Introduction to L1Calo Upgrade

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Science & Technology
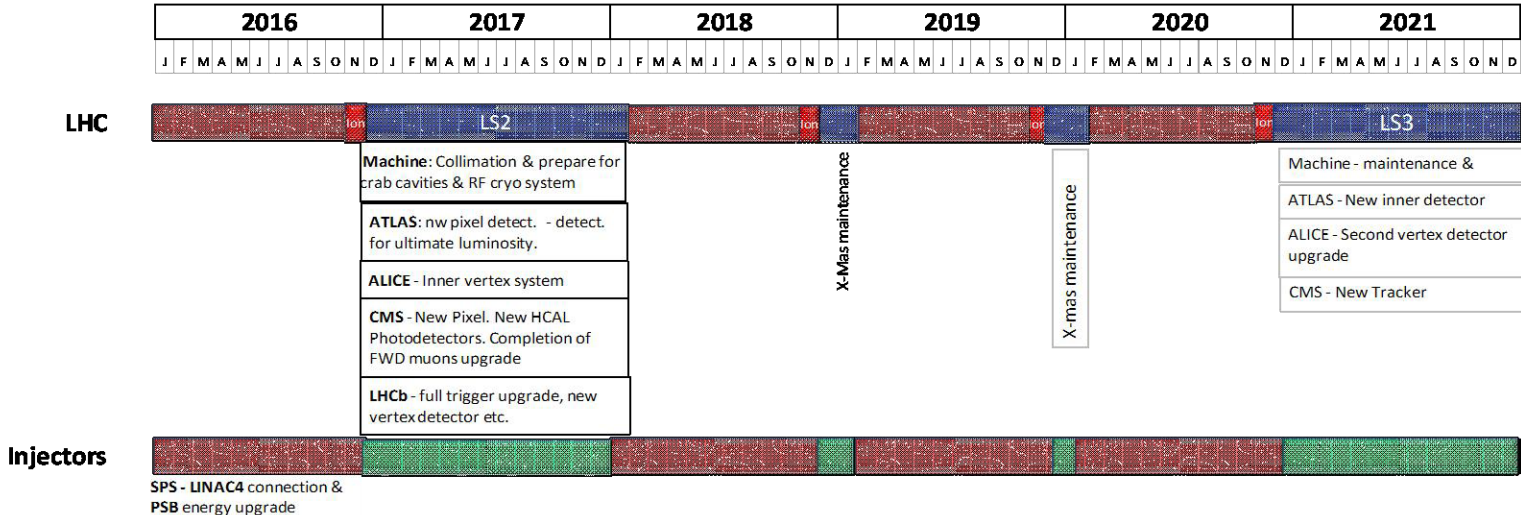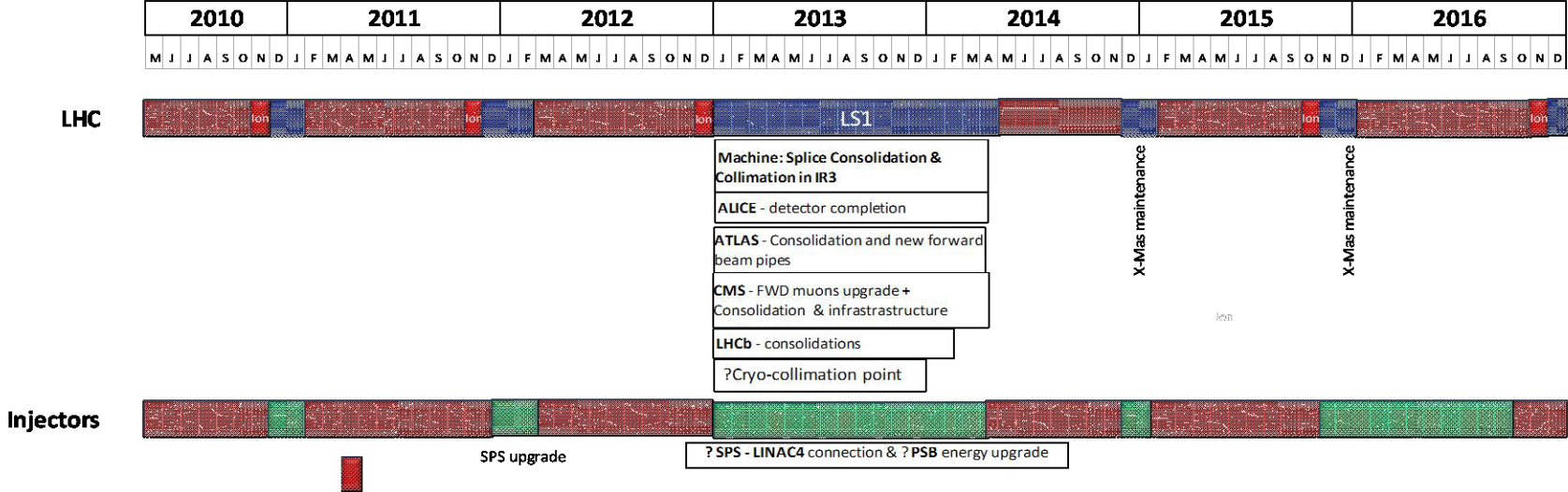Facilities Council

