ANALYSIS WITH TWR DATA 2003

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- The Analysis can be found at:

  `http://www.ps.uci.edu/~silvestri/GRB.html`

- Comparison TWR-DAQ and Muon-DAQ systems
- Blind Analysis
- Raw TWR and Muon data 2003
- TWR and Muon T0 Calibration and HIT Cleaning
- Minimum Bias Reconstruction
- L1-level Muon Reconstruction, L2-level and Final Results
- Composite WF
- Conclusion and Future Plans

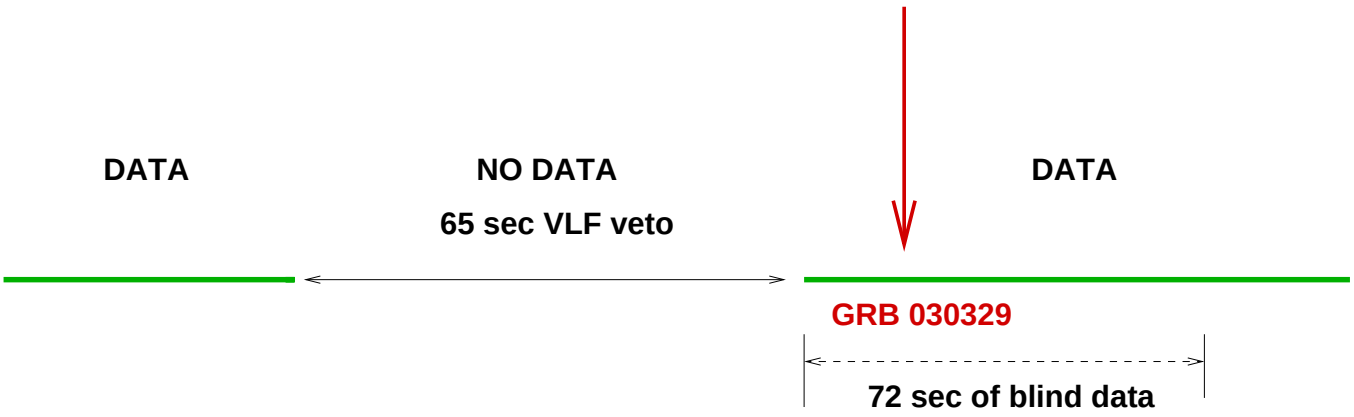
AMANDA collaboration meeting at University of Wisconsin
Madison - June 2003

GOAL OF THIS ANALYSIS

- Show the capabilities of the new TWR DAQ System
- Compare two independent sets of data (TWR/Muon)
- Perform very similar analysis $\longrightarrow$ get same results
- Charge from Waveform: 1.HIT reconstructed only
- Improve TWR capabilities: reconstruct more HITs and After-Pulse
- Extraordinary GRB event on March 29, 2003 UTC 41834.0
- Blind analysis of 8.5 minutes data around GRB spot
- Data used: unfiltered data, multiplicity M=24
- Two different T0 calibrations (TWR/Muon)
- Very good agreement at all analysis levels
- ZERO background events for 8.5 minutes data

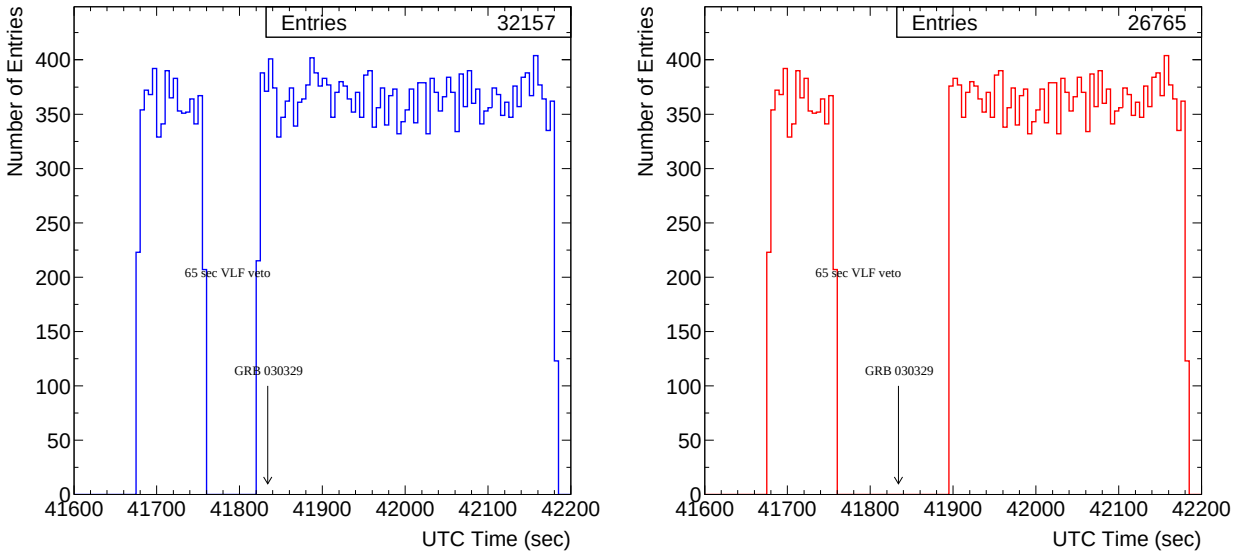
BLIND ANALYSIS

- GRB event UTC 2003 88 41834.0 (March 29, 2003)
- Raw TWR/Muon Data: sample of 504 sec
  UTC = (41676.990970 - 42181.717768) sec
- VLF-antenna veto: 65 sec long Gap found on this data sample
- BLIND requirement:
  12 sec before GRB + 60 sec after GRB = 72 sec



BLIND ANALYSIS

- Decision made according to the time since trigger Δt taken by the HETE experiment ($\Delta t \approx 50$ sec)
- We decided to reconstruct all events, to prove agreement between TWR and Muon numbers of all events reconstructed
- On reconstructed events we applied the blind requirement
- GMTSEC: GMT second distribution
- the blue one before and the red one after blind requirement



RAW DATA 2003 AND PROCESSING

- Raw TWR and Muon data $\longrightarrow$ Multiplicity M=24
- 8.5 minutes data: TWR data volume $\approx$ 455 MB; Muon data volume $\approx$ 38 MB (in TWR all WFs recorded)
- Reader: Amanda Reader ver. 2.4.0$\longrightarrow$F2K file;
  TWR-Reader$\longrightarrow$ ROOT file
  TWR-Merger (F2K file + ROOT file) = F2K merged file
- One single merged file for the two different analysis
- Analysis Chain: Raw data$\longrightarrow$Minimum Bias reco$\longrightarrow$L1-level muon reco$\longrightarrow$L2-level and final cuts$\longrightarrow$Results
- Passing rates

RECO	TWR DATA	MUON DATA
merged data	32168	32168
minimum bias	32158	32163
blind requirement	26765	26767
L1- muon recoos	369	364
L2- and final cuts	ZERO	ZERO

OM-SELECTION

- In order to reconstruct exactly same events in both data samples:
  - Same OM-Selection
  - Same standard HIT-Cleaning
- All available TWR channels = 575 OMs
- Important to consider following numbers to understand: TWR system is completely equivalent to Muon system
- 144 BAD MUON-OMs excluded
  (list used for standard reconstruction)
- 106 NOT CONNECTED TWR CHANNELS
- 101 COMMON OMs
  (bad muon OMs $\equiv$ not connected TWR)
- Difference of 5 OMs: (OM #: 27, 60, 61, 117, 474)
- TWR system$\longrightarrow$ No OM deficit at all!
- We started the analysis with all available 575 TWR channels

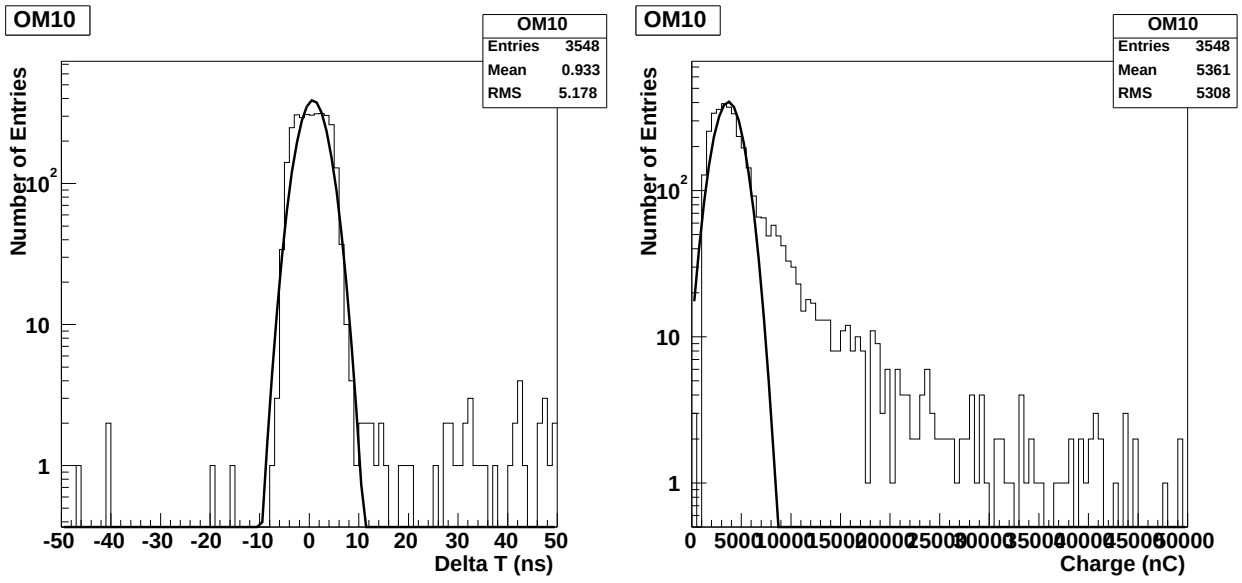
TWR/MUON T0 CALIBRATION

- Preliminary T0 calibration of Muon data: calibration file 2002 adopted (amacalib.2002.020501.db) used also for 2003 online processing at the Pole

- TWR T0 calibration (see Jiwoo's Talk):
  - GEOMETRY the same;
  - TIMING: same absolute time and correction on LE time difference between TWR/Muon DAQ; updated α according to the charge;
  - ADC correction extracted by the charge.

