Coincidence Analysis with GP13 and G@A

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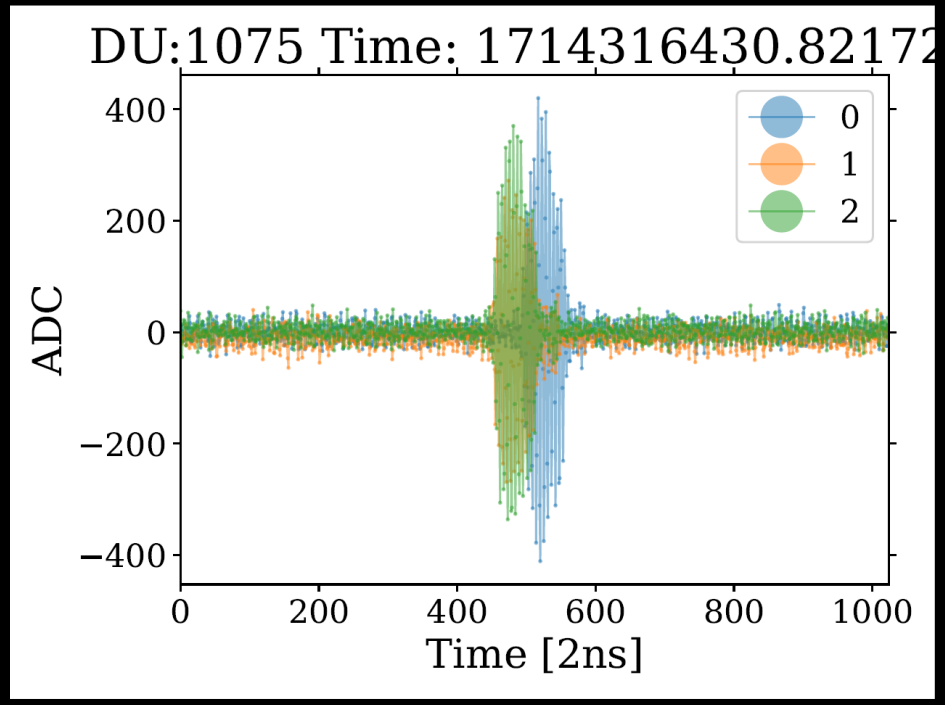
2024.06.08

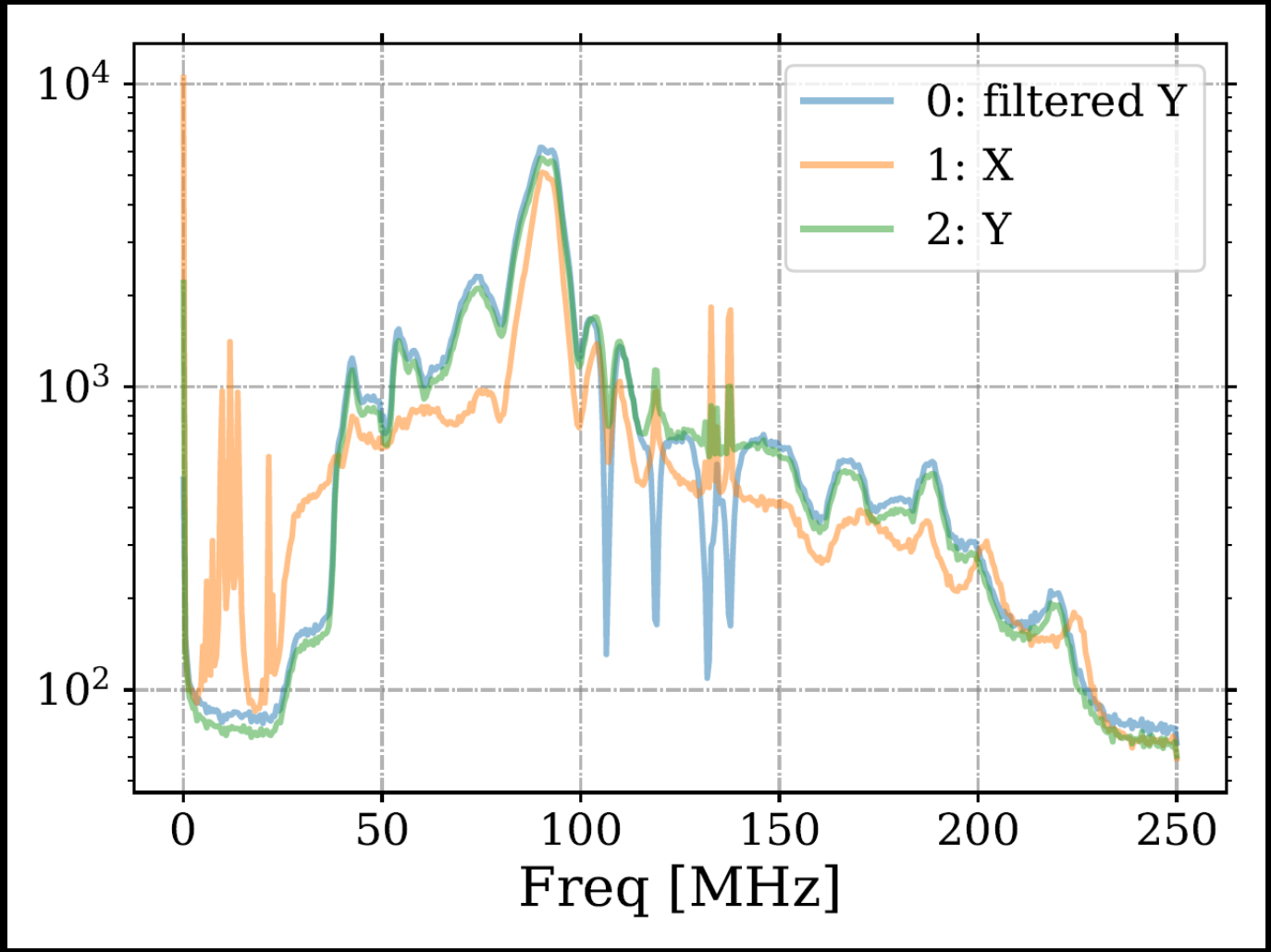
Data of GP13

- UD files:
  - GP13_20240428_150018_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_001.root
  - GP13_20240428_150756_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_001.root
  - GP13_20240428_150857_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_002.root
  - GP13_20240428_150957_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_003.root
  - GP13_20240428_151054_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_004.root
  - GP13_20240428_151128_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_005.root
  - GP13_20240428_151203_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_006.root
  - GP13_20240428_151234_RUN127_UD_RAW_ChanXYZ_20dB_13dus_BeaconTest_100M_007.root
- Number of DUs: 13
- Number of UD events: 6051
- (offline coincidence analysis)

Beacon Signal

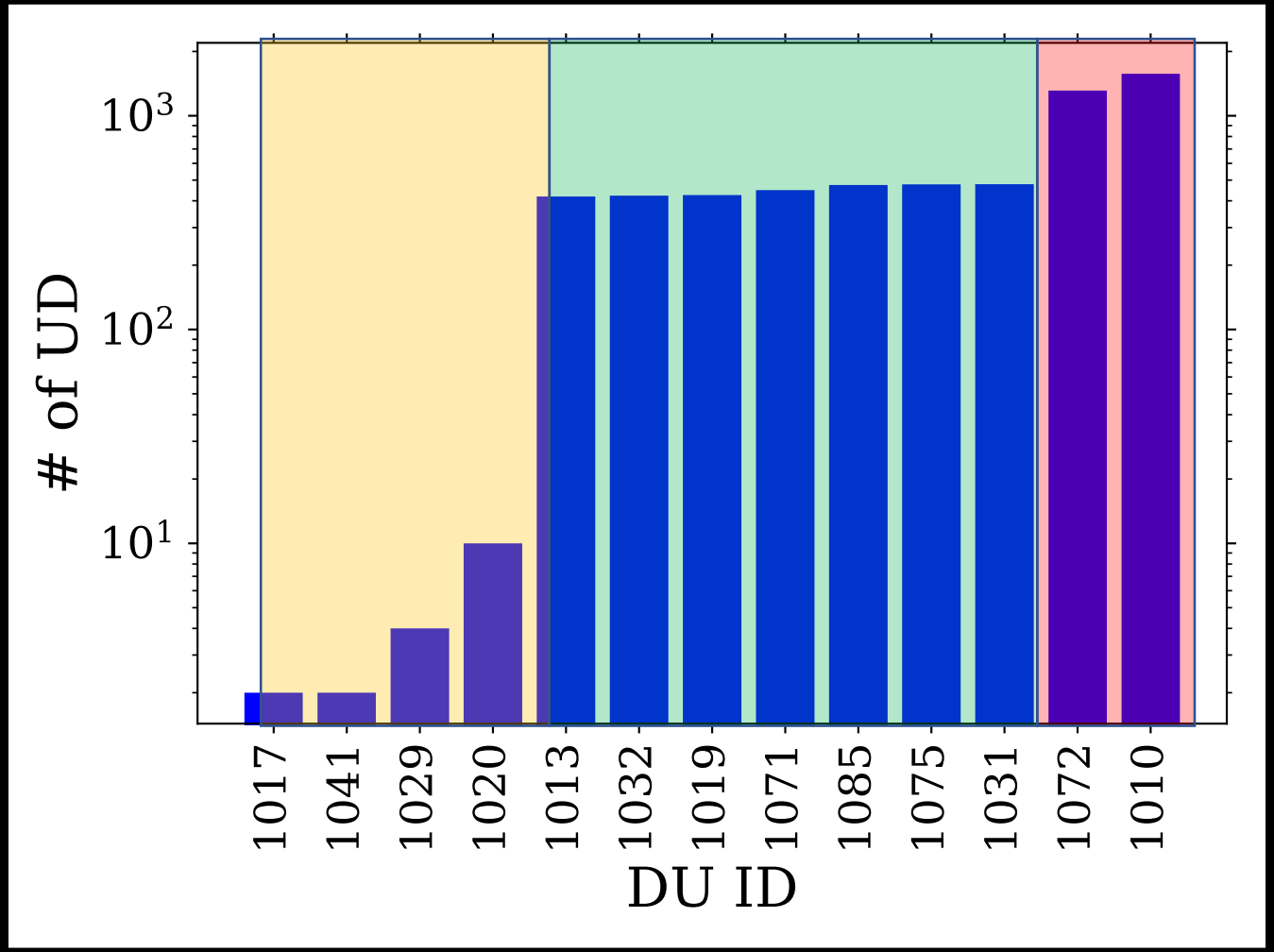
- Pulse at time domain
- 100MHz at FFT spectrum





