Update on HO Muon Trigger

HO Trigger Weekly Meetings

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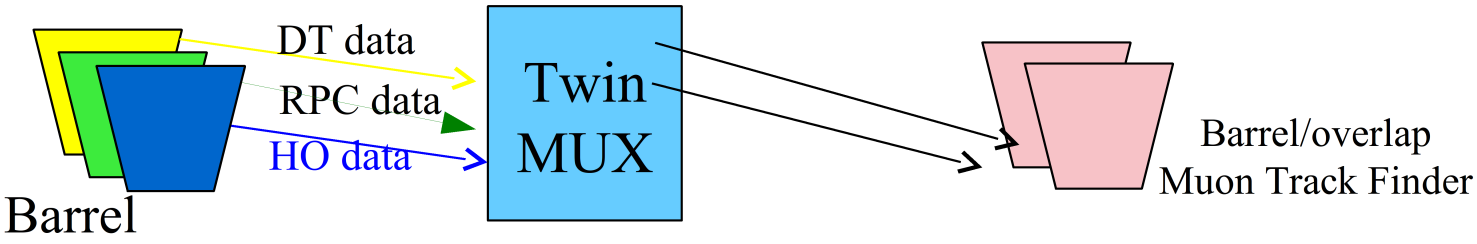
HELMHOLTZ ASSOCIATION

DESY

HO in L1 Muon trigger

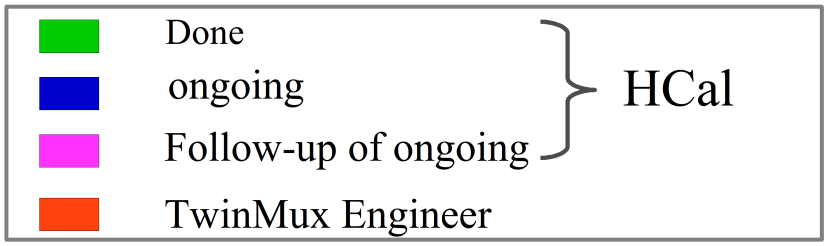
- Brief Outline of the project:
  - Introduction of HO in L1 trigger follows HO→ TwinMUX → BMTF chain.



  - HCal promise was to work on HO → TwinMUX chain.
  - TwinMUX → BMTF chain has not been responsibility of HCal, has been conveyed and discussed in the L1 trigger meetings several times.

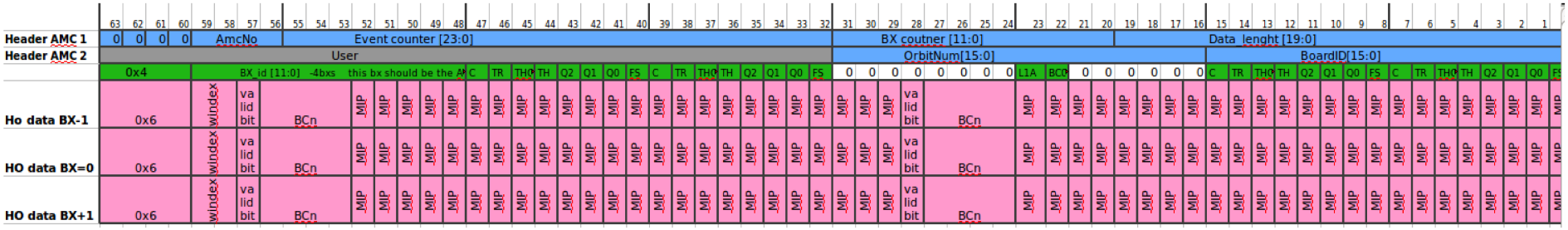
Commissiong Status/ June CMS week

- Commissiong of HO links in TwinMUX:
  - HO TP data-format in TwinMux payload
  - HO fibers plugging to TwinMux at P5
  - New data-format of HO TPs in TwinMux
  - New data-format of HO TPs integrated in CMSSW release
  - HO enabled in TwinMux software
  - Updated HO oSLB firmware from BU
  - HO TwinMux link alignment
  - New electronics Emap of HO from oSLB to TwinMux
  - HO TP unpacker in TwinMux
  - Inclusion of HO+DT algorithm in TwinMux Emulator
  - Preparation of LUT for reading HO in TwinMux firmware
  - Inclusion of HO plots in DQM
  - Implementation of HO-DT-RPC super-primitive in TwinMUX



Electronic Emap to read HO in TwinMux

- TwinMUX payload
  - TwinMUX Unpacker unpack the HO bits in 3 BX. As obvious, some Emap was needed to translate this bit info to (eta, phi).



- EMap was needed to translate to geometrical coordinates (eta, phi)

sector	ring	TwinMux	TwinMux-link	TwinMux_bit	subdet	ieta	iphi
2	-1	YB-1_S2	6	15	TwinMux	-5	5

- Created the Emap for TwinMUX HO bits (snapshot above)
- The critical task for unpacker was to establish the consistency of this new Emap created for TwinMUX with the Emap of HCal.
- Well tested in today's date!

HO TP unpacker in TwinMUX

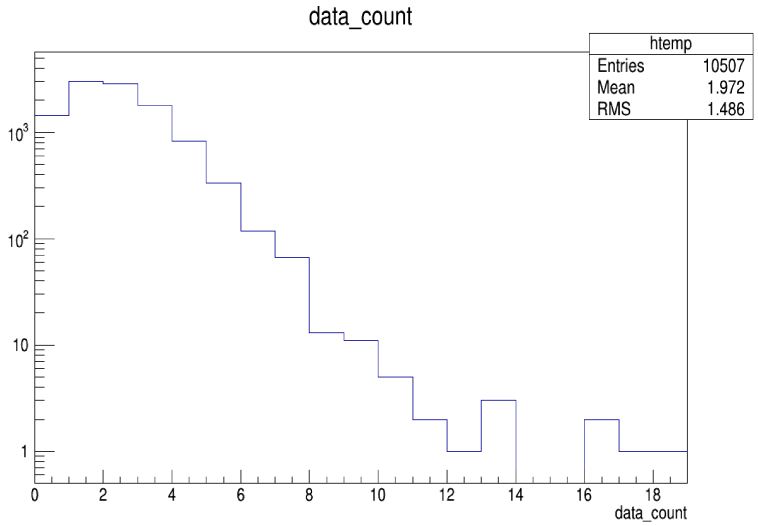
- Presented the detailed report last L1 trigger meeting [*]
- Summary:
  - HO unpacker in TwinMUX is well tested with 2017B dataset.
  - Validity of the EMap is confirmed with the unpacker testing, 56% matched.
  - Unpacker Testing has spotted some spurious HO TPs.
  - Received suggestion from Karol to introduce the valid-bit check from TwinMux payload, which mark the good data.
  - Recent results are shown with valid-bit.

