



KM3NeT Tier-2 Computing & ORCA4 Data Analysis in TSU



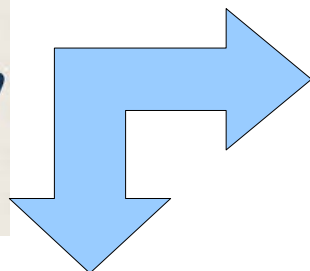
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(for the KM3NeT-TSU group)

24 January 2020



High Energy Physics Institute
Tbilisi State University

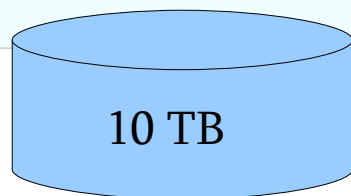
KM3NeT Tier-2 Computing @ TSU



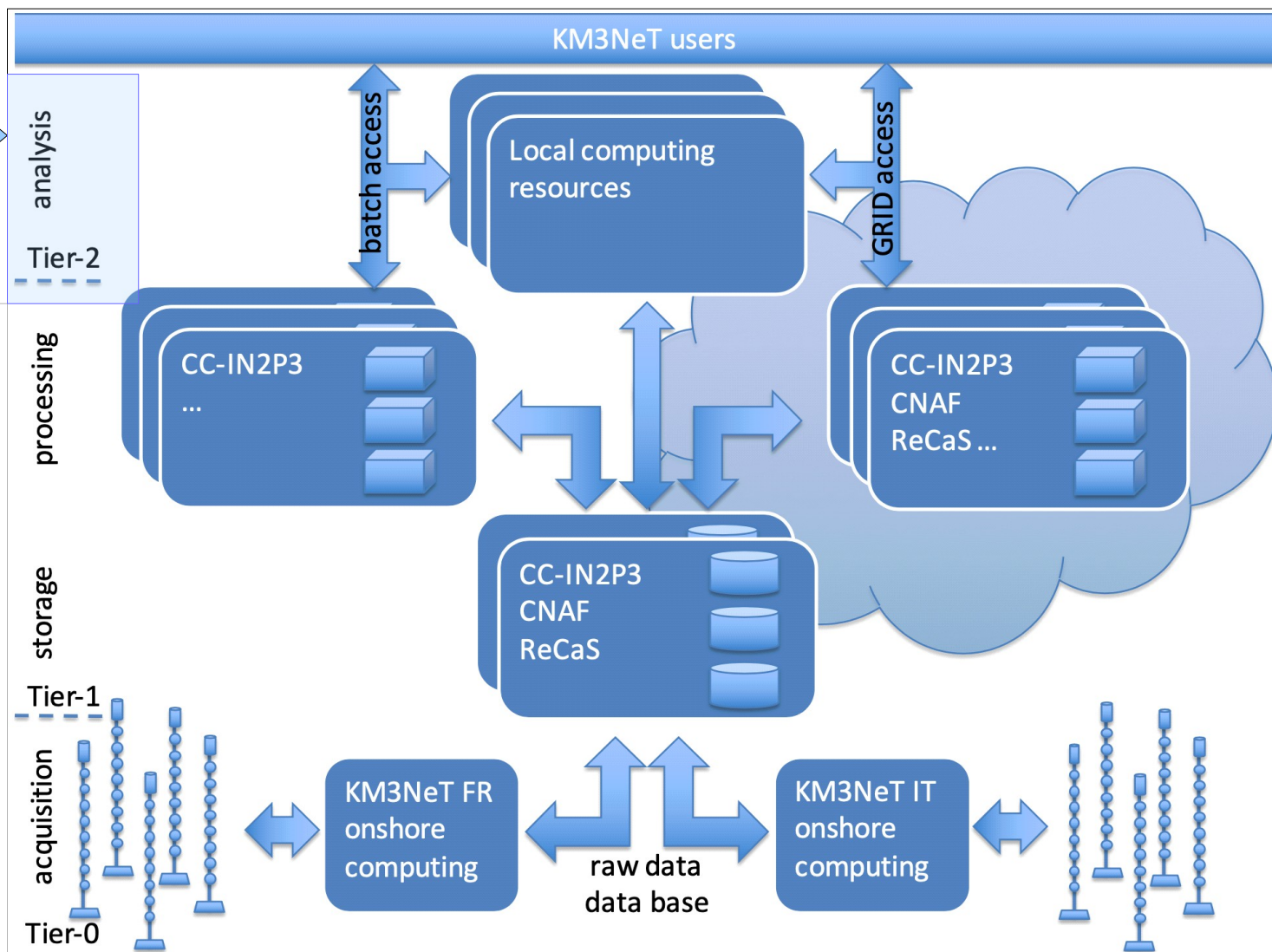
KM3NeT @ TSU
217.147.226.114

PowerEdge T140

Intel Xeon E-2186G
3.8 GHz
12 MB cash memory



Linux CentOS7



KM3NeT Computing Model

Data transfer rate: (Lyon-cc → TSU): about 2.5 MB/sec

KM3NeT Software @ TSU

- KM3NeT software:

KM3NeT framework: JPP; simulation (muons and neutrinos) & analysis software

Software				
Jpp	C++		Y	KM3NeT software framework
mupage	C++		Y	Atm-muons
gSeaGen	C++		P	Neutrino interactions
JSirene	C++	(Jpp)	Y	KM3NeT detector response
km3sim	C++	Geant 4.0	P	KM3NeT detector response
km3pipe	Python	Numpy, scipy	Y	KM3NeT python-framework
genhen	Fortran	cernlib	-	Neutrino DIS
km3	Fortran	cernlib	-	Neutrino interactions

- KM3NeT Detector configuration files

- Look-up tables for Cherenkov photons

- Environmental data:

water optical properties (absorption and scattering length)