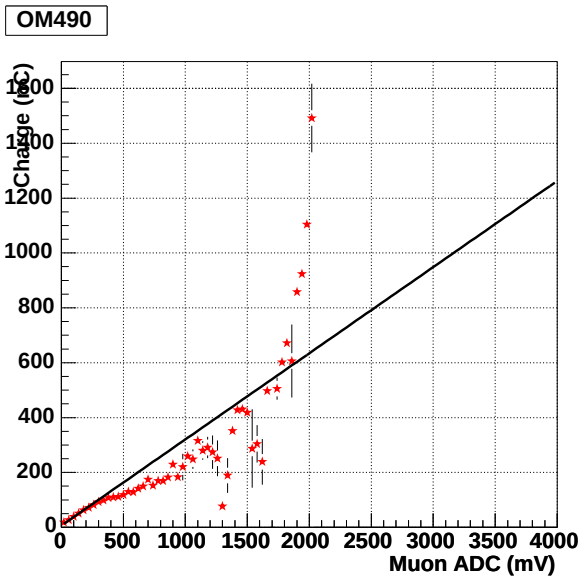
- Time resolution of order of $\sigma_{\Delta t} \approx 5$ nsec

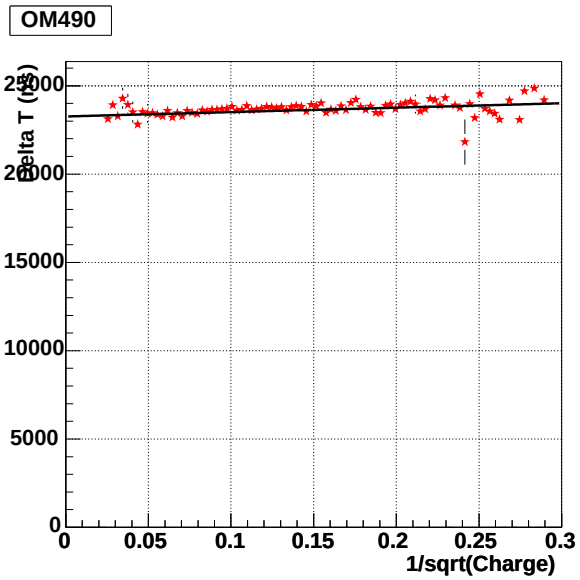
- 1PE fit from charge distribution



TWR/MUON T0 CALIBRATION

- Charge extracted for the 1.HIT only
- Charge does not saturate as quickly as ADC amplitude
- Improve charge by extracting info from more HITs and After-Pulse
- Improve Energy and Angular resolution
- Still semi-dependent TWR T0 calibration on Muon Trigger
- Future: Independent TWR trigger system



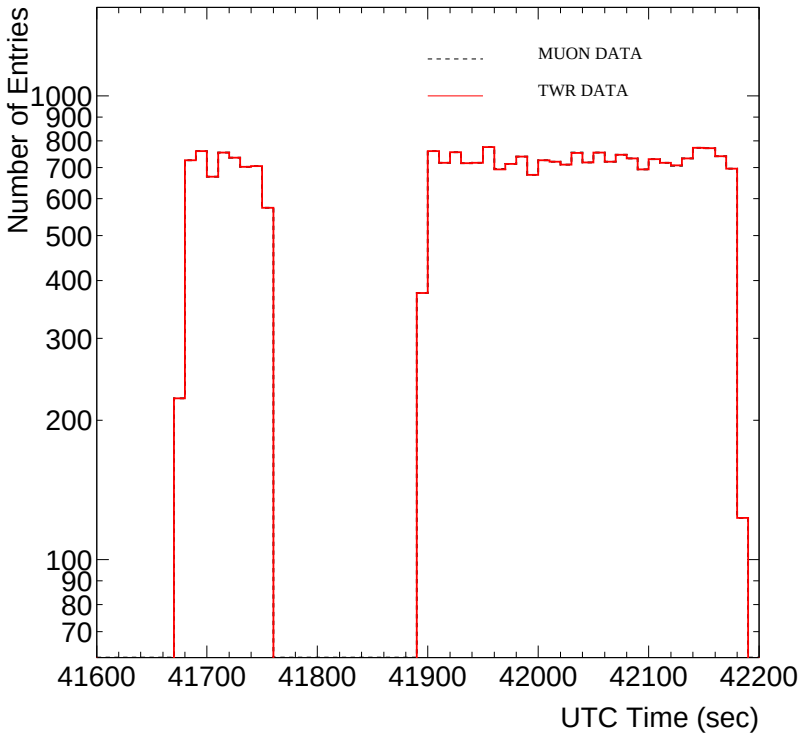


MINIMUM BIAS RECONSTRUCTION

- Minimum Bias Reconstruction: Zeuthen script "reco-2000-L1.script" updated, April 2002
- Bad OM period of the year: only the 106 not-connected TWR channels
- Input file: same merged file for TWR/Muon Analysis (`ab_2003_088_7002_028.data.mu.min_bias.ready_for_tdrss.gz`)
- MB reconstruction:
  - Bad-OM selection
  - Calibration
  - HIT-cleaning
  - All event reconstructed
- Raw TWR Data 32168$\longrightarrow$32158 events reconstructed
- Raw Muon Data 32168$\longrightarrow$32163 events reconstructed
- Compare TWR/Muon system $\longrightarrow$ study of most important variables

MINIMUM BIAS RECONSTRUCTION

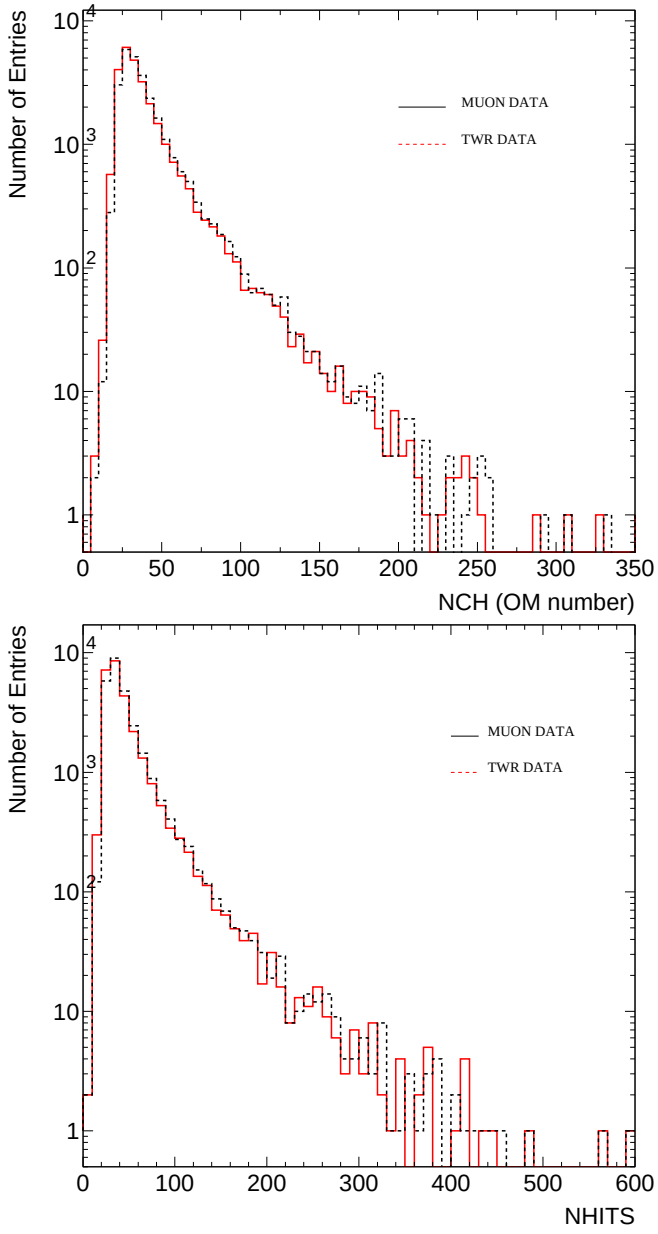
- RECOOS kept for both samples 99.97% of all initial events
- We were able to find very good agreement for all variables
- GMT second distribution agrees exactly on both data sample $\longrightarrow$ we are looking exactly at the same reconstructed data.



