Muoni nel run del 2017 (DPG + POG)

C. Battilana *(Univ. & INFN BO)*

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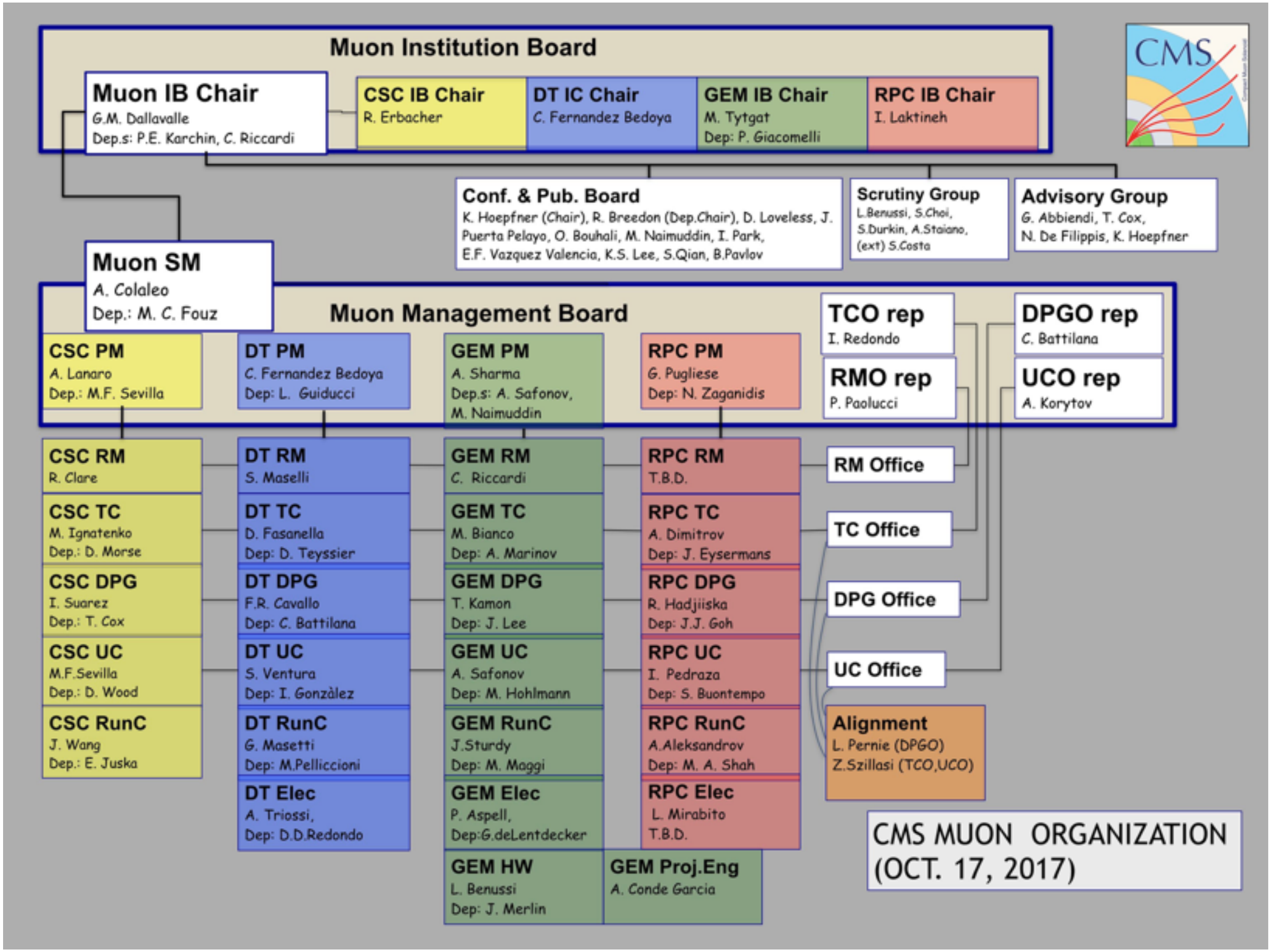
Istituto Nazionale di Fisica Nucleare

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

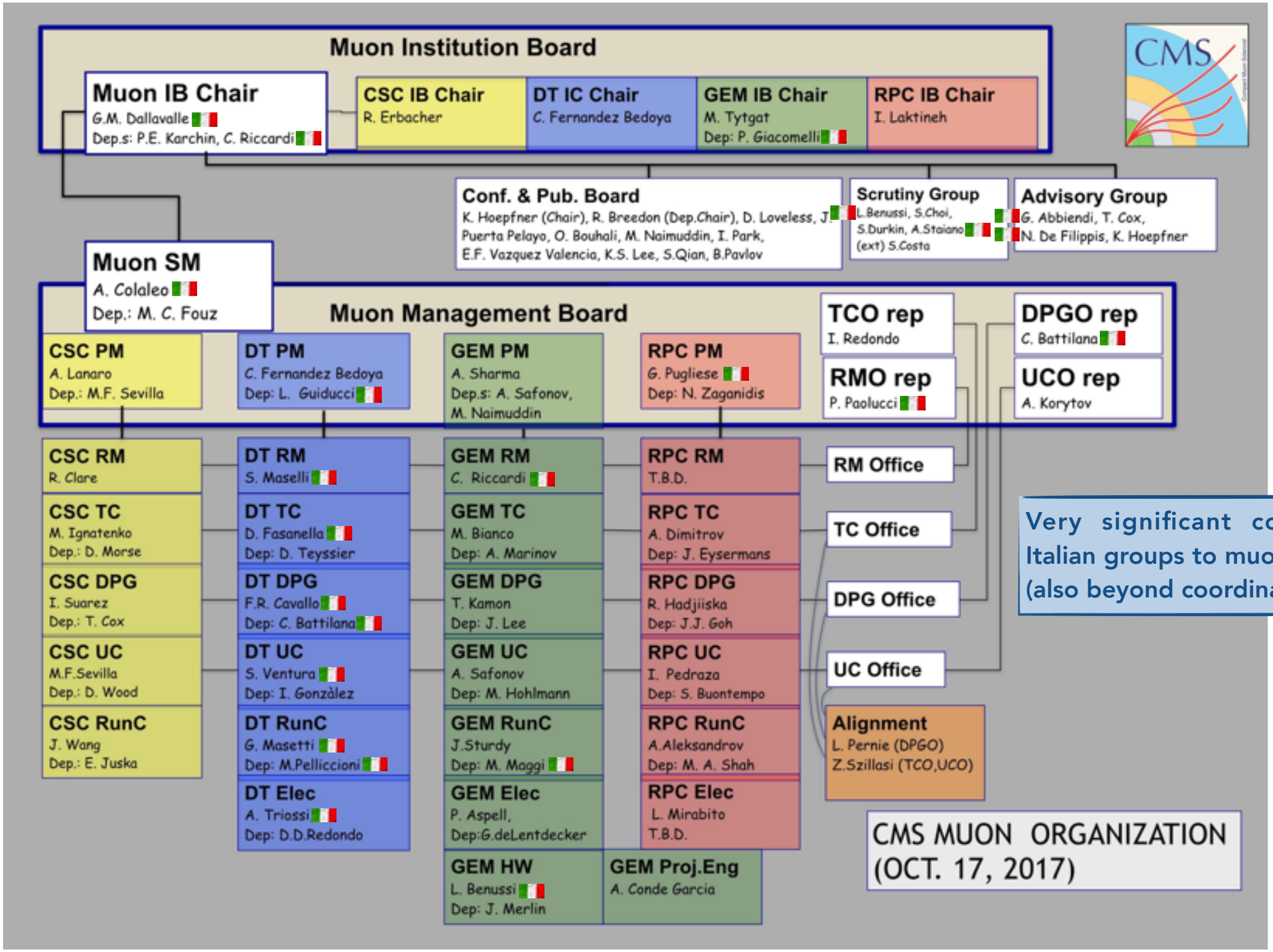
Outline

- Italian involvment in muon detectors and POG activities
- Muons in the 2017 run (but not only)
  - performance of DT, CSC, RPC
  - muon reconstruction, identification, isolation
  - GEM slice test
- Short-term plans
  - highlights of YETS planned activities
  - preparation for the 2018 run
- Summary

Italian contribution to muon system



Italian contribution to muon system



Very significant contribution form Italian groups to muon-system activities (also beyond coordination!)

Italian contribution to muon physics object

Muon POG core team:

Group Conveners

Dmytro Kovalskyi (MIT)

Santiago Folgueras (Oviedo)

Selection and Calibration
- *Gael Perrin (ETH)*
- *Sergio Sanchez (Oviedo)*

High Level Trigger
- *Kyeongpil Lee (SNU)*
- *Benjamin Radburn-Smith (SNU)*

Offline SW / RECO
- *Dmytro Kovalskyi (MIT)*

MG Generators / Production
- *Alessandra Fanfani (BO)*

DQM / Data Certification /Validation
- *Pablo Martinez (IFCA)*
- *Alicia Calderon (IFCA)*

Upgrade Studies
- *Cesare Calabria (BA)*
- *Jason Lee (Seoul Univ.)*

Muon Object Contacts with PAGs

- *R. Radogna (BA), V. Mariani (PG), L.Cristella (BA) out of 12 MOCs*

Italian contribution to muon physics object

Muon POG core team:

~18% 🇮🇹 - was ~42% in 2016

Selection and Calibration
- *Gael Perrin (ETH)*
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High Level Trigger
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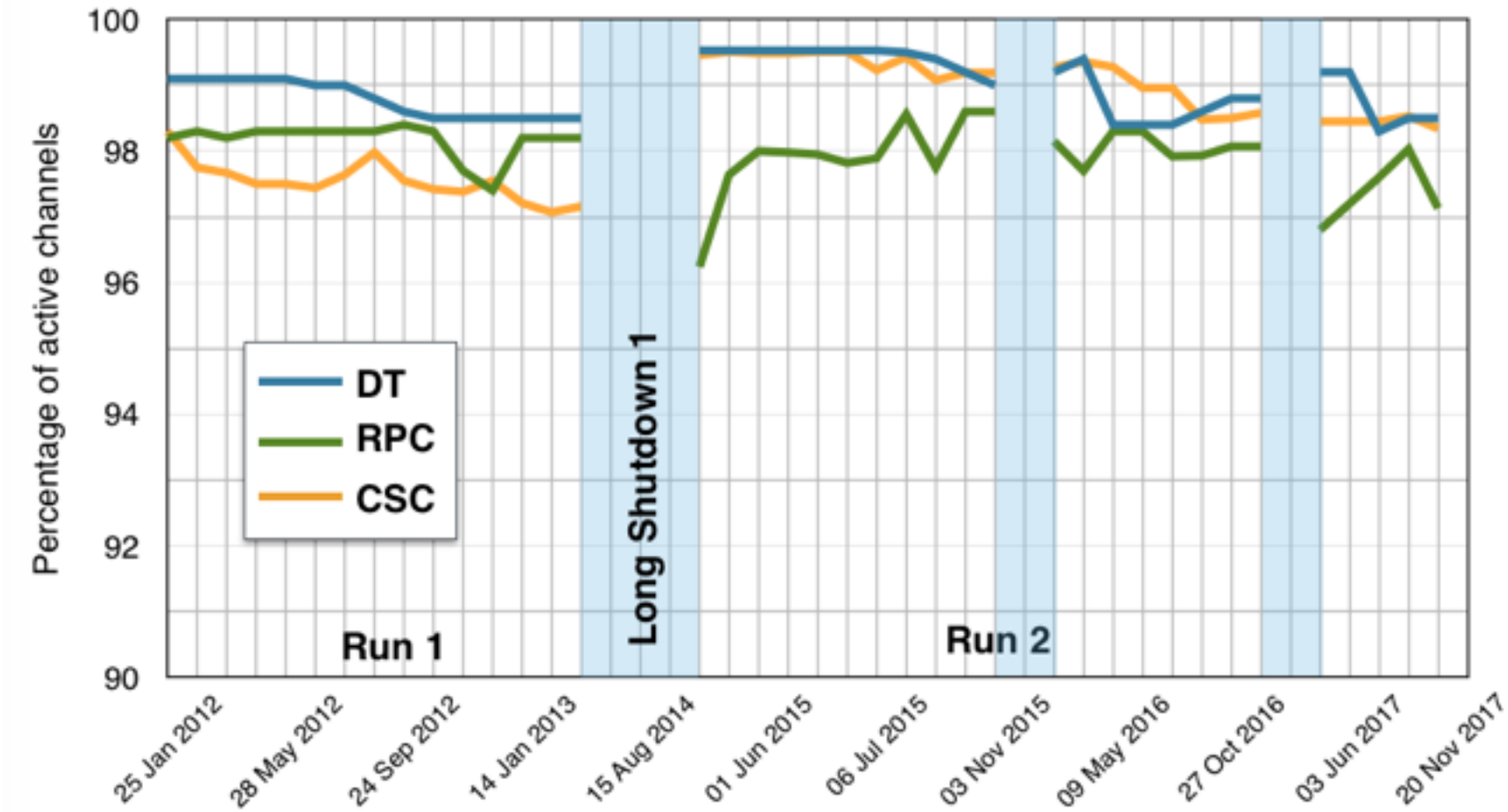
Muon Object Contacts with PAGs

- *R. Radogna (BA), V. Mariani (PG), L.Cristella (BA) out of 12 MOCs* **~25% 🇮🇹 - was ~15% in 2016**

Other "Italian" contributors in 2017 *(from EPR tables + browsing this year's talks, not being exhaustive)*

- *G. Abbiendi (BO), P. Traczyk (TO), S. Fiorendi (MI), F. Primavera (BO), S. Chhibra (BO), G. Miniello (BA), N. De Filippis (BA), F. Errico (BA), C. Battilana (BO) …*

Status of the muon detectors



Fraction of active channels in muon detectors (end of 2017)

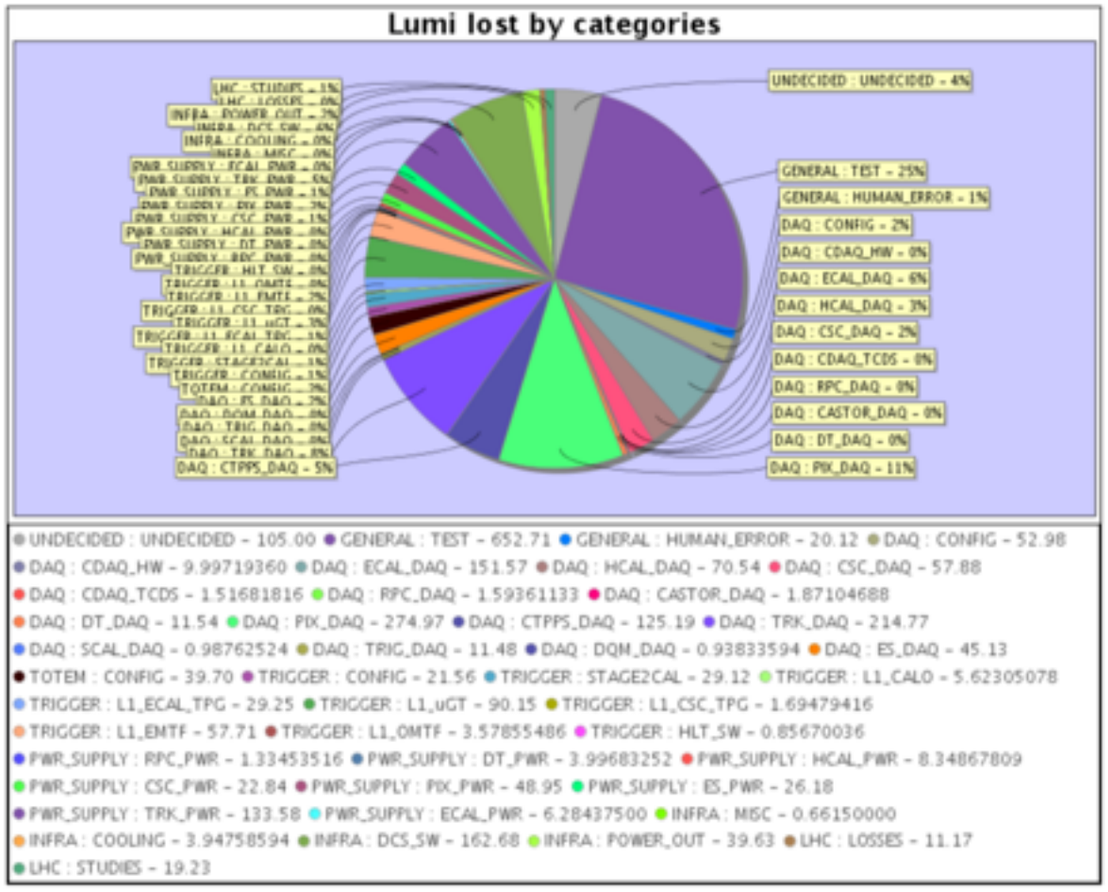
- DT: 98.5%
- CSC: 98.34%
- RPC: 97.13%

To be partly recovered over YETS (see later)

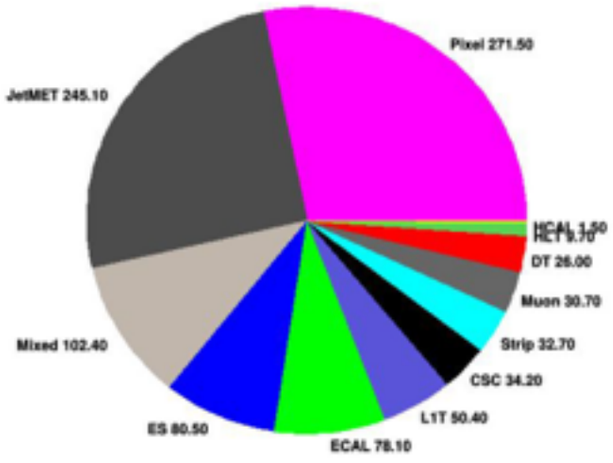
- Main causes of dead channels:
  - **DT:** readout link problems
    (~50% addressed by switch to uROS)
  - **CSC**: 4 chambers off
    - 2 with LV connector issues (both recurring problems)
    - 2 off because of EYETS2016 cooling leak
  - **RPC:** 20 chambers off
    - 17 chambers (barrel) due to gas leak
    - 3 chambers (endcaps) for HV/LV issues