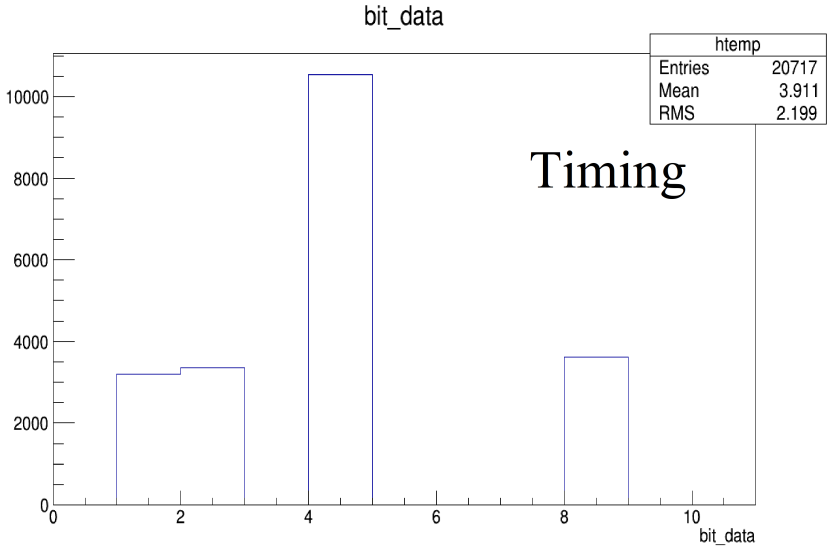
[*] https://indico.cern.ch/event/655486/

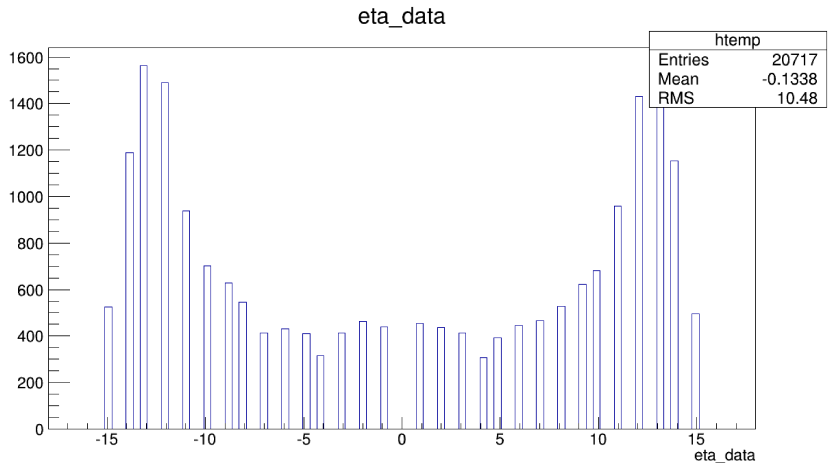
DESY

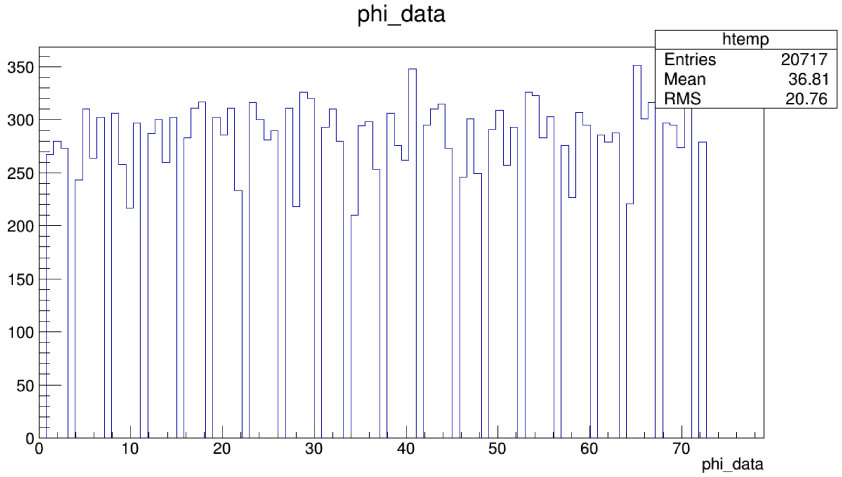
HO TPs from HCAL FEDS

HO Tps from HCAL FEDs







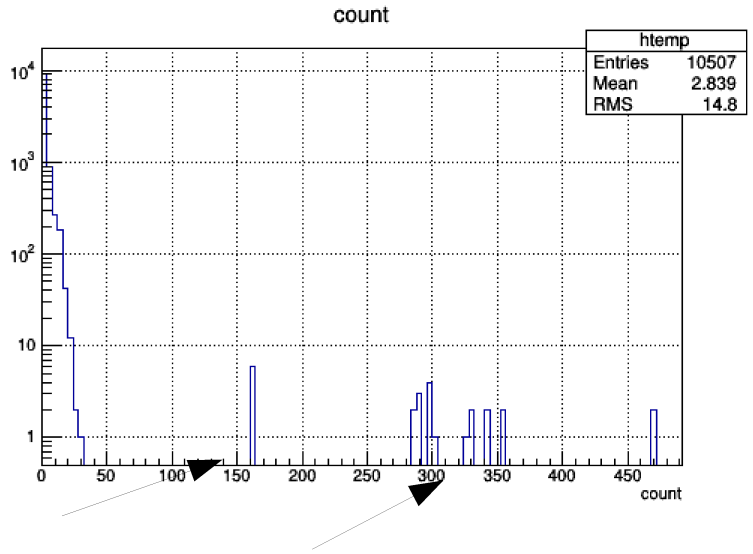


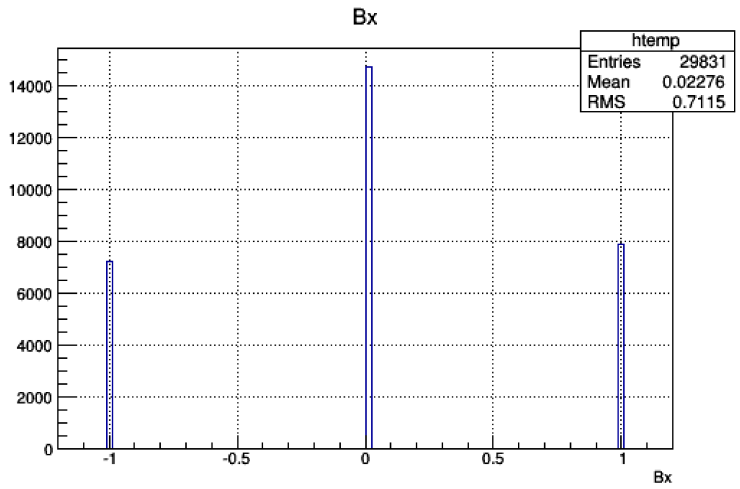
- TP distribution (data_count) looks reasonable and maximum value is less than 20.

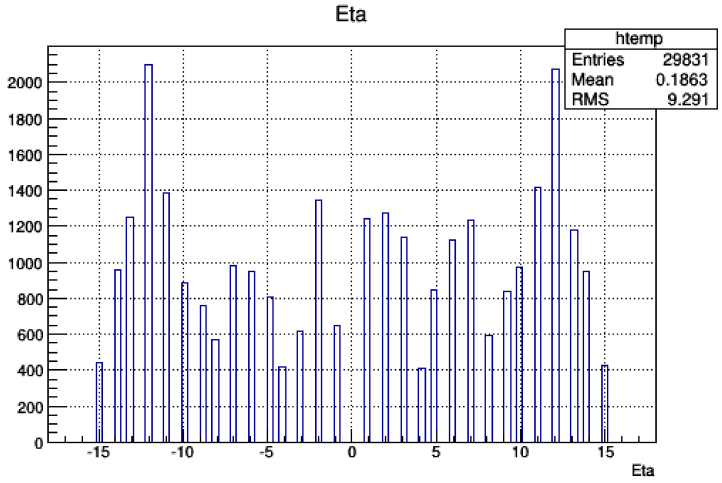
HO TPs from TwinMUX FEDS

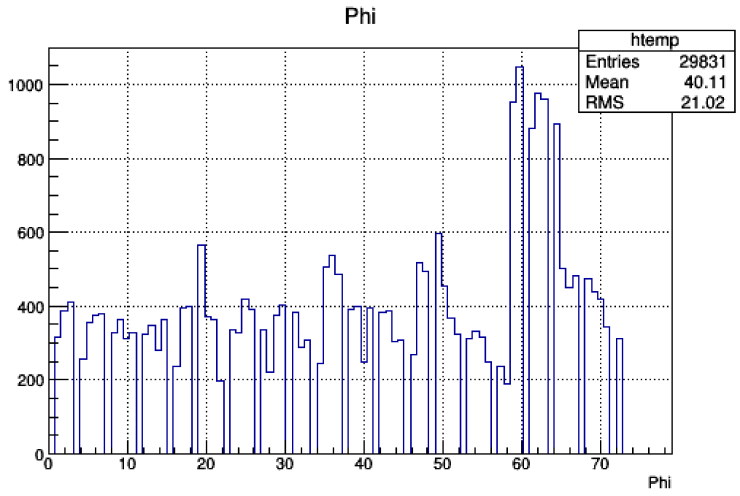
[without Valid-bit testing]

