

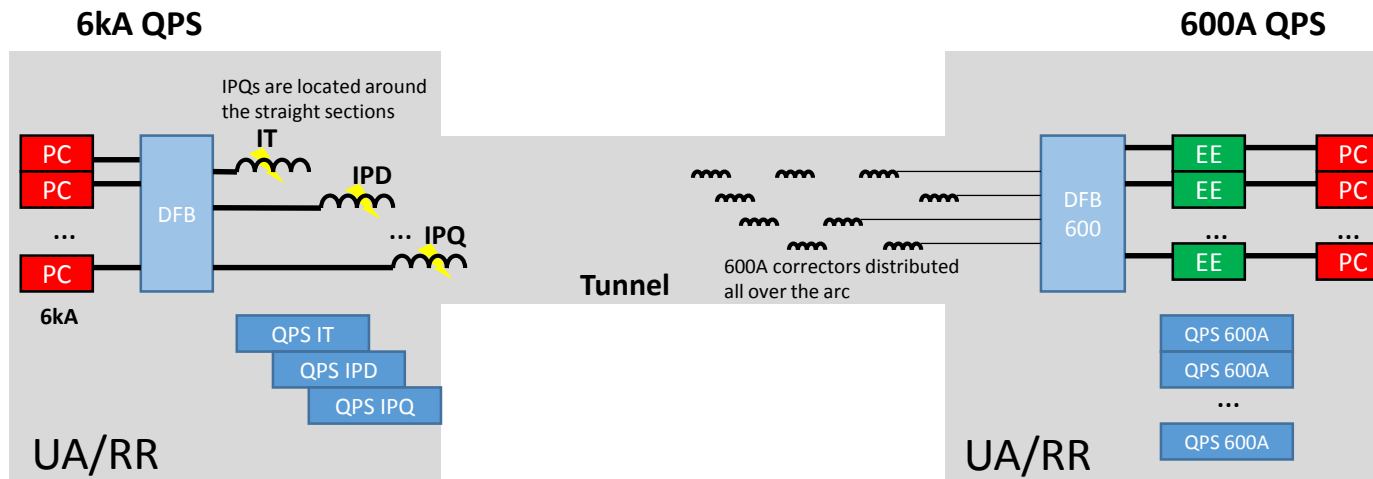
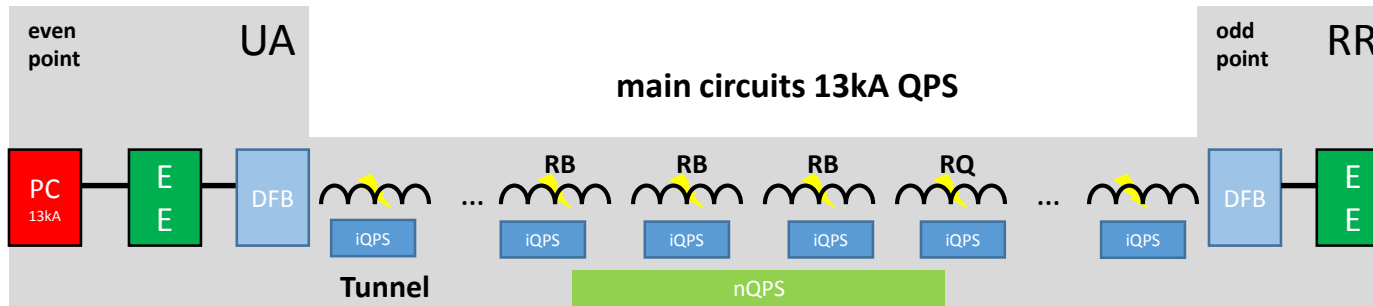
QPS performance 2016

Jens Steckert on behalf of TE-MPE-EP & EE

Topics

- QPS overview
- Changes/Activities 2015 → 2016
- Performance 2016
- Comparison with 2015 performance
- R2E 2016
- Activities in LS2
- Conclusion

