Detectors Plans for LS1

Chamonix, February 8th, 2012

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Our present understanding of LS1

- Detectors access: 17-24th November 2012 till mid July 2014
- Delivered Luminosity up to LS1 start < 25 fb^{-1}
- Detector access independent from LHC activities = 20 months (experimental caverns decoupled from the tunnel)
- At restart 13-14 TeV c.m.Energy, 25 ns bunch spacing

Detectors main goals:

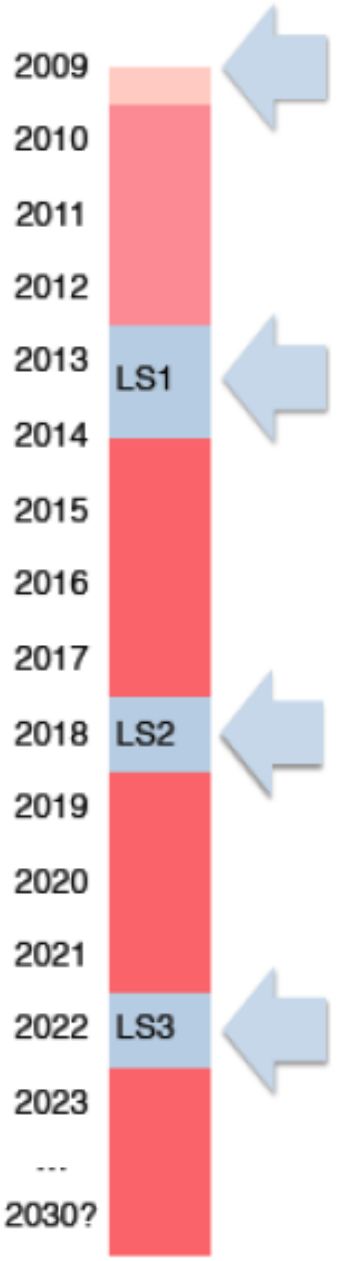
- Consolidate infrastructure

- Fix known problems

- Install detector elements which have been staged

- Install first upgrade components (towards $L_p = 10^{34}$)

Since last Chamonix, we follow this logic



✧ LHC startup, √s = 900 GeV

√s=7~8 TeV, L=6x10^{33} cm^{-2} s^{-1}, bunch spacing 50 ns

~20-25 fb^{-1}

Go to design energy, nominal luminosity

√s=13~14 TeV, L~1x10^{34} cm^{-2} s^{-1}, bunch spacing 25 ns

~75-100 fb^{-1}

Injector and LHC Phase-1 upgrade to full design luminosity

√s=14 TeV, L~2x10^{34} cm^{-2} s^{-1}, bunch spacing 25 ns

~350 fb^{-1}

HL-LHC Phase-2 upgrade, IR, crab cavities?

√s=14 TeV, L=5x10^{34} cm^{-2} s^{-1}, luminosity levelling

~3000 fb^{-1}

ATLAS plans for LS1

- *New Aluminum beam pipes to prevent activation problem and reduce muon BG*
- New insertable pixel b-layer (IBL) + new pixel services (nSQP) + new small Be pipe
- *New evaporative cooling plant for Pixel and SCT + IBL CO_2 cooling plant*
- Replace all calorimeter Low Voltage Power Supplies
- *Finish the installation of the EE muon chambers staged in 2003 + additional chambers in the feet and elevators region*
- Upgrade the magnets cryogenics with a new spare main compressor and decouple toroid and solenoid cryogenics
- *Add specific neutron shielding where necessary (behind endcap toroid, USA15)*
- Revisit the entire electricity supply network (glitches!)

ATLAS plans for LS1

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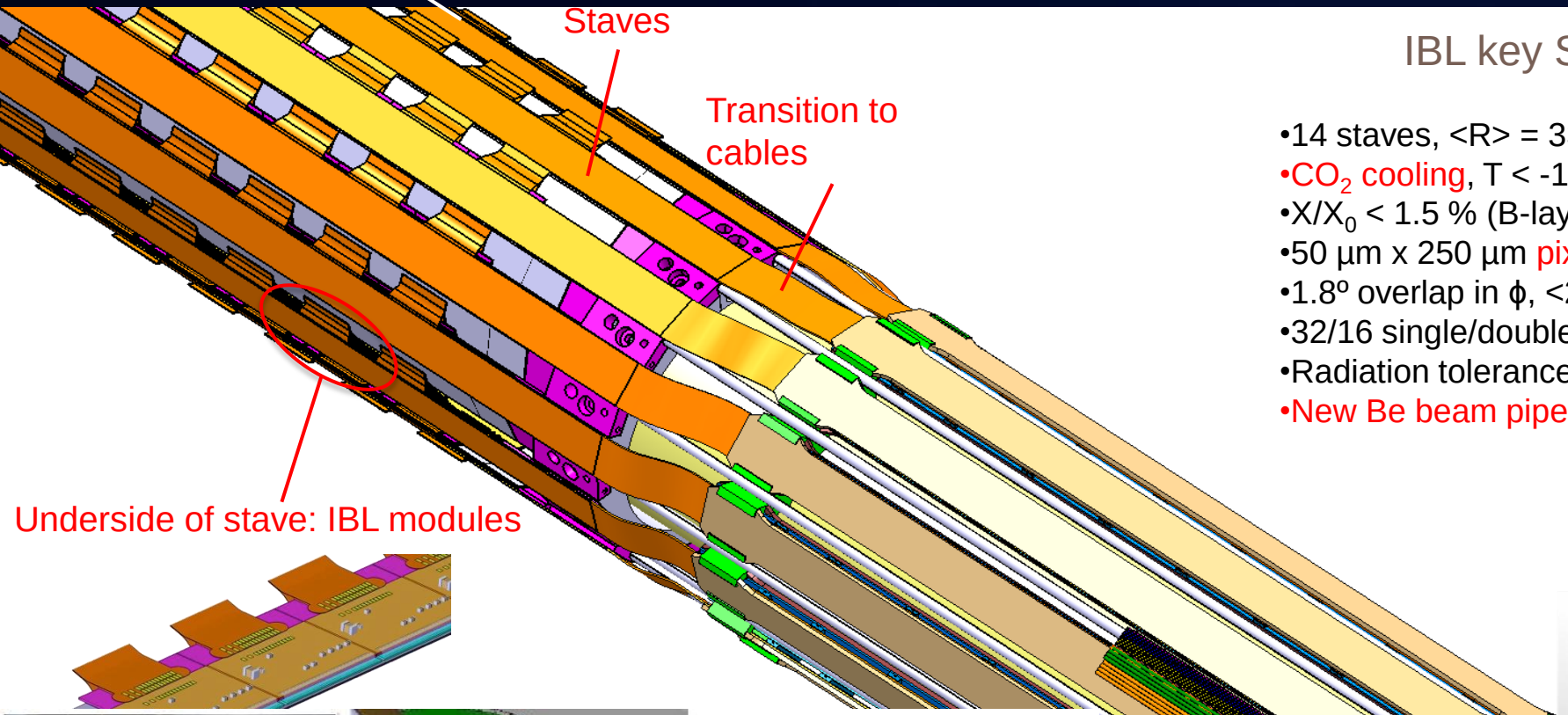
- [illegible]electricity supply network (glitc[illegible]s!)

