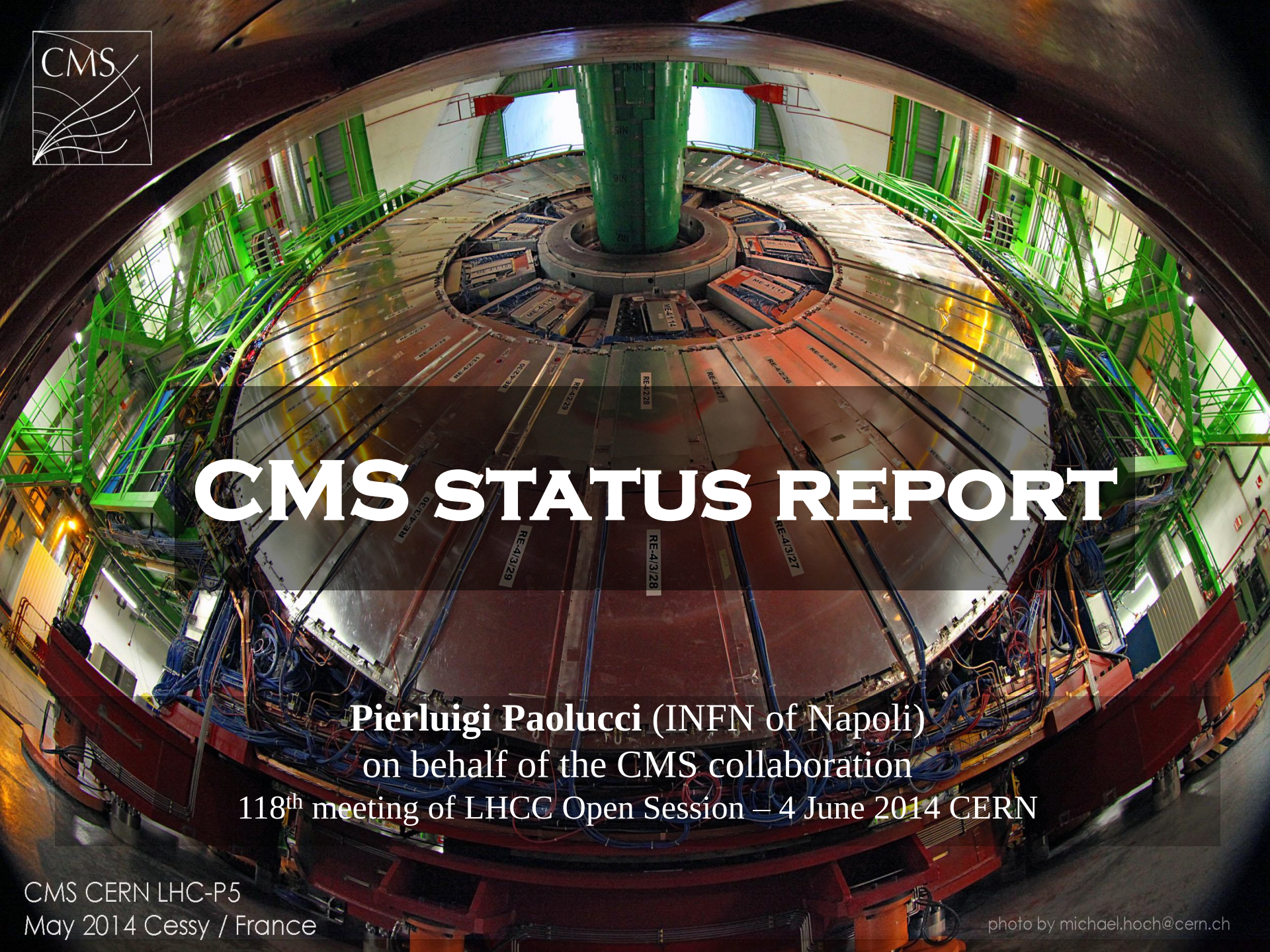

CMS STATUS REPORT

Pierluigi Paolucci (INFN of Napoli)
on behalf of the CMS collaboration

118th meeting of LHCC Open Session – 4 June 2014 CERN

CMS CERN LHC-P5
May 2014 Cessy / France

photo by michael.hoch@cern.ch

Outline

- LS1 activities
- Sub-system status report
- DAQ-Offline-Computing
- Physics highlights
- Conclusion

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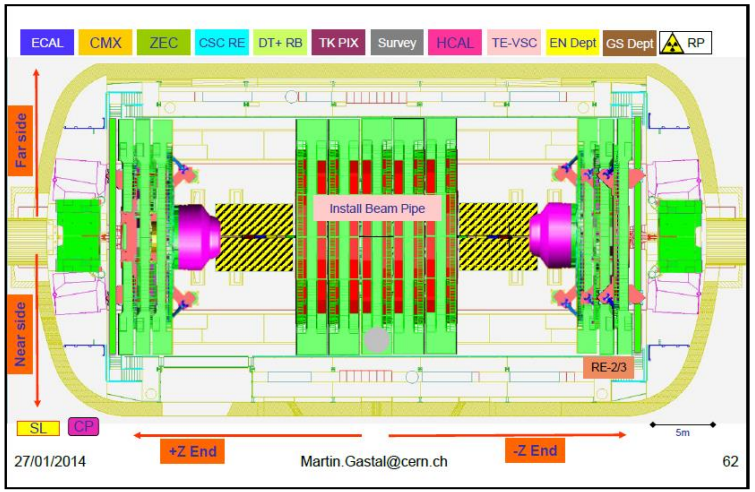
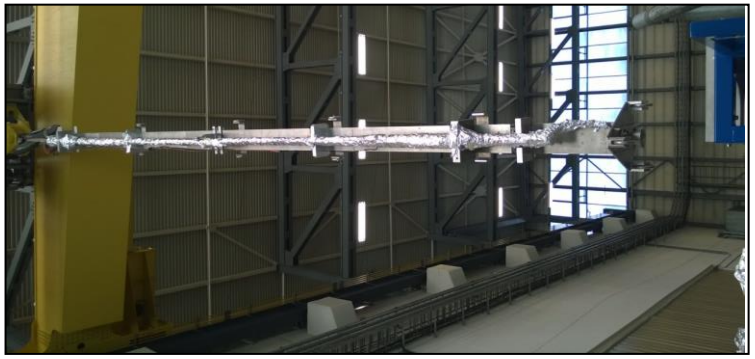
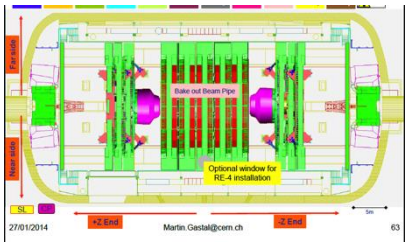
Technical Coordination

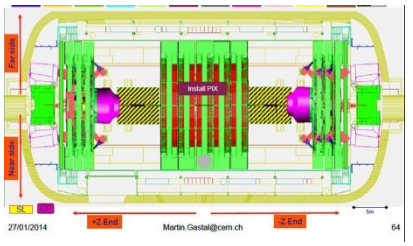
Currently configuring for **beam-pipe installation** new central beam-pipe installation (45mm outer diameter) starts next week followed by pixel Installation.



