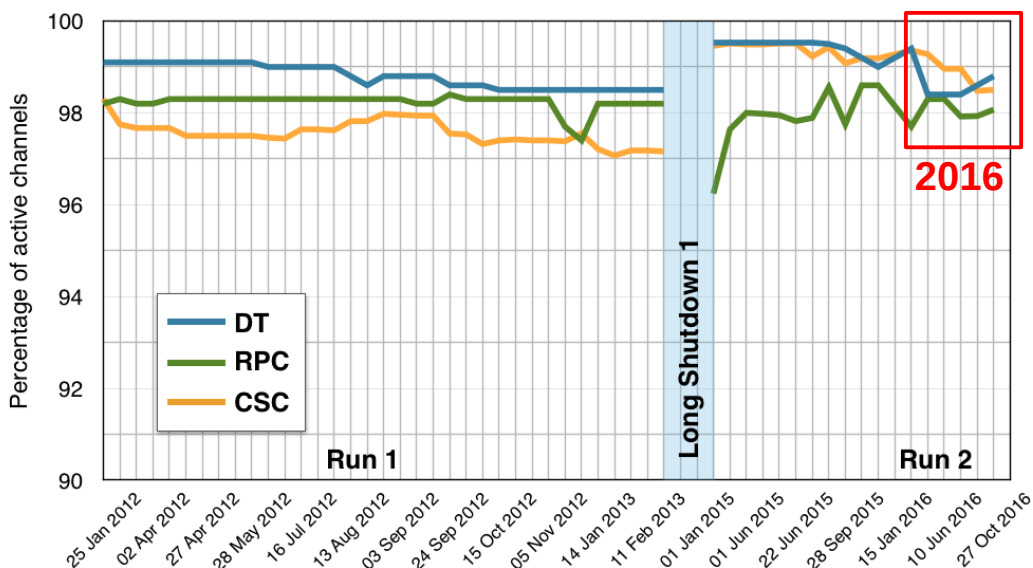# RPC Operation and Plans

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On behalf of the CMS Muon group

CMS Run & DPG Coordination Workshop
24-26 January 2017, Torino, Cavallerizza Reale

RPC Operation in 2016

- Stable operation during 2016

- 99.97 % effectiveness

- Active fraction of detector channels between 97.9 – 98.3 %

  – plan to recover 0.5 – 1% of total chambers during EYETS

- Data quality of all runs up to last pp-run were marked as **GOOD**

  – 5 runs marked as **BAD** corresponding to **145 pb^{-1}**
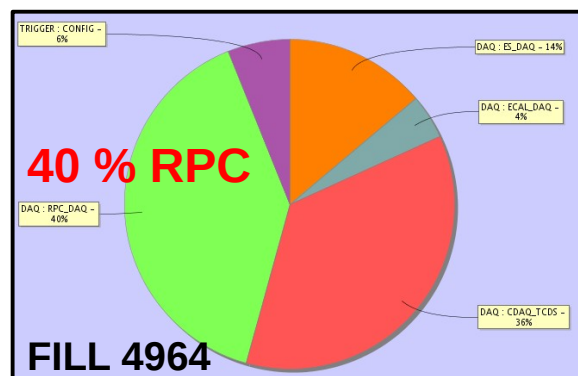
  – Total **downtime** corresponding to **12.51 pb^{-1}**

First Runtime	Begin Time	Last Runtime	End Time	Run time	No stable beam	Delivered Luminosity, pb^{-1} pp μb^{-1} PbPb	Recorded Luminosity, pb^{-1} pp μb^{-1} PbPb	Eff. by Lumi (%)	Luminosity lost, pb^{-1} pp μb^{-1} PbPb	Lumi lost at Downtime Events, pb^{-1}pp μb^{-1}PbPb	Remaining Lumi loss, pb^{-1}pp μb^{-1}PbPb
LHCFILL004726	2016.03.24 23:56:39	LHCFILL005451	2016.10.26 21:00:18	1805:36:21	0:00:00	40522.49	37323.35	92.11%	3199.14	12.51	3186.63

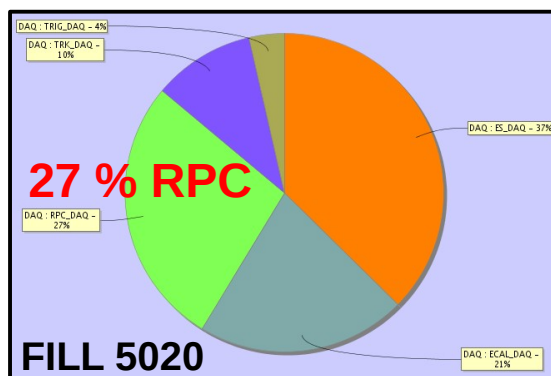|	Run time	Livetime	Downtime	Effectiveness	Events
Including non stable beam	1805:36:21	1805:00:28	0:35:53	99.97%	3
Stable beam only	1805:36:21	1805:00:28	0:35:53	99.97%	3