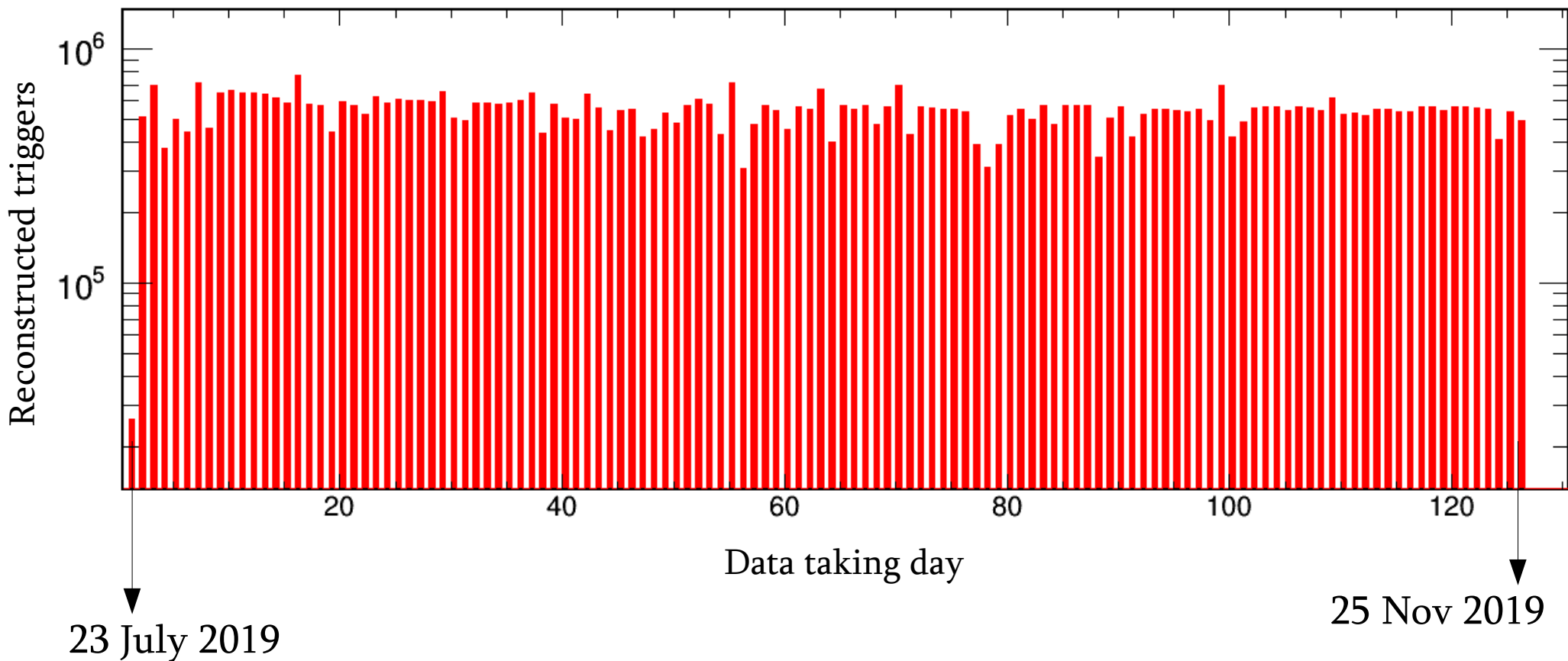
ORCA4 (KM3NeT_00000044) Processed Data

- Jannik Hofstaedt, email from Dec 13, 2019 [ORCA4 data & MC]
wiki.km3net.de/index.php/DU_Analysis/ORCA4_data_analysis#Reconstructed_Data_and_Simulations
- Reconstructed data:
Lyon-cc: /sps/km3net/repo/data/KM3NeT_00000044/v5.40/reco
runs: 5782-6783 (24 July – 25 November, about 566 runs)
- Detector files:
Lyon-cc: /sps/km3net/repo/data/calibration/KM3NeT_00000044/
- Simulated data (MC):
atmospheric muons:
Lyon-cc: /sps/km3net/repo/mc/atm_muons/KM3NeT_00000044/v5.40/reco
mupage → Jsirene (prescale 1/3); km3 (1/10)
neutrinos: (only genhen)
Lyon-cc: /sps/km3net/repo/mc/atm_neutrino/KM3NeT_00000044/v5.40/reco
- Processed KM3NeT/ORCA4 files:
are transfered to KM3NeT@TSU server

KM3NeT/ORCA4 Data

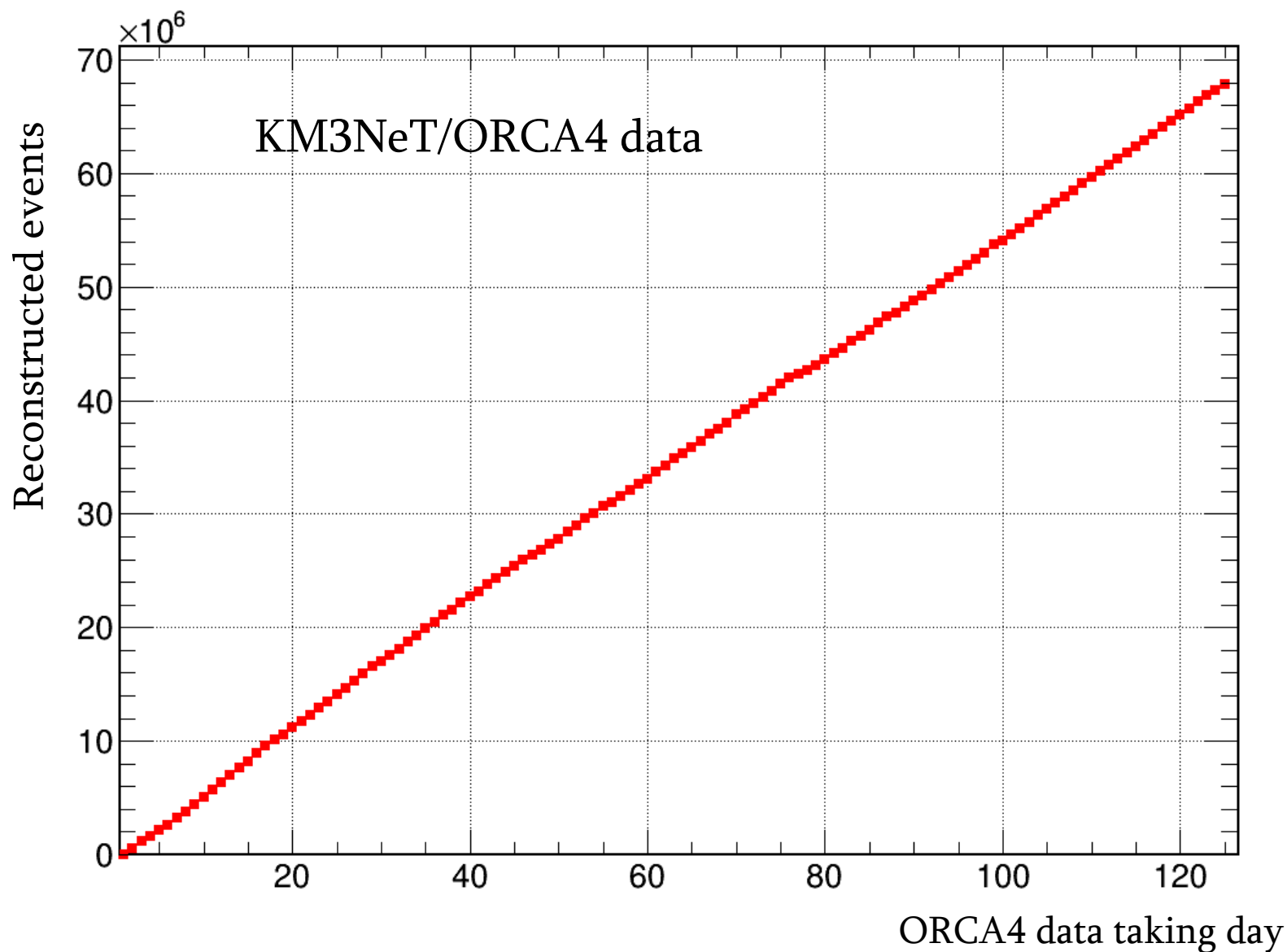
- Processed Data: 23 July 2019 – 25 Nov 2019 (126 days)
- 68 285 262 (about $7 \cdot 10^7$) reconstructed triggers / 533 files

