	2
	600	300	6
	600	400	2
	600	120	22
	600	60	12
		Sum	258
Superconducting magnets		In kind Spain	University of Madrid
	Current	Voltage	Quantity
	50	10	222
Corrector magnets		In kind Russia	Budker Institute Novosibirsk
	Current	Voltage	Quantity
	5	10/40/60	
	10	40/60	
		Sum	330

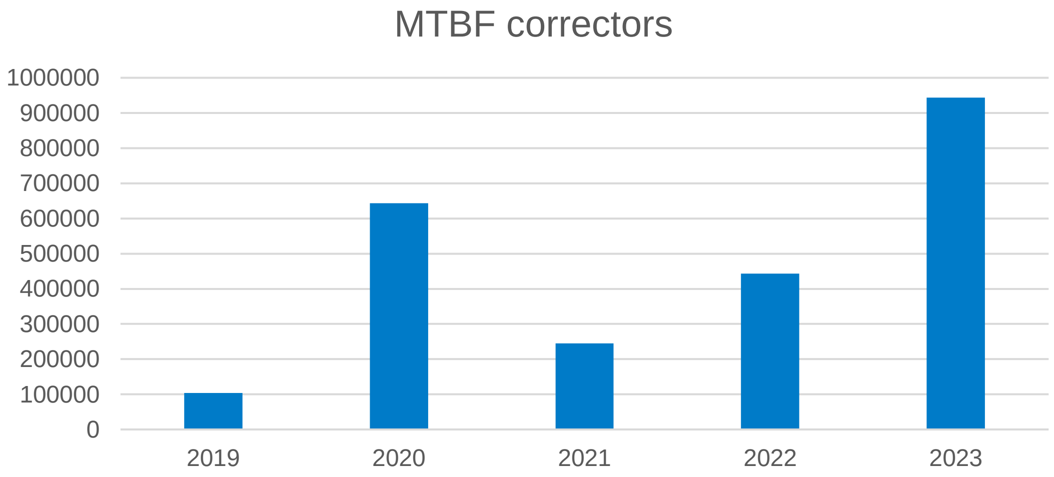
$\sum 810$

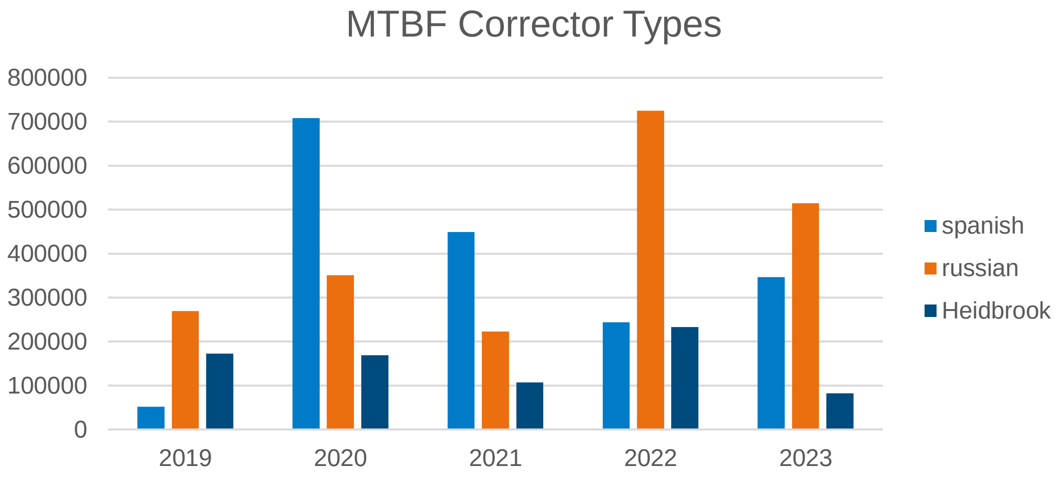
Power parts in the XFEL

Modulators (250 kW, switching MW at 10 kVlevel), Chopper supplies 12-480 kW), correctors (600W)









Swap systems to recover from trips

Redundancy system.

- For a group of power supplies a spare power supply is installed.
- In case of failure, the shift crew detects the failure.
- The shift crew switches over to the spare PS.
- Within few minutes the machine can restart to operate.

Power Supplies PETRA IV

Magnet	Electrical data of power supplies	Number
Quadrupoles	120A/30V	1348
Sextupoles	15A/30V	432
Octupoles	30A/30V	288
Correctors incl. FOFB units/skew quads	+/- 15A/+/-48 V	2372

∑ 4440

Increase reliability!!!

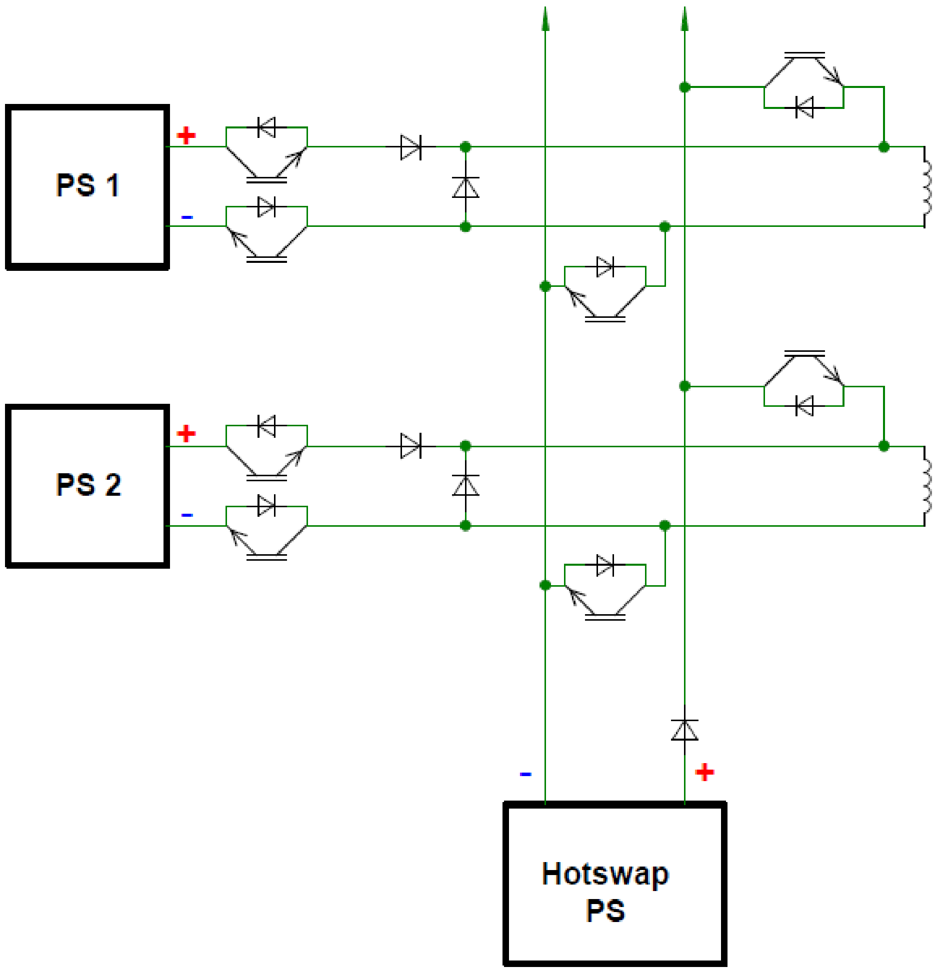
Why hot swap?

- This task will be difficult to solve.
  - The failure rate of the power supplies is directly related to the number of supplies.
    - PE IV have roughly a factor of 5 more supplies than PE III
    - A factor of 2-3 less failure rate would be required, leading to an increase of 10 to 15 that the new power supplies have to be better than the old ones.
    - The DESY power supplies are in comparison with other accelerators already at high level.
  - **The increase of reliability by a factor of 10-15 is not feasible staying with this technology**
  - **Solution would be a hot swap system, replacing a broken Power supply automatically by a spare one with the help of semiconductor switches (invented by ESRF)**

Hot swap ideas

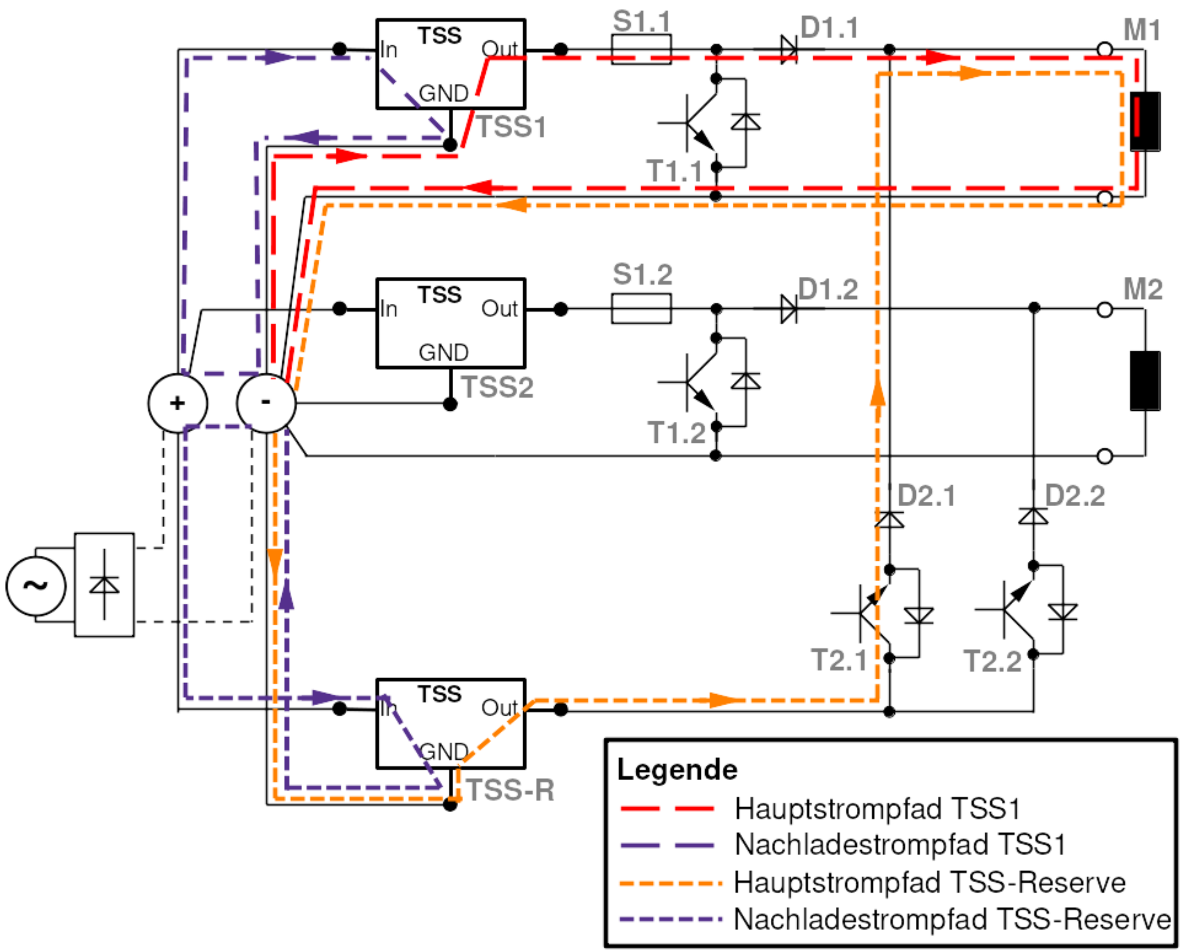
With a fast switching matrix tripped PS will be replace in short time