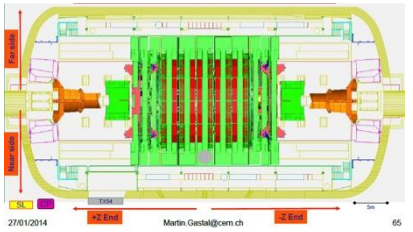




Bake-out July-Aug



Install pixel (barrel+forward) BCM+PLT Aug-Sep



Closed for magnet test & CRAFT Oct-Nov

Keep contingency for re-opening beam-pipe pump-down:
Jan 2015 then ready for physics

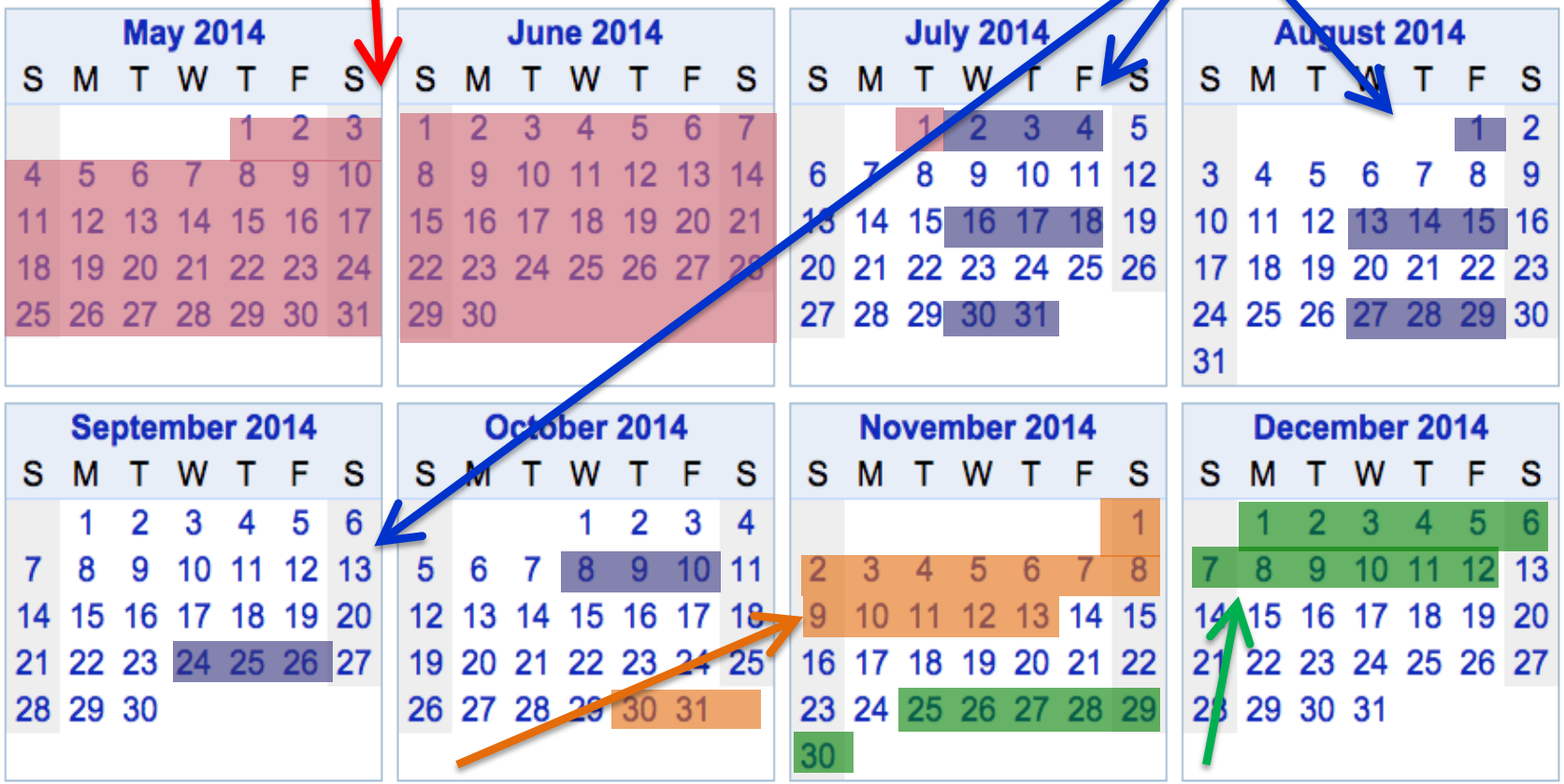
LS1 winding down

- A sample of what still needs to be *deployed*…
  - DAQ2
  - Trigger Control and Distribution System (TCDS)
  - L1 trigger improvements
  - Forward HCAL back-end electronics
  - Lumi DAQ

Global Run tentative schedule

Cooling maintenance + DAQ2 installation/commissioning

Commissioning runs



Cosmic alignment run at B=0T

Cosmic alignment run at B=3.8T

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Trigger Upgrade Status

Trigger rate up to 6 times the RUN1 is expected.

Calorimeter and Muon trigger upgrade necessary.

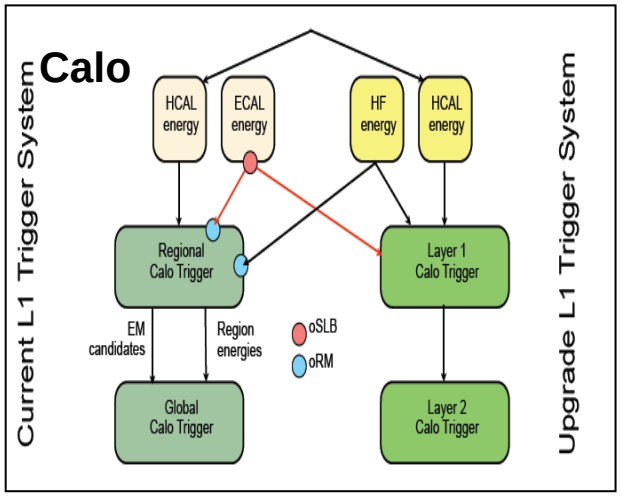
CALO: Legacy trigger and new trigger for 2015 run

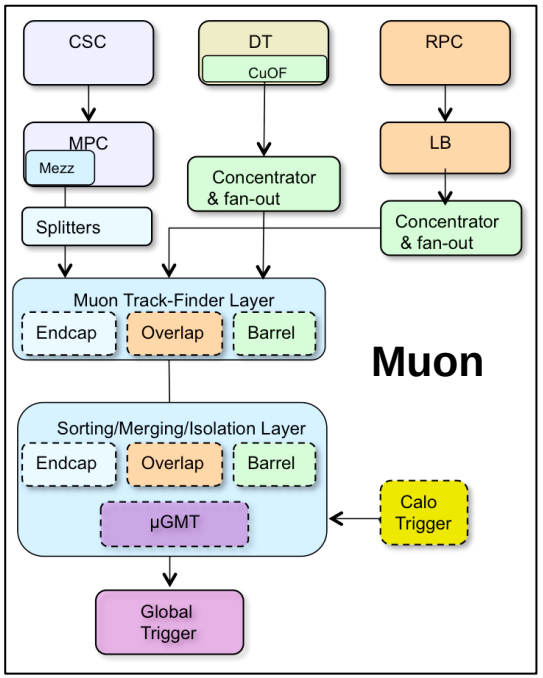
- Calo Layer 1 (CTP7)
  - 2 prototypes + 6 additional pre-production boards built.
  - Excellent results with processor system, power supplies, clock system and optical/backplane links
    - Tested 4.8 & 6.4 & 9.6 Gbps synch. and 10 Gbps asynch.
- Calo Layer 2 (MP7) about ready

Muon: combining 3 independent subsystem triggers

Work in progress:

- Muon trigger link concentration and fan-out
- Muon Track-Finder (barrel/endcap/overlap)





Tracker readiness for RUN2
ready to operate at **-15 ºC** (validated at -20 ºC)

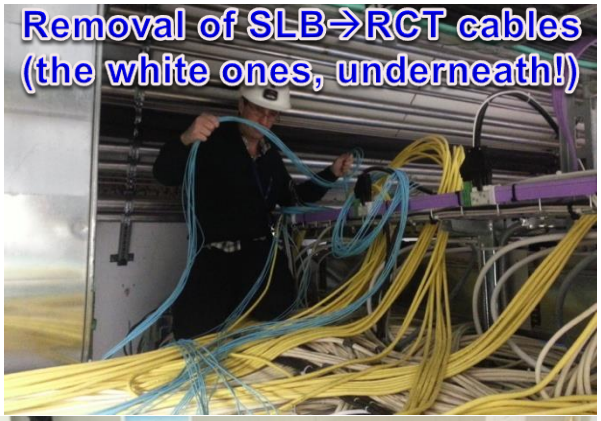
Finalizing the new molds for the inner nose

Final insulation from the bulkhead periphery all the way to the edge of the vac-tank

- Pixels are pre-calibrated on surface lab
- Pixel almost ready for re-installation

ECAL + eγ trigger

- **Upgrade to ECAL Level-1 trigger:** change links between ECAL Trigger Concentrator Cards (TCC) and Regional Calorimeter Trigger (RCT) from electrical to optical
- All hardware in place and optical fibers being installed and commissioned



Nov. 2013: damaged connector found on ES.
Both ES removed from CMS to the surface, repaired, reinstalled and now re-commissioned.
99.95% channels operational.

