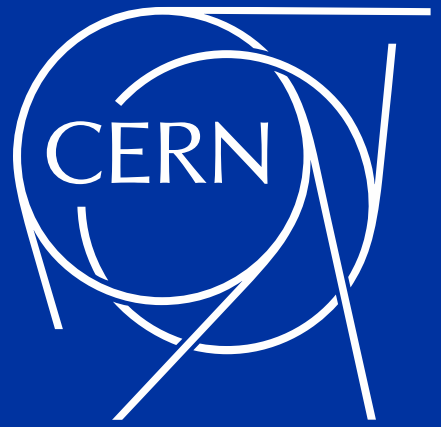


R2E Annual meeting opening

Brennan Goddard

Tuesday 1 March 2022

Radiation to Electronics annual meeting: Introduction

First of all, welcome to this R2E annual meeting

The R2E project is housed in the Accelerator Systems (SY) Department of the CERN Accelerator and Technology Sector (ATS)

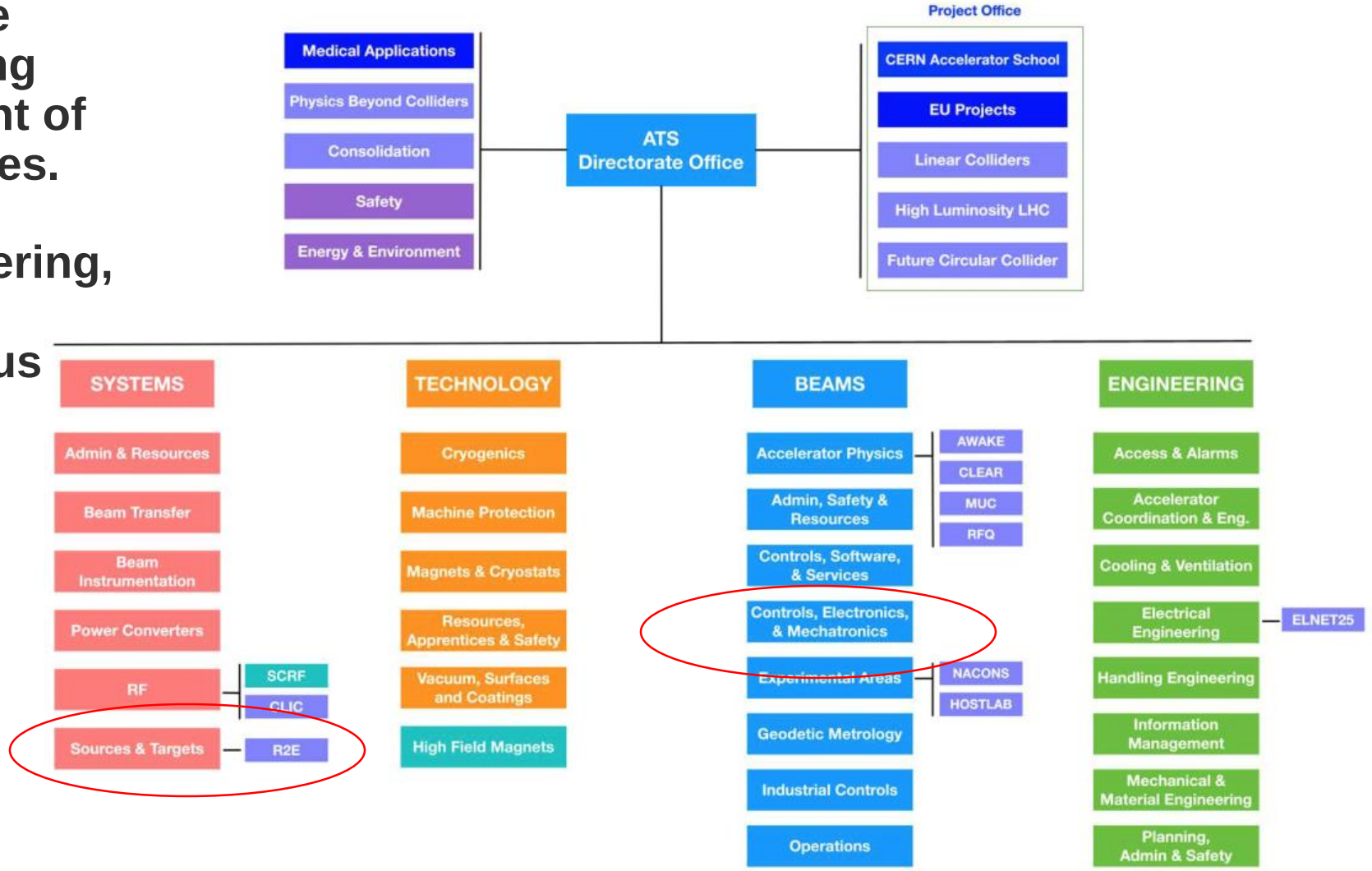
Crucial presence also in the BE (Beams) department, especially for electronics testing and facility operation