QPS overview



Main Elements

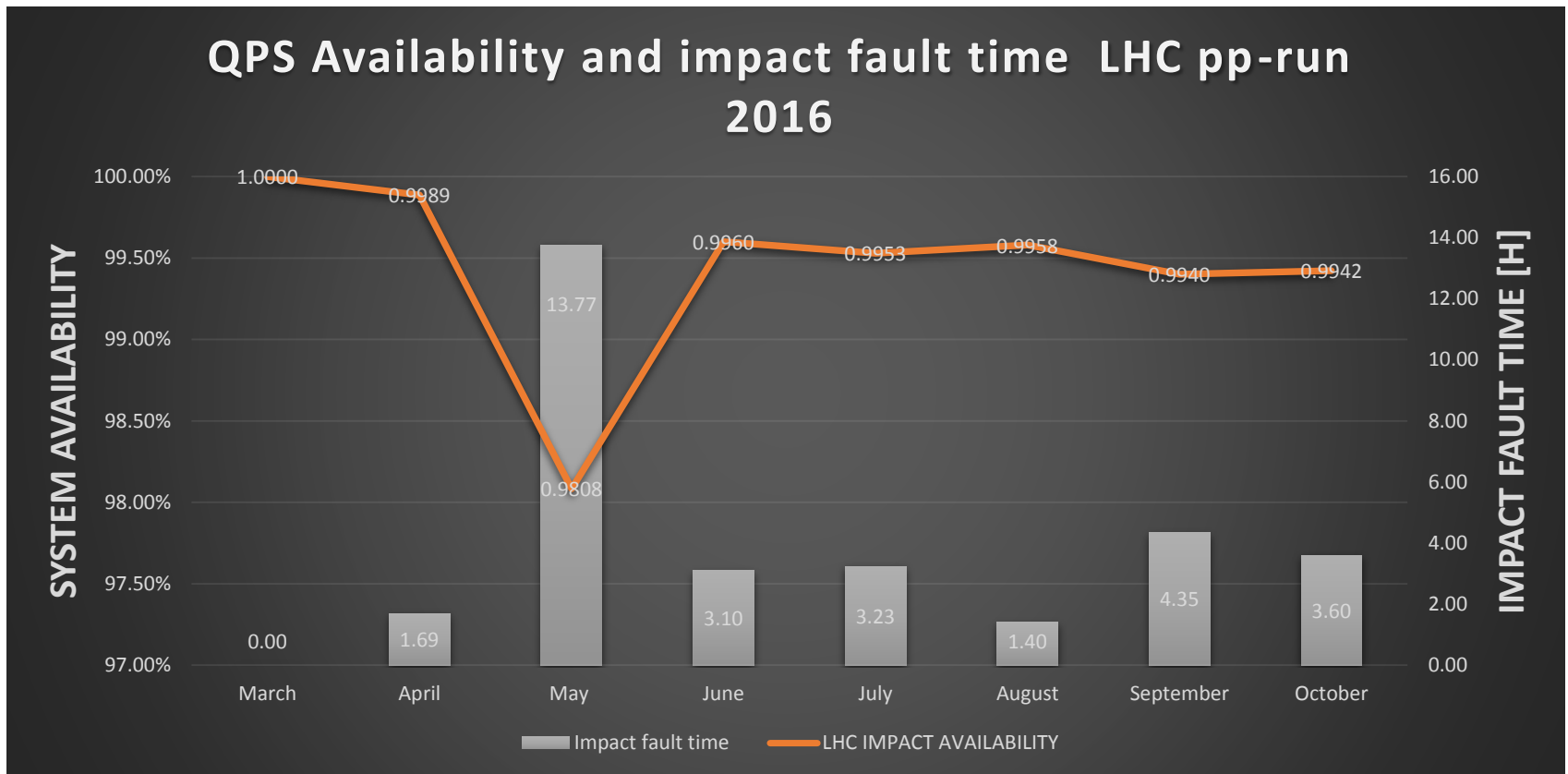
#	Item
32	EE13kA
202	EE600
6084	HDS
1624	iQPS
4032	DQQDL
436	nQPS
1632	DQQDS
4096	DQQBS
76	QPSIPX
360	nDQQDI
48	DQQDT
1124	DQQDC
114	QDS600
624	DQQDG
212	nDQQDG
1672	DQQDC