HCAL status

- Installation and commissioning of SiPM readout on HO (April) - DONE
- Installation of new thin window, multi-anode PMTs DONE
  - Being commissioned by July

- Production of new Back-End board for HF
  - Pre-production (10 boards) ok, production ordered and expected delivery at CERN in July
  - Commissioning planned for late September.
- HF Front End

Test of new QIE10-based readout successfully tested at FNAL test beam
Expected installation in Year-end Technical Stop 2015/16

Drift Tubes towards Run2

250 chambers
172200 drift tubes

Chamber HV: 312 channels recovered

Chamber Minicrates: 3200 channels recovered

Sector Collector (Read-Out and Trigger) relocated out of UXC: installed 3500 optical links that make single outputs of all 250 chambers available in USC

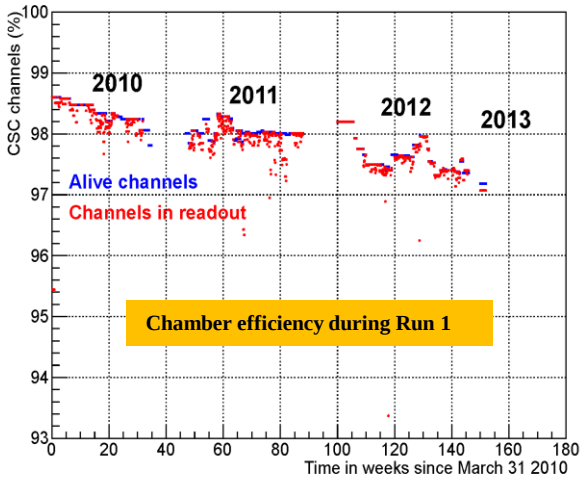
Review of CSC activities during LS1

Focused on 3 main areas (in order of priority):

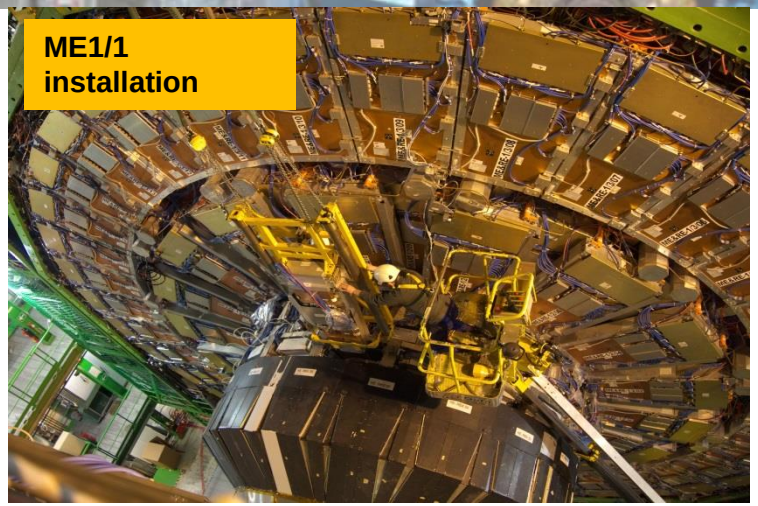
1. Present system consolidation, maintenance and repair
   - Repair system faults from Run 1 –> recover highest efficiency. Improve system reliability (HV, LV, racks, detector infrastructure)

2. ME1/1 chamber electronics upgrade
   - 72 chambers extracted, refurbished and reinstalled in CMS.
   - Increase capacity for data rate and exploit full chamber segmentation in 2.1<|η|<2.4 to enhance rate capability (including @ HL-LHC) and improve muon reconstruction

3. Completion of station 4 (ME4/2 ring 1.2<|η|<1.8)
   - Re-establish 4-station redundancy over all 0.9<|η|<2.4 range. Improve muon-ID efficiency and sustain high-Lumi L1 rates at a reasonably low pT threshold
   - Construct and test 72 CSC at CERN, install and commission in CMS *(in close coordination with RE4 project)*



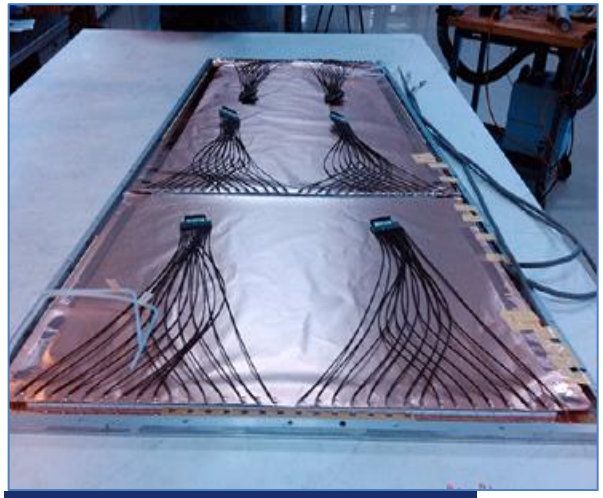
CSC consolidation in pictures



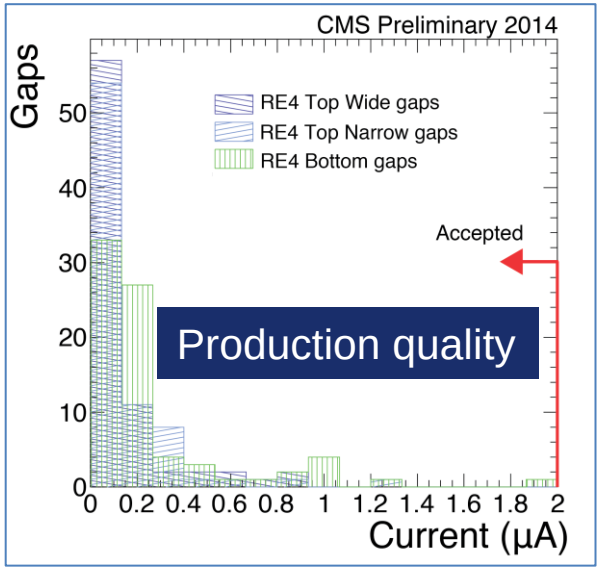
RPC upgrade

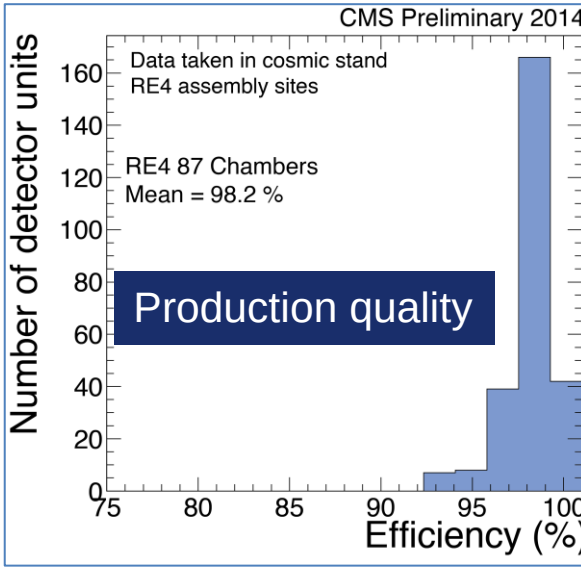
Maintenance and repairs
99.5% of working channels today