MINIMUM BIAS RECONSTRUCTION

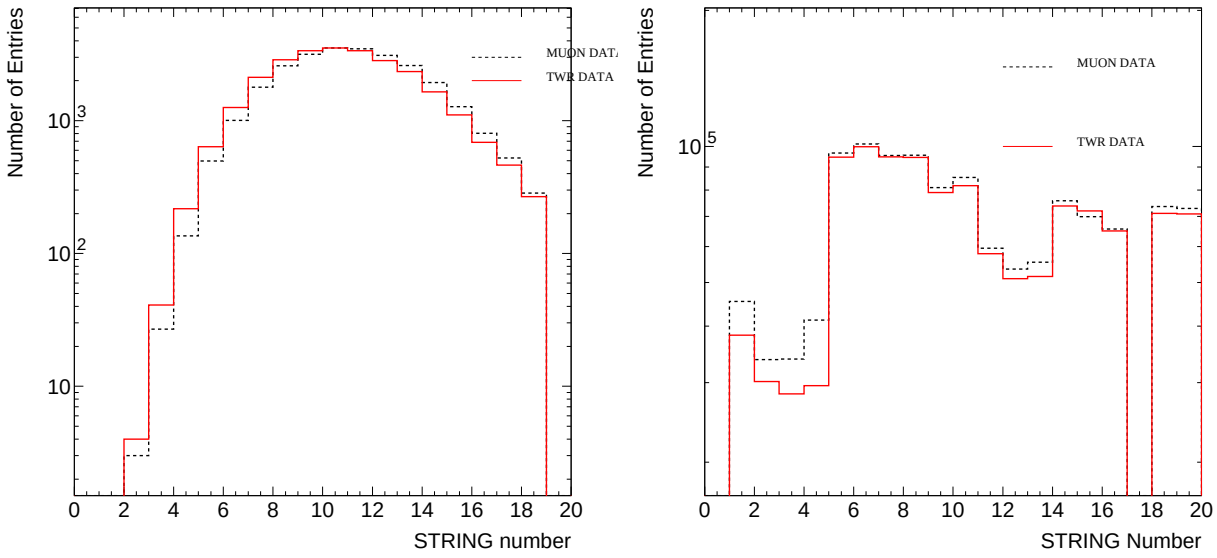
- NCH and NHITS distributions show a perfect agreement (Following plots: TWR are RED and MUON are dashed)

- No deficit for TWR distributions, which might be caused by a lower sample of available OMs



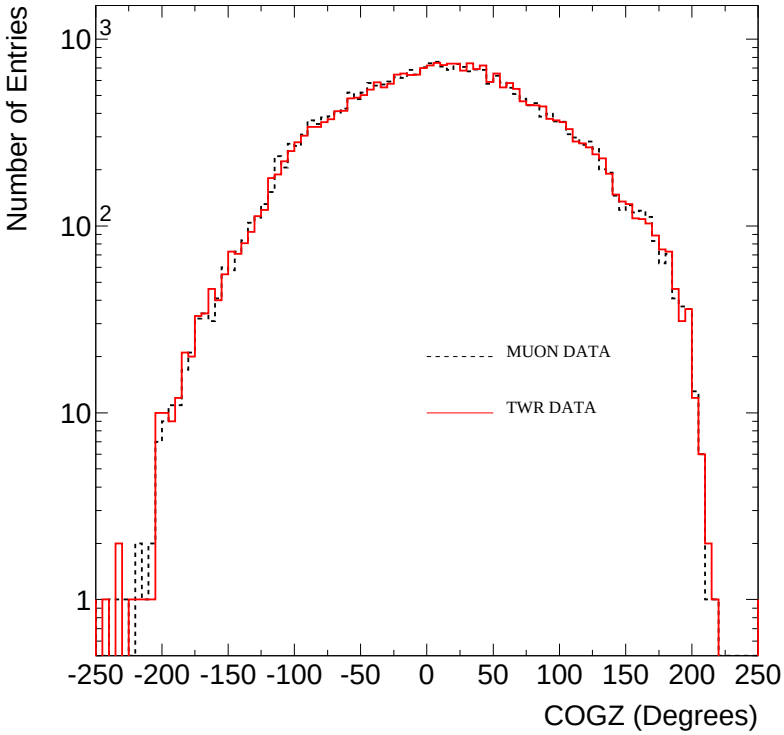
MINIMUM BIAS RECONSTRUCTION

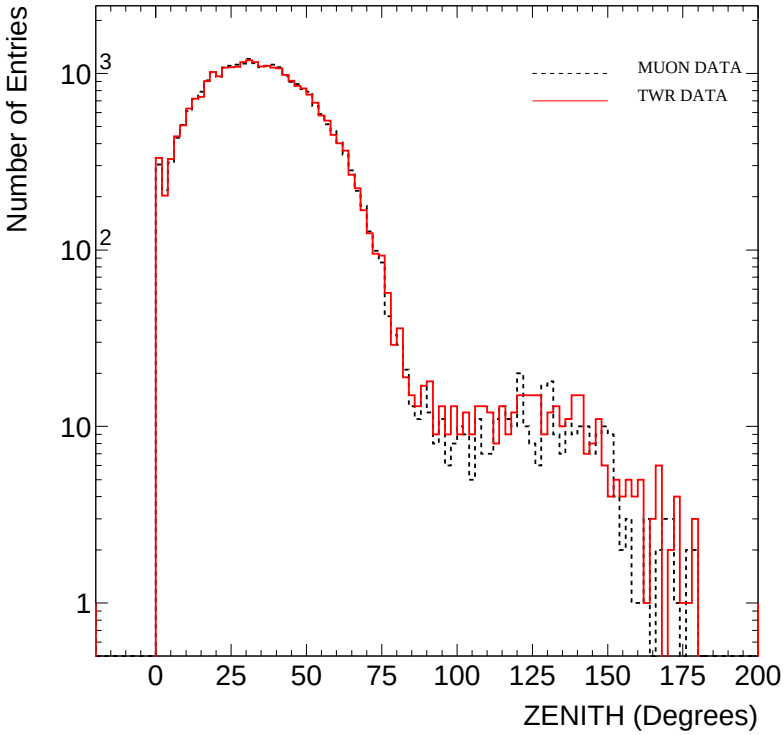
- NSTR (Number hit strings) and HSTR (String number for all OMs) distributions also show a good agreement
- But on this variables the string-1 entries are missing.
- However we do see in reconstructed data that OMs of string 1 are present.
- We are investigating on this feature.



MINIMUM BIAS RECONSTRUCTION

- Reconstructed ZENITH and COGZ agree very well in both sample.

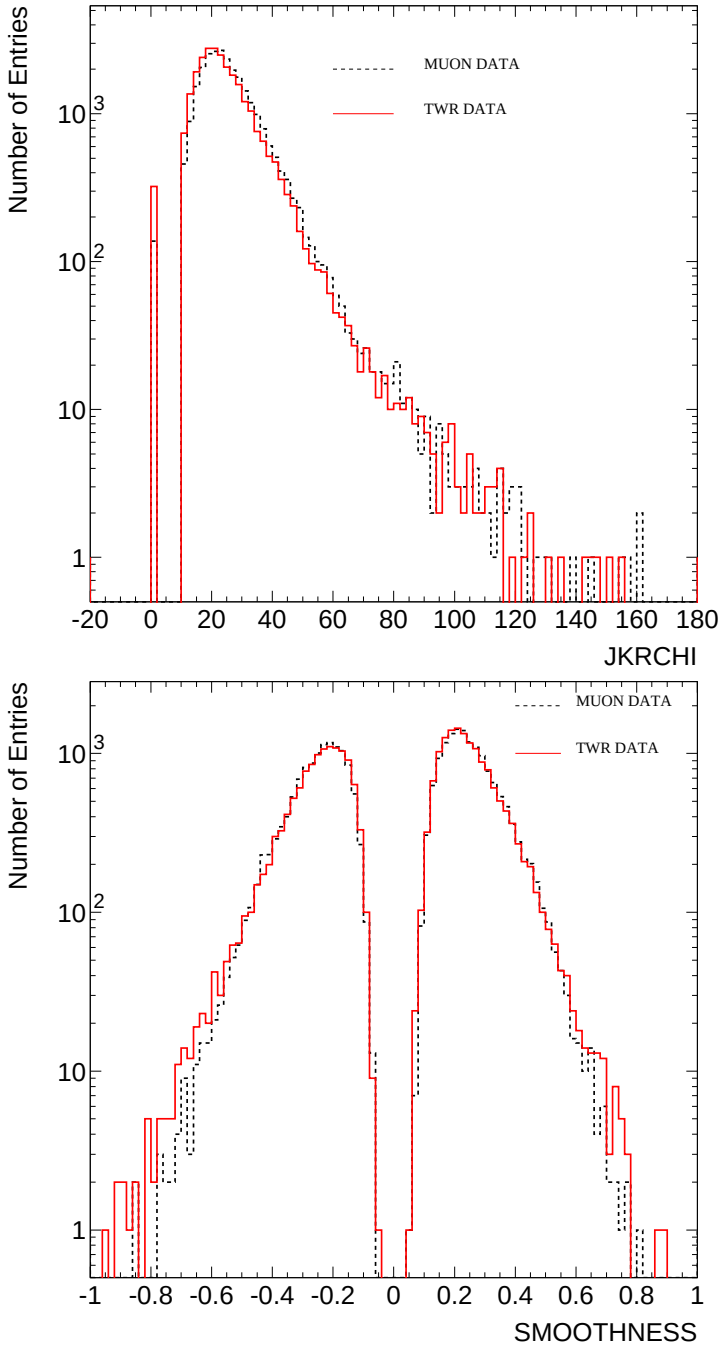




MINIMUM BIAS RECONSTRUCTION

- χ^2-distribution (JKRCHI: Fit result reduced minimum value) and SMOOTHNESS

- Standard variables for higher level cuts agree also very well.



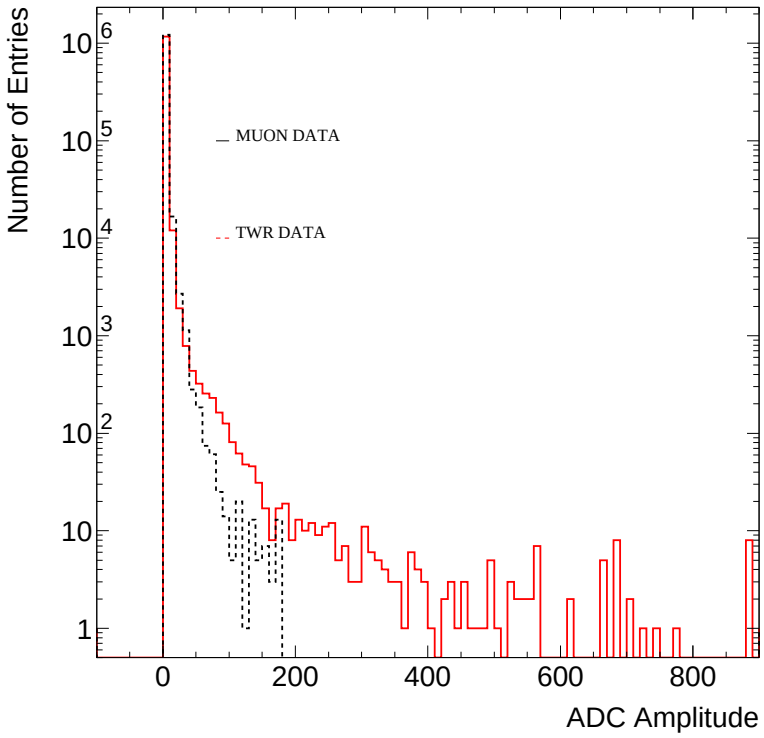
CHARGE VERSUS ADC

- Furthermore we expect an improvement from the TWR data sample for ADC/CHARGE distribution, in particular for higher amplitudes.

