Chamonix14
Session 3: 2015 commissioning with beam

Mike Lamont and Giulia Papotti

Experiments' Expectations for 2015	Emilio Meschi
Baseline Machine Parameters and Configuration	Roderik Bruce
Optics options for the 2015 LHC run	Massimo Giovannozzi
Nominal Cycle and Options	Matteo Solfaroli Camillocci
Scrubbing: Expectations and Strategy	Giovanni Iadarola

Situation

- The LHC has been pulled apart and put back together again
- There have been major system consolidation and upgrades including significant control system upgrades at all levels
- Operationally not a new machine, carry forward considerable experience – however will face familiar and new challenges

2015 – Energy

Issue	Possible effects
Higher stored beam energy	Even bigger disaster if things go wrong
Lower tolerance to beam loss, lower quench margins	Premature beam dumps Tighter parameter control required
More energy dumped in triplets and collimator regions	Beam loss, heat load
Lower intensity set-up beams	Commissioning efficiency
Systems closer to maximum (RF, converters, beam dump…)	Premature dumps, asynchronous dumps

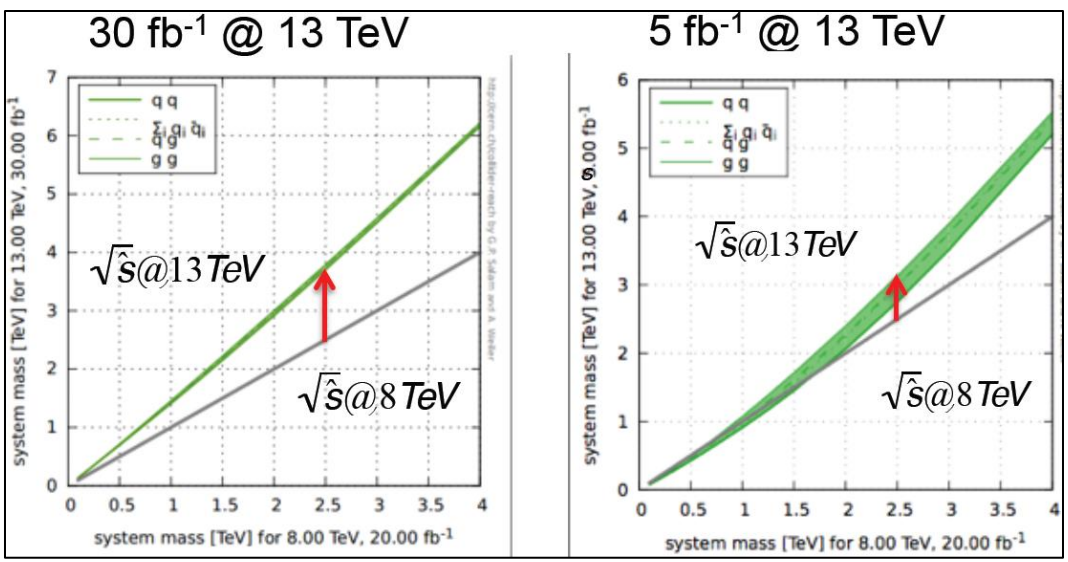
2015 – 25 ns

Issue	Possible effects
Injection of 25 ns beams	Bigger beam size, higher intensity per injection
Electron cloud	Instabilities, emittance growth, desorption, heat-load
UFOs+	Premature dumps
Long range beam-beam	Poor lifetime, larger crossing angle

Scrubbing will be one of the main drivers of commissioning 2015

Experiments

- See 2015 as a commissioning year and an investment
  - 25 ns very strongly favored
  - It is accepted that running at 25 ns could result in lower delivered luminosity
  - Will accept up to 1 fb^{-1} @ 50 ns
- Target energy taken to be 6.5 TeV
- Peak mean pile-up of around 50 "is considered to be acceptable" – un-levelled