Overview

- Current understanding of Schedule

- Luminosity vs Bunch spacing

- CMS

- ATLAS

- Developments in ATLAS – Phase 0 and Phase I

- Developments in ATLAS – Phase II

- Contrasts CMS – ATLAS

- This Afternoon:
  - *Phase I upgrades and planning*
  - *Coffee*
  - *Simulation*
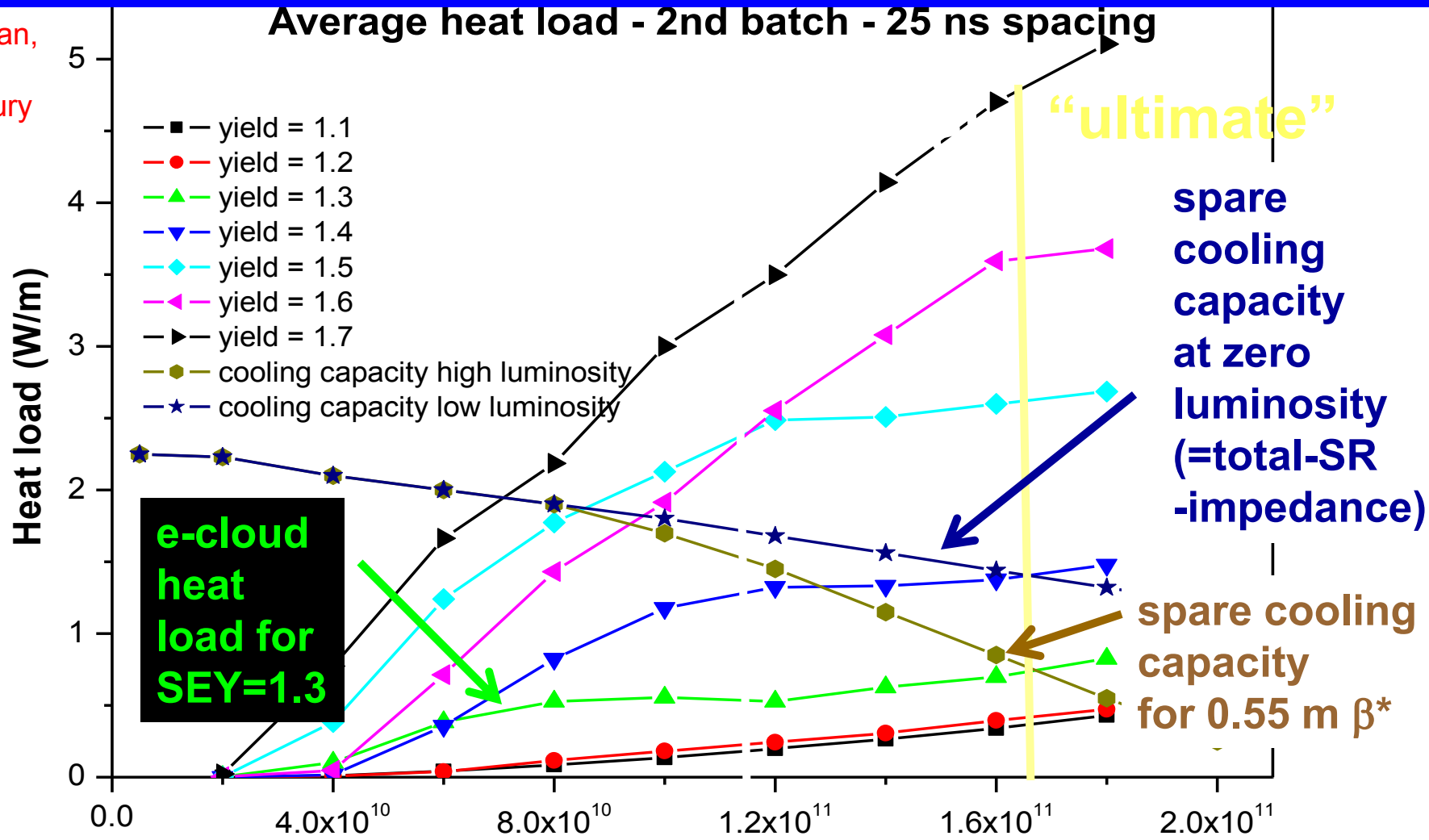 - *Phase II studies*
  - *Technical Proposal*