- **RPC upgrade (RE4) completed on May 5.**
- 686 gaps produced in 22 months
- 72 super-modules installed ahead of schedule
- Commissioning is on-going. No major problem encountered until now.
- RE4 project has been completed on schedule and in the budget



Naked Super-Module





RPC RE4 144 chambers installed

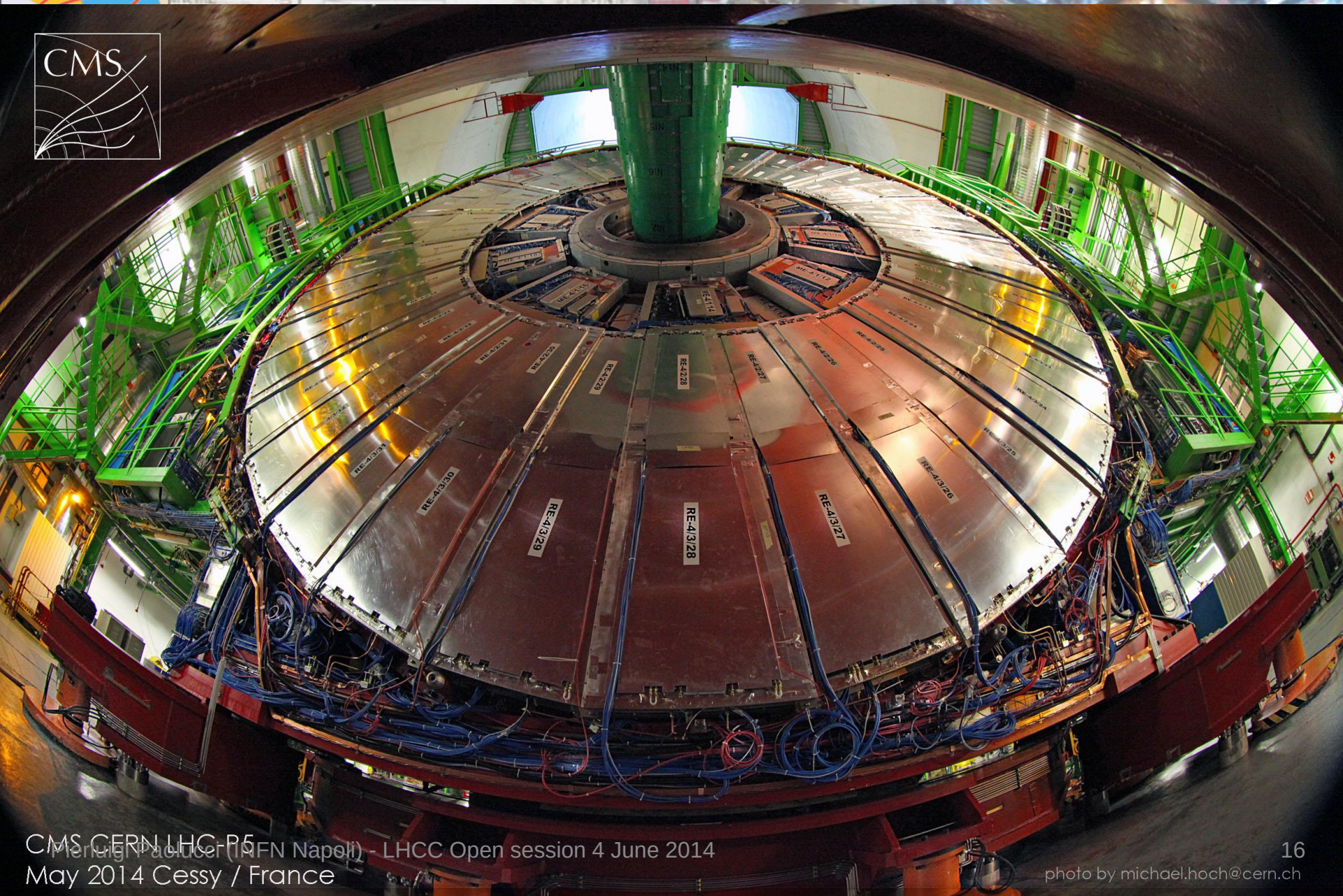
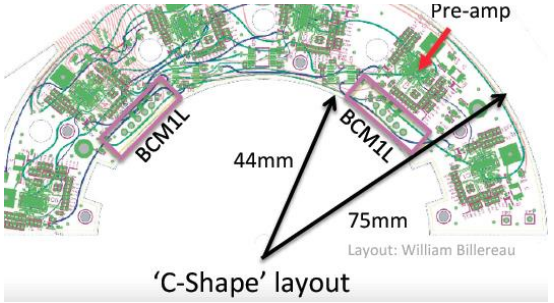


photo by michael.hoch@cern.ch

Beam monitoring and luminosity

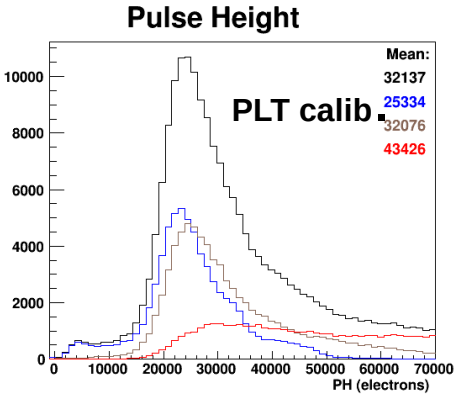
BRIL (Beam Radiation Instrum. and Luminosity) milestones achieved

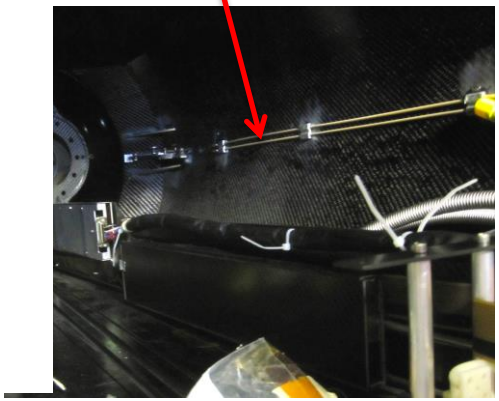
- Upgrade Fast Beam Conditions monitor
  - Single integrated PCB with rigid and stiff component, minimizing material budget and connections: structure done.