As SY Department Head, I have the pleasure to open this annual meeting.

CERN Accelerator Technology Sector (ATS)

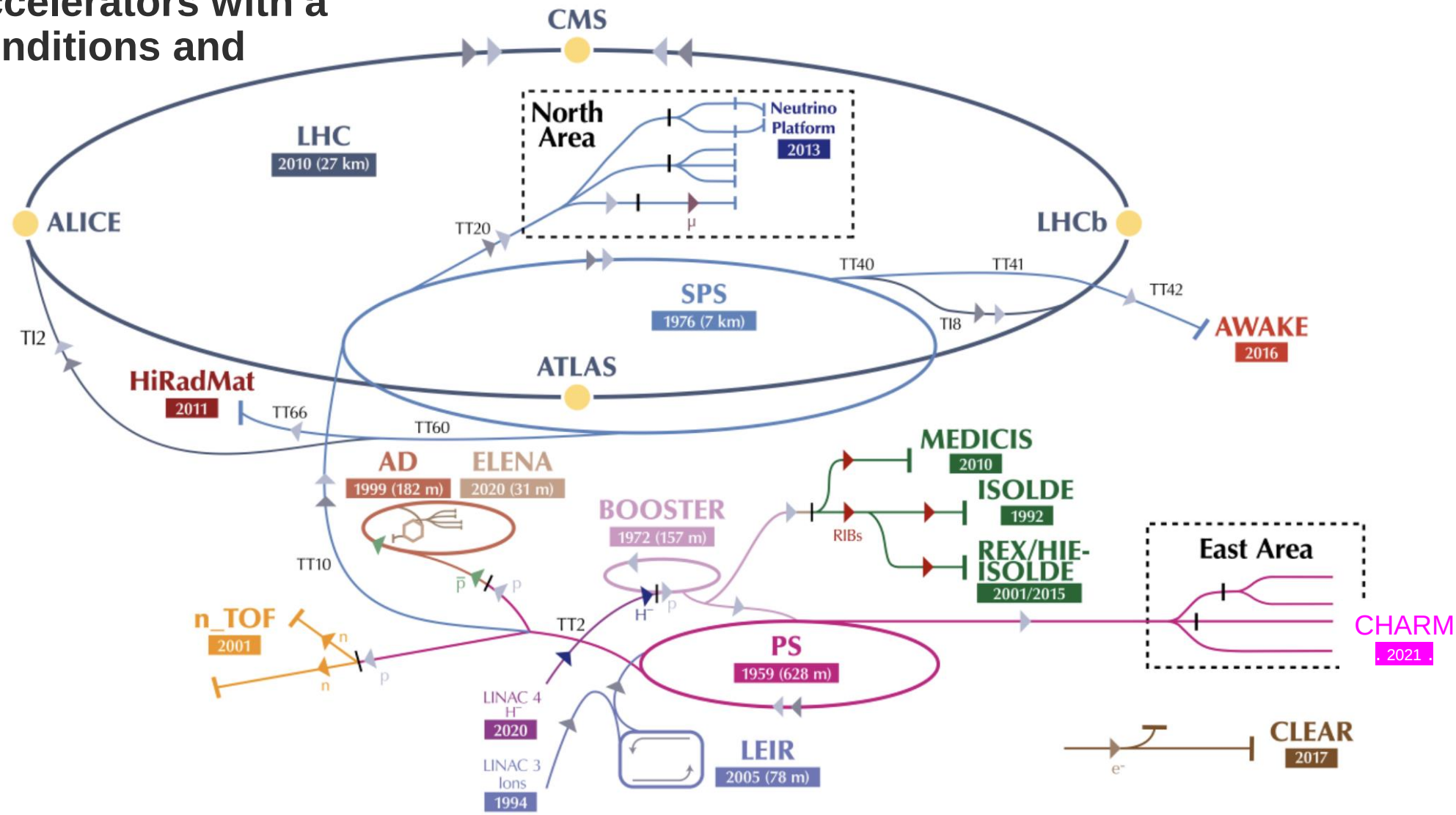
ATS responsible for operation and exploitation of the whole accelerator complex including LHC, and for the development of new projects and technologies.

