

Shutdown schedule until 2035 to ensure reliable operation of the LHC & Injectors

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What we will present

- Outline and background assumptions
- Information included
- Overall plan
 - Technical stops
 - End of year Technical Stops
 - Long Shutdowns
- LINAC4 connection to PSB?
- Conclusions

Outline

- Aim
 - Establish a base-line scenario for shutdowns until 2035
 - Taking into account the optimum periodicity and length of Technical Stops, End of Year Technical Stops, Long Shutdowns
- With the following assumptions
 - LINAC4 is connected to PSB during first **suitable stop*** after LS1
 - PSB is not upgraded to 2GeV operation
 - There is no upgrade of SPS RF system
 - There is no HL-LHC program
 - Only maintenance and consolidation needed to maintain 2012 performance and reliability levels are performed

* Two possible scenarios studied

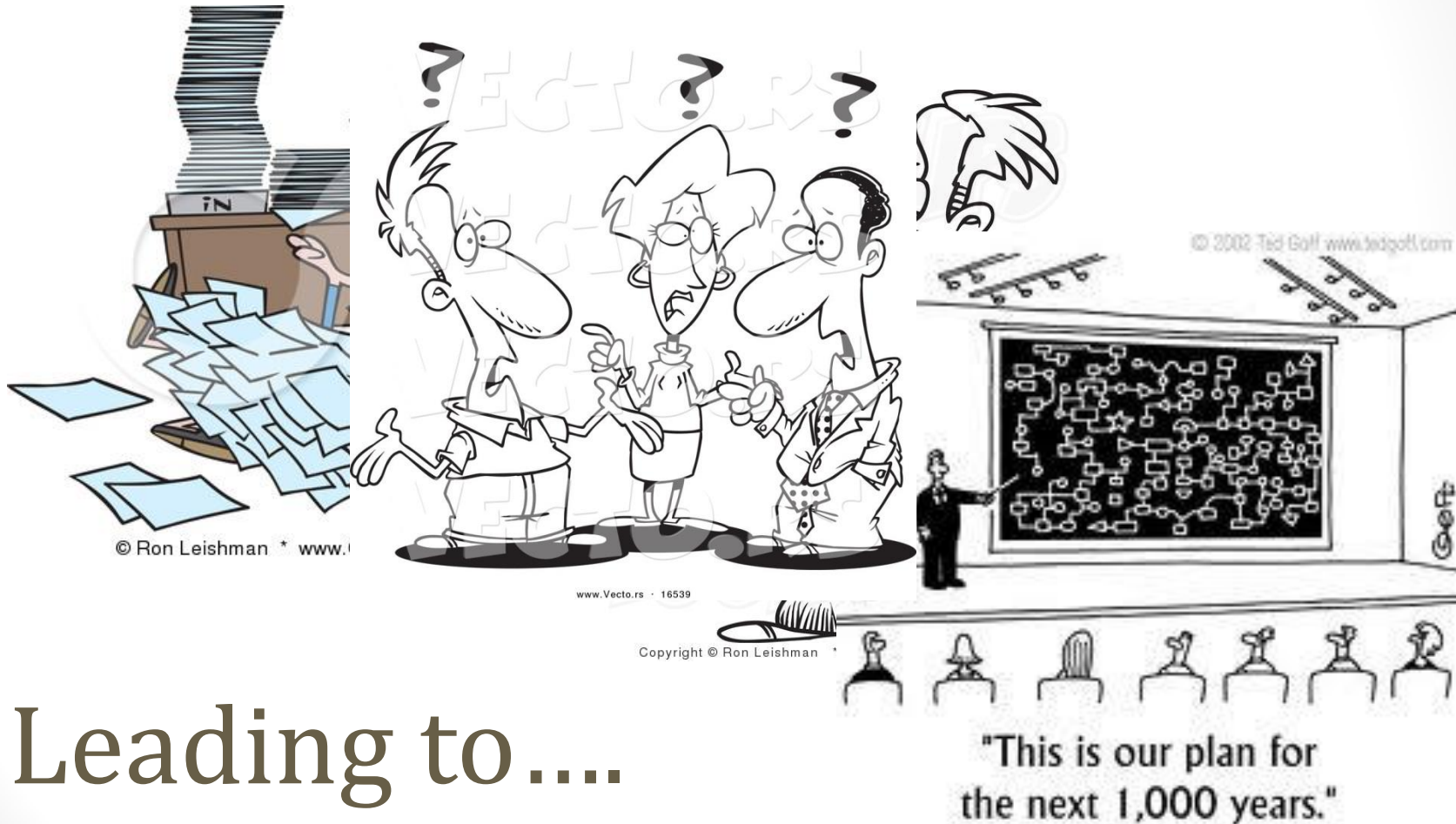
No LIU and no HL-LHC

Information included

Standard maintenance and essential consolidation (including replacement of equipment) needed to maintain reliable LHC & Injector operation until 2035

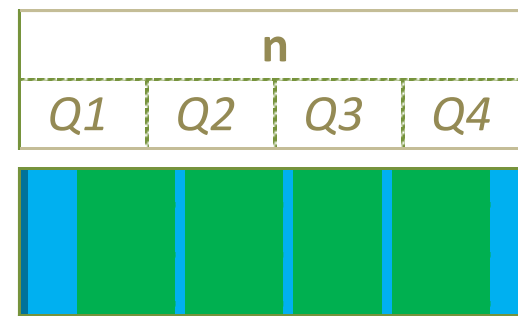
- **What** do you need to do?
- **When** do you need to do it?
- **How long** will it take?
- **How frequently** should it be done?
- Are the **resources** available to do multiple works in parallel?
- Do you need a significant cool-down period (**ALARA**)?