Operational stability and quality of data in 2017

- Low overall loss of luminosity due to muon detectors
  - **DT:** 15.5 pb^{-1} - ~half due to DSS communication issue, ~half human error driven
  - **CSC:** 82.4 pb^{-1}
  - **RPC:** 2.9 pb^{-1} - 15 minutes of downtime during the HV scan fill, 1.5 minutes of downtime after restarting LBBs in YEN3, 6.5 minutes to reconfigure the system after some MAO went off



For quality conditions only: 962.9 /pb



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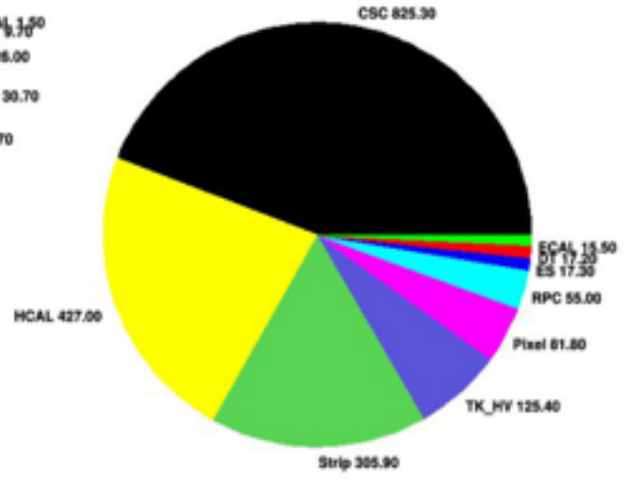
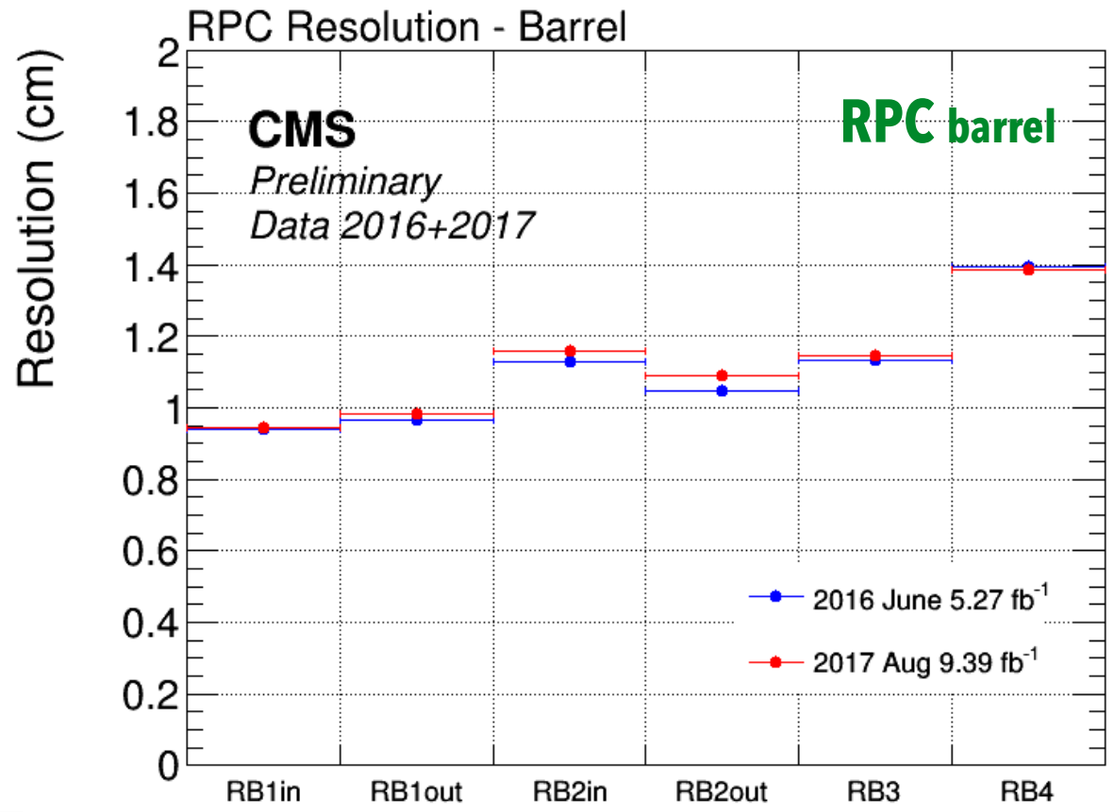
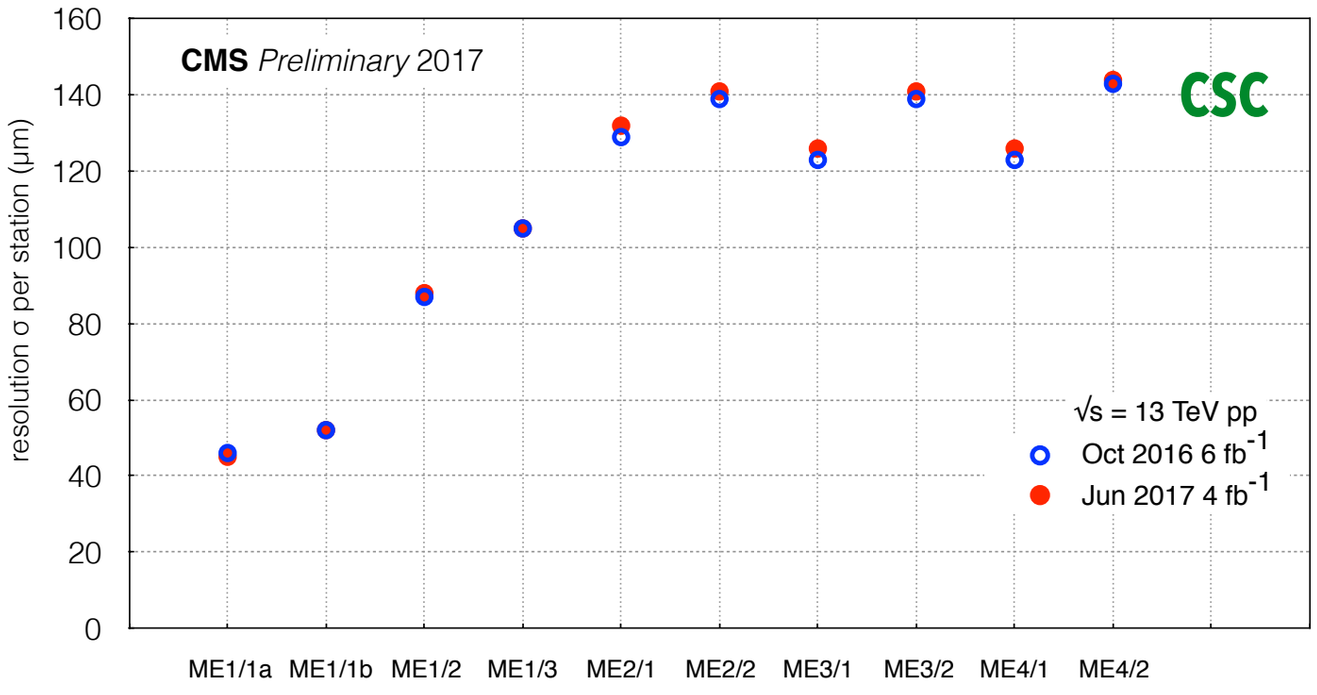


- A (non final) summary on data certification
  - **DT:** 43.2 pb^{-1} DSS communication issue, instabilities of the CAEN HV mainframes
  - **CSC:** 578.2 pb^{-1} "virtual" (DCS communication issue randomly affecting RR flags) ➜ flags being correctly reverted to GOOD, ~280. pb^{-1} "real" from various power supply-related issues
  - **RPC:** 48.34 pb^{-1}

Spatial hit resolution

- Reference for muon performance in Run2
  - MUO-16-001: *Performance of the CMS muon detector and reconstruction with proton-proton collisions at sqrt(s)=13 TeV*
  - presently addressing CWR comments

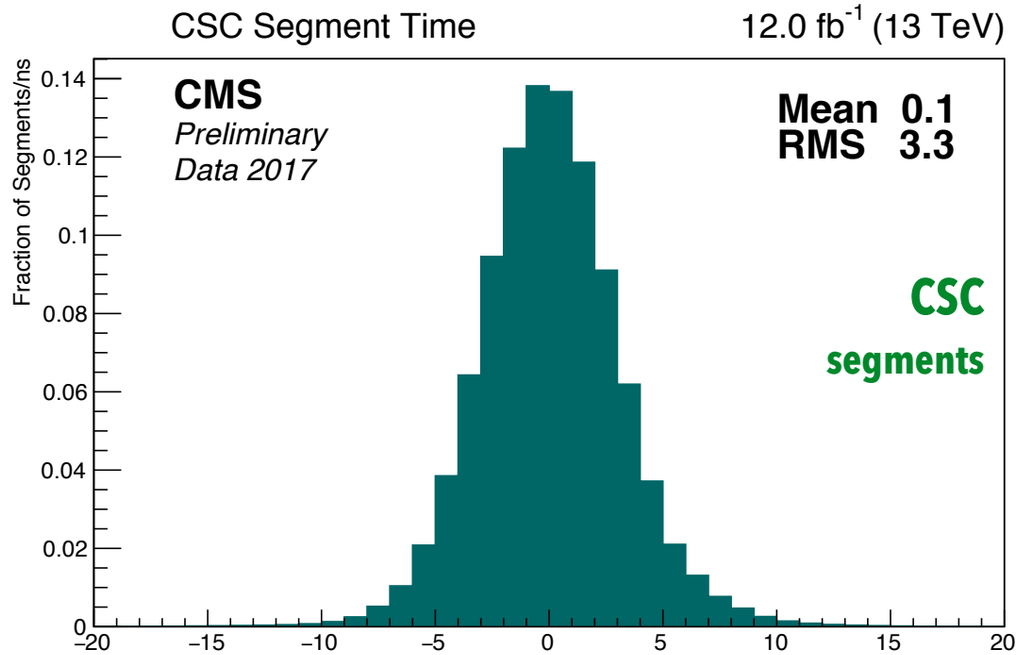


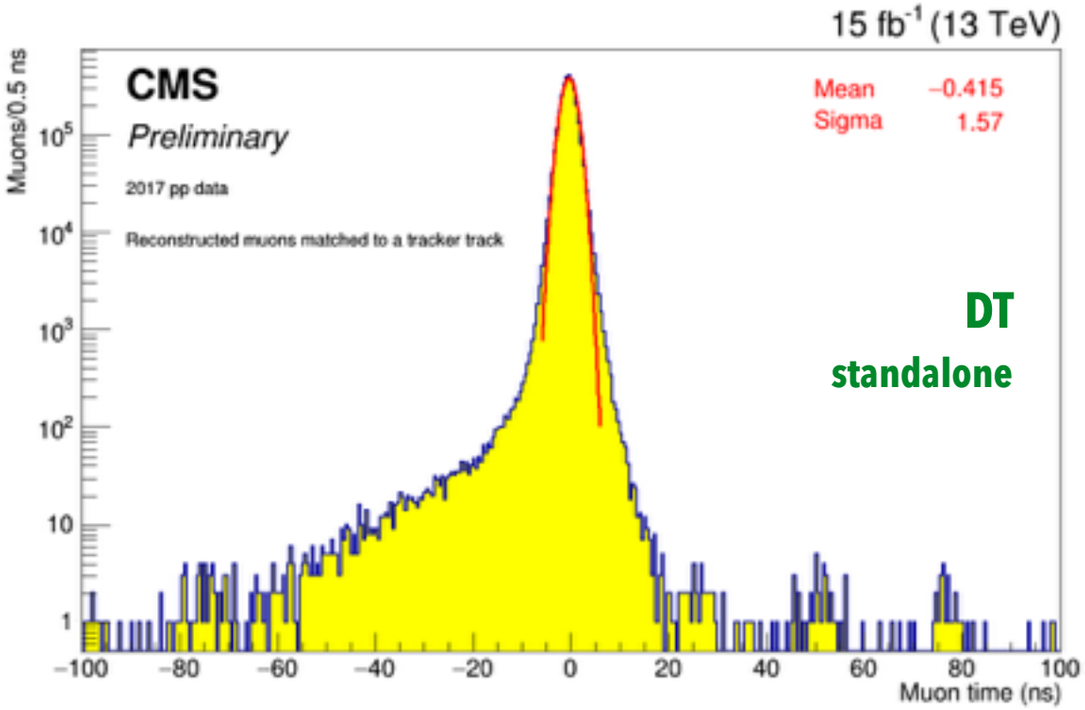


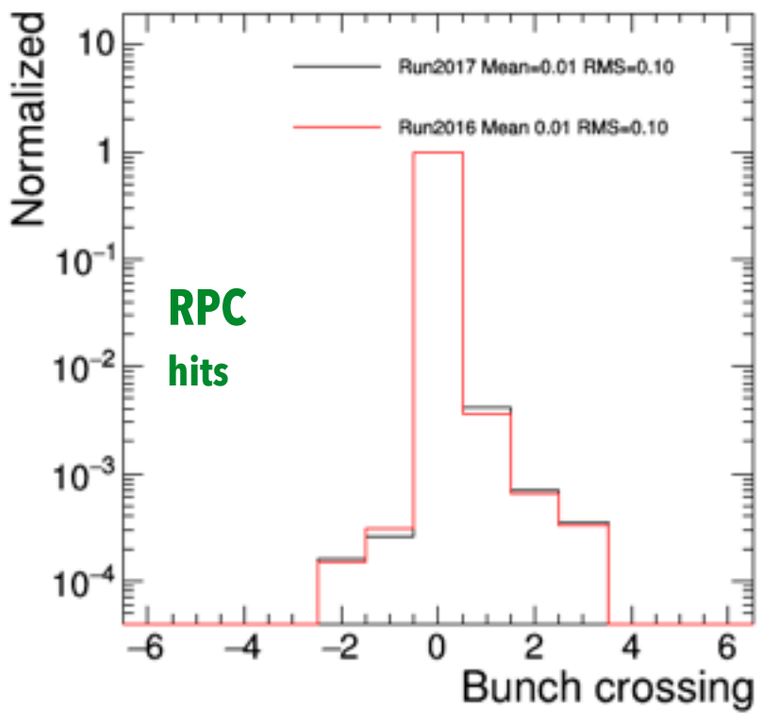
- Muon hit resolution w.r.t. reconstructed DT/CSC segments
  - consistent with 2016 and expectation from detector design

Hit/segment/muon timing resolution

- Performance summary
  - CSC/RPC: timing consistent with 2016
  - DT: small improvements expected in ReReco
- New in 94X: muon timing available also for TRK-only muons