- ~14000 hardware interlocking circuit boards → Numerous possibilities to stop LHC
- ~29000 active circuit boards (excluding EE) → MTBF per element : ~4Mh

Changes/Activities YETS 2015/16

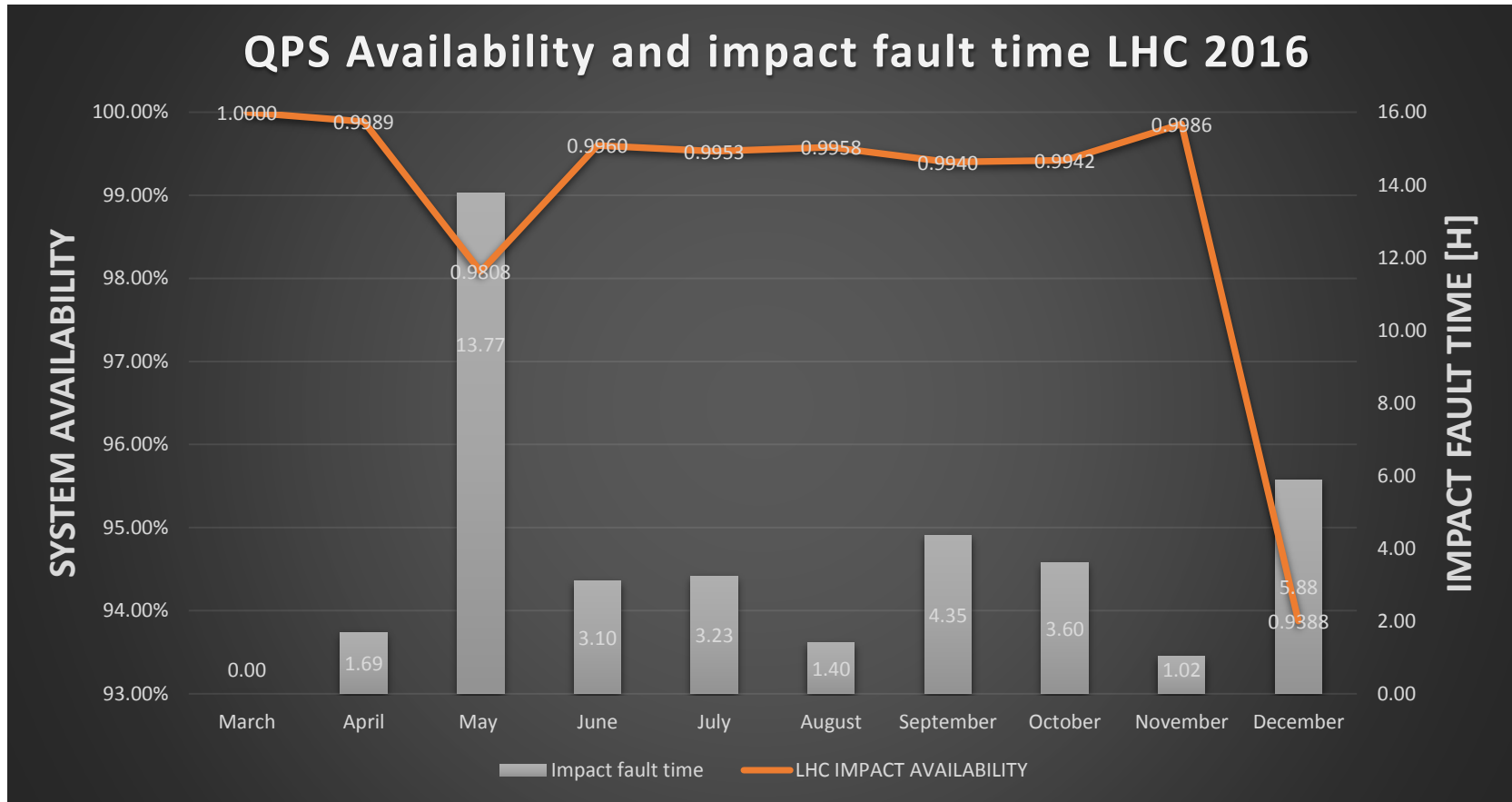
- Replaced 600A quench detectors type DQQDG with rad-tol version nDQQDG in RR13/17, RR53/57, RR73/77
- Upgraded RU-circuits to nDQQDG and DCCT for current measurement
- Firmware updates for nQPS systems (436 crates all sectors) enhancing stability of local communication & fault management
- Annual maintenance of all 13kA EE systems
- Maintenance of 600A EE systems showing signs of degradation