Reconstructed ORCA4 triggers vs. data taking day



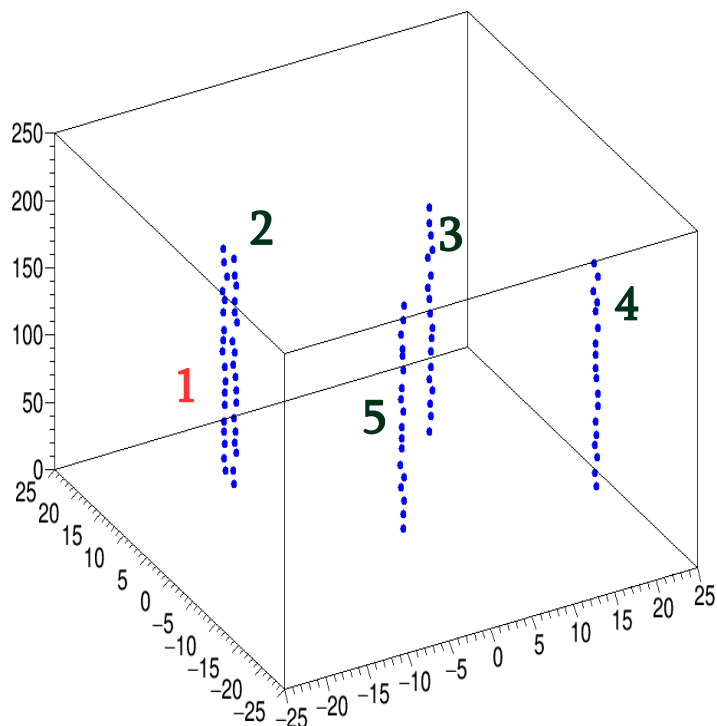
KM3NeT/ORCA4 Data

- ORCA4 data: 23 July 2019 – 25 Nov 2019 (126 days)

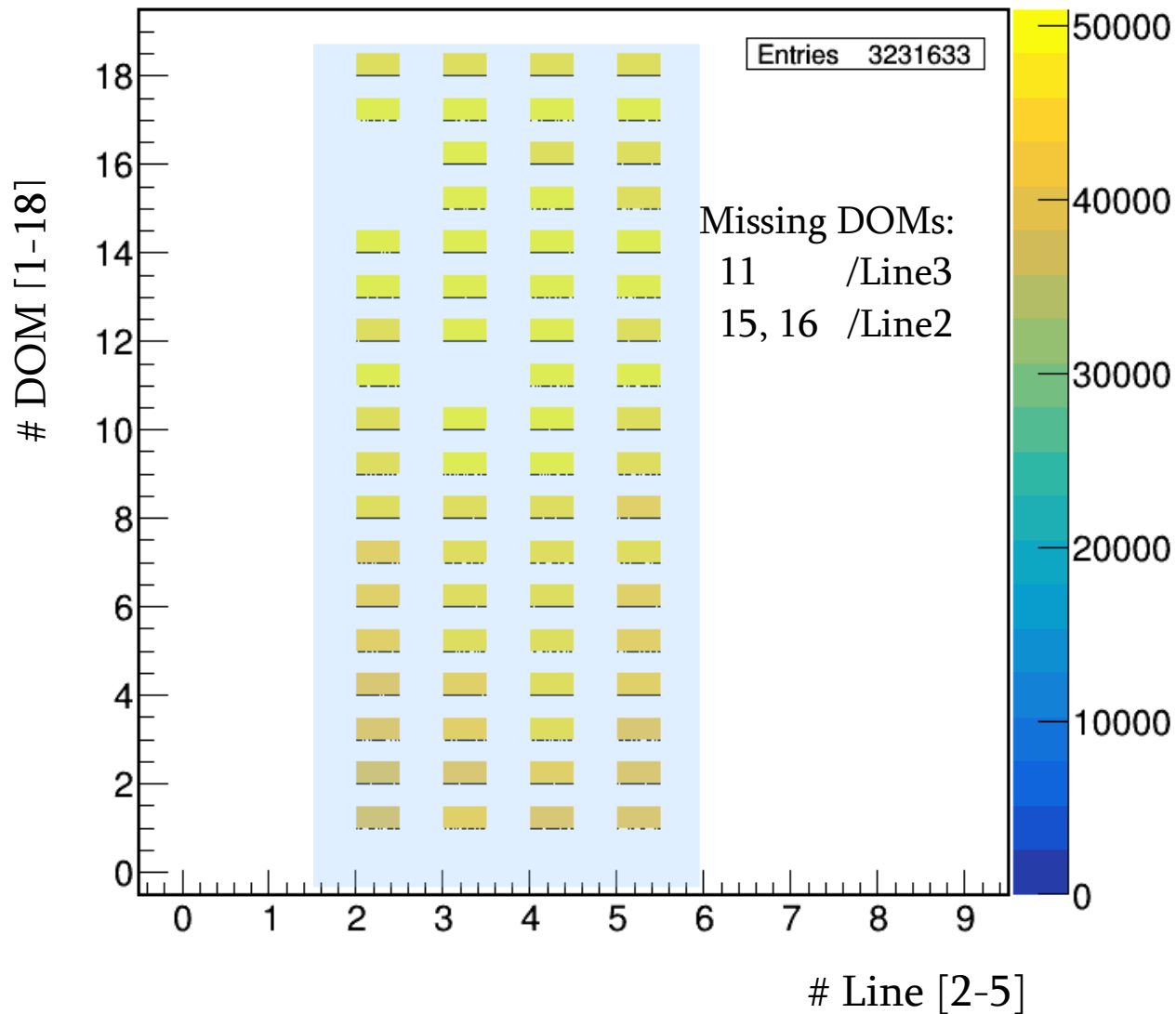


KM3NeT/ORCA4 Configuration(s)

ORCA4 Configuration



Lyon-cc /sps/km3net/repo →
511 detector configurations
(>50 runs without detx-files)

