Future LHC running conditions

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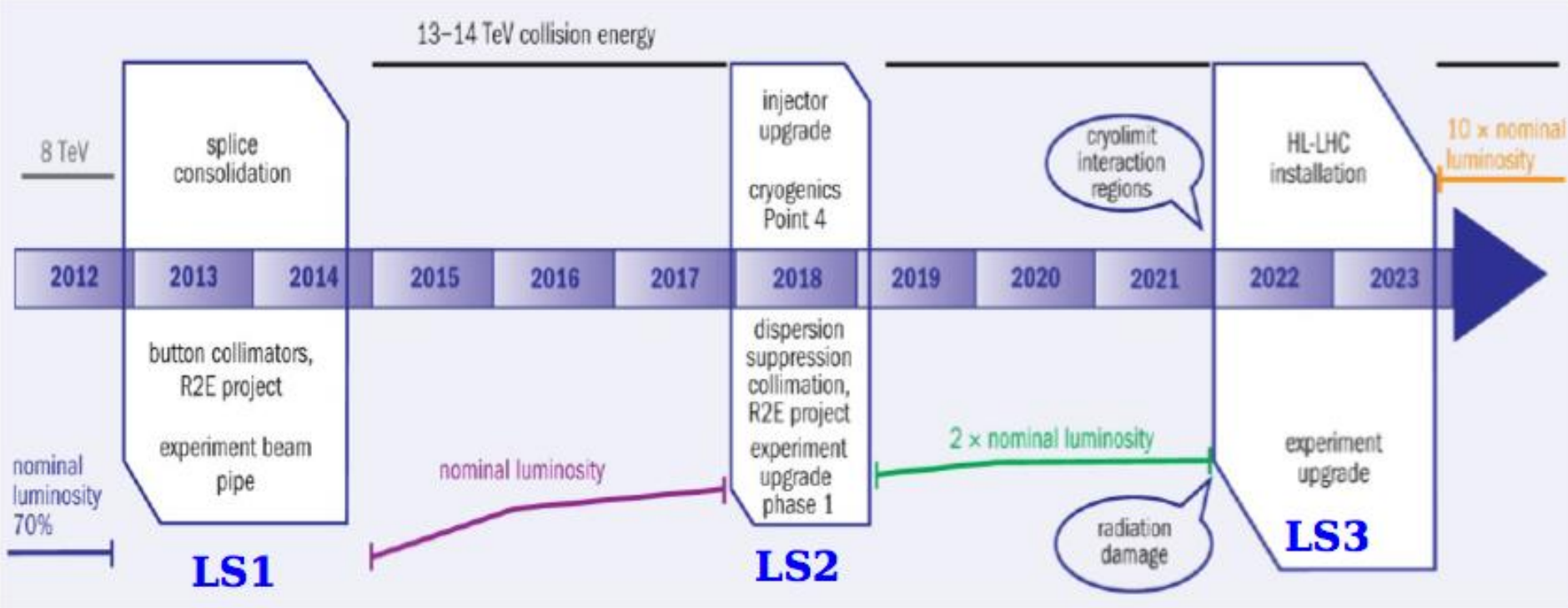
LHC plans