Downtime

- Total downtime of 35 minutes 53 seconds → **12.51 pb^{-1} / 0.74%**

- Accumulated in 3 instances

- All caused by CCU errors:

  - crash of XDAQ in YEN-3 near (affecting both RE-3/RE-4 near)

  - RPC DAQ configuration halted → run cannot be started

- Temporary fix in source code preventing crash XDAQ

  - root cause problem to be evaluated on hardware control boards

- **EYETS: replacement of all RE-3 near control boards**
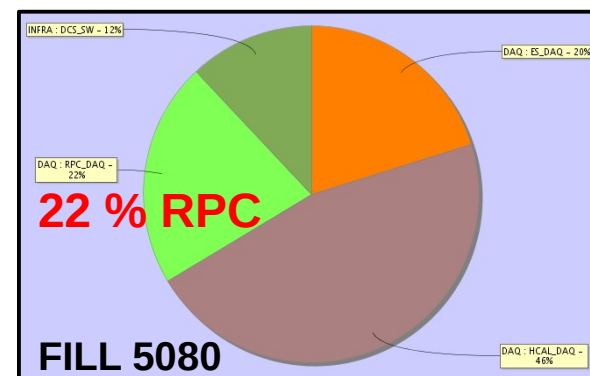
Bad data certification runs

- Major failure with 48V power supply problems in W-2 affecting 6 sectors

- In situ solution:
  - corresponding worker W-2 far disabled
  - global running was not affected

- Problem was solved during next interfill
  - cleaned *all* connectors in UXC with contact spray
  - problem never appeared again

Corresponding runs marked as BAD: 145 pb^{-1}
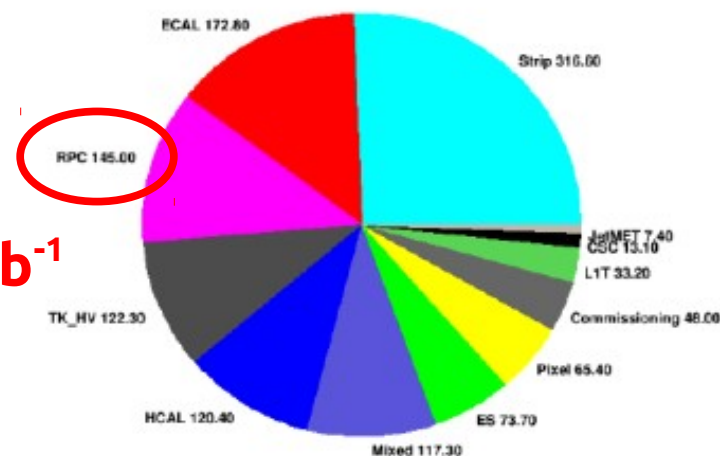
Minor system failures and gas operation

- Minor system failures:

  - CAEN bus communication errors (LV boards turned OFF) → problem didn't appeared anymore after cleaning connectors

  - MAO OFF / loss communication with branch controller

  - DCS blocked peer

  - ...

  → none of them affected data taking

- Gas operation

  - very stable gas operation, no downtime nor gas kill alarm

 - though several maintenance activities planned in EYETS

Ambient temperature

- Temperature carefully monitored in barrel and endcap

- Observed decrease in temperature of ~ 0.5 degC since April 2016

- Affecting efficiency of chambers

  - 0.5 degC corresponds to ~ 10V shift in working point

  - 10V change of WP corresponds to efficiency drop of ~ 0.2 %

- Decided to implement high voltage temperature correction, on top of existing P correction