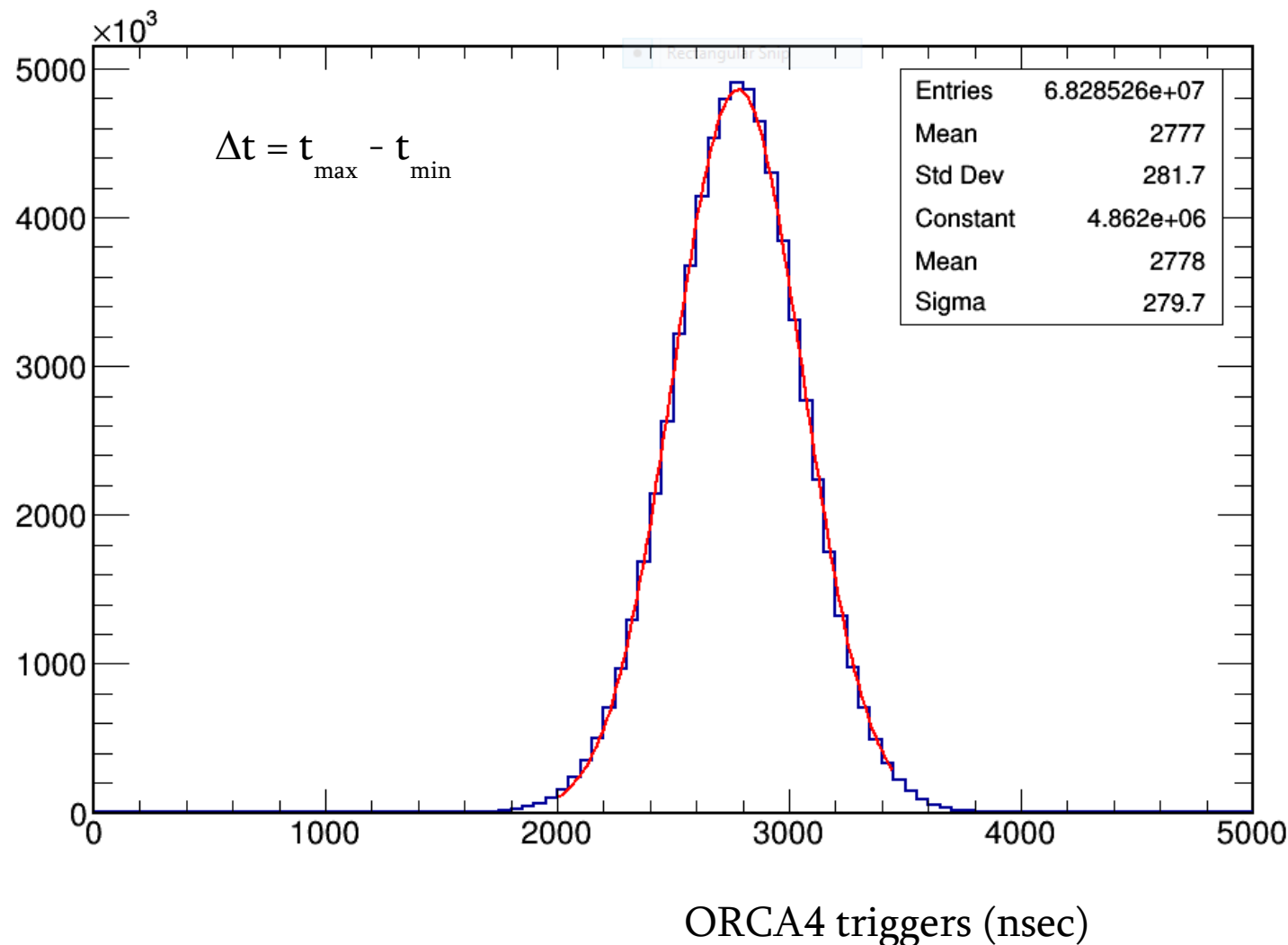


KM3NeT/ORCA4 Data (Event time)