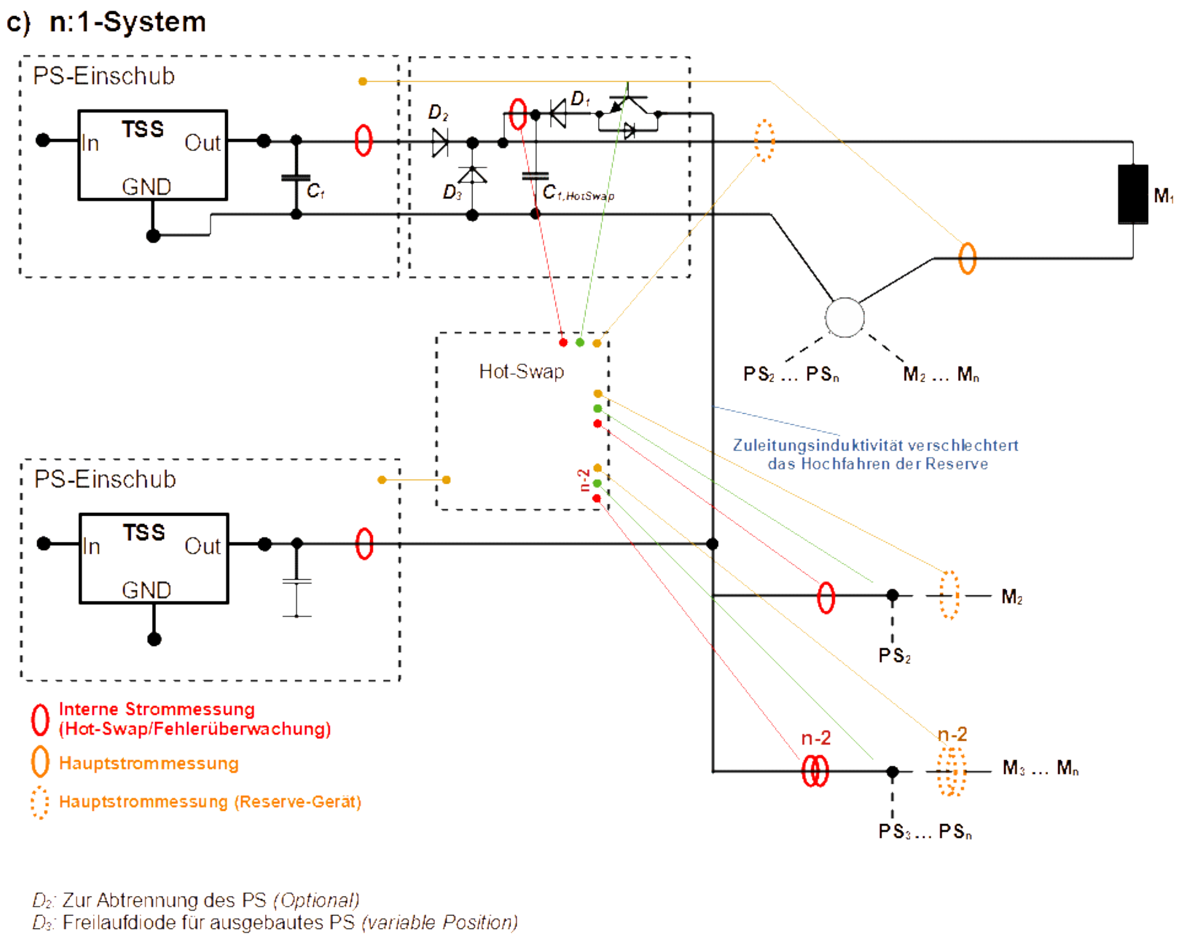
Version developped
By ESRF



Hot-Swap different variants

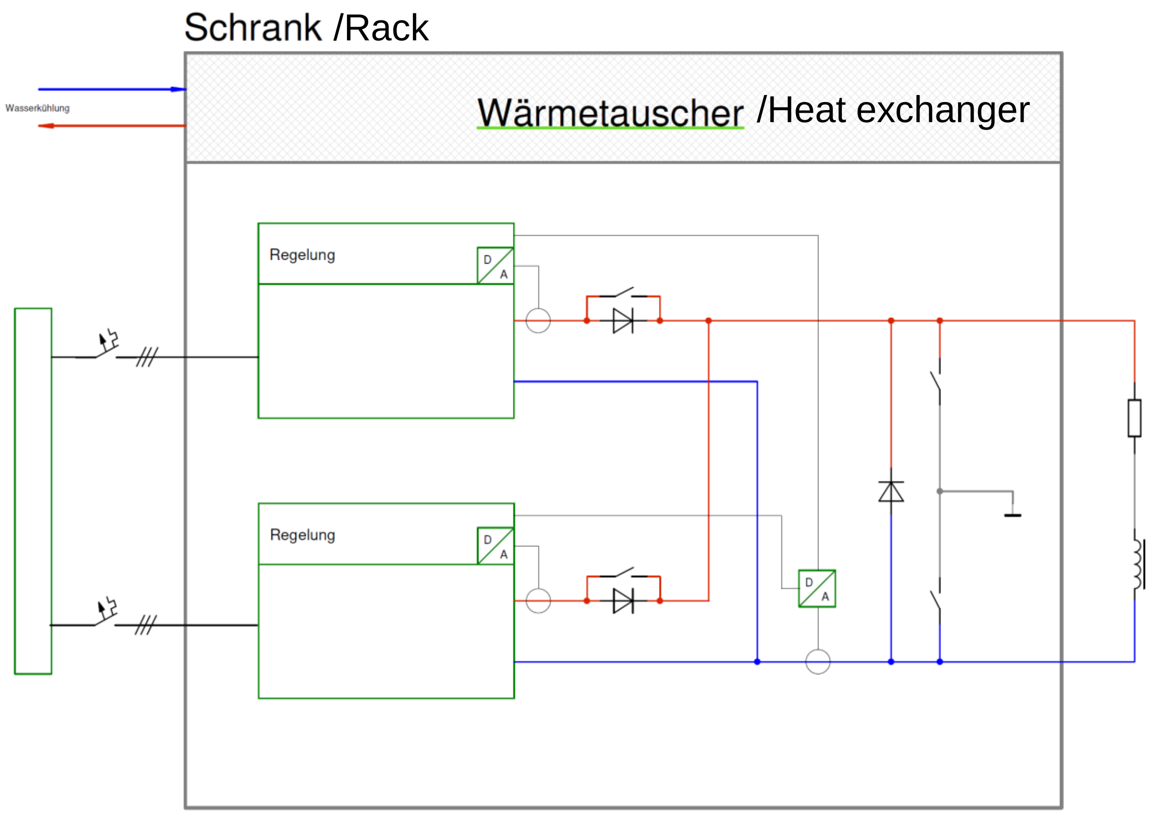
Version 2.0, version 2.1





Hot swap system V3.0

Overview already shown last TAC



- Complete redundancy supply
  - No contingency within the power supply
  - Two power supplies in parallel
  - In case one supply fails, the second supply takes over
  - No additional “intelligence” is needed for switching nor switching matrix
  - By monitoring the output filter current, a very fast detection of failure can be guaranteed.
  - Low current testing shows very good results
  - High current tests to be finished in the next time