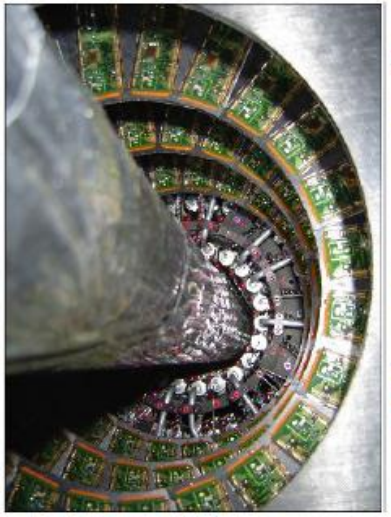
LS1 projects approved by the Collaboration and already in execution since 2010 , ready for SL1 implementation

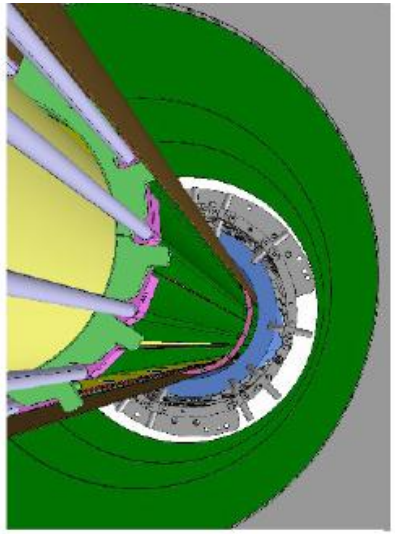
IBL Detector (4th pixel layer)

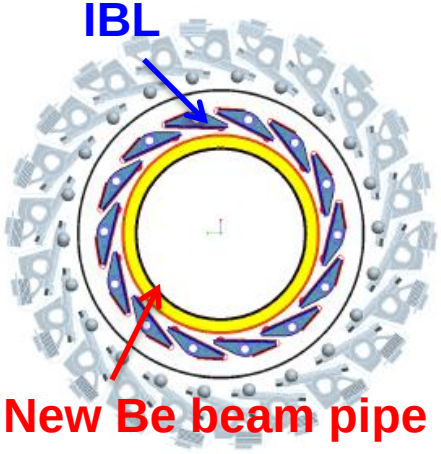


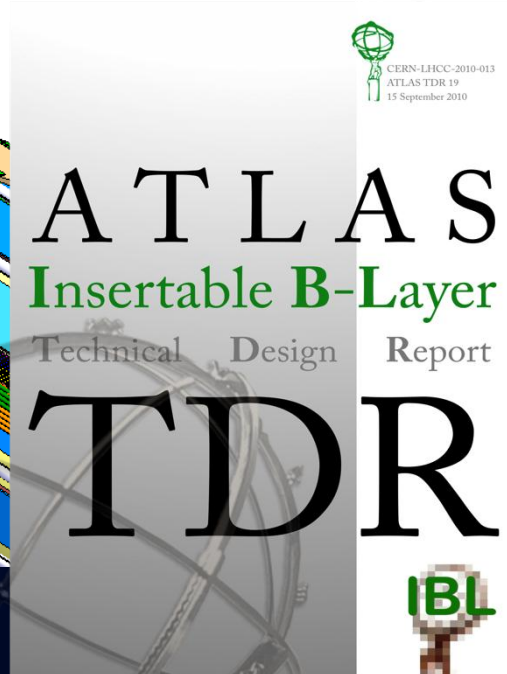
IBL key Specs / Params

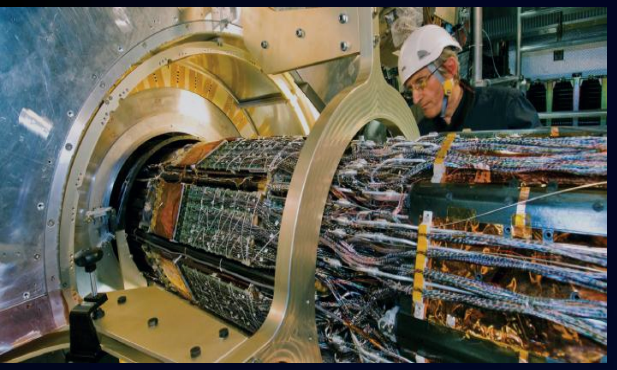
- 14 staves, <R> = 33.25 mm
- CO_2 cooling, T < -15ºC @ 0.2 W/cm^2
- X/X_0 < 1.5 % (B-layer is 2.7 %)
- 50 µm x 250 µm pixels (planar & 3D)
- 1.8º overlap in ϕ, <2% gaps in Z
- 32/16 single/double FE-I4 modules per stave
- Radiation tolerance 5x10^{15} n_{eq}/cm^2
- New Be beam pipe of smaller radius