It comprises Beams, Engineering, Accelerator Systems and Technology departments, plus ATS-DO



CERN accelerator complex

A multitude of accelerators with a huge range of conditions and beam types



H⁻ (hydrogen anions) | p (protons) | ions | RIBs (Radioactive Ion Beams) | n (neutrons) | p̄ (antiprotons) | e⁻ (electrons) | μ (muons)

R2E annual meeting

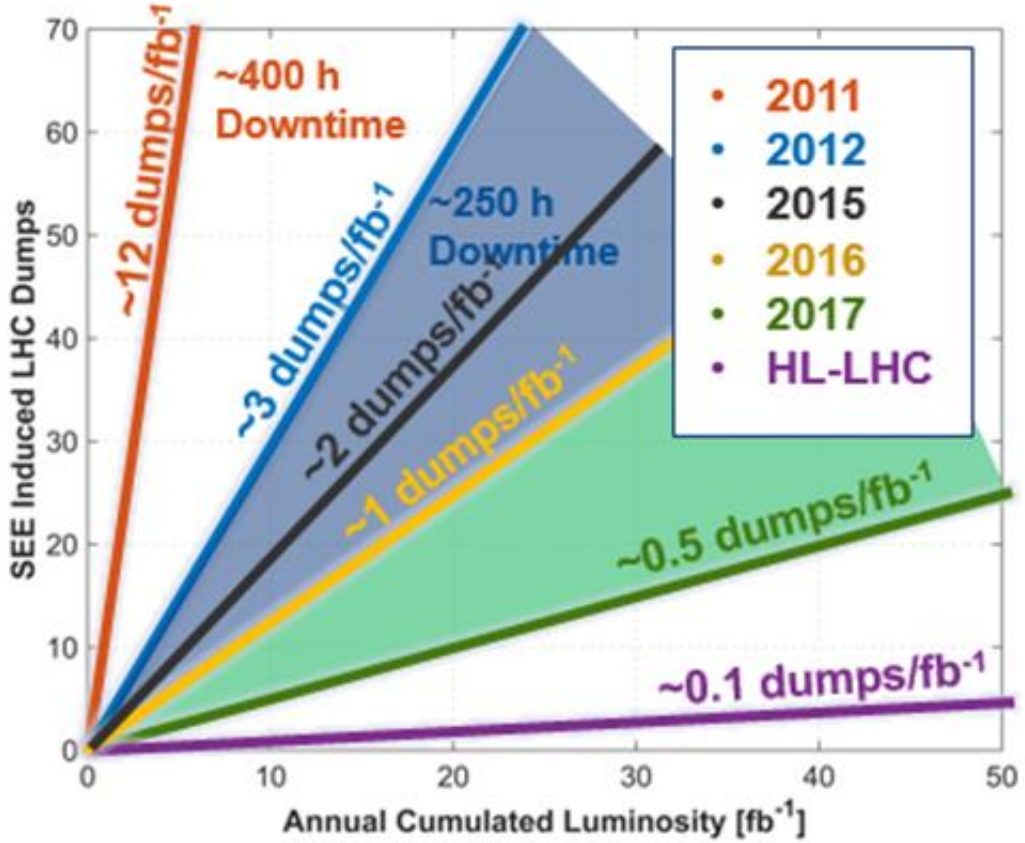
R2E was launch at CERN in 2010, following the LHC start and radiation issues with electronics.

Since then many studies, mitigations, actions, projects, were launched and performed.

LS1 was the first period where many actions took place, like shielding…

Which led to a very successful Run2 of the LHC.