  → HV(P) = HV(P, T)
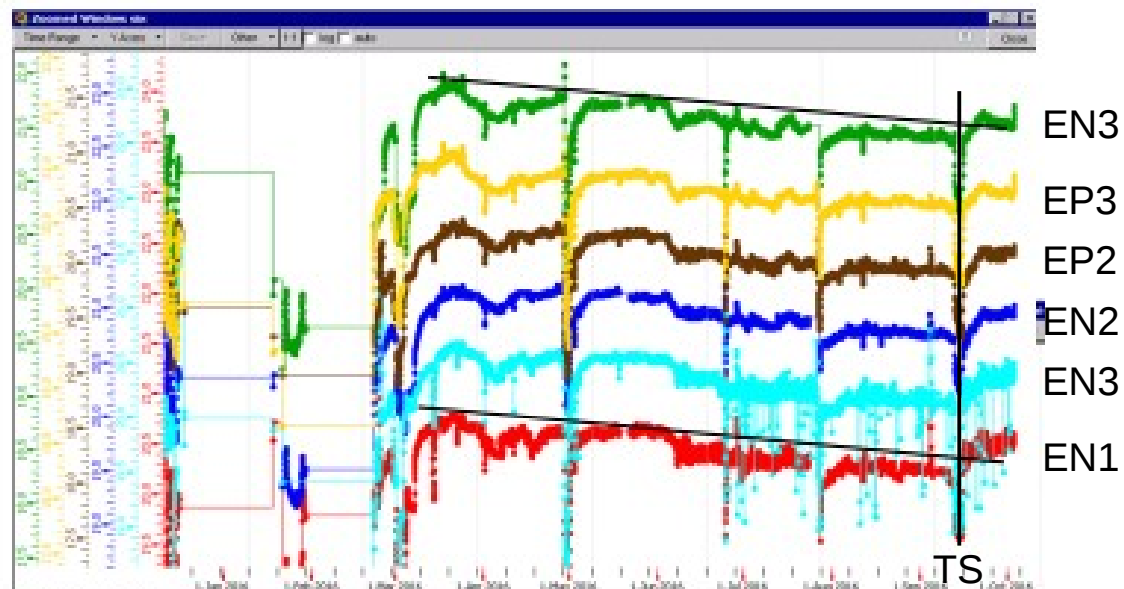
2016 temperature evolution in endcap stations
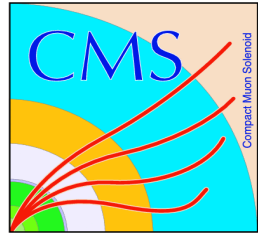
EYETS maintenance activities (1)

- During EYETS only W-2/W+2/RE+1/RE-1 accessible

- RPC Gas maintenance:

    - gas leak reparation in W-2 and W+2

    - 10 to be checked and try to repair

    - 5 leaks aimed to be repaired → reduction of leak rate about 100 l/h

- Gas leak reduction by installing valves on return lines and flow cell adjustment → expected reduction of 50 l/h

- Total reduction of 150 l/h

EYETS maintenance activities (2)

- Barrel threshold reparations:

  - Replacing failed distribution board for threshold control

- Endcap LV reparations

  - 6 chambers to be repaired

  - 2 already done (connector problems)

- 10 HV connector reparation of chambers now operating in single gap mode

- Control boards replacement in RE-3 to avoid further CCU errors + monitor CCU errors during commissioning

"partially" extraction: a special tool has been build for LS1 in order to "partially" extract the DT&RPC station for 80 cm ONLY in order to have access on the RPC Threshold control board.
We are using this tool almost during all long technical stop.

# EYETS monitoring activities
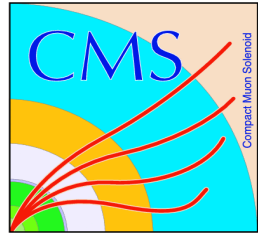
- Annual resistivity scan with argon

- Gas leak measurements

- Cooling test at 12 bar to check the tightness of cooling pipes

RPC Inclusion in L1 muon trigger

- **OMTF:** combine RPC + DT + CSC hits

  – RPCs in OMTF since beginning of 2016

- **BMTF:** combine DT + RPC hits

  – TwinMux deployment near end of 2016

  – Successful tests performed in 2016 p-pb collisions

  – measured average increase of trigger efficiency by 1.3%

- **EMTF:** combine CSC + RPC hits to increase trigger efficiency in $|\eta| < 1.85$ and CSC ring gaps

