

# Status and Plans for the LHC and the Experiments

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**RRB 39**

October 12, 2014  
Sergio Bertolucci

CERN



# Chamonix 2014 Conclusions

Frédéric Bordry  
8 October 2014

# 9<sup>th</sup> meeting of CERN Machine Advisory Committee (CMAC9) linked to Chamonix

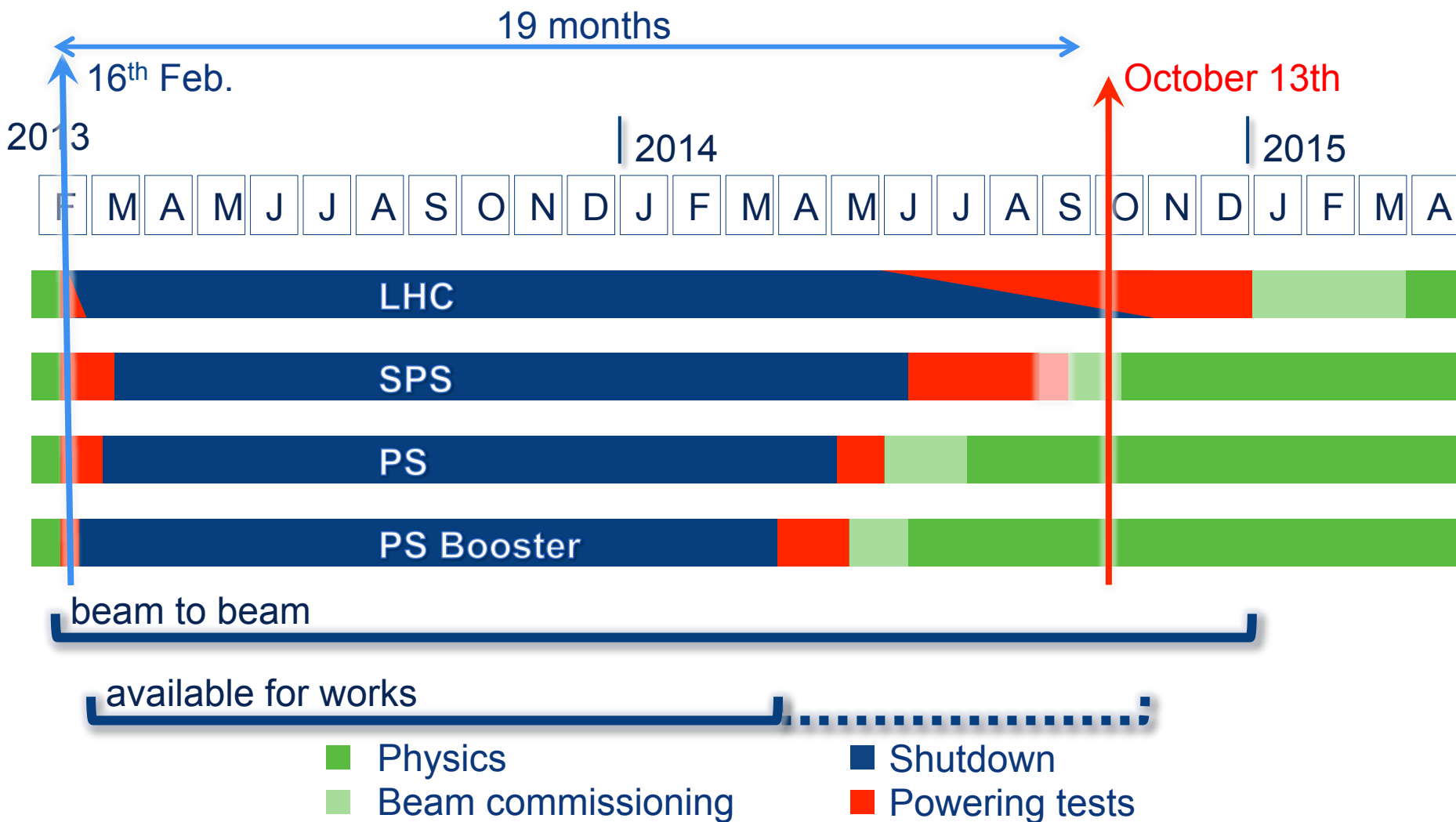
## CMAC members

Brinkmann Reinhard	DESY
Fischer Wolfram	BNL
Gourlay Stephen	LBNL
Holtkamp Norbert	SLAC
Oide Katsunobu	KEK
Qing Qin	IHEP
<b>Roser Thomas (chair)</b>	BNL
Seeman John	SLAC
Shiltsev Vladimir	FNAL

Meetings during Chamonix (afternoon, morning, evening).  
Closed session on Friday 26<sup>th</sup> September at CERN.  
CMAC Close Out : Friday 26<sup>th</sup> September at 15h30.

