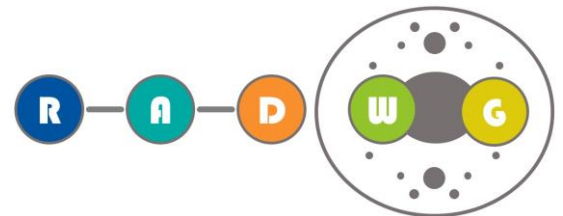


R2E - is it still an issue?

Salvatore Danzeca (EN/STI) on behalf of the R2E Project and RADWG



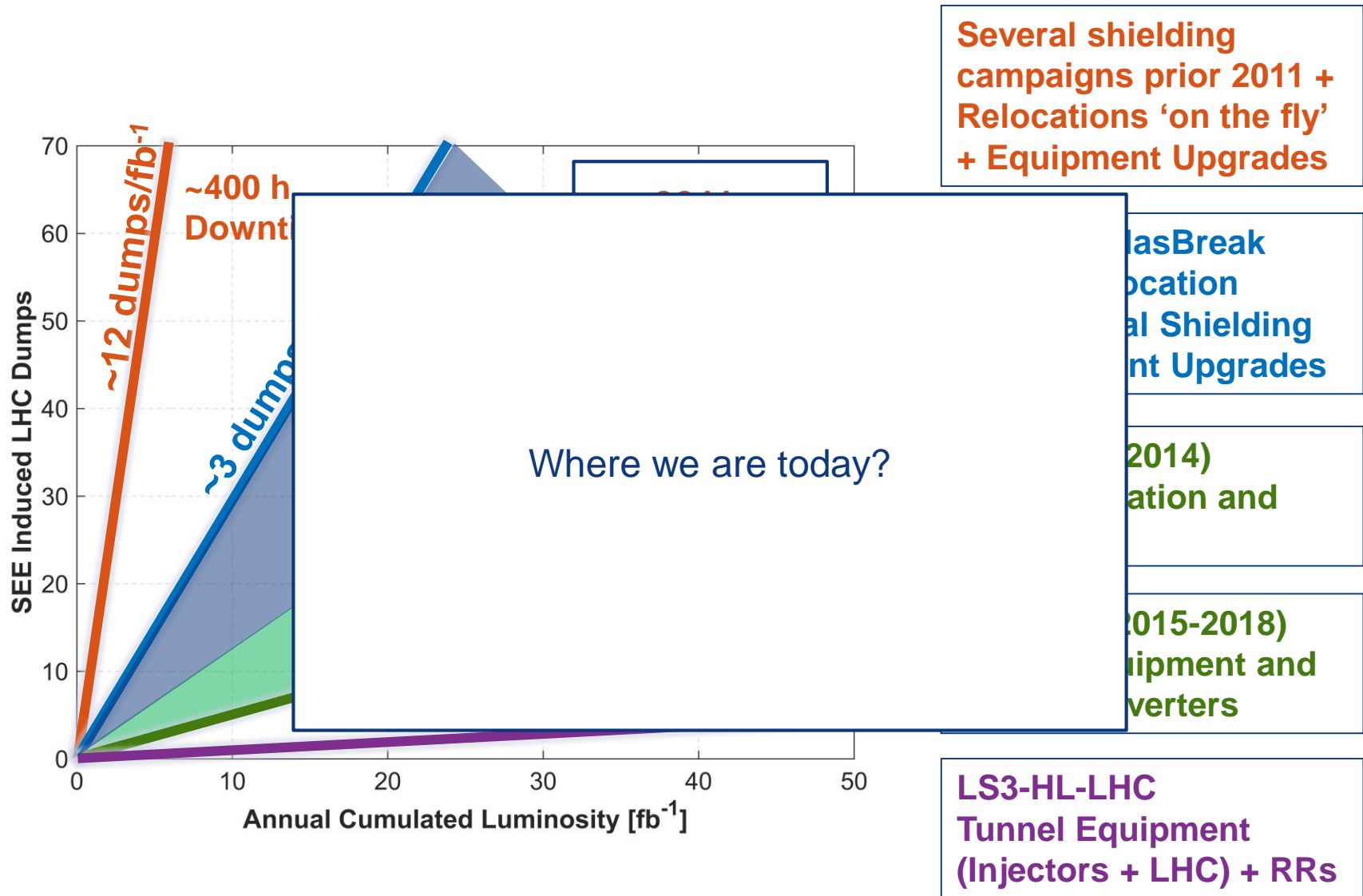
ENGINEERING
DEPARTMENT



Overview

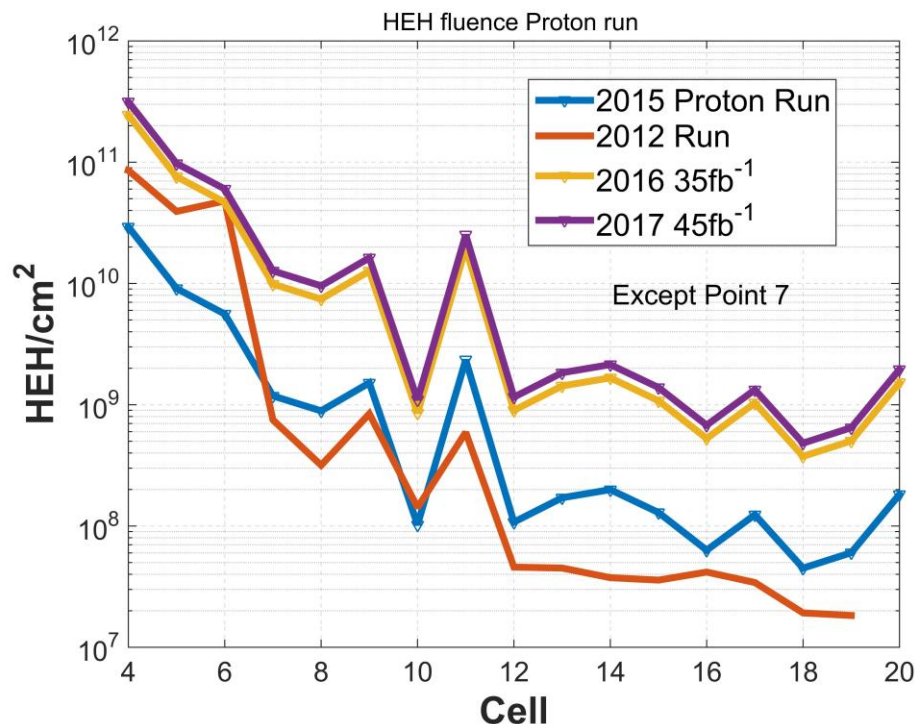
- R2E and the mitigation strategy from 2011
- Radiation levels: 2012 vs 2015
- Failure analysis and expected failures
- in view of radiation levels: TID issues to be considered
- Conclusions

R2E and the Mitigation Strategy from 2011



Radiation Levels – Tunnel Areas

- Failure rates are proportional to the radiation levels
- Tunnel areas – several equipment installed: QPS, EPC, Cryo



- Analysis based on the **RadMon** measurements up to end November
- 2012 vs 2015 highlights the impact of the **25ns operation**
- 2015 HEH fluence higher than 2012 in cells >8 due to the higher **beam-gas interaction**
- **2015 low luminosity** impacts the cell <8 with less fluence
- expected radiation level for **2016 and 2017** are **~8x and ~10x higher** than the 2015

Radiation Levels – Critical Areas