- Si-Pixel Luminosity Telescope
  - Success trial installation of new detector mock-up in pixel volume
  - Hybrid board production & testing in full swing


Some members of the Design and production team at CERN





April Global Run: some achievements

Lots of new things in the April Global Run (7-11 April)

- **All:** clock frequency scan
- **ECAL:** test new optical links
- **Strips:** run constantly at –15°C
- **HCAL:** Commission new SiPMs
- **DT:** Commission relocated electronics
- **Muon Endcap:** First global run with 4th endcap station (RPC and CSC)

First run with Prompt Calibration Loop on cosmics

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DAQ status

- **DAQ2**: New central DAQ system for run 2
  - **Aim:**
    - Accommodate new uTCA based sub-detector back-end electronics as well as legacy ones
    - Replacement of most networking and computing equipment (5-years end-of-life)
    - Lumi-DAQ system to acquire data time-based (independent of level-1 triggers)
    - Various improvements motivated by operational experience from run 1
  - **Status:**
    - Most components demonstrated on small scale test bed
    - Custom electronics 100% produced and installed
    - Most of the IT-equipment delivered and installed
  - On track for changeover scheduled July-2014 (global run)
- **HLT** farm for RUN2: plan to order CPU and storage in few months
- Online cloud: Use of HLT farm for offline processing
  - Was recently used for offline production (Heavy Ion reprocessing for QM2014)

Run II readiness: CSA14

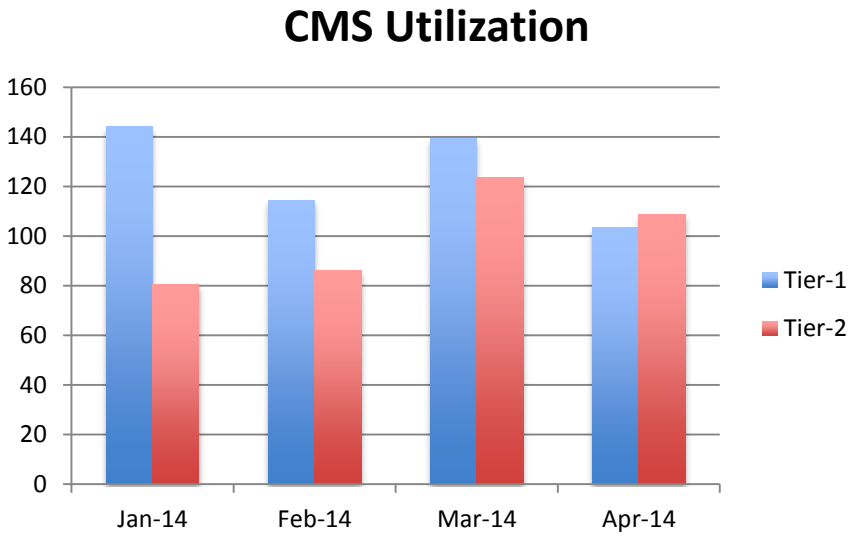
Planning integrated **Computing, Software and Analysis Challenge 2014 (**CSA14) for Summer

- major milestone for analysis readiness towards data-taking
  - New lepton ID, new PU rejection, new jet definition for high-PU 13TeV collisions
  - Realistic beam conditions, detector alignment and calibration
  - Intense work to update DQM code (online and offline) to new run conditions and new DAQ

Considered scenarios

Bunch Spacing [nsec]	Int. Lumi	Target Lumi [10^{33} $cm^{-2}s^{-1}$]	PU
50	100 pb^{-1}	7.5	40
25	> 1 fb^{-1}	7 to 14	20 to 40

Computing



- Resources are fully utilized
  - Several high-priority campaigns (detector upgrade studies, CSA14, specific physics results)
- Computing improvements will be validated during CSA14:
  - More flexible and efficient access to data
  - Improved distributed analysis tools
  - Prompt reconstruction distributed also to Tier1 sites

- 125% utilization at Tier1s
- 99.8% utilization at Tier2s

Next major CMSSW version to be released in June

- Major new features include:
  1. Geometry for 2015 CMS detector
  2. Integration of Geant 4.10
  3. Deployment of multi-threaded framework
- Our change to a multi-threaded framework is needed in 2015 to:
  - Process large samples in less time
  - Reduce the total memory per node
- Modifications to our reconstruction algorithms have been done to effectively use this framework

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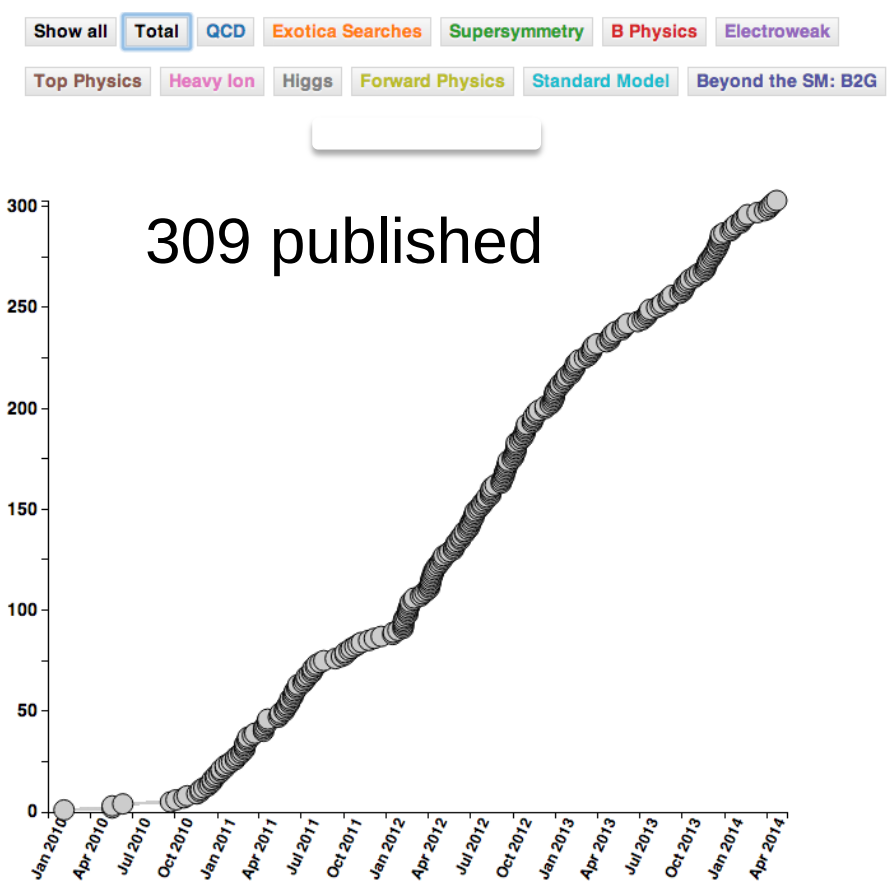
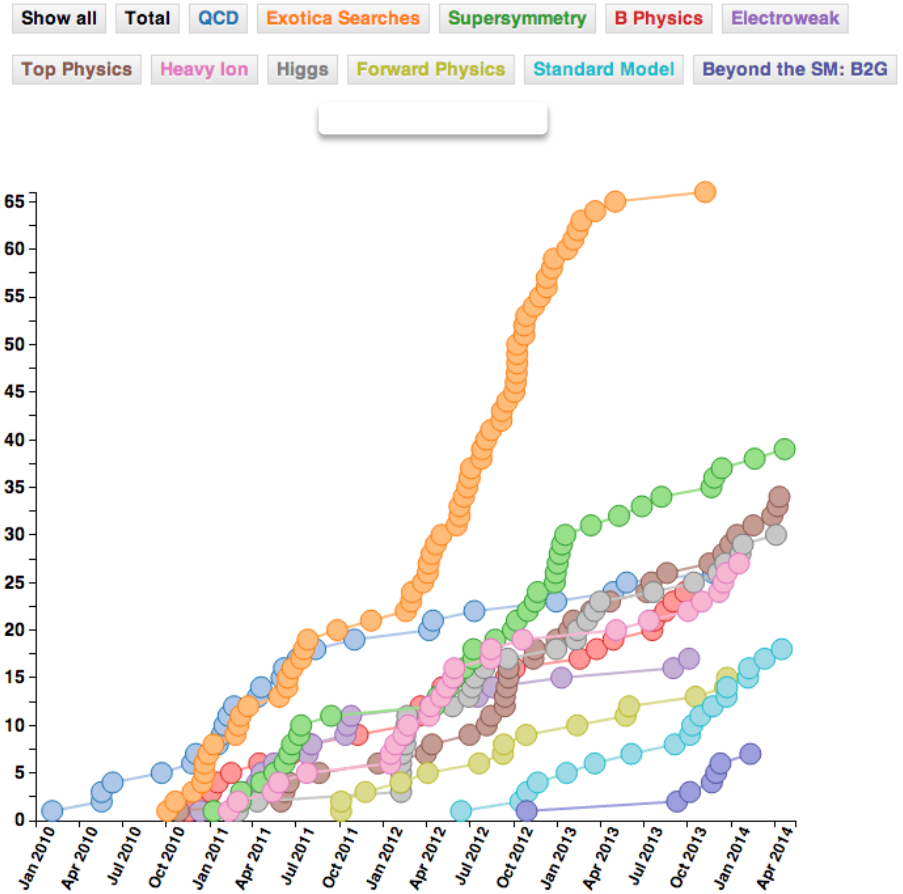
Published papers (from CDS)