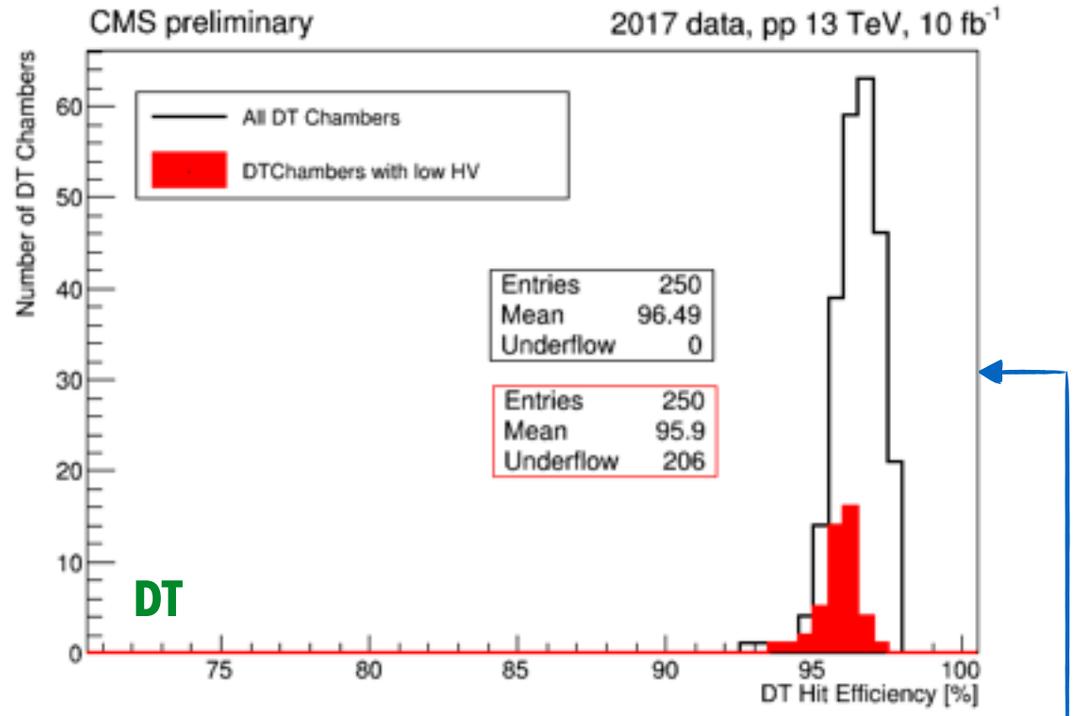




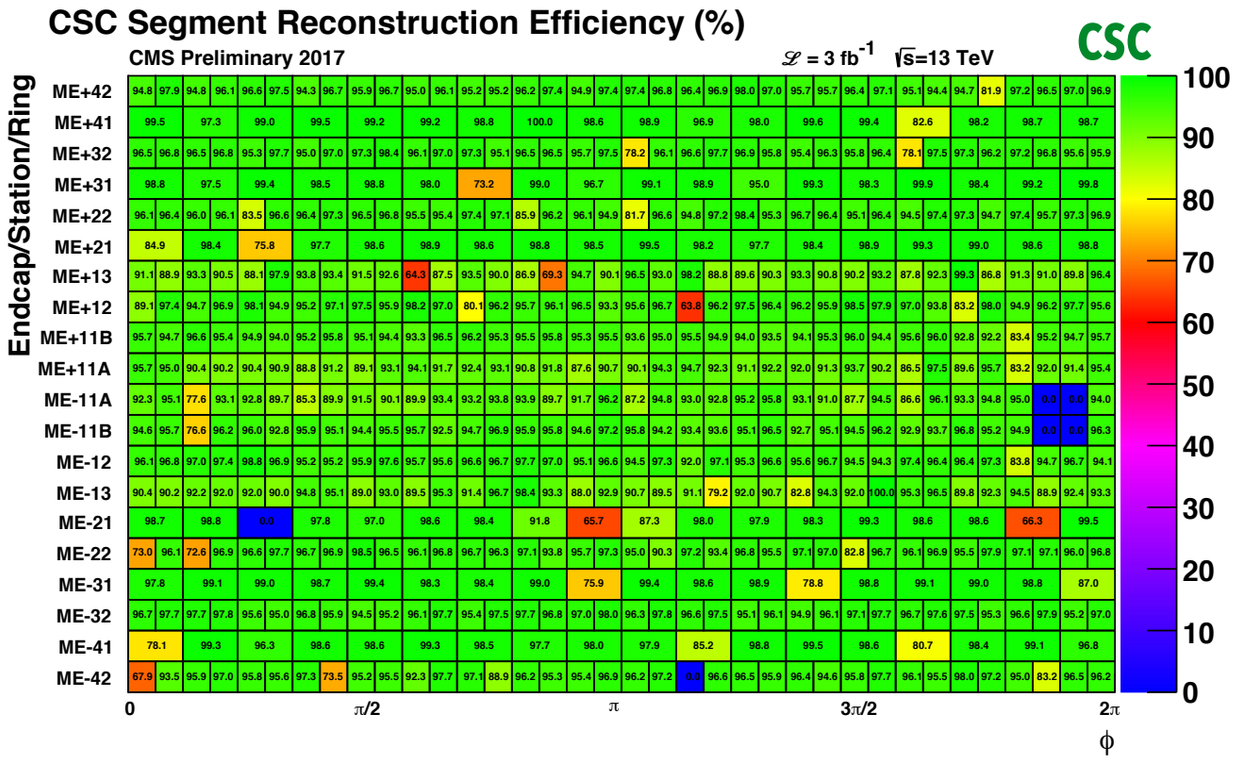


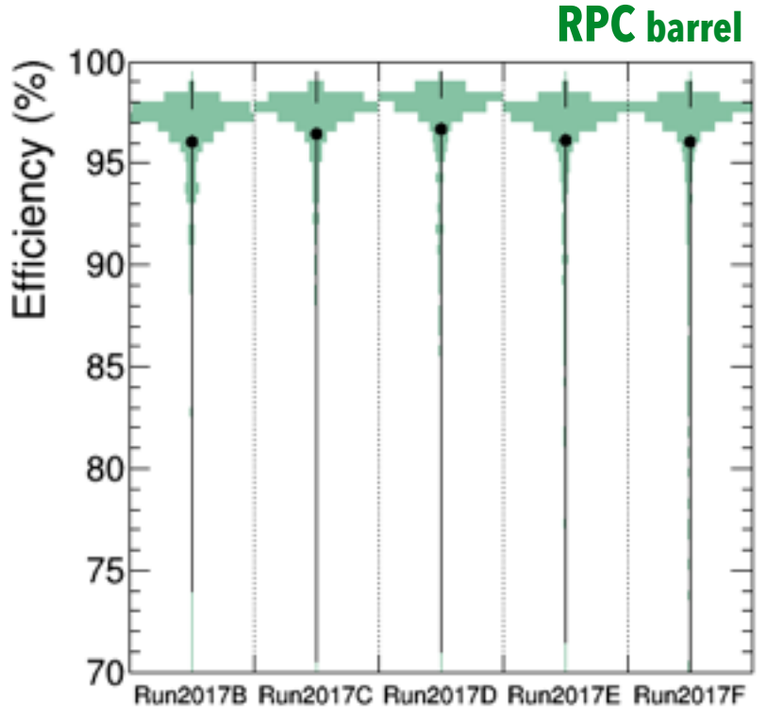
Reconstructed hit/segment efficiency

- Efficiency measured with TnP or w.r.t. reconstructed segments
  - mostly stable w.r.t. 2016 and along the 2017 run
  - stable also w.r.t. inst. lumi (more in backup and @ RPC WS)
  - few outliers (mostly known HW issues)
  - mild DT hit efficiency reduction:
    chambers with different HV settings (more in next slide)



2016 DT
<hit eff>: 97.14

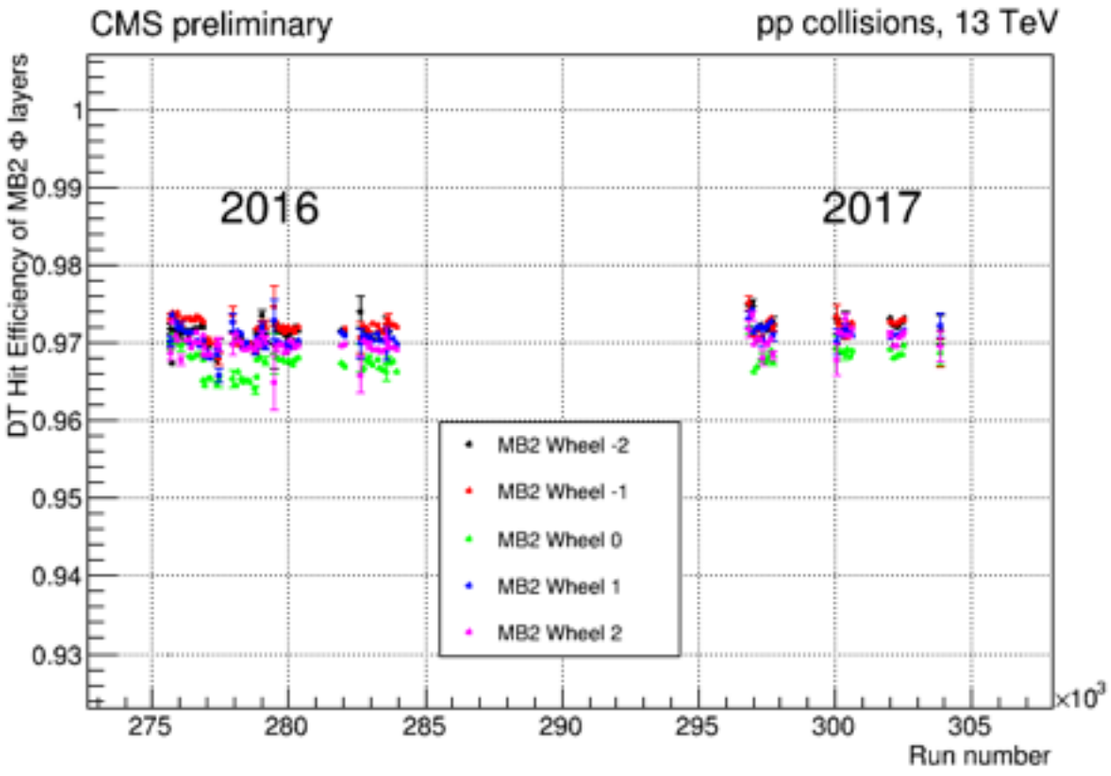


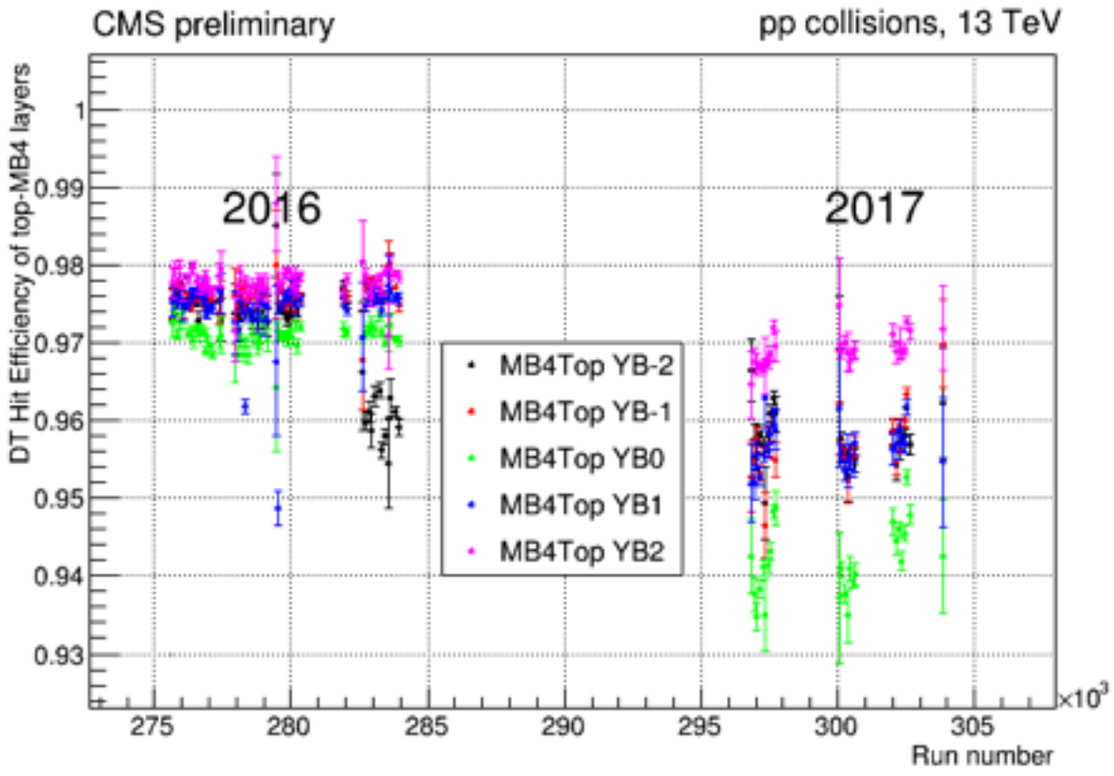


RPC 2016 vs 2017
(incl. underflow)
$\langle eff \rangle^{2016}$: 93.34
$\langle eff \rangle^{2017}$: 93.76

DT HV settings and hit efficiency

- HV settings for aging mitigation
  - DT HV lowered by 50 V in the chambers most exposed to BKG (MB1s YB-2/+2, MB4 sectors 3-4-5 all wheels)
  - implies few % hit efficiency loss (~1% in MB1s, ≲ 3% in MB4s) - efficiency stable w.r.t. time in other chambers





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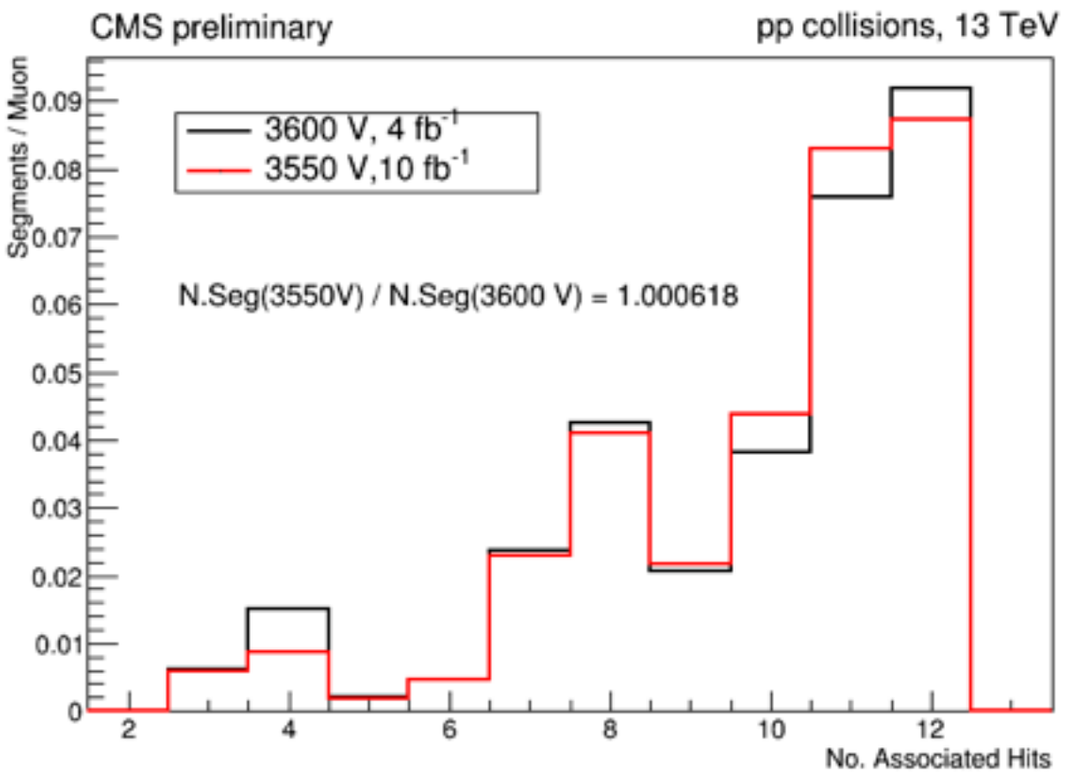
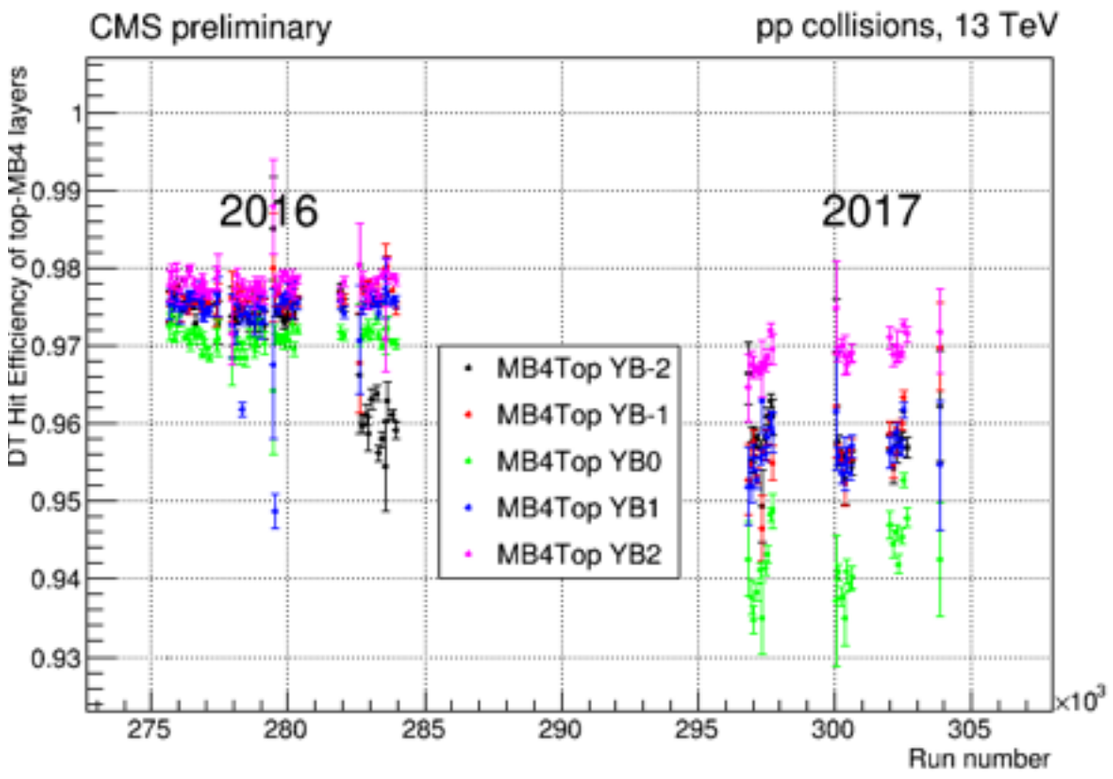
  - small loss at hit level ➜ negligible impact on segments/muons (MB1)