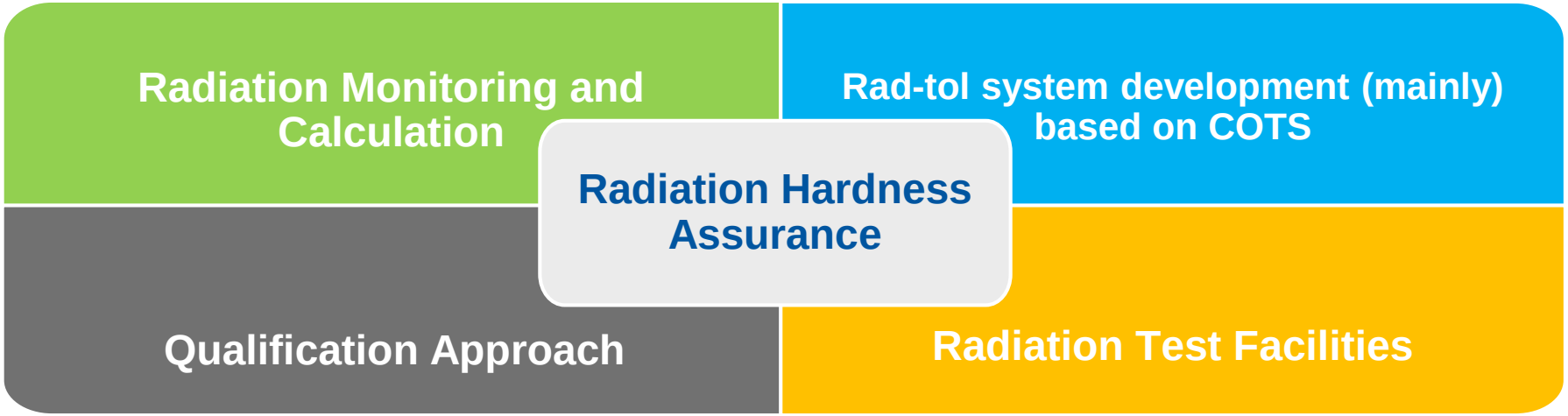
For HL-LHC, 0.1 dump/fb^{-1} is the (challenging) goal



Main R2E building blocks

The development process is complex and long and needs <u>many components</u> to succeed.

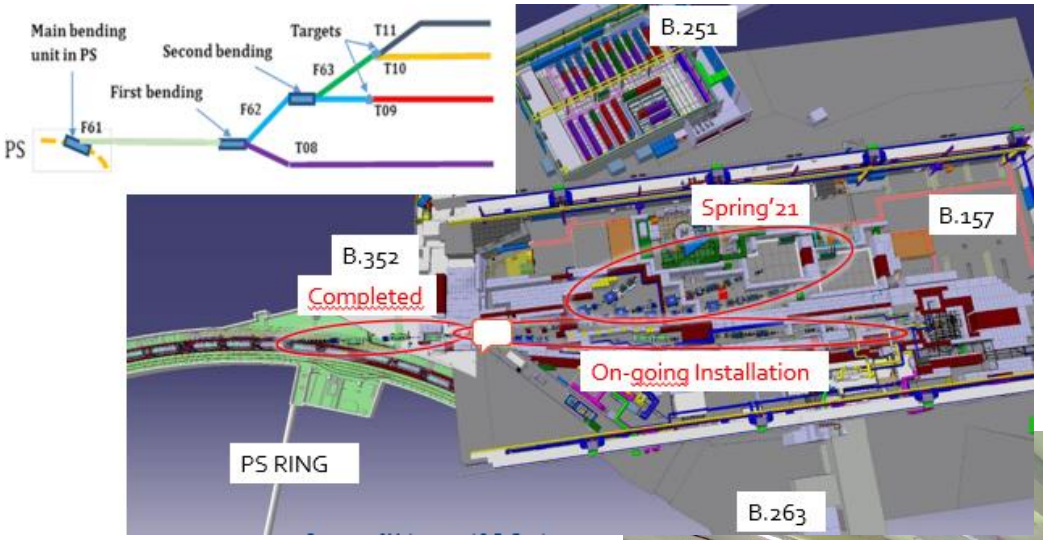
Building blocks from Rubén, R2E meeting 2018.