Small signal tests of the full redundant supply

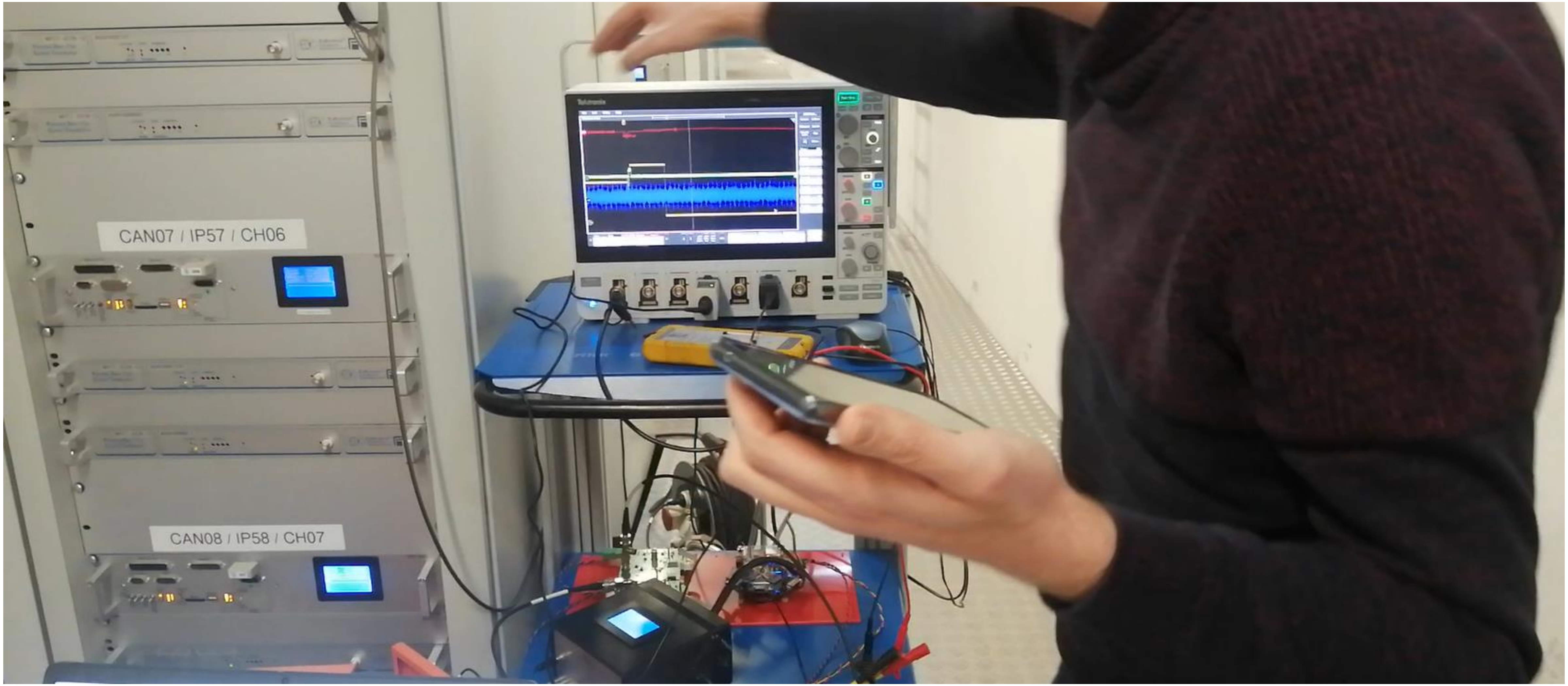
Results from last TAC

Ch1 (yellow):	PWM signal
Ch 3 (blue):	Filter current
Ch 3 (magenta):	Output current in AC-mode 3,3 mA/div on a 3 A DC current $=1*10^{-3}$
Ch4 (green)	Output voltage

Failure is detected within 30 µs, deviation $2*10^{-4}$

First Hot Swap Test with beam was successful

Yippee



Repeated Hot Swap Test with beam again successful

This time 60mA, 80 mA, 100 mA beam, switching from one power supply to the next in 6 sec. interval

Hello Riccardo,

For the hot-swap test a quadrupole PS in the von-Laue hall was used.
According to MPC, the current drop was <5 mA for a current of 112 A of
the PS. So it was only a dk/k = 4e-5:

https://ttfinfo.desy.de/elog/FileEdit?file=/petra/data/2023/11/15.03_a/2023-03-15T16:36:26-00.xml&xsl=/elogbook/xsl/elog-fileform.xsl&mode=edit

From the machine side we have seen nothing during the hot-swap test; no drop in lifetime, no change in currents of the orbit feedback and no orbit distortion.

I've tried to measure some turn-by-turn orbit data during the test (decimated mode with a length of 16 s) with one BPM but there was no orbit distortion related to the hot-swap seen. However, the orbit feedback was running all the time and it was a quadrupole (so the orbit distortion depends on the offset of the orbit in the quadrupole).

Regards,
Joachim

Repeated Hot Swap Test with beam again successful

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https://ttfinfo.desy.de/elog/ ...).xml&xsl=/elogbook/xsl/elog-fileform.xsl&mode=edit

The result was so good, that we now will look at the 1:n solution, even if it might have a slightly lower performance

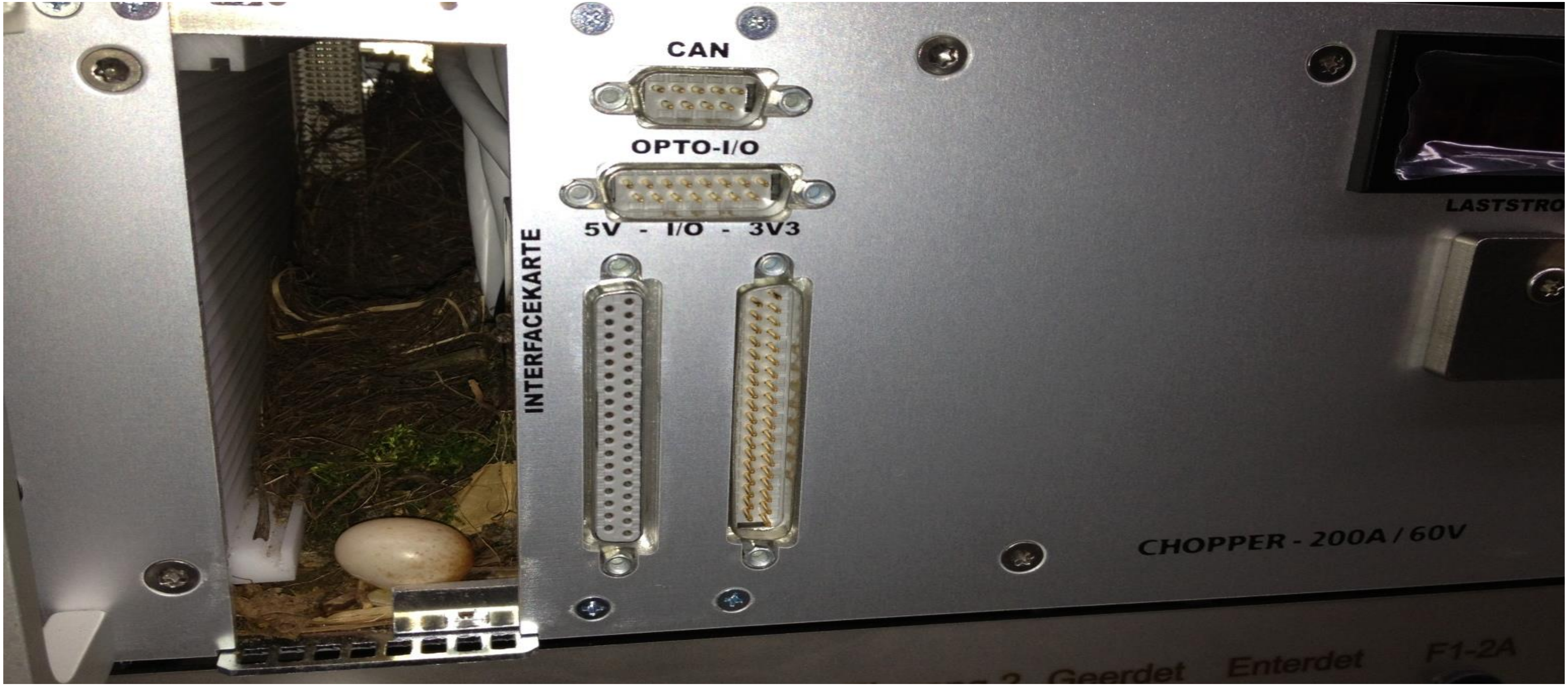
From the machine side we ... drop in lifetime, no change ... orbit distortion.

I've tried to measure some turn-by-turn orbit data during the test (decimated mode with a length of 16 s) with one BPM but there was no orbit distortion related to the hot-swap seen. However, the orbit feedback was running all the time and it was a quadrupole (so the orbit distortion depends on the offset of the orbit in the quadrupole).

Regards,
Joachim

Even with the best statistics not foreseeable failures occur and have to be handled

One cannot predict every failure!



One cannot predict every failure!

Thank you for your attention and my team for doing such a the good job

Keep in mind:

One failure can happen
Two is the start of a series

Contact

Deutsches Elektronen-
Synchrotron DESY

www.desy.de

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MPC
Hans-joerg.eckoldt@desy.de
+ 49 (0)170 634 2366

Additional material

Maintenance

Maintenance

- No regular maintenance is done in the sense of oil-change in a car

- The available time to do maintenance work at the supplies is getting shorter due to the demands of the user and machine
  - During the maintenance day usually the time is just sufficient to replace broken components.

What to do instead?

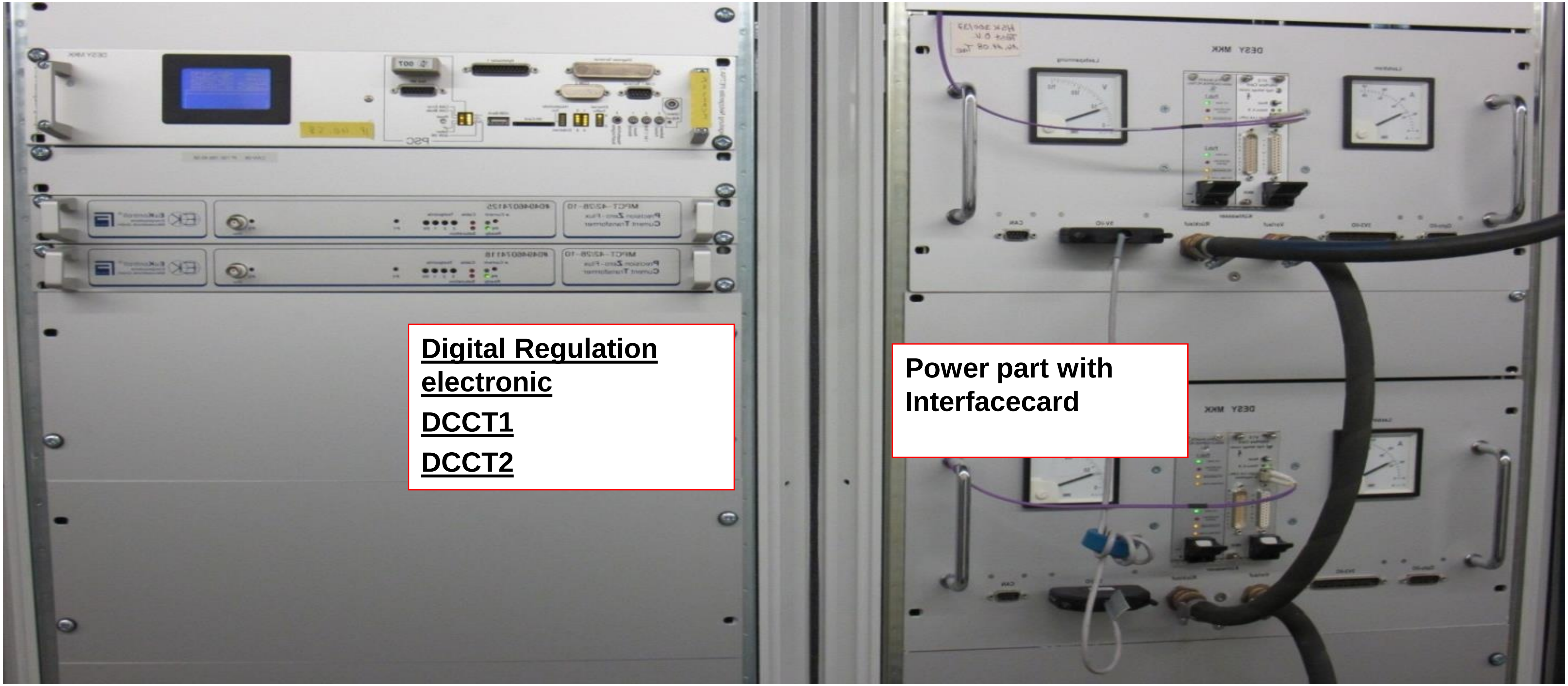
- Failure analysis
  - Each failure is written into the electronic logbook and analyzed
  - By this series failures can be detected
    - One series failure was an auxiliary power supply that started to fail after 3 years of operation.
    - All auxiliary power supplies (600) were replaced during this shutdown
    - This took 8 weeks (a work that cannot be done during the maintenance days)
    - Shortly afterwards a new failure appeared by a bad contact
    -
- Remote access and scans of data with the digital regulation
  - Eg. Ripple, temperatures
  - Big advantage is that this can be done during the machine operation
  - (when there will be the next for PETRA or first XFEL run)
  - When a „strange“ supply is detected, it will be replaced during the maintenance day and examined in the test stand