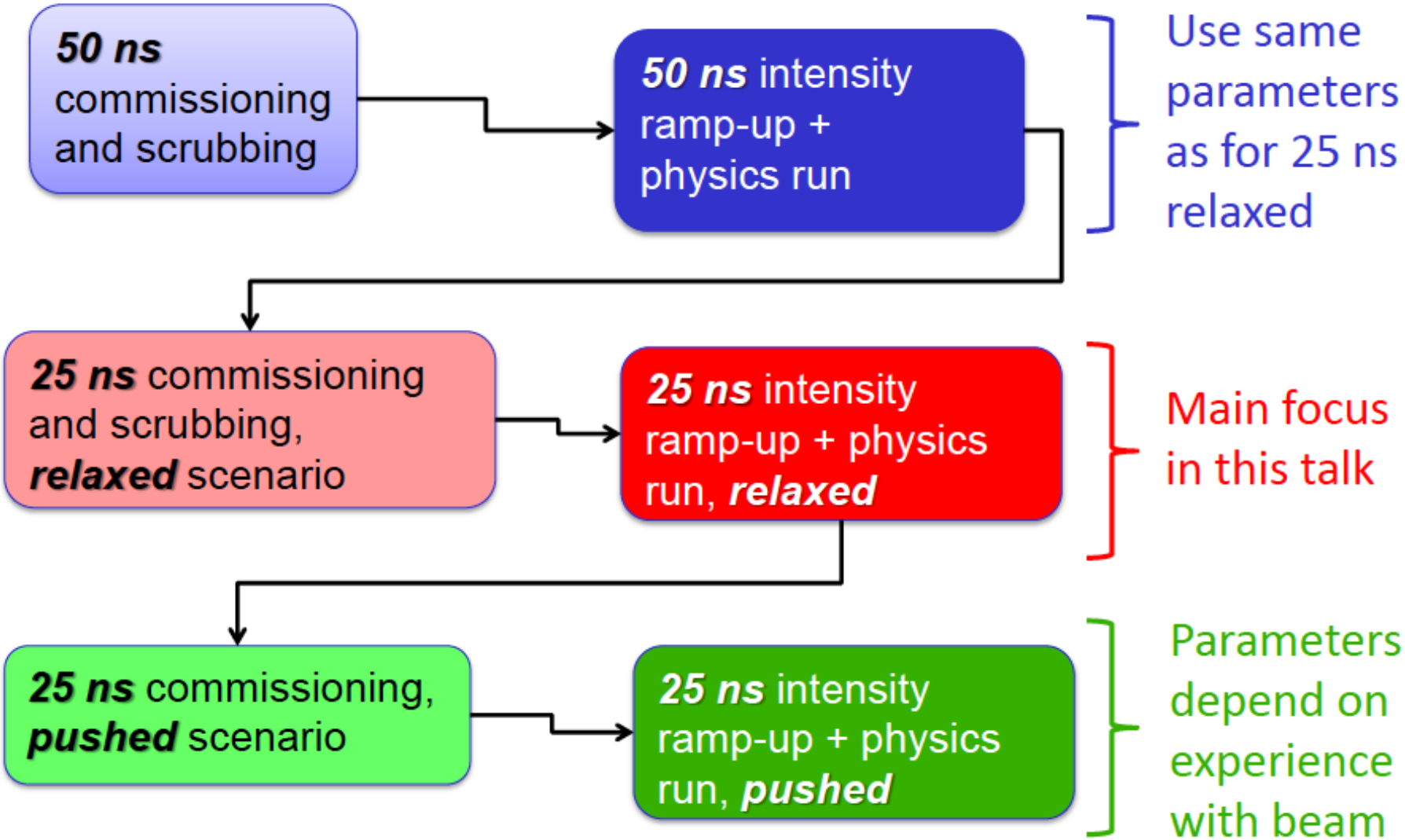


Emilio Meschi

Special runs

- 5 days initially:
  - Low pileup and un-squeezed optics for LHCf and VdM
- Later:
  - High β* (90m) for TOTEM/ALFA (pilot or extended)
  - Precision VdM
  - Intermediate proton-proton run
- Ions (baseline - 5.1 TeV)
  - Peak luminosity: 3 to 4 x 10^{27} $cm^{-2}s^{-1}$
  - Estimate around 0.8 nb^{-1} (John Jowett)