All processed data: 6.8×10^7 triggers

t_{\min} - time of the first hit in the event

t_{\max} - time of the last hit in the event



Expected hits: $N = N_{\text{pmt}} R \Delta t$

$$N_{\text{pmt}} = 69 \times 31 = 2139 \text{ PMT}$$

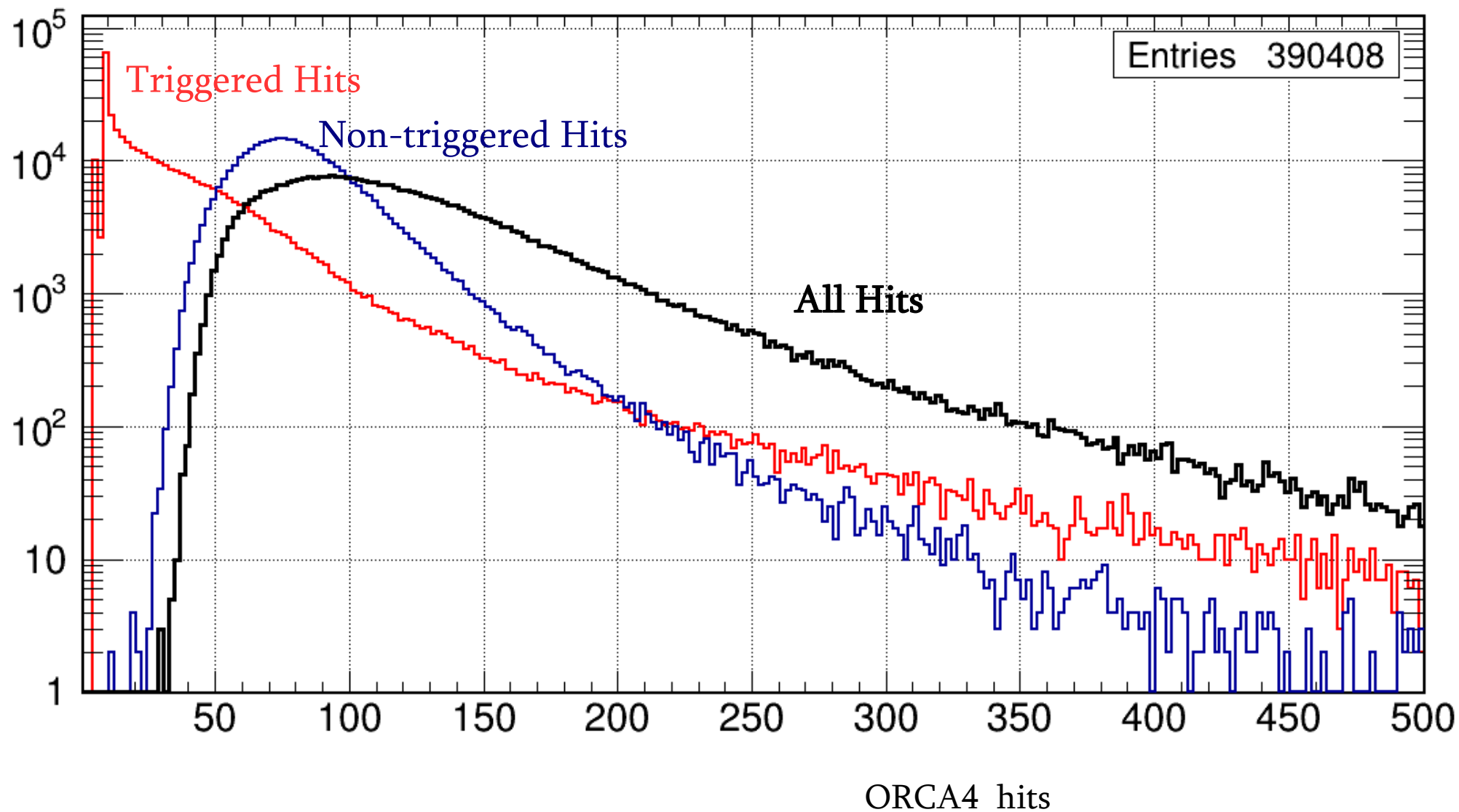
$$R = 10 \text{ kHz}$$

$$\Delta t = 2.8 \text{ } \mu\text{sec}$$

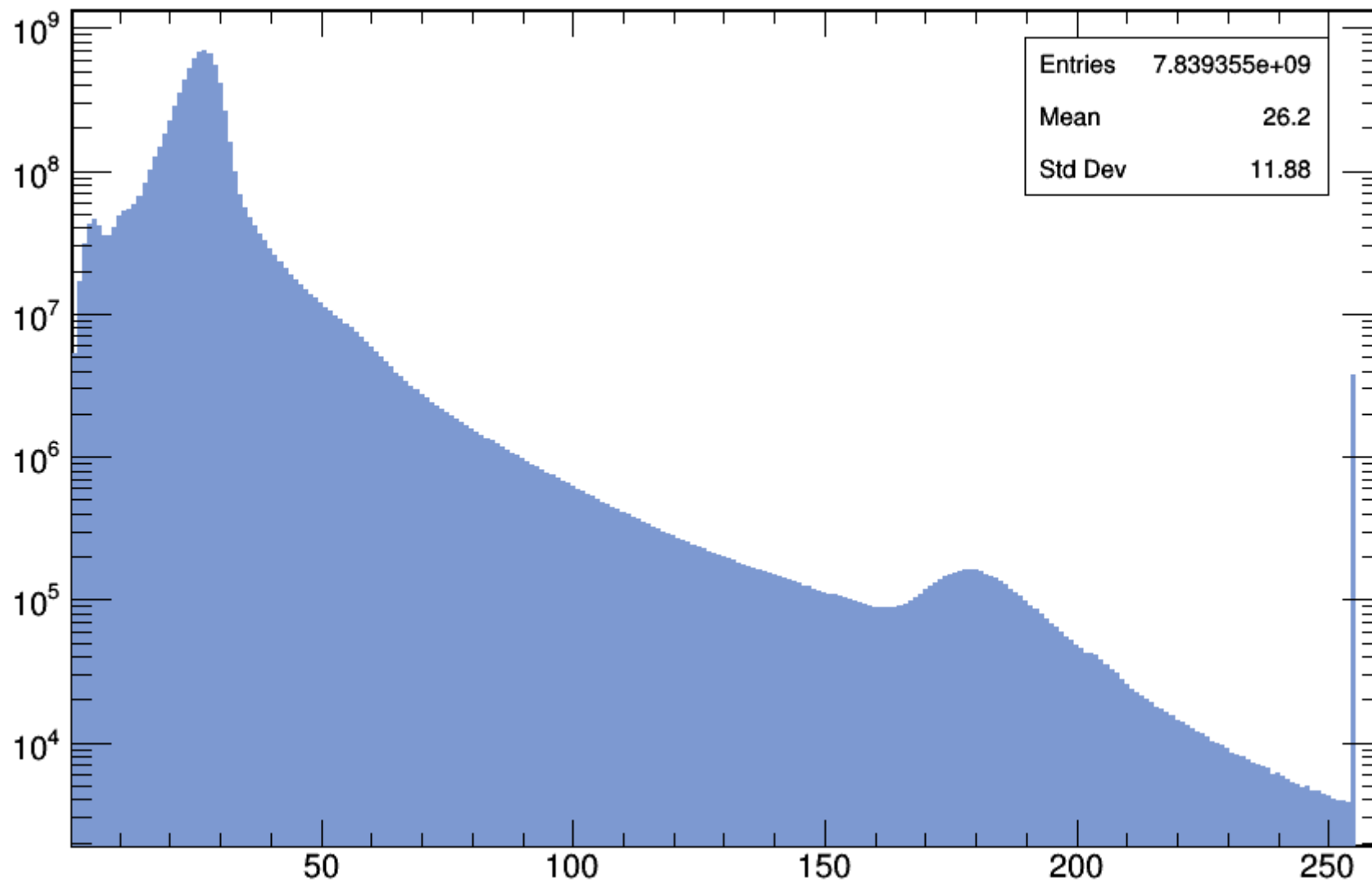
$$N_{\text{pmt}} \approx 60 \text{ hits (bkg hits)}$$