Performance 2016 p-p run



- Average availability for proton run: 99.49%
- Target availability: 98%
(promised in Chamonix 2016 → 120h downtime → rank 4 !)
- Mean LHC impact fault time: 3.9h per month

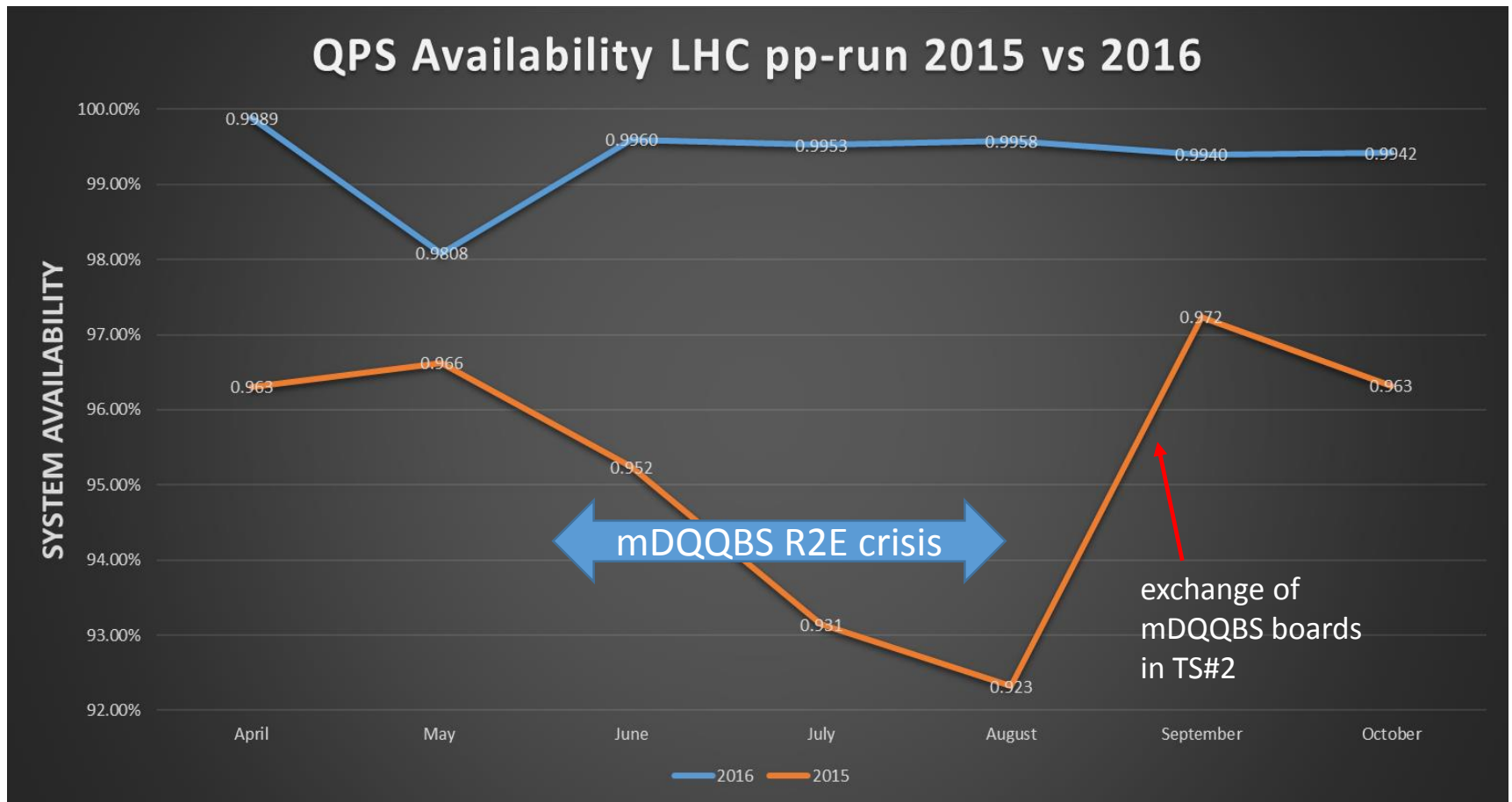
Performance 2016 total



➔ December had only 4 days of operation:

5.9h impact fault time lead to an availability of 93.8%...