Main focus of CMAC9: **strategy for the restart of the machine**, plan for LIU & HL-LHC, optimizing luminosity

# LS 1 from 16th Feb. 2013 to Dec. 2014



# PS Physics has started

- **nTOF planned for 15-07-2014**
  - Slightly delayed start for EAR2 installation work
  - **First beam on target 25-07-2014**
  - Since, physics during night and weekends and continuation of installation during daytime.
- **East Area planned for 15-07-2014**
  - **First beam on 15-07-2014, physics start on 16-07-2014**
- **AD beam**
  - In March 2014, beam on target delayed by 3 weeks due to Horn strip line problem new optimistic date for beam on target 01-08-2014
  - **First beam delivered on target 05-08-2014, physics start on 16-09-14**
- **Ion beam in preparation for 2015 run planed for 25-08-14**
  - **Argon Ions were successfully injected, accelerated and extracted from PS on 26-08-2014**

Better define different periods:

Shut-down  
HW commissioning  
Cold Check-out  
Beam Commissioning



Clear definition of roles and responsibilities for each period and interfaces

*IEFC will follow this issue*



# SPS: start-up with beam more-or-less on schedule

Beam was foreseen for Monday 8<sup>th</sup> September,

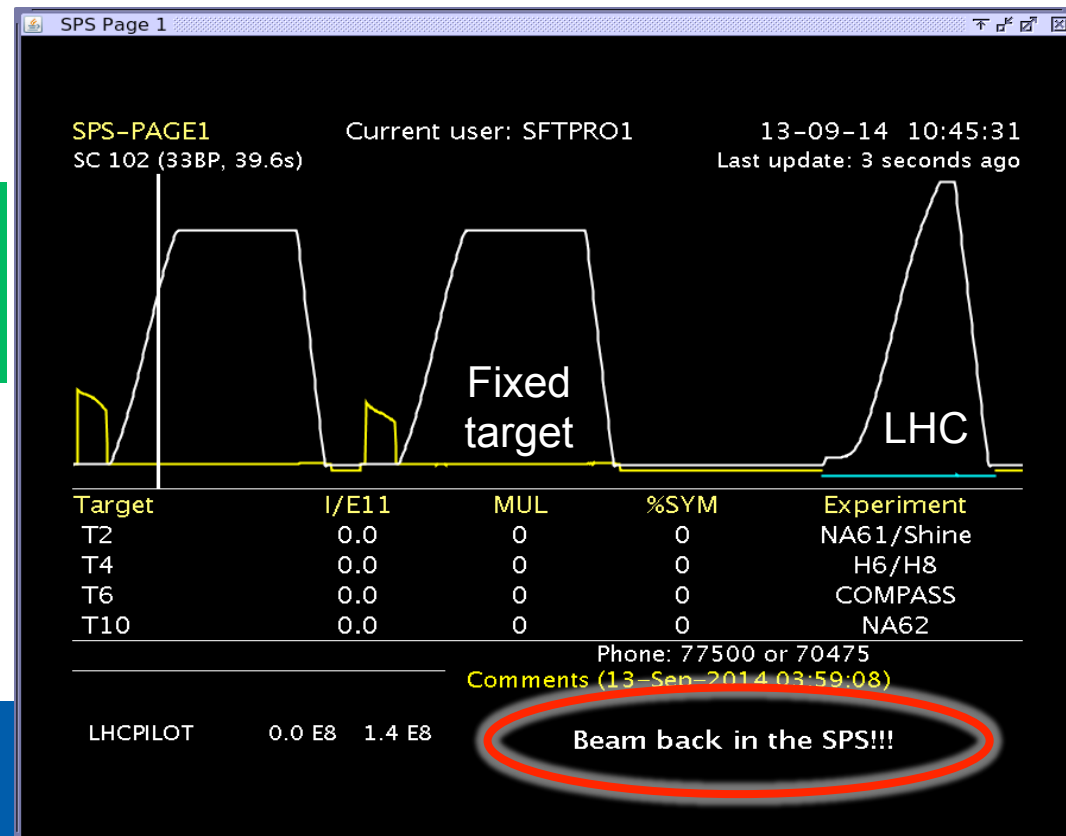
Despite...

- Conditioning of injection and dump kickers which took longer than foreseen after LS1
- Hardware testing of main circuits and debugging of converter software issues after updates during LS1
- Water leak on water cooled main bus bar in SPS point 3 was detected on 8<sup>th</sup> Sept.