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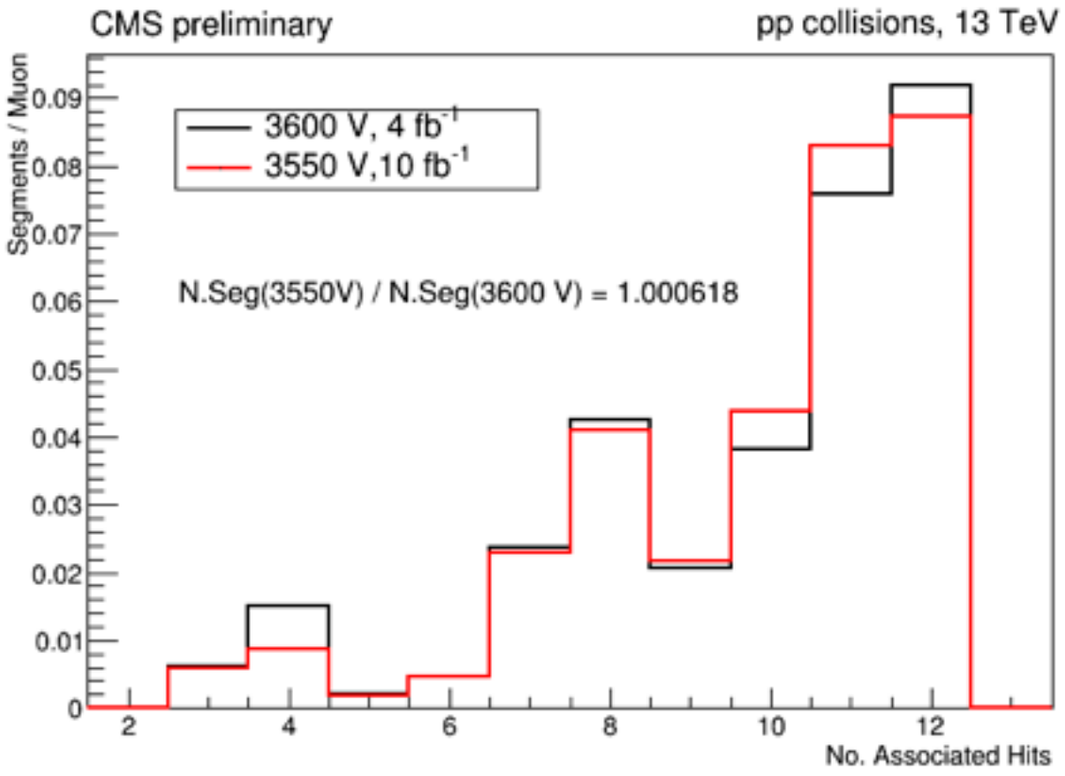
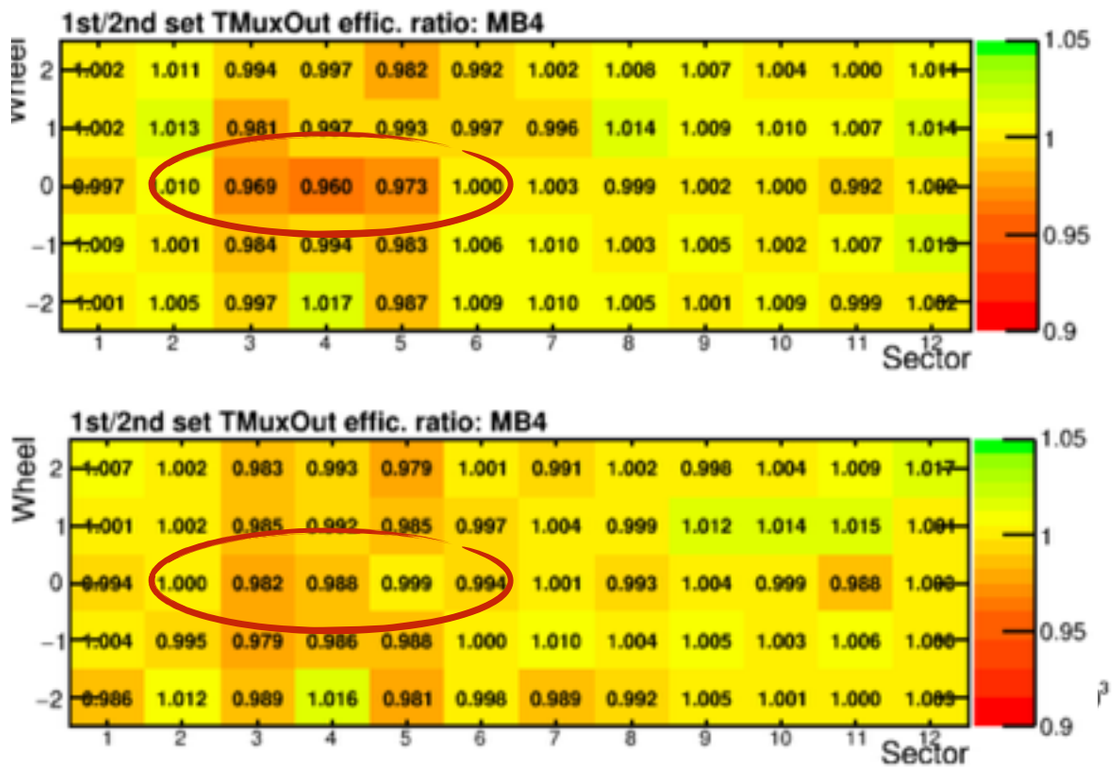
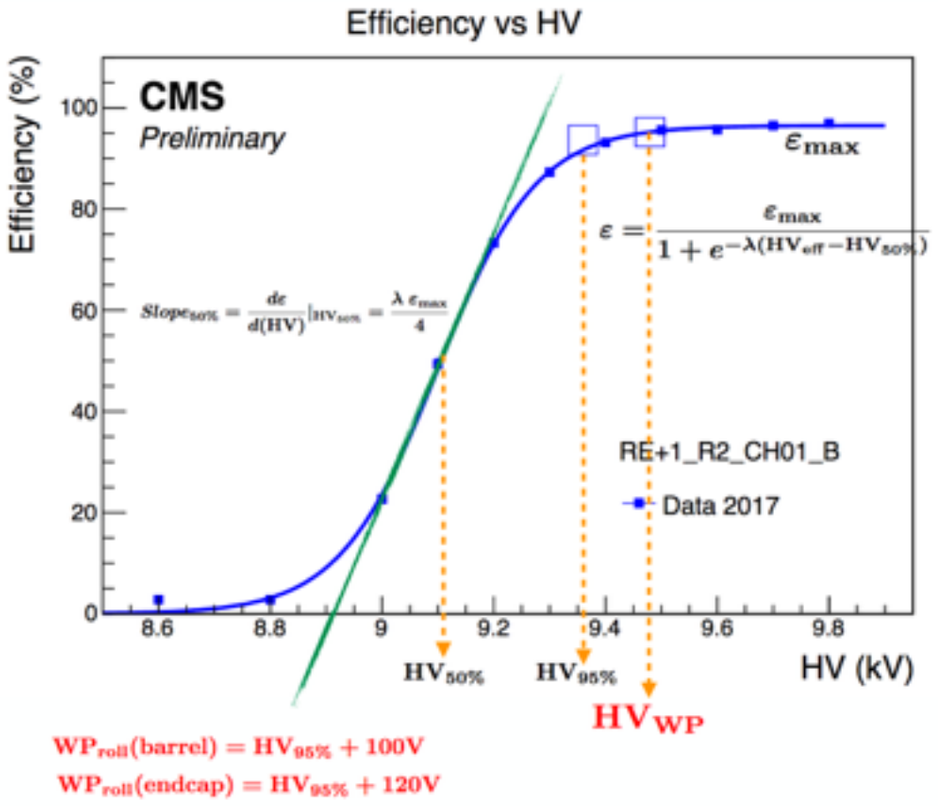
  - small loss at hit level ➜ negligible impact on segments/muons (MB1)
- Collected some data with lower FE thresholds (MB4s sectors 3-4-5, YB0) to compensate HV settings change
  - studies ongoing - preliminary results confirm efficiency increase for DT trigger primitives

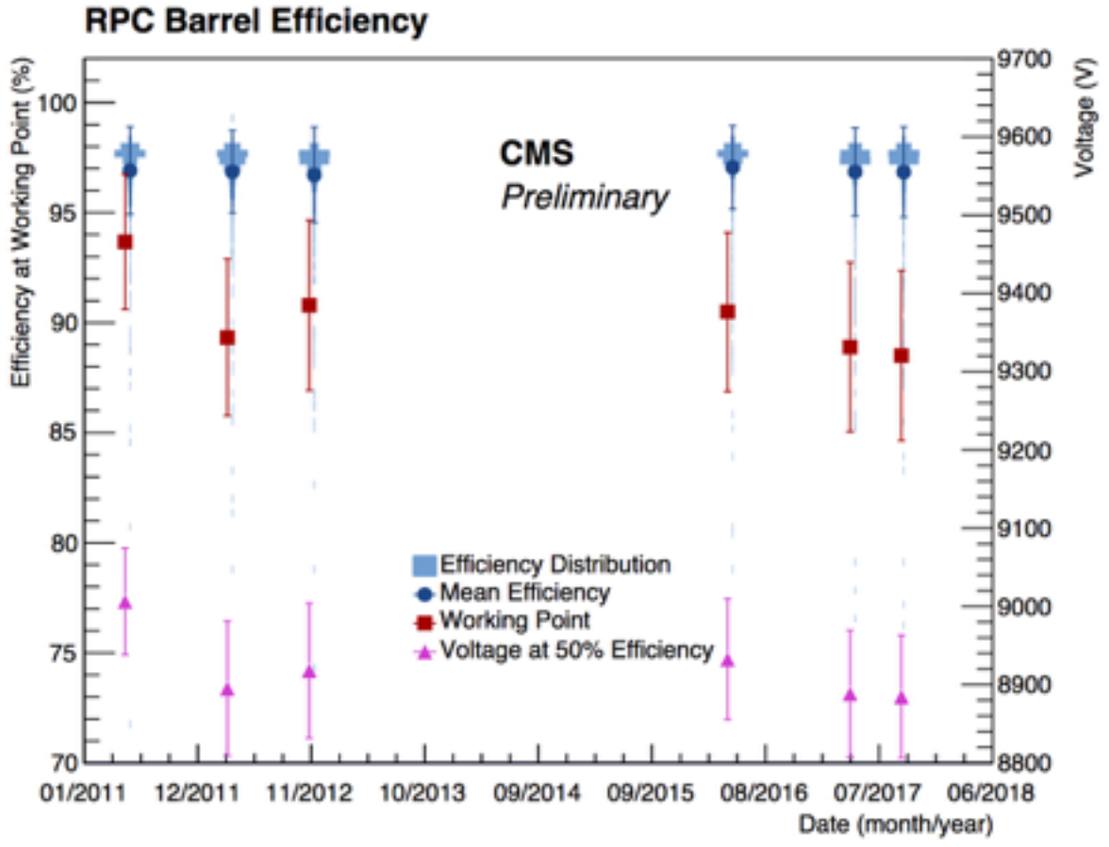




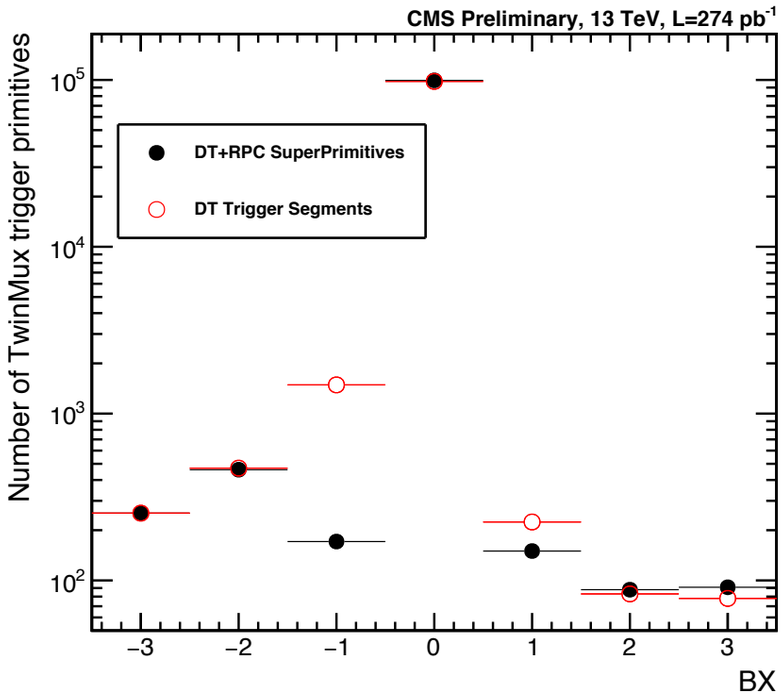
HV calibration of the RPC system

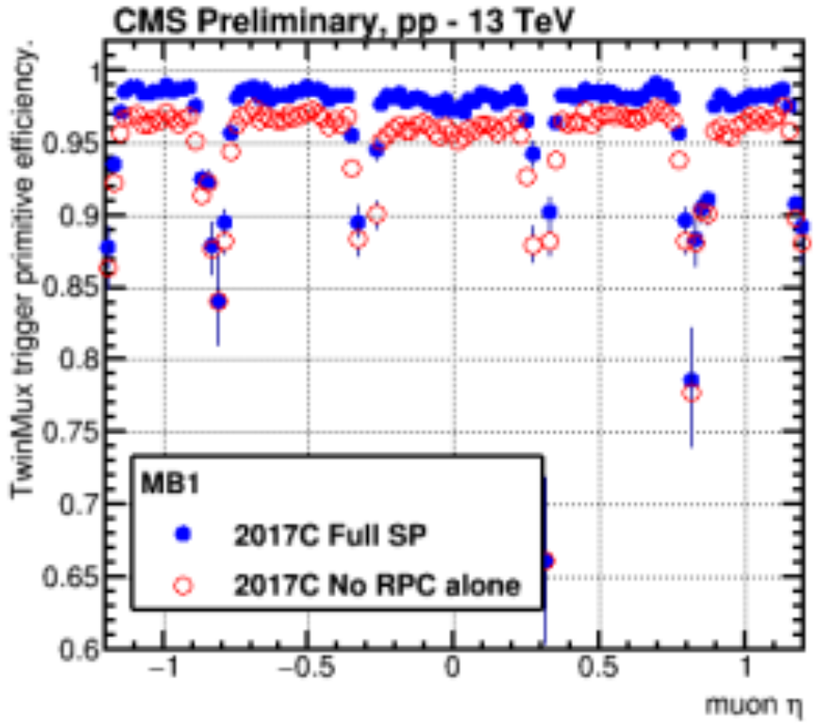
- HV w.p. shift with respect to 2016, due to different concentration of isobutane (5% vs 4.5%)
  - calibration procedure performed ➜ updated working points applied by the end of the run
  - the present working points are 40 (20) V lower for barrel (endcap):
    - efficiency does not significantly change (w.p. are defined to be @ "plateau")
    - new working points avoid over-stressing the chambers
    - new working points have lower cluster size ➜ better input for trigger (clusters larger than 3 strips are cut)
    - more details [in this talk from R. Reyes]