Followed by a careful analysis of the data.....



Technical stops

- In order to perform preventive and corrective maintenance
- Strong request
 - EL, RF, CV*, CRG, ABT, BI
 - CV & CRG maintenance determines the
length = 5 days, and frequency – every 10 weeks
- Useful but not essential: MSC, VSC, GS
- Not needed: EPC, SU, STI

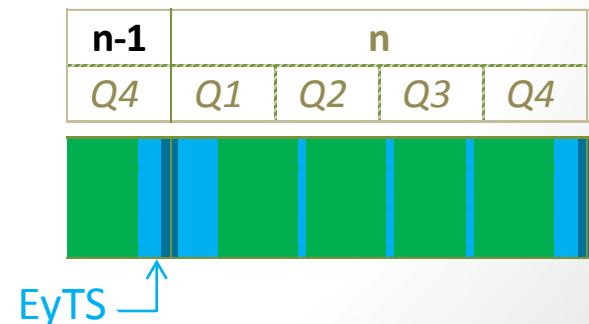


Technical Stops

Operation

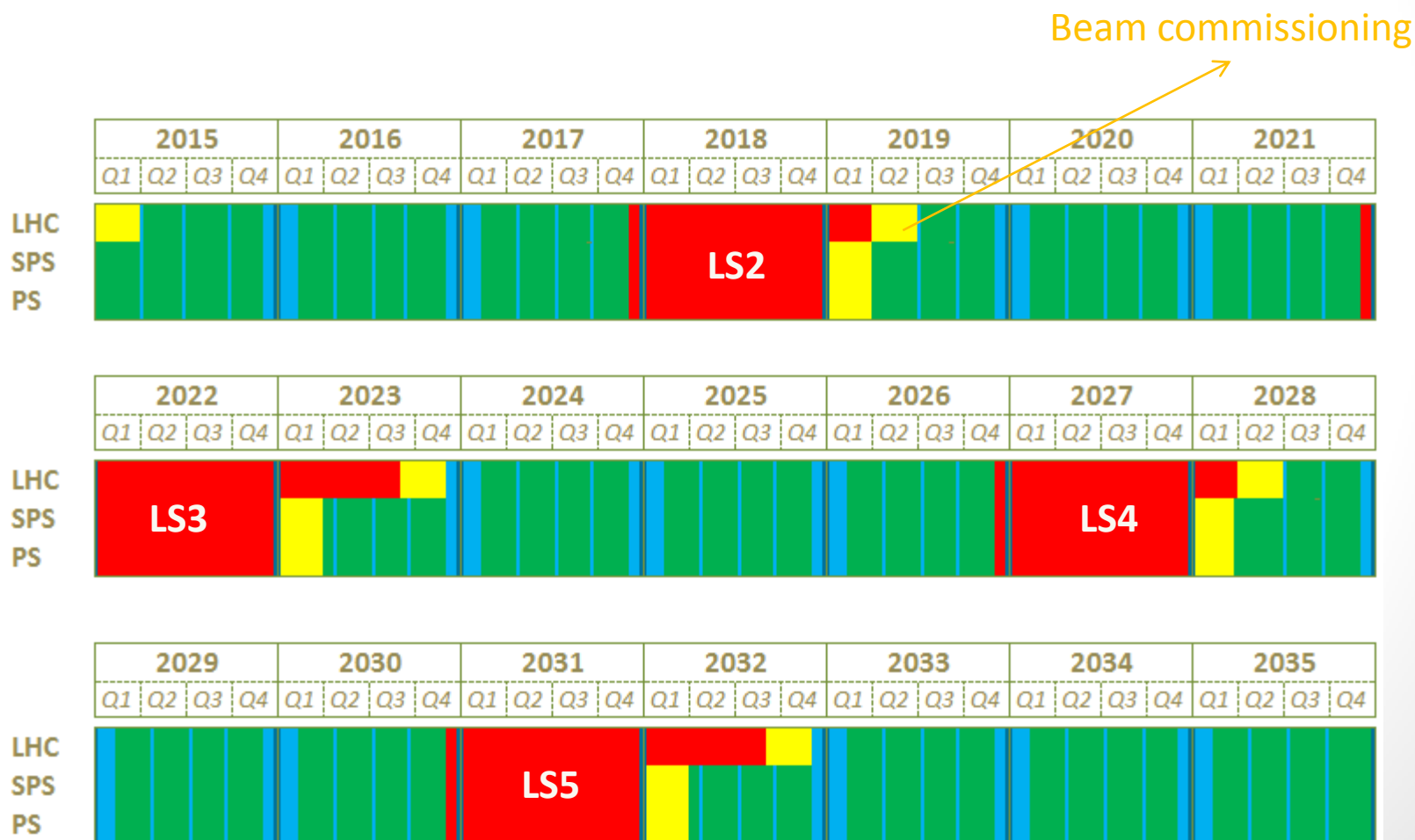
End of year Technical Stops

- *Assuming ion operation in LHC with no protons in the Injectors at the end of each year to optimize the cool-down time before access*
 - Longest possible cool-down period is essential for ABT