Number of Pulses

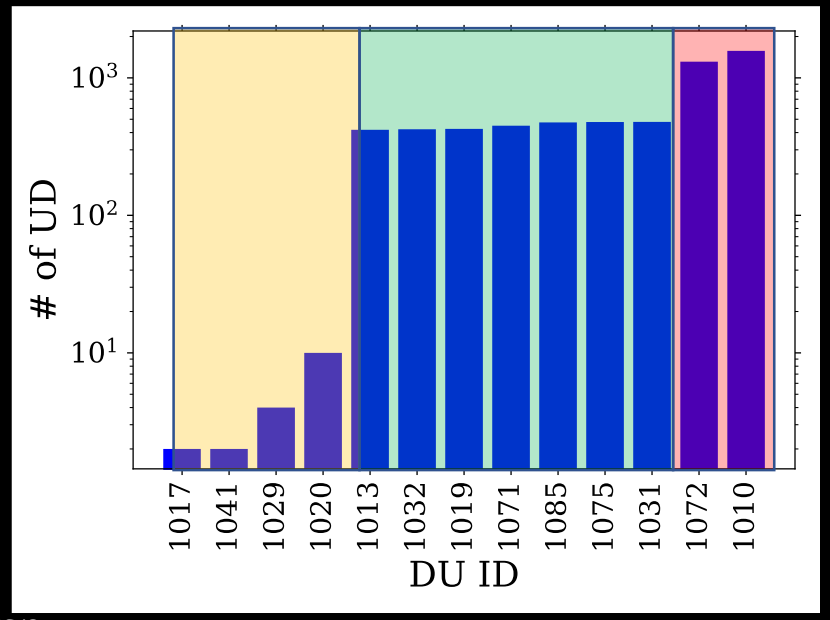
- Three groups
- 1010, 1072: ~1k pulses
- Seven DUs: ~400 pulses
- 1017, 1014, 1029, 1020: <10 pulses

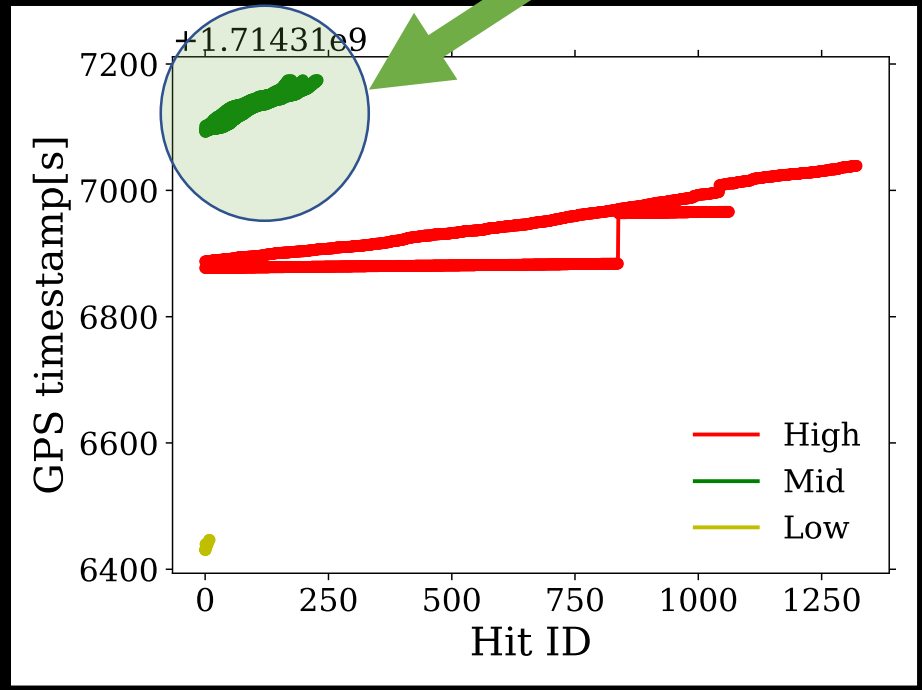


GPS Timing by DUs

- Three groups divided by pulse number:
  - High: [1010, 1072]
  - Mid: [1031, 1075, 1085, 1071, 1019, 1032, 1013]
  - Low: [1017, 1041, 1029, 1020]

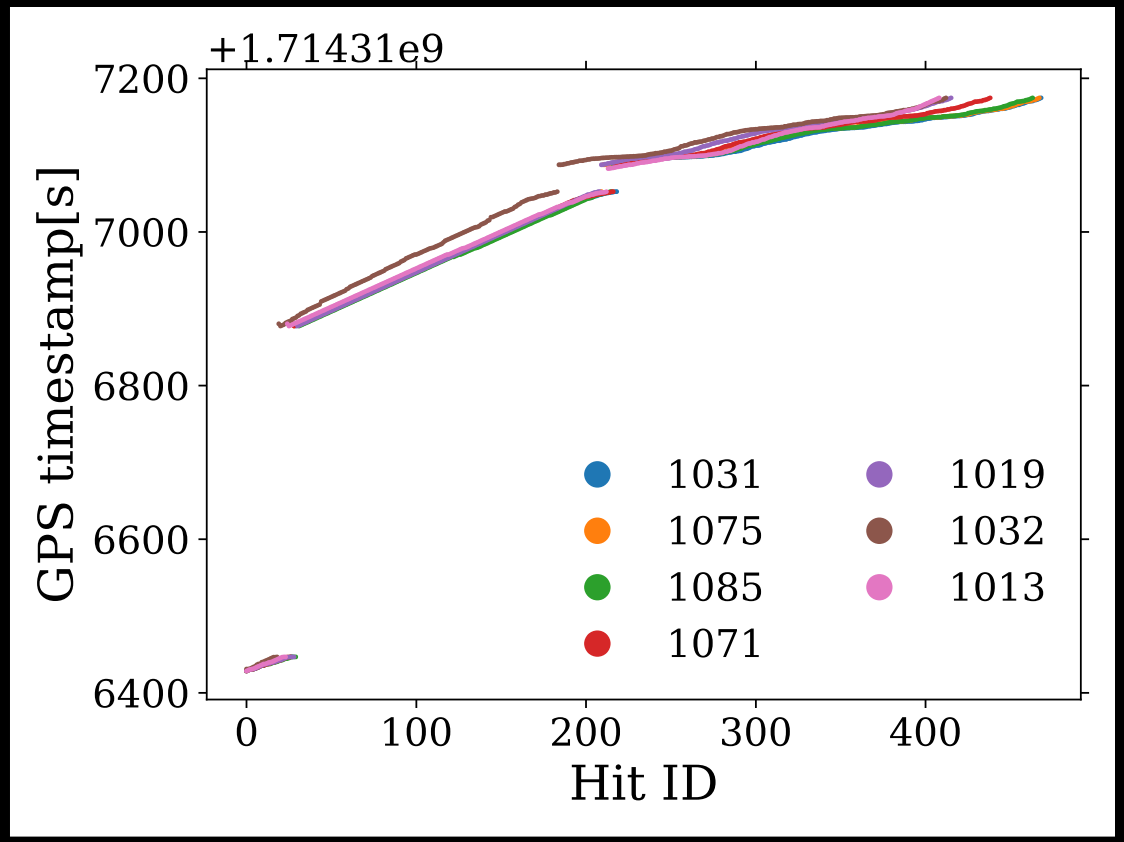
Only these DUs are considered for coincidence analysis