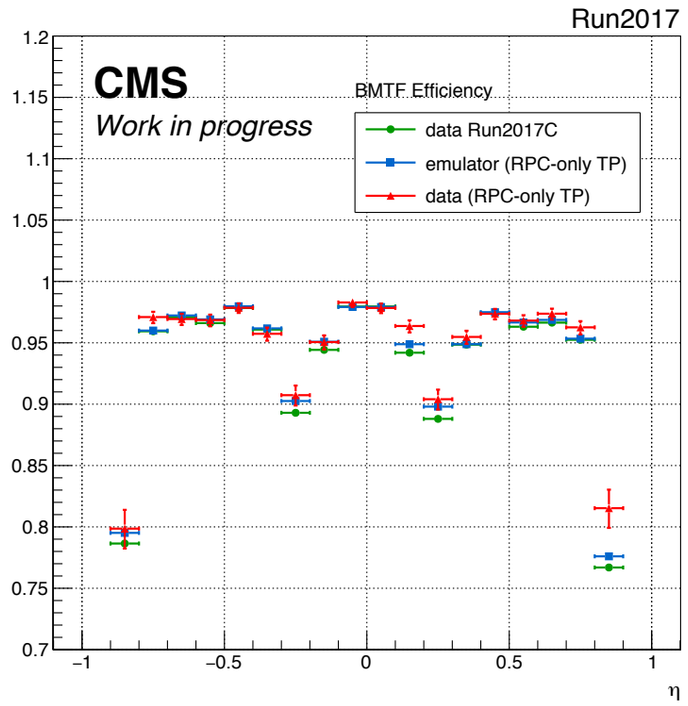




Evolution of trigger primitives in the muon barrel



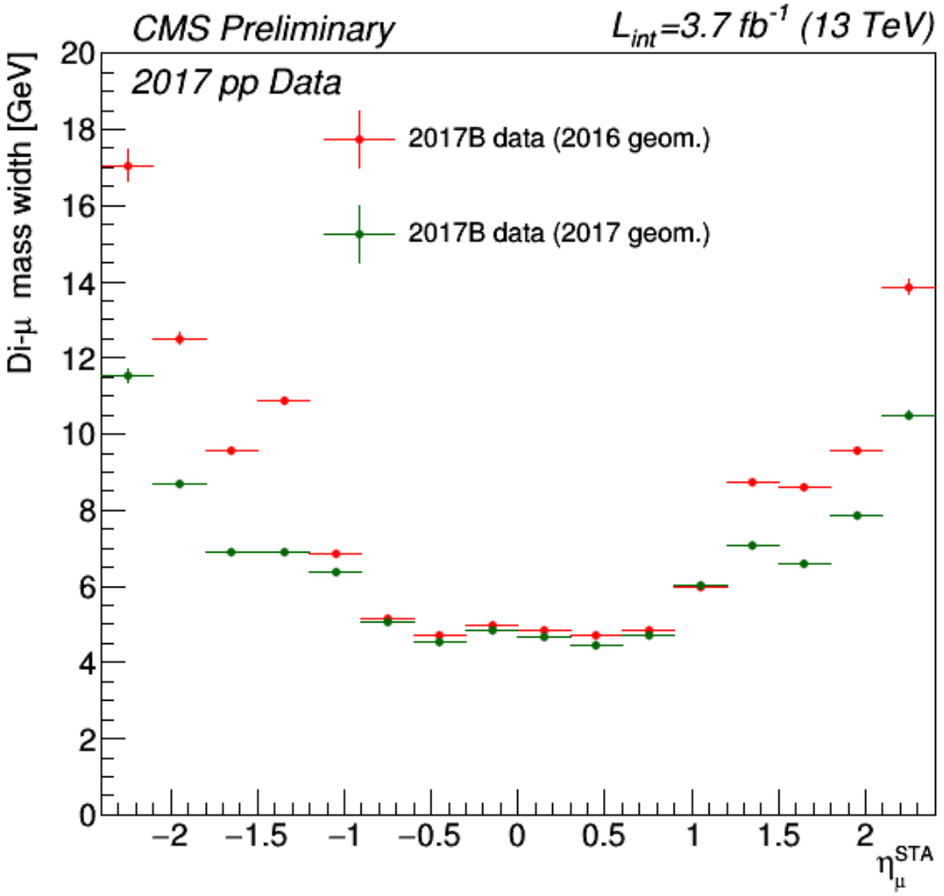


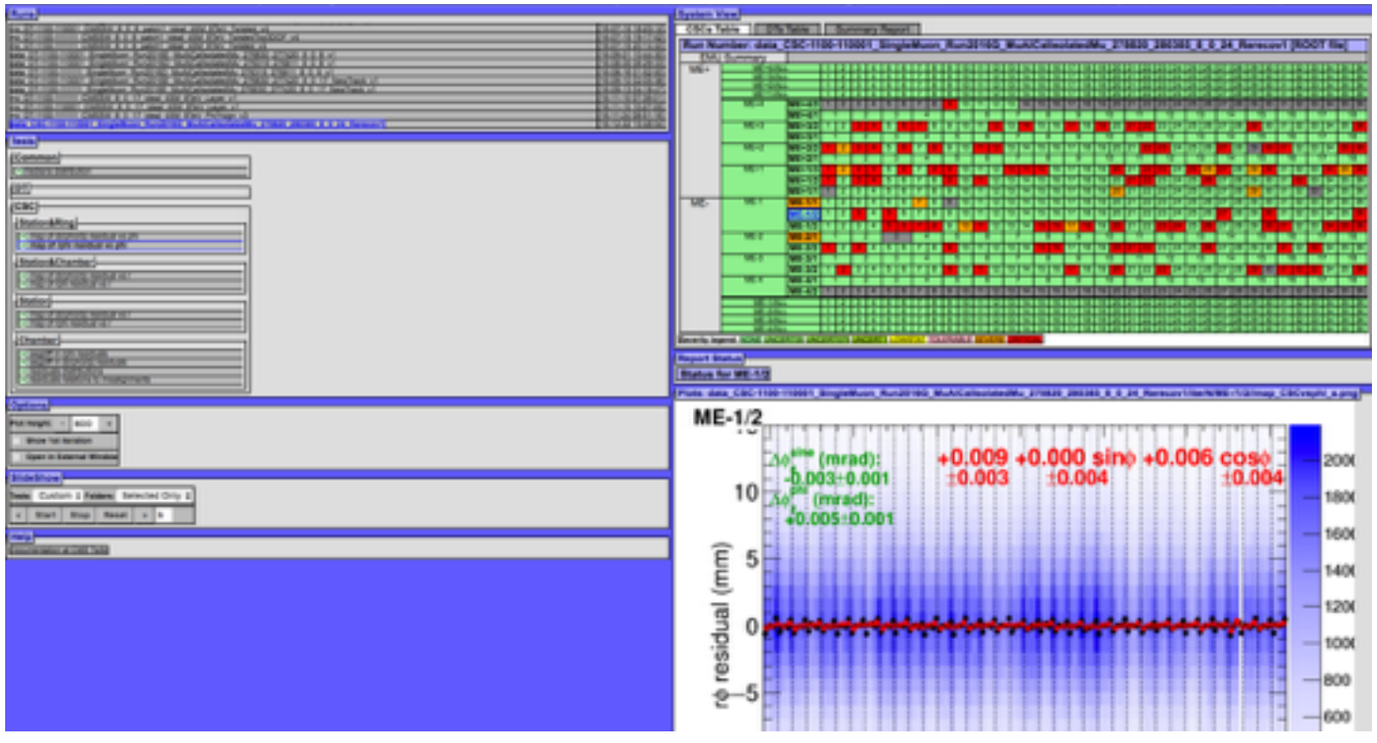


- Use of RPC information @ TwinMux - status and plans
  - **all 2017:** use RPC to improve BX ID of DT TPs ➜ less prefiring, +1.4% BX ID eff. @ chamber level
  - **summer 2017:** RPC-only TPs in TwinMux RO ➜ +3% TP efficiency in MB1 / MB2, more robust if DTs fail (S.Marcellini)
  - **last week of nominal pp run:** RPC-only TPs in trigger chain ➜ minor BMTF eff. increase / few % rate reduction
  - finalize performance studies (e.g. @ high-p_T) ➜ target: use RPC-only TPs in 2018
  - **combined HO+DT TPs** ➜ target: improve BMTF efficiency for $|\eta|$~0.3 cracks
    - present (evolving) results (S. Bhattacharya, A. Mohamed) indicate marginal (~3%) eff. increase for significant (>20%) rate increase

Track-based muon alignment

- Track-based alignment from 2017 data
  - deployed in HLT/Express/Prompt during Run2017C (from run 300262)
    - DT: ~consistent with 2016 geometry
    - CSC: significant improvement (movement of disks during EYETS)
    - APEs: from covariance matrix of minimized likelihood
  - more details in this talk (L. Pernié)



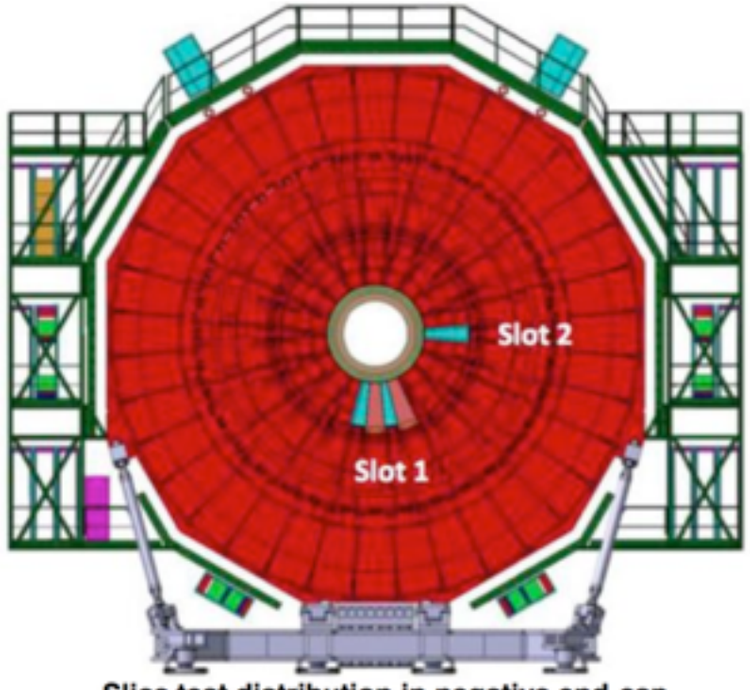


- Conditions for 94X ReReco derived
  - presently under validation
  - 2 different IOV ranges for the whole 2017 run
- New monitoring/validation tools developed for/during the 2017 run

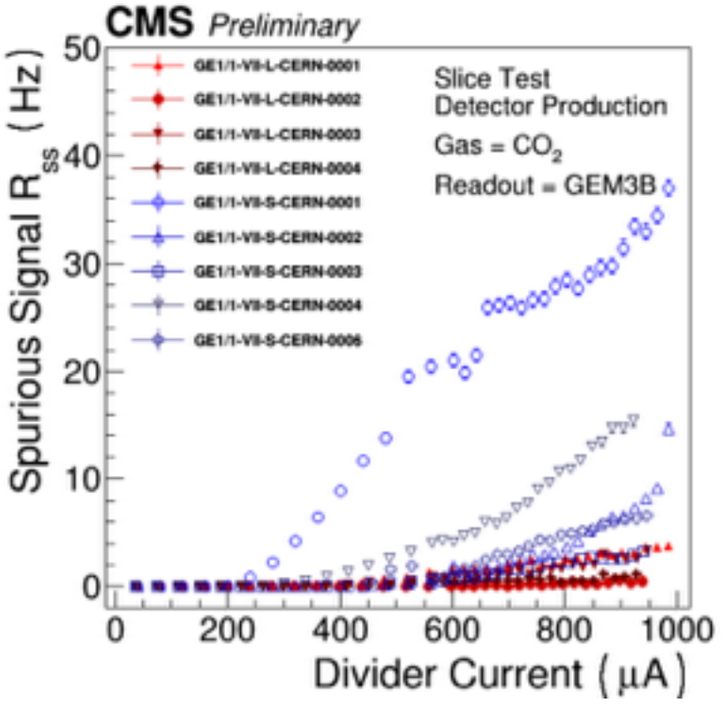
Summary on GEM slice test experience

More details in M. Bianco's presentation at the WGM

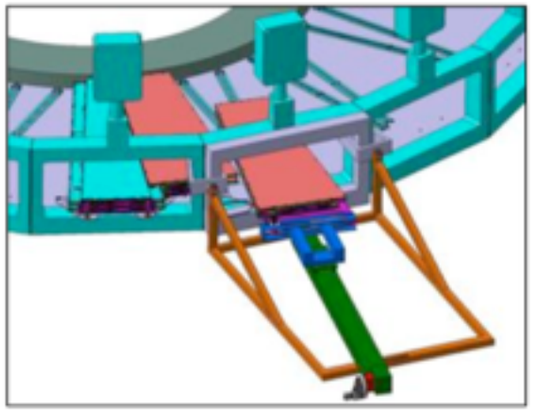
- The GEM slice test
  - 10 GE1/1 chambers
    - installed in January, being operated since May
    - two chambers grouped in a GEMINI chamber
  - slot 1 - 4 GEMINI (40°):
    - oriented to have high cosmic rate with HV supplied through HV divider
  - slot 2- 1 GEMINI (10°):
    - with HV supplied individually to different electrodes
- Gain experience on QA/QC, installation, integration, and operation
  - develop rigorous methods for chamber assembly/certification ➜ revert into well established assembly and QA/QC technique for LS2
    - e.g.: spurious signal (leakage through internal frames) reduced in latest version
  - improved installation procedure



Slice test distribution in negative end-cap




Complex manual insertion of slice test chambers

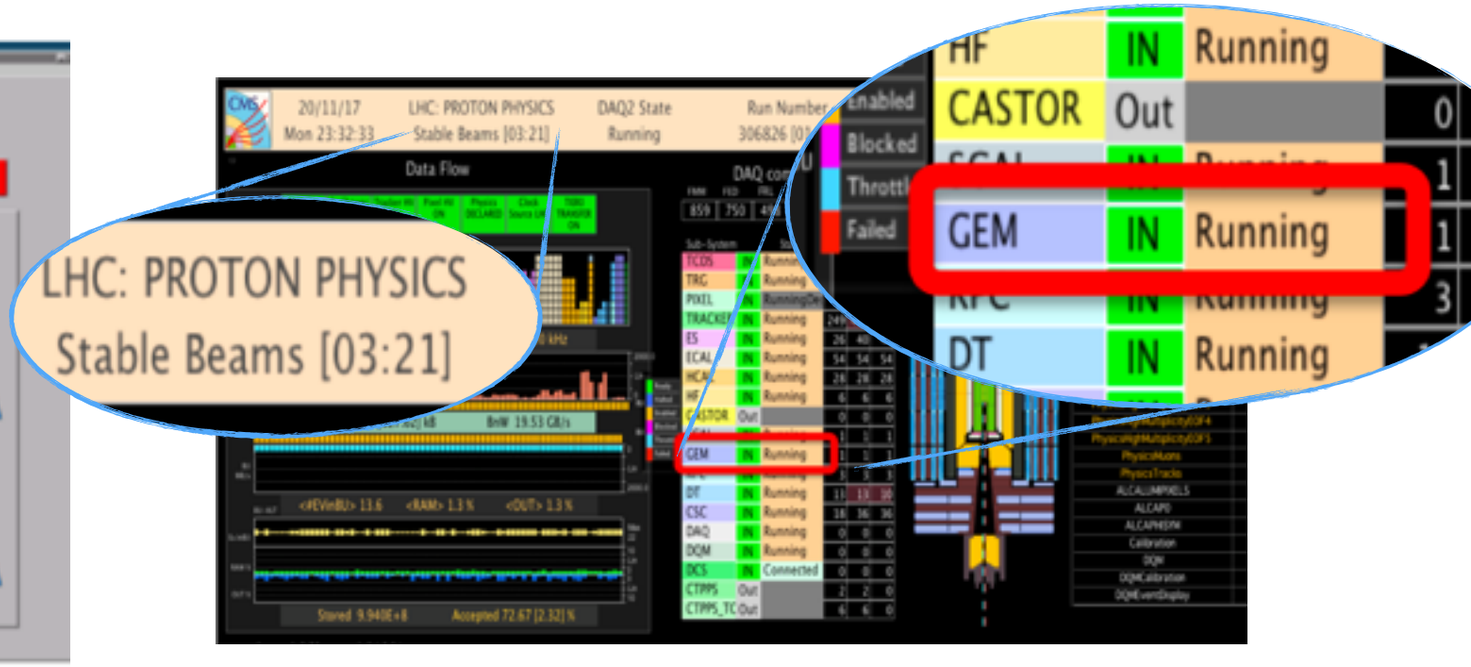

Design insertion jig for chamber insertion + new fixation plate on the disk

Summary on GEM slice test experience (2)

More details in M. Bianco's presentation at the WGM

- Detector Control System status
  - trending available for HV, LV, GAS
    - also archiving on DB
  - alarms with SMS operational
  - DSS Operational
  - FSM and Detector Protection deployed
    - currently used to follow LHC changes of states
    - in test system, not included in the central DCS
    - full inclusion into central DCS, probably during YETS

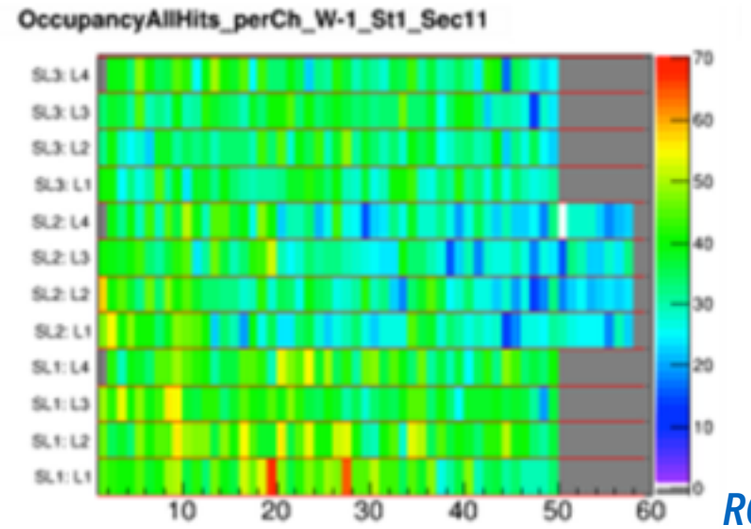
- DAQ / Offline SW
  - GEM included in central running with cosmic rays and collisions (5 TeV run - 20 Nov)
    - high rate tests ongoing
    - plan to participate to global operations ~full time in 2018
  - analysis of collected data is ongoing
  - in the process of integrating all necessary DataFormats/ CondFormats, Unpackers and DQM in CMSSW



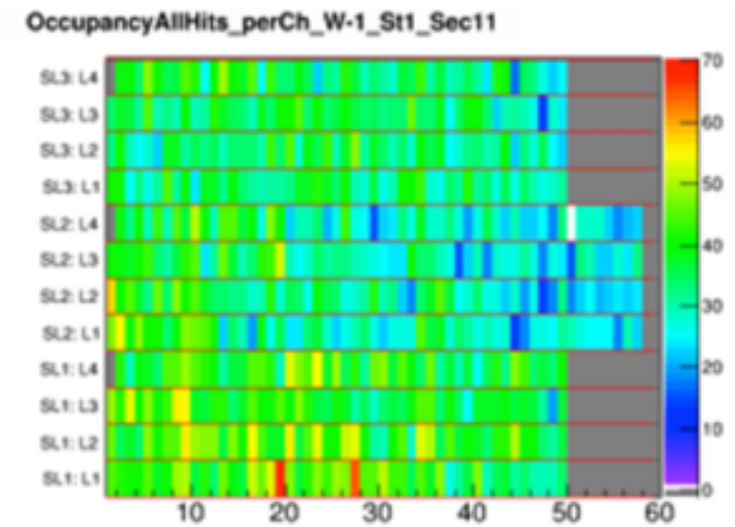
Muon detectors: plans for YETS and next steps

- Main foreseen activity for DTs over YETS: transition to new Readout Server system (μROS)
  - more robust/powerful electronic based on μTCA - will also solve part of dead channel issues
  - a slice test was successfully operated during the 2017 run - unpacking and DQM code have also been developed (being presently integrated in CMSSW)

- Few highlights on other YETS activities:
  - DT:
    - deploy new FW to fix HV CAEN mainframe instabilities
    - interventions on some problematic minicrates in YB+/-2
  - RPC:
    - fix some HV issues (11 chambers)
    - fix a chamber with gas problems
    - more details in [this talk from A. Dimitrov]
  - CSC:
    - fix 2 ME1 off (due to water leak)
    - replacement of 3 ALCT boards (functioning but sometimes giving problems)
    - replacement of 11 DCFEBs



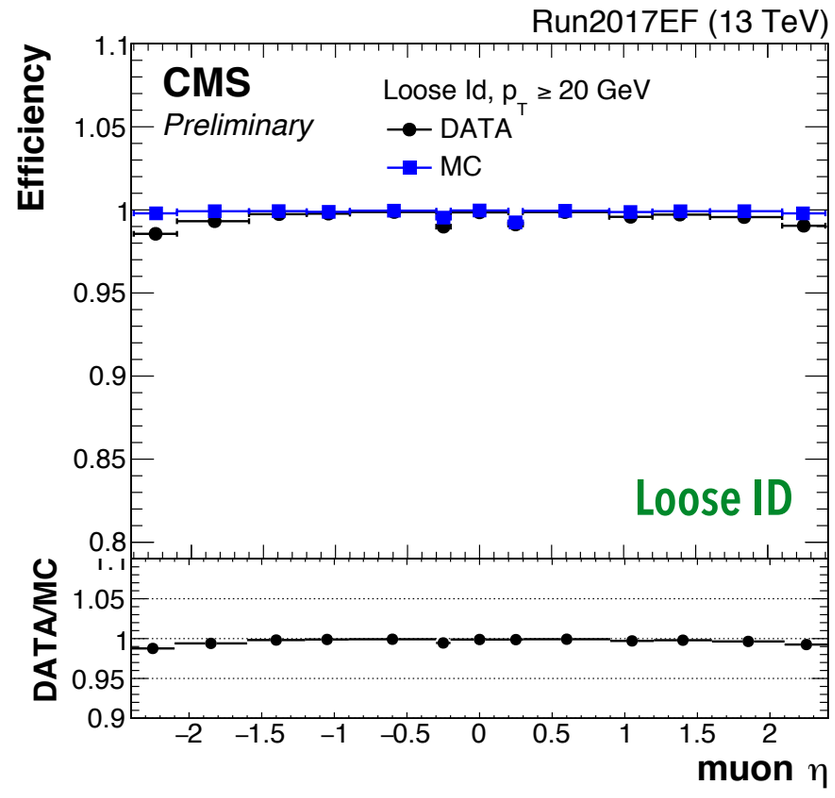
ROS (present system)