Lucio Rossi and Oliver Brüning (CERN): HL-LHC

Krakow symposium, Sep 2012

`https://indico.cern.ch/contributionDisplay.py?contribId=153&confId=175067`

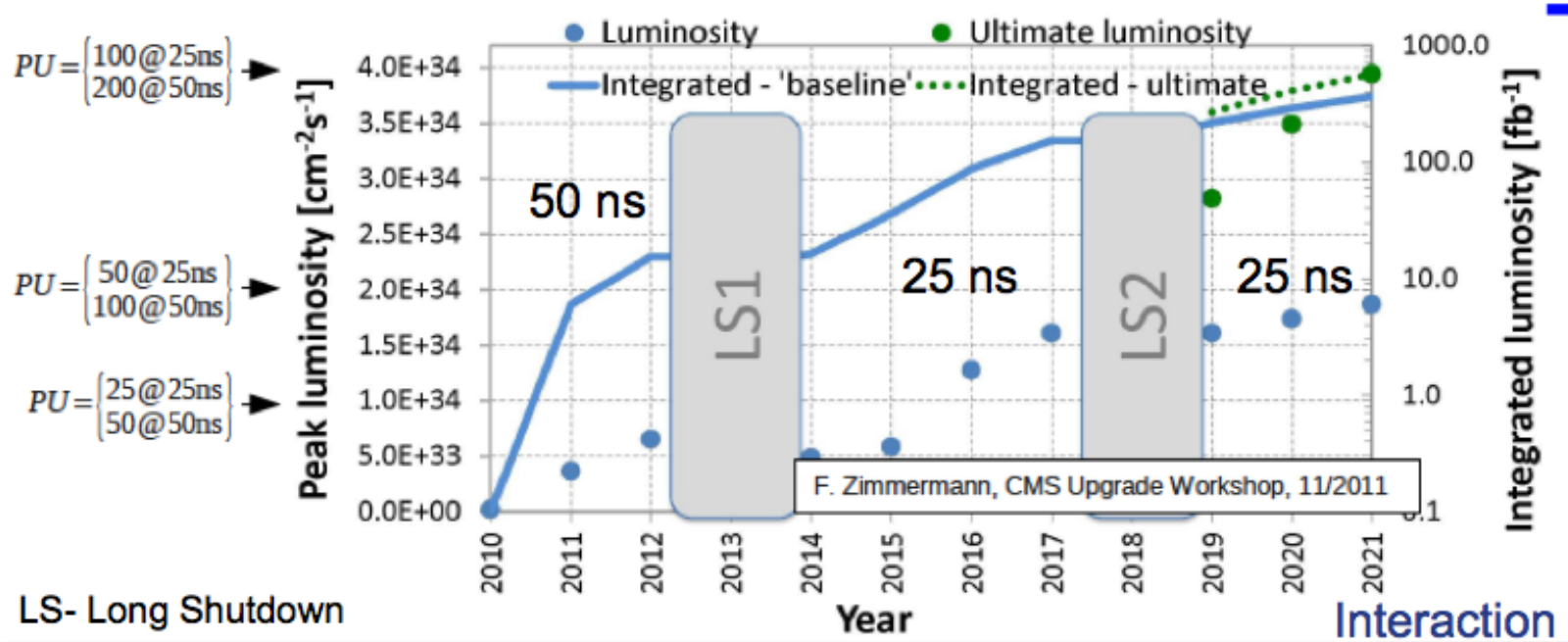


LHC

Energy increase
8 TeV to 13/14 TeV

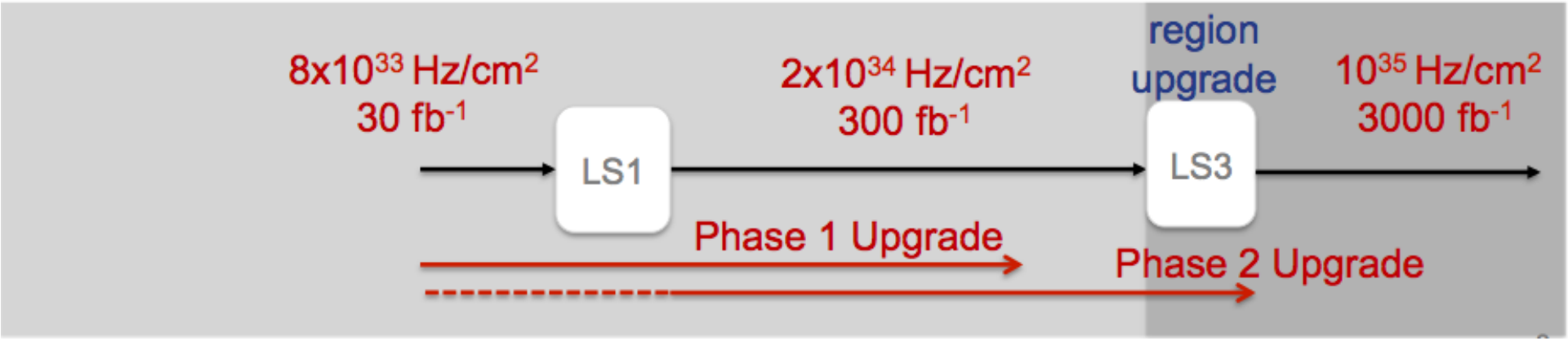