- Requests from all groups ranging from 4 to **10 weeks** *(incl. Xmas holidays)*
 - Essential works
 - CV & Cryo maintenance (determines the length = 10 weeks)
(CV maintenance in the injectors: 8weeks)
 - Alarm tests during Xmas holidays;
 - EL 400kV maintenance(4wks) ; ABT (4 wks CD +4wks)
 - Access (6-8wks) RF (6 wks), VSC (6 wks), & BI
 - Useful but not essential
 - SU, EPC, MSC



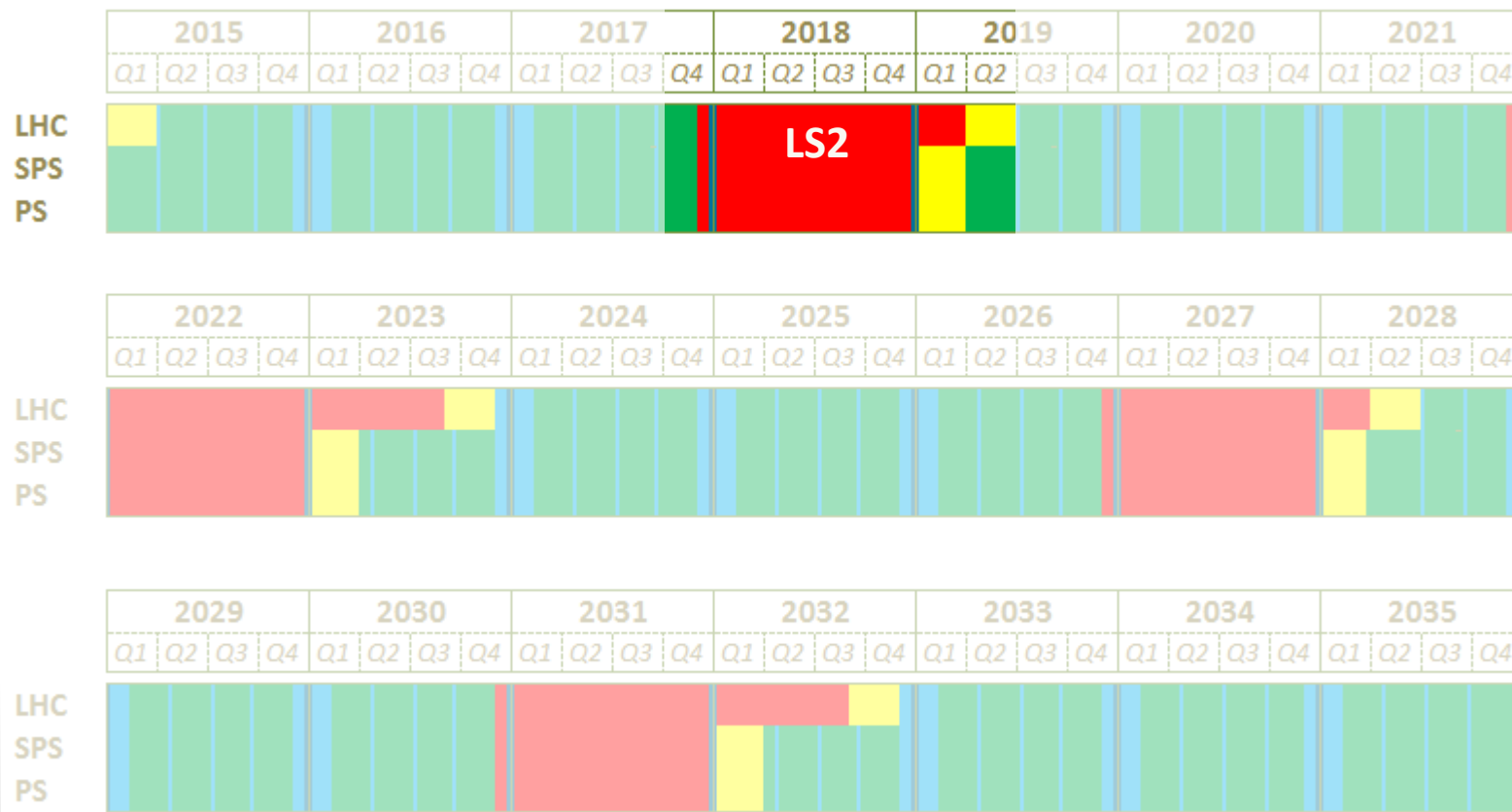
Long Shutdowns

Scenario 1 – Connection of L4 during LS2



LS2 from 2018 *(according to scenario 1)*

LHC 16 months, Injectors 12 months



LS2 - LHC

- **Maintenance**

- Cooling – Ventilation & Cryogenics equipment

are defining the length :