TwinMux HO TPs / No Selection



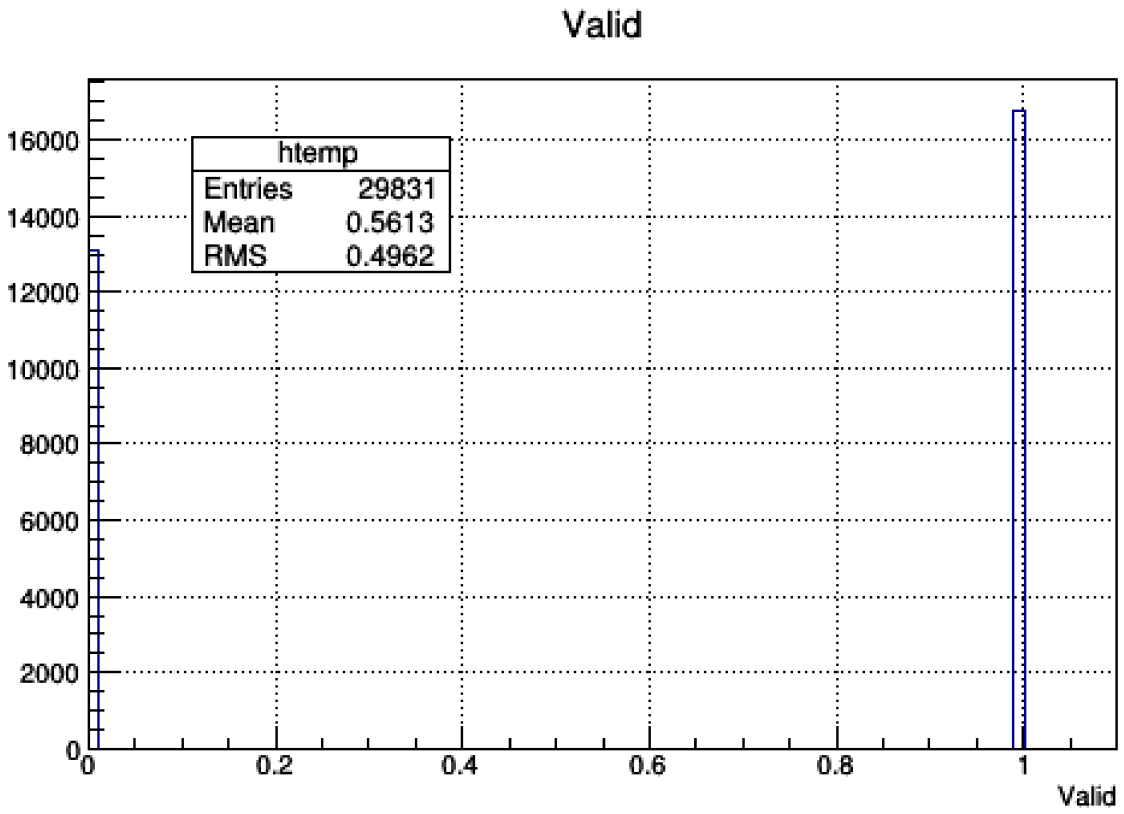






- Spurious Tps (count) are visible (nTP > 20), not expected

TwinMux HO TPs / No Selection

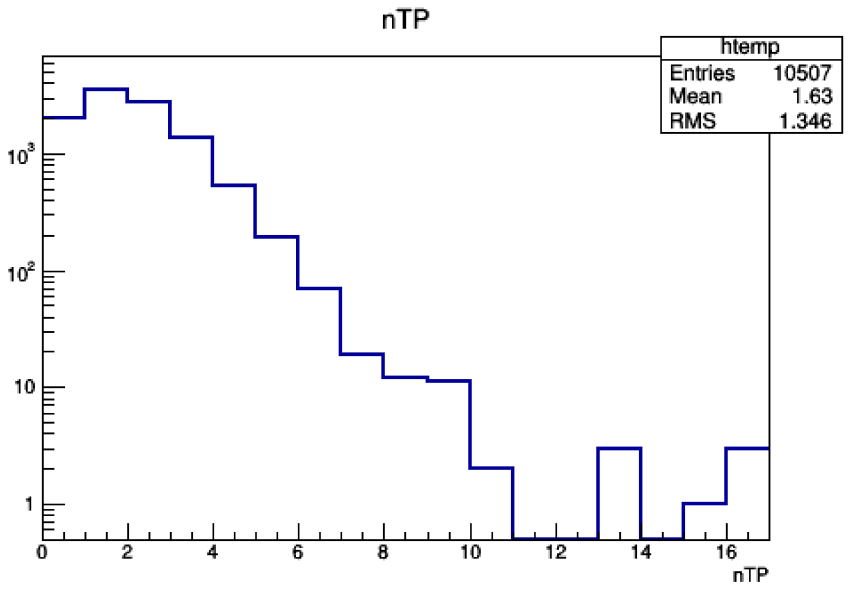


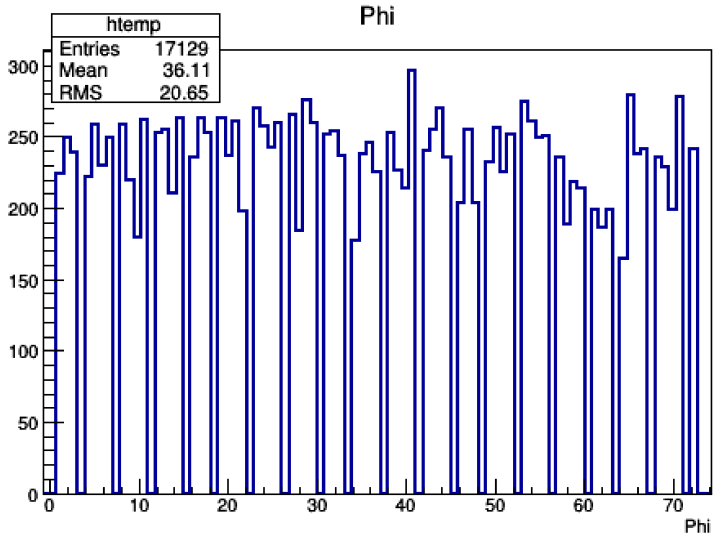
- TPs are consistent with HCAL TPs for 56% cases, ie. valid is high for 56%

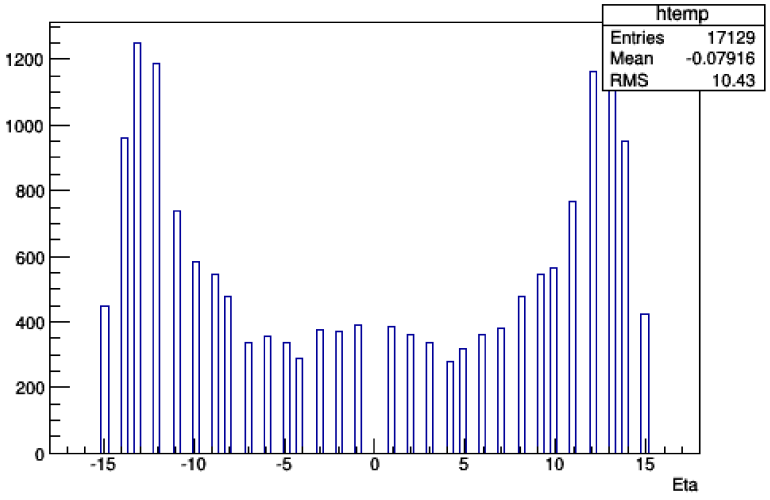
HO TPs from TwinMUX FEDS

[GoodDataMarker flag (valid) ON for both Links]