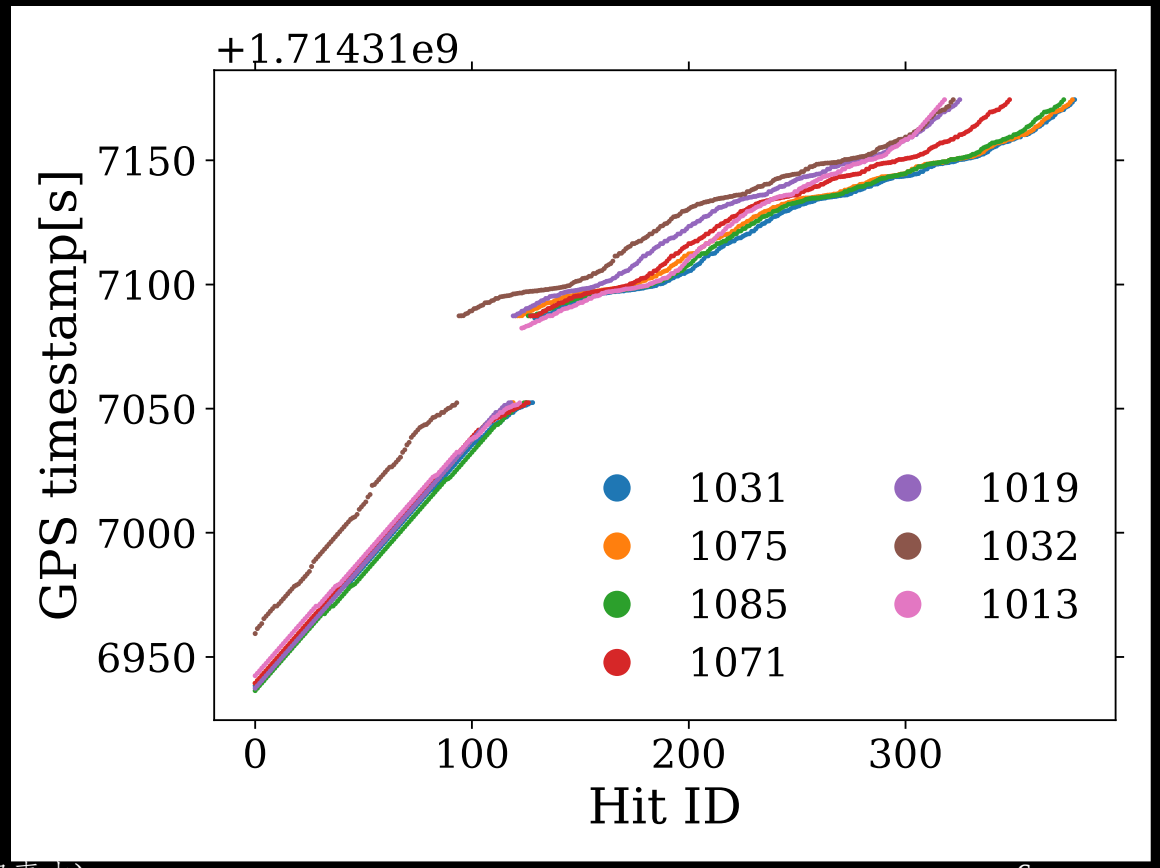




Zoom-in of Hit Time

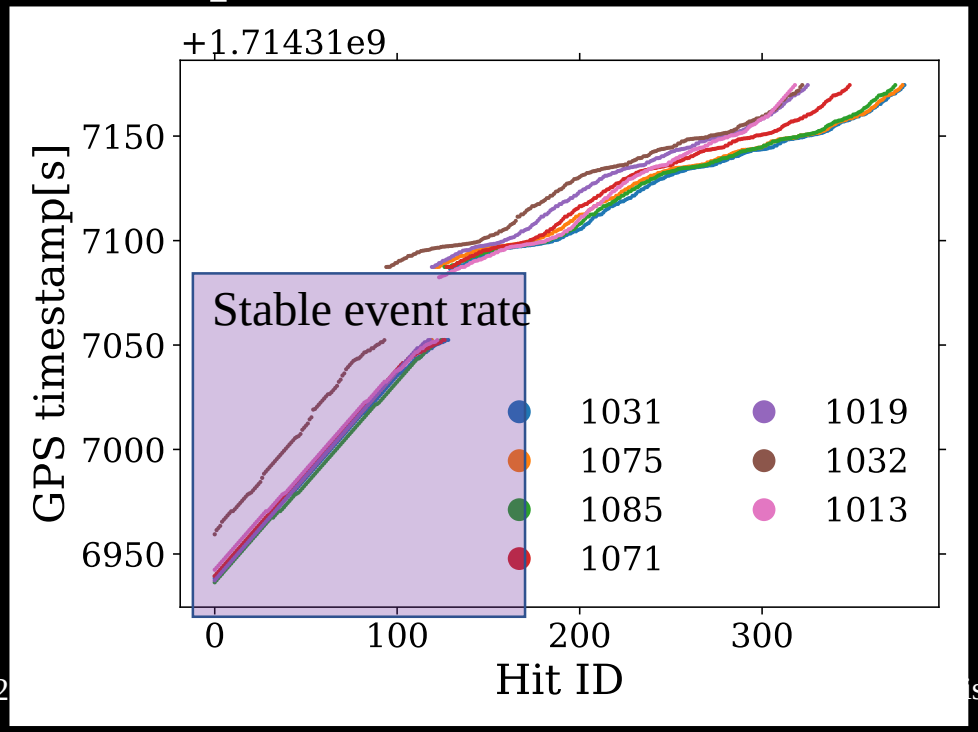
- Discontinuity of the GPS timing, change of burst rate?