Steady rate of publication, in all groups





Breakdown of CMS Publications

Table with April 2014: submitted “collision” papers

	PRL	PRD	PRC	PLB	JHEP	EPJC	NP	SUB	PUB
EWK	2	3	0	5	6	1	0	17	16
QCD	5	3	0	3	11	3	0	25	24
FWD	0	1	0	1	5	2	0	9	9
SMP	3	1	0	2	7	4	0	17	11
FSQ	0	1	0	0	3	2	0	6	5
BPH	6	2	0	6	8	2	0	24	23
TOP	6	3	0	7	11	7	0	34	27
HIG	4	2	0	9	10	3	1	29	25
SUS	7	6	0	6	15	4	0	38	35
EXO	15	7	0	26	19	0	0	67	67
B2G	2	0	0	2	3	0	0	7	4
HIN	7	0	3	7	6	4	0	27	23
	57	29	3	74	104	32	1	312	274

Table 1 – *Number of papers based on collision data submitted since 2009, per Physics Analysis Group and per journal. The rightmost column presents the number of pub papers. ("NP" means Nature Physics.)*

June 2014

Constraints on the Higgs boson width

arXiv: 1405.3455 – submitted to PLB 14 Ma

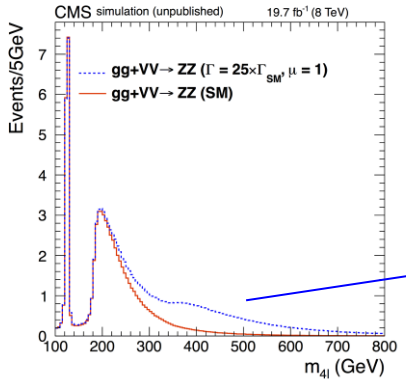
A measurement of relative off-shell and on-shell production and $H \to ZZ$ decay provides direct information on Γ_H

$$\sigma^{\text{on-shell}}_{gg\to H\to ZZ} \sim \frac{g^2_{ggH} g^2_{HZZ}}{m_H \Gamma_H}$$

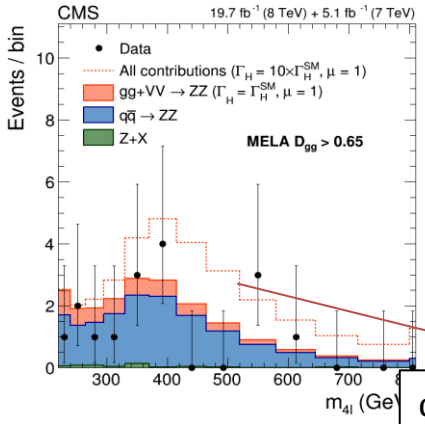
$$\sigma^{\text{off-shell}}_{gg\to H\to ZZ} \sim \frac{g^2_{ggH} g^2_{HZZ}}{(2m_Z)^2}$$

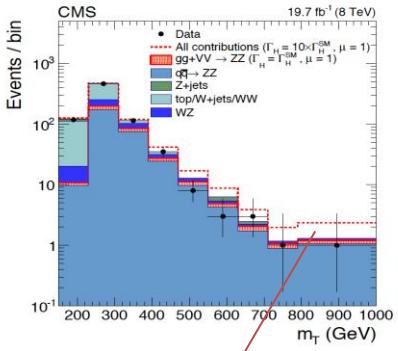
$H \to ZZ \to 4l$ channel: at high mass 2D fit on m_{4l} and a matrix element likelihood discriminant D_{gg}

$H \to ZZ \to 2l2\nu$ channel: fit on the transverse mass or ET

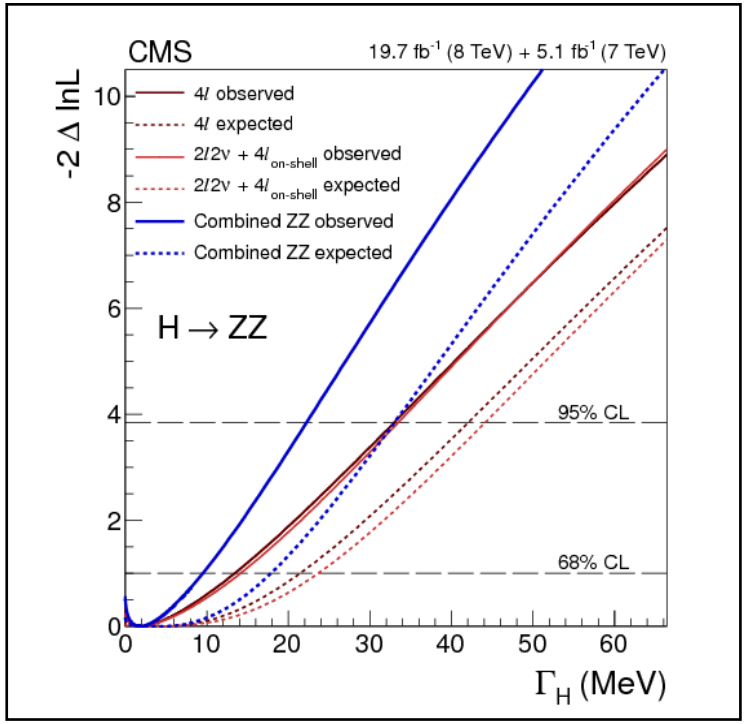


4-lepton invariant mass distribution
A clear enhancement is visible using $\Gamma_H = 25\,\Gamma_{SM}$





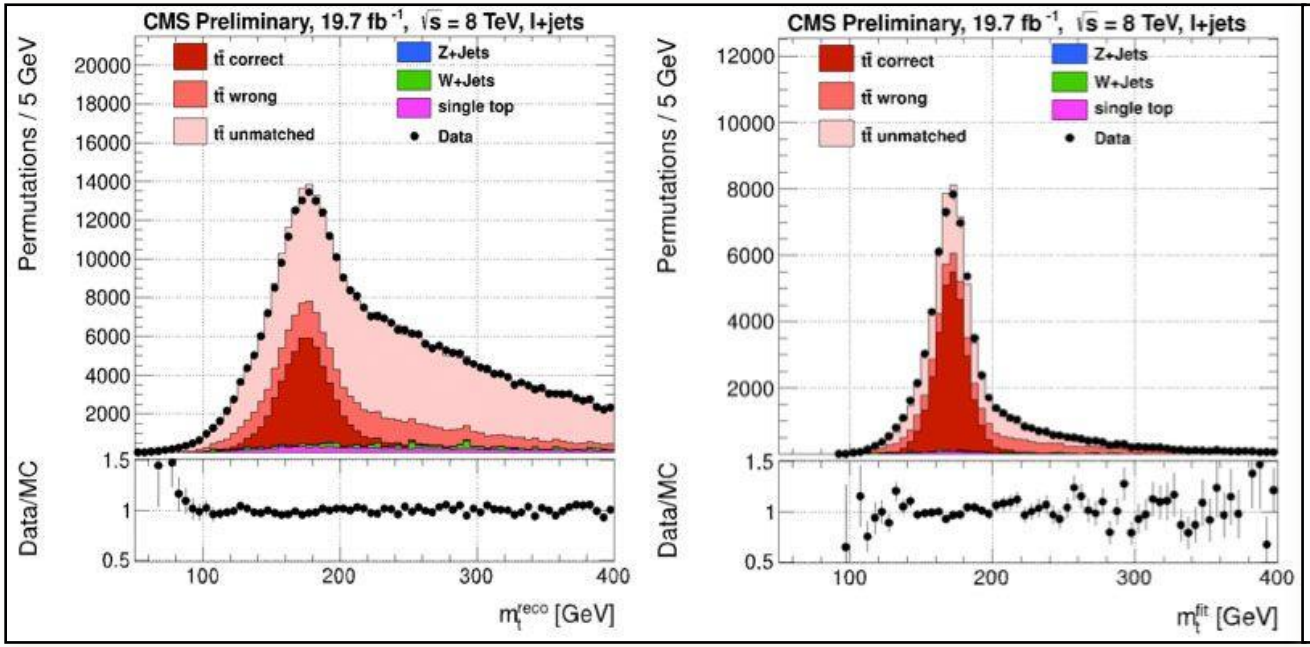
dashed line total yield for $\Gamma_H = 10\,\Gamma_{SM}$