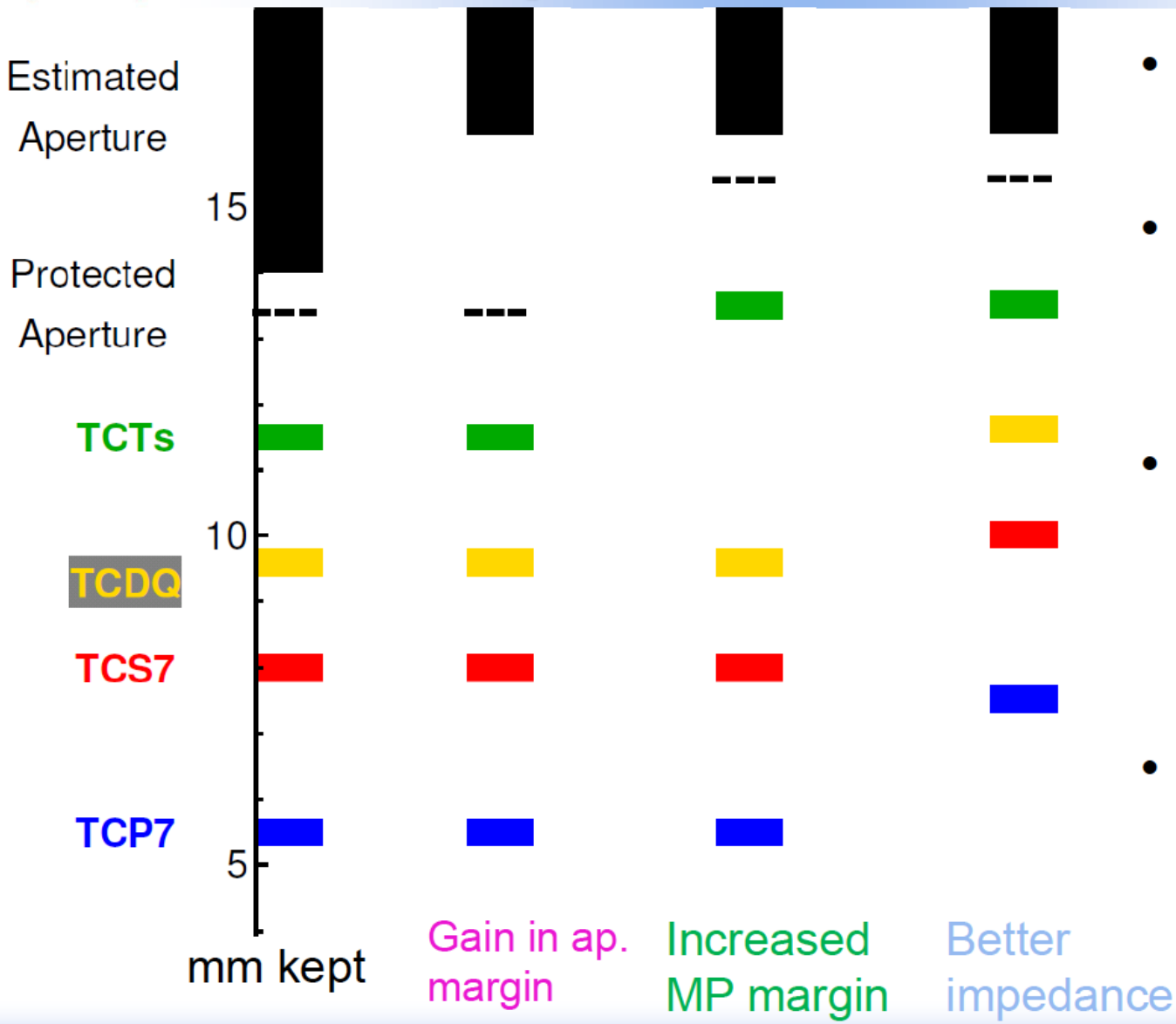
2015 proton run outline



Collimation/beta*

- **Run 2:** Many things have changed - start carefully…
- For initial 50 ns run, use same settings as for 25 ns
- **Collimator settings:** 2012 settings in mm
- **11 σ** beam-beam separation
- **β*=80cm** at startup to allow relaxed margins
  - Establish limits (aperture, stability…)
  - Push performance later when limits are better known
  - Ultimate 2015 around β*=40 cm

How can the gain in aperture be used?



- Gain in aperture margin
- Gain in MP margin – move out TCTs
- Gain in impedance – move out all collimators
- OR: increase crossing angle and β* – plot doesn't change

Optics - options

- **MINIMUM**: no optics change w.r.t. 2012
  - Except those necessary for 25 ns, 6.5 TeV
- **MEDIUM**: same as MINIMUM, with
  - New IR4 optics.
  - Tweaked IR6 optics (MKD-TCDQ phase)
  - IR1/2/3/5/6/7 same optics as MINIMUM
- **MAXIMUM**: overall new injection and collision optics, and crossing scheme, ATS-compatible

Optics - status