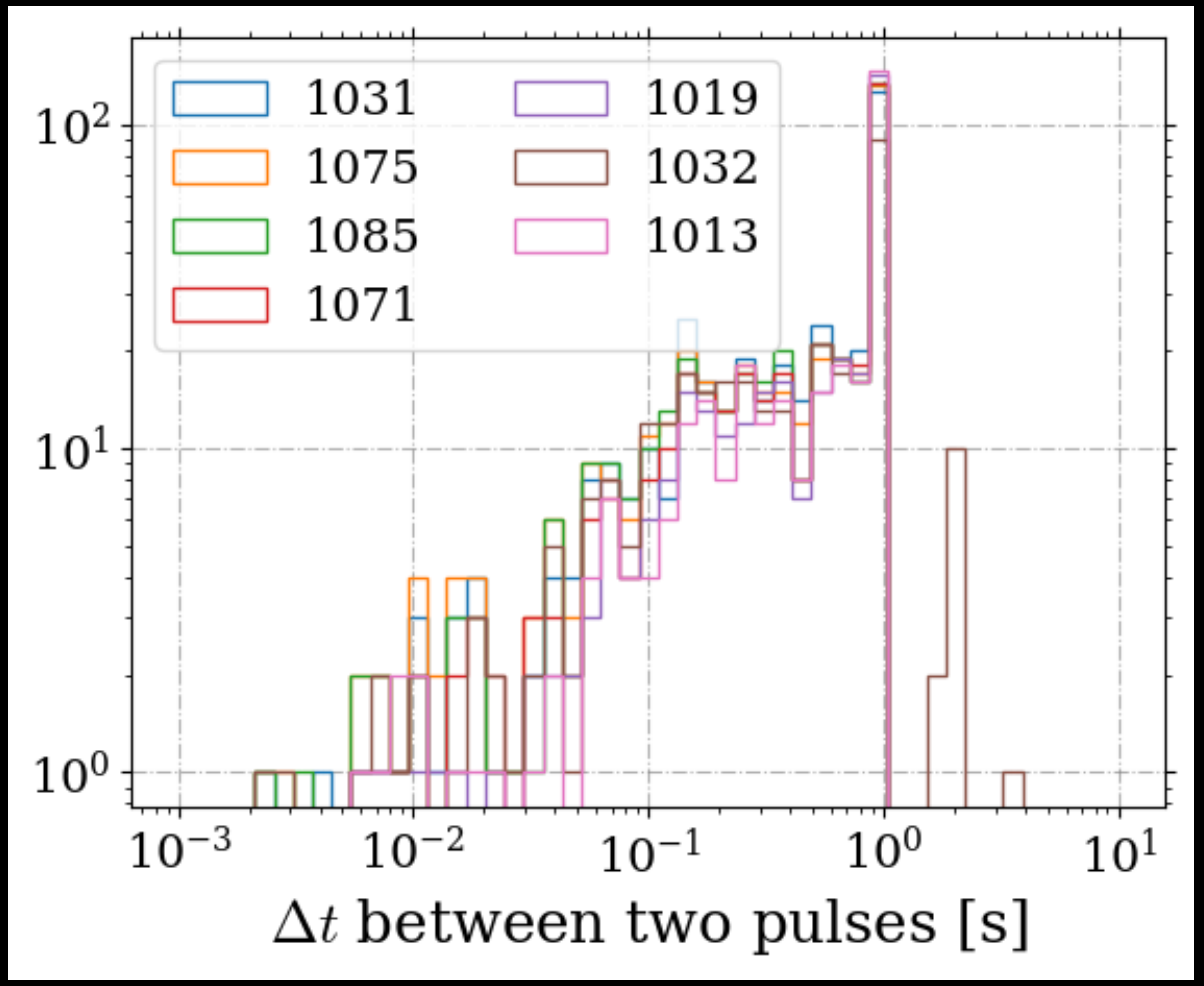




Burst Rate

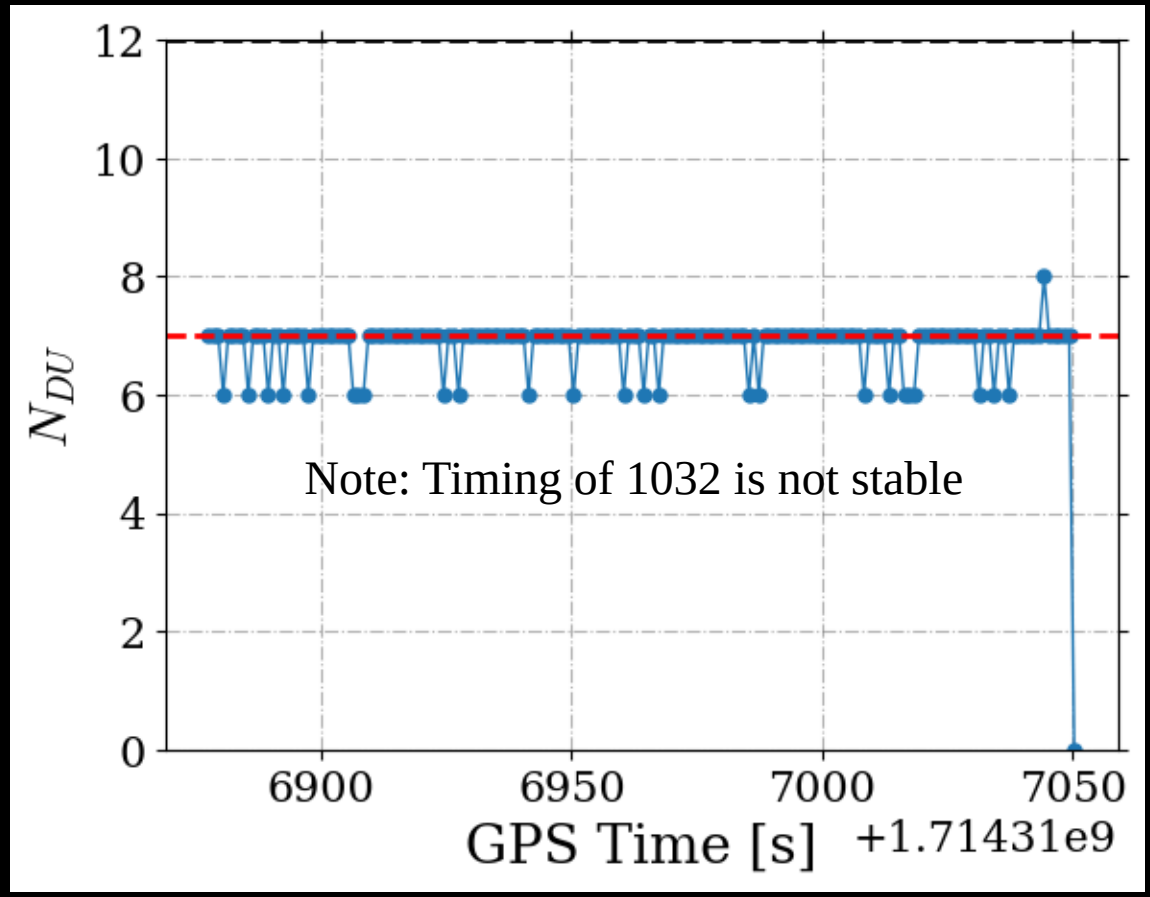
- Peak at 1Hz -> The beacon rate?
- Gaussian/Poisson process as noise
- 1032 peaks around 0.5Hz.





Offline Coincidence for GP13

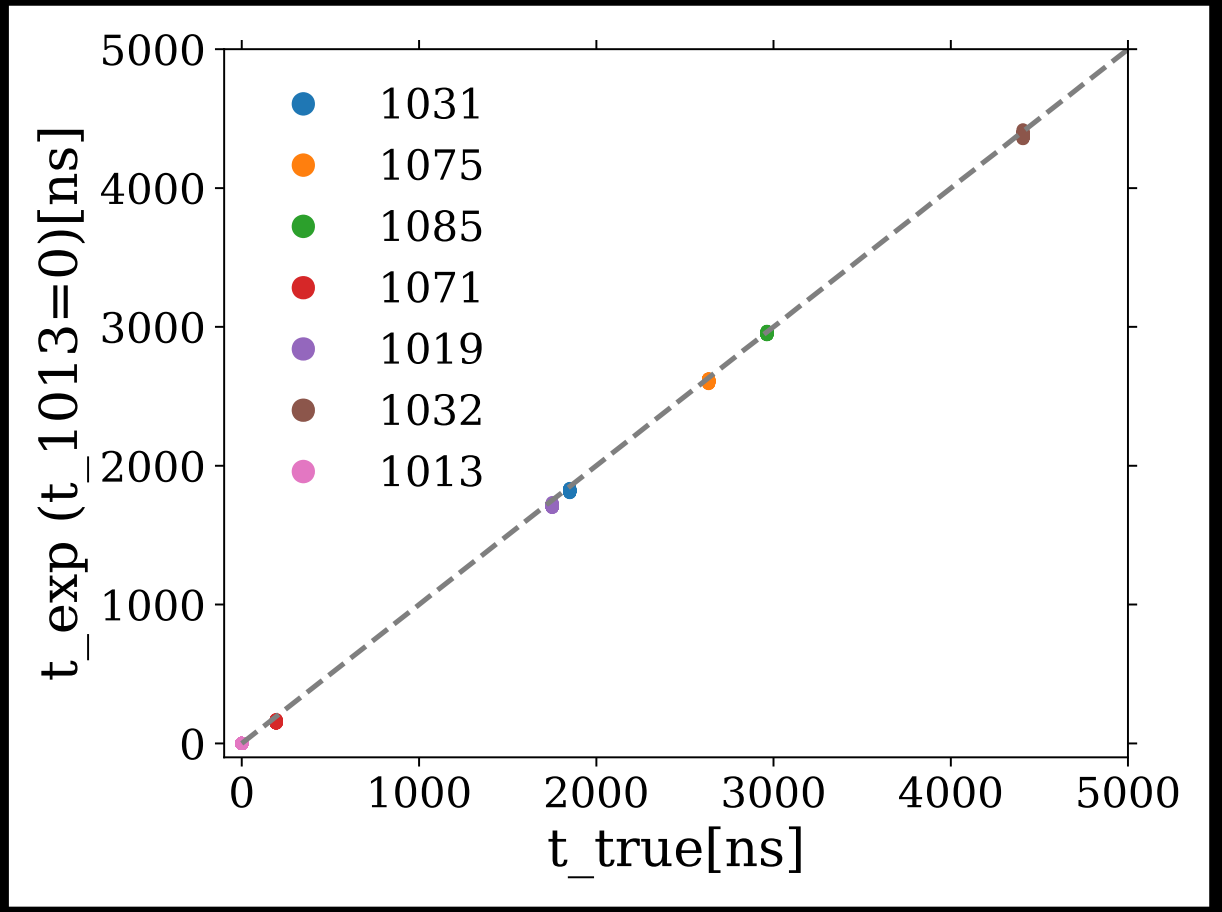
- Coincidence window: 10ms
- Minimum DUs for a CD: 3
- Timestamp to be searched: from 1714316877.41 to 1714317051.41 with stepsize=1s
- Expected 174 events
- Observed 173 events (one event where 1031 occurs twice.)
- Timing of 1032 is off from others.