KM3NeT/ORCA4 Hits

Data: 5 runs



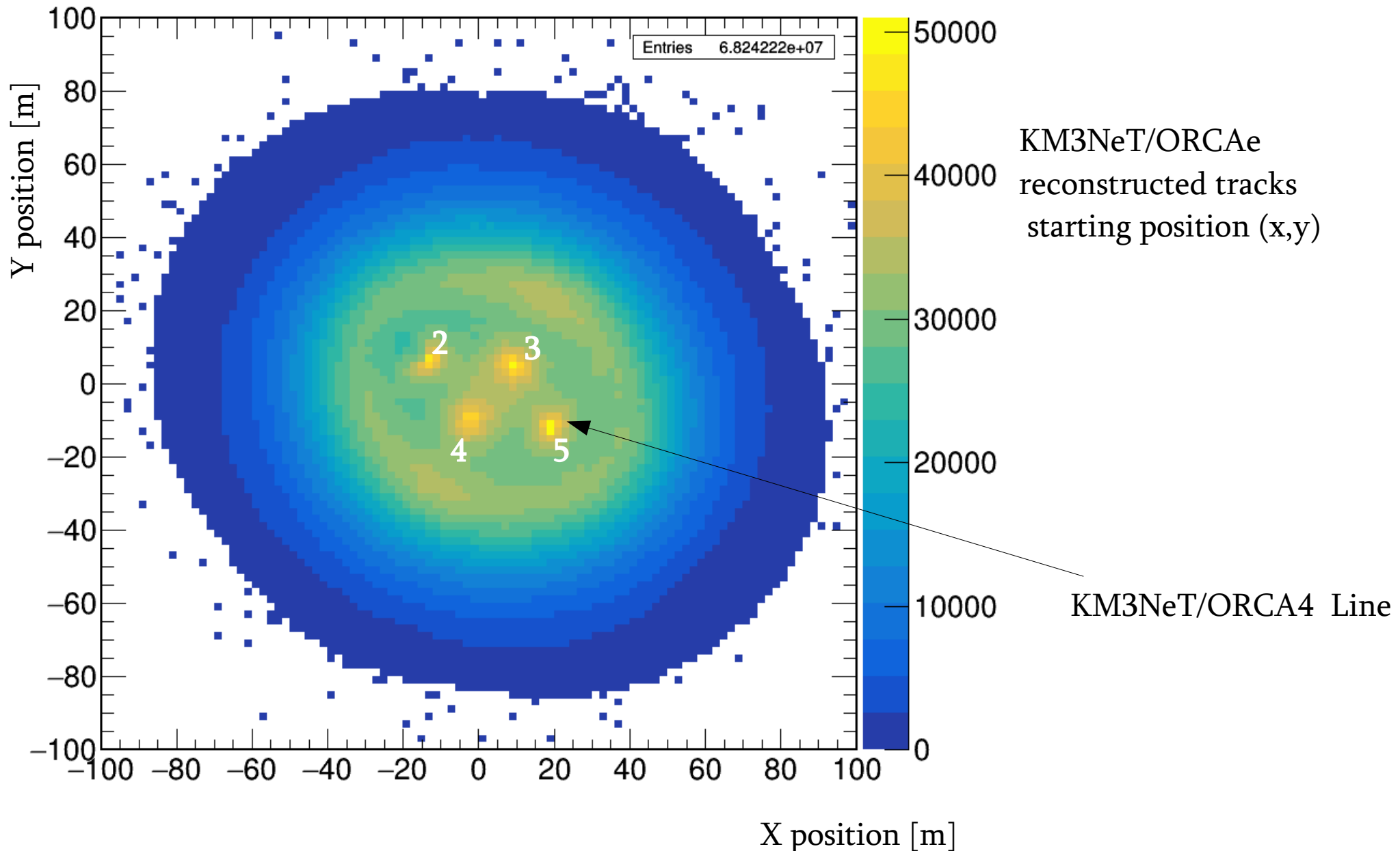
KM3NeT/ORCA4 Data PMT Signals

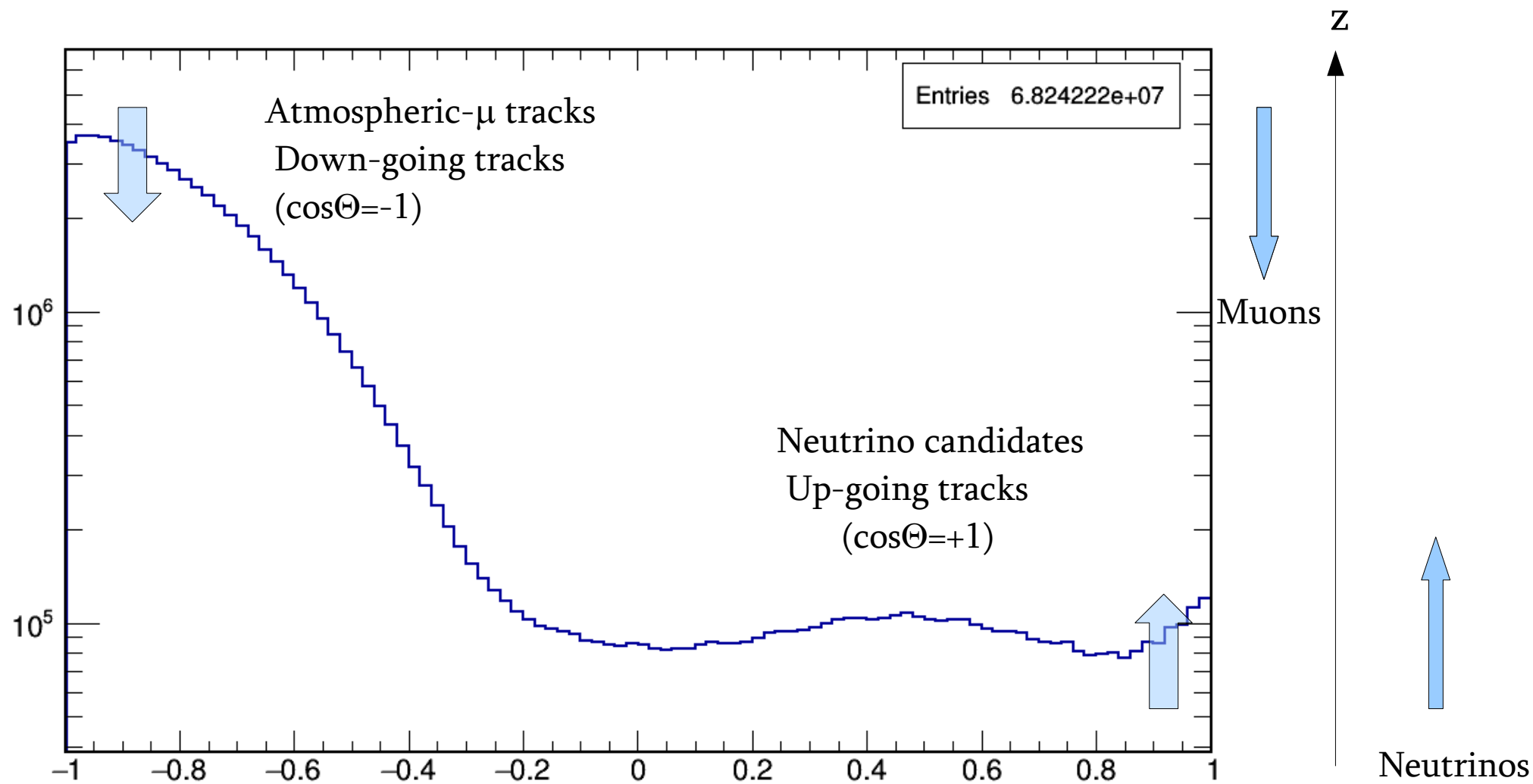


ORCA4 PMT signals

KM3NeT/ORCA4 Reconstructed Tracks (x,y)

ORCA4 data: 23/07-25/11/2019 (about $7 \cdot 10^7$ triggers/tracks)