16 months

*Cryogenics equipment could be maintained
in 1 year but including CV gives 16 months*

- ABT septa & kickers 6 months CD+ 3 months
 - RF maintenance 6 months
 - Electrical equipment, collimation,
beam instrumentation, detection... in the shadow

- **Potential main consolidation**

- MSC exchange 20 s/c magnets 6 months
 - MBW-MQW (*shields, absorbers*)

LS2 – Injectors (1/3)

- **Maintenance & “recurrent” consolidation**

- Cooling and ventilation equipment **12 months**
- Kickers and Septa 6 months CD + 3 months
- SPS irradiated cables campaign 6 months CD + 5 months
- Cable clean up campaign up to 12 months
6 months/zone with 2 zones in //
- Renovation of SPS surface buildings 9 months
- Renovation of 8 PS main magnets * 6 months CD + 4 months
- Exchange of 20 SPS magnets * 4 months

* See next slide

LS2 – Injectors (2/3)

Roadmap for preventive maintenance of injectors magnets

- by end 2014-2015 every magnet should have spare units (coils or entire magnet)
- complete the PFW procurement and perform consolidation during LS2
- procure additional spare coils for the SPS bending magnets
- spare PS machine bus-bars manufactured, postpone decision for replacement
- spare PS machine-to-power generator bus bars do not exist: decision to take

LS2 – Injectors (2/3)

- **In addition**

- Connection of LINAC 4 to PSB (*scenario 1*)
- Replacement of TT2 power converters
- Replacement of SPS access system
- SPS evacuation alarms, BIW and replacem^t of PVC fire detection cables