Observed vs. Expected Arrival Time

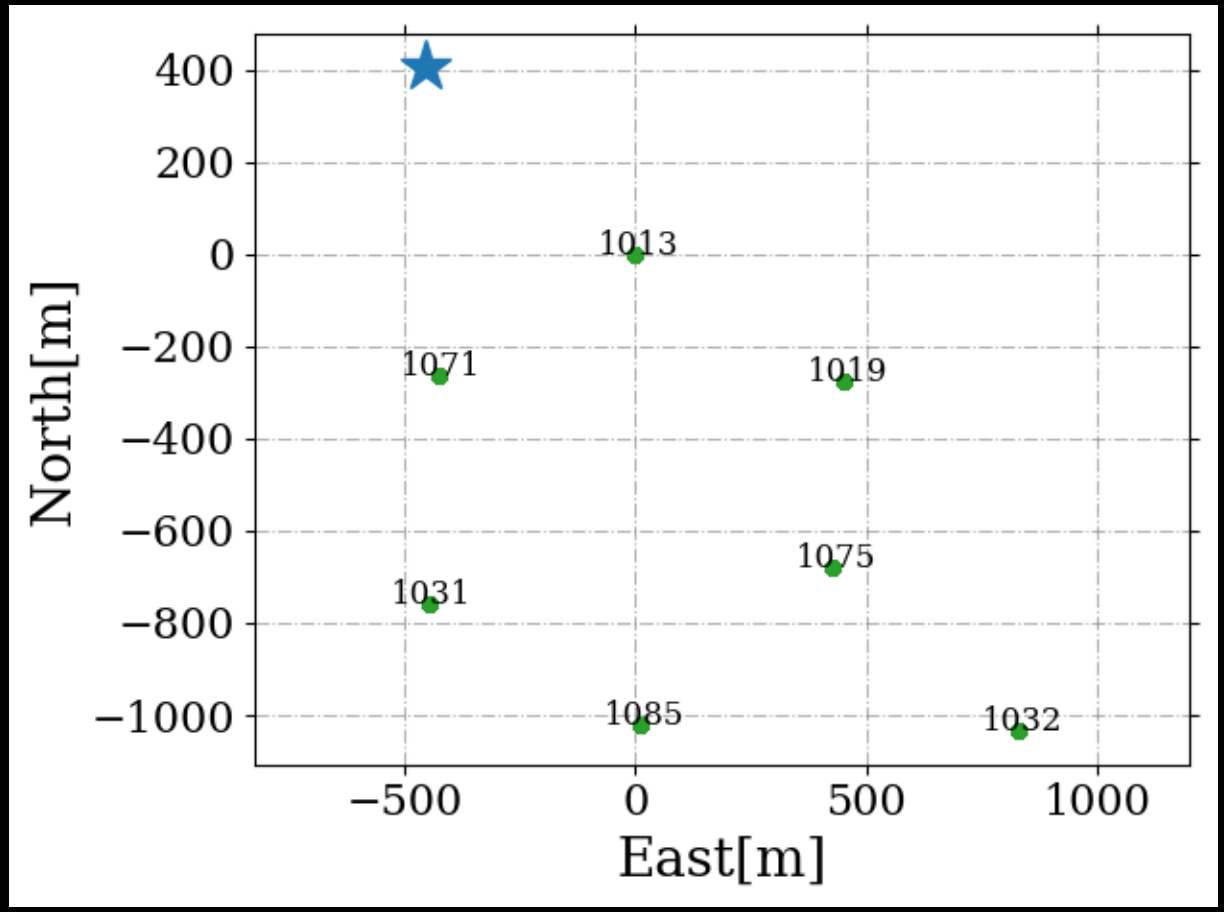
- Time shift with respect to DU1013:

DU	Δt[ns]
1031	-32
1075	-24
1085	-10
1019	-40
1032	-28
1071	-39



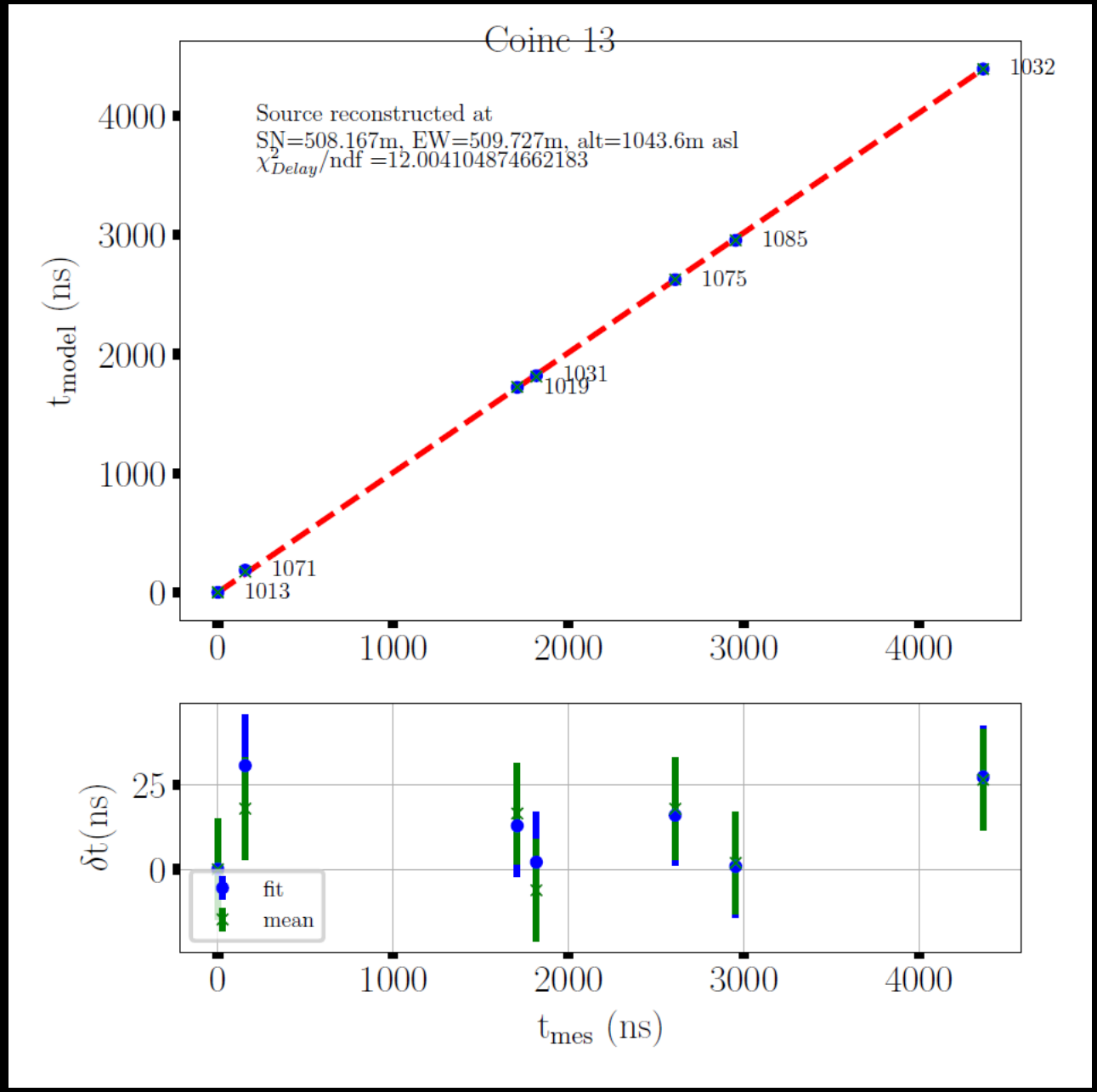
Calibrate GPS Timing with Beacon

- Beacon is set at the central station. (☆) as DU1076.
- Performing spherical wave reconstruction based on time of arrivals @ DUs



Typical event

- « Delay plot » à la TREND:
  - Plotting measured trigger delay wrt 1st triggered DU vs time obtained from isotropic propagation from reconstructed Point Source.
  - Also shown as x: time expected from « mean » position (see below)