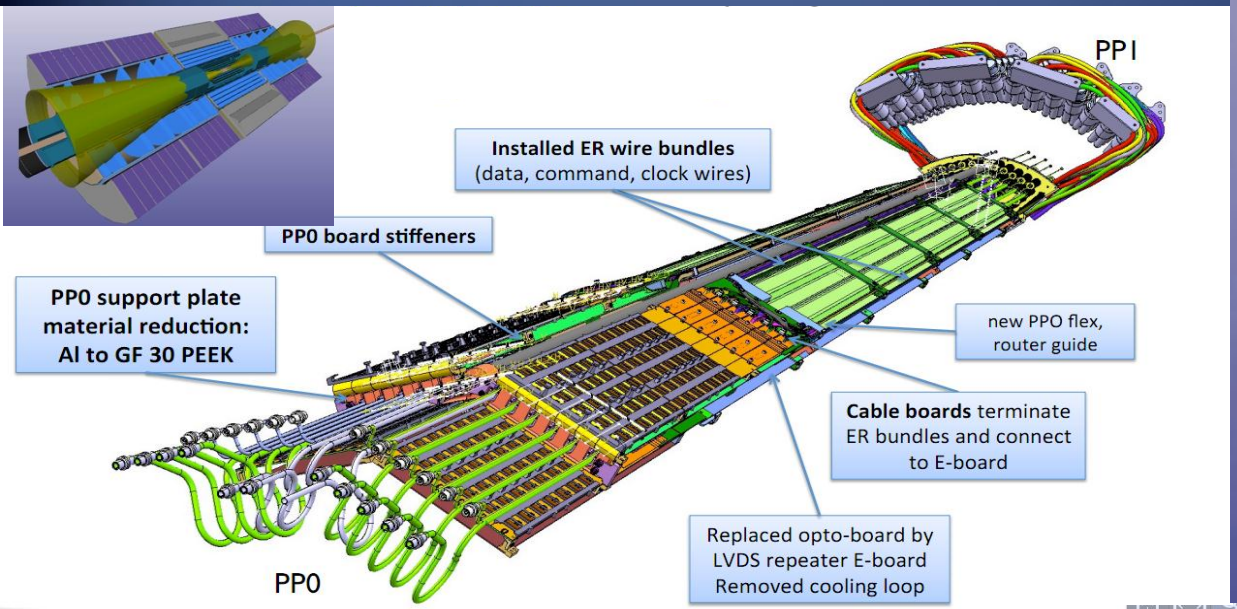


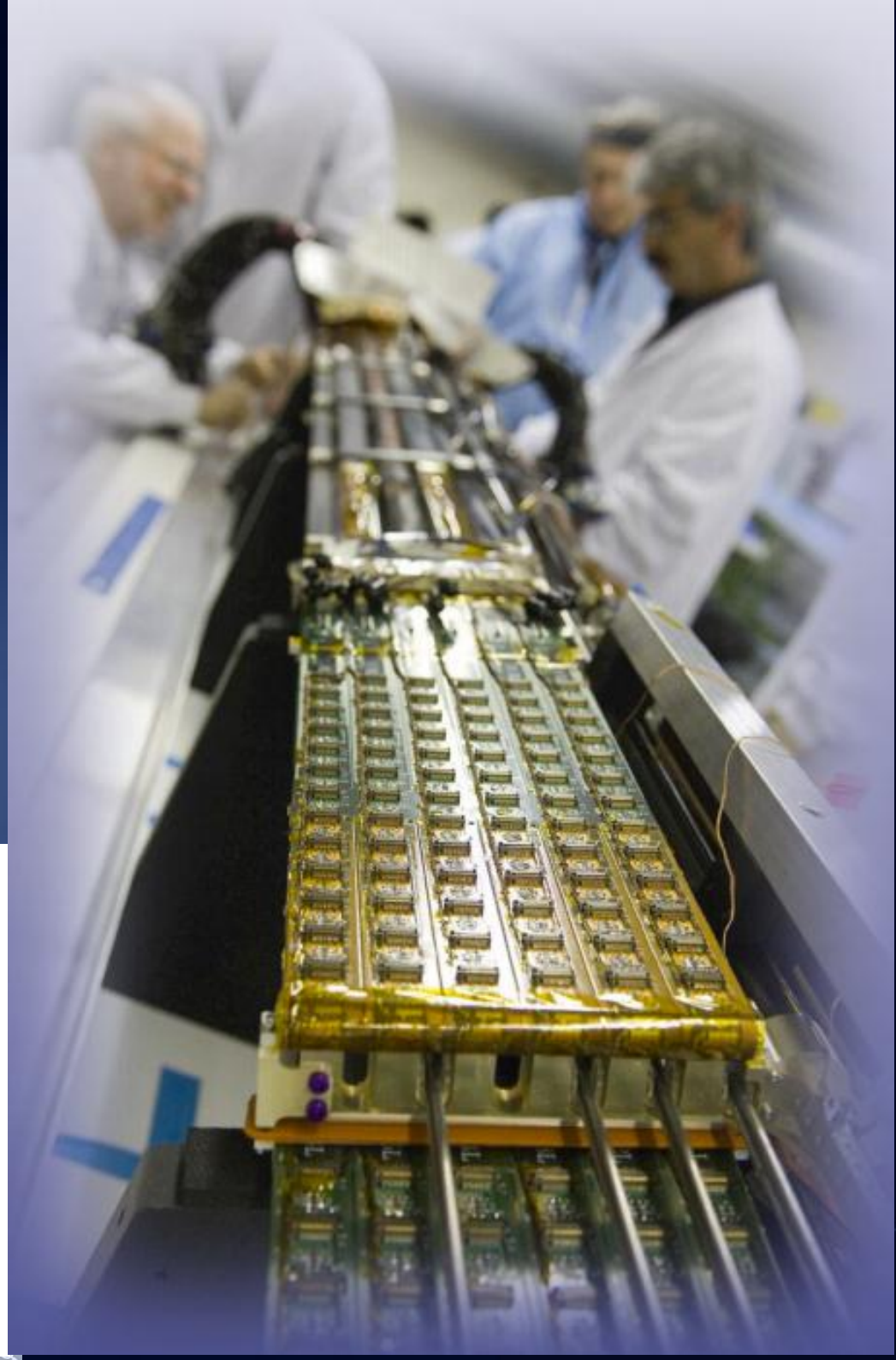




nSQP : *new Service Quarter Panels*

- ✓ New service layout for all pixel service
- ✓ Redundant and safer location for fibers transmitters
- ✓ Material transparency optimization
- ✓ Doubling of the readout bandwidth in view of $L_p = 2 \times 10^{34}$