Injection upgrade

HL-LHC

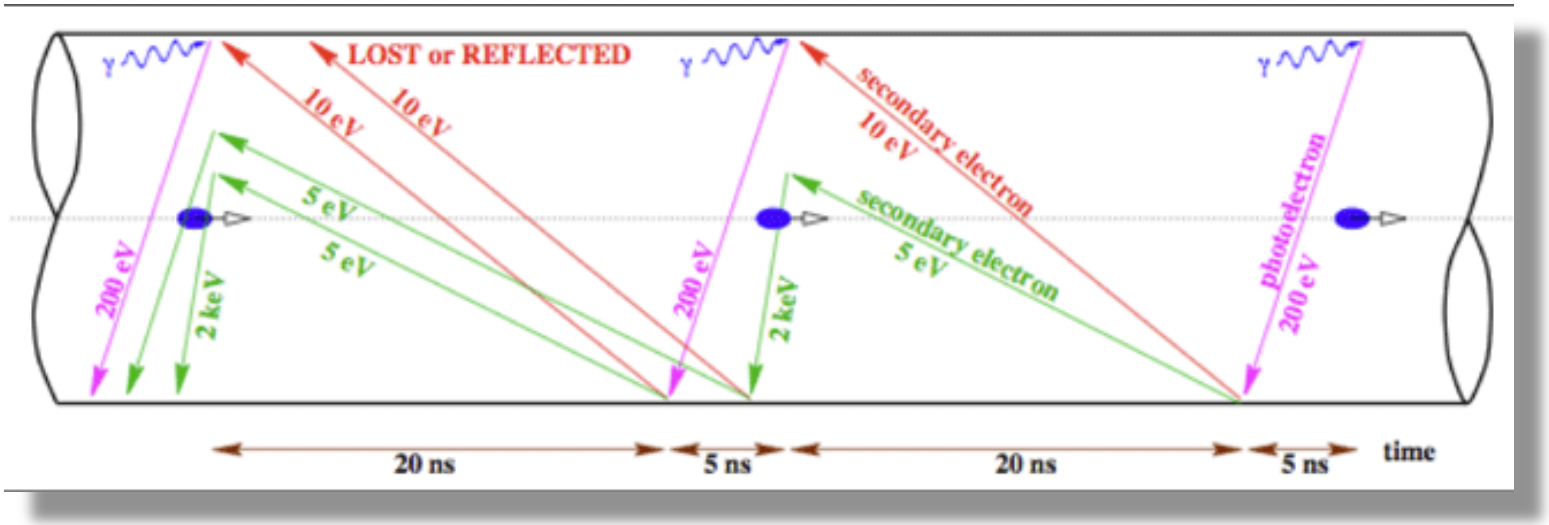


Luminosity-leveled at 5×10^{34} cm^{-2}s^{-1} in HL-LHC

LS- Long Shutdown



25 ns & electron cloud



25 ns spacing: the following bunch interacts with the radiation caused by the previous bunch