TwinMux HO TPs / No Selection

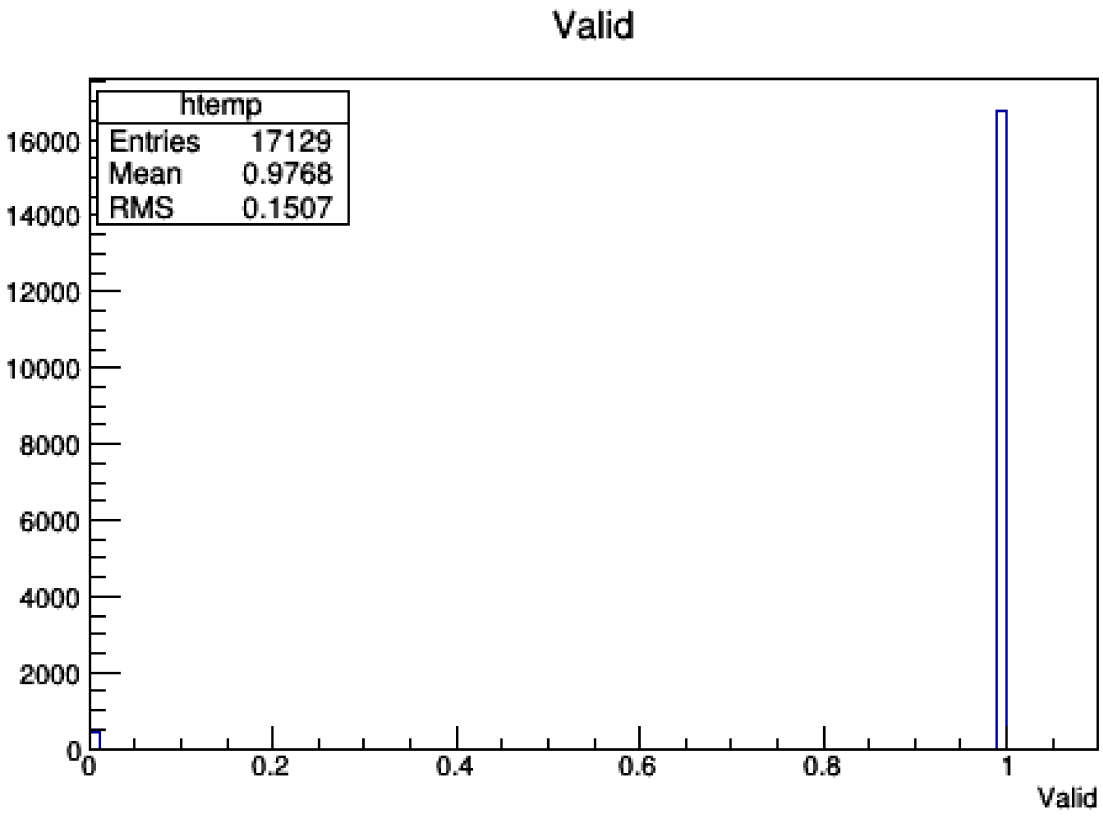






- No of TPs same as from HCAL FEDS, (10507)

TwinMux HO TPs / No Selection



- Valid is high for ~98%, ie. TwinMux TPs are consistent with HCAL Tps at given (eta, phi)

HO TP in TwinMux

- New Data Format
  - New HO TP class (HOTPDigiTwinMux) is integrated in CMSSW[1]

```
HOTPDigiTwinMux(int eta,
                int phi,
                int bx,
                int mip,
                bool validbit, //consistency check with HCal FED
                int wheel,
                int sector,
                int index,
                int link);
```

- In recent development, the 'link' values changed from 1,2 to 6,7. Hence, modified the corresponding class and make pull request today.

[1] http://cmslxr.fnal.gov/source/DataFormats/L1Trigger/interface/HOTPDigiTwinMux.h

DESY

Remaining task on Unpacker & EMap

- Adding Electronics Emap in Database
  - Contact person: Vladimir Rokovic
- Modify Unpacker to read Emap from Database, currently reading locally.
- Probing further 2% discrepancies
  - Possibilities:
    - Idles are sent for long orbits, therefore some data might get lost.
    - HO data for bit_data (4) should be checked (ie. the data arriving in right timing), my guess is data arriving earlier in HCAL FEDs can not make in three BX windows of TwinMUx FEDs.

DESY

HO in TwinMUX Emulator

- Implementation of HO-DT matching at the TwinMUX is done by Soham (TIFR).
  - Efficiency gain ~2% seen in barrel gap region
  - Rate increase due to HQ digis was tolerable
- Rate estimation w/o reco info requires the knowledge of how to read pT from the LUTS, in discussion with DT group.
- Contact Person:
  - Soham Bhattacharya

DESY

LUTs for reading HO in TwinMUX firmware

- Conversion of HO coordinates in DT local coordinates was needed to introduce the algorithm in TwinMUX
  - Both detector has different local coordinates
- LUT files are ready for all wheels, given the criteria mentioned by Andrea Triossi.
  - have 8 bits for an eta mask and 4 bits for the local HO phi coordinate
- Link to the LUTs files:
  http://cmsdoc.cern.ch/cms/HCAL/document/Mapping/HO/oSLB/TwinMux_HO_LUTs.xls
- Further discussion is needed within L1 trigger group for Andrea Triossi to implement DT+HO algo. in firmware incorporating these LUTs.
- Contact Person:
  - Richard Kellogg

DESY

Commissiong Status/ Today

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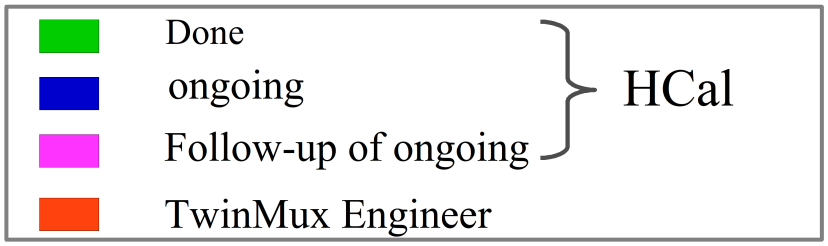


TwinMUX → BMTF

- As has been discussed with L1 trigger group. HO+DT super-primittive should be consider special
  - should have different quality value

- BMTF engineer (Janos) presented his ideas in January CMS week about introducing HO in BMTF.
  - https://indico.cern.ch/event/608148/contributions/2459315/attachments/1405027/2146145/20170131_Muon-trigger-meting.pdf

- Contact Person:
  - Jorge Fernandez De Troconiz (senior BMTF Enginner)
  - Stavros Mallios (current BMTF Enginner)
  - Georgios Karathanasis (BMTF emulator developer)

Remaining Task

- HO Unpacker
  - Probe the source of 2% discrepencies
  - Add Emap in database
  - Modify unpacker to read Emap from databse, currently reading locally.

- TwinMUX firmware should implement HO+DT algorithm.
  - We have provided the LUT for conversion of HO coordinates in DT local coordinates
  - It will be done by Andrea Triossi
  - L1 Trigger meeting should be targeted for this.

- As Costas demanded (during June CMS week meeting):
  - Firstly BMTF emulator studies should be performed. If the results are optimistic, then only the BMTF firmware should implement the HO+DT algo.
  - This should be discussed with L1 trigger meeting.