Work during long shut-downs

Preventive maintenance

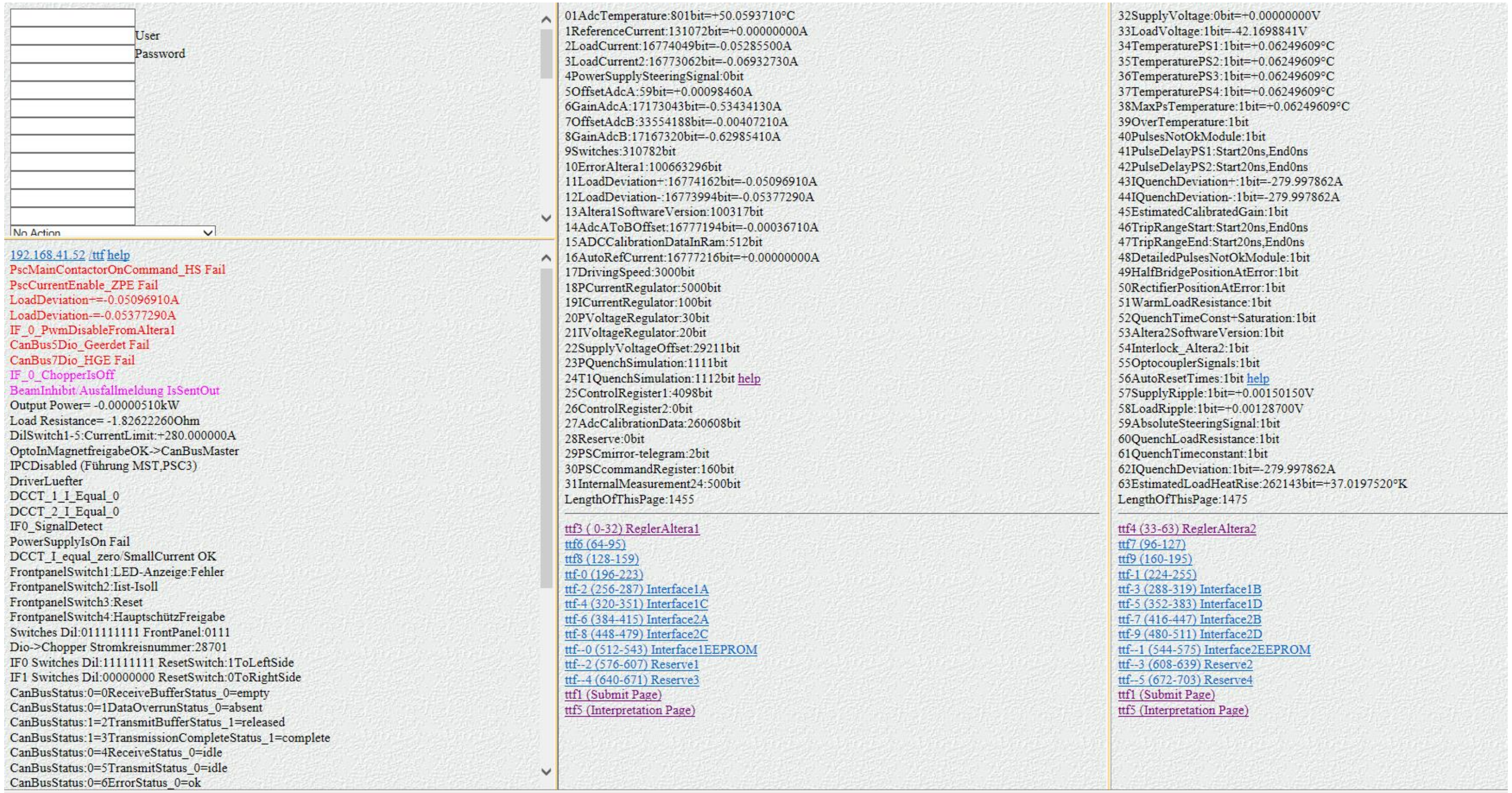
- Test Grounding switches,
- Check of screw connections
- Check of accuracy of current and voltage values
- Calibration of DCCTs if necessary
- Scans of control electronics
- Emergency off-Test :
  - Has to be done regularly
- Check ofWater components
  - Magnet valves
  - Hoses, leaks

Assembly of power supply



Homepage of a PS

About 500 signals can be read out



User
Password
No Action

192.168.41.52 /ttf help
PscMainContactorOnCommand_HS Fail
PscCurrentEnable_ZPE Fail
LoadDeviation+=-0.05096910A
LoadDeviation-=-0.05377290A
IF_0_PwmDisableFromAltera1
CanBus5Dio_Geerdet Fail
CanBus7Dio_HGE Fail
IF_0_ChopperIsOff
BeamInhibit/Ausfallmeldung IsSentOut
Output Power= -0.00000510kW
Load Resistance= -1.82622260Ohm
DilSwitch1-5:CurrentLimit:+280.000000A
OptoInMagnetfreigabeOK->CanBusMaster
IPCDisabled (Führung MST,PSC3)
DriverLuefter
DCCT_1_I_Equal_0
DCCT_2_I_Equal_0
IF0_SignalDetect
PowerSupplyIsOn Fail
DCCT_I_equal_zero/SmallCurrent OK
FrontpanelSwitch1:LED-Anzeige:Fehler
FrontpanelSwitch2:Iist-Isoll
FrontpanelSwitch3:Reset
FrontpanelSwitch4:HauptschützFreigabe
Switches Dil:011111111 FrontPanel:0111
Dio->Chopper Stromkreisnummer:28701
IF0 Switches Dil:11111111 ResetSwitch:1ToLeftSide
IF1 Switches Dil:00000000 ResetSwitch:0ToRightSide
CanBusStatus:0=0ReceiveBufferStatus_0=empty
CanBusStatus:0=1DataOverrunStatus_0=absent
CanBusStatus:1=2TransmitBufferStatus_1=released
CanBusStatus:1=3TransmissionCompleteStatus_1=complete
CanBusStatus:0=4ReceiveStatus_0=idle
CanBusStatus:0=5TransmitStatus_0=idle
CanBusStatus:0=6ErrorStatus_0=ok

01AdcTemperature:801bit=+50.0593710°C
1ReferenceCurrent:131072bit=+0.00000000A
2LoadCurrent:16774049bit=-0.05285500A
3LoadCurrent2:16773062bit=-0.06932730A
4PowerSupplySteeringSignal:0bit
5OffsetAdcA:59bit=+0.00098460A
6GainAdcA:17173043bit=-0.53434130A
7OffsetAdcB:33554188bit=-0.00407210A
8GainAdcB:17167320bit=-0.62985410A
9Switches:310782bit
10ErrorAltera1:100663296bit
11LoadDeviation+:16774162bit=-0.05096910A
12LoadDeviation-:16773994bit=-0.05377290A
13Altera1SoftwareVersion:100317bit
14AdcAToBOffset:16777194bit=-0.00036710A
15ADCCalibrationDataInRam:512bit
16AutoRefCurrent:16777216bit=+0.00000000A
17DrivingSpeed:3000bit
18PCurrentRegulator:5000bit
19ICurrentRegulator:100bit
20PVoltageRegulator:30bit
21IVoltageRegulator:20bit
22SupplyVoltageOffset:29211bit
23PQuenchSimulation:1111bit
24T1QuenchSimulation:1112bit help
25ControlRegister1:4098bit
26ControlRegister2:0bit
27AdcCalibrationData:260608bit
28Reserve:0bit
29PSCmirror-telegram:2bit
30PSCcommandRegister:160bit
31InternalMeasurement24:500bit
LengthOfThisPage:1455

ttf3 (0-32) ReglerAltera1
ttf6 (64-95)
ttf8 (128-159)
ttf-0 (196-223)
ttf-2 (256-287) Interface1A
ttf-4 (320-351) Interface1C
ttf-6 (384-415) Interface2A
ttf-8 (448-479) Interface2C
ttf--0 (512-543) Interface1EEPROM
ttf--2 (576-607) Reserve1
ttf--4 (640-671) Reserve3
ttf1 (Submit Page)
ttf5 (Interpretation Page)