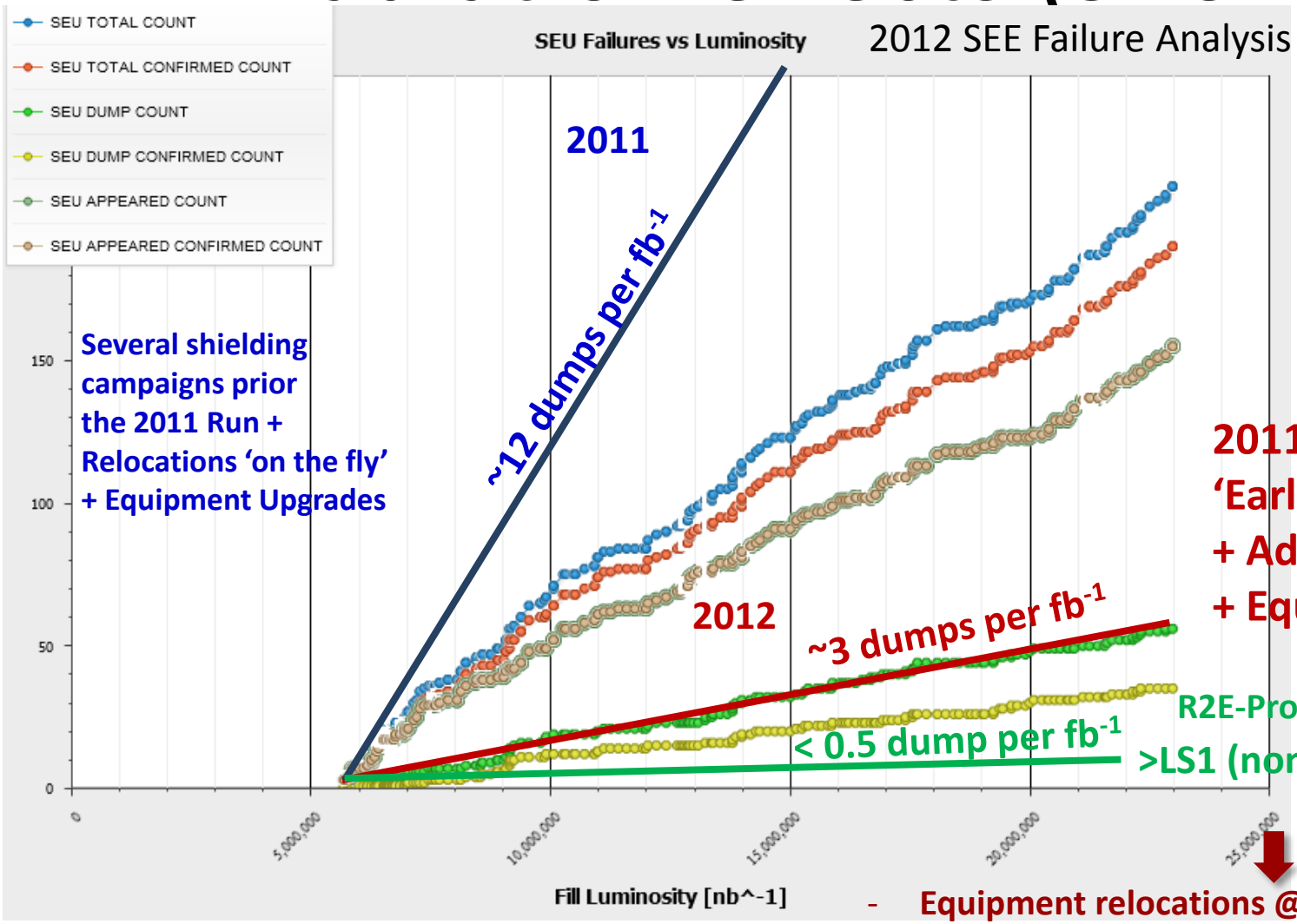
Electron cloud: consequences

- Possible consequences:
  - single-bunch instability
  - multi-bunch instability
  - emittance growth
  - gas desorption from chamber walls
  - excessive energy deposition on the chamber walls (important for the LHC in the cold sectors)
  - particle losses, interference with diagnostics,…
- In summary: the EC is a consequence of the interplay between the beam and the vacuum chamber ⟹ "rich physics"
  - many possible ingredients: bunch intensity, bunch shape, beam loss rate, fill pattern, photoelectric yield, photon reflectivity, SEY, vacuum pressure, vacuum chamber size and geometry, …

Defense: design (saw-tooth pattern on the beam screen inside the cold arcs, NEG coatings, solenoids, etc.)

Electron bombardment of a surface has been proven to reduce drastically the secondary electron yield of a material.
This technique, known as **scrubbing**, provides a mean to suppress electron cloud build-up and its undesired effects

Radiation effects (SEU ++)



2011/12 xMasBreak
'Early' Relocation
+ Additional Shielding
+ Equipment Upgrades

R2E-Project aiming for …
>LS1 (nominal -> ultimate)

- **Equipment relocations @ 4 LHC Points (>100 Racks, >60 weeks of work)**
- **Additional shielding**
- **Critical system upgrades (QPS, FGC)**

50 versus 25 ns

	50 ns	25 ns
GOOD	• Lower total beam current • Higher bunch intensity • Lower emittance	• **Lower pile-up**
BAD	• **High pile-up** • Need to level • Pile-up stays high • High bunch intensity – instabilities…	• More long range collisions: larger crossing angle; higher beta* • Higher emittance • Electron cloud: need for scrubbing; emittance blow-up; • Higher UFO rate • Higher injected bunch train intensity • Higher total beam current

Expect to move to 25 ns because of pile up…

Summary

25 ns is preferred by experiments

➔ It might or might not be a problem for LHC

Expect a pile-up of ~30-50 @ 25 ns