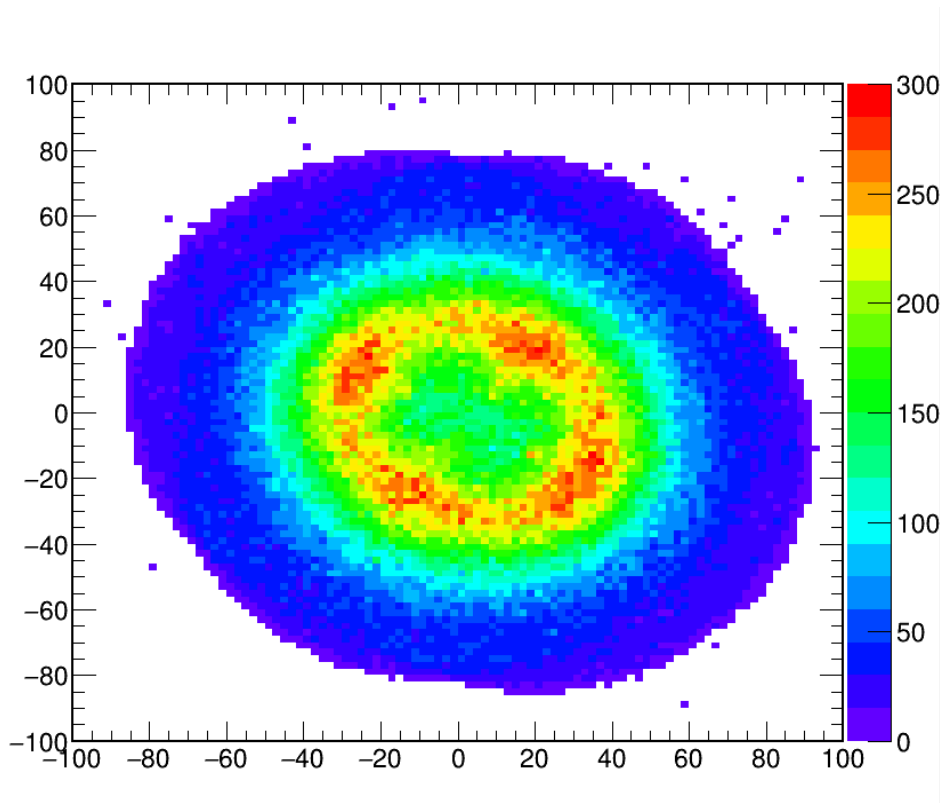
KM3NeT/ORCA4: reconstructed tracks z-direction

- ORCA4 MC data (with rbr hits)

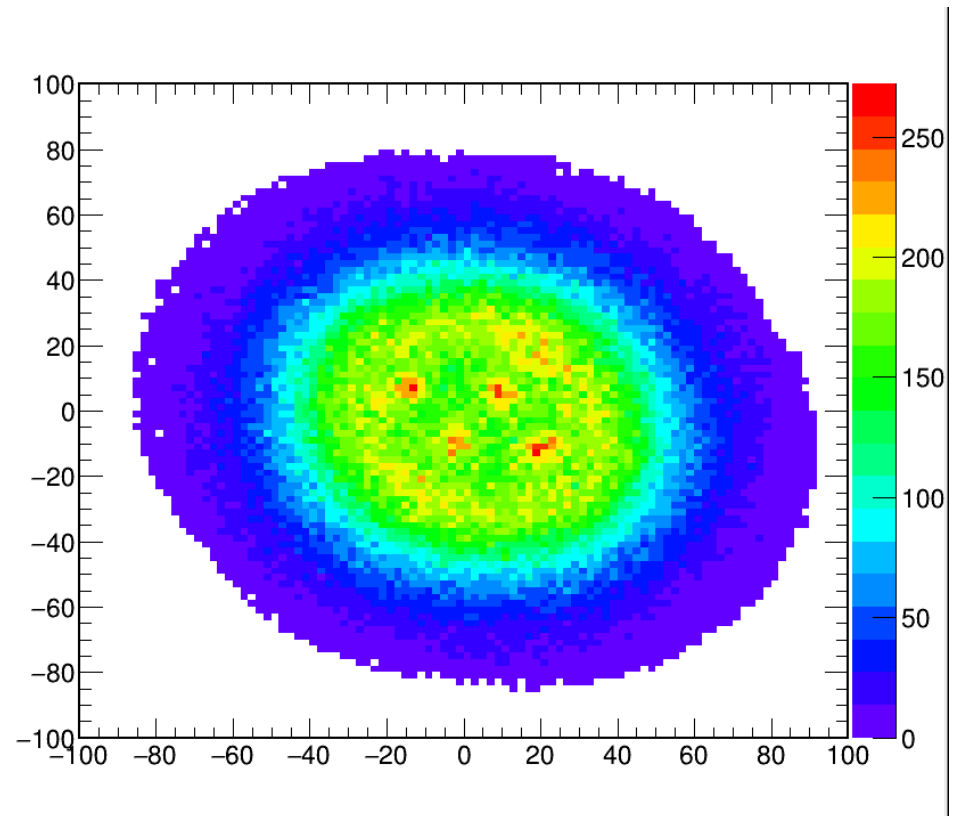
atm- μ (mupage)		Sirene		1502 files (375 @TSU)
		km3		4394 files
atm- ν (genhen)	10-10 ⁸ GeV -1 < cosz < 1 sim: 10 ⁵ ev. / File	ν_{μ} -CC	Sirene	487810 (about 5x10 ⁷)
			km3	481320
		anti ν_{μ} -CC	Sirene	531424 (about 5x10 ⁷)
			km3	524506

- ORCA4 MC data @TSU:
 - part of atm-muon events (24/01)
 - All neutrino MC events