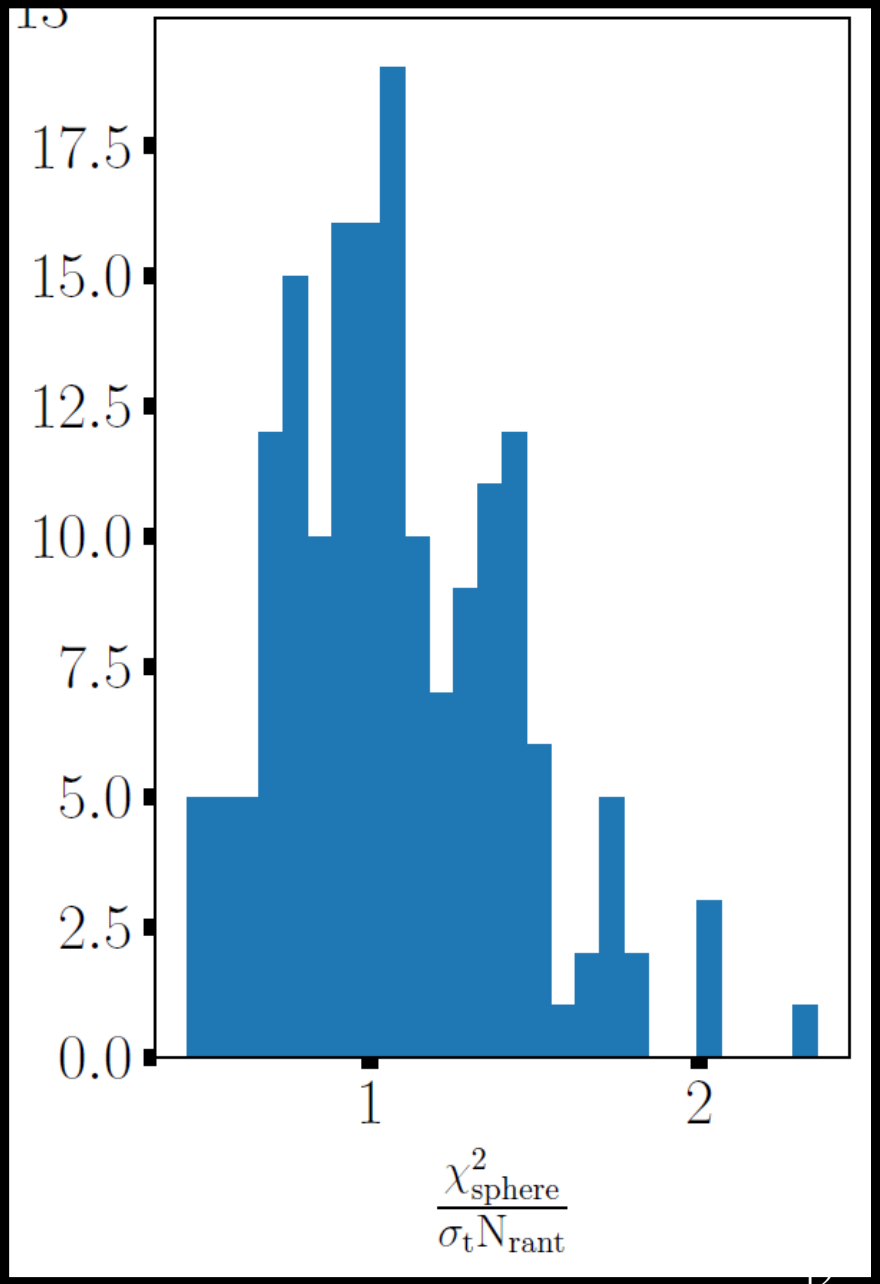


Quality cuts

- Chi2 computed from spherical fit assuming σ_{timing} = 15ns

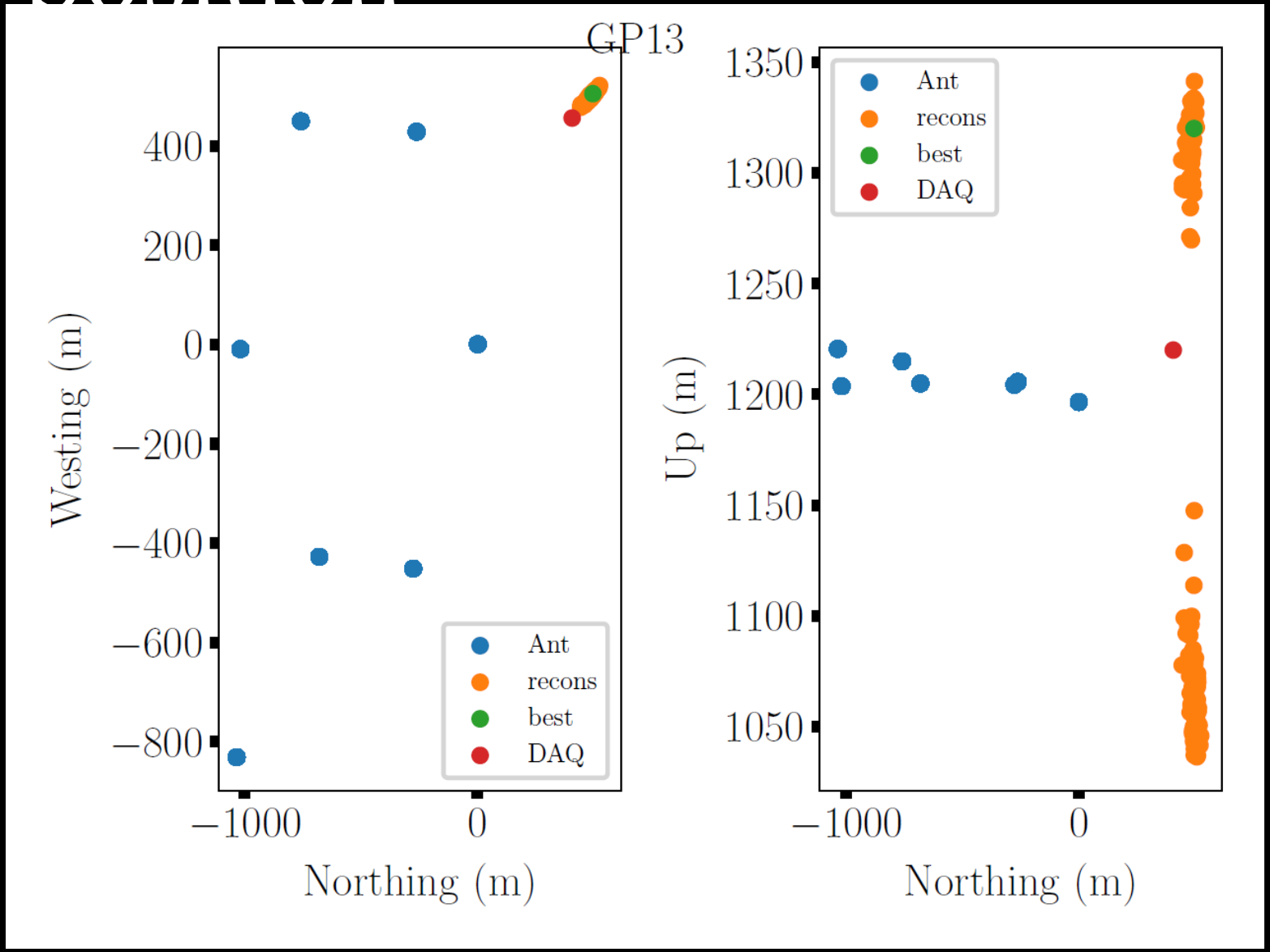
➔171/172 events with x2/ndf<5 ☺

➔ Mean ~1 ☺

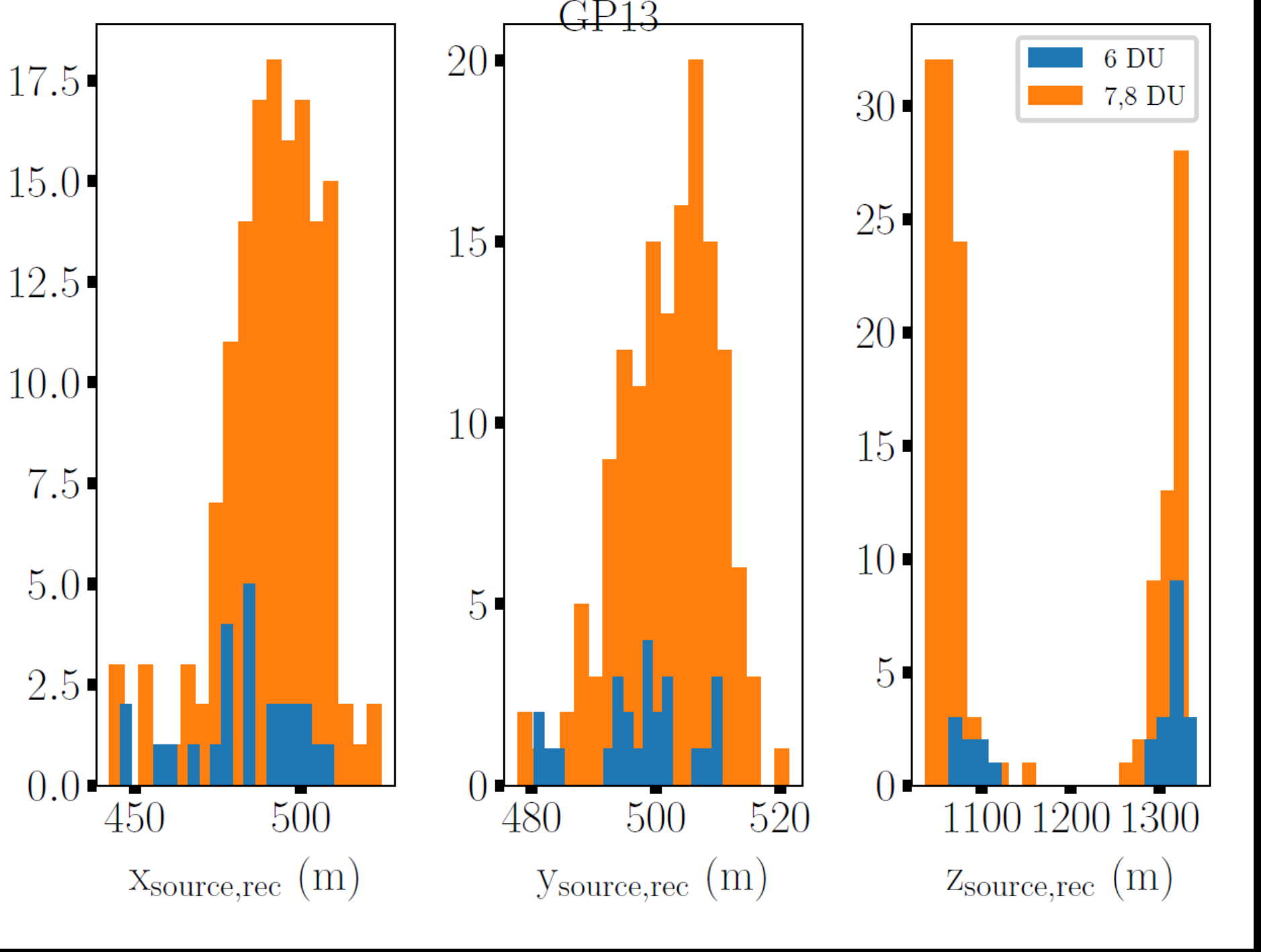


Rconstructed position

- Nominal beacon position [406, 456, 1220]
- Mean reconstructed position = [490, 501, 1320]
- (Also mirror effect in z)

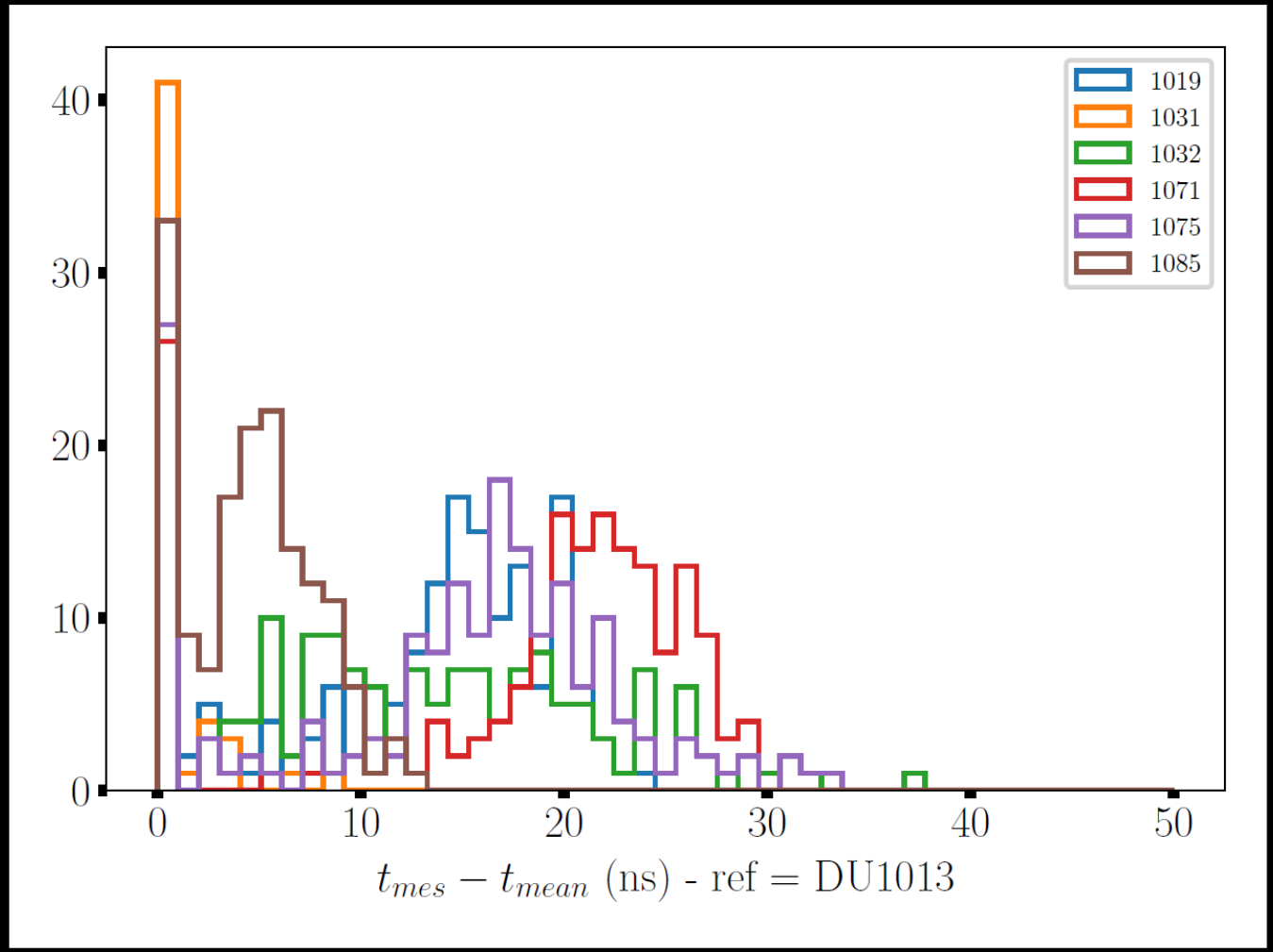


- σ_x ~15m
- σ_x ~8m ☺



Also

- Differences between measured trigger time and time expected from mean reconstructed source (in ns):
  - DU 1019 , mean= 11.8 std dev= 7.3
  - DU 1031 , mean= -3.6 std dev= 4.9
  - DU 1032 , mean= 11.1 std dev= 9.9
  - DU 1071 , mean= 18.3 std dev= 8.8
  - DU 1075 , mean= 14.4 std dev= 8.1
  - DU 1085 , mean= 3.7 std dev= 4.3
- Mean != 0: wrong refractive index value? Wrong source position?
- Sigma too good to be true?
- In any case requires
  - more thinking
  - precise measurement of beacon position