9 months

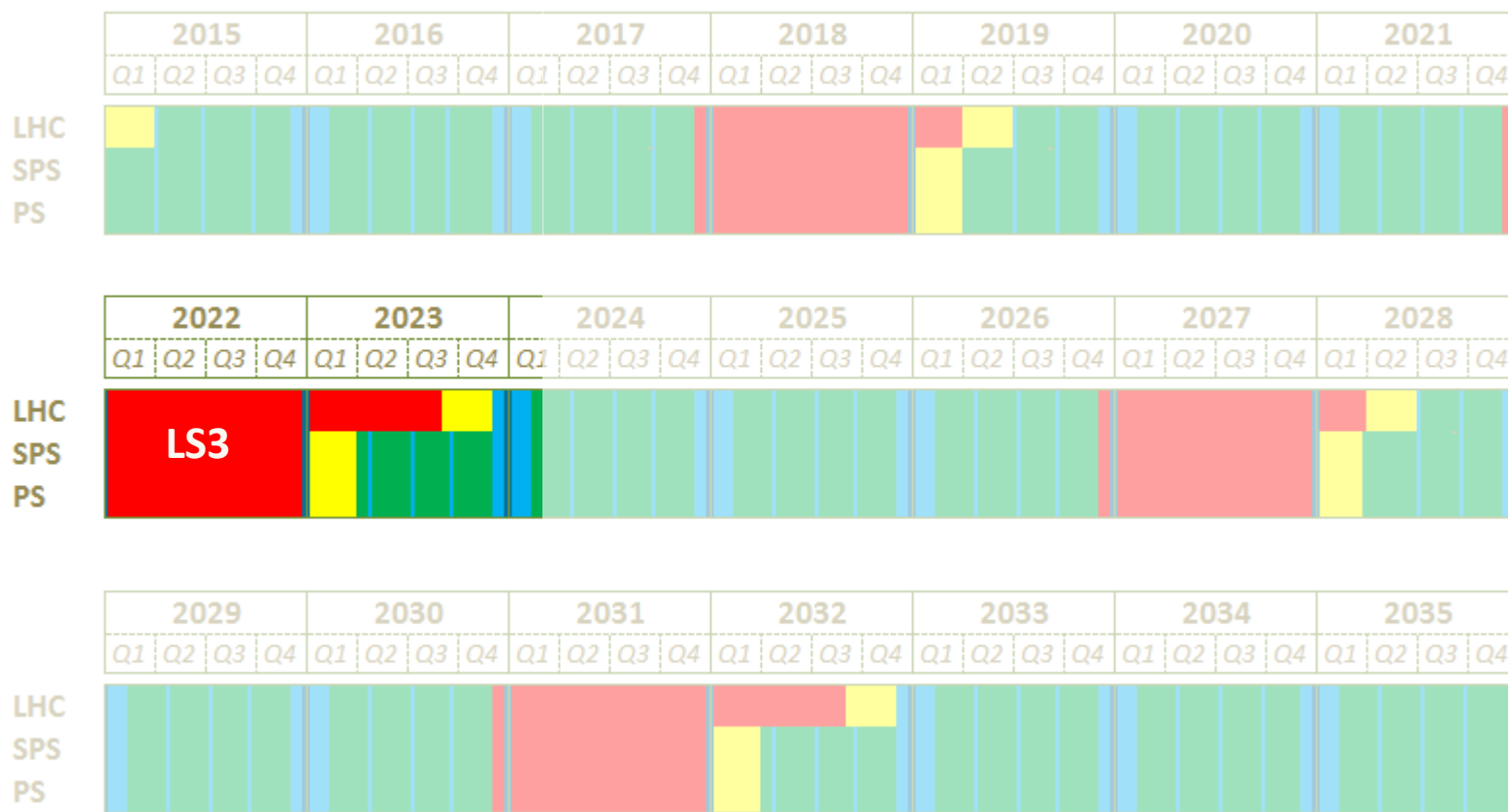
9 months

12 months

12 months

LS3 from 2022 *(according to scenario 1)*

LHC 20 months, Injectors 12 months



LS3 - LHC

- **Maintenance**

- *Cooling – Ventilation & cryogenics equipm^t* 16 months
- *ABT septa & kickers* 6 months CD+ 3 months
- *RF maintenance* 6 months
- *Electrical equipment, collimation, beam instrumentation, detection...* in the shadow

- **In addition**

- Inner triplet magnets exchange **20 months**
- Arc pumping group replacement 6 months
- Collimator replacement campaign 6 months CD + 3 months
- Cryo compressor consolidation 12 months
(*can be done in parallel with maintenance*)
- MSC exchange 20 s/c magnets 6 months

LS3 - Injectors

- **Maintenance & “recurrent” consolidation**

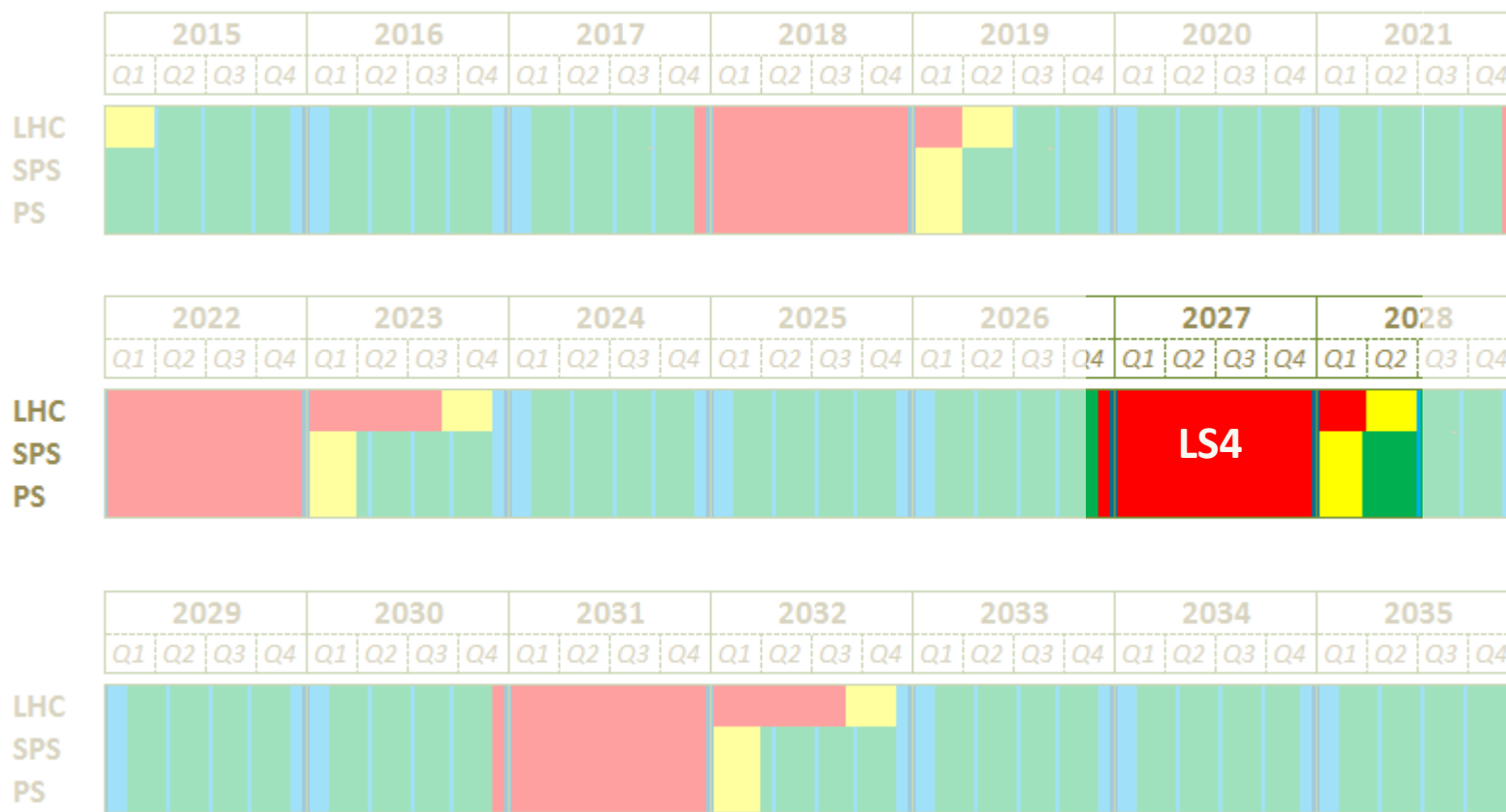
- | | |
|---|------------------------|
| • Cooling and ventilation equipment | 12 months |
| • Kickers and Septa | 6 months CD + 3 months |
| • SPS irradiated cables campaign | 6 months CD + 5 months |
| • Cable clean up campaign | up to 12 months |
| <i>6 months/zone with 2 zones in //</i> | |
| • Renovation of 8 PS main magnets | 6 months CD + 4 months |
| • Exchange of 20 SPS magnets | 4 months |
| • Renovation of SPS surface buildings | 9 months |