Critical Areas	2012 HEH Measurements	2015 HEH Predictions		2015 Measurements (4fb-1)		2016 Predictions 35fb-1	2017 Predictions 45fb-1
UJ14/16	1.10E+08	5.04E+07	→	6.82E+07	→	5.7E+08	7.3E+08
RR13/17	1.80E+07	1.68E+07	→	1.44E+07	→	1.2E+08	1.5E+08
UJ56	1.20E+08	4.24E+07	→	9.77E+07	→	8.1E+08	1.0E+09
RR53/57	1.80E+07	2.64E+07	→	9.17E+06	→	7.6E+07	9.8E+07
UJ76	5.50E+07	6.48E+06	→	9.75E+06	→	8.1E+07	1.0E+08
RR73/77	3.00E+07	1.92E+07	→	1.57E+07	→	1.3E+08	1.6E+08

- UJ14/16 shielded 2011/2012
- Sensitive equipment relocated from the UJs during the LS1
- RR13/17/53/56 shielded improvement during the LS1
- HEH fluence in the critical areas scale with the expected luminosity (apart from the UJ76 and RR73/77)
- Operational parameters can have important impact (see UJ76)
- Some failures can appear in the RR during the next years

Information collection

- **R2E** collects information on the eLogBook and Post Mortem Database
- **Analysis**
 - Radiation levels at the failure location
 - Iteration with the equipment owners
- **What we store:**
 - Location
 - Date-Time failure
 - Equipment/Component