Summary

- HO unpacker in TwinMUX is well tested with 2017B dataset.
  - Validity of the Emap is confirmed with the unpacker testing, 98% matched.
  - Pushed my code-setup in git:

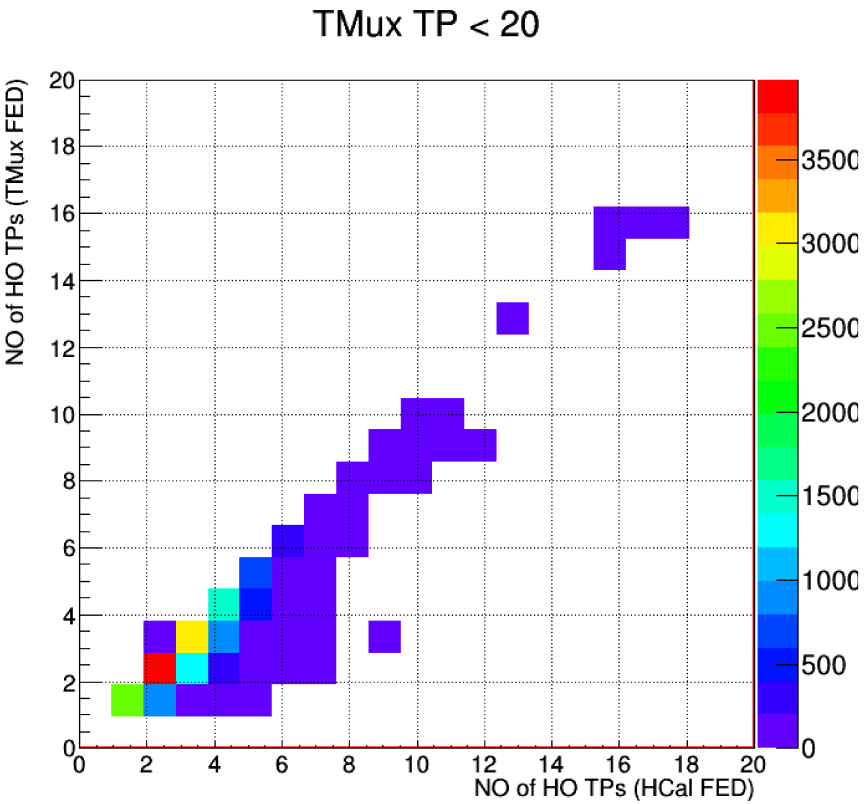
    https://github.com/saxenapooja/cmssw/tree/hotp-unpacker
- HO-DT algorithm is well introduced in TwinMUX emulator.
  - In discussion with DT group regarding the rate studies using LUTs
- LUTs for introducing the HO in TwinMUX firmware is ready.
  - As criteria given by Andrea Triossi
- Studies with BMTF are important for correct estimation of the improvement HO could offer.
  - So far, nothing has been worked on.
- HO→TwinMUX chain is accomplished .
  - The discussion with L1 trigger on pursuing BMTF chain should be pushed.

I would like to thank you all for your cooperation throughout this project.