- **In addition**

- | | |
|----------------------|-----------|
| • SU full SPS survey | 10 months |
|----------------------|-----------|

LS4 from 2027 *(according to scenario 1)*

LHC 16 months, Injectors 12 months



LS4 - LHC

- **Maintenance**

- *Cooling – Ventilation & cryogenics equipm^t*
- *ABT septa & kickers*
- *RF maintenance*
- *Electrical equipment, collimation, beam instrumentation, detection...*

16 months

6 months CD+ 3 months

6 months

in the shadow

- **Consolidation**

- Septa replacement
- Collimator replacement campaign
- MSC exchange 20 s/c magnets
- VSC replace arc pumping

6 months CD + 3 months

6 months CD + 3 months

6 months

6 months

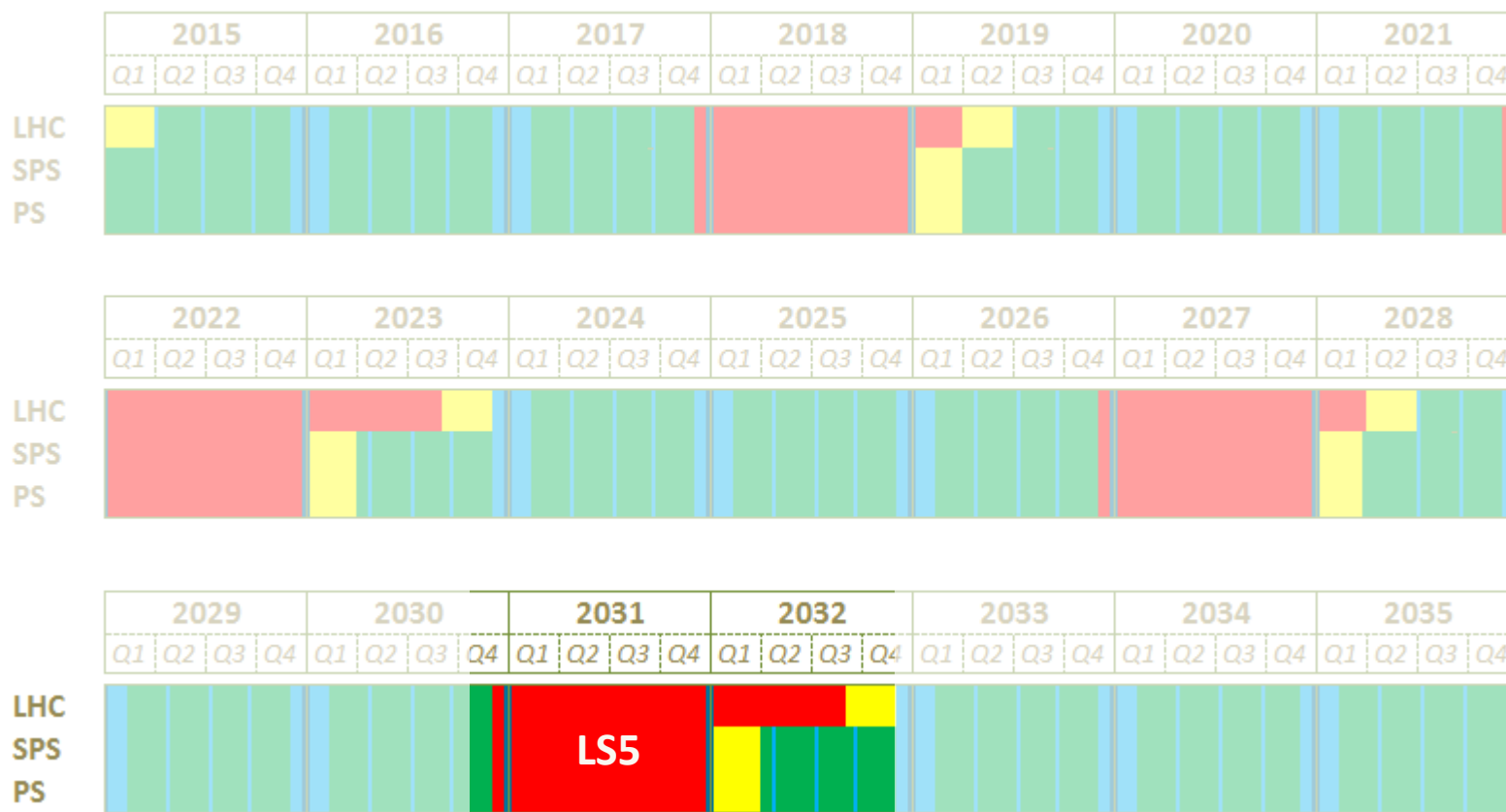
LS4 - Injectors = 12 months

- **Maintenance & “recurrent” consolidation**

- Cooling and ventilation equipment **12 months**
- Kickers and Septa 6 months CD + 3 months
- SPS irradiated cables campaign 6 months CD + 5 months
- Cable clean up campaign up to 12 months
6 months/zone with 2 zones in //
- Renovation of 8 PS main magnets 6 months CD + 4 months
- Exchange of 20 SPS magnets 4 months
- Renovation of SPS surface buildings 9 months