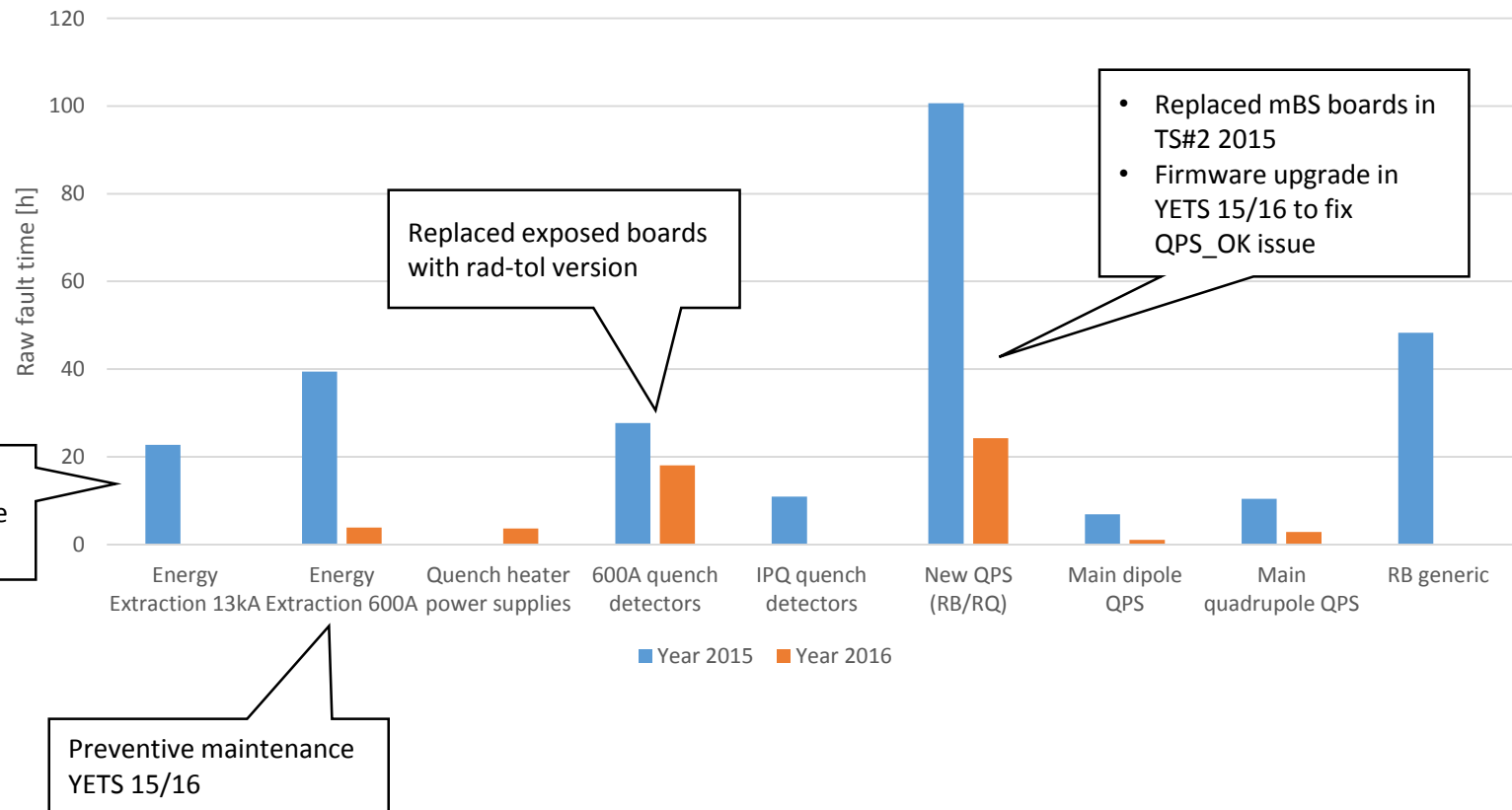
Comparison 2015 vs 2016



- Significantly improved availability in 2016
- mDQQBS (CSCM splice monitor boards) R2E crisis in 2015