Draft 10 year plan

[Outcome Chamonix 2011 presented @ LMC 81 - draft]

2010	2011	2012	2013	2014	2015	2016
M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D

LHC

LS1

X-Mas maintenance

X-Mas maintenance

Machine: Splice Consolidation & Collimation in IR3

ALICE - detector completion

ATLAS - Consolidation and new forward beam pipes

CMS - FWD muons upgrade + Consolidation & infrastrasture

LHCb - consolidations

?Cryo-collimation point

Injectors

SPS upgrade

? **SPS - LINAC4** connection & ? **PSB** energy upgrade

2016	2017	2018	2019	2020	2021
J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D

LHC

LS2

LS3

X-Mas maintenance

X-mas maintenance

Machine: Collimation & prepare for crab cavities & RF cryo system

ATLAS: nw pixel detect. - detect. for ultimate luminosity.

ALICE - Inner vertex system

CMS - New Pixel. New HCAL Photodetectors. Completion of FWD muons upgrade

LHCb - full trigger upgrade, new vertex detector etc.

Machine - maintenance &

ATLAS - New inner detector

ALICE - Second vertex detector upgrade

CMS - New Tracker

Injectors

SPS - LINAC4 connection & PSB energy upgrade

3

Average heat load - 2nd batch - 25 ns spacing

Heat load (W/m)

Legend:
- yield = 1.1
- yield = 1.2
- yield = 1.3
- yield = 1.4
- yield = 1.5
- yield = 1.6
- yield = 1.7
- cooling capacity high luminosity
- cooling capacity low luminosity

"ultimate"

spare cooling capacity at zero luminosity (=total-SR -impedance)

spare cooling capacity for 0.55 m β*

e-cloud heat load for SEY=1.3

x-axis: N_b, values 0.0, 4.0×10^{10}, 8.0×10^{10}, 1.2×10^{11}, 1.6×10^{11}, 2.0×10^{11}