mitigation → prevention

Radiation tests facility

2021 new EAST area commissioning, CHARM confirmed as a major radiation test facility



Initial T8 commissioning teething troubles ironed out

IRRAD and CHARM successfully operated for 8 weeks

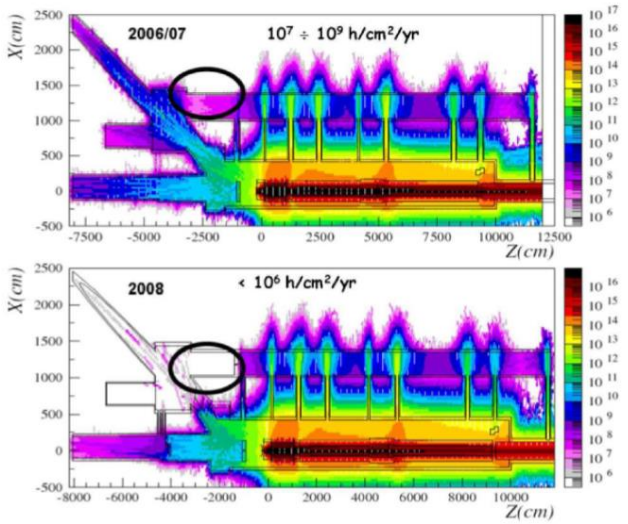
Radiation calculation, FLUKA

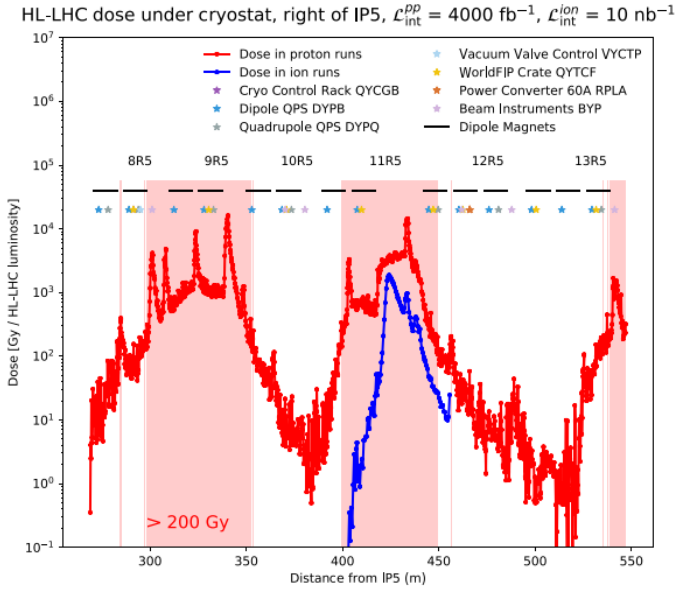
Deep involvement in preparation for HL-LHC

Key in determining radiation levels for LIU and HL-LHC configuration and operational conditions

Efficiently covering large majority of HL-LHC (WP10) areas of concern for equipment groups:

- Shielded areas (UJ, UL, RR) around IP1, 5 and 7
- DS in IP1, 5 and 7 (including possible cell 9 location for 11T/TCLD)