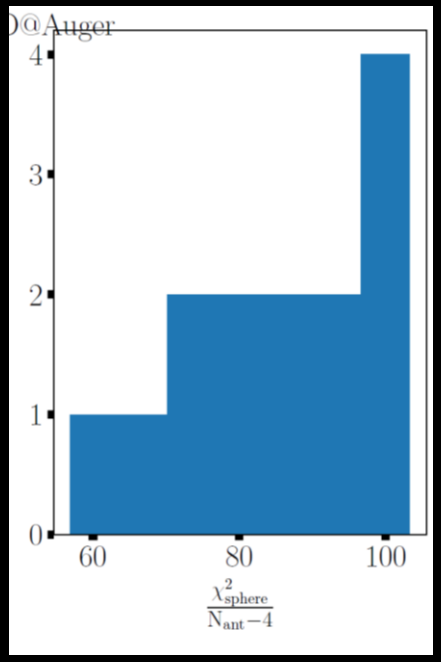


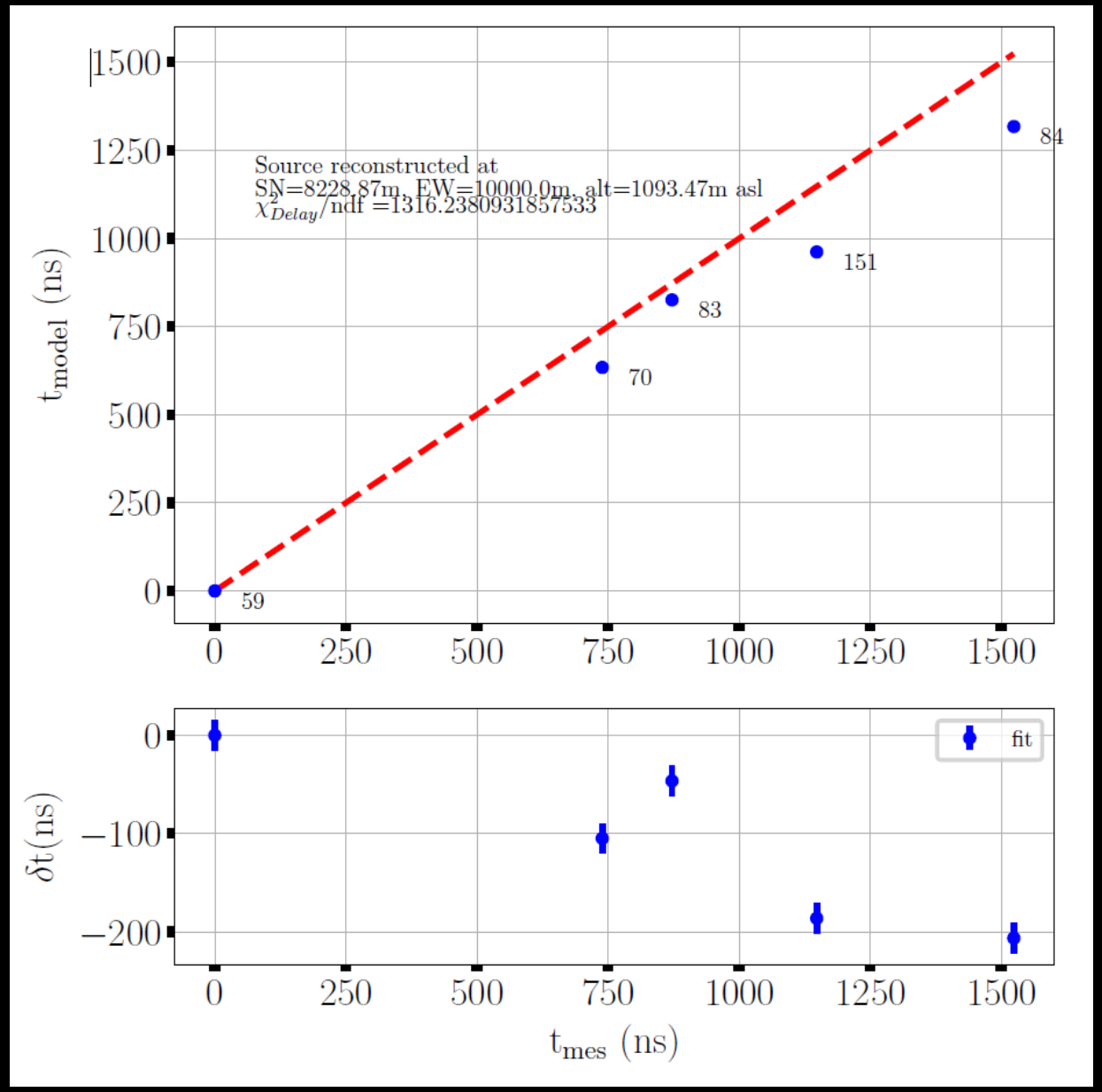
Data of G@A

- CD file: gaa_20240427_224428_RUN003002_CD_phys.root
- Number of DUs: 5 (59, 70, 83, 84, 151)
- Number of CD events: 14
- Indices of events: 4475, 4605, 6801, 6802, 6803, 6819, 6825, 6829, 6840, 6845, 6847, 6862, 6917, 7568
- (online coincidence)

Spherical recons

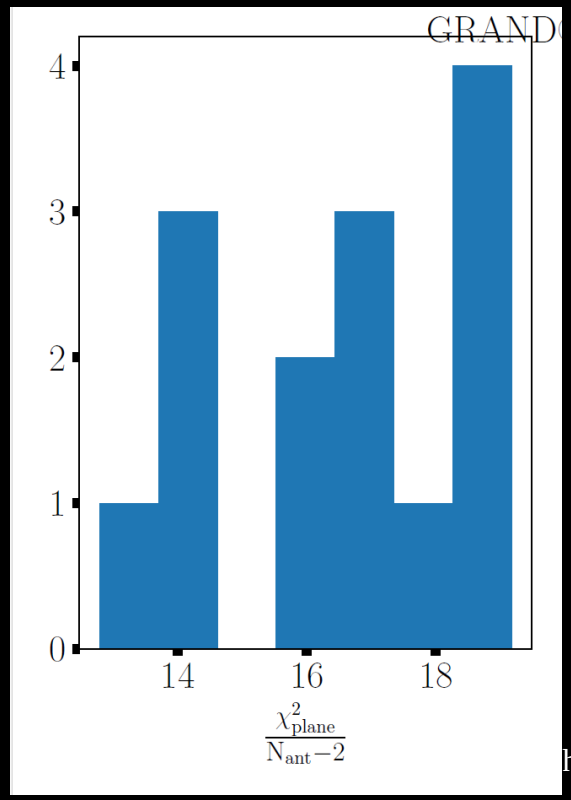
- Source reconstructed FAR away with spherical fit (ie ~plane wave)
- Yet rather bad fit ☹

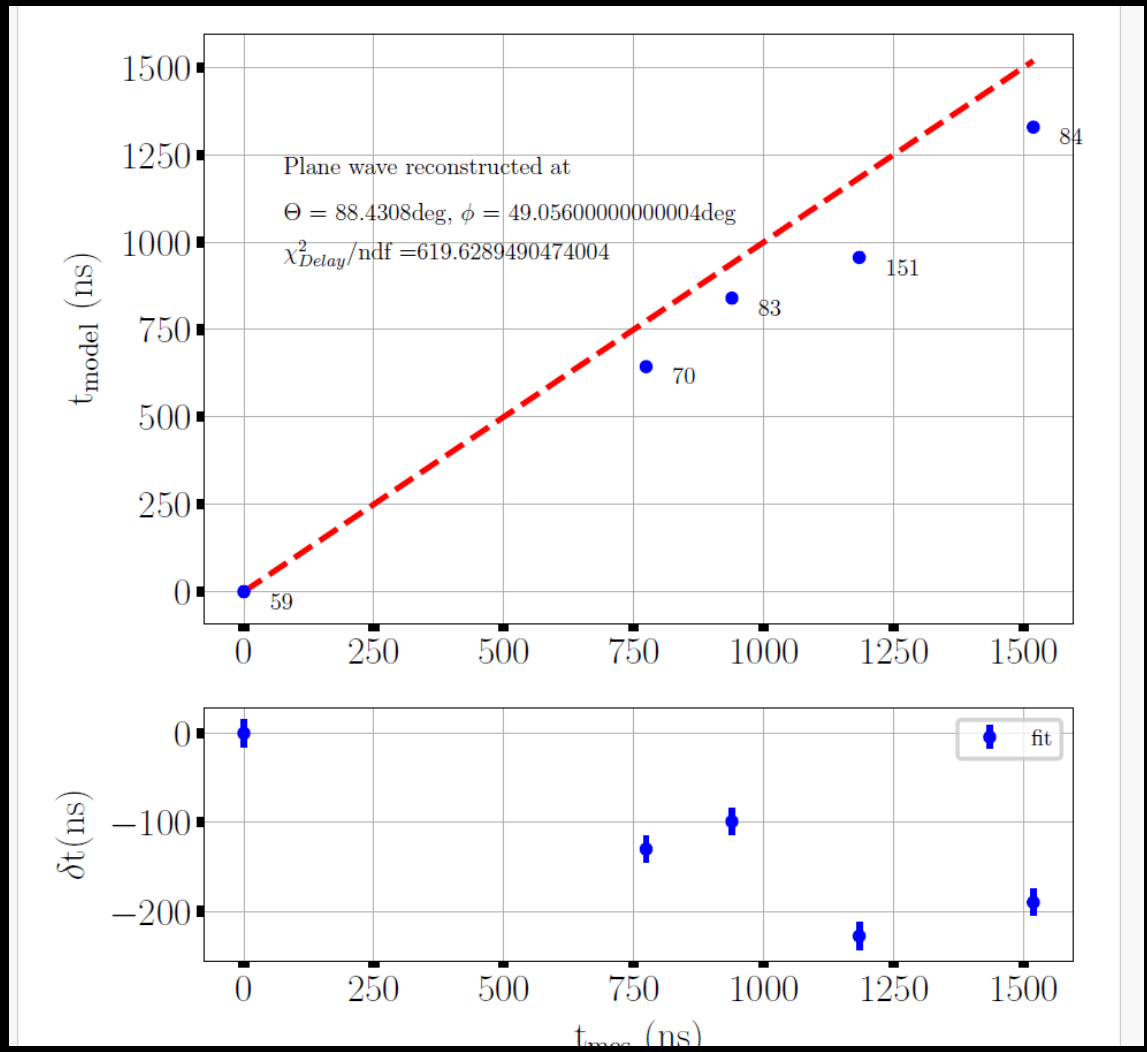




Plane wave reconstruction

- Valid for distant sources
- Again delta between expected and measured ➔ to be understood





Direction reconstruction

- Directions cluster along horizon + North-West
- Results of SWF & PWF, as well as Aurelien's analysis are consistent