- Reconstructed CHARGE keeping 1.HIT only

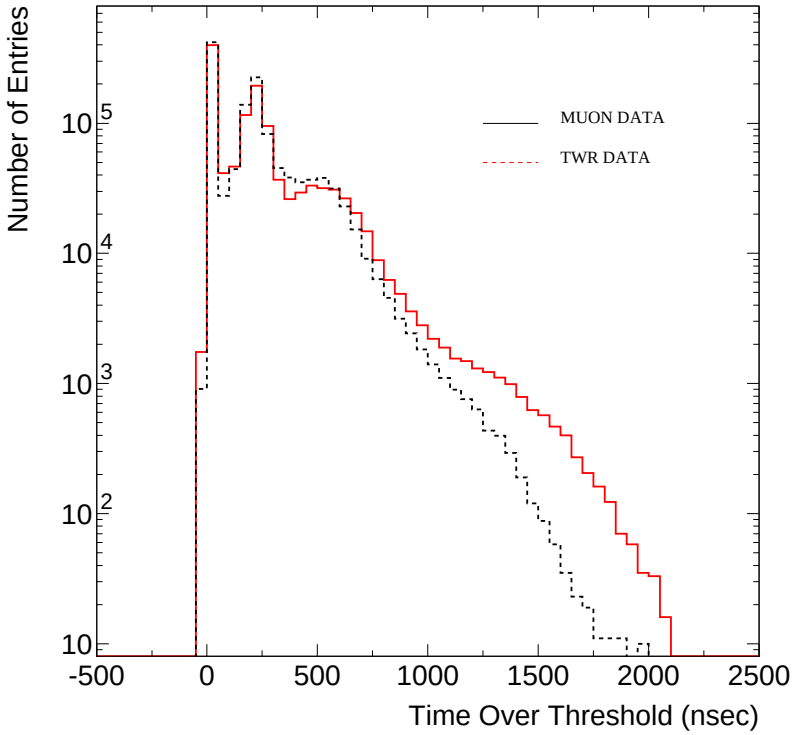
- Compare: full Muon-DAQ amplitude to smallest TWR-DAQ amplitude

- Here: Capabilities of the TWR system are kept at minimum stage.



Time Over Threshold

- Full CHARGE Reconstruction: additional HITs and After-Pulsing from single WF
- Crucial information to develop powerful methods for Energy reconstruction, Energy- and Angular resolution
- TOT distribution: large TWR TOTs value due to lower TWR-DAQ thresholds of some channels compared to Muon-DAQ

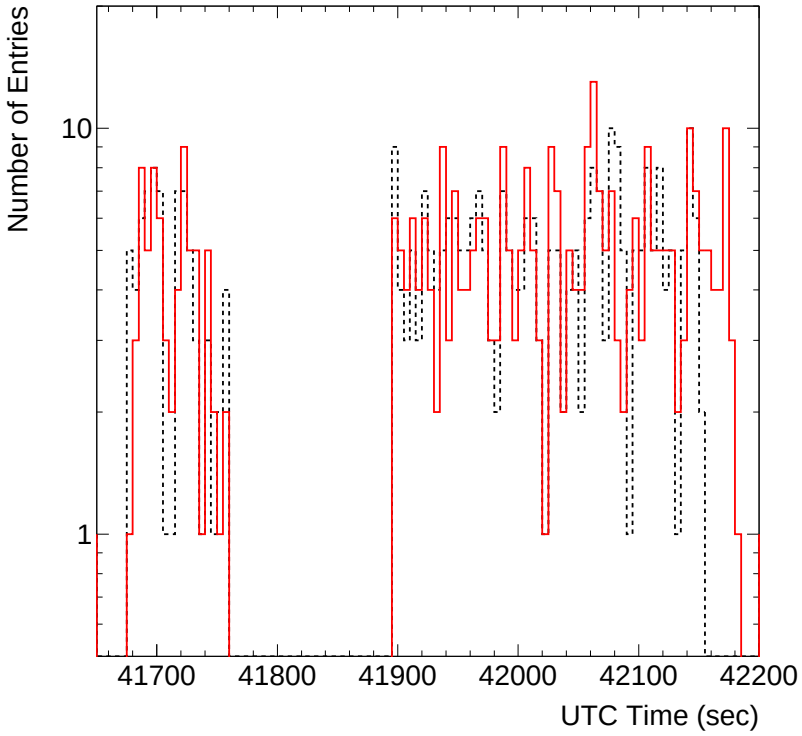


L1-LEVEL MUON RECONSTRUCTION

- At this stage stronger cuts have been applied:

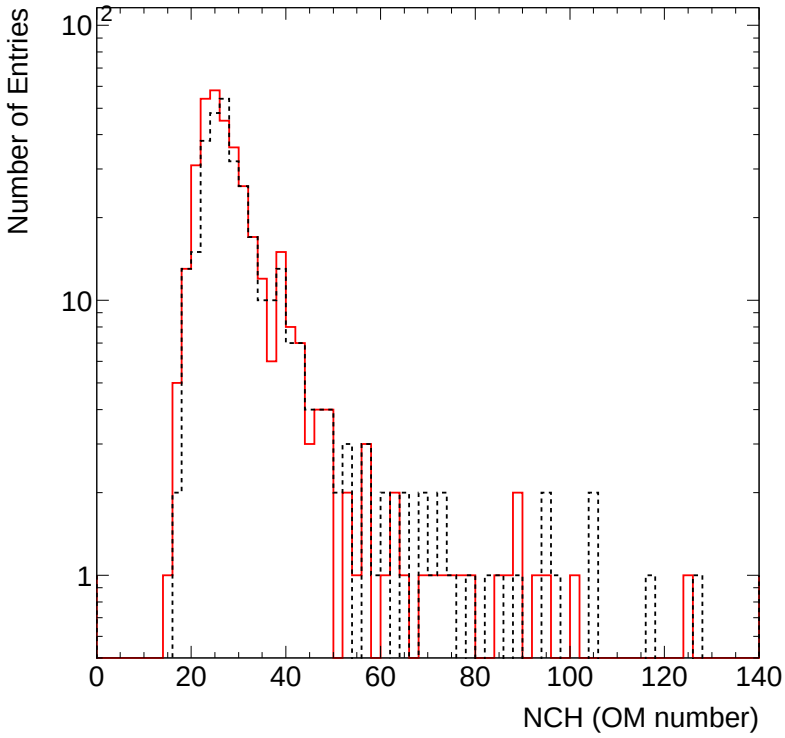
  ZENITH(1)$> 70^{o}$ and ZENITH(2)$> 70^{o}$

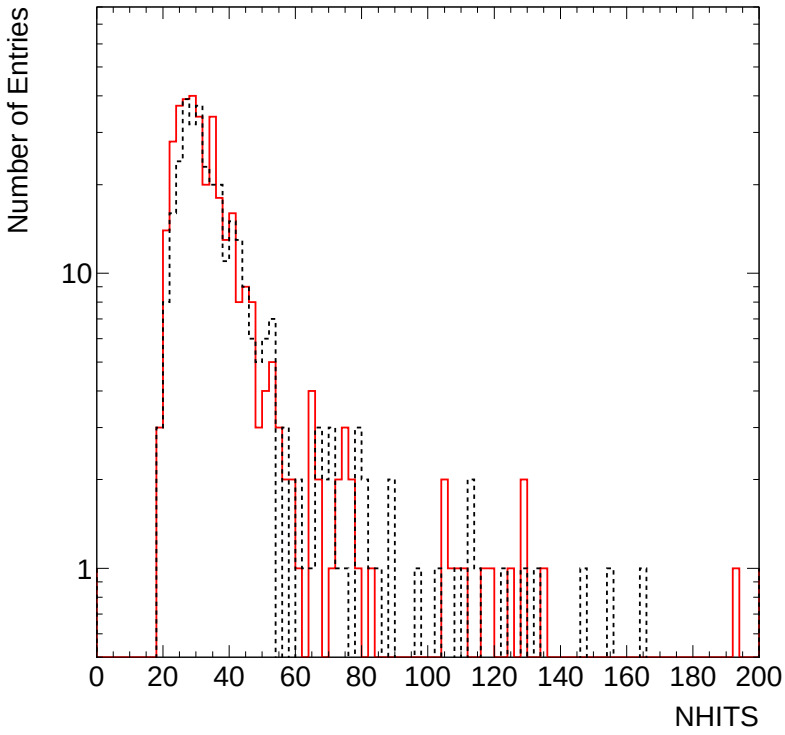
- L1-Level Muon RECO: Approximately 1% data of MB sample are left