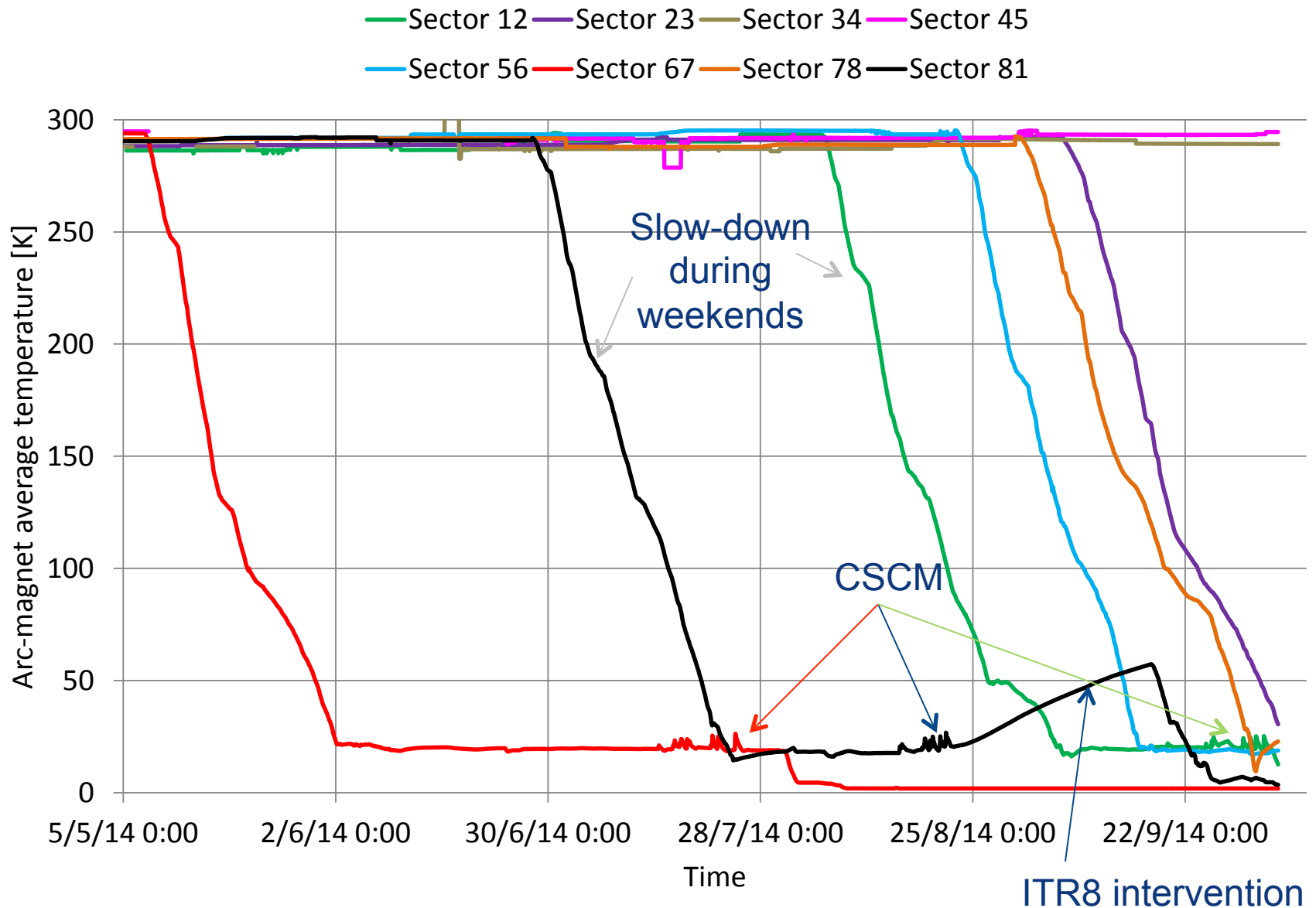
**1<sup>st</sup> beam on Saturday  
13<sup>th</sup> September**