- **MAXIMUM:** ATS compatible optics studied in depth
  - potential issues found
  - felt prudent to stay with something more familiar initially
  - to be developed and deployed in Run 2
- **MEDIUM:**
  - Improvements for BI and ADT enumerated
  - In the process of validation…
    - Performance in terms of DA. It is closer to option-min and no surprises are expected.
    - Performance in terms of cleaning efficiency.

Nominal cycle

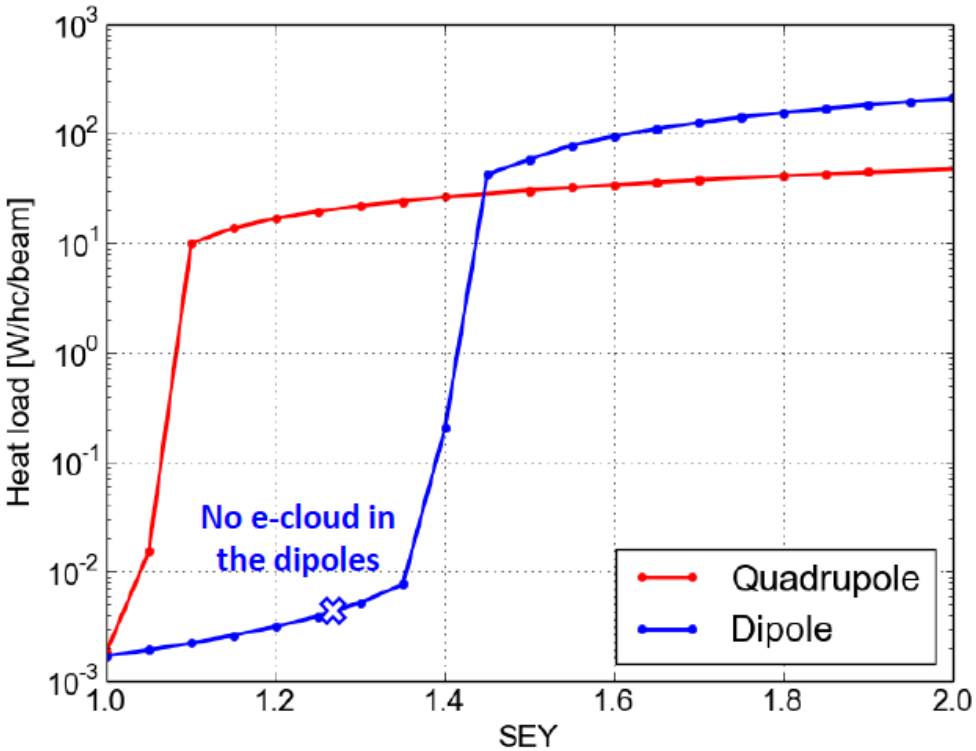
Phase	Minimum Time [mins]	
Pre-cycle /ramp-down	85 pre-cycle 65 ramp-down	Work on ramp-down times during hardware commissioning (QF/QD/QX)
Pre-injection set-up	15	
Set-up with beam	15	
Injection	30	24*SPS@40s/cycle, better orbit control in the SPS, stability of extraction power supplies, LICs, transverse damper - defensive cleaning
Prepare ramp	5	
Ramp	20.5	Re-measure snapback, Q' etc. FiDel in good shape
Flat-top	5	
Squeeze	12.5	to 80 cm
Collide	1	
TOTAL	**3h full precycle 2h45m rampdown**	**More exotics options – test/deploy later in run**