LS5 from 2031 *(according to scenario 1)*

LHC 20 months, Injectors 12 months



LS5 - LHC

- **Maintenance**

- *Cooling – Ventilation & cryogenics equip.* 16 months
- *ABT septa & kickers* 6 months CD+ 3 months
- *RF maintenance* 6 months
- *Electrical equipment, collimation, beam instrumentation, detection...* in the shadow

- In addition

- Change Inner triplet magnets??? **20 months**
- Collimator replacement campaign months 6 months CD + 3
- MSC exchange 20 s/c magnets 6 months

LS5 - Injectors

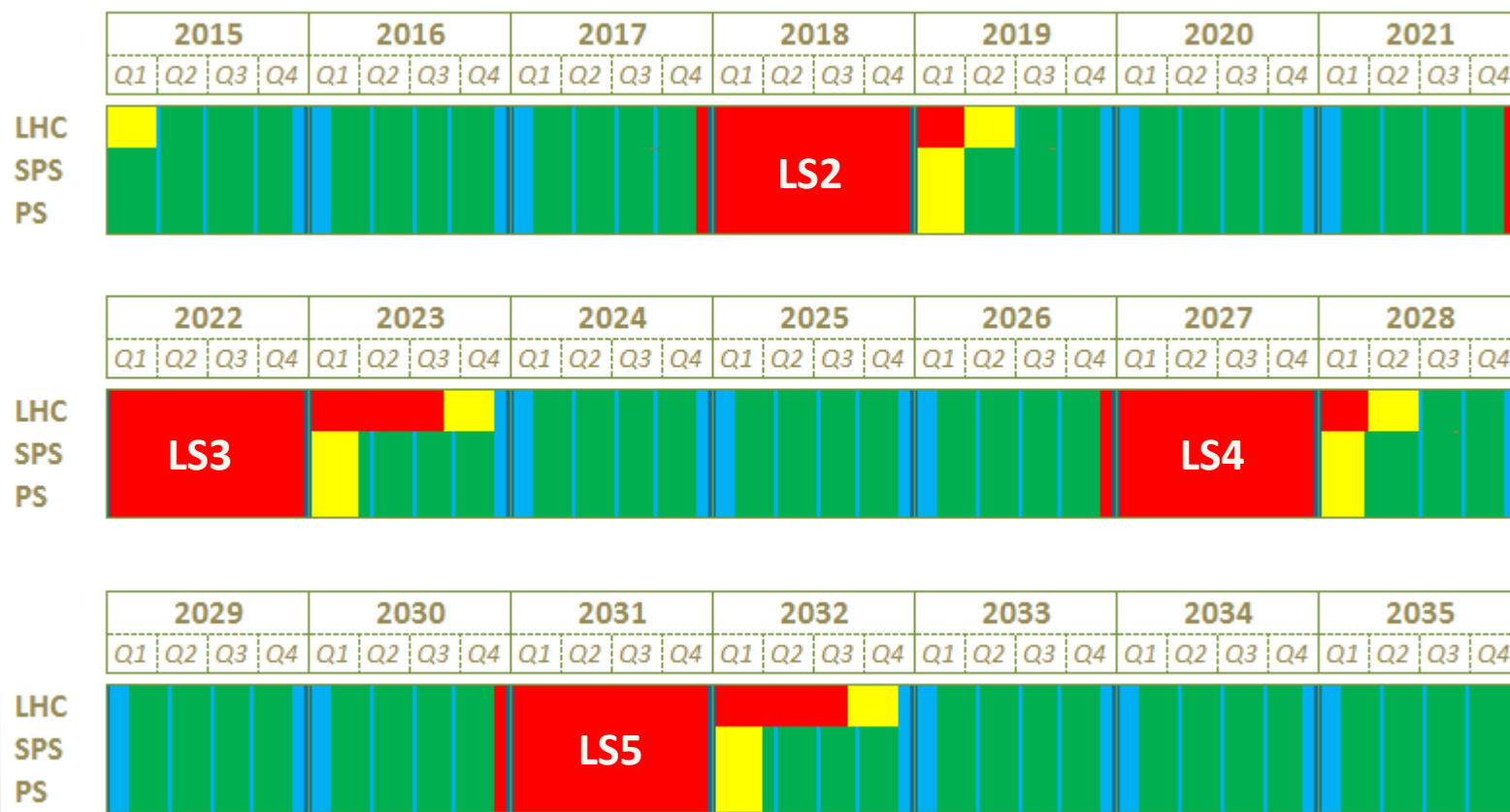
- **Maintenance & “recurrent” consolidation**

- Cooling and ventilation equipment **12 months**
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- Exchange of 20 SPS magnets 4 months
- Renovation of SPS surface buildings 9 months

Can we wait until 2018 to connect Linac4 to PSB?