**North Area (started physics 6<sup>th</sup> Oct)  
HiRadMat (first run 13<sup>th</sup> Oct)**

**LHC (2015)**

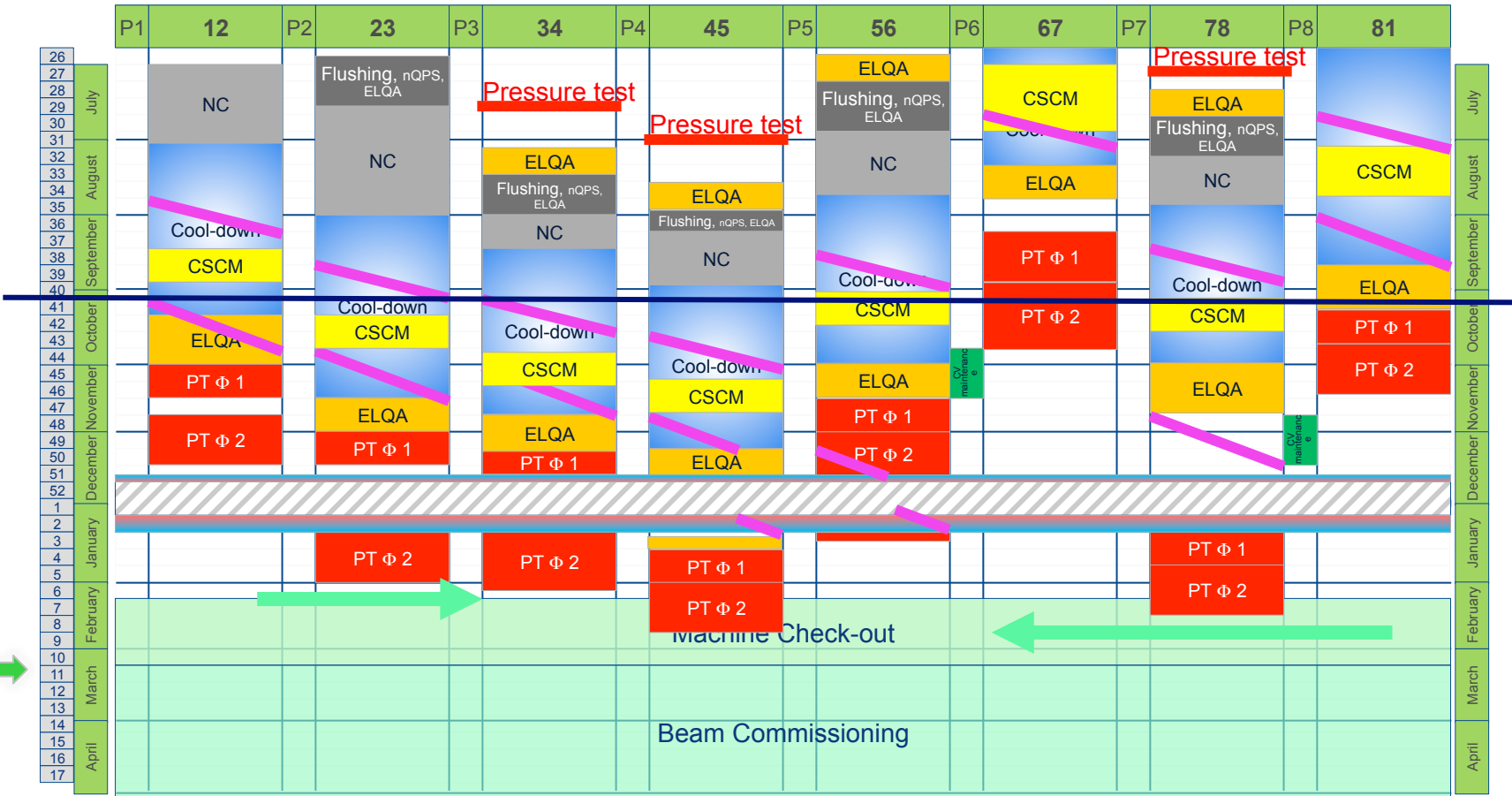


# Cool-down of LHC sectors



# LHC schedule V4.1

**Safety First,  
Quality Second,  
Schedule Third**



1<sup>st</sup> beam on week 11 (starting 9<sup>th</sup> March 2015)





# Maximum beam energy : 13 TeV c.m. in 2015

Decision to run at a **maximum** energy of 6.5 TeV per beam during the powering tests and during 2015.

(10 to 15 training quenches per sector are expected to be needed to reach that energy).

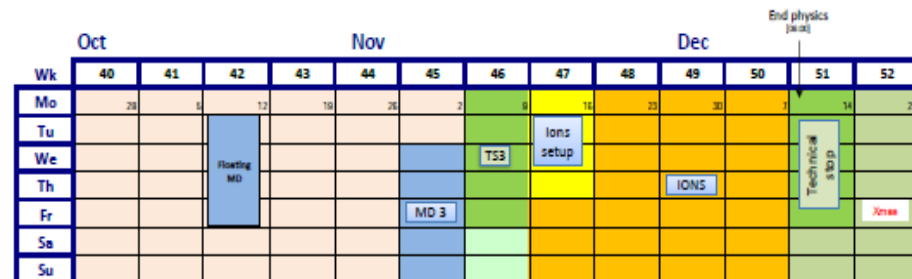
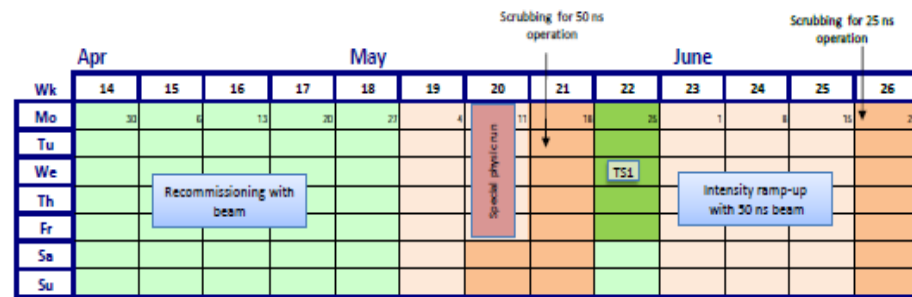
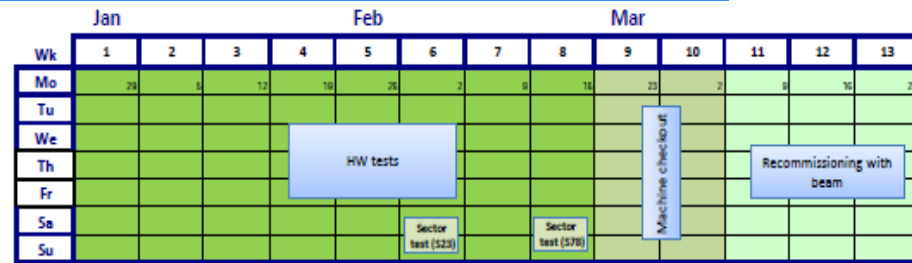
*“We accept the risk that results from late quench tests could force to run at lower energy” Emilio Meschi*

**NO change of beam energy in 2015.**

*A decision regarding the possibility of increasing the energy will be taken later in 2015, based on the experience gained in all eight sectors at 6.5 TeV per beam during powering tests and operation with beams.*