Matteo Solfaroli

Experience in Run 1 showed that the electron cloud can **limit the achievable performance with 25 ns** beams mainly through **beam degradation at low energy** and **high heat load** at **high energy**

To cope with nominal number of bunches **more scrubbing is necessary**

→ Main goal: e-cloud **suppression in the dipole magnets** (all along the fill)

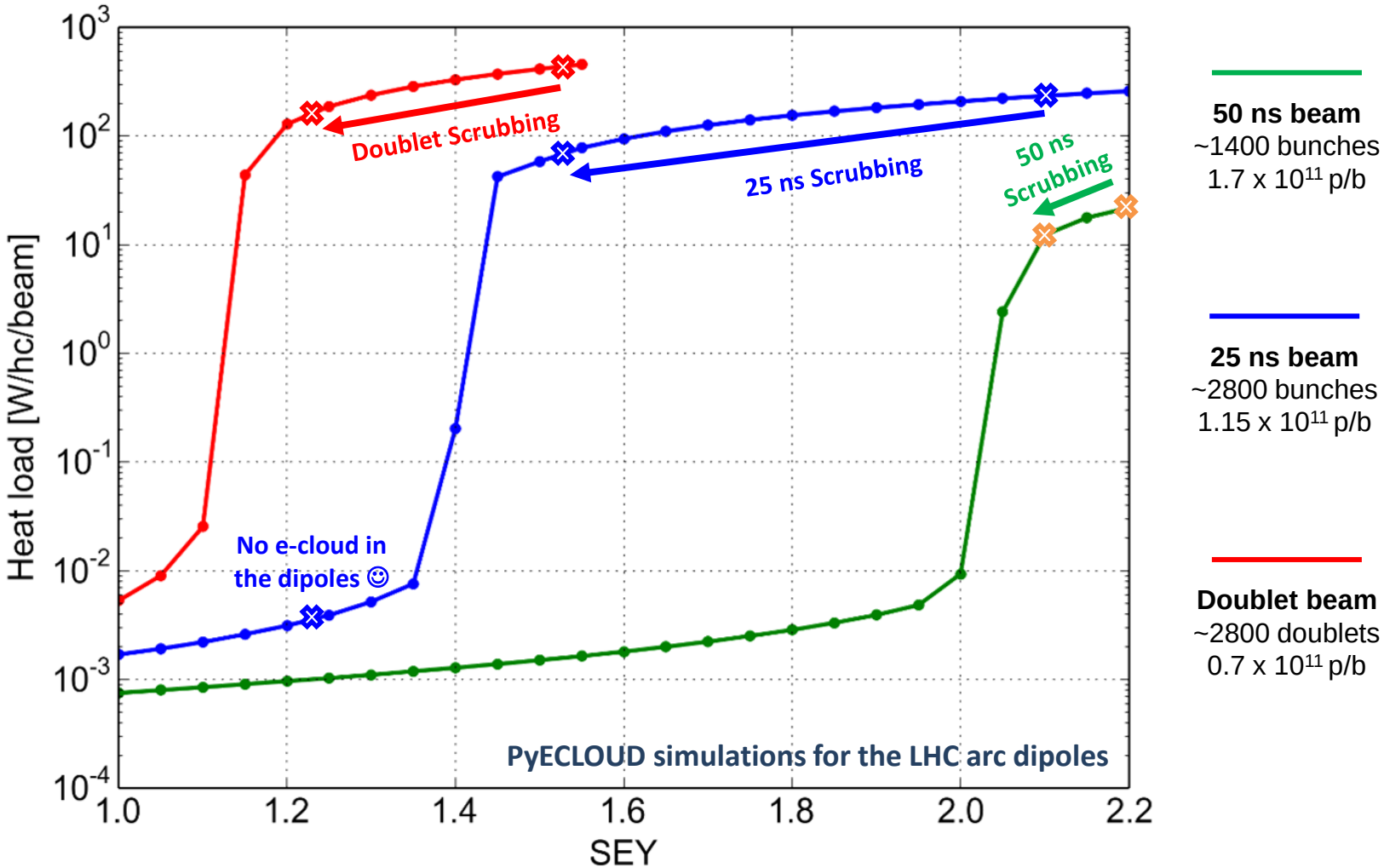


- It would bring the **arc heat loads well within cooling capacity**
- It would significantly **improve beam quality preservation**

G. Iadarola and G. Rumolo

“Doublet” scrubbing beam: PyECLOUD simulation results

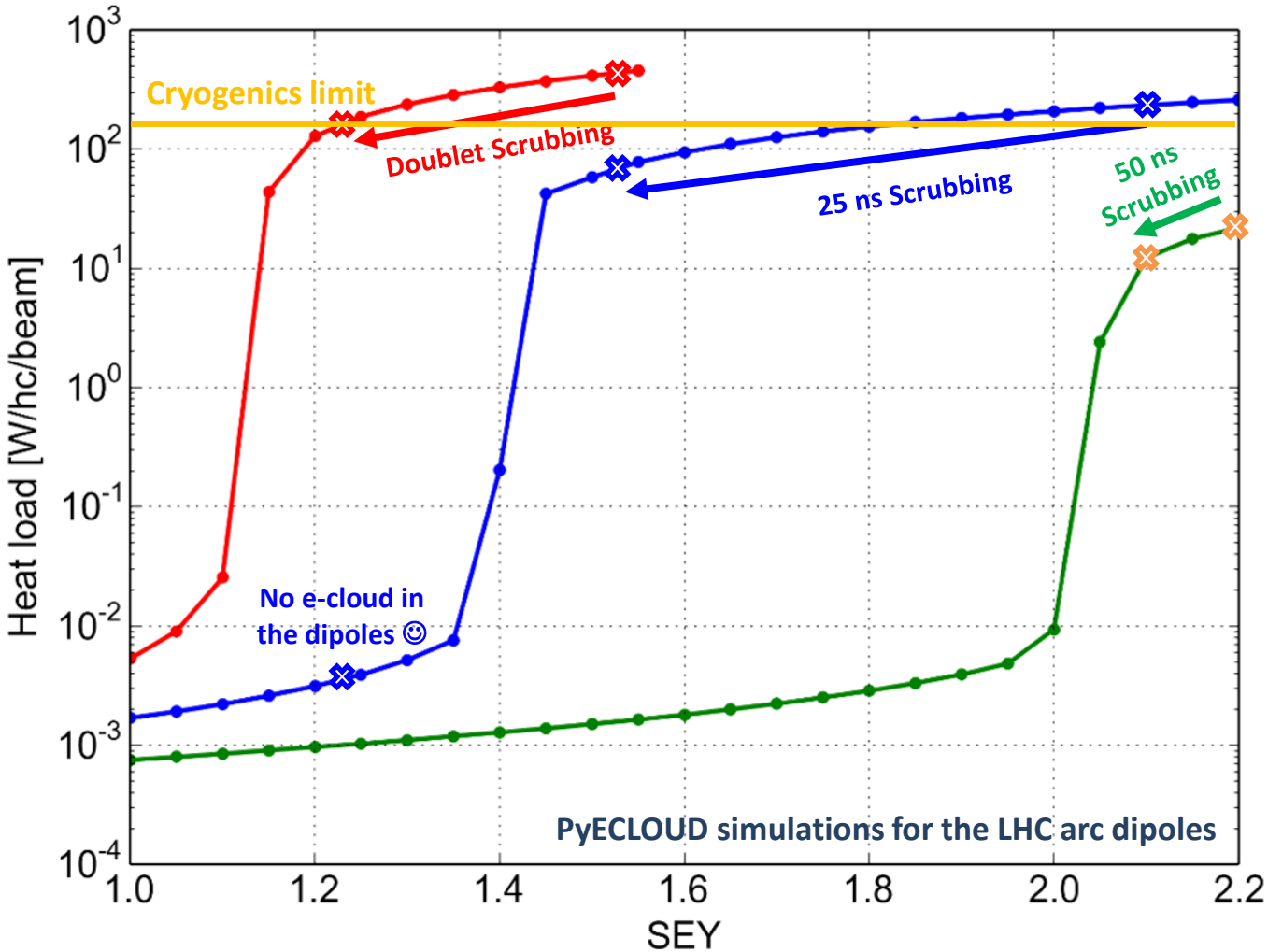
Buildup simulations show **a substantial enhancement of the e-cloud** with the “doublet” bunch pattern