Fault time evolution 2015 to 2016

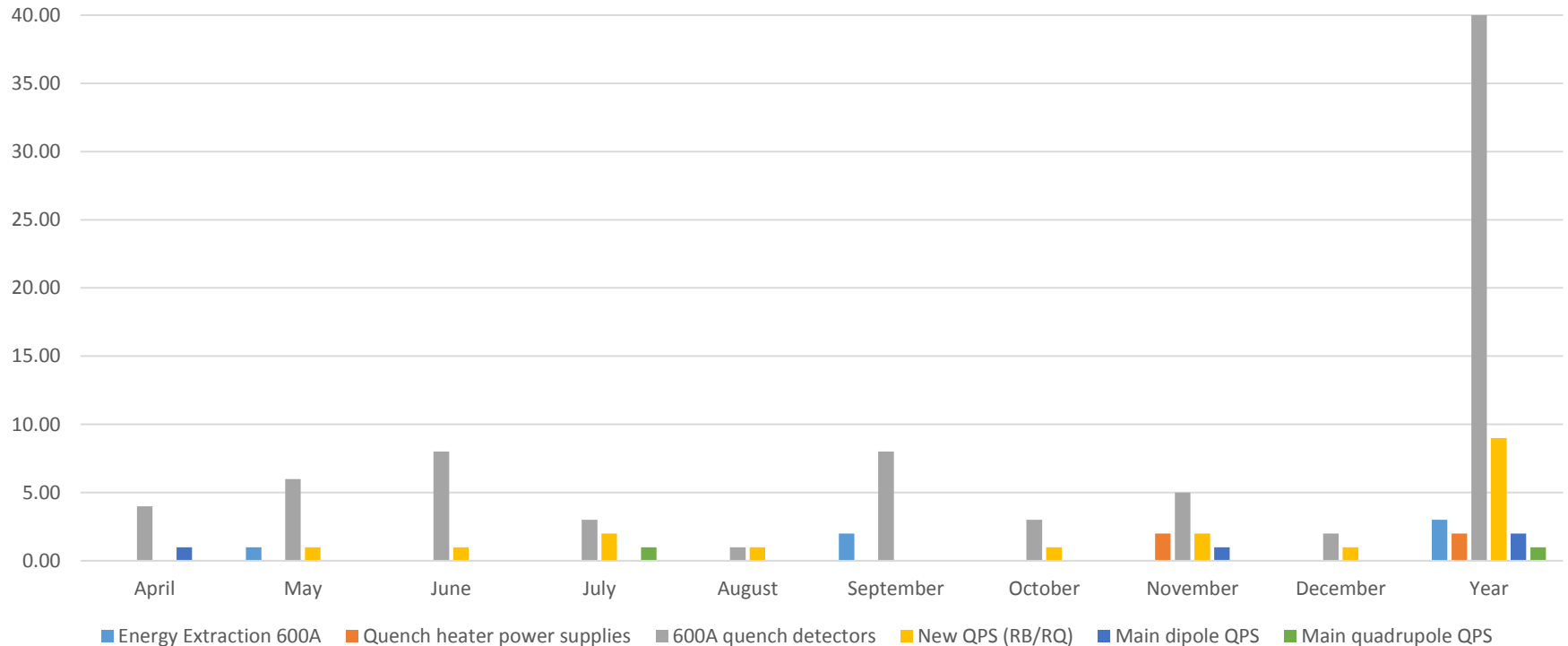
Raw fault time 2015 vs 2016



- Only a **few, but effective** interventions in YETS 15/16
- Improved raw fault time by 80% in 2016 !