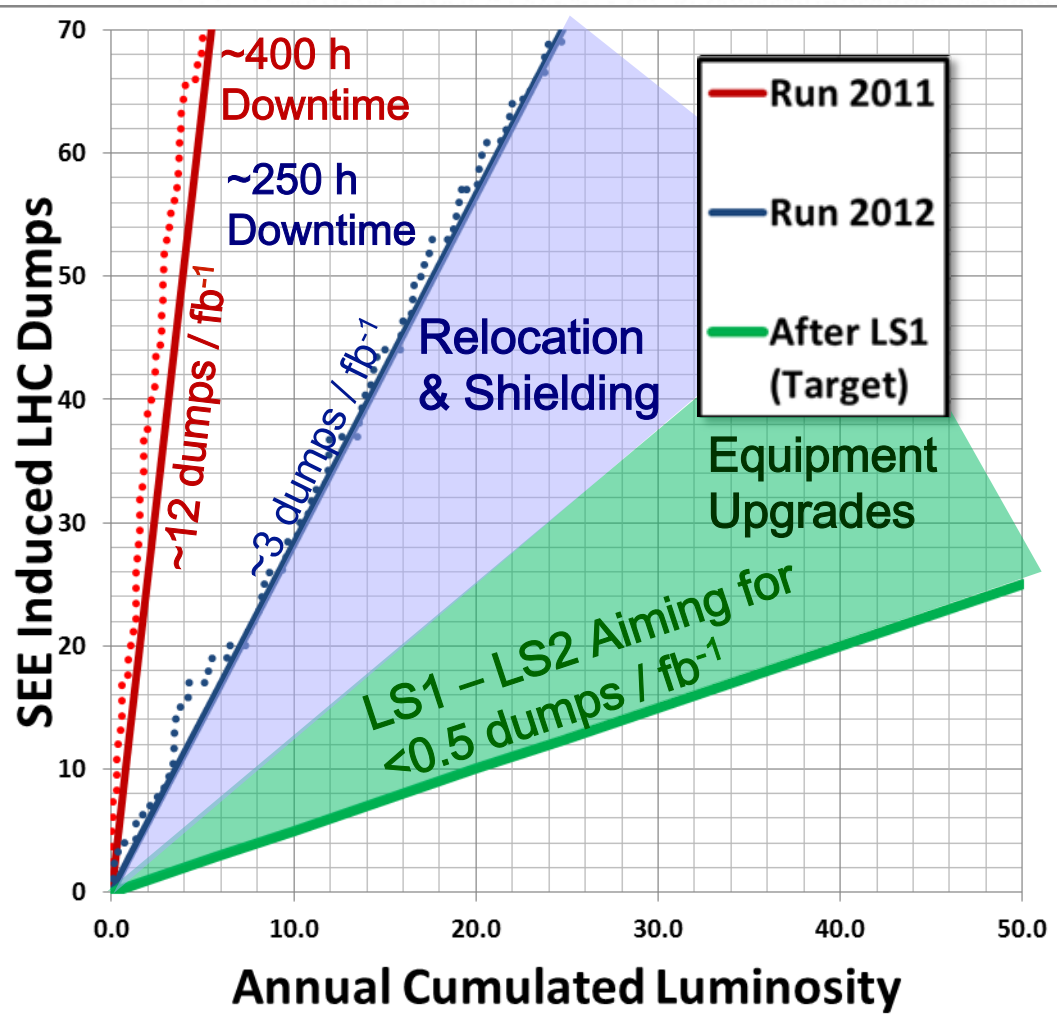
# LHC Strategy for 2015

- To restart with the similar 2012 parameters and a relaxed  $\beta^*$  (80cm) (Alice 10m; LHCb 3m) to establish asap collisions at 13 TeV with 50 ns bunch spacing, no combined collide-squeeze, ramp-squeeze,...
- LHCf request and VdM with same optics
- To do a 1<sup>st</sup> scrubbing run (50ns+25ns; 7-9 days) and to accumulate up to 1fb<sup>-1</sup> with 50 ns (around 20 days)
- To establish the running with 25 ns: enough time for the scrubbing (10-15 days and no pressure for production)
- To run at 25ns with  $\beta^*$  (80cm) during 2 months (45 days) and to decrease the  $\beta^*$  (60 cm- 40 cm?) to have around 45 days of operation to prepare 2016 and 2017
- One month for heavy ions.



## R2E SEE Failure Analysis

- ⊙ **2008-2011**
  - ⊙ Analyze and mitigate all safety relevant cases and limit global impact
- ⊙ **2011-2012**
  - ⊙ Focus on long downtimes and shielding
- ⊙ **LS1 (2013/2014)**
  - ⊙ Final relocation and shielding
- ⊙ **LS1-LS2 (2015-2018)**
  - ⊙ Tunnel equipment and power converters



# UFOs may get worse at higher energy

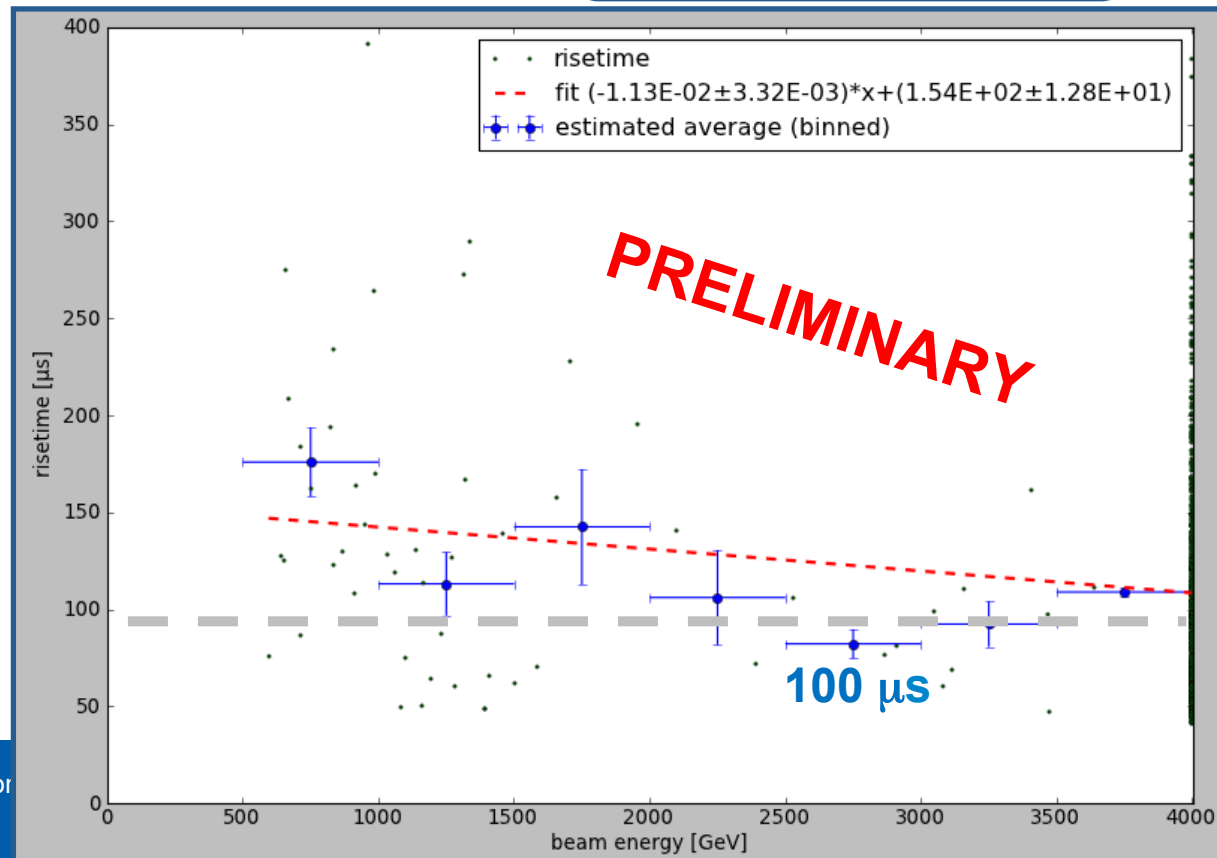
- UFO rate increases (also with 25 ns spacing)
- energy loss / UFO increases
- quench margin is reduced
- also: **duration of UFOs decreases**