For the 2016 we plan to add the R2E information on the failures tracked in the AWG tool (AFT)

QPS

	Dumps
2012	32
2015 after TS2	2

2012 Failures and Actions during LS1

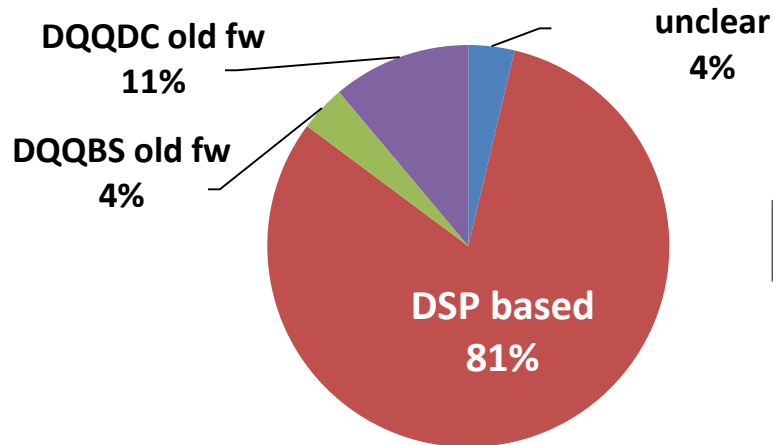
- **Locations :**
- UJ14/16, UJ56, RRs P1/P7, DS
- **Failure types in 2012:**
 - Digital detection system for nQPS
 - 600A protection (DSP based system)
 - uFIP communication
 - DAQ&uFip: no dump but required access
- **Mitigations:**
 - Firmware upgrades
 - Upgraded detection systems type nDQQDI
 - Relocation

2015 Failures and strategies

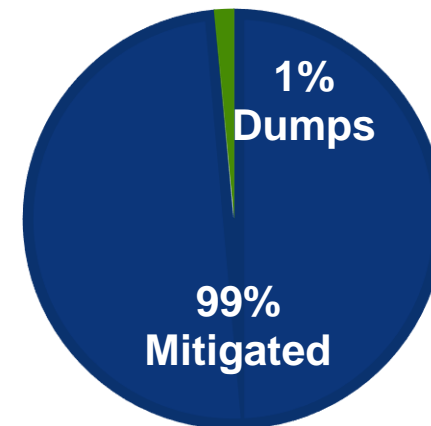
- **Locations in 2015:** RR13 and RR57
- **Failure types in 2015:**
 - 600A protection (DSP based system)
- **Mitigated Events:**
 - DAQ systems: 139 transparent (mitigated) errors recorded, no dump, no downtime.
- **Mitigations:**
 - Deployment of the new 600A design during the YETS

QPS

- **2011:** 3.5 dumps per fb⁻¹
- **2012:** 1.4 dumps per fb⁻¹
- **2015:** 0.5 dumps per fb⁻¹



2012: 32 R2E trips



2015: Most of the events are mitigated

EPC

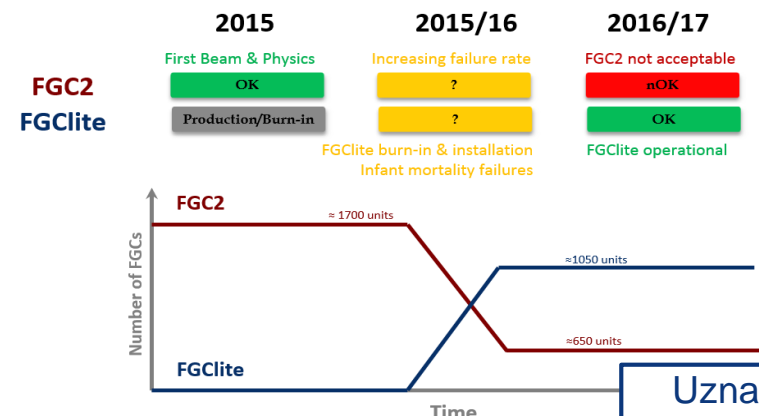
	Power part	Control
	Dumps	Dumps
2012	15	10
2015	2	3

2012 Failures and Actions during LS1

- **Locations:** UJs, RRs, ARC
- **Failure types:**
 - 600A: Aux Power Supply
 - FGC [10 events]
 - 120A failure [1 event]
- **Mitigations:**
 - AC/DC power supply problem corrected during the LS1
 - Radiation tolerant power converters
 - New FGClite design