Giovanni Iadarola and Giovanni Rumolo

“Doublet” scrubbing beam: PyECLOUD simulation results

Buildup simulations show **a substantial enhancement of the e-cloud** with the “doublet” bunch pattern



50 ns beam
~1400 bunches
1.7×10^{11} p/b

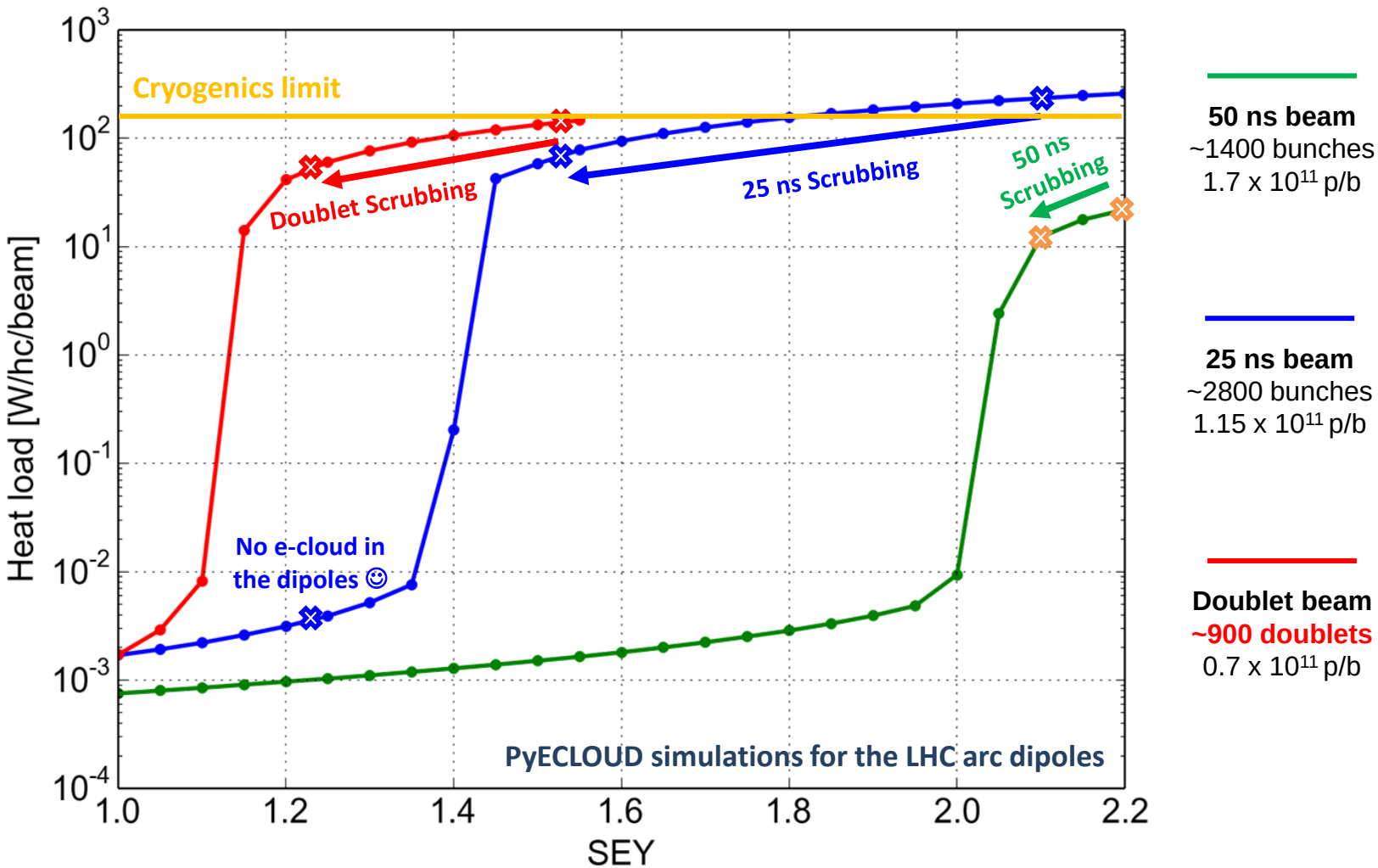
25 ns beam
~2800 bunches
1.15×10^{11} p/b