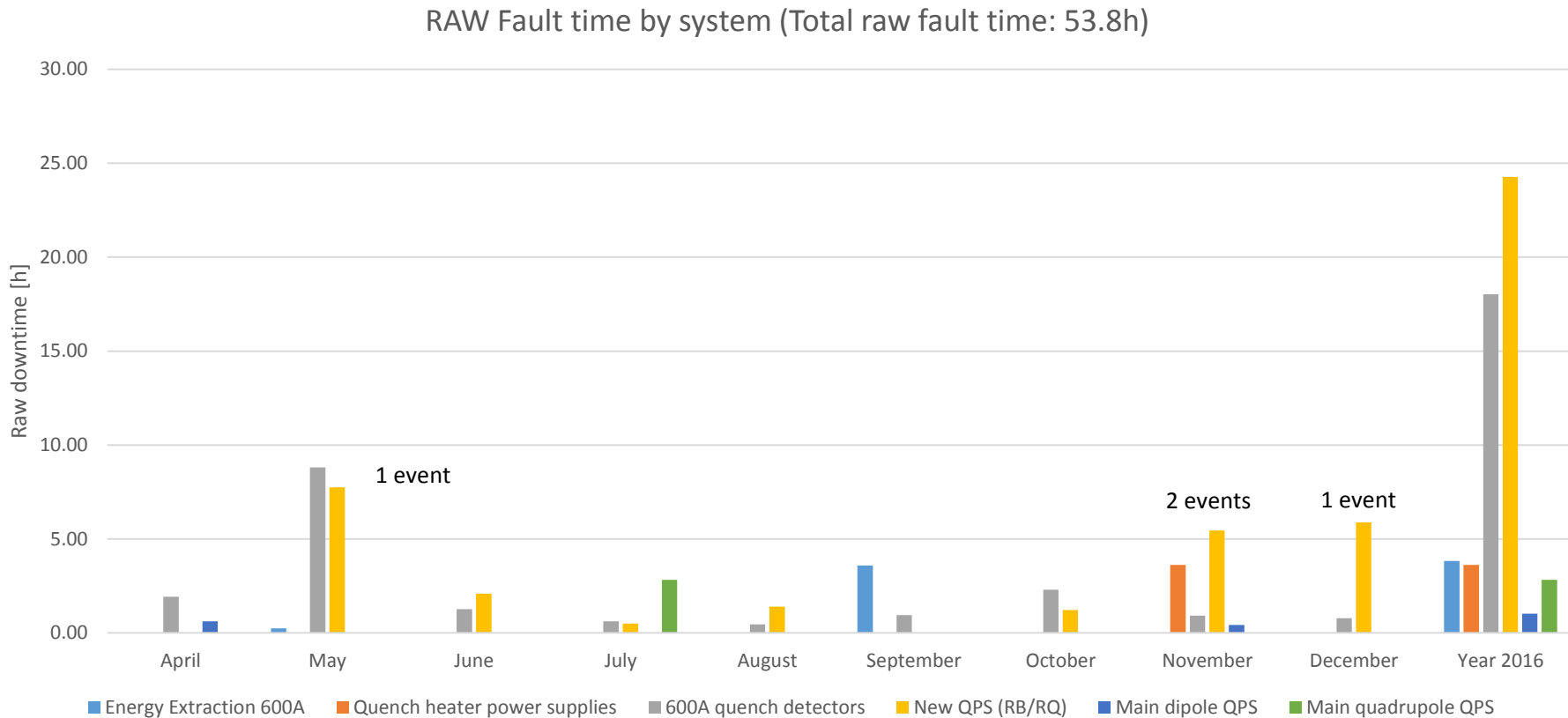
Raw faults by system 2016

RAW Fault occurrence by system (Total 57 faults)



- Top runner in frequency: 600A (lots of short trips)
- nQPS communication issues 2nd (9 cases)
- EE600 third (3 cases...)