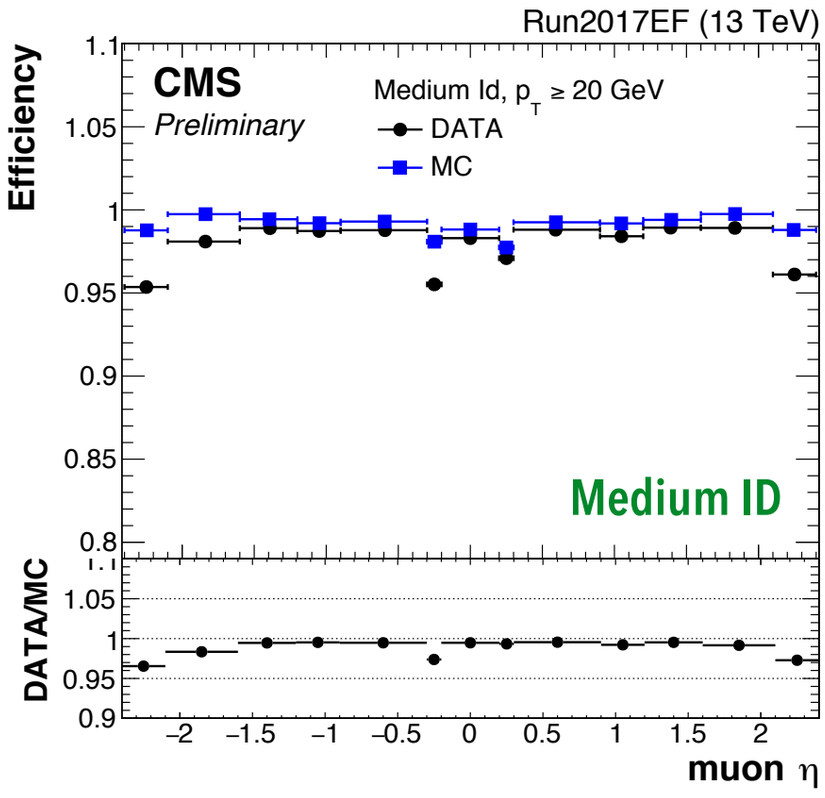


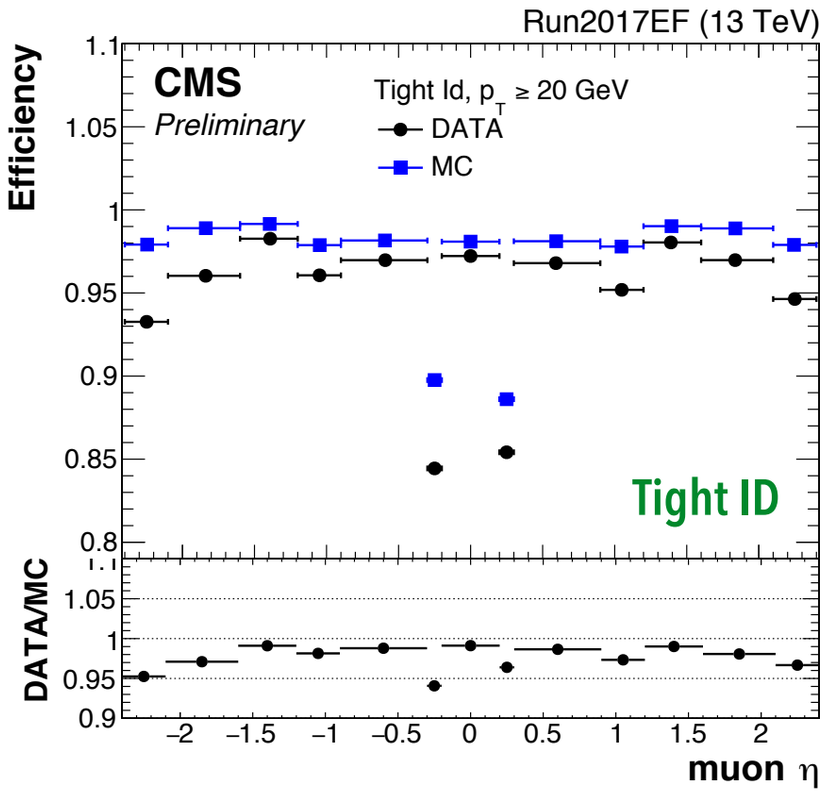
μROS

Muon object reconstruction and identification

- Efficiency from Tag-and-Probe with Z (P. Fernandez) and J/Psi (L. Cristella., T. Madlener, S. Fonseca)
  - data eff. (data/MC SFs): Loose ~100%(1.00) - Medium ~98%(0.99) - Tight ~96%(98.5)
  - rather similar to end of 2016 and stable w.r.t. run period
- More refined studies (finer binning + in depth systematic checks) ongoing (D. Hsu)
  - for now performed using 2016 data - plan to extended work to 2017 dataset

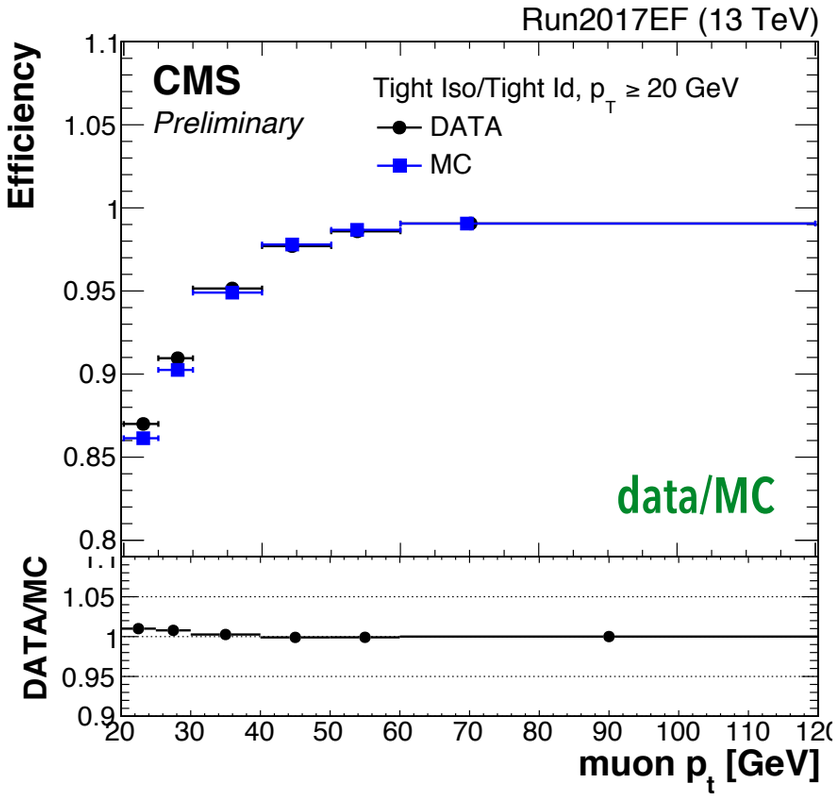


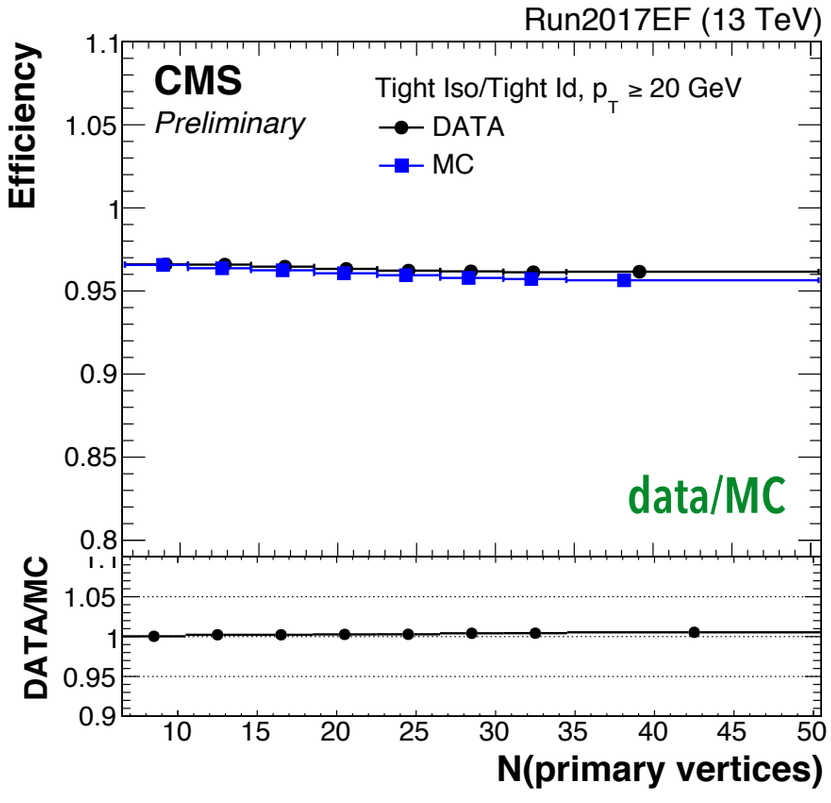


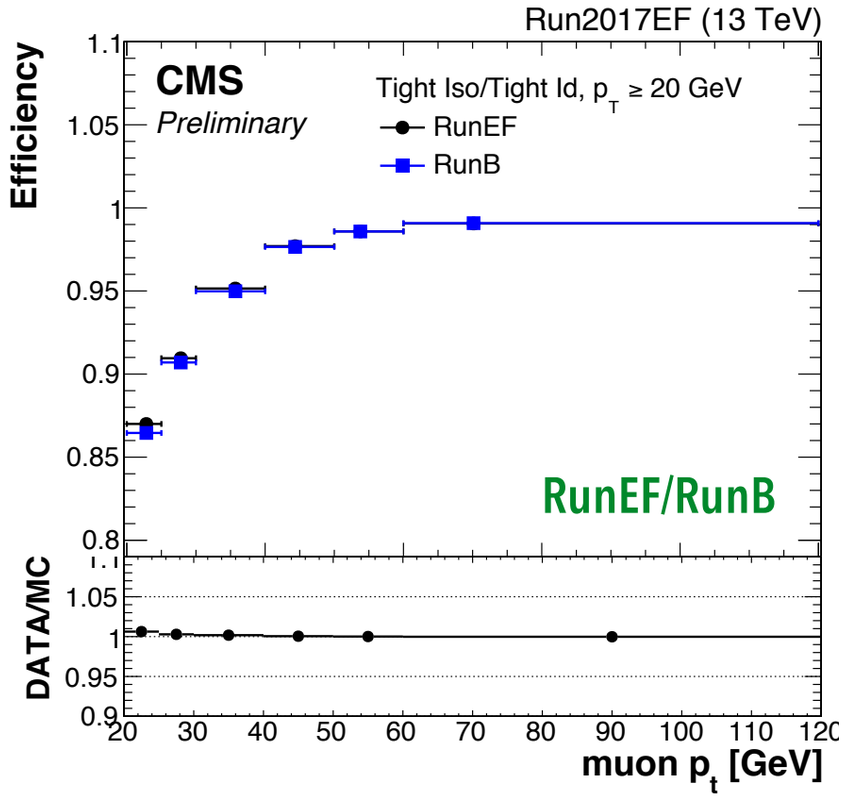


Muon isolation

- Efficiency from Tag-and-Probe with Zs (P. Fernandez)
  - tight PF ISO (Δβ corrected) excellent data/MC agreement + perf. stable w.r.t. run period
  - slight drift of the working point (originally tuned for 95% eff.) - could potentially retune if helped by some PAG
- New interface for muon selectors from 94X
  - simplifies handling of muon IDs and isolation w.p. + includes definitions beyond "usual" selectors (e.g. ttH/SUSY MVA)







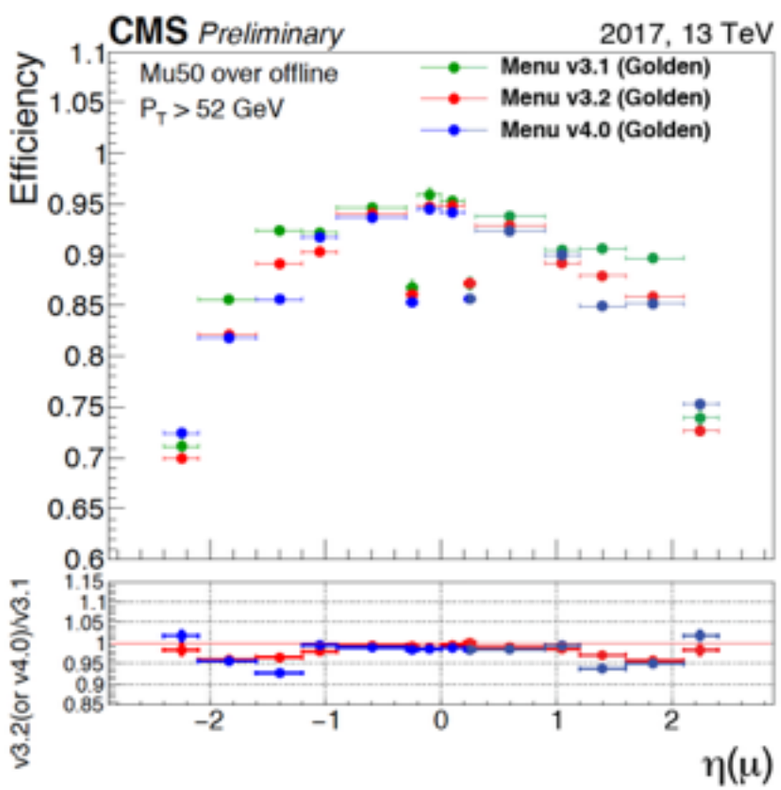
High Level Trigger

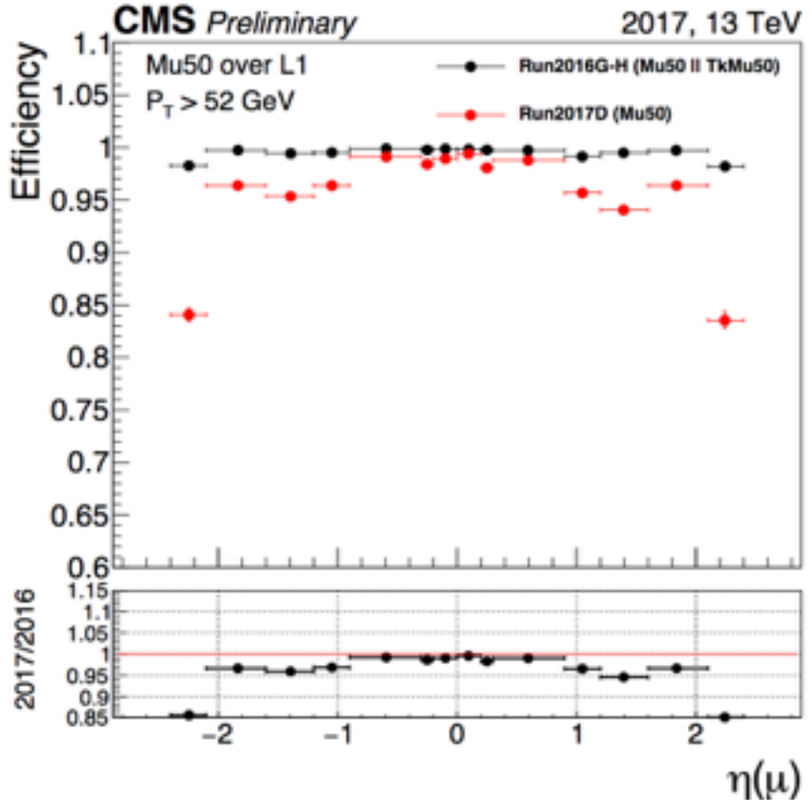
- Major change in 2017: overhaul of the L3 online muon reconstruction (IterL3)
  - to exploit the new pixels - uses iterative tracking - incorporates HLT TkMu reconstruction (single μ triggers)
  - an intense roadmap towards deployment as well as during datataking

Period	First Run	Menu	Comment	Links Performance Plots
2017A	296172	/cdaq/physics/Run2017/2e34/v1.0.0/HLT/V6	Using 2016 muon L3 reconstruction	
2017B	297050	/cdaq/physics/Run2017/2e34/v1.1.1/HLT/V2	Using IterL3 muon reconstruction: - FullIterL3 for Single Muon paths (signal paths only) - IterL3FromL2 for dimuon paths	JIRA
	297557	/cdaq/physics/Run2017/2e34/v1.2.1/HLT/V1	Contains bad pixel mitigation for IterL3	proposal (slide15) JIRA
	298653	change in the L1	EMTF assigns SingleMu quality to station 2-3-4 tracks only in sector -6.	slides
2017C	299368	/cdaq/physics/Run2017/2e34/v2.0.0/HLT/V3	Use FullIterL3 for all muon paths Inclusion of paths for pre-firing studies and HLT_OldMu100, HLT_TkMu100	JIRA JIRA
	300079	/cdaq/physics/Run2017/2e34/v2.1.0/HLT/V1	Changes deployed for the OI step seeding: - include hitless seeding - dynamic rescaling of errors	JIRA proposal
	300088	change in the L1	EMTF assigns SingleMu quality to station 2-3-4 tracks in all sectors	slides
	300262	change in the conditions	Update of the muon alignment and APE	announcement slides
	302026	/cdaq/physics/Run2017/2e34/v3.0.0/HLT/V1	Disabling the L2 filter in all muon paths using full IterL3 (but this had no effect in the end) Inclusion of backups for (isolated) single and dimuon paths	JIRA proposal JIRA
Run2017F	305388	/cdaq/physics/Run2017/2e34/v4.0.0/HLT/V1	New change to L2 filter disable done in previous update at HLT menu v3.0 (JIRA)	JIRA

High Level Trigger

- Major change in 2017: overhaul of the L3 online muon reconstruction (IterL3)
  - to exploit the new pixels - uses iterative tracking - incorporates HLT TkMu reconstruction (single μ triggers)
  - an intense roadmap towards deployment as well as during datataking
  - overall performance is "relatively good" - with room for improvement
    - less efficient than old L3+TkMu (~ -3%, most significant drops in endcaps - K.P. Lee)
    - rates @ 1.5E34: HLT_IsoMu27 ~195Hz - HLT_Mu50 ~55Hz
    - purity studies ongoing (M. Oh), ~75% of HLT_IsoMu27 triggers pass TightID + PF Iso (variations w.r.t. run period/menu ver.)
  - task force being formed within MUO to get HLT in shape for 2018 (if interested contact MUO conveners)
    - kick-off discussion during yesterday's Muon POG working meeting