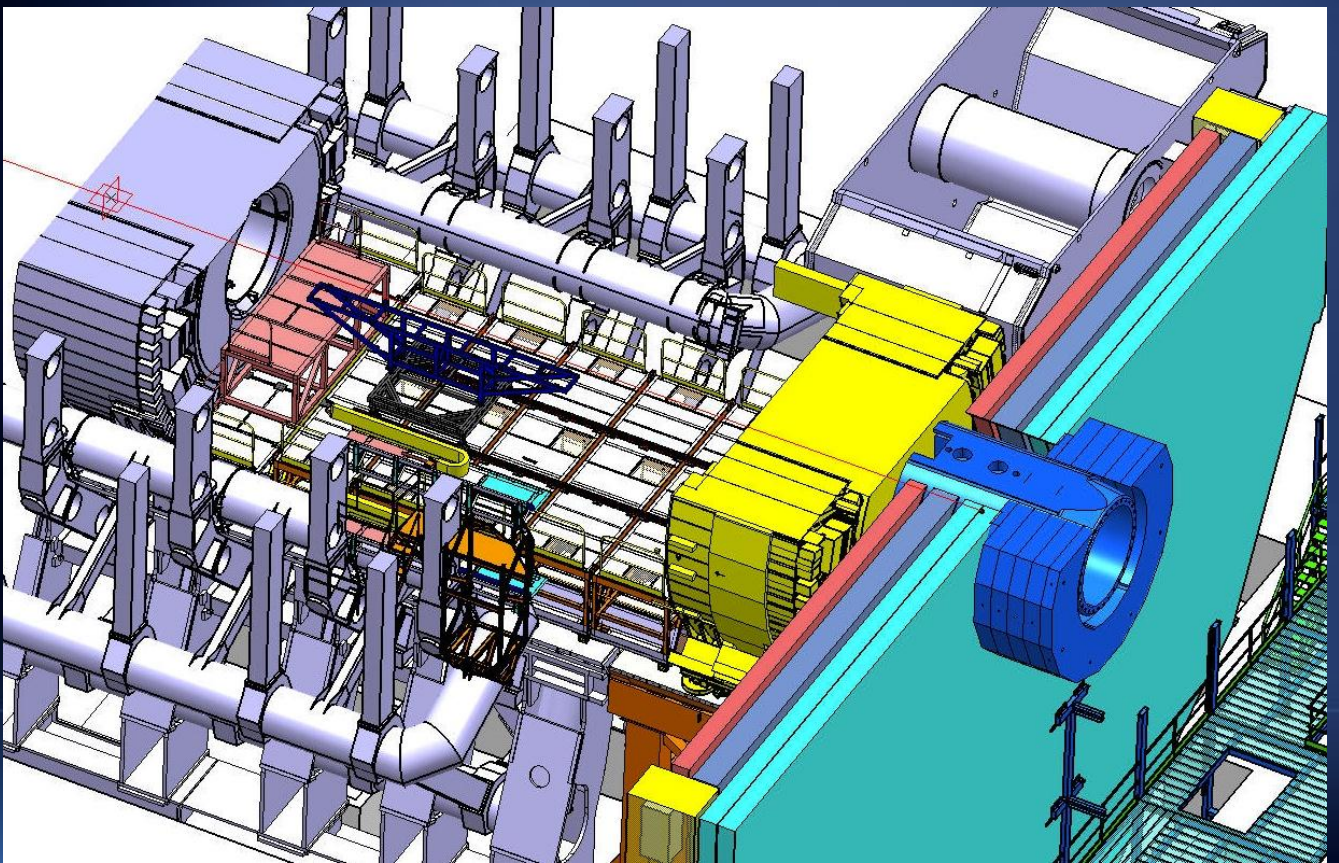


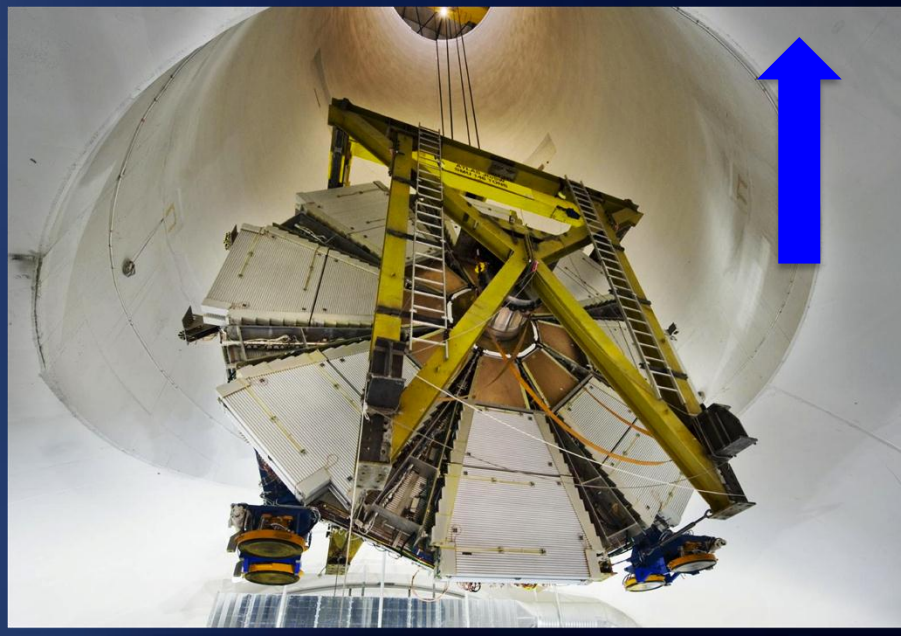
ATLAS Schedule

LS1 : Driven by the work to install the IBL detector:

- open fully ATLAS (large opening : 2 months)
- bring Muon Small Wheel (9m diameter) on the surface
- bring pixel detector on the surface
- integrate IBL, pixel detector and nSQP in SR1 clean room
- reinstall everything and close
- commission before beam injection

20 months necessary





CMS plans for LS1

- Yoke Endcap disk 4 construction at +z and –z ends in situ, finish 4’th muon endcap stations +z and –z (CSC & RPC)