Scenario 1

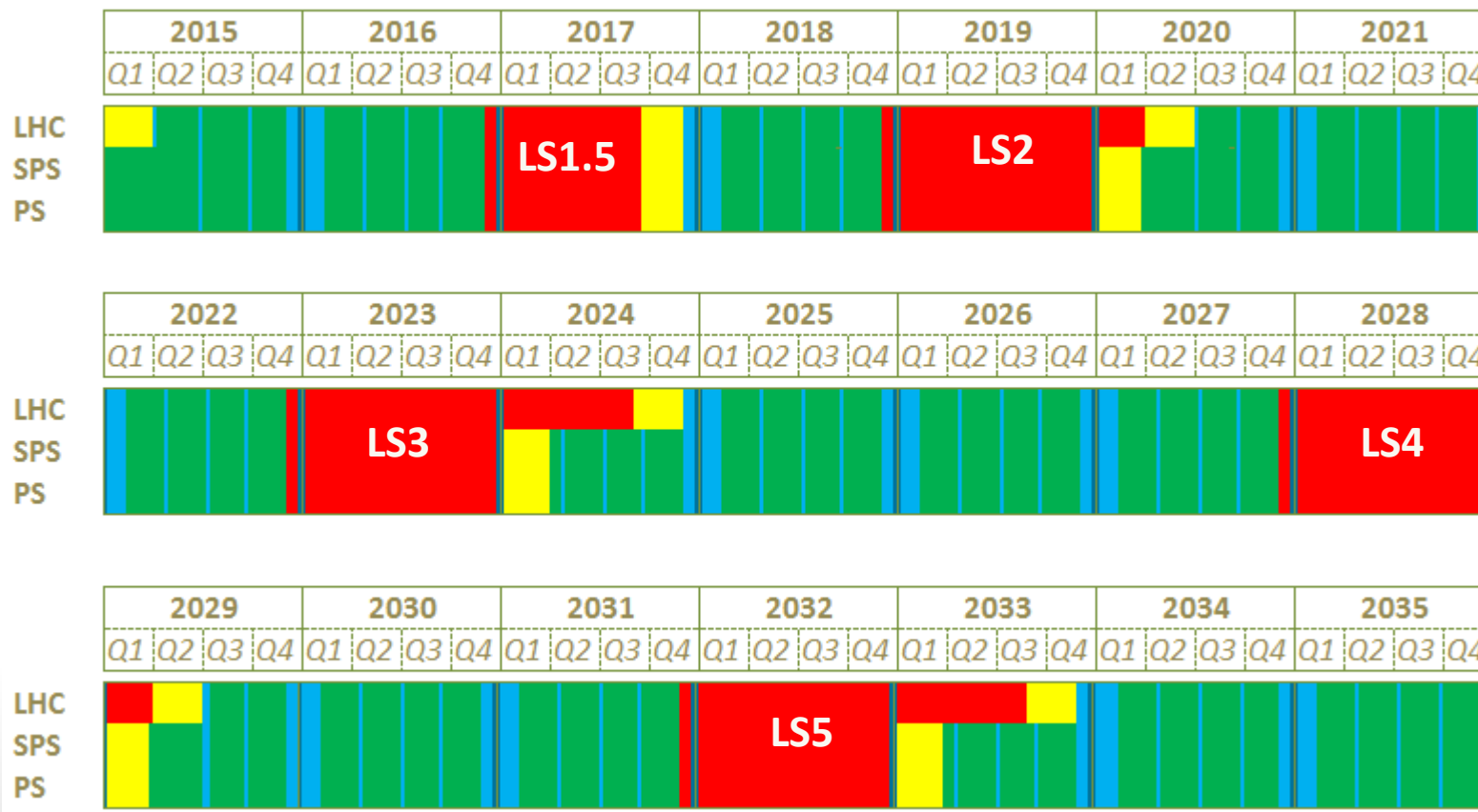
from 2015 to 2035: beam = 57%



L4 connection to PSB in 2017

Scenario 2

from 2015 to 2035: beam = 54 % of time



To LS1.5 or not to LS1.5?

Advantages

- Mitigate risk of Linac2 failure
- Linac4 is not left idle
- Reduce LS2 workload (mainly in Injectors) EL, GS, CV....

Disadvantages

- 9 months is too short to complete LHC CRG maintenance
- Need LS2 in 2019 at the latest
- Reduces potential physics output by 1 year
 - = 12% 2015 to 2020
 - = 4% 2015 to 2035

Conclusions

- Two base-lines established
 - With and without LS1.5
- Minimum shutdown lengths have been given
 - Leading to beam operation $\sim 3/5^{\text{th}}$ of the time from 2015 to 2035
- **Preference for scenario 2 with LS1.5**
 - Mitigate risk of Linac2 failure
 - Linac4 is not left idle
 - Reduce LS2 workload (mainly in Injectors) EL, GS, CV....
 - Reduced physics potential ($\sim 4\%$) can be recuperated with one year of additional running in 2036