2015 Failures and strategies

- **Locations in 2015:** ARC, RR77, RR57
- **Failure types in 2015:**
 - FGC2
 - 120A
- **Mitigations:**



Uznasky,
2014

RF

	Dumps
2012	1
2015	4(TBC)

- **Locations:** UX45
- **Failure types**
 - ARC detector: circulator/load
 - ARC detector: klystron window
- **Mitigations**
 - Cases are still under investigations
 - **Radiation effects to be confirmed**

Others

- **Cryo:** Mecos and PLC relocation Effective: **NO DUMPS**
- **Collimation:** after the last relocation in the LS1: **NO DUMPS**
- **EN/EL:** relocation: **NO DUMPS**

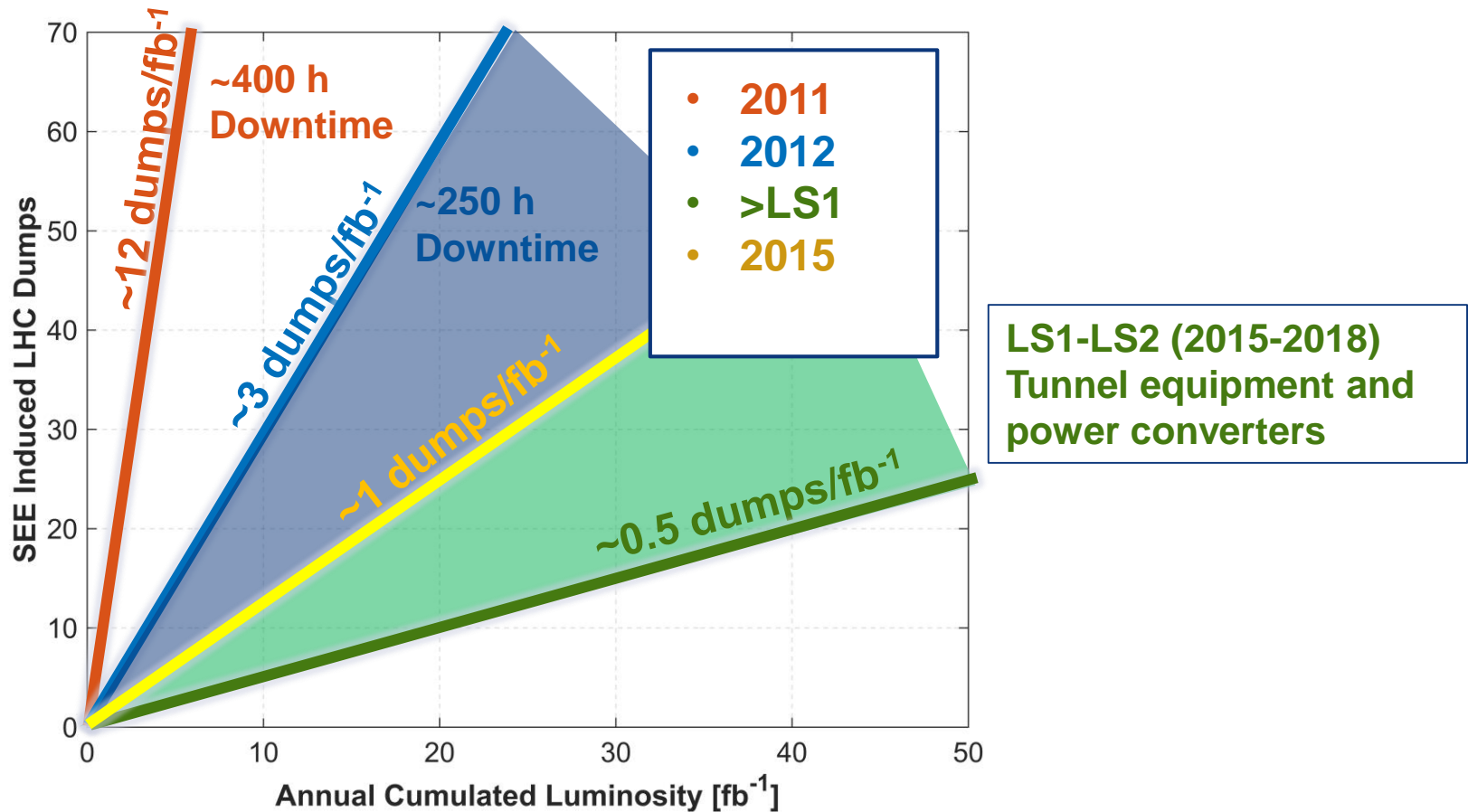
Cryo		Collimation		EN/EL	
	Dumps		Dumps		Dumps
2012	4	2012	1	2012	1
2015	0	2015	0	2015	0