  – CPPF hardware boards ready + tests ongoing

 – EYETS: installation at P5 + tests + commissioning
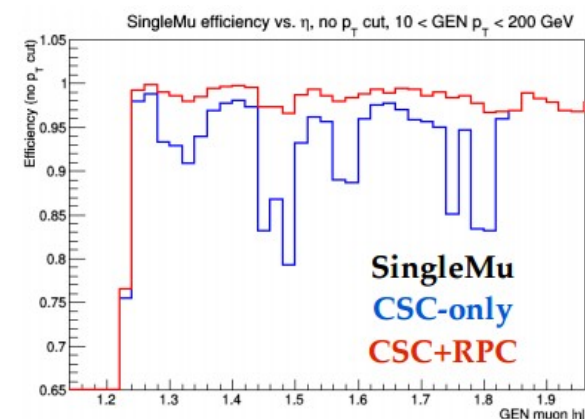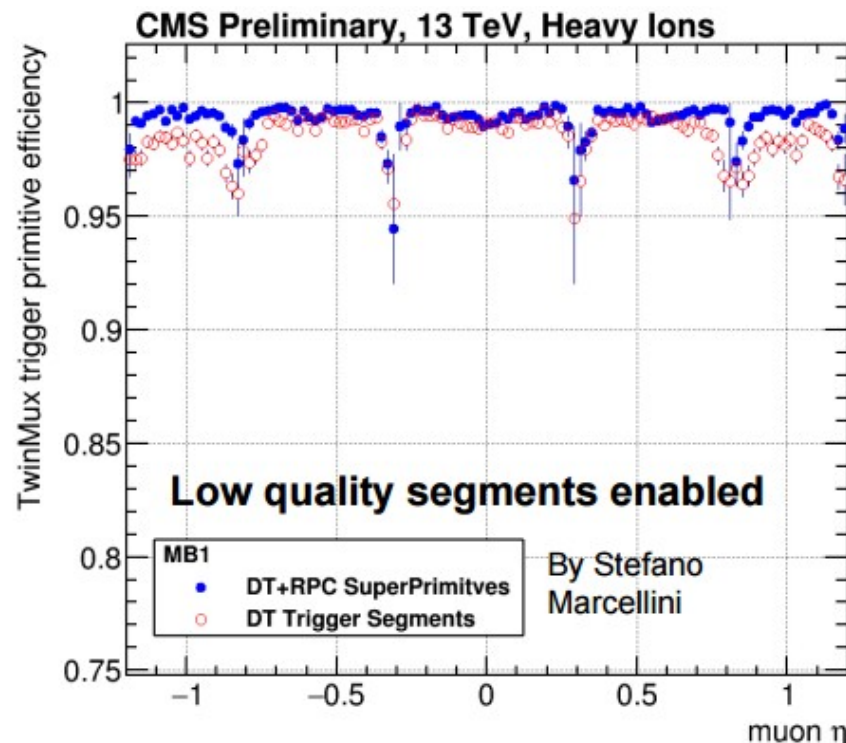
Calibration and run activities

- MWGR1:

  - no participation (still argon flux for resistivity/gas leak measurements)

- MWGR2:

  - plan to participate, focus commissioning EMTF

  - full detector operational → global check of detector + check repaired chambers during EYETS

- Cruzet: participation

- CRAFT:

  - threshold calibration without beam

- 2017 run requests:

  - high voltage scan scan to check stability of working points

  - threshold/noise scan near end of the year (without beam)

Organization for 2017
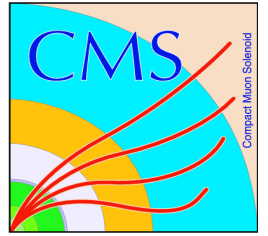
- **DOC shifter** (twiki.cern.ch/twiki/bin/view/CMS/RPCDOCduties)

    - guarantee continuous detector operation

    - "on call", monitoring of the RPC system, attending daily run meetings + report

    - weekly report at the TC and DPG meetings

- **Data Manager** (twiki.cern.ch/twiki/bin/viewauth/CMS/RPCOfflineShifts_Run2)

    - data certification at CMS centre, also offline CMS centres available now

    - certification based on several tools including noise tool, WBM, DQM

    - weekly report at the TC and DPG meetings

- **Prompt Feedback Monitoring** (twiki.cern.ch/twiki/bin/view/CMS/RPCPromptAnalysis)

    - aim to investigate detector performance on daily basis, guaranteeing good performance