DESY

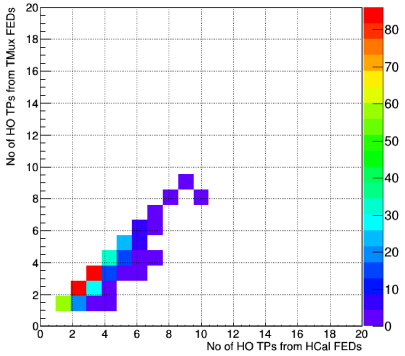
Backup

Hcal Tps vs TwinMUX TPs

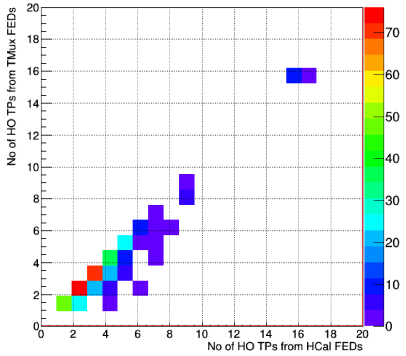


Wheel : 2

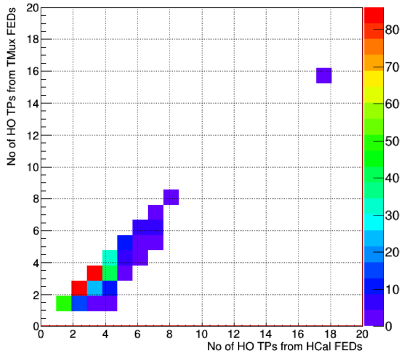
Wh2_Sec1



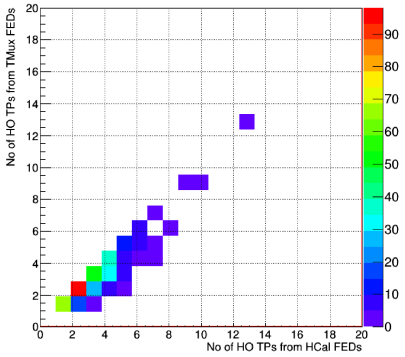
Wh2_Sec2



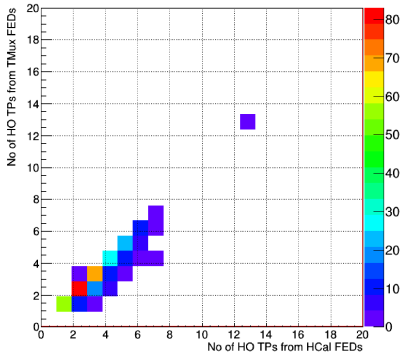
Wh2_Sec3



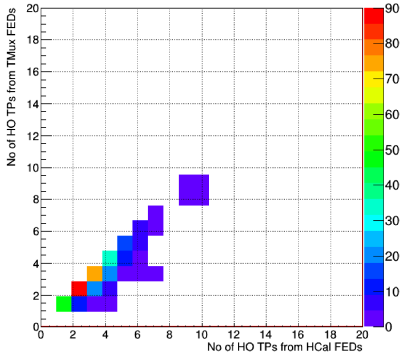
Wh2_Sec4



Wh2_Sec5

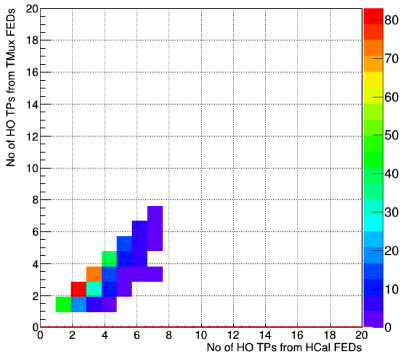


Wh2_Sec6

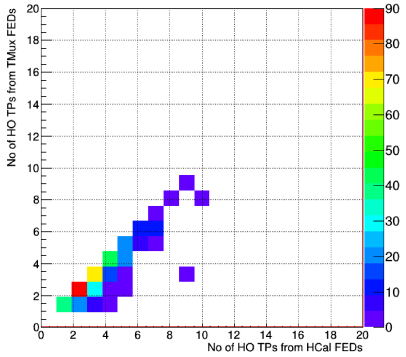


Wheel : 2

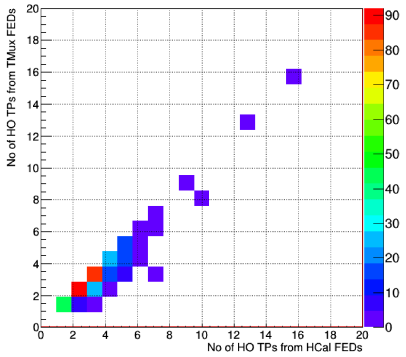
Wh2_Sec7



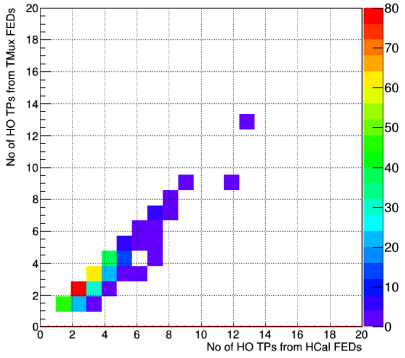
Wh2_Sec8



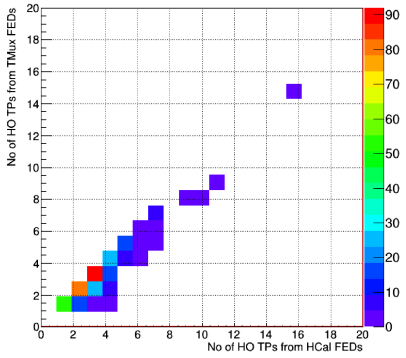
Wh2_Sec9



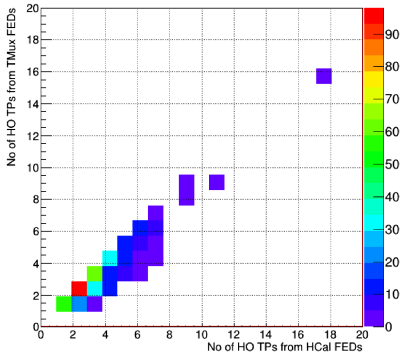
Wh2_Sec10



Wh2_Sec11

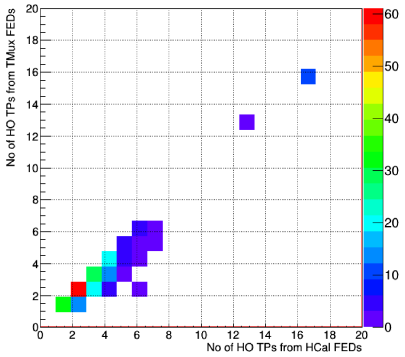


Wh2_Sec12

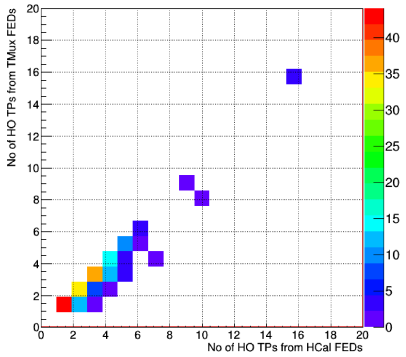


Wheel : 1

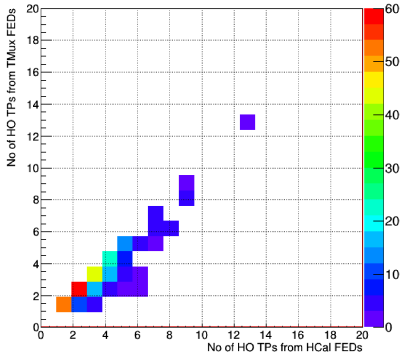
Wh1_Sec1



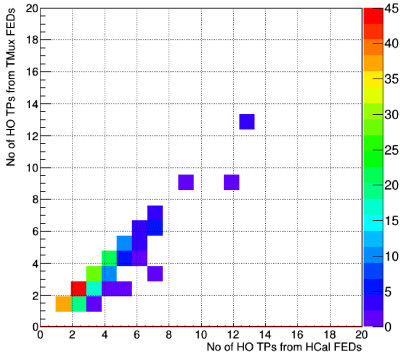
Wh1_Sec2



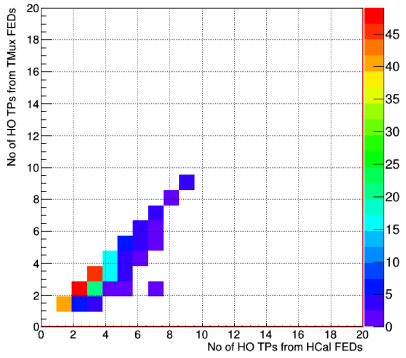
Wh1_Sec3



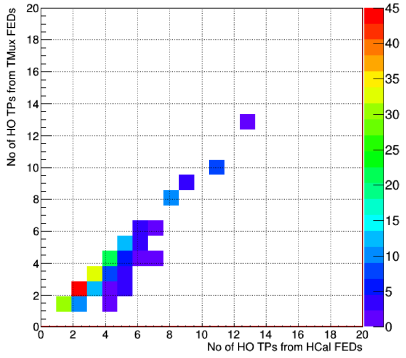
Wh1_Sec4



Wh1_Sec5

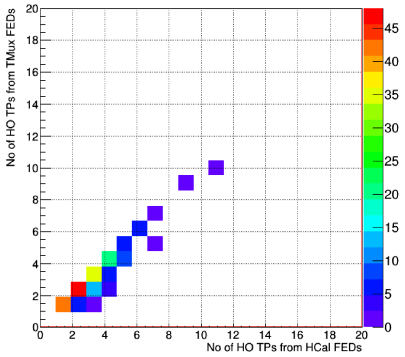


Wh1_Sec6

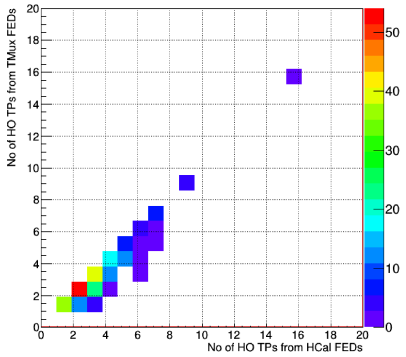


Wheel : 1

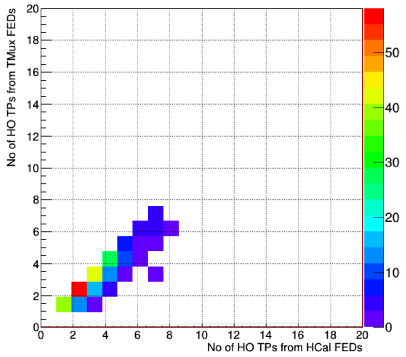
Wh1_Sec7



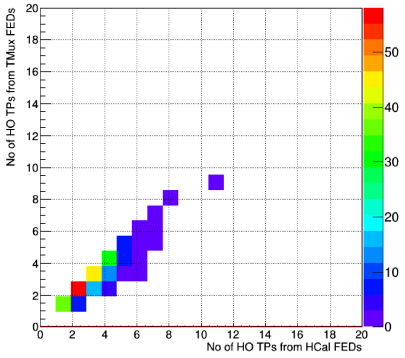
Wh1_Sec8



Wh1_Sec9



Wh1_Sec10



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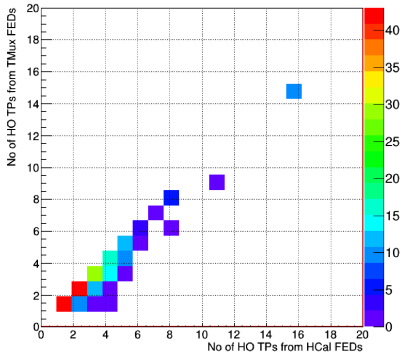
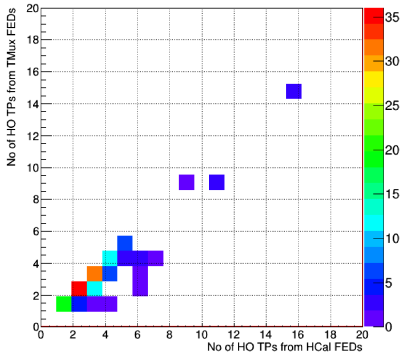
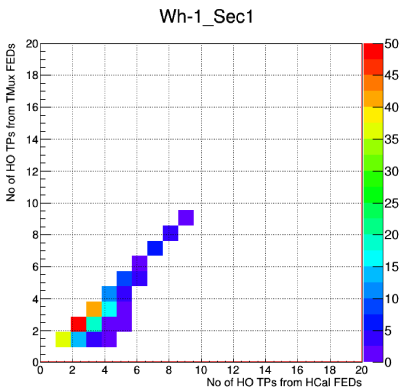
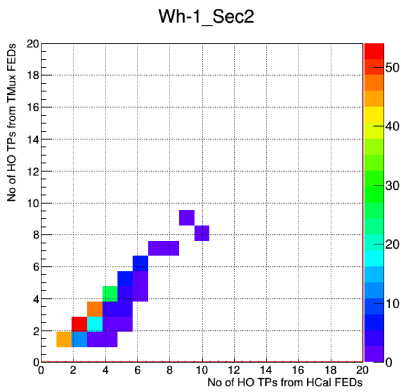