32SupplyVoltage:0bit=+0.00000000V
33LoadVoltage:1bit=-42.1698841V
34TemperaturePS1:1bit=+0.06249609°C
35TemperaturePS2:1bit=+0.06249609°C
36TemperaturePS3:1bit=+0.06249609°C
37TemperaturePS4:1bit=+0.06249609°C
38MaxPsTemperature:1bit=+0.06249609°C
39OverTemperature:1bit
40PulsesNotOkModule:1bit
41PulseDelayPS1:Start20ns,End0ns
42PulseDelayPS2:Start20ns,End0ns
43IQuenchDeviation+:1bit=-279.997862A
44IQuenchDeviation-:1bit=-279.997862A
45EstimatedCalibratedGain:1bit
46TripRangeStart:Start20ns,End0ns
47TripRangeEnd:Start20ns,End0ns
48DetailedPulsesNotOkModule:1bit
49HalfBridgePositionAtError:1bit
50RectifierPositionAtError:1bit
51WarmLoadResistance:1bit
52QuenchTimeConst+Saturation:1bit
53Altera2SoftwareVersion:1bit
54Interlock_Altera2:1bit
55OptocouplerSignals:1bit
56AutoResetTimes:1bit help
57SupplyRipple:1bit=+0.00150150V
58LoadRipple:1bit=+0.00128700V
59AbsoluteSteeringSignal:1bit
60QuenchLoadResistance:1bit
61QuenchTimeconstant:1bit
62IQuenchDeviation:1bit=-279.997862A
63EstimatedLoadHeatRise:262143bit=+37.0197520°K
LengthOfThisPage:1475

ttf4 (33-63) ReglerAltera2
ttf7 (96-127)
ttf9 (160-195)
ttf-1 (224-255)
ttf-3 (288-319) Interface1B
ttf-5 (352-383) Interface1D
ttf-7 (416-447) Interface2B
ttf-9 (480-511) Interface2D
ttf--1 (544-575) Interface2EEPROM
ttf--3 (608-639) Reserve2
ttf--5 (672-703) Reserve4
ttf1 (Submit Page)
ttf5 (Interpretation Page)

Scan Tool

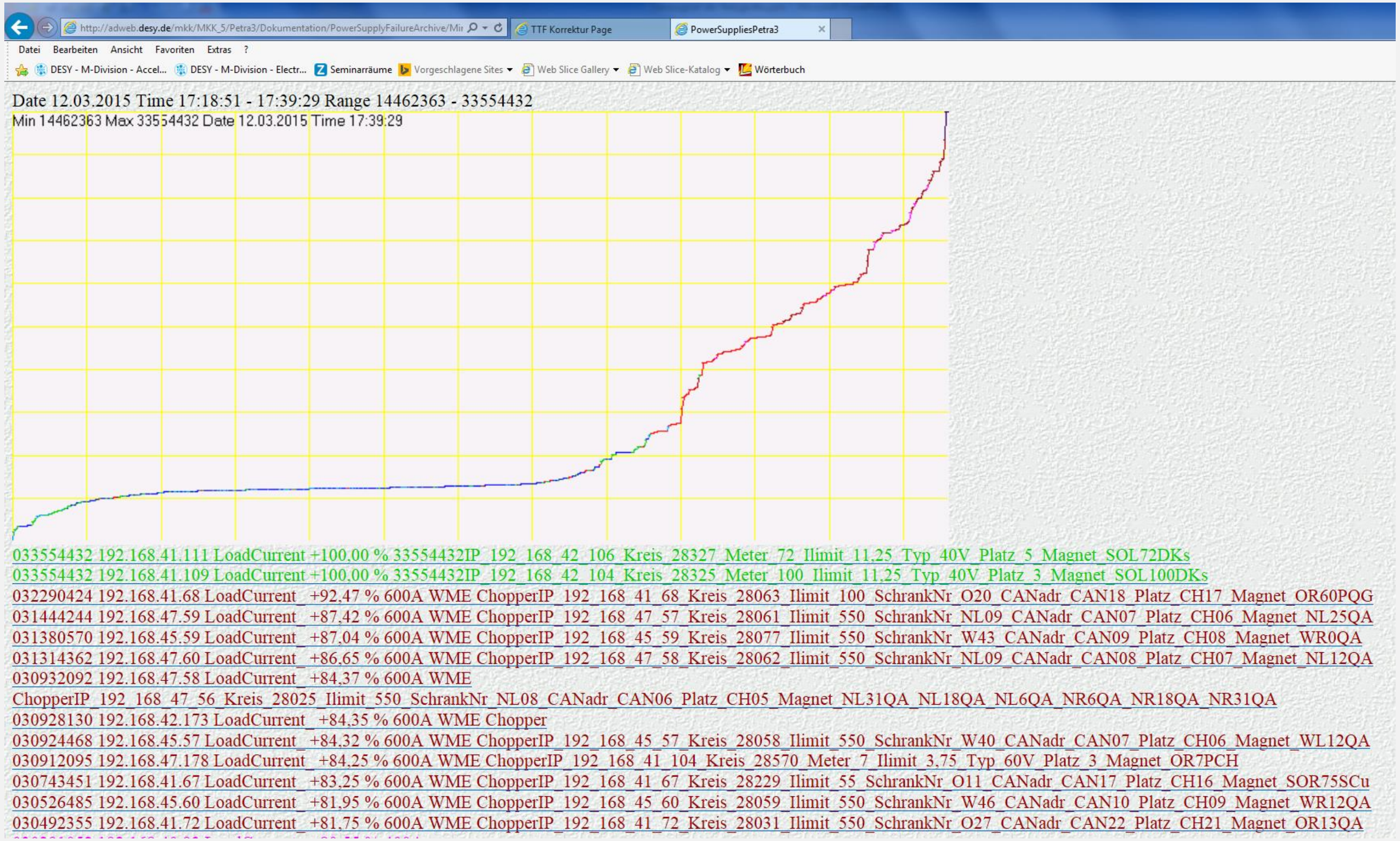
Thursday, March 12, 2015	5:05 PM	138730	SortedInidatParameter029_MaxPscCurrent.html
Thursday, March 12, 2015	5:05 PM	138085	SortedInidatParameter030_internalUsupplyOffset_P3.html
Thursday, March 12, 2015	5:05 PM	138074	SortedInidatParameter031_ScopeTimeBase.html
Thursday, March 12, 2015	5:05 PM	138078	SortedInidatParameter032_ScopeTriggerDelay.html
Thursday, March 12, 2015	5:05 PM	138079	SortedInidatParameter033_50HzStabilityForce.html
Thursday, March 12, 2015	5:05 PM	138084	SortedInidatParameter034_50HzStabilityLearnDelay.html
Thursday, March 12, 2015	5:05 PM	138087	SortedInidatParameter035_50HzStabilityLearningSpeed.html
Thursday, March 12, 2015	5:05 PM	138082	SortedInidatParameter036_D_VoltageRegulator_P9.html
Thursday, March 12, 2015	5:05 PM	138084	SortedInidatParameter037_ReserveOrLEM_IoutOffset.html
Thursday, March 12, 2015	5:05 PM	141027	SortedInidatParameter038_IP.html
Thursday, March 12, 2015	5:39 PM	138060	SortedParameter000_1AdcTemperature.html
Thursday, March 12, 2015	5:39 PM	138076	SortedParameter001_ReferenceCurrent.html
Thursday, March 12, 2015	5:39 PM	138070	SortedParameter002_LoadCurrent.html ←
Thursday, March 12, 2015	5:39 PM	138074	SortedParameter003_LoadCurrent2.html
Thursday, March 12, 2015	5:39 PM	138084	SortedParameter004_PowerSupplySteeringSignal.html
Thursday, March 12, 2015	5:39 PM	138074	SortedParameter005_OffsetAdcA .html
Thursday, March 12, 2015	5:39 PM	138070	SortedParameter006_GainAdcA.html ←
Thursday, March 12, 2015	5:39 PM	138072	SortedParameter007_OffsetAdcB.html
Thursday, March 12, 2015	5:39 PM	138070	SortedParameter008_GainAdcB.html
Thursday, March 12, 2015	5:39 PM	138068	SortedParameter009_Switches.html

Readout of data and values from the digital regulation

With the help of the Scan-Tool, it is possible to read values of the entire PETRA machine within 15 min.. This data can then be imported to into Excel-sheets and analysed