- 1’st endcap muon station readout granularity restoration +z & –z
- Mu barrel electronics consolidation and move sector collectors to USC, replace MB1 θ TRB (also gains spares)

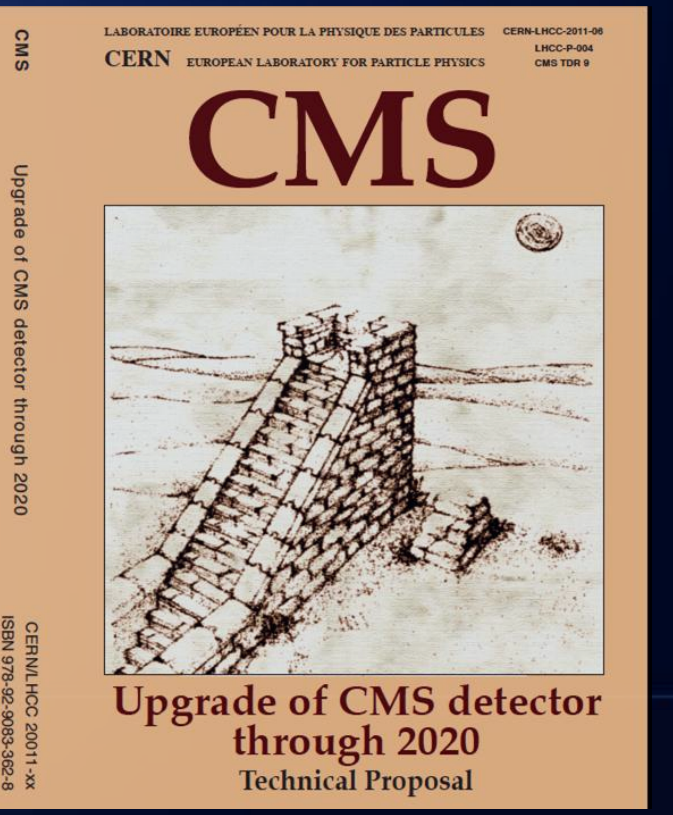
- *HF calorimeters PMT --> multi-anode (in garages off crit. Path)*
- *HO calorimeter HPD --> SiPM*

- Be beam pipe --> remove 59.6 mm install 45 mm
- Pixel concentric adjustment system
- Barrel -endcap seal revision for colder Tracker operation
- Piping and test structures for 4-layer pixel cooling
- PLT installation, BRM consolidation & upgrade
- N_2/dry-air system upgrade for colder tracker operation