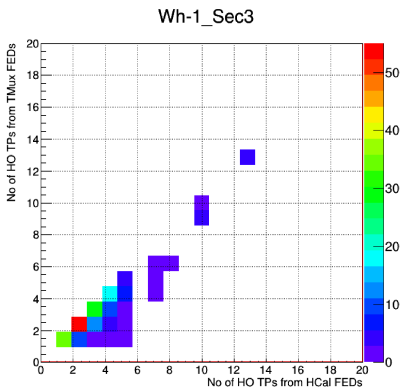
Wh1_Sec12

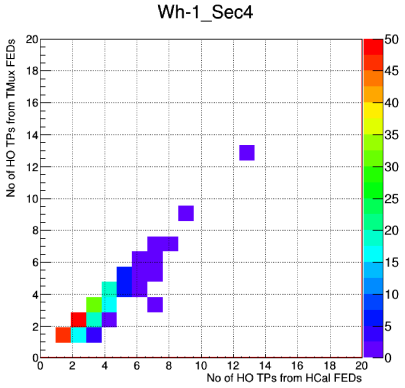


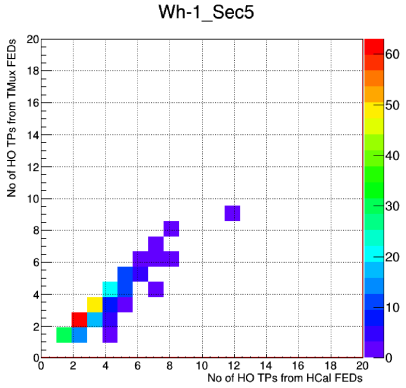
Wheel : -1

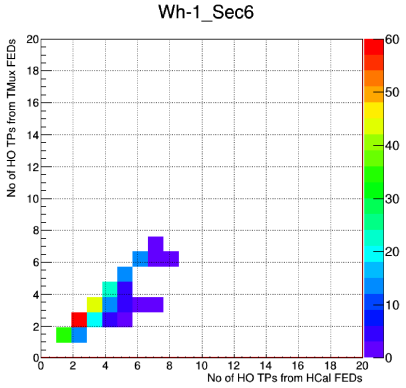

Wh-1_Sec1
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs


Wh-1_Sec2
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs


Wh-1_Sec3
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs

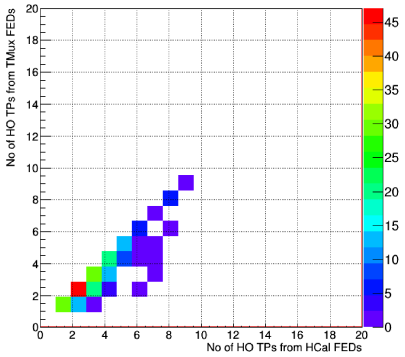

Wh-1_Sec4
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs


Wh-1_Sec5
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs

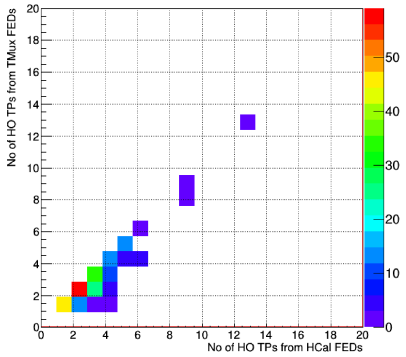

Wh-1_Sec6
No of HO TPs from TMux FEDs
No of HO TPs from HCal FEDs

Wheel : -1

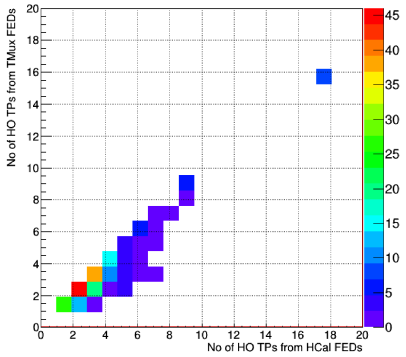
Wh-1_Sec7



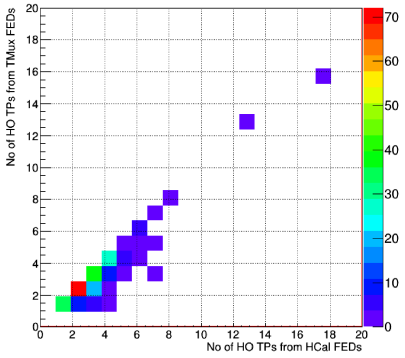
Wh-1_Sec8



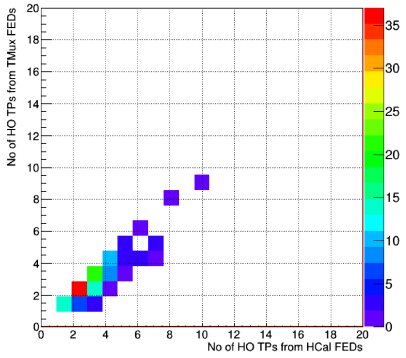
Wh-1_Sec9



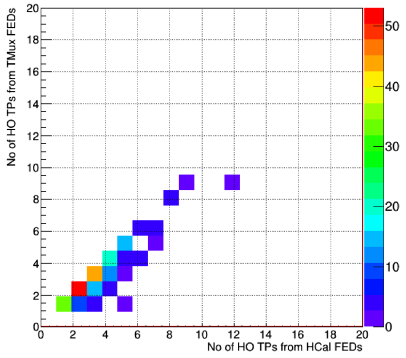
Wh-1_Sec10



Wh-1_Sec11

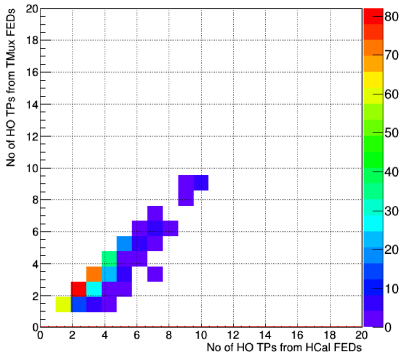


Wh-1_Sec12

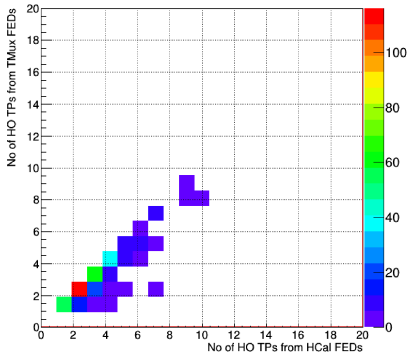


Wheel: -2

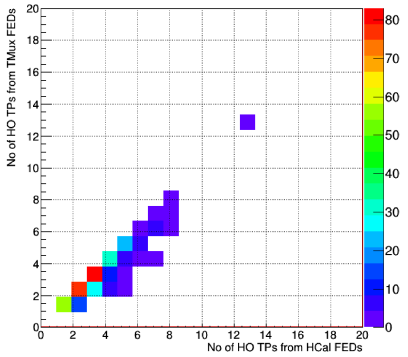
Wh-2_Sec1



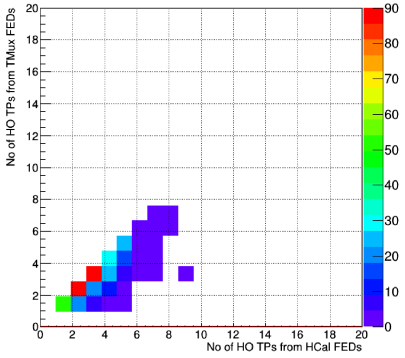
Wh-2_Sec2



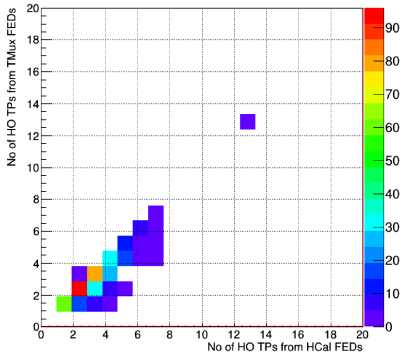
Wh-2_Sec3



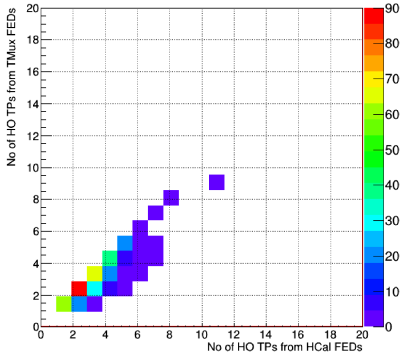
Wh-2_Sec4



Wh-2_Sec5

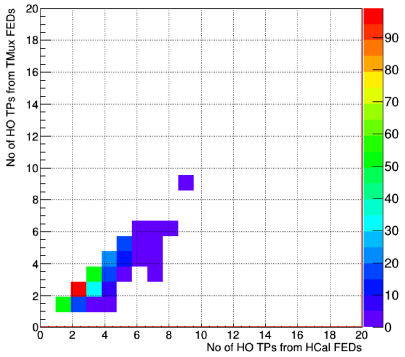


Wh-2_Sec6

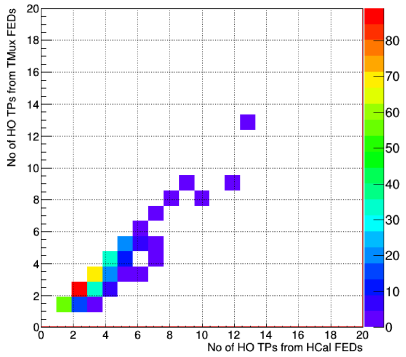


Wheel : -2

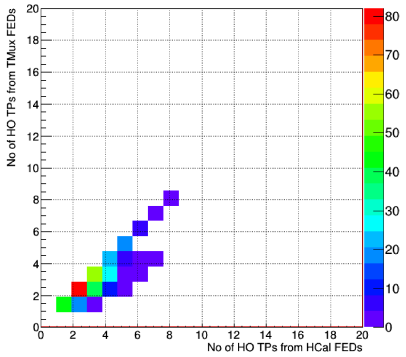
Wh-2_Sec7



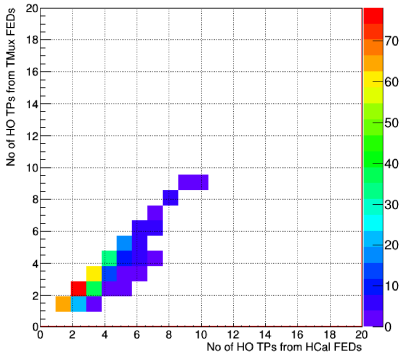