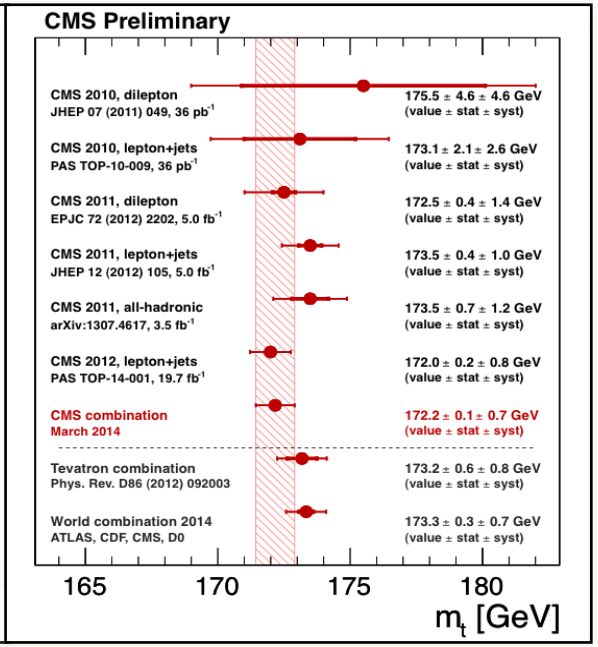


Combined with $H \to ZZ \to 4l$ on-shell measurement, an upper limit is set at 95% CL of $\Gamma_H < 22$ MeV (corresponding to $5.4 \times \Gamma_H^{SM}$)

Top Mass from 8 TeV data

At the recent "Rencontres de Moriond" conference, the CMS collaboration presented a new improved mass measurement (80% of the data collected during Run I).
The new measurement yields a top quark mass $\mathbf{m_{top}=172.04\pm0.19\pm0.75\ GeV}$





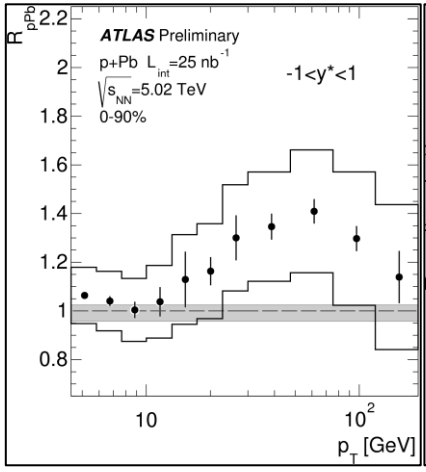
Signature: 1 lepton + 4 jets (2 from b) + missing transverse momentum
Reconstructed invariant mass distributions for events before and after the kinematic fit to a top-quark pair event hypothesis.
Systematic: jet energy scale, pile-up effect and modeling of the jet-energy resolution

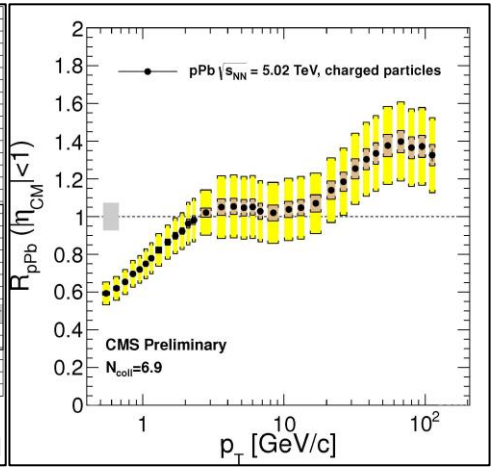
Heavy Ions highlights

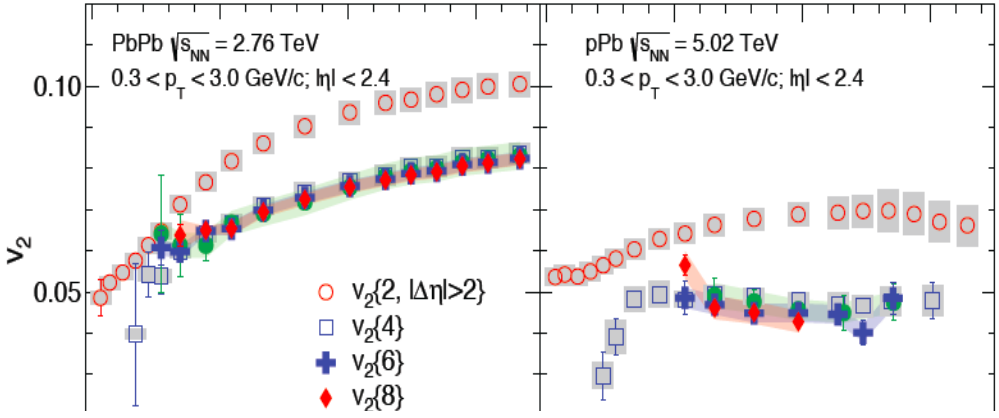
PAS-HIN-14-006

Gives info about the mechanism of particle production in proton-nuclei collision.
The azimuthal anisotropy Fourier harmonic v2, extracted with 4, 6, 8 and all (LYZ) particle correlations shows that the v2 signal in pPb collisions is of COLLECTIVE nature. This supports the interpretation that hydrodynamic expansion behavior is observed in pPb collisions as well as previously in PbPb interactions.

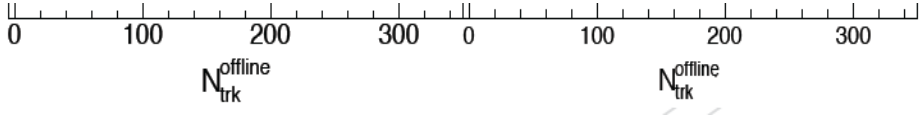
- ATLAS confirmed the surprising Hadron RpPb result
- CMS made public in November 2013.
- 5.02 TeV pp reference data to increase R_{pPb} precision







The 2-4 particles correlation analysis extended to 6-8



Nuclear modification factor in pPb normalized to p-p. It rise above 1 (anti-shadow region)

ATLAS (left) and CMS (right)

More data analysis results

Since LHCC March 5th

- EXO-12-030 - Search for LQ with top+tau pairs
- FSQ-13-003 - Drell-Yan pT distributions at low and high mass
- HIG-14-003 - H -> gamma gamma with Dalitz decays
- HIG-14-001 - tHq, H -> gamma gamma
- TOP-14-006 - LHC Top charge asymmetry combination
- SUS-13-018 - Search for direct Sbottom production
- TOP-13-014 - Top Mass World Combination
- TOP-14-001 - Top mass in lepton+jets (e,mu)
- SUS -13 020 - pMSSM interpretation 8TeV
- HIG-14-002 - Width measurement from off-shell production in H->ZZ S

Since Moriond

- HIG-13-032 - H->hh->2gammagamma 2b
- GEN-14-001 - Underlying Event Tunes and Double Parton Scattering
- TOP-14-003 - Search for anomalous single top + photon production (FCNC)
- TOP-14-007 - Limits on anomalous couplings and FCNC in t-channel single top
- B2G-13-004 - Search for Dark Matter production in association with top quark pairs
- EXO-12-047 - Monophoton search
- SMP-13-013 - Measurement of Z production as function of pT, Y
- QCD-11-006 - Studies of Multijet Events at 7 TeV

Summary

- Maintenance and repair of the present system is proceeding very well.
- Set of global and cosmic runs foreseen in 2014 to prepare the community for RUN2.
- Muon upgrade (CSC and RPC) have been completed in time and within budget.
- Many improvements on-going in the reconstruction and online software.
- DAQ upgrade (DAQ2) progressing on schedule.
- Trigger for 2015 on schedule.
- 309 papers published.
- A lot of new results in the physics analyses.
- Not covered here: preparation of Technical Proposal for Phase II in full swing.