683 arc ( $\geq$  cell 12) UFO events with 1374/1380 bunches until 20.08.2012. Signal RS04  $> 2 \cdot 10^{-4}$  Gy/s. Only datasets with  $R^2 \geq 0.95$ .

*„Risetime becomes faster for higher beam energies.“*

no mitigation during LS1 to reduce UFO activity

T. Baer,  
UFO Study Working Group,  
4 Sept. 2012



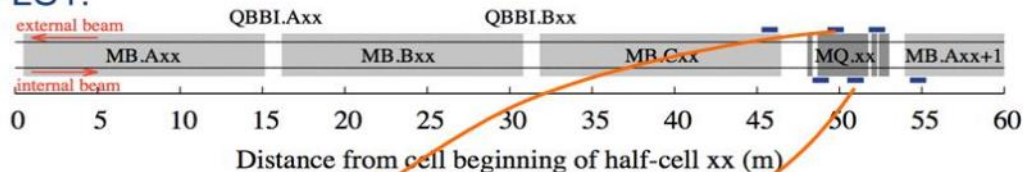
# U<sub>(Unknown)</sub>FO loss concern and scenario

## 1. Relocation of BLMs for 100% coverage of SC magnets to allow localizing and quantifying UFOs

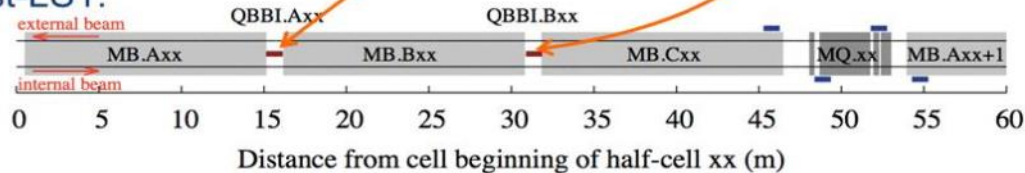
BLMs moved from centre of MQ to position above MB-MB interconnects:

**Initial numbers of UFO events will be larger. Don't panic !**

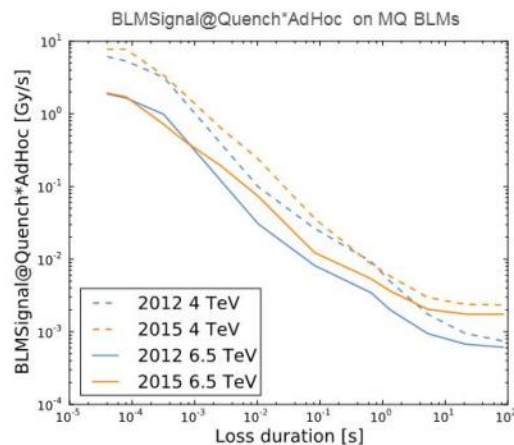
Pre-LS1:



Post-LS1:



## 2. Refinement of BLM thresholds (based on quench tests) to avoid unnecessary triggers and quenches.



# LHC goal for 2015 and for Run 2 and 3

## Priorities for the 2015 run :

- Establish proton-proton collision at 13 TeV with 25ns and *low*  $\beta^*$  to prepare production run in 2016.  
Optimisation of physics-to-physics duration
- Later in 2015: decision on special runs “when and duration” (90m optics): not in the 1<sup>st</sup> part of the year. Waiting LHCC recommendation
- Pb-Pb run: one month at the end of 2015

The goal for Run 2 luminosity is  $1.3 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$  and operation with 25 ns bunch spacing (2800 bunches), giving an estimated pile-up of 40 events per bunch crossing.