Wh-2_Sec8



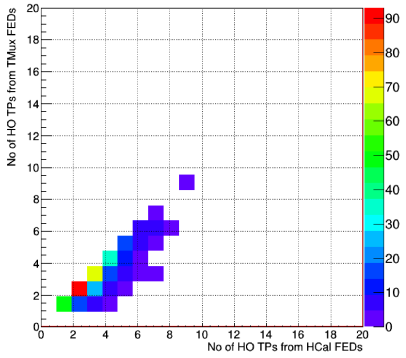
Wh-2_Sec9



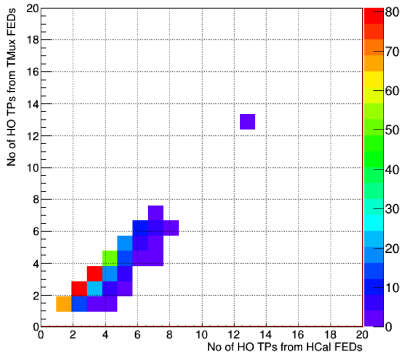
Wh-2_Sec10



Wh-2_Sec11

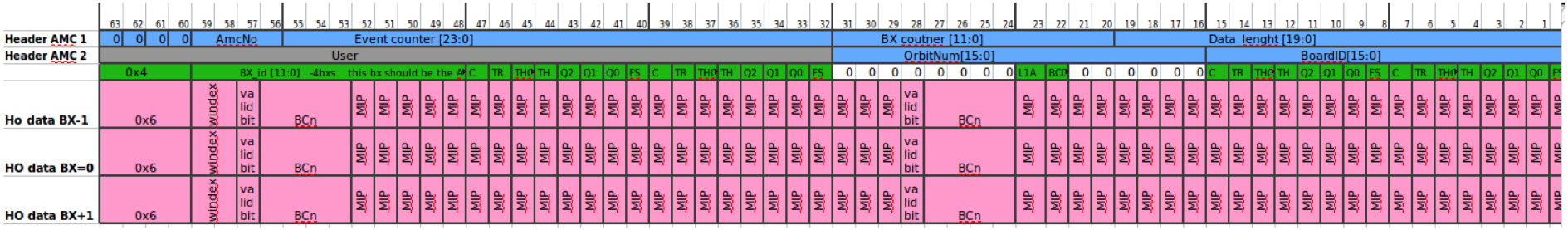


Wh-2_Sec12



HO Unpacker in TwinMUX

- TwinMUX payload
  - TwinMUX Unpacker unpack the HO bits in 3 BX. As obvious, some Emap was needed to translate this bit info to (eta, phi).



- Emap was needed to translate to geometrical coordinates (eta, phi)

sector	ring	TwinMux	TwinMux-link	TwinMux_bit	subdet	ieta	iphi
2	-1	YB-1_S2	6	15	TwinMux	-5	5

- Created the Emap for TwinMUX HO bits (snapshot above)
- The critical task for unpacker was to establish the consistency of this new Emap created for TwinMUX with the Emap of HCal.

HO Electronics Emap

- Prepared the Electronics Emap from TwinMUX link, index to HCal local coordinates (iη,iφ) for whole HO detector
  - Using this as local txt file for unpacker testing
    - Working on validity of HO TPs in TwinMux with TPs from HCal FEDs
    - Conversion to coordinates required by TwinMux
  - Will request to add this Emap in database of L1 trigger.

- Additional remarks:
  - New HO TP class (HOTPDigiTwinMux) is in CMSSW[1]

    HOTPDigiTwinMux(int ieta, int iphi, int bx, int mip, int validbit, int wheel, int sector, int index, int link)
  - New Electronics class for this EMap need to be written

[1] http://cmslxr.fnal.gov/source/DataFormats/L1Trigger/interface/HOTPDigiTwinMux.h

DESY