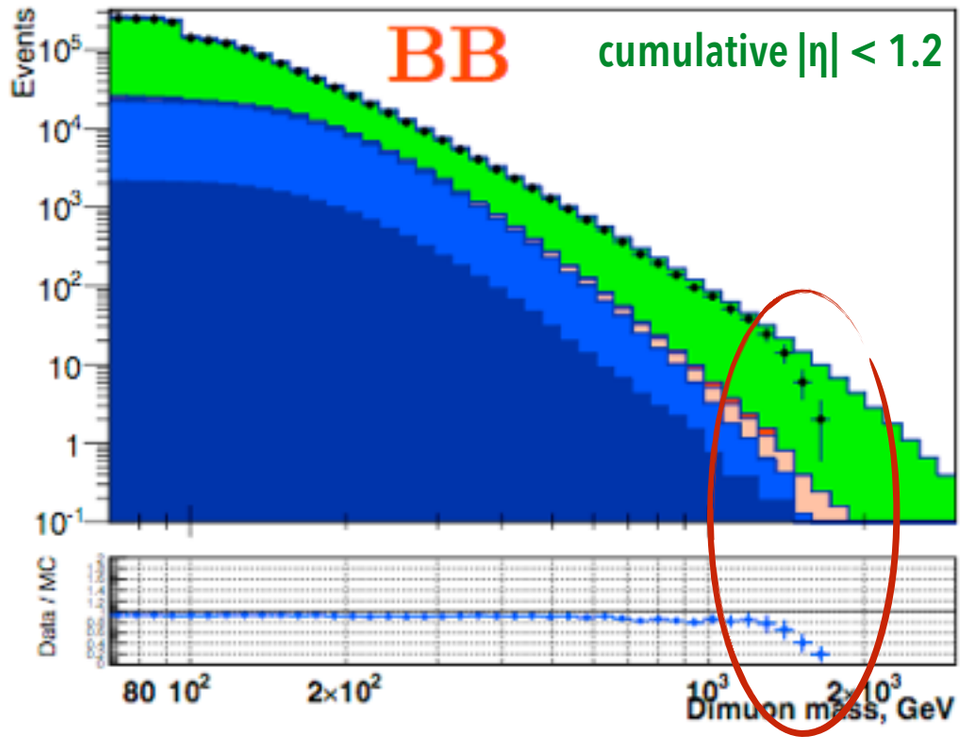




High-p_T muon study group

- Study the deficit at high mass observed by Z′→ μμ analysis in the muon system barrel

  "look for potential EXPERIMENTAL sources of SIGNIFICANT deficit when recording/selecting of high-p_T muons"



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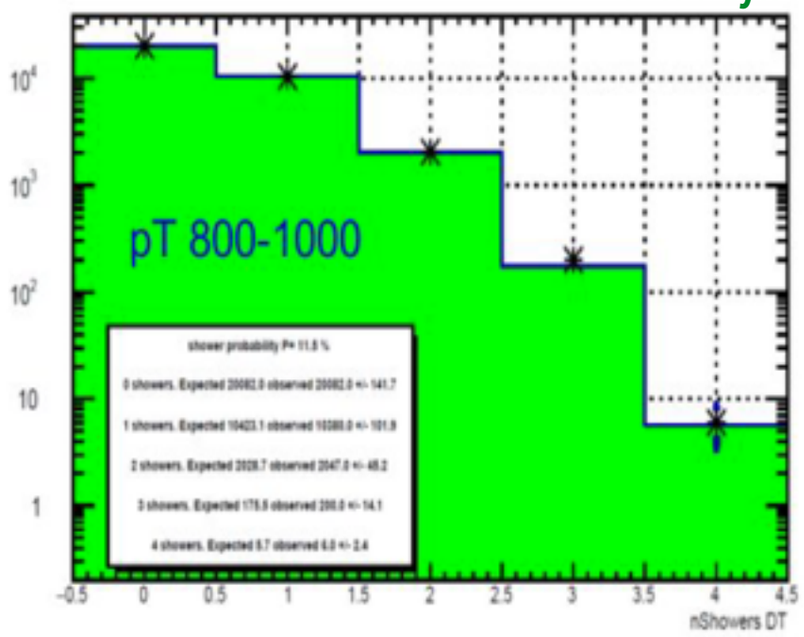
- Study the deficit at high mass observed by Z′→ μμ analysis in the muon system barrel

  "look for potential EXPERIMENTAL sources of SIGNIFICANT deficit when recording/selecting of high-p_T muons"

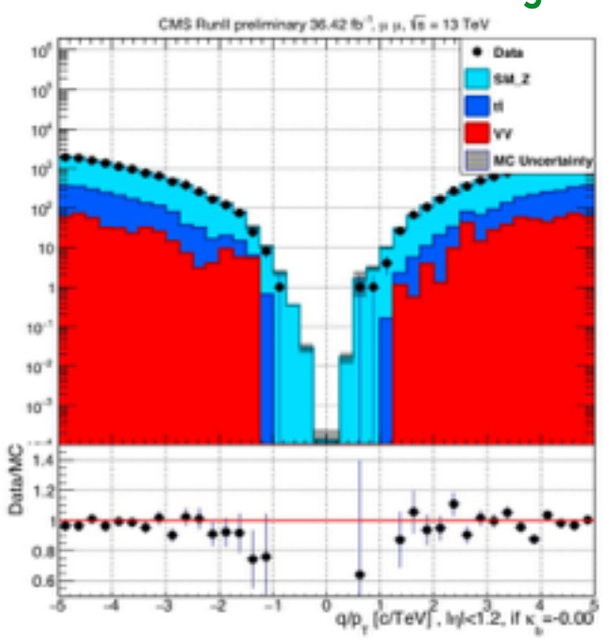
  - a common detector + trigger + POG + analysis WGs effort (many people involved)
  - covering a wide spectrum of topics!
    - L1 / HLT performance (including prefiring)
    - muon reconstruction/identification issues
    - excessive / anomalous presence of showering muons in data
    - momentum assignment (scale/resolution)
    - cross checks from single-muon + MET final states

P. Traczyk



pt [GeV],	b_bias,	Dk_b
pt 60,	-0.011739,	0.007262
pt 100,	-0.012765,	0.008236
pt 150,	-0.014181,	0.008820
pt 200,	-0.004433,	0.009568
pt 250,	-0.002972,	0.010029
pt 330,	-0.000015,	0.012986
pt 400,	-0.007055,	0.014946
pt 500,	-0.008424,	0.022577
pt 600,	0.006843,	0.024844

R. Radogna



High-p_T muon study group

- Study the deficit at high mass observed by Z′→ μμ analysis in the muon system barrel

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    Everything "OK"

- work documented in [1], [2], summary in this talk (J. Alcaraz)
- no EXPERIMENTAL issues were found

High-p_T muon study group

- Study the deficit at high mass observed by Z′→ μμ analysis in the muon system barrel

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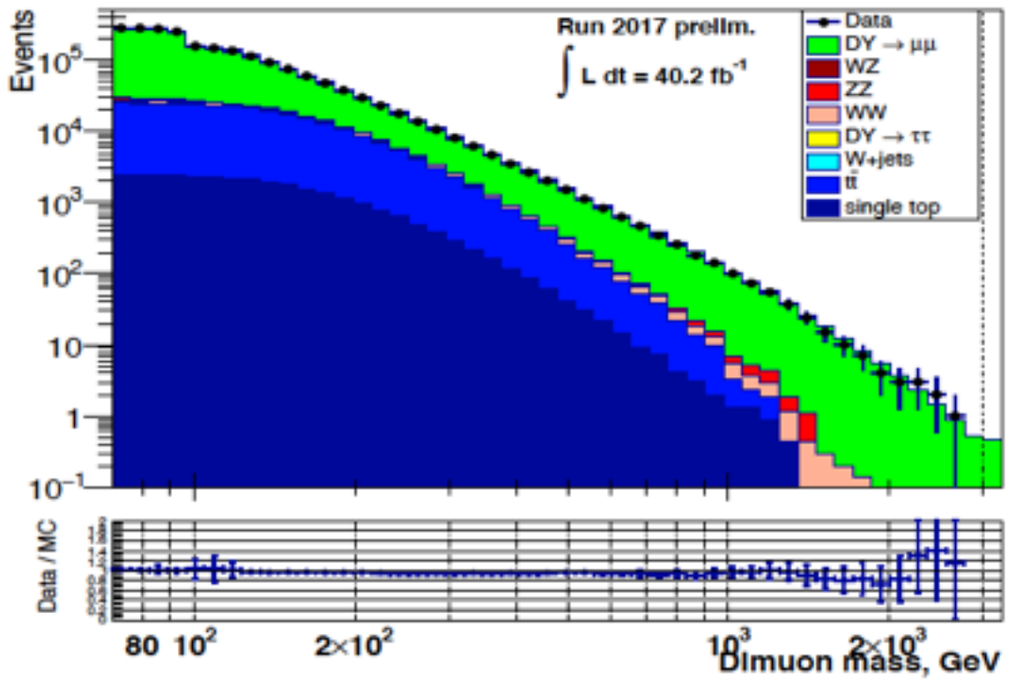
    - momentum assignment (scale/resolution)
    - cross checks from single-muon + MET final states

    Everything "OK"

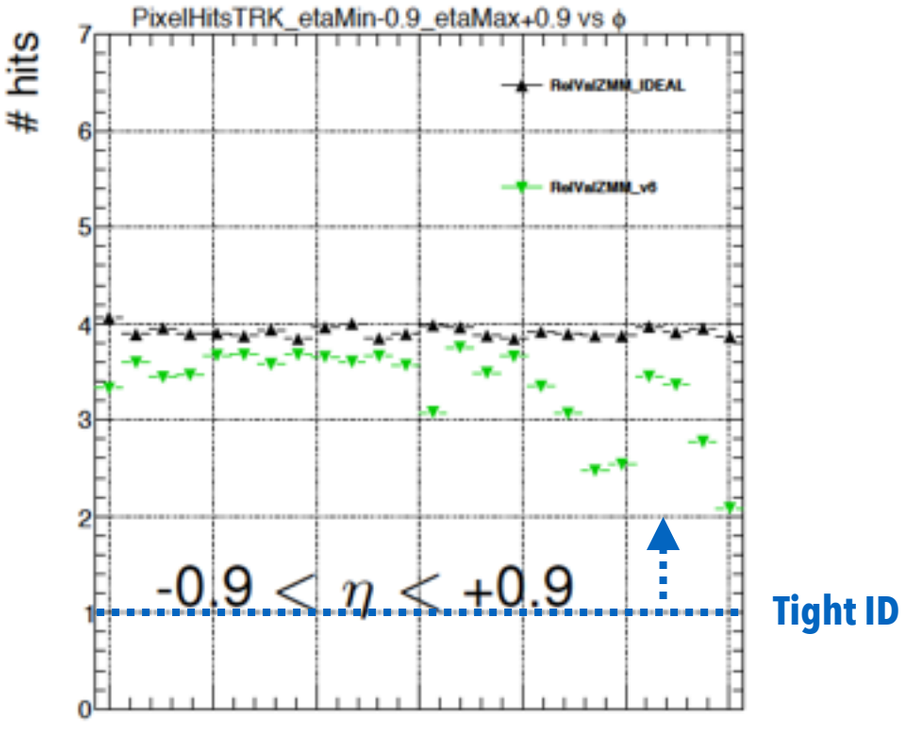
- work documented in [1], [2], summary in this talk (J. Alcaraz)
- no EXPERIMENTAL issues were found
- studies not repeated with this year's sample (yet)
  - but no deficit observed in the 2017 dataset

cumulative |η| < 1.2

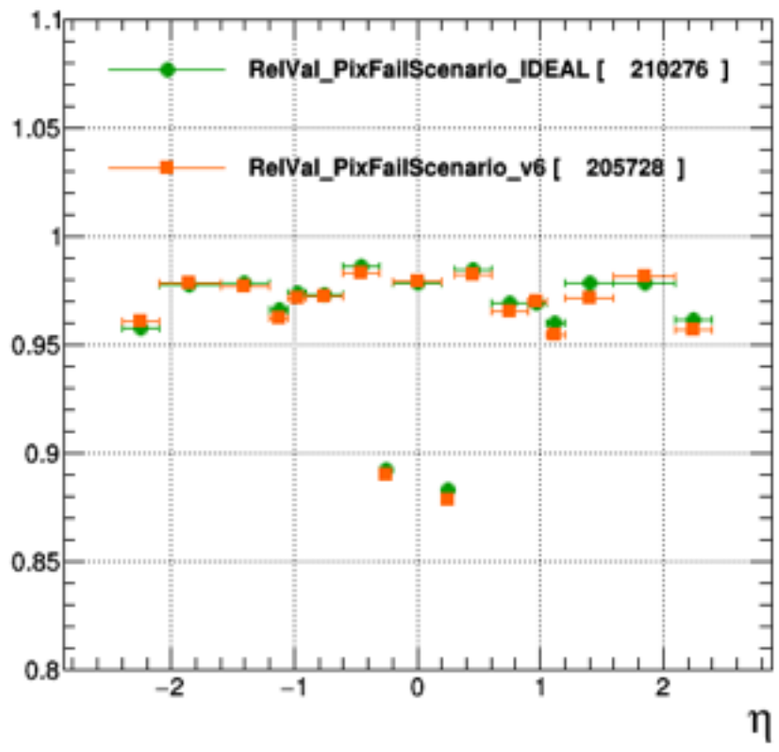


Pixel failure scenarios: impact of muon reconstruction / ID

- Impact of pixel failures on muon RECO/ID estimated using dedicated TTbar RelVals
  - just a brief summary, more in S. Sanchez's talk
  - in a nutshell:
    - muon requirements on pixels in standard IDs rather mild
    - small overall impact, more significant @ HLT
- High Level Trigger
  - HLT_IsoMu27_v13: -1.0 % (per muon with $p_T > 30$ GeV)
  - HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_v12: **-4.0%**
  - HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ_v13: **-4.3%**
- Efficiency losses (cut-based IDs):
  - Loose ID: -0.13%
  - Medium ID: -0.61%
  - Tight ID: -0.52%
  - Soft ID: -0.57%



Tight ID



Muon POG activities: next steps

- Another muon (POG) paper in the pipeline, MUO-17-001: *Performance of the reconstruction and identification of high momentum muons in proton-proton collisions at sqrt(s) = 13 TeV*

- Provide high-level object corrections on 2017 dataset (milestone: Moriond 18)
  - target end of January for delivering recommendation on efficiency scale factors
  - in the process of organizing work on scale/resolution recommendations/calibrations

- Improve single lepton triggers (also beyond IterL3) (*)
  - e.g. optimize isolation trying to reduce rate

- General plan to revise/perfect muon object and existing monitoring tools (*), e.g. :
  - automate TnP and Muon POG ntuple production
  - improve Muon DQM (extend list of monitored quantities, exploit DCS information, HDQM)
  - improve reconstruction/identification performance for specific signatures (close-by muons, displaced muons …)
  - …

- (*) There's definitely room to give significant contributions in different areas
  - if interested contact MUO conveners to get more details on planned activities / wish-list

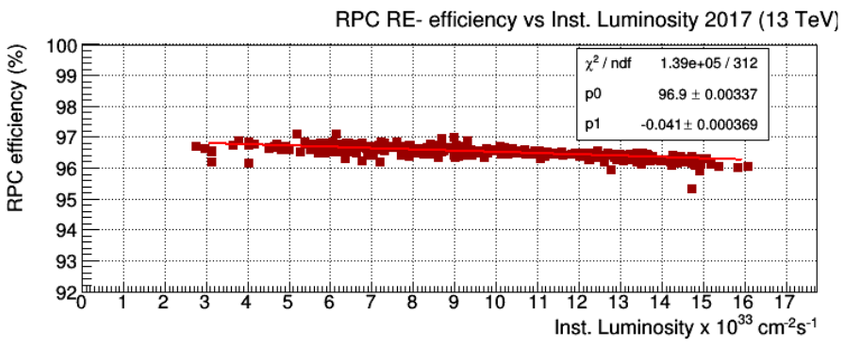
Summary

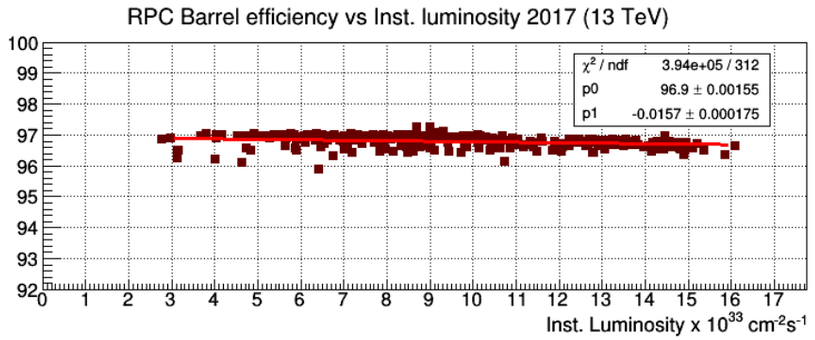
- Italian community plays an important role both in muon detector and POG activities
- Detector wise, overall small fraction of inactive channels, very good operational performance and high fraction of collected data has good quality
  - Small technical issue in CSC certification being addressed
- Detector performance mostly stable w.r.t. 2016, with few adjustments
  - Completed integration of RPCs in the barrel trigger, started keeping an eye on chamber longevity
- No major surprises in muon reconstruction/identification performance as well
- Some intervention on specific chambers planned for YETS, plus switch to μROS for DT
- Most significant activity for Muon POG is the preparation of HLT for 2018
  - Both to solve IterL3 issues and get prepared for higher lumi.
- Combined detector + POG muon paper almost finalized
  - Plus an additional paper on high-p_T muons will follow

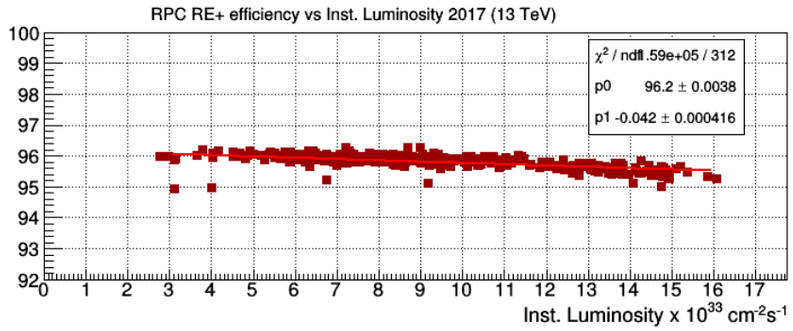
Questions?