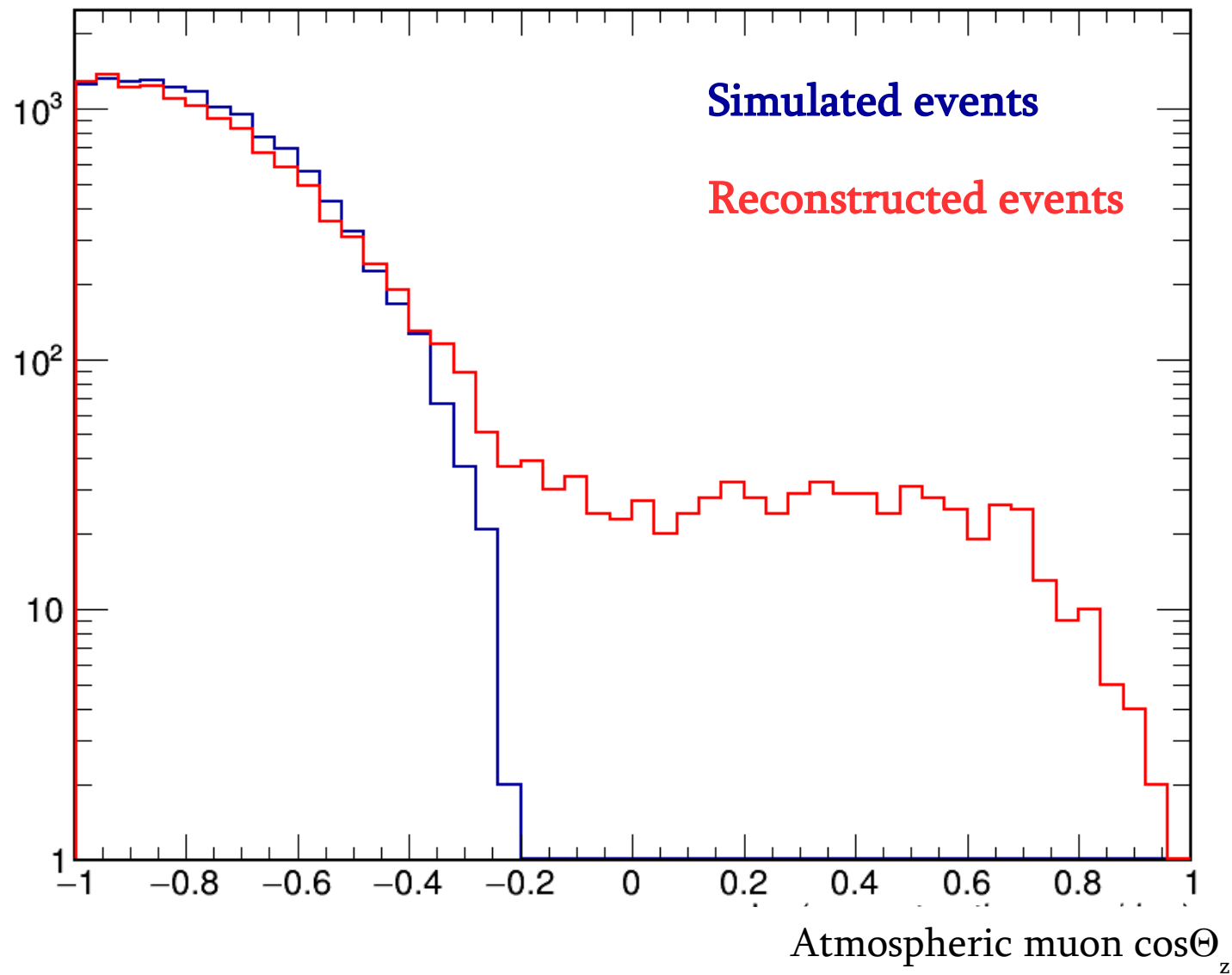
- Reconstructed MC data (atmospheric neutrinos and muons)



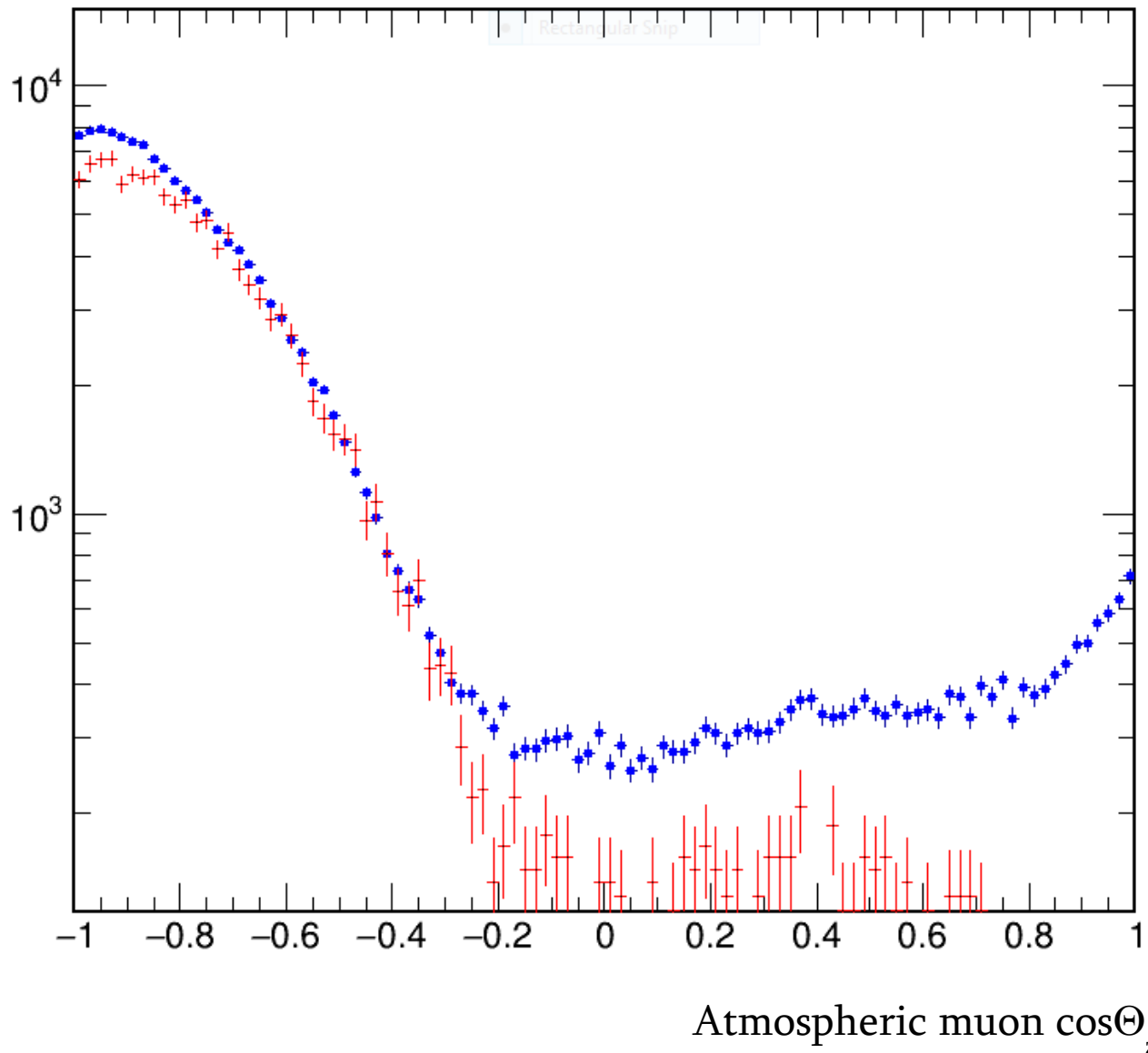
Neutrino MC (ν_{μ} -CC / km³)



Atm-muon MC (mupage/ km³)



KM3NeT/ORCA4 Data/MC comparison



Data
(run 5820, about 1.5×10^5 trig)

Comparison with atm-muon
MC (mupage) reconstructed data

Summary and Outlook

KM3NeT computing @HEPI TSU:

- KM3NeT software for simulation, event reconstruction and analysis (Jpp, mupage, km3sim, . . .) are installed at TSU
- Low-level ORCA4 data analysis was performed:
 - Processed ORCA4 data for 126 days (aanet -data format) is copied to TSU
 - 533 runs (from 566) are analyzed with a help of [KM3NeT@TSU](#) Tier-2 server
(About $7 \cdot 10^7$ reconstructed triggers)
- ORCA4 data → analysed in a same way

Outlook

- Data/MC comparison and high level analysis of muon and neutrino events