Scan Results

Deviation of load currents



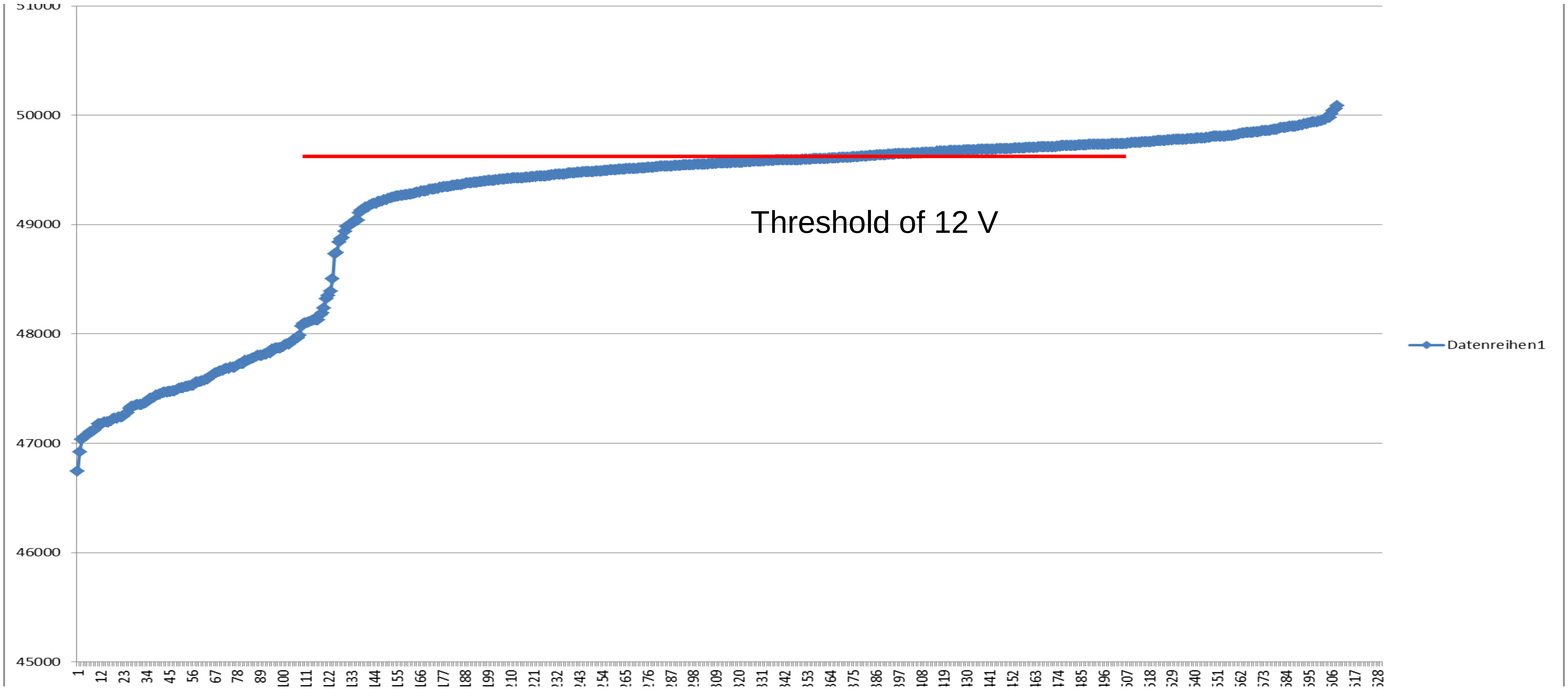
Result of a scan

To-Do list for the workshops

- [Request timed out] - 192.168.151.212
- [Request timed out] - 192.168.151.240
- 192.168.41.65 schlechte Werte
- 192.168.41.127 schlechte Werte
- --
- Spannungsueberw12VRipple
- http://192.168.53.168/ttf.htm
- 40V
- 87Spannungsueberwachung12V:49405bit=+12.0765094V
- 88Spannungsueberw12VRipple:1514bit=+0.37008060V
- ---
- 3V3
- http://192.168.48.132/ttf.htm
- 200A
- 85Spannungsueberwachung3V3:40804bit=+3.11957186V
- 86Spannungsueberw3V3Ripple:206bit=+0.01574920V
- 119SpannungsueberwMax_3V3:40938bit=+3.12981651V
- 120SpannungsueberwMin_3V3:40535bit=+3.09900611V
- http://192.168.45.53/ttf.htm

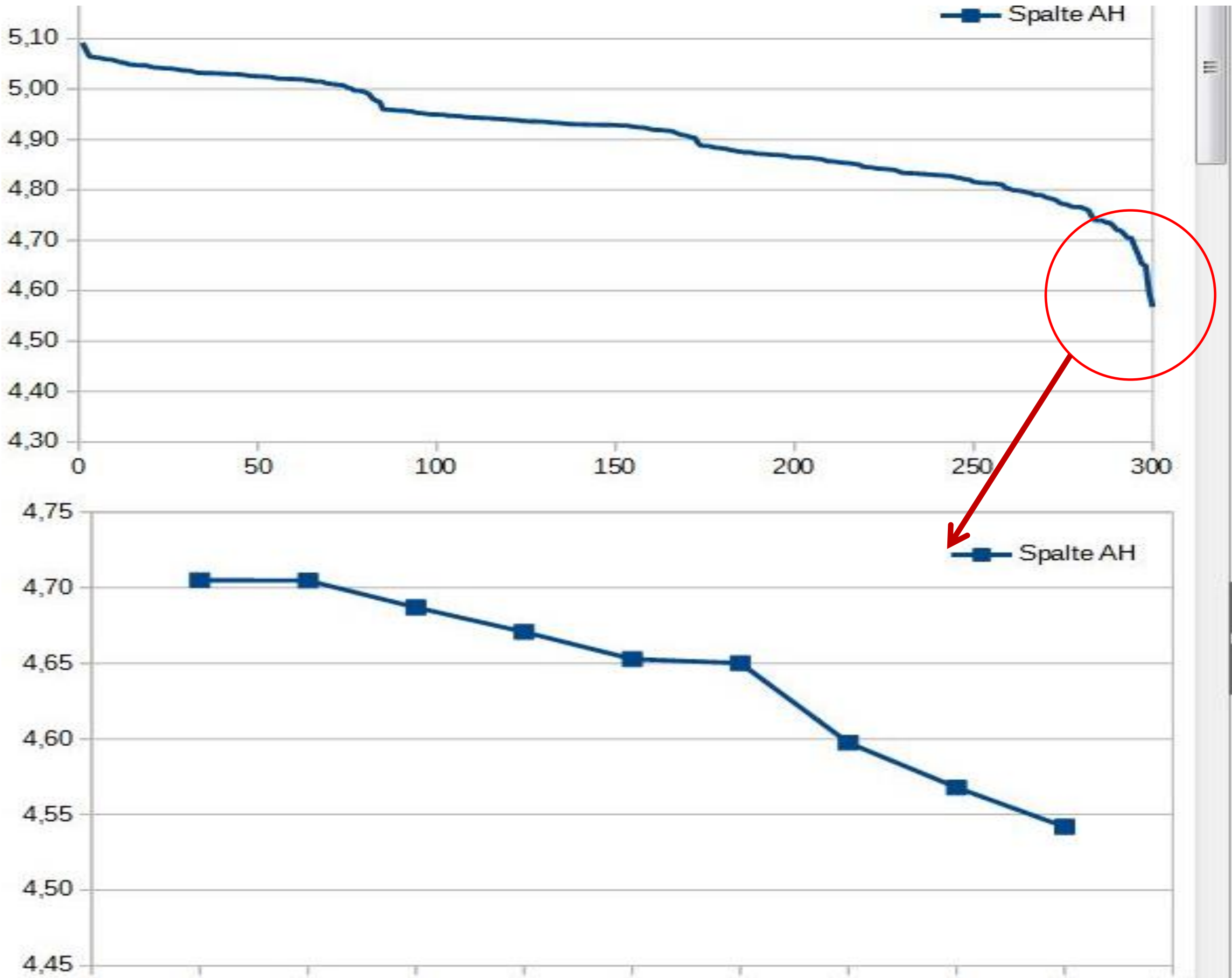
- http://192.168.47.179/ttf.htm
- 600A
- 281Spannungsueberw1V2Ripple:2404bit
- 000002279 192.168.47.179 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_47_179_Kreis_28823_Ilimit__Halle_Nord r._Magnet_NR 119QA_Optik_I_474_U_10,2_R_0
- 000001919 192.168.47.180 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_47_180_Kreis_28824_Ilimit__Halle_Nord r._Magnet_NR 126QA_Optik_I_420_U_9,3_R_0
- 000001875 192.168.47.157 LoadCurrent__ -0,02_ % 200A ChopperIP192_168_47_157_Kreis_28815_Ilimit__Halle_Nord r._Magnet_NR 104PQK_Optik_I_160_U_20,1_R_0,1
- 000001809 192.168.41.56 LoadCurrent__ -0,02_ % 200A ChopperIP192_168_41_56_Kreis_28705_Ilimit__Halle_Ost_Magnet_OR 75PQK_Optik_I_123_U_14,1_R_0,1
- 000001787 192.168.42.179 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_42_179_Kreis_28758_Ilimit__Halle_18_Magnet_OR 93PDE_Optik_I_402_U_26,7_R_0,1
- 000001766 192.168.42.175 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_42_175_Kreis_28762_Ilimit__Halle_18_Magnet_OR 126QA_Optik_I_420_U_10,9_R_0
- 000001761 192.168.47.176 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_47_176_Kreis_28819_Ilimit__Halle_Nord r._Magnet_NR 87PDD_Optik_I_275_U_18,2_R_0,1
- --
- http://192.168.47.179/ttf.htm
- 600A
- 283Spannungsueberw2V5Ripple:1621bit
- 000001621 192.168.47.179 LoadCurrent__ +0,00_ % 600A WME ChopperIP192_168_47_179_Kreis_28823_Ilimit__Halle_Nord r._Magnet_NR 119QA_Optik_I_474_U_10,2_R_0
- 000001388 192.168.41.55 LoadCurrent__ -0,02_ % 200A ChopperIP192_168_41_55_Kreis_28704_Ilimit__Halle_Ost_Magnet_OR 68PQK_Optik_I_142_U_15,9_R_0,1
- 000001302 192.168.41.56 LoadCurrent__ -0,02_ % 200A ChopperIP192_168_41_56_Kreis_28705_Ilimit__Halle_Ost_Magnet_OR 75PQK_Optik_I_123_U_14,1_R_0,1
- 000001277 192.168.45.73 LoadCurrent__ +0,00_ % 55A Kompower ChopperIP192_168_45_73_Kreis_28269_Ilimit__Halle_West_Magnet_WR 111S

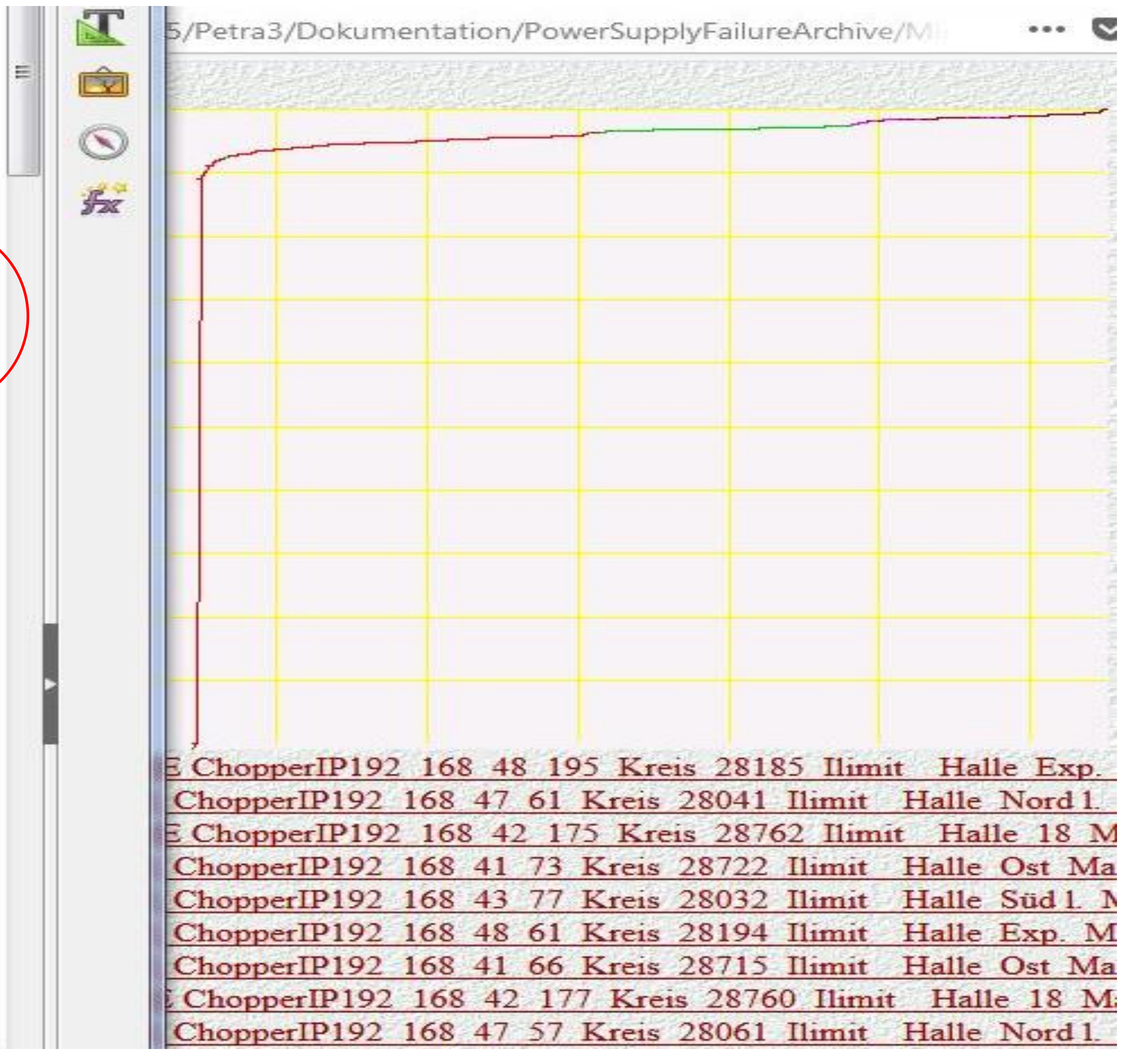
12 V auxiliary power supplies non conformity