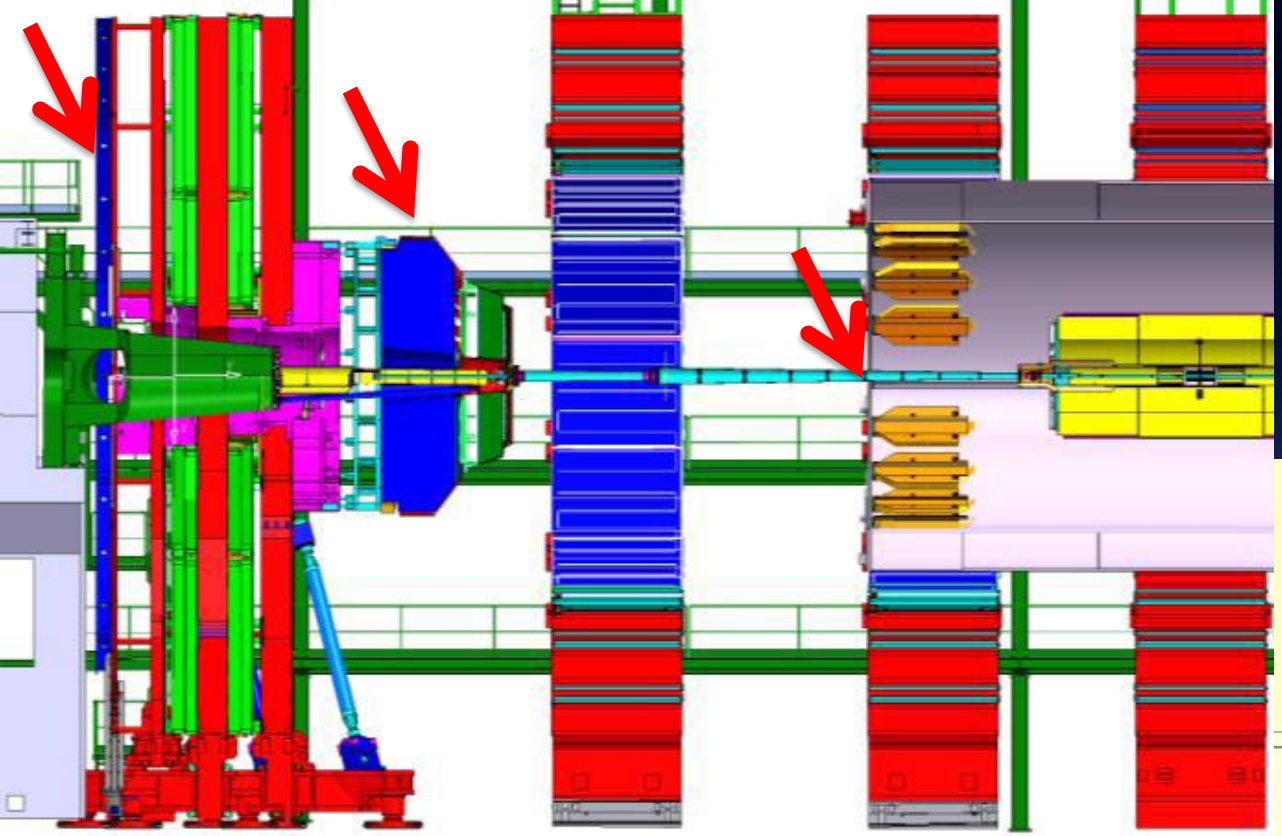
CMS plans for LS1

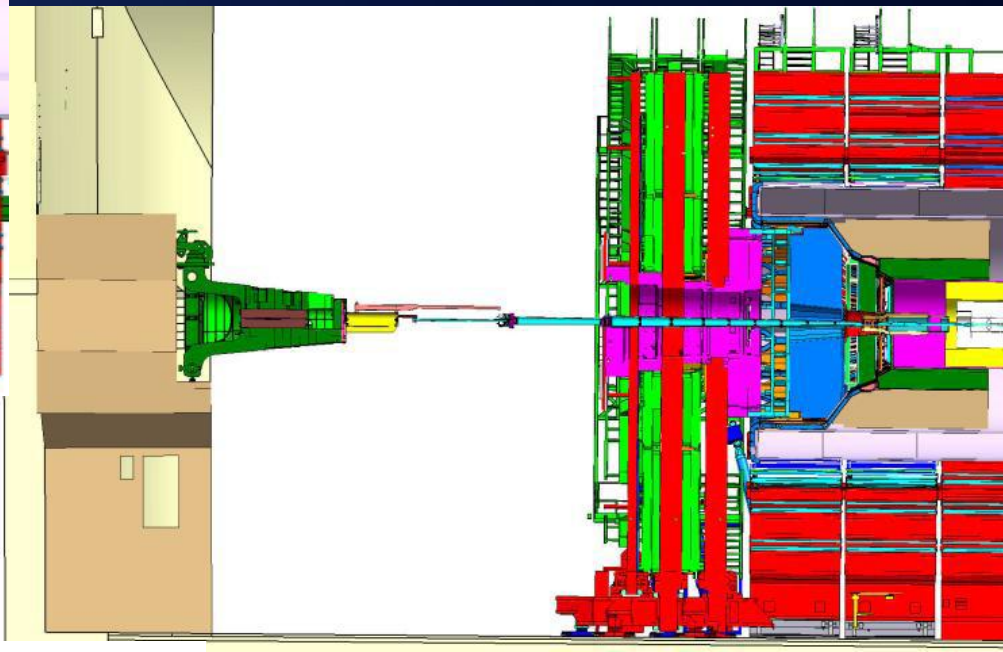
- RP shielding tests installation: beam pipe region, tracker bulkhead & endcap regions
- *UPS extension: S1 and S2 service caverns (power glitch tolerance)*
- Moving/guiding system improvement to reduce risk (YE disks + HF)
- *Rack system & YE1 cooling consolidation, turbine replacement*
- Safety & DSS system upgrades

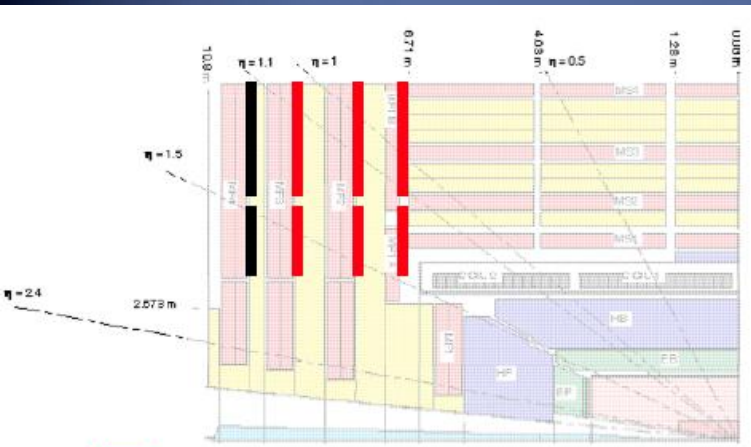
CMS technical proposal for the upgrade through 2020 (LS1 + LS2) [CERN-LHCC-2011-006; CMS-UG-TP-1