*“A maximum pileup of ~50 is considered to be acceptable for ATLAS and CMS”*



# LHC goal for 2015 and for Run 2 and 3

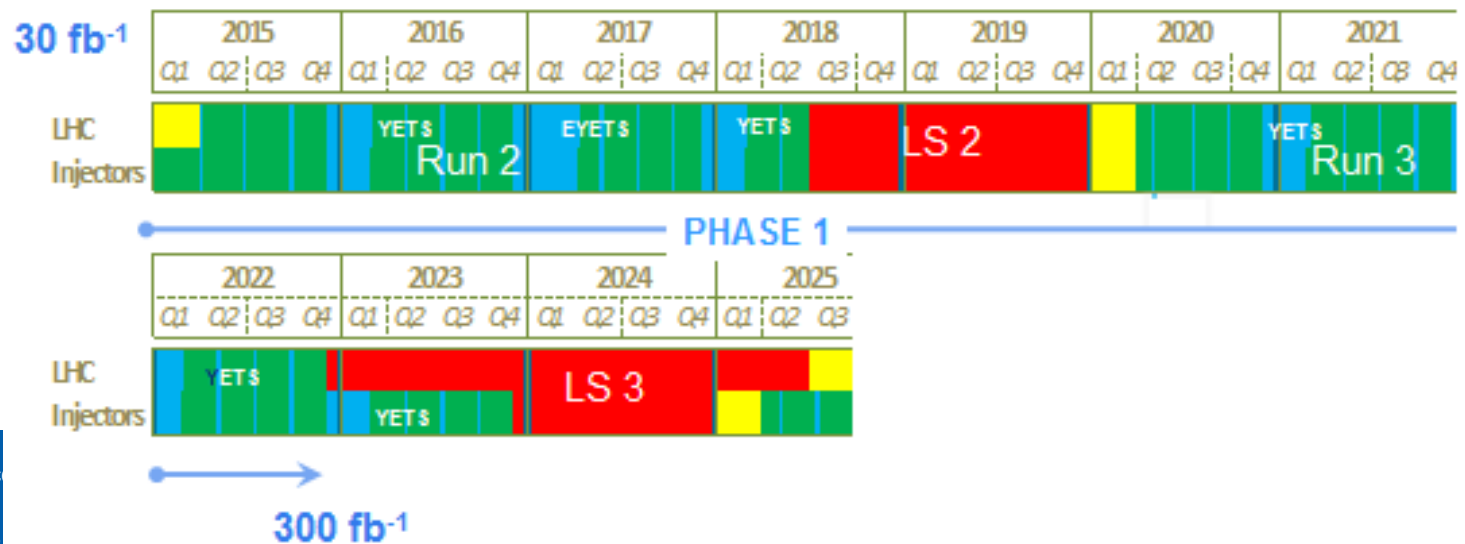
Integrated luminosity goal:

2015 :  $10 \text{ fb}^{-1}$

Run2:  $\sim 100\text{-}120 \text{ fb}^{-1}$

(better estimation by end of 2015)

$300 \text{ fb}^{-1}$  before LS3



# The LIU and HL-LHC projects Cost and Schedule Review

9-11 March 2015 ; Chair: N. Holtkamp (CMAC 10)

The goal of the cost and schedule review of the LIU and HL-LHC projects is to assess the status and risks of both projects

Four major activities ongoing in parallel:

- Accelerator complex operation
- Accelerator Consolidation Program
- **LHC Injector Upgrades (LIU)**
- **High Luminosity LHC upgrade**

This review will cover the LIU and HL-LHC projects, taking into consideration their working hypothesis linked to the Consolidation project and the operation of the CERN accelerator complex.

*This review will not assess the cost and schedule of the Consolidation project nor the operation of the accelerator complex.*

# The Experiments

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- Approaching the LS1 endgame
- Focusing on closing the detectors and on the recommissioning
- Concentrating on the Run II scenarios
- ...and of course keeping producing physics results and working for the upgrades.

# The Experiments

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- Long term schedule stabilized at the end of 2013
- Phase-I upgrades figures and timelines pretty consolidated
- Phase-II figures and timelines still based on LOI and subject to R&D results
- HL-LHC studies continuing (2<sup>nd</sup> ECFA HL-LHC Experiments Workshop  
<https://indico.cern.ch/event/315626/> )

# Phase II Upgrades, a proposal for discussion

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## The scenario:

- By the year 2023, LHC will have delivered an integral luminosity  $\sim 300/\text{fb}$  to each of the two general purpose experiments.
- At that time, both the LHC low-beta insertions and many critical components of the experiments will have reached the end of their life-cycle, due to radiation damage. This aging model has by now been validated by the data collected in Run I.
- It is inconceivable under any reasonable scenario to stop the LHC program at that point, as it is also indicated as the top priority in the Update of European Strategy on Particle Physics  
**→ ATLAS AND CMS PHASE II UPGRADES ARE MANDATORY.**
- The goal of the upgrades, clearly stated by both experiments, is **to retain the same performances as in Run I** in a much more challenging environment

# Phase II Upgrades, a proposal for discussion

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## The scenario:

- ATLAS and CMS have presented in the October '13 RRB meeting a first assessment of their Phase II upgrade cost, **with a total core cost of ~550 MCHF** and starting already in 2017, in order to flatten the spending profile as much as possible.
- Core costs **DO NOT include offline computing**, for which the experiments assume the continuation of the present effort.
- The LHC schedule is optimized for an efficient running of both machine and accelerator. **Moving the Phase II upgrades beyond 2023 is not an option**, because it would be economically wrong to run with a crippled machine and inefficient experiments.