Scan of 5 V voltage inside the PS

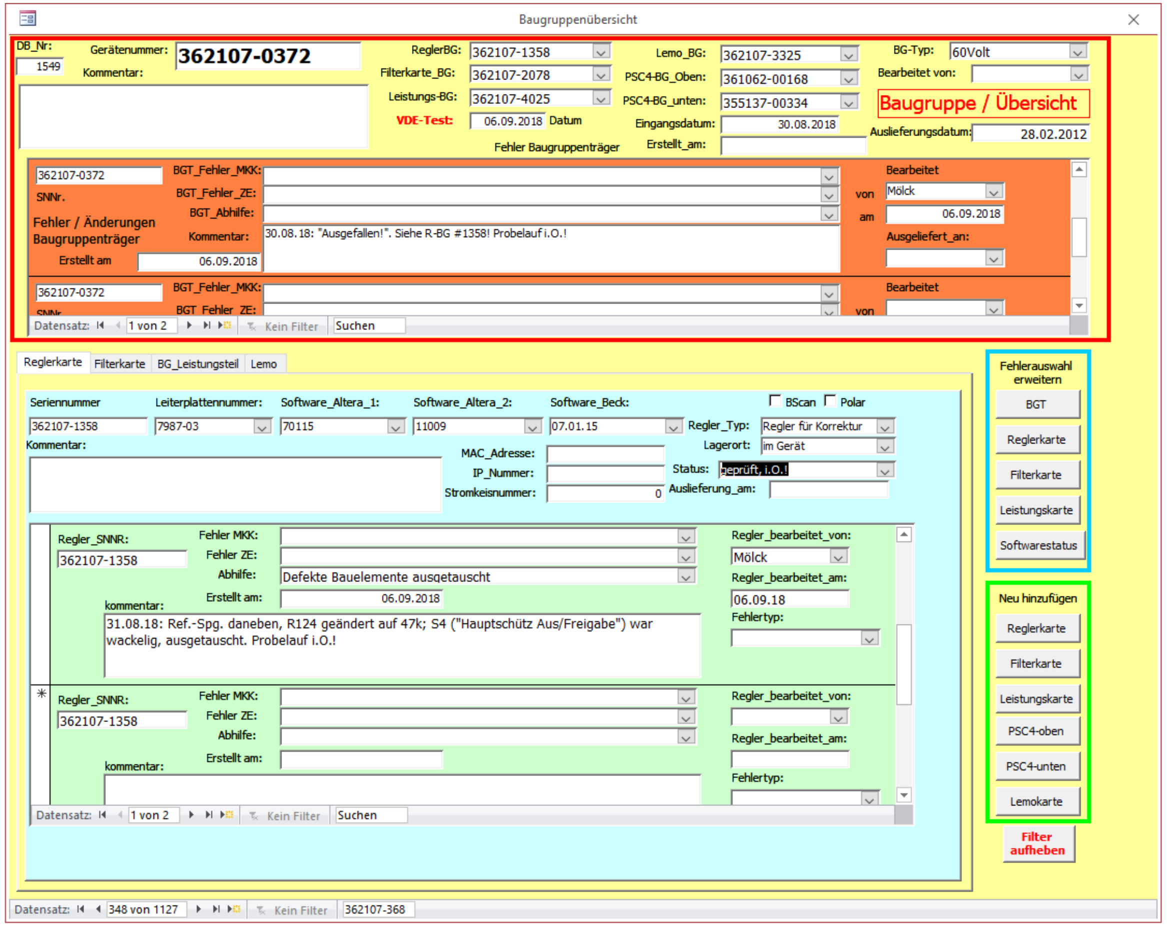
10 PS müssen angesehen werden

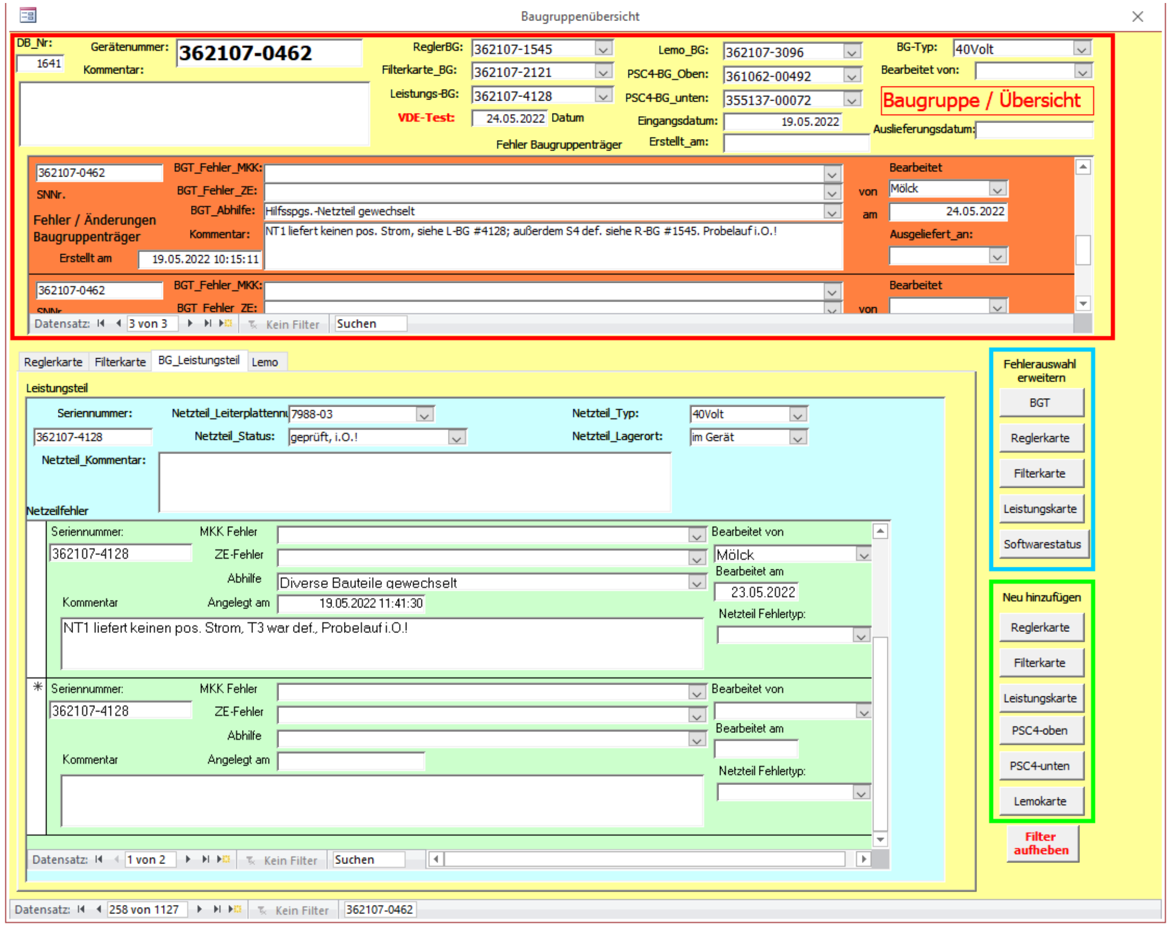




Tracking of Repairs

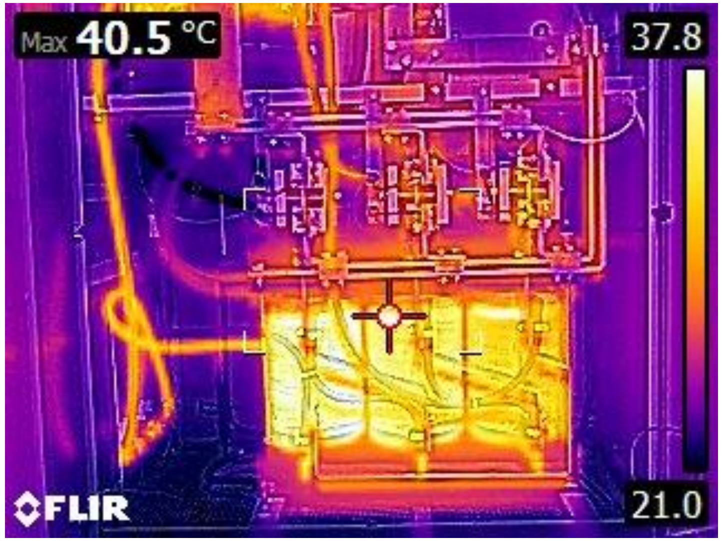
All repairs are documented

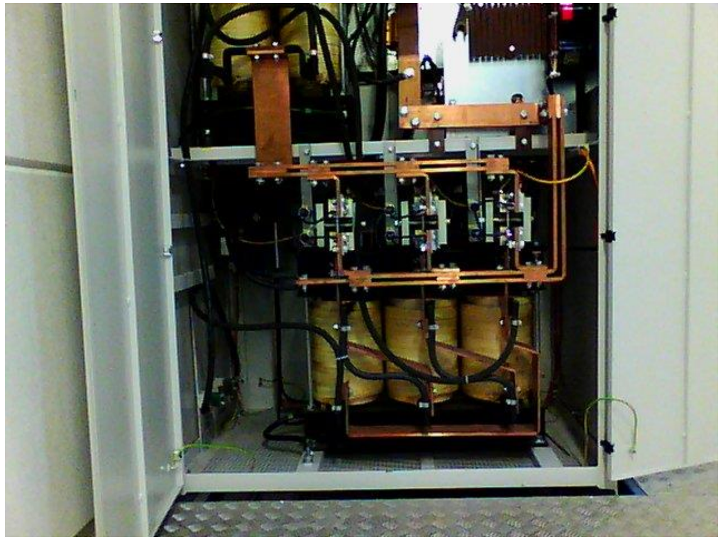




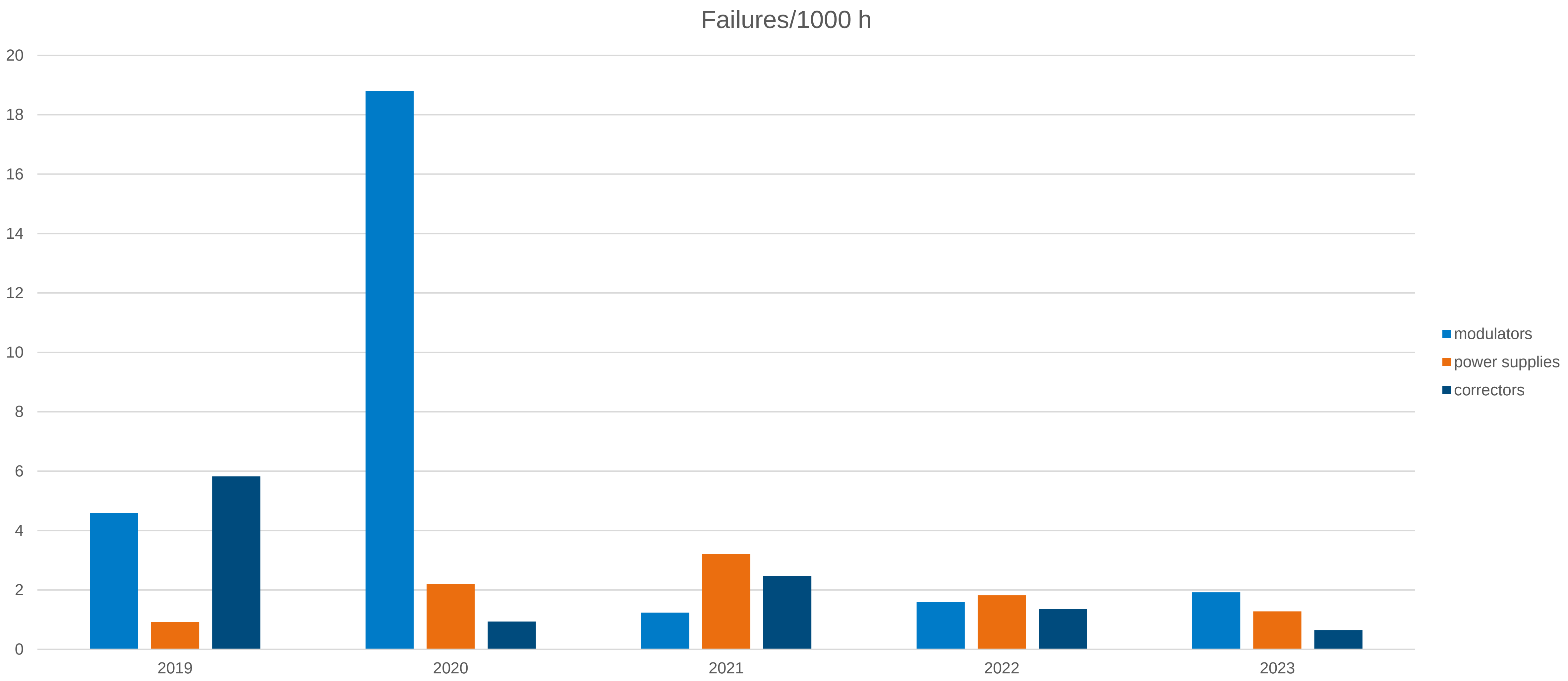
Präventive Maintenance

Baugruppen	Wartung	Wartungstätigkeit(en)	Häufigkeit (1)	Dokumente (2)
	[ja/nein]	Stichpunktartig auflisten		Eintrag VA, AA, CL oder keine
Thyristorgeräte	ja	Pulssymetrie prüfen	jährlich	-
	ja	Genauigkeit prüfen	jährlich	-
	ja	Soll-Ist-Abweichung prüfen	jährlich	-
	ja	Spannungsripple prüfen	jährlich	-
	ja	Klemmstellen prüfen	jährlich	-
	ja	DCCT-Lüfter Tausch	4 Jahre (zuletzt 01/2018)	-
	ja	Magnetventil Funktion prüfen	jährlich	-
Diodengeräte	ja	Klemmstellen prüfen		
	ja	Magnetventil Funktion prüfen	jährlich	-