L1-LEVEL MUON RECONSTRUCTION

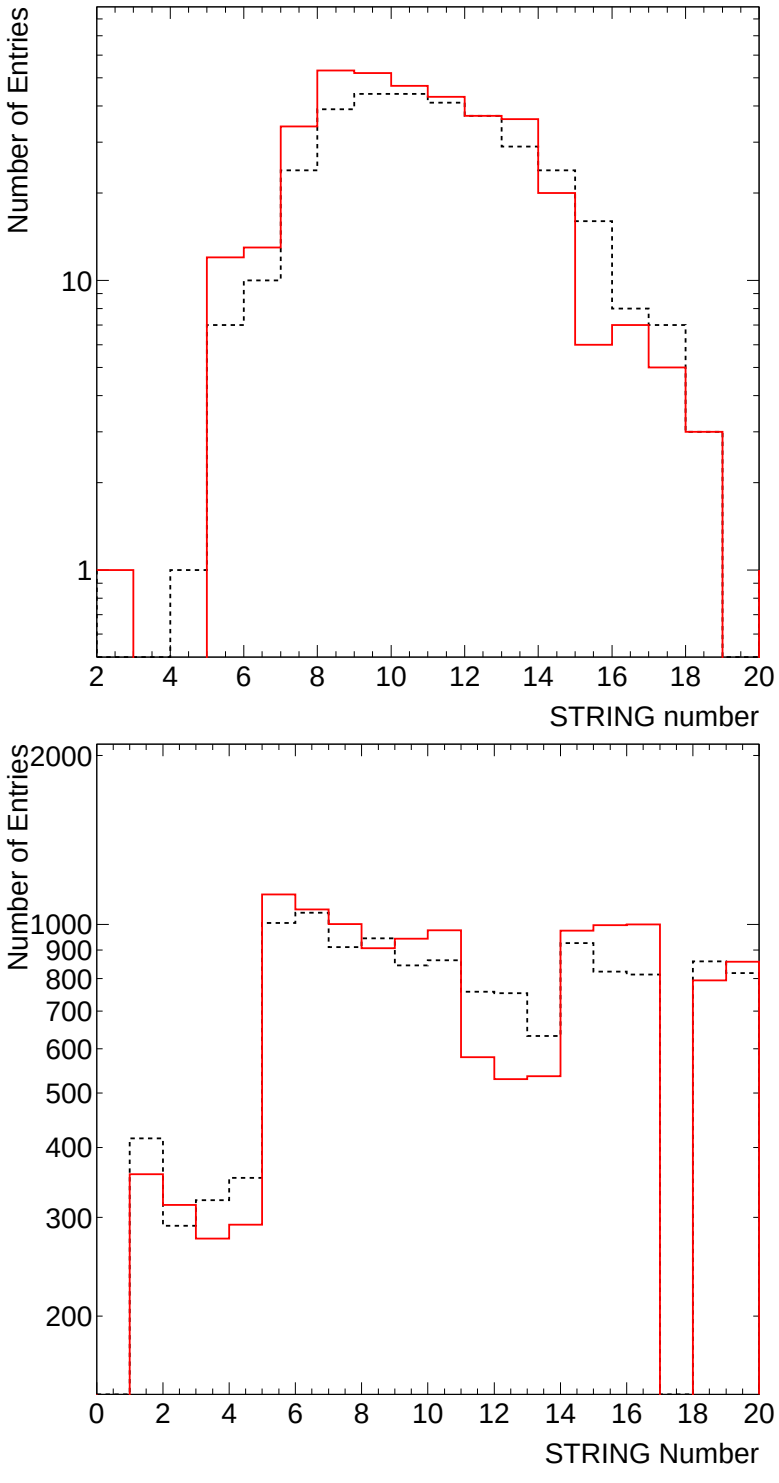
- NCH and NHITS distributions





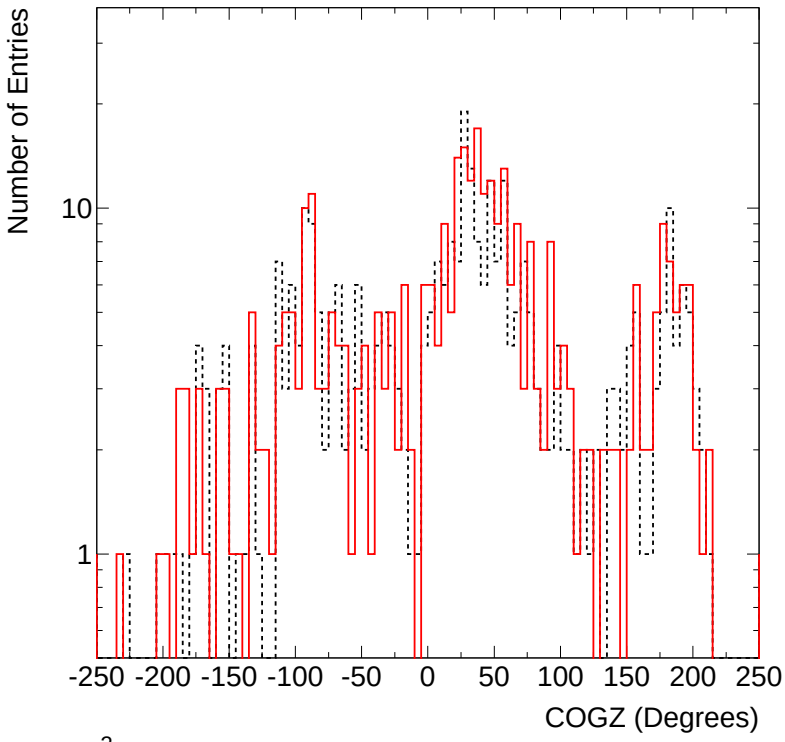
L1-LEVEL MUON RECONSTRUCTION

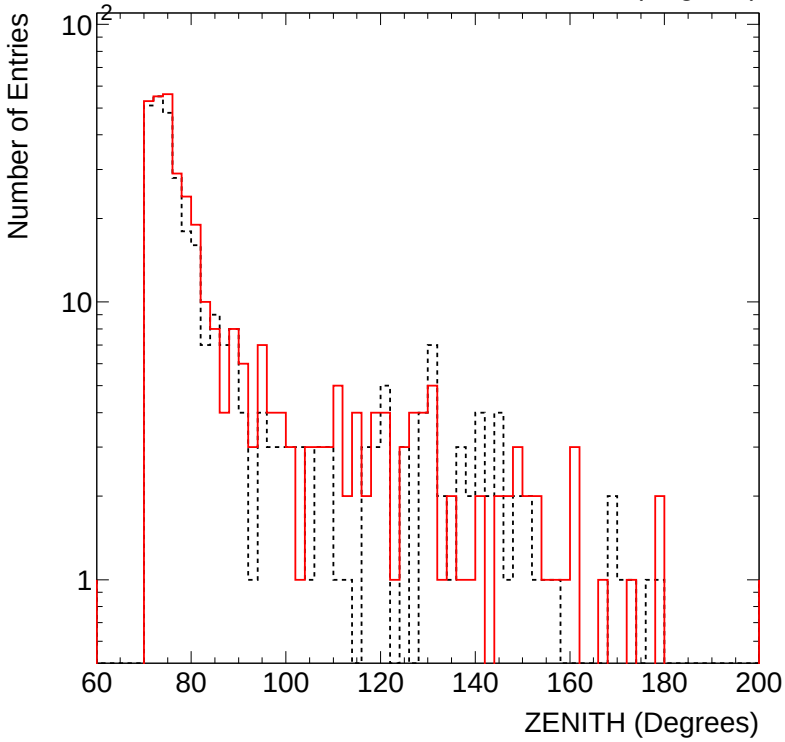
- In HSTR the TWR deficit on string 1-4 and 11-13 is probably caused by higher threshold set for electrical channels of TWR-DAQ