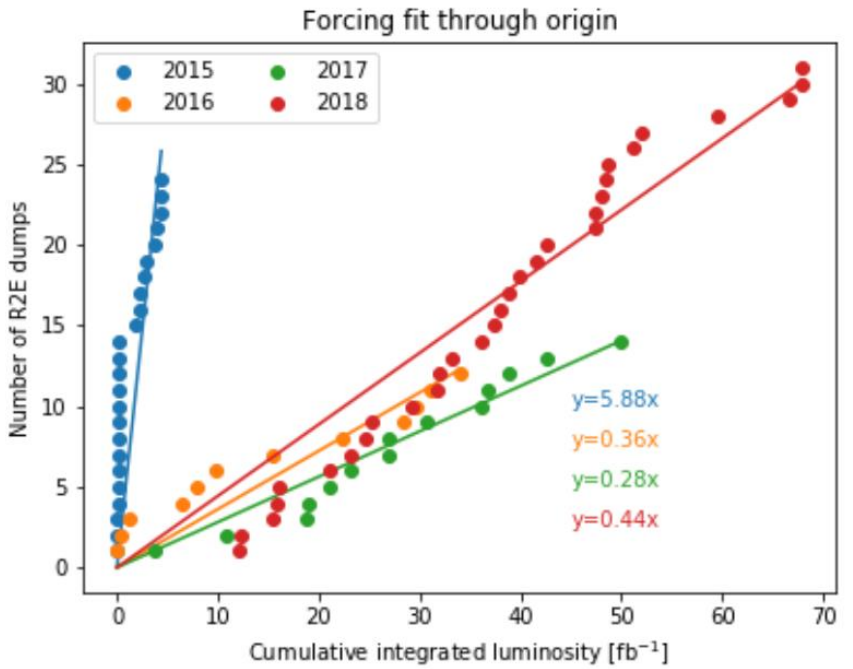


R2E vigilance

Many mitigations and many upgrades have already been performed.

However, we need to stay vigilant, changes can go very fast with beam settings and especially with the new LIU beams → see example of SPS operation in 2021

Ideally all new electronics devices must be qualified by R2E



2015:
- Start of the year: nQPS SEEs (introduced in LS1)
- Rest of the year: mainly FGC2 in the arc

2016:
- SEE rate reduction mainly due to lower arc radiation levels (vacuum conditioning)

2017:
- Further improvement thanks to FGClite deployment in ARC; most R2E events in power converters in RR (upgraded in LS2 with radiation tolerant versions)

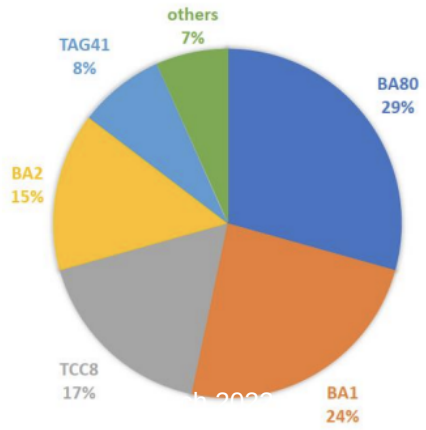
2018:
- Increased radiation levels in DS of IP1 and IP5 due to TCL6 opening → impact on QPS equipment (possibly lifetime related, i.e. no longer linear versus integrated luminosity)

Illustration: SPS access system SEU issues in 2021

Racks located in 10 locations, initial project proposal with racks on surface was changed

Installation of COTS failsafe I/O modules: major source of SPS downtime in 2021 → SEUs

Rack Location	Number of Events
BA80	22
BA1	18
TCC8	13
BA2	11
TAG41	6
BA3	2
TT10	1
ECN3	1
BA6	1