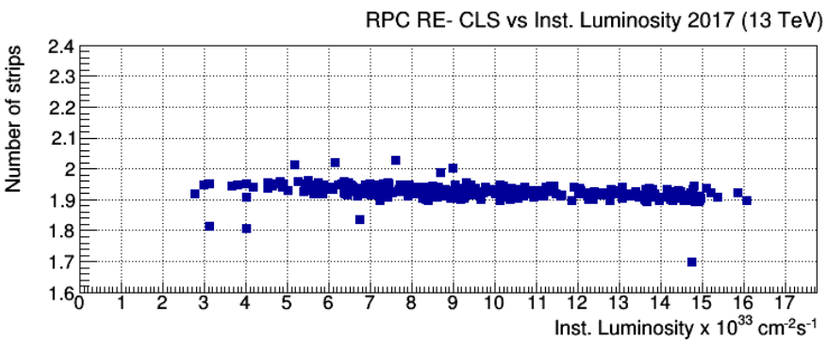
Backup

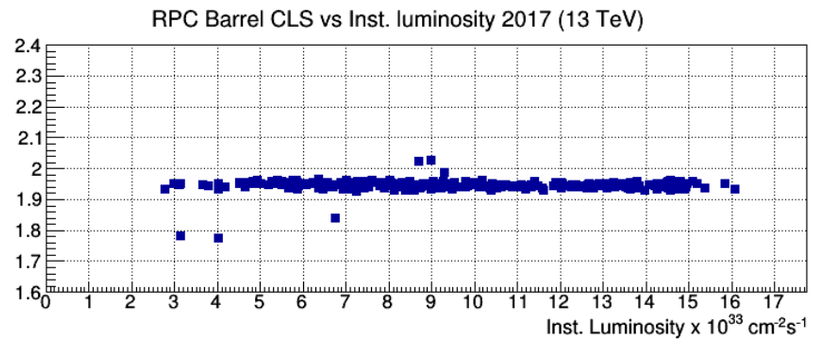
RPC efficiency and cluster size stability w.r.t. inst. lumi

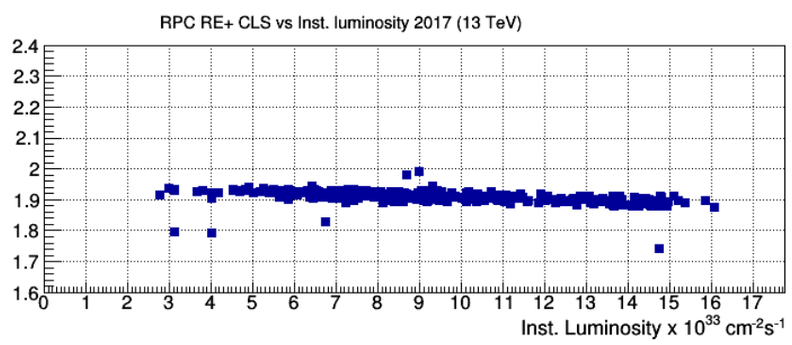










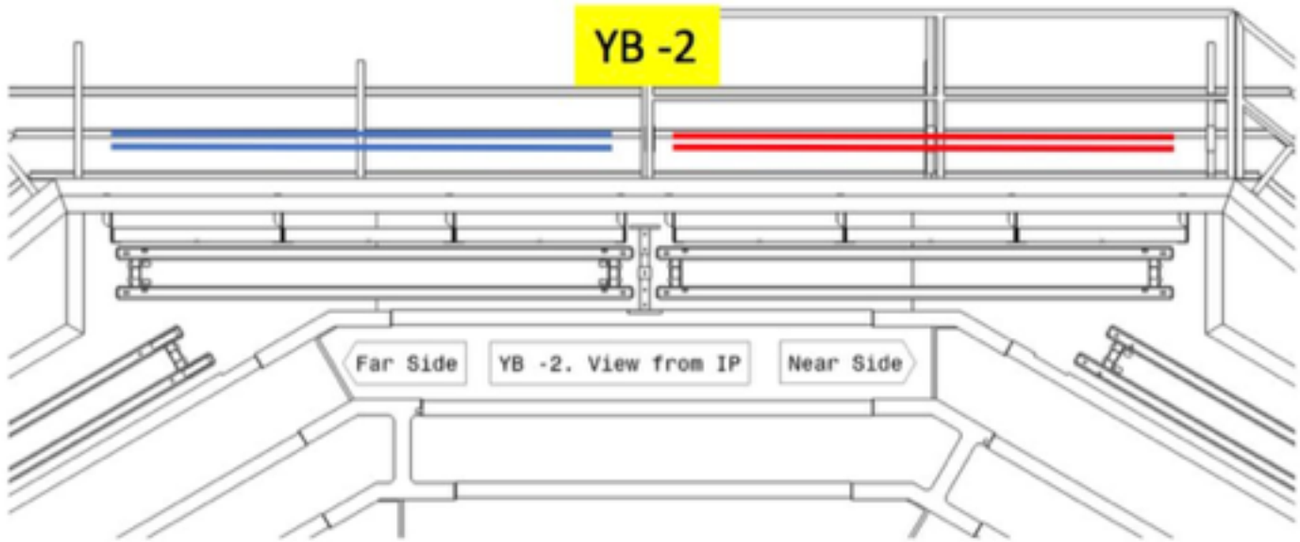


- M. Shopova @ RPC workshop
  - Stable w.r.t. instantaneous luminosity (~ 0.04% / 10^{30} $cm^{-2}s^{-1}$ in endcap, < 0.02% / 10^{30} $cm^{-2}s^{-1}$ in barrel)

Background rates - RPC (1)

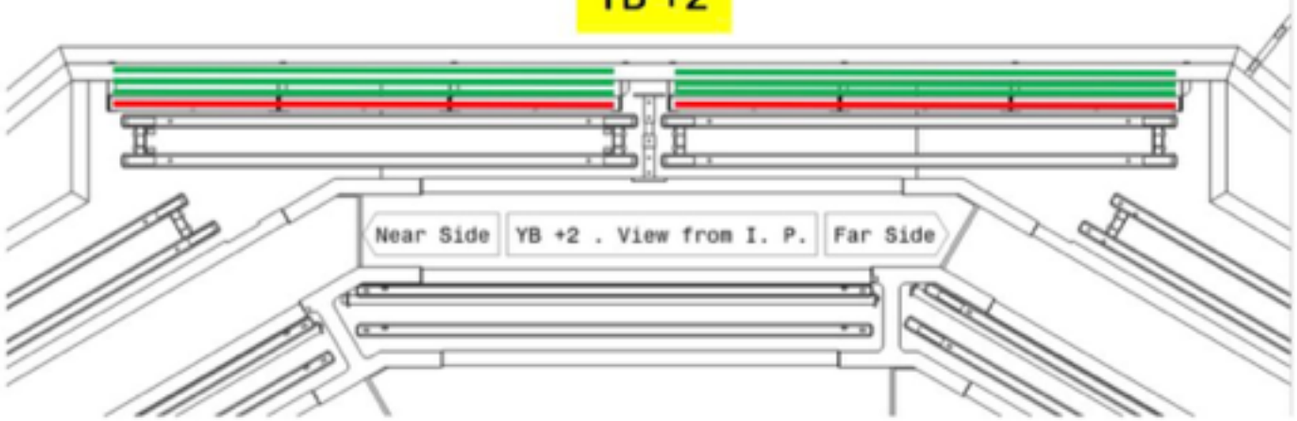
MB S4 Shielding as installed YETS 2016-2017

YB -2



- V2 Near Side: 12 trays with 14mm of lead. (95.98 kg x tray = 1151.5 kg total load)
- V2 Far Side:12 trays with 20mm of Stainless steel . (94.84 kg x Tray = 1139 kg total load)

YB +2

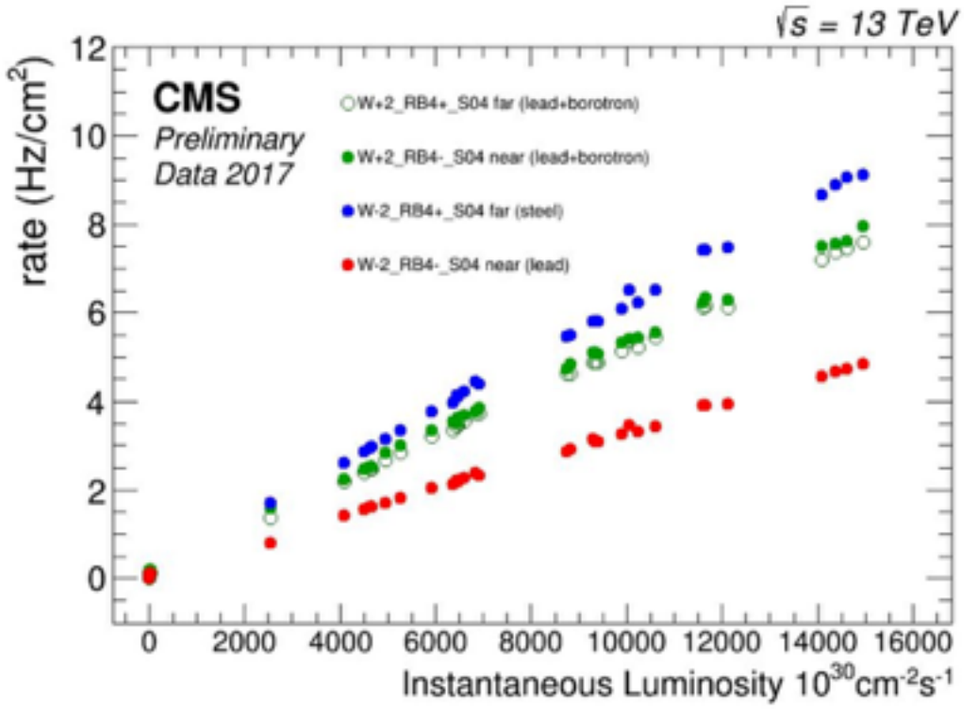


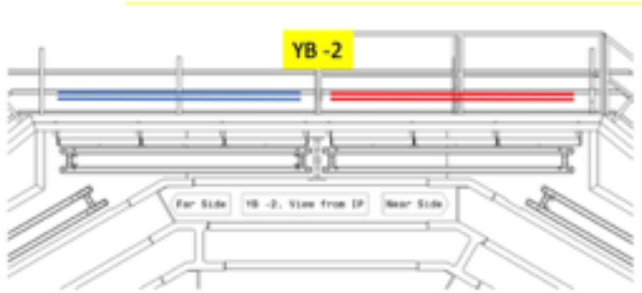
- V2 Far and Near side: 24 trays with 7mm of lead + 90 mm of Borotron UH50. 100.93 kg per tray = 1211. 16 kg total load per side.

M. Duran, R. Rabadan

Background rates - RPC (2)

Shielding effect on W+2/W-2





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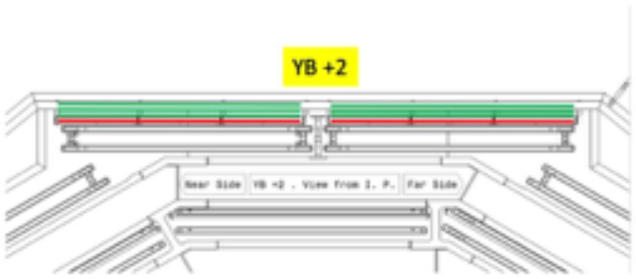


- V2 Far and Near side: 24 trays with 7mm of lead + 90 mm of Borotron UH50. 100.93 kg per tray = 1211. 16 kg total load per side.

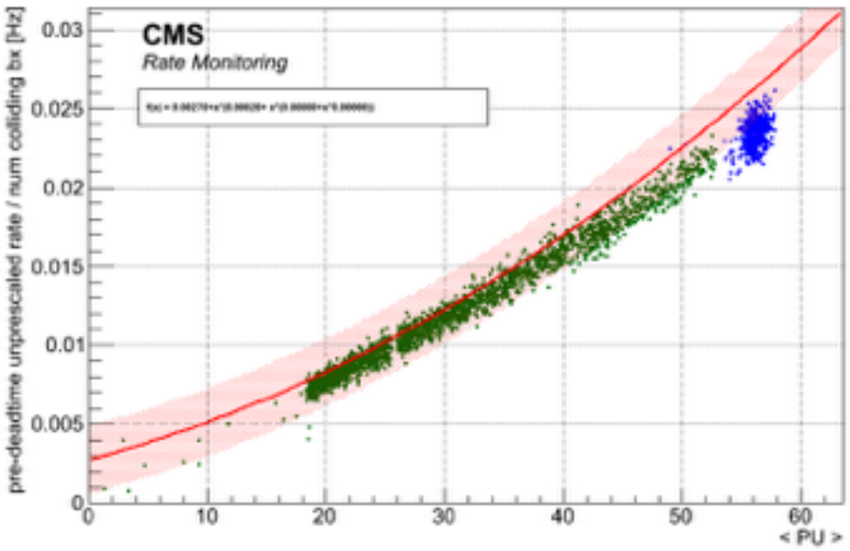
- No significant near/far rate difference on W+2 where shielding is the same (7 mm lead + 9 mm UH50)
- Higher rate attenuation found in W-2_RB4_S04_near (14 mm of lead) compared to W-2_RB4_S04_far (20 mm of stainless steel)

M. Duran, R. Rabadan

HLT Rates and Purity

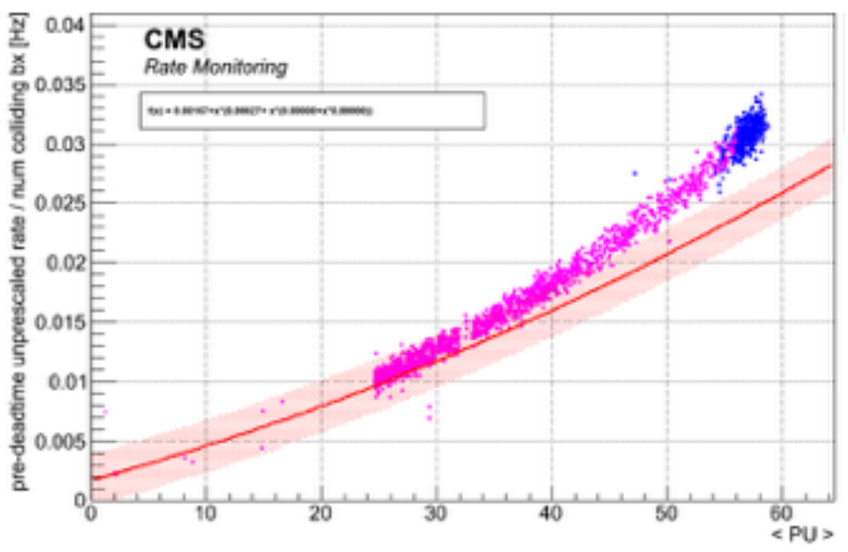
Menu v3.2

HLT_Mu50

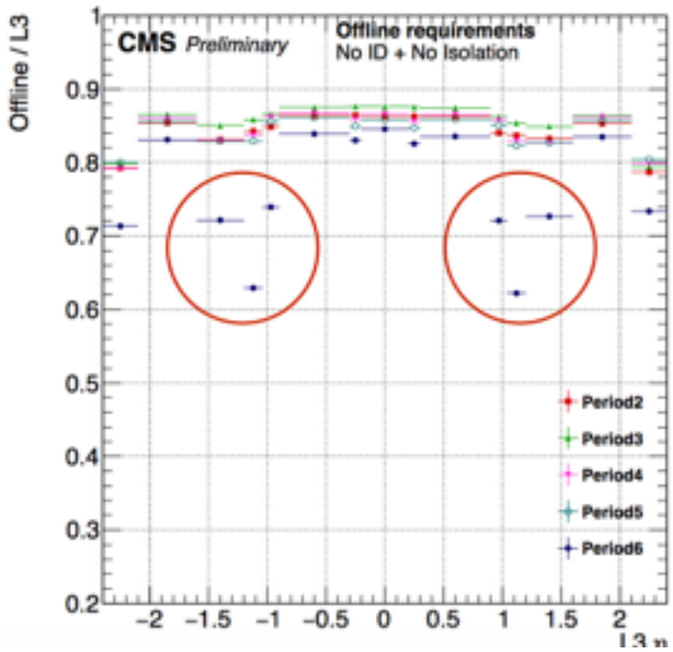


Menu v4.0

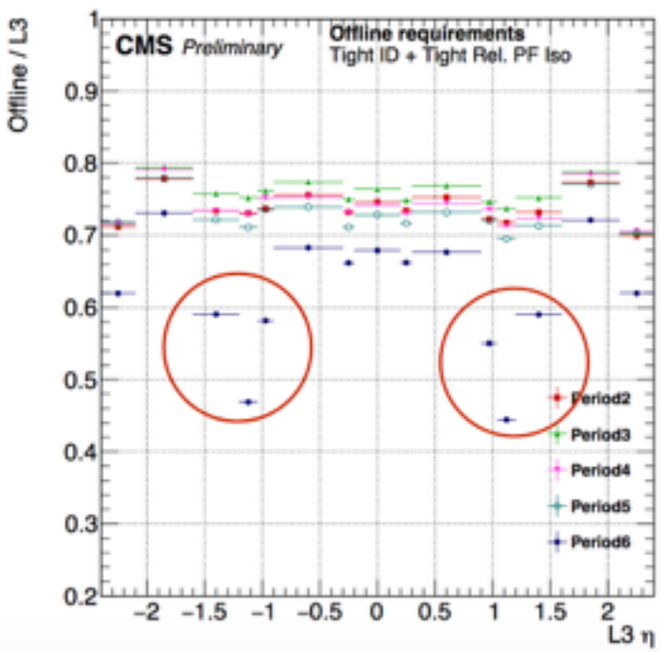
HLT_Mu50



No ID + No Iso



Tight ID + Tight Iso



	Run Range	Update
Period1	296172 ≤ run ≤ 297049	Old L3
Period2	297050 ≤ run ≤ 297556	2 flavours of IterL3
Period3	297557 ≤ run ≤ 299367	Bad pixel mitigation
Period4	299368 ≤ run ≤ 300261	Full IterL3 everywhere
Period5	300262 ≤ run ≤ 305387	New alignment
Period6	305388 ≤ run	IterL3 update

Included in this study

M. Oh's talk

More pixel failure scenarios