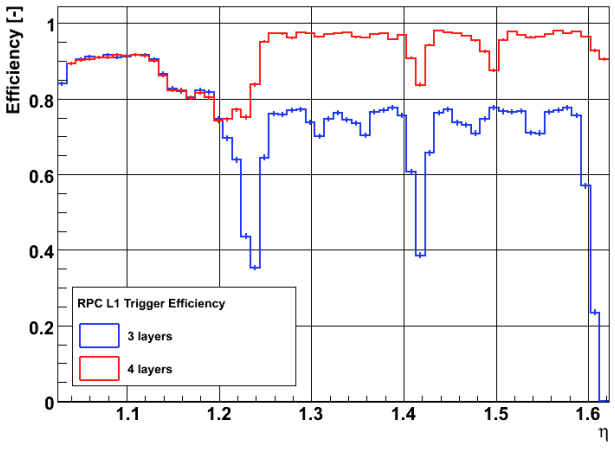


Principal configurations









CMS Schedule

LS1: The complete programme of all desirable activities would require 23.5 months, but CMS can be ready for beam on 1 Sept 2014, **21.5 months** from LS1 start on Nov 2012, by concentrating on critical items. In fact, a later LS1 start date, <17Jan 2013, would still allow completion on 1 Sept 2014 due to critical delivery dates locking the sequence.

The present CMS pixel tracker is designed for 25ns, 1 x 10^{34}.
Pixel upgrade (additional sensor layer, lower mass, deeper buffers) is substantially more performant and resilient. It will be ready to install from June 2016 (matching LS2 baseline, pre-Chamonix 2011).

- → *can be installed in a 5 mo extended end-of-year stop "LS1.5" (providing 45mm o/d central beam pipe is installed in LS1).*
- → *will need to install if existing detector limitations become significant for the LHC performance achievable before LS2.*
- → *eager to install, for timely benefit from improved performance, if "LS1.5" is needed or makes sense (eg to connect LINAC4 or to correct a major fault in machine or experiments) and a substantial data-set is anticipated between LS1.5 and LS2.*

LHCb plans for LS1

- Exchange of the beam pipe UX85/3

  Requires

  - *Opening of all sub detectors and the muon filter.*
  - *Remove beam pipe sectionUX85/2-4.*
  - *Install protection for UX85/1*

- Exchange of beam pipe support structures around UX85/2

  it improves transparency in the acceptance region

- Consolidation work on the magnet

  replacing the protection between coils and support brackets.

- Regular maintenance work on all services and sub systems.

- Establishing correct pressure difference UX – Tunnel - US

LHCb infrastructure needs

- LHCb will make most of the LS1 and the following extended technical stops to prepare the installation of the upgrade in LS2 as much as possible. During the LS1 LHCb will concentrate on the cabling and the optical fibers installation. This requires the opening of the shielding wall and adding new support structures

- For the LHCb upgrade, the size of the existing PC-Farm has to be tripled. LHCb has started to define the specification, with input from the involved departments (EN, GS and IT). Present evaluation show that this requires a new construction at point 8. If agreed, excavation work shall start preferably during the LS1, to avoid any risk of power cuts etc. during the physics data taking afterwards.

LHCb Schedule

LS1: LHCb activities compatible with LHC LS1 plans

LS2: A major upgrade of LHCb is scheduled for 2018 (LS2) to run at up to $2^* 10^{33}$ $cm^{-2}s^{-1}$ with a data taking at 40MHz. The LS2 - being one year at present – might be too short for the upgrade installation. A detailed schedule is under preparation, for presentation to the LHCC in June.

Main work during LS2 (excluding services):

- Detector electronics do be replaced/adapted for the 40MHz readout
- New RICH photon detectors
- New Tracking detectors, including the Vertex Locator
- Readout and DAQ system upgraded to 40 MHz

ALICE plans for LS1

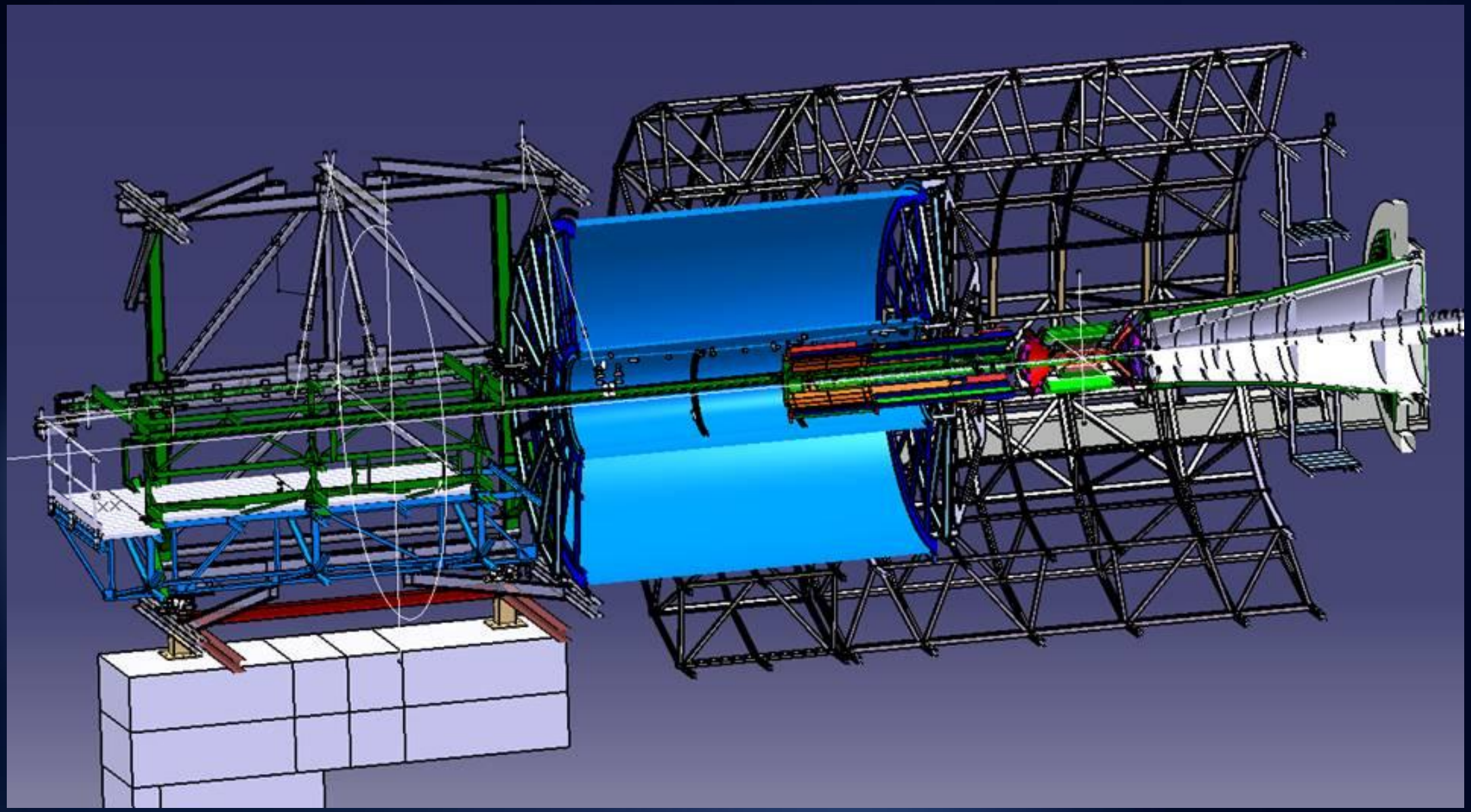
- Installation of EM Calorimeter extension + support structures and services