going above $N_b = 1.7 \times 10^{11}$ & ultimate luminosity requires dedicated IR cryo plants; limit then becomes $N_b \sim 2.3 \times 10^{11}$
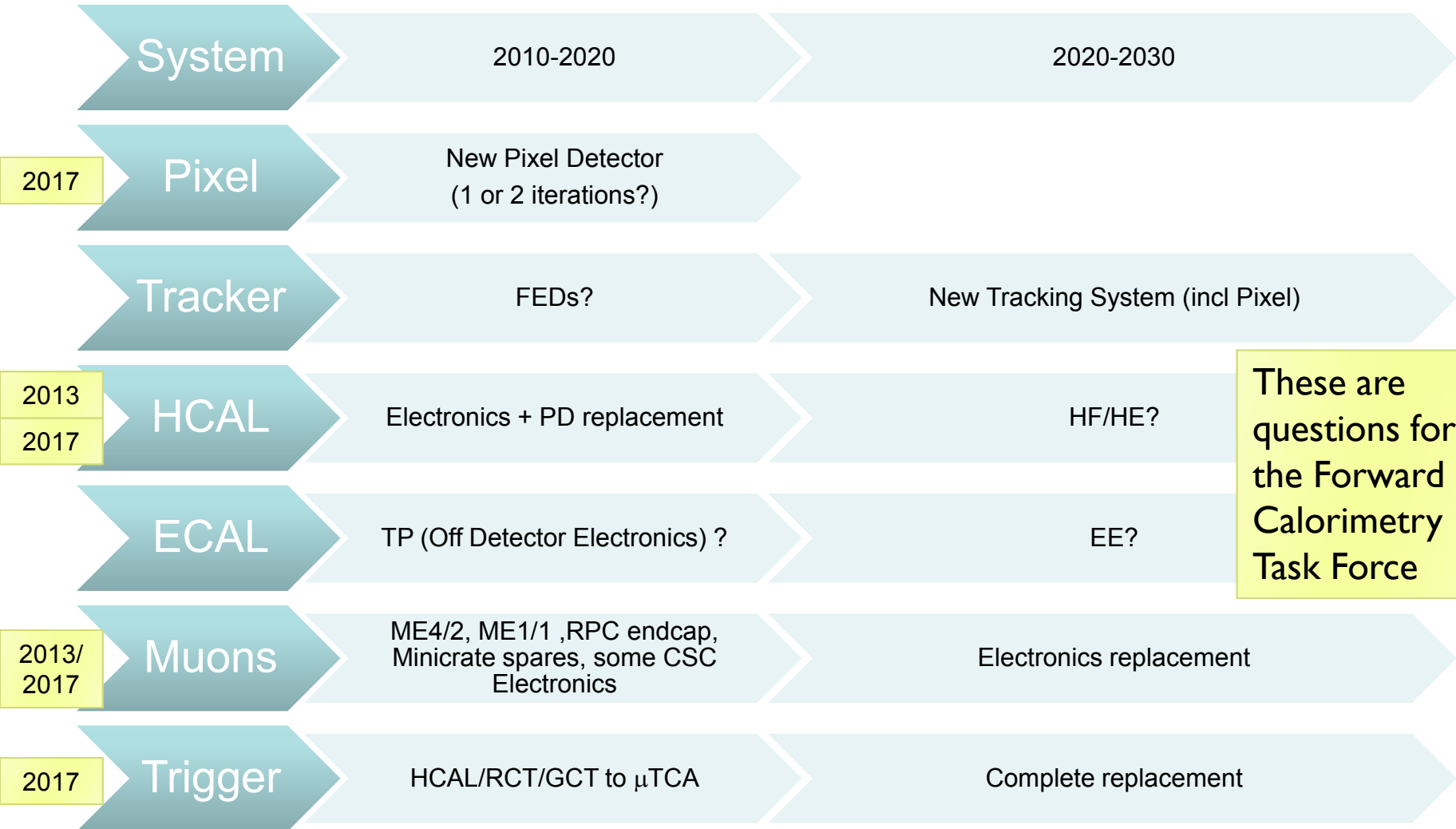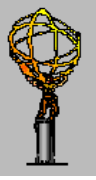
cooling & e- heat for 50 ns spacing