L1-LEVEL MUON RECONSTRUCTION

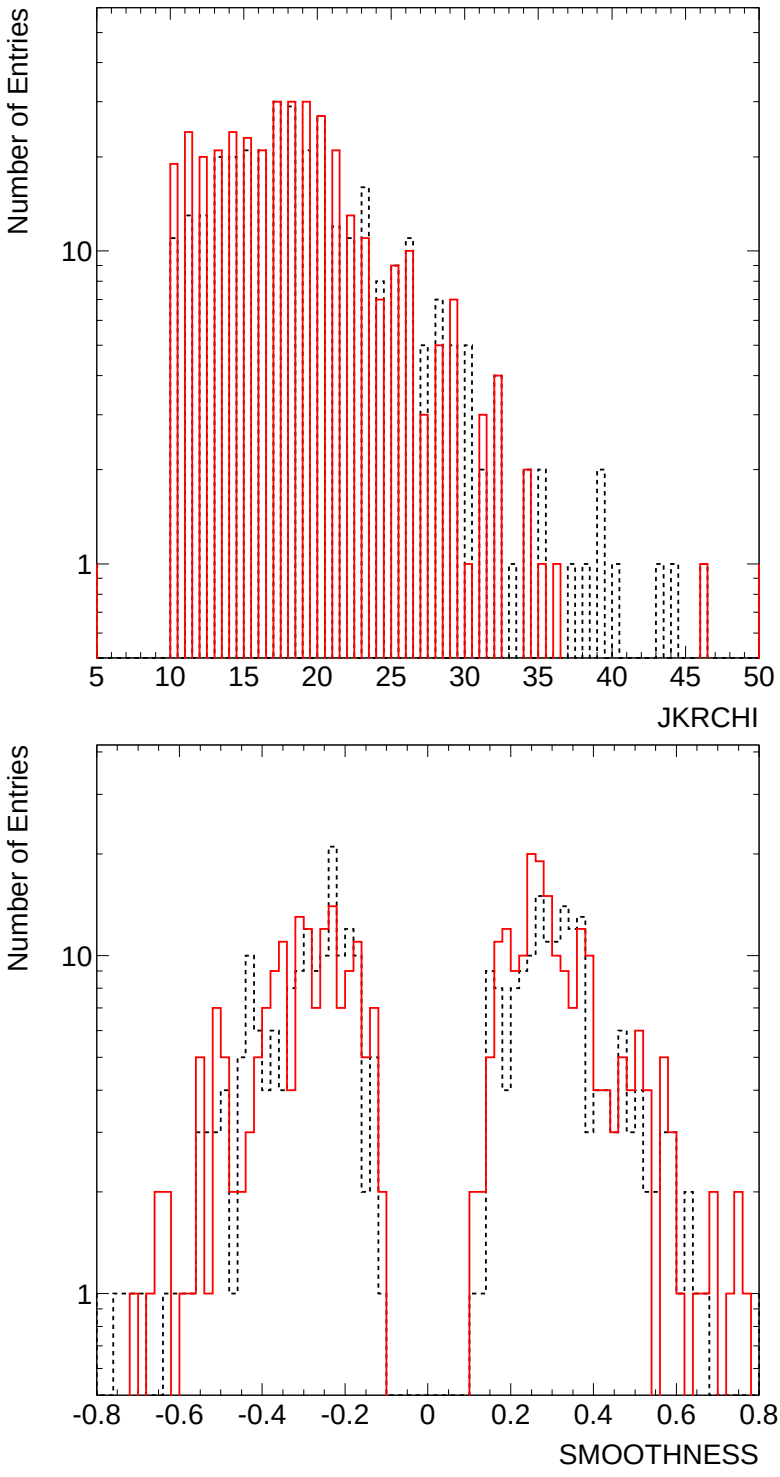
- COGZ and ZENITH distributions





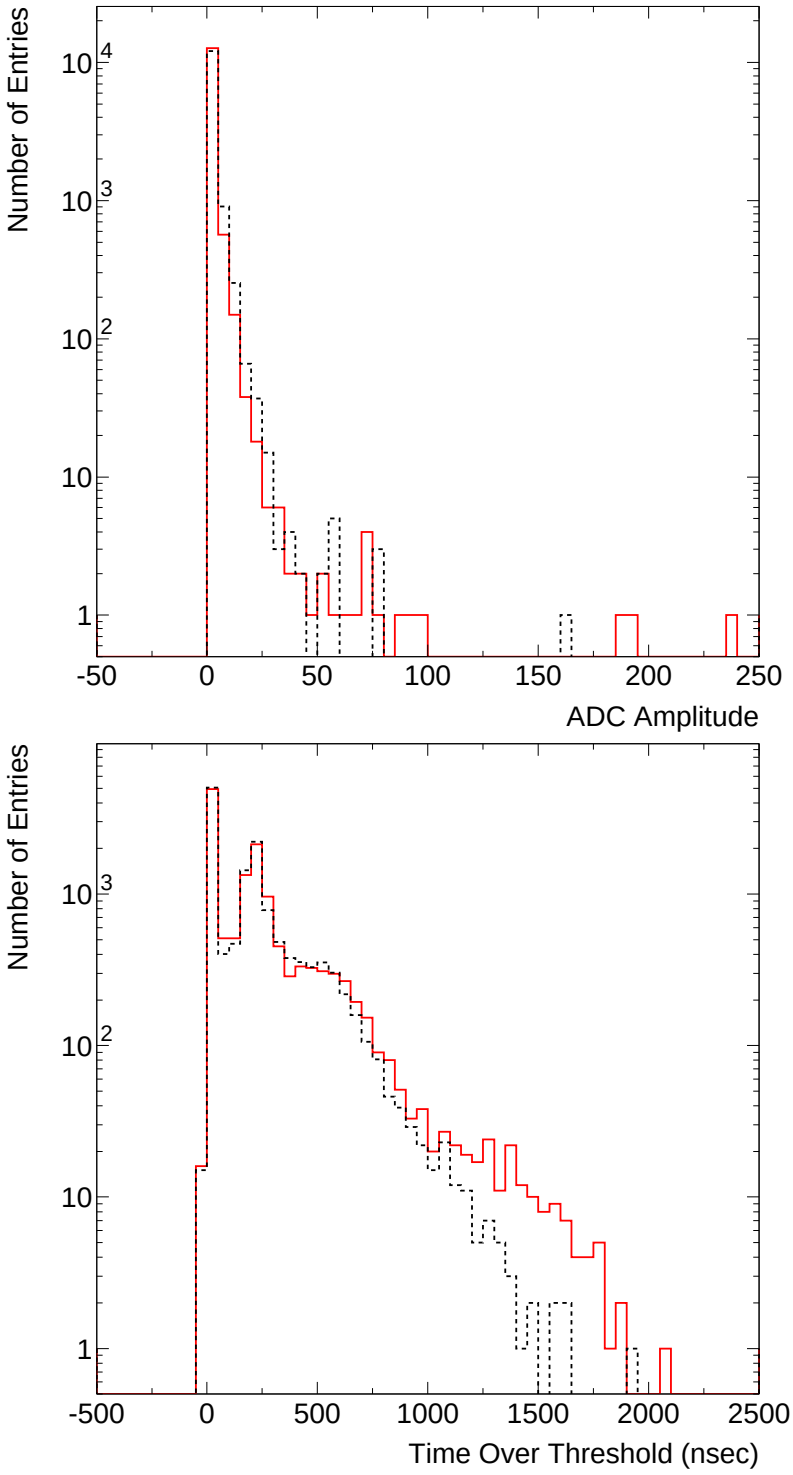
L1-LEVEL MUON RECONSTRUCTION

- JKRCHI and SMOOTHNESS distribution



L1-LEVEL MUON RECONSTRUCTION

- CHARGE/ADC and TOT distributions



L2-LEVEL AND FINAL RESULTS

- At this stage we are ready to apply stronger cuts
- In order to define background expected for the GRB 030329.
- Cuts adopted by Kyler's GRB analysis at UCI.
- Those cuts are Declination dependent, the cuts in red were applied
- GRB 030329:

  RA: 10:44:49.5 DEC: +21:31:23 (J2000)

CUT/DEC.	$0^o - 10^o$	$10^o - 22.5^o$	$22.5^o - 37.5^o$	$37.5^o - 55^o$	$> 55^o$
SMOOTH <	0.29	0.29	0.29	0.29	0.29
NCH>	24	24	24	0	0
JKRCHI<	7.5	7.5	7.65	7.65	7.85
SP.ANGLE<	7^o	8^o	12.5^o	12.5^o	12.5^o

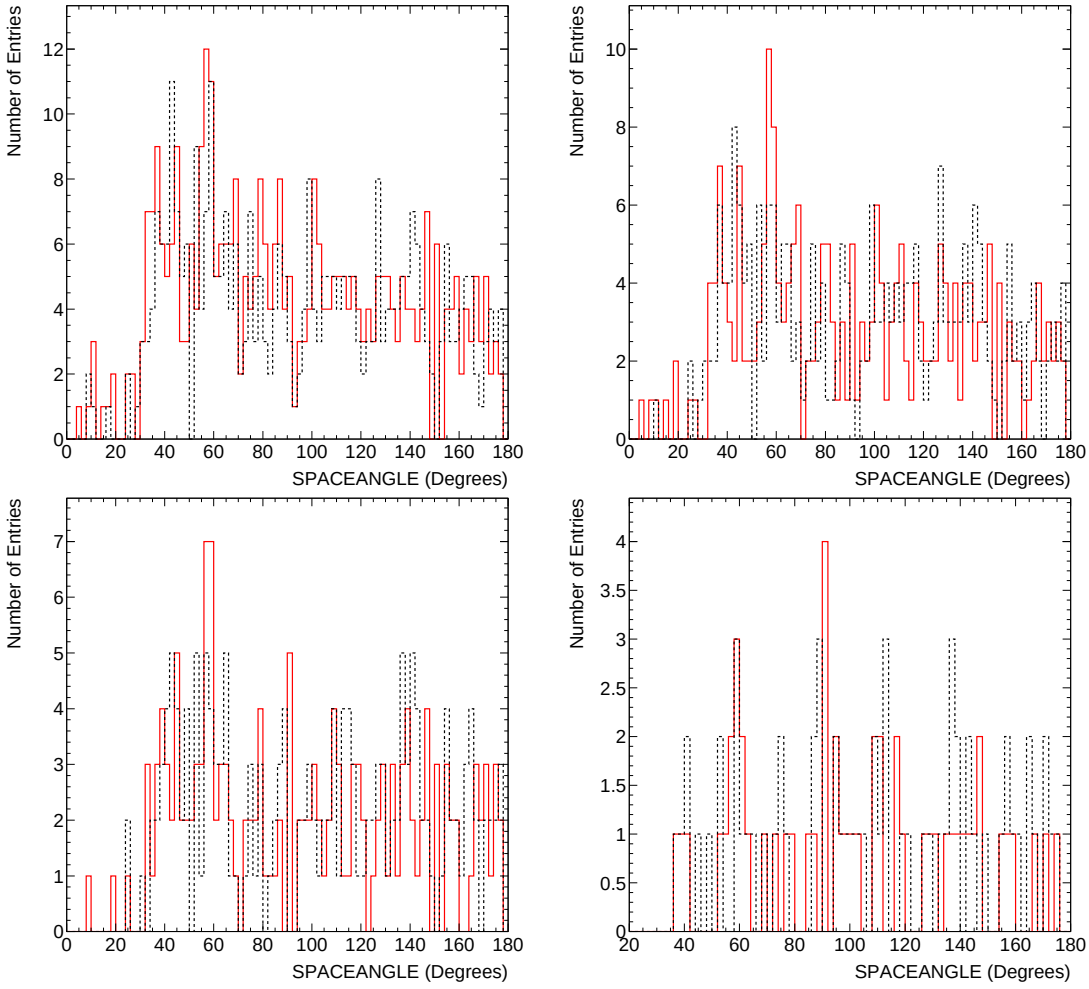
- After cut application $\longrightarrow$ ZERO background events are left

SPACEANGLE

- After $|SMOOTALLPHIT(2)| < 0.29;\ NCH > 24;\ JKCHI(2) < 7.5)$ only 64 events are left