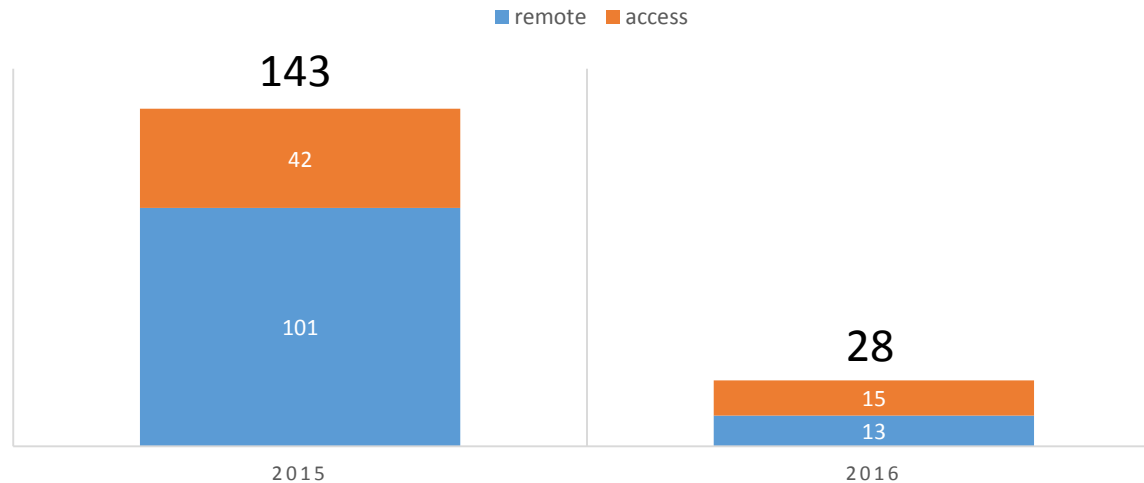
Raw fault time by system 2016



- nQPS first, mostly loop/communication issues (24.2h)
 - Event in may was caused by a triple fault requiring a long access
- QDS600 2nd despite being first in occurrence (18h)
- EE600 3rd basically caused by two events in September (3.8h)

MPE piquet in 2016

OF PIQUET INTERVENTIONS 2015 VS 2016



- Decrease in piquet interventions scaled with decrease in raw faults ~80% less in 2016
- Remote accesses decreased over proportionally due to the modified QPS_OK behaviour of nQPS (does not block restart of sector anymore)

600A quench detectors in detail

- Some faults aftermath of R2E upgrade in YETS 2015/16
 - Undulator QPS cabling
 - Filter settings of the new detectors
 - decay throughout the year
- Main source for 600A FPA : global interlock
- 0-xing induced trips dominated by only two circuits (46 oo 52 trips during ramp down and precycle)
 - Corrective actions by MPE & EPC in preparation
- Plan to improve EMC shielding on current sensor cables to reduce trips
- Further analysis of OFB and triplet correctors ongoing
 - Chamonix

Radiation to electronics

- No R2E-induced faults of quench detectors in 2016
 - Upgrade of the exposed 600A quench detectors successful !
- No R2E-induced system triggers during pp-run 2016
 - System reached nominal state in terms of rad tolerance
- Two suspicious events during ion-p run
 - Crate controllers of nQPS in B8L8 & B9R1 in fault
 - Complete analysis pending
 - First investigation shows no abnormal radiation levels in these locations
 - “Normal” hardware fault not excluded
 - Closer investigation in tunnel during EYETS

EYETS 2016/2017 activities

- Optimize 600A quench detectors cabling (shielding)
- Try to improve 0-xing spike trips of 600A detectors
- Work on further mitigations to nQPS internal communication loss issue

➔ Don't fix what's not broken

Upgrades in LS2

- Renovation (replacement) of the main quad QPS base layer (392 crates type DQLPUB)
 - Remote power cycle
 - Interlock loop monitoring
 - Quench heater supervision
 - New digital quench detectors
 - Improved PM timing
 - ➔ driven by long term QPS maintenance plan
(upgrade in LS3 not feasible due to HL-LHC activities)
- Start of HL-LHC with 11T protection systems

Conclusions

- System has reached its nominal configuration in 2016
- Excellent R2E performance during pp run (0 faults)
Two unconfirmed events during ion run
- Faults induced by massive upgrades in LS1 have decayed
(cables & connectors, cards not properly inserted etc...)
- YETS 15/16 interventions significantly improved system availability
- No major changes foreseen prior LS2
- Challenge to keep & improve excellent performance of 2016 in the future !

Thank you !

Questions ?