Doublet beam
~2800 doublets
0.7×10^{11} p/b

Giovanni Iadarola and Giovanni Rumolo

“Doublet” scrubbing beam: PyECLOUD simulation results

Buildup simulations show **a substantial enhancement of the e-cloud** with the “doublet” bunch pattern



Giovanni Iadarola and Giovanni Rumolo

"Doublet" scrubbing beam: PyECLOUD simulation results

Buildup simulations show **a substantial enhancement of the e-cloud** with the "doublet" bunch pattern

For example if: **$SEY_{dip} = SEY_{quad} = 1.45$**:

	$N_{bunches}$	Bunch int.	Total int.	Heat load	P_{dip}	P_{quad}	P_{TDI}*
Std. 25 ns beam	~2800	1.15 x 10^{11} p/b	3.2x 10^{14} p/beam	71 W/hc/beam	1 W/m	9.2 W/m	415 W
Doublet beam	~900	0.7 x 10^{11} p/b	1.2x 10^{14} p/beam	125 W/hc/beam	2.6 W/m	3.2 W/m	107 W

* Thanks to **N. Mounet and C. Zannini**

With the doublet beam:

- Arc beam screen **cooling capacity fully exploited**
- Stronger EC with significantly **lower total intensity**
- Scrubbing power much **better distributed along the arc**
- Lower intensity have a **positive impact on impedance heating** on sensitive elements (e.g. TDI)

Plan B: If scrubbing insufficient even with scrubbing beam, **the 8b+4e scheme** could provide a significant e-cloud mitigation with 50% more bunches compared to 50 ns beam

Giovanni Iadarola and Giovanni Rumolo

Conclusions

- 2015 should be interesting
  - Lots of experience but new challenges
- Collimation, beta*, optics, other parameters:
  - Settling to a consensus
  - Conservative choices - better to deal with the known unknowns
- Scrubbing
  - Will be critical
  - Doublet beam attractive – development in SPS and early tests in LHC – priority
  - Two stage scrubbing strategy is proposed…

Many thanks to the speakers!