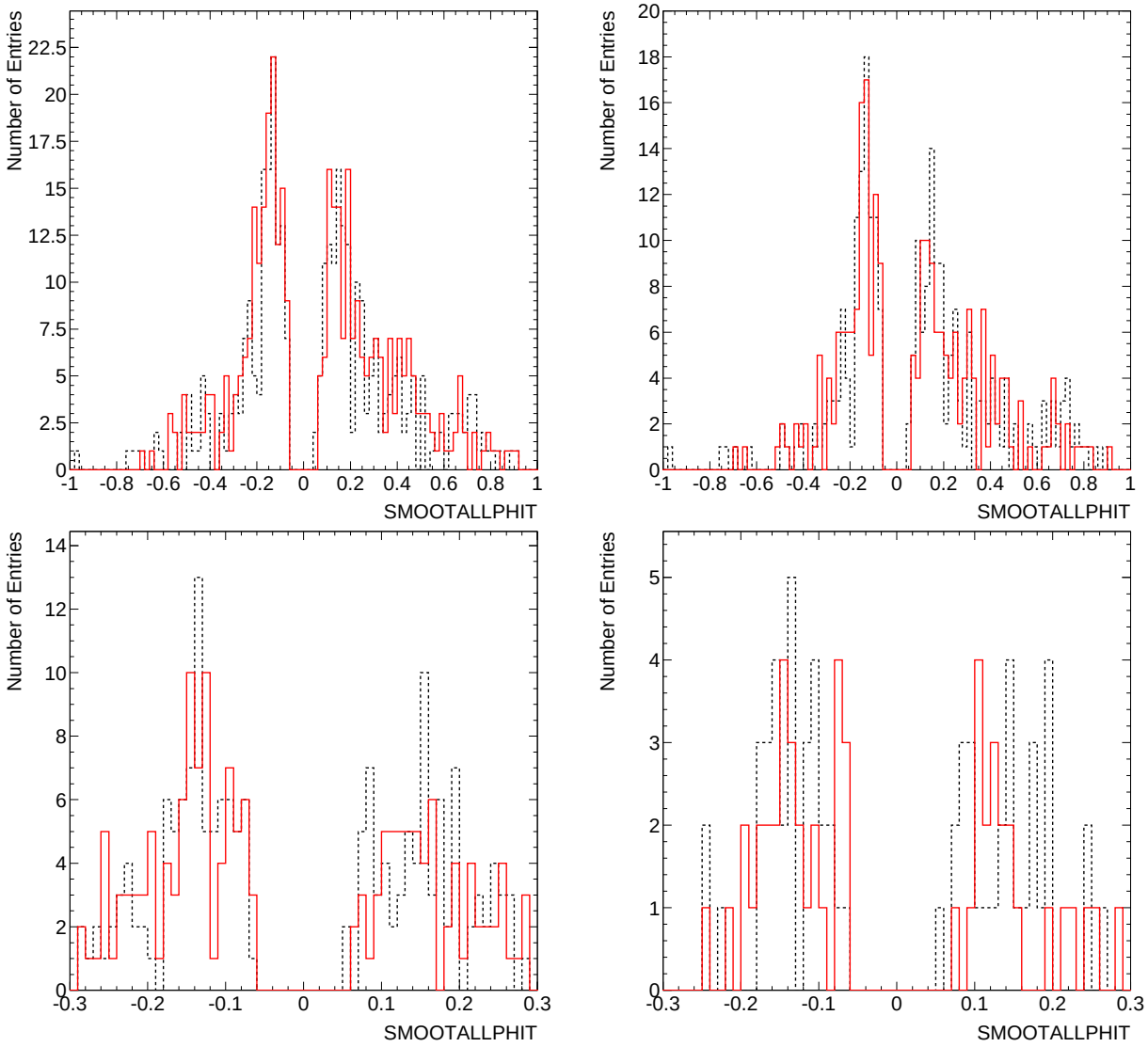
- The two final cuts: $ZENITH(2) > 80^{o}$ and $SPACEANGLE < 8^{o}$ independently get rid of all events

- We do expect ZERO background events for 8.5 minutes



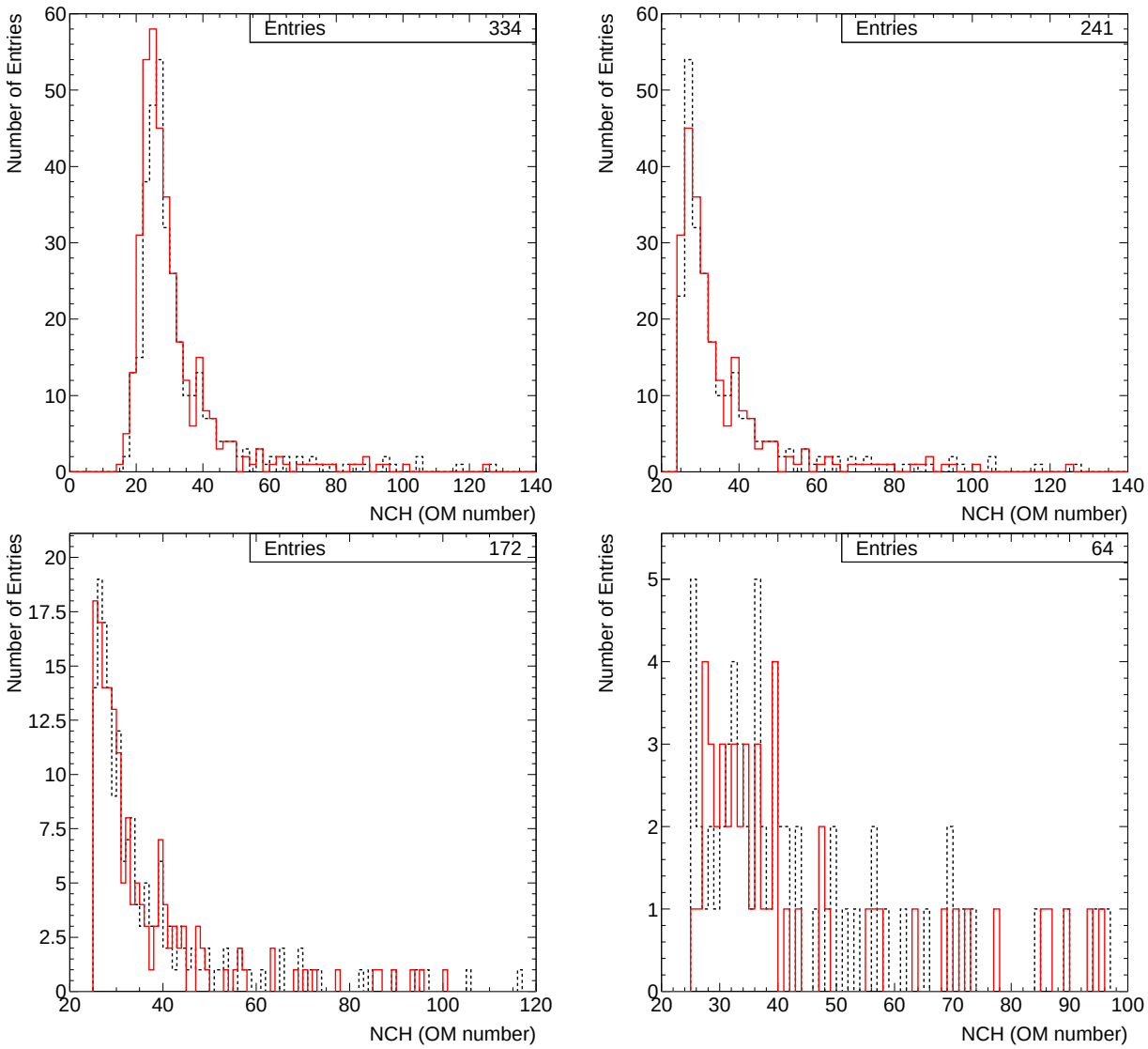
SMOOTALLPHIT

- After $|SMOOTALLPHIT(2)| < 0.29;\ NCH > 24;\ JKCHI(2) < 7.5)$ only 64 events are left



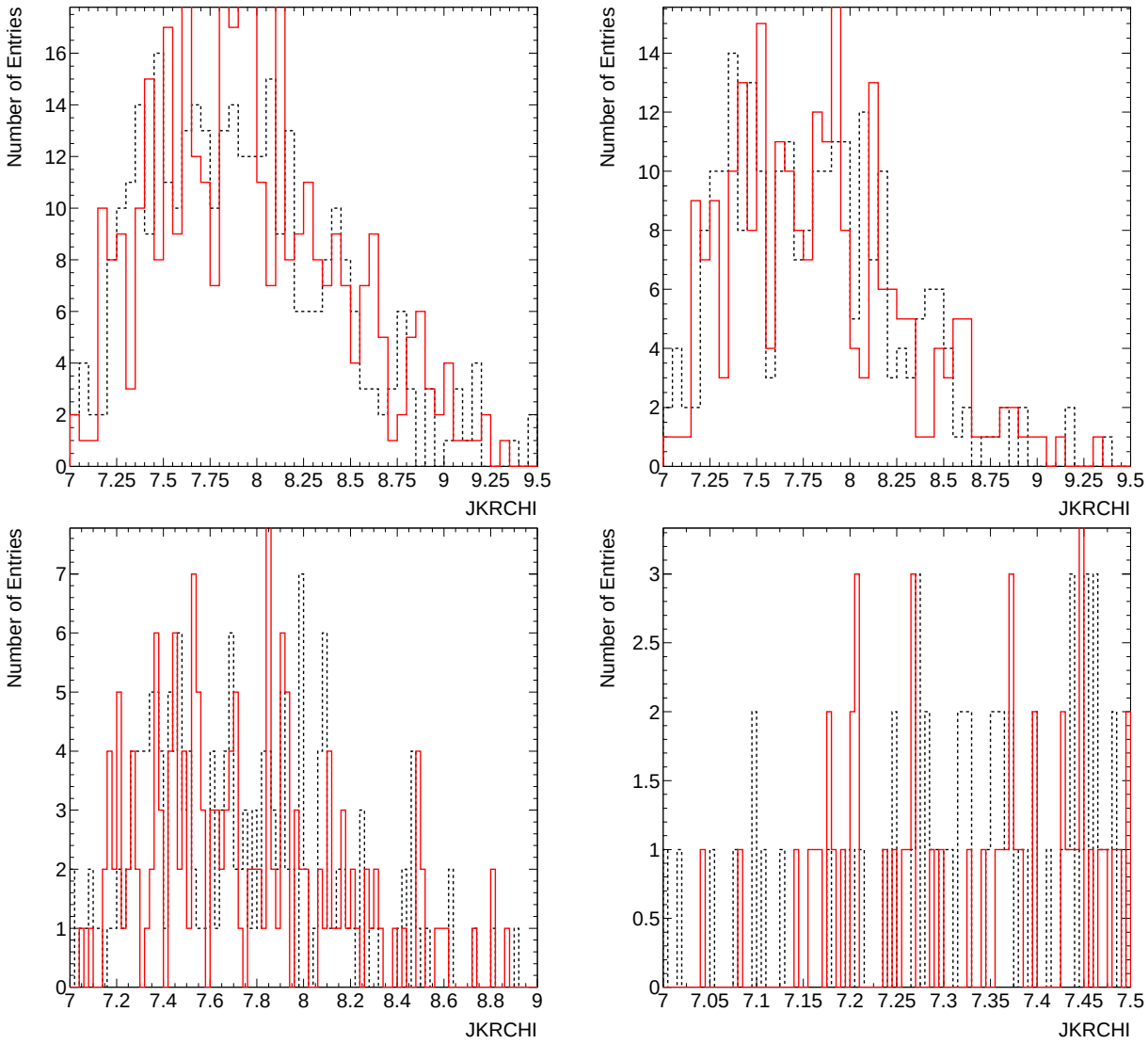
NCH

- After $|SMOOTALLPHIT(2)| < 0.29;\ NCH > 24;\ JKCHI(2) < 7.5)$ only 64 events are left