- *Completion of the Transition Radiation Detector system by adding the 5 final modules*

- Opening of the central detector to get access to the tracker for consolidation efforts

- *Major consolidation work on electrical infrastructure and cooling infrastructure, which dates from LEP times*

TPC moved to parking position



ALICE infrastructure needs

- Refurbishment of both surface cranes in SXL2 and SX2 and the large door of the SXL2 building (EN-HE) in 2012
- Refurbishment of the entire electrical infrastructure in the counting rooms 1 to 4 and replacement of all UPS units (EN-EL)
- Ventilation and chilled water production upgrade and consolidation (EN-CV)
- A-side beam pipe removal and central beam pipe transfer to temporary rails (TE-VSC)
- ALICE storage building at P2 (GS)

ALICE Schedule

LS1: ALICE activities compatible with LHC LS1 plans

LS2: ALICE is planning for a major detector upgrade in LS2. The project will be presented to the LHCC in spring of 2012.
One year will probably not be sufficient for installation of this upgrade project.

General remark

All experiments will need a strong support during LS1 from the various services and support groups

- BE/ABP-SU
- DGC-RP
- EN/EL,CV,HE
- TE/VSC,CRG
- PH/DT
- ….

Better to make sure that there is an adequate level of coordination between all support groups and the experiments, before we enter in a crisis situation !!

ATLAS planned upgrades

Element	Phase 0&1 (now through LS2)	Phase2 (after LS2)
Tracking	4th barrel pixel layer (IBL), new pixels services (nSQP), New evaporative cooling plant, CO2 cooling plant for IBL, FTK level 1+ tracking. New tracking detector at 220 m (AFP)	Major revision, new Inner Detector, including possible LVL1 trigger capability + all new services
Calorimetry	Change all power suppliers, New LVL1 trigger electronics LAr. Additional better trigger capability for muons in the Hadron Tiles calorimeter.	New Front and back-end electronics, including trigger. New Forward calorimeter if proven necessary. Fix LAr hadronic cold electronics if neces.
Muon System	Install EE-chambers staged. Add additional chambers in key positions inside the barrel. Sharpen LVL1 muon trigger. New muon small wheels.	Increase trigger capability in the big wheels, add additional trigger inner layers in the barrel. New front-end electronics
Trigger/DAQ	New LVL1 trigger processors which make use of better detector granularity. Add a trigger level (FTK) between LVL1 and LVL2.	Major revision
Common systems	New forward pipes in Aluminum, new small radius Be beam pipe. More neutron shielding in the forward region and in between caverns. UPS extension. Consolidate cryogenics.	New TAS and forward shielding. Major infrastructure consolidation, including safety systems

CMS planned upgrades

Element	Phase 0&1 (now through LS2)	Phase2 (after LS2)
Tracking	Pixel–––> 4 (barrel)+3(endcap) layers, low mass, CO2 cooled, improved ROC Pixel and strip trackers cold operation.	Major revision, new pixel & strip trackers including trigger capability
Calorimetry	HCAL Phototransducer change HB/HE Depth segmentation Front and back-end electronics	New technology in endcap & forward regions.
Muon System	4’th endcap muon station (CSC+RPC) 1’st endcap μ station high η granularity DT MB1 TRB repl, DT Sector Collector move.	DT minicrate revision. Rate and background mitigation,
Trigger/DAQ	New L1 trig in μTCA(improved ganularity & algoritms). Revised optical links (Opto SLB’s. HCAL & ECAL Trigger fibres and crates). Event builder & HLT renewal.	Major revision
Common systems	YE4 shielding wall, 45mm o/d beampipe, Magnet cryo redundancy. Lower risk moving system,(YE’s + HF) UPS extension. Beam monitors PLT and BSC 2, N2 system upgrade.	Rebuild of forward pipes, TAS, shielding. BCM system replacement

Summary remarks

- *LS1 LHC planning (20 mo) ok for ATLAS, ALICE and LHCb*
- *LS1 today's startup date problematic for CMS, need more then 20 months, some material delay might require 2-4 months more*
- *CMS might require a LS1.5 of 5 months after summer 2016, for the pixel installation*
- *ALICE and LHCb advance the possibility that a 1 year LS2 shutdown is not long enough, more info after LHCC step*
- *In LS1 all experiments require a very high level of support by various CERN groups. A careful planning is necessary to avoid surprises*