# Phase II Upgrades, a proposal for discussion

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## Balancing bottom-up and top down:

- Approval of the upgrades should proceed through an **iterative process**, which will strike a balance between experiments requests, physics performances and needs, and funding agencies capacities.
- Experiments will submit **Technical Proposals** to the LHCC, outlining the connection **of the physics requirements with the technical solutions**.
- **A preliminary money matrix**, negotiated with all the involved funding agencies, **will be mandatory** to assess the credibility of the proposals.
- Subject to the soundness of the physics case, the technical maturity and a realistic global funding, the LHCC will ask the collaborations to proceed to **Technical Design Reports**, which **MUST contain a detailed cost breakdown connected to the physics requirements and performances, a money matrix and a schedule**.

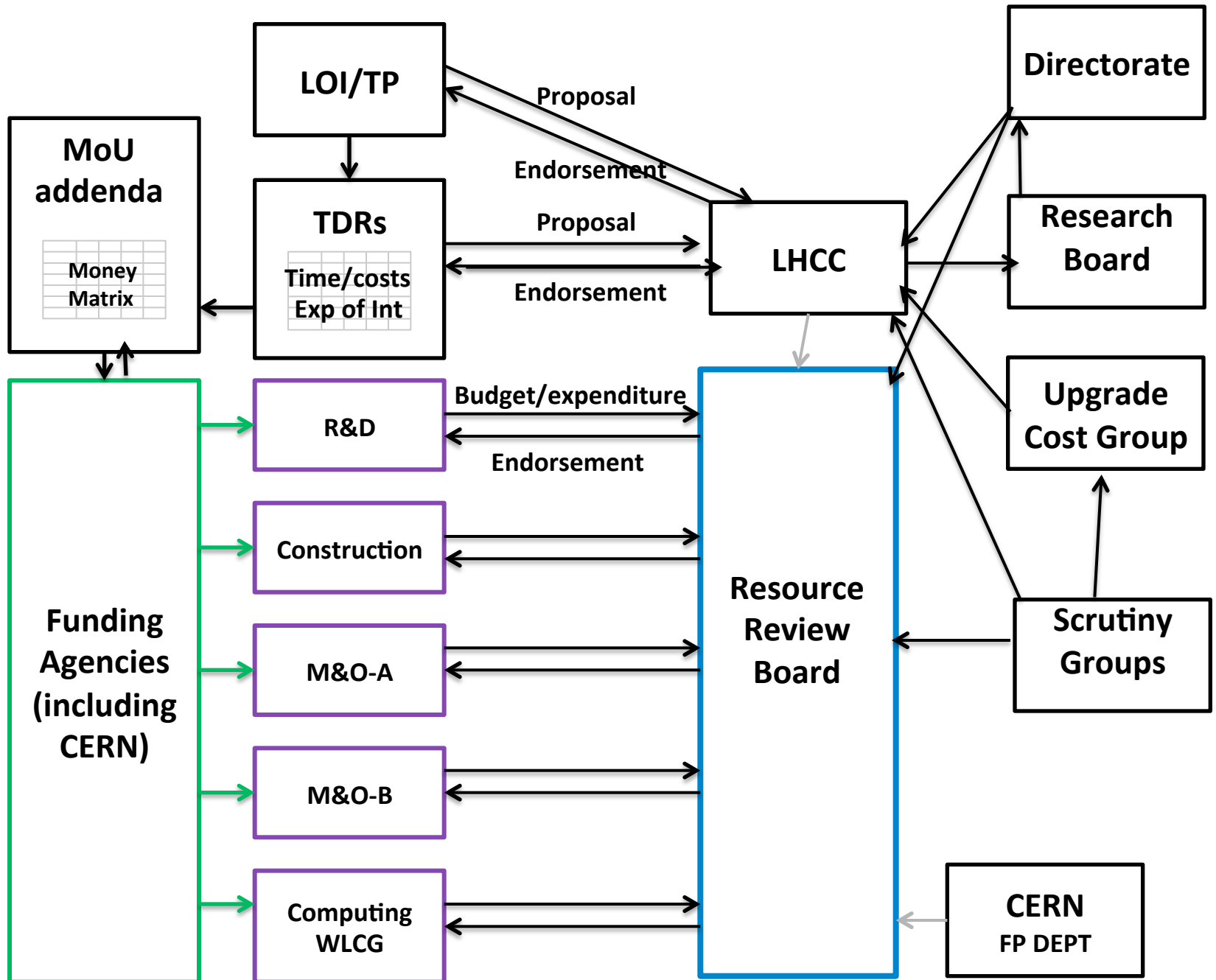
# Phase II Upgrades, a proposal for discussion

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## Balancing bottom-up and top down:

- The LHCC and the Upgrade Cost Group will scrutinize the TDRs and recommend them for approval to the Research Board, based on their scientific and technical merits AND on a detailed cost analysis, **which will check the compatibility between the needed and the available resources.**
- **The Funding Agencies will run a similar process for their communities**, thus providing a realistic input to the money matrix.
- Detailed and timely information will be provided to the RRB throughout the process by the Scrutiny Group, whose representatives are ex-officio members of the LHCC and of the UCG.
- In case of a substantial unbalance between the needed and the available resources, **the experiments will be asked to present staging or descoping plans.**
- **NO TDR WILL BE APPROVED** by the Research Board if it lacks **a realistic funding scenario.**

# Experiment approval and monitoring process



# Phase II Upgrades, a proposal for discussion

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## The time scale:

- The proposed time scale foresees the process to have an important deadline in **October '15**, with the goal to have **both experiments** ready to go for their TDRs
  - earlier dates might not allow for mature choices, (much) later dates would damage the experiments and their timely readiness.
- Of course, we shall use the October '14 and the April '15 RRB's to steer/advance the process.

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**THANK YOU**