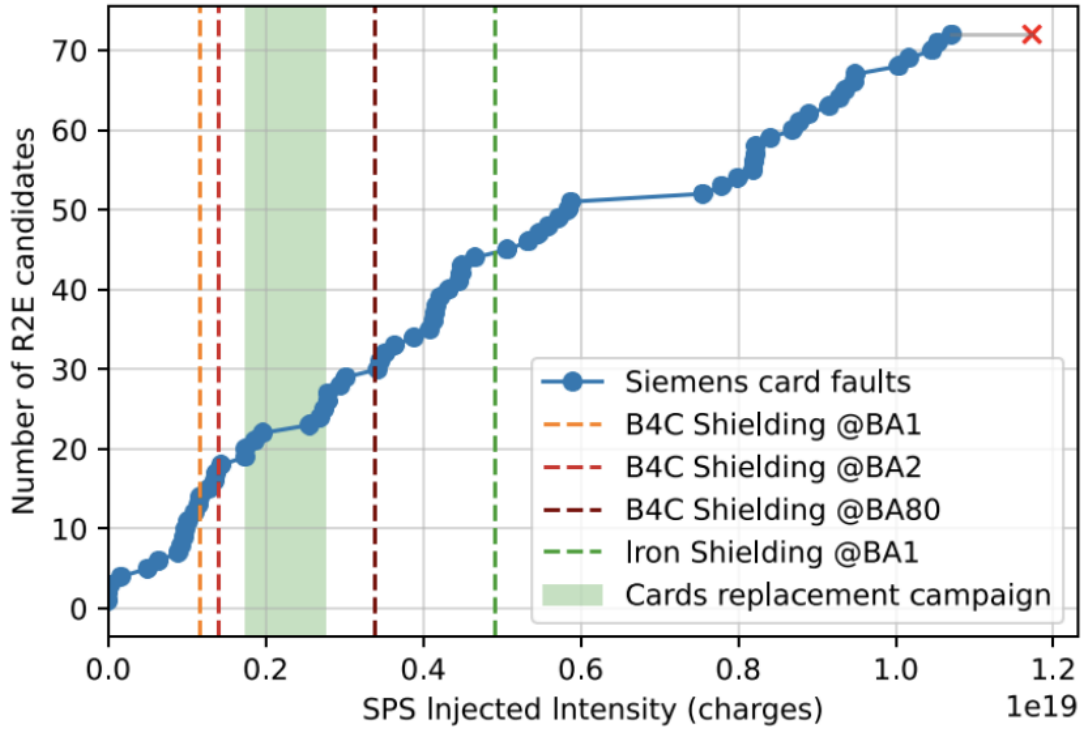
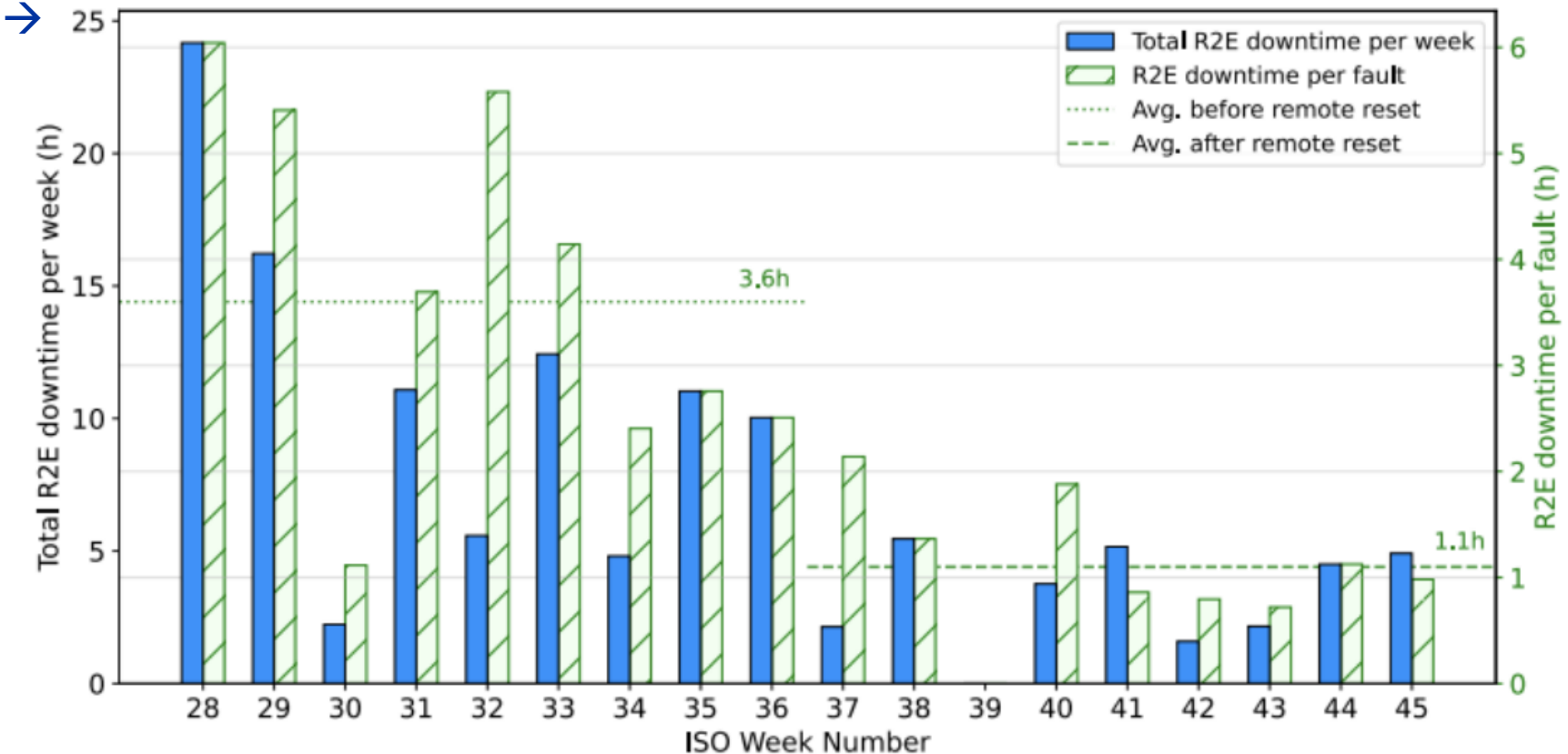