Average heat load - 2nd batch - 50ns - LPA scheme

L. Tavian, 2005
H. Maury Cuna, 2009

ACES 2011 Workshop, CERN, March 2011
Oliver Brüning BE-ABP

Heat load (W/m)

- ■ yield = 1.1
- ● yield = 1.3
- ▲ yield = 1.5
- ▼ yield = 1.7
- ◆ cooling capacity low luminosity
- ◀ cooling capacity high luminosity

"LPA"

(longer flat bunches)

spare cooling capacity at zero luminosity (=total-SR-impedance)

spare cooling capacity for 0.25 m β*

e-cloud heat load for SEY=1.5!

going above N_b=2.3x10^{11} & ultimate luminosity requires dedicated IR cryo plants; limit then becomes N_b~5.0x10^{11}

CMS Upgrade Scope

System	2010-2020	2020-2030
Pixel (2017)	New Pixel Detector (1 or 2 iterations?)	
Tracker	FEDs?	New Tracking System (incl Pixel)
HCAL (2013, 2017)	Electronics + PD replacement	HF/HE?
ECAL	TP (Off Detector Electronics) ?	EE?
Muons (2013/2017)	ME4/2, ME1/1 ,RPC endcap, Minicrate spares, some CSC Electronics	Electronics replacement
Trigger (2017)	HCAL/RCT/GCT to μTCA	Complete replacement

These are questions for the Forward Calorimetry Task Force

9 March 2011

ATLAS - Phase I and before
(for running up to 2020)

- Insertable B-Layer in inner tracking detector (IBL) + readout
    - *Improves tracking as inner ID layer starts to degrade*
- Fast Track Processor (FTK)
    - *Provides ~offline-precision tracks to HLT, including IBL data*
- Muon
    - *New small wheel + extra chambers in feet region – changed MuCTPi*
    - *Additional information to L1Topo*
- CTP firmware modifications
    - *allow extra inputs from L1Topo (also from Muons?)*
- L1Calo Topological Trigger - CMM++ and L1Topo
    - *Keep trigger rate reasonable at low object thresholds*
- Phase I task force: Latency,...
- Initial use of ATCA
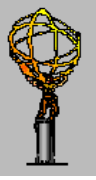
Possible ATLAS - Phase II
(running after 2021)

- Probably 2-stage hardware trigger L0/L1 (causes problems for muons)
- Calo digitisation on detector
  - *complete replacement of L1Calo to handle finer granularity*
- New Inner Detector, and Level-1 Track trigger (included in L1)
- Barrel MDT included in L1Muon trigger (included in L1)
  - *Signals were too slow to use in Phase I or in Lo formation*
- New Global Topology Trigger (topo processing, + CTP functions)
- New timing distribution system - possibly built from a mixture of
  - *updated TTC (perhaps not rad-hard), and*
  - *GBT data links (rad-hard)*
- Possible new readout architecture – S-Links old and probably too slow, RODs need to handle two-stage hardware trigger
- Possibly big changes in HLT and DAQ
  - *E.g. Is it still useful to use RoIs? Still separate L2 and EF? Use GPUs ?*
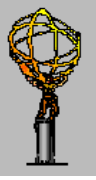
Contrasts ATLAS vs CMS

- Track Trigger:
  - *CMS is self-seeded - very technically demanding, powerful if it works*
  - *ATLAS is (probably) RoI-seeded by L0, so depends critically on good L0 Electron and muon triggers*
- xTCA:
  - *CMS interested in μTCA (~75 x 180 mm),*
  - *ATLAS thinking mostly of ATCA (280 x 322 mm).*
  - *More CERN support at present for μTCA?*
- Documentation:
  - *CMS Technical Proposal (whole experiment) submitted August 2010*
  - *ATLAS LoI (the previous stage) to be submitted late 2011*
  - *Level-1 TP to be submitted mid-2011*