    - extended use of DQM/WBM/Noise tools

    - close collaboration with DOC

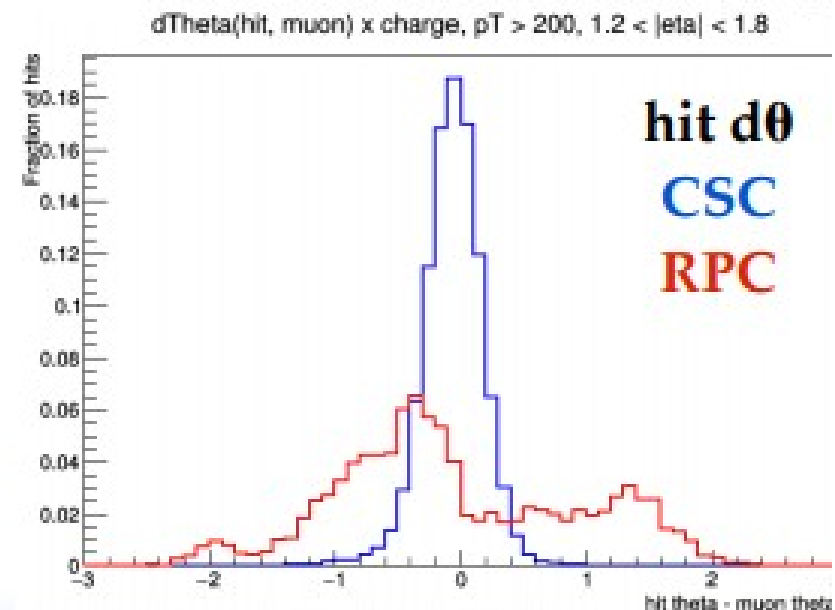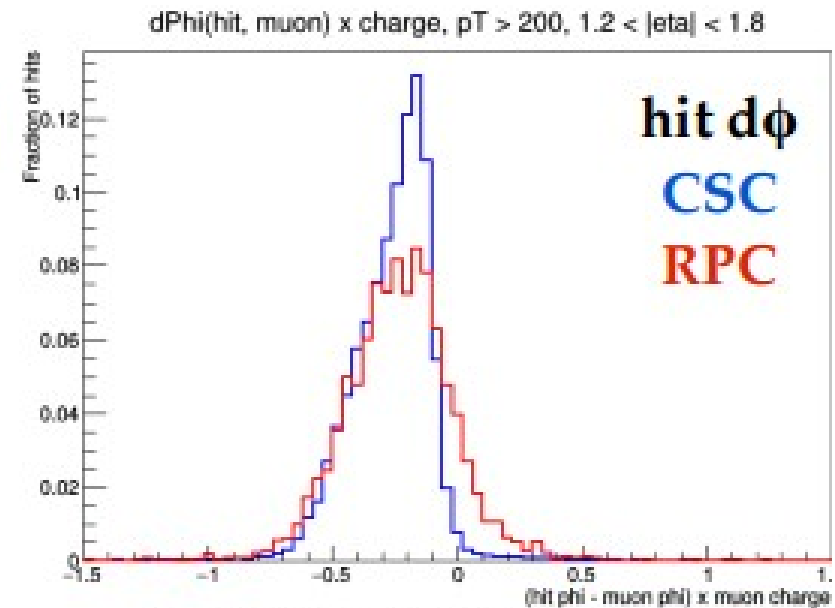   - weekly report at the DPG meetings + attendance of TC meeting

Summary
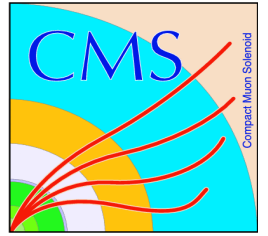
- Excellent operation of the RPCs in 2016 with minor problems or system failures

- EYETS maintenance activities ongoing including with focus on gas maintenance, HV/LV repairs and RPC inclusion in L1 muon trigger

- Plan to participate from MWGR2 and ongoing calibration runs

Backup

EMTF algo with RPCs: v1

- Because of RPC+CPPF latency, won't use RPC hits for pattern-formation

  - Not a severe disadvantage - only need CSC LCTs in 2 stations to fire pattern

- Assign RPC hit zone based on θ, match closest in φ to fired pattern

  - **For now, only use RPC hit if no CSC LCT can be matched in that station**

  - Widen dθ window to 2.3° (8 units)

- For pT assignment, set all dθ values with RPCs to 0, CLCTs to straightest

dPhi(hit, muon) x charge, pT > 200, 1.2 < |eta| < 1.8

hit dφ
CSC
RPC

dTheta(hit, muon) x charge, pT > 200, 1.2 < |eta| < 1.8

hit dθ
CSC
RPC

CPPF concentrator

- CPPF will **concentrate** RPC links, **cluster** fired strips, and assign θ and ϕ **coordinates** on the EMTF scale

  - Each link will carry up to 2 hits from each of 6 subsectors: ring 2 in stations 1 and 2, rings 2 and 3 in stations 3 and 4

  - Total of 6 CPPF-EMTF links per sector (+1 from the neighbor sector)

  - All contiguous strips in a single station/subsector/ring/roll clustered into a single hit, with ϕ defined by central strip or half-strip

  - ϕ in units of $1/15°$ (vs. $1/60°$ from CSCs), θ units of $36.5/32°$ (vs. $36.5/128$ from CSCs)