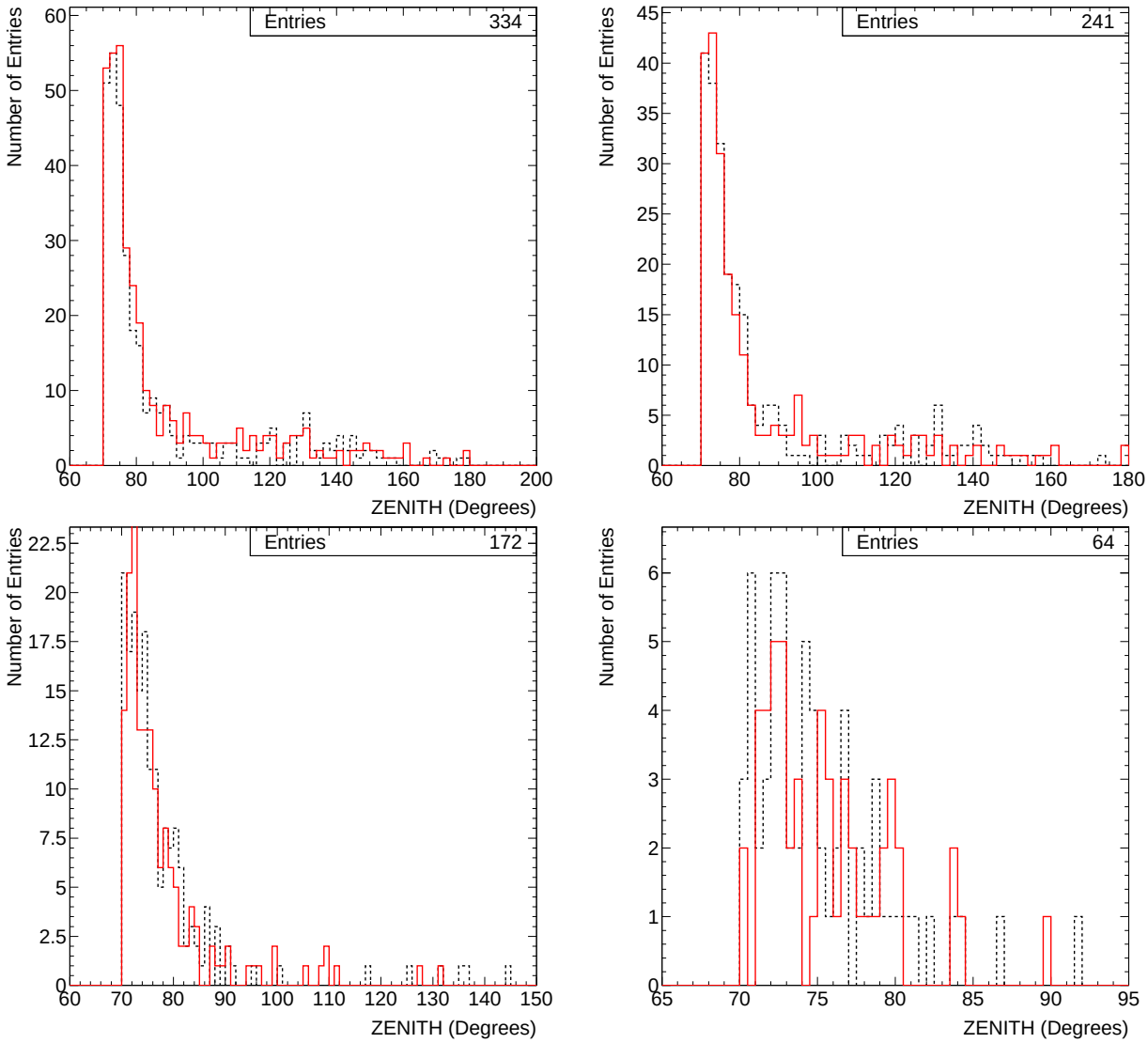
JKRCHI

- After $|SMOOTALLPHIT(2)| < 0.29;\ NCH > 24;\ JKCHI(2) < 7.5)$ only 64 events are left



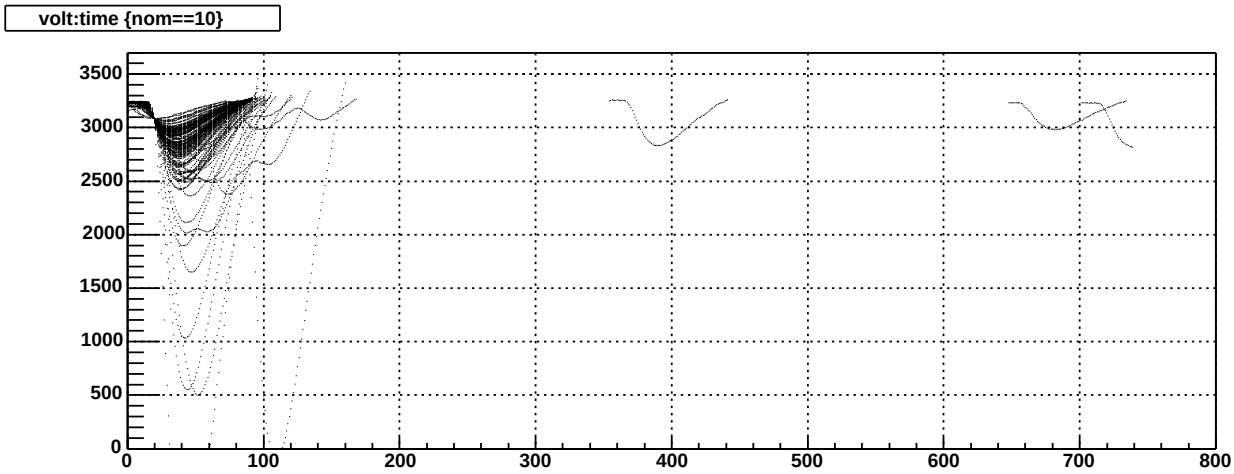
ZENITH

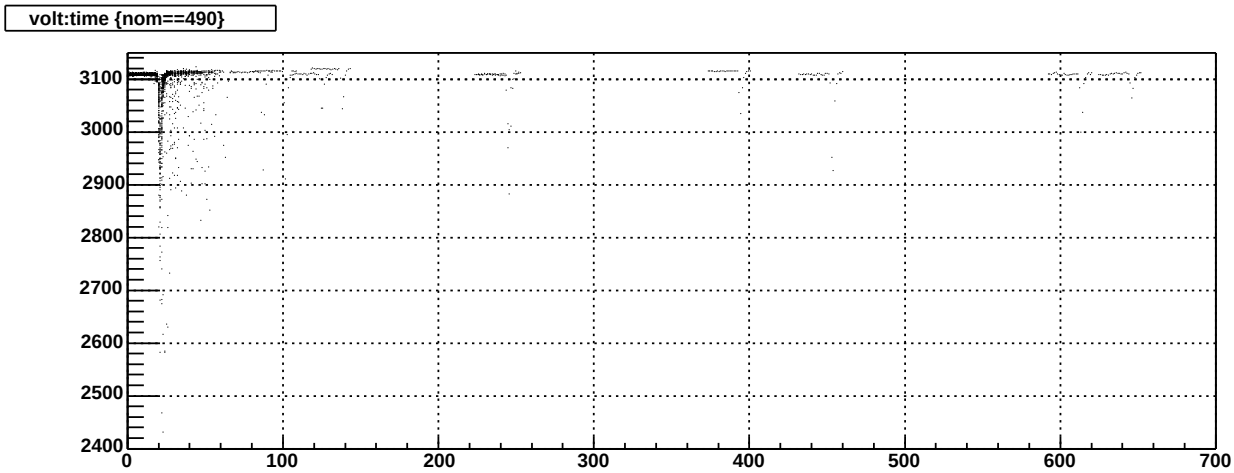
- After $|SMOOTALLPHIT(2)| < 0.29;\ NCH > 24;\ JKCHI(2) < 7.5)$ only 64 events are left



COMPOSITE WF

- Study of Composite WF for all OMs
- Average of large number of WFs $\longrightarrow$ get the 1PE WF
- Implementation of averaged 1PE WFs in AMASIM
- WF simulation and comparison with DATA
- Typical WFs for electrical channel (OM 10) and optical channel (OM 490), here example of 1000 WFs





CONCLUSION AND FUTURE PLANS

- Results of this Analysis at:
  `http://www.ps.uci.edu/~silvestri/GRB.html`
- Comparison of two independent systems (TWR-DAQ and MUON-DAQ)
- Reconstruction of all data: Very good agreement at all analysis levels
- Preliminary GRB analysis: ZERO background events
- Improve TWR capabilities: reconstruct more HITs and After-Pulse
- Study waveforms and compare to MC predictions for N2 and flasher light sources
- Improve understanding of energy response and angular resolution
- Look at "BAD channels" in MUON-DAQ analysis to see if any OMs can be resurrected in using TWR information.
- Study of composite WFs and 1PE WFs implementation in AMASIM
- These studies as additional help to software trigger effort