Illustration: SPS access system SEU issues in 2021

Short-term mitigations reduced effects x5 with shielding, remote reset, card replacement

Rack re-location crash program to cure, just completed in Year End Technical Stop

25h per week →



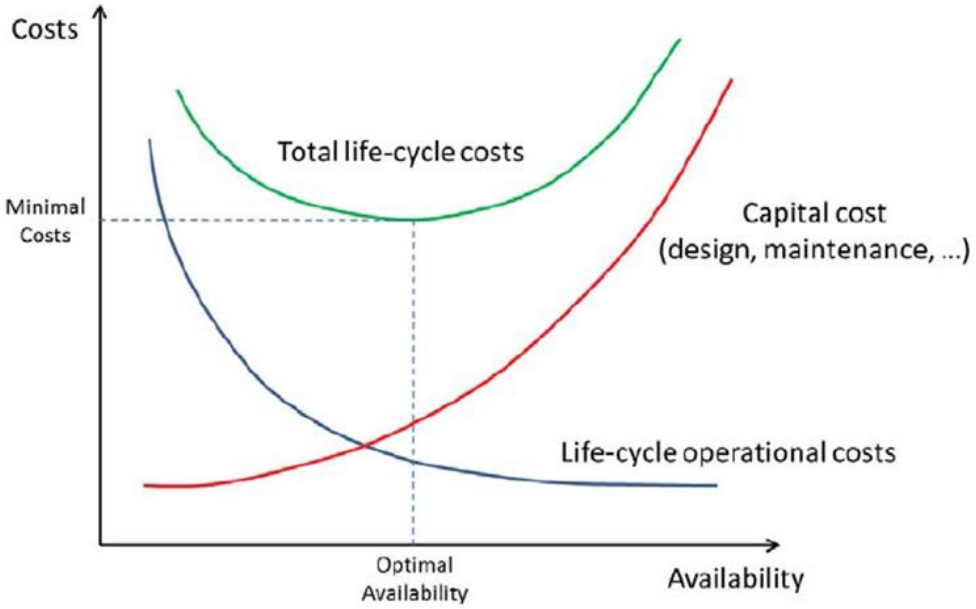
R2E within ATS

The project is strongly supported by ATS

R2E activities will continue to run at least until LS3 to prepare LHC for High Luminosity operation, and should be progressively migrated to regular support for exploitation

R2E is an excellent example of collaboration inside CERN but also outside CERN with other labs and companies.

Long-lasting efforts have been made to develop competencies and to build infrastructure for R2E. All need to continue to be secured



Conclusions

R2E is an important and successful project at CERN

Crucial for Injector and LHC operation, as well as the HL-LHC upgrade

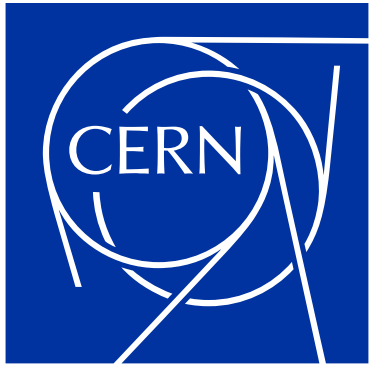
Sensitivity of COTS electronics remains a critical topic: cost vs performanc

CHARM is fully operational and ambitious plans are in progress to add heavy ion irradiation capacity CHIMERA

Looking forward to LHC operation this year to see all the improvements done during LS2

The future R2E activity is fully supported by the management of the Accelerator and Technology Sector

These R2E days are an important contribution to R2E continuing success – I hope everyone enjoys this stimulating event



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