24 & 25 May - general public
4536 visitors: 300 people/h visiting



New CMS building at P5: inaugurated 24 May

Thanks a lot

Backup

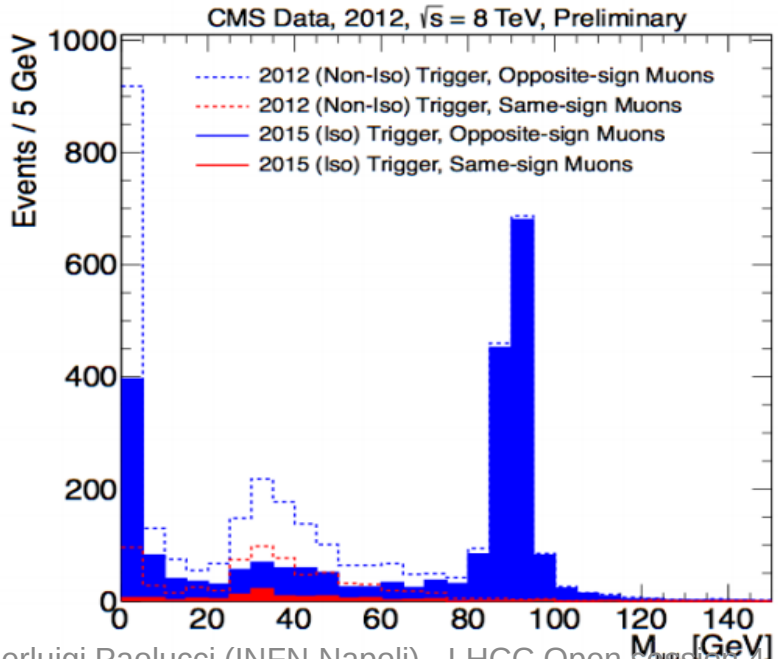
HIN Analyses for Quark Matter

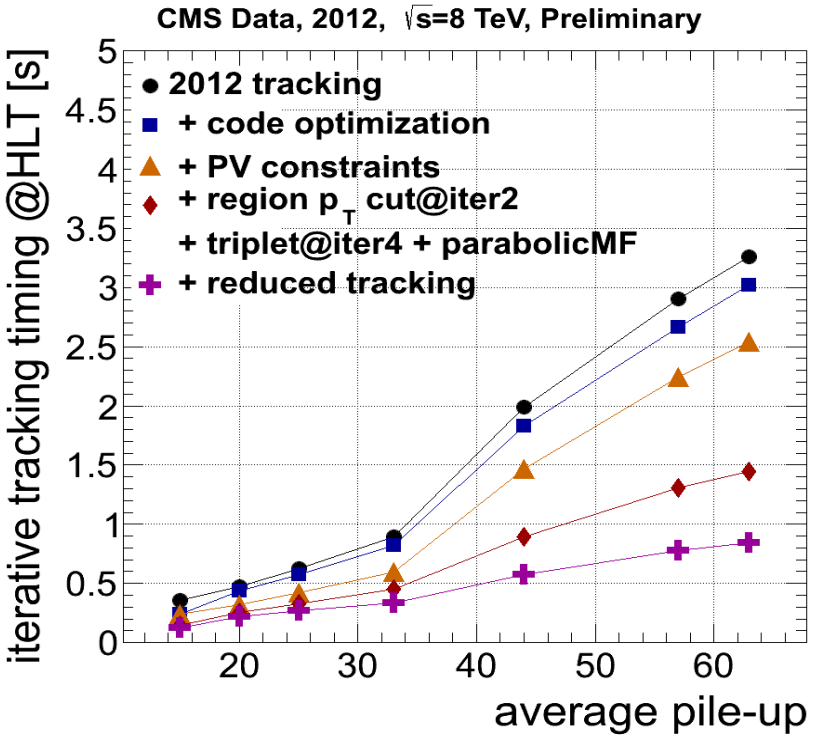
Analysis Entry	Description
HIN-12-007	Psi(2s)/Psi(1s) in PbPb w/ updated 2013 pp reference
HIN-13-007	W boson x-section and charge asymmetry in pPb
HIN-14-001	Jet x-section and nuclear modification factor in pPb
HIN-14-002	Long-range (ridge) correlations with K^0_s and Λ in high multiplicity pPb
HIN-14-003	Z boson x-section and forward-to-backward ratio in pPb
HIN-14-004	Exclusive B meson x-section and nuclear modification factor in pPb
HIN-14-006	Multiparticle correlations in PbPb and high multiplicity pPb
HIN-14-007	b-jet x-section and nuclear modification factor in pPb
HIN-14-008	Eta dependence of long-range (ridge) correlations in pPb
HIN-14-010	Jet-track correlations (missing p_T) in PbPb
HIN-14-012	Flow factorization breaking in pPb and PbPb
HIN-14-013	Bose-Einsten correlations w/ identified pions and kaons

https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsHIN

Trigger Coordination Status

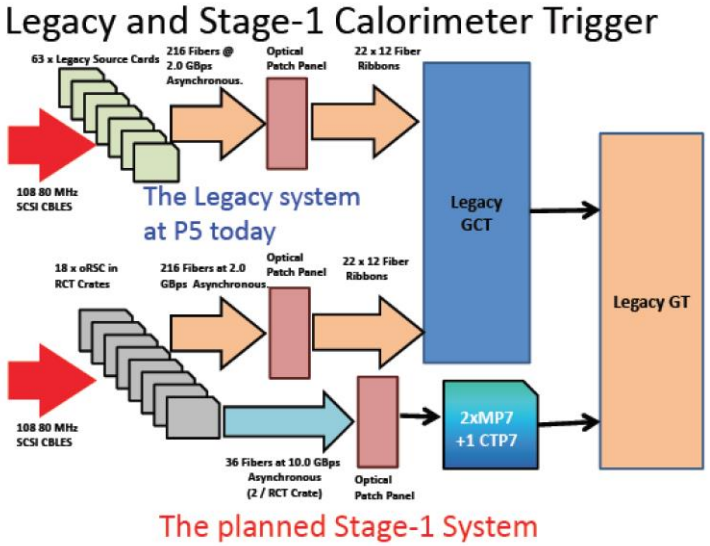
- Many changes in the object reconstruction at HLT
  - Goals: reduce CPU time, particularly in tracking
  - improve resolution to allow tighter thresholds
  - Improve efficiencies





2015 Intermediate Calo Trigger Upgrade

- Connection of legacy trigger from Regional Calo Trigger to new uTCA Layer-2 processors for jets, EG, taus, and energy sums via ORSC optical interface



- Met key milestone this month on testing the ORSC optical link interface to the MP7 layer-2 processor (10 Gbps asynchronous link)
  - 50 hour communication test of 2 ORSCs to one MP7 (full calorimeter input) at 10 Gbps asynch. with no errors and with data aligned