Failures Overview

Equipment	Dump 2012	Dump 2015		Dump 2016 35fb ⁻¹
QPS	32	2	→	1-5
Power Converter	15	5	→	24
Cryo	4	0	→	0
EN/EL	1	0	→	0
Vacuum	4	0	→	0
Collimation	1	0	→	0
RF	1	4	→	4
Others (hidden)	-	-	→	1-10
Total	3 /fb ⁻¹	3 /fb ⁻¹ 1.2 /fb ⁻¹		~1-1.5 /fb ⁻¹

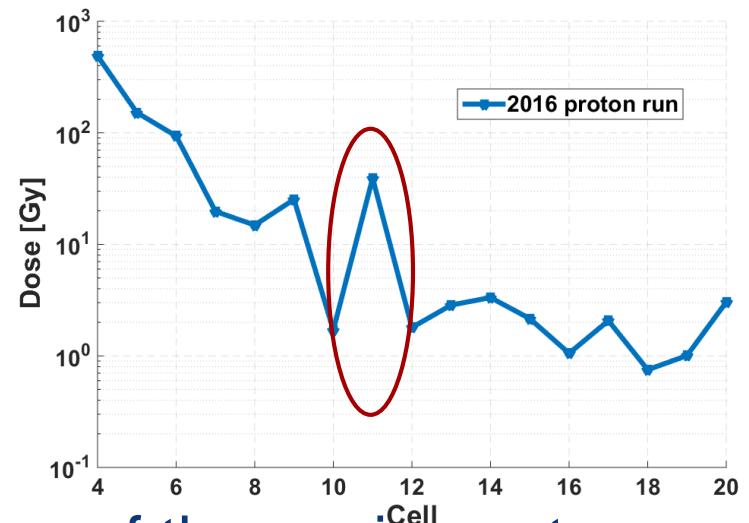
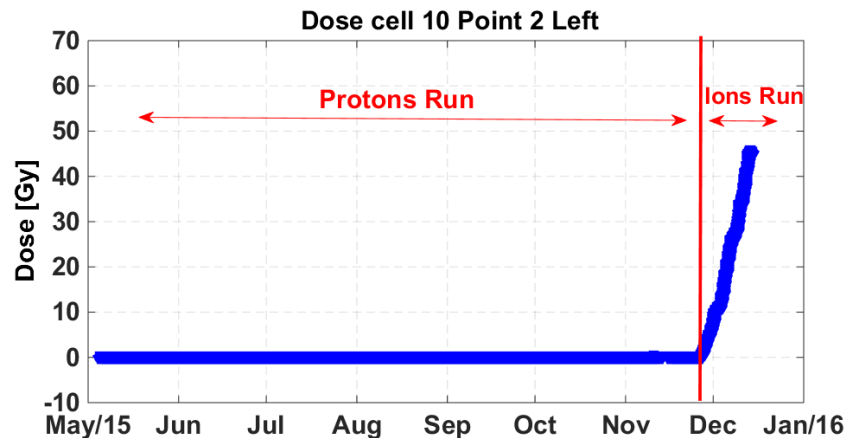
- 2015 going in the right directions approaching ~1 dump/fb⁻¹
- 2016 limited by the EPC equipment solved partially during the EYETS
- 2016 run will highlight if the RF failures are due to the radiation
- 2016 other new failures can appear due to increase of the radiation levels

Where we are today?



Looking at the future

- It is and it will be not only a question of SEE: **long term TID** effects will become an issue



- Ions run losses reduce the lifetime of the equipment
- The increase of the radiation levels due to higher luminosity (2016-2017) may lead to pre-emptive maintenance of several equipment

Conclusions

- R2E - is it still an issue?

YES IT IS!

- **A lot of equipment remains in tunnel/exposed areas**
- **Long term TID will become a serious issue for the equipment in the tunnel areas**
- **Increased radiation level in the critical areas can lead to new failures.**
- Strategy:
 - Radiation level measurements and analysis
 - Follow-up the equipment failures
 - Follow-up the new development supporting the radiation tests and the correctness of the qualification process
 - Relocation if needed



ENGINEERING
DEPARTMENT

Thank you