Chopper-Netzgerät	ja	Reserveumschaltung prüfen	jährlich	-
	ja	Erdungsschütze prüfen	jährlich	-
	ja	Verkabelung prüfen	jährlich	-
Digitale Regelung	ja	Referenzspannung 10V prüfen	2 Jahre	-
	ja	Browserseite Zugang prüfen	jeder Shutdown	
	ja	SD-Kartentausch	4 Jahre (zuletzt 2018)	
Magnetüberwachung	ja	Software (Funktion) prüfen	jährlich	-
7/8-Verkabelung/Aluschienen	ja	Isolation prüfen	nach jedem Shutdown	CL
Verkabelung Kasematte OR	ja	Klemmstellen/Temp. Prüfen	jeder Shutdown	-
JEMA-Geräte	ja	AVX-Kondens. Sichtprüfung	bei jeder Gelegenheit	-
	ja	Austausch 15V-Versorg. IGBT	alle 2 Jahre	-
	ja	Kontrolle der DSP-Parameter	wöchentlich	Gruppe MSK: Doku im MSK-Logbuch

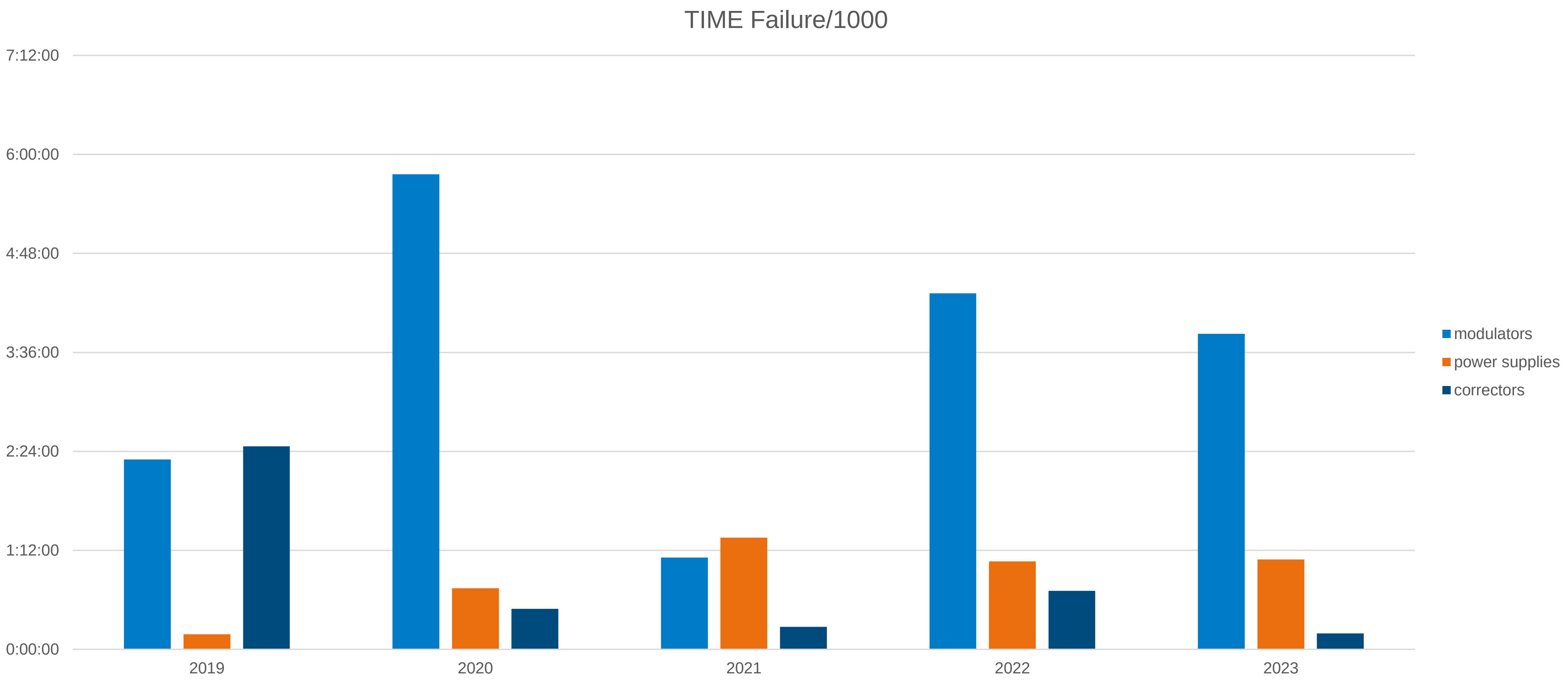




Failures in the XFEL /1000 h



Time to repair



Investigtion of failures of modulators

Aging of components (comunication path became week)