Relative Tagging Ratio Study with PS
Note #82
August 2018

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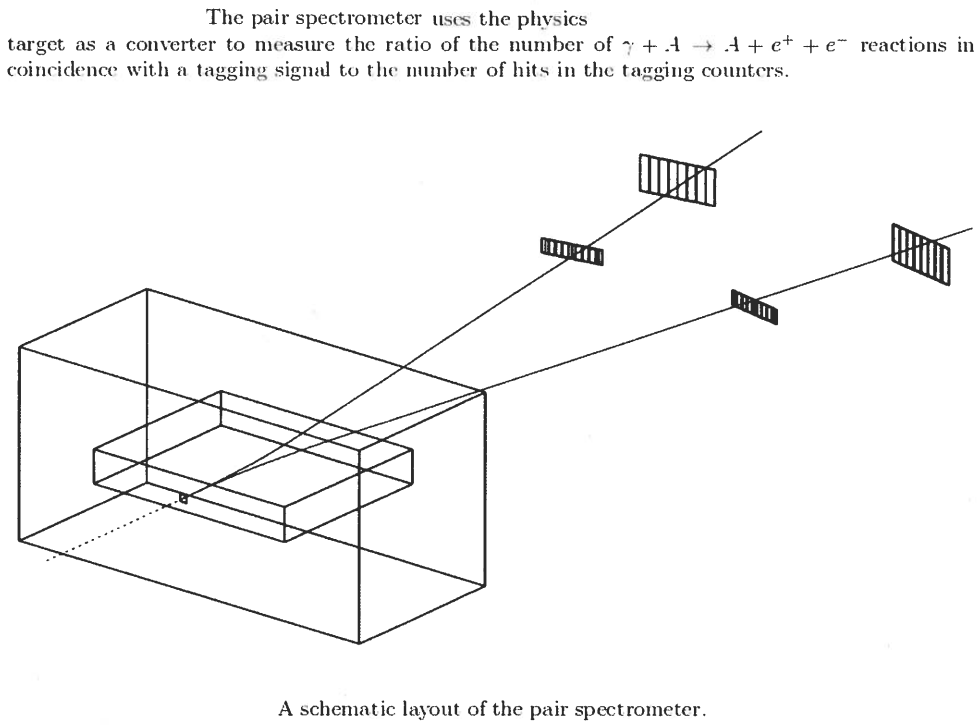
Abstract

For precision measurement of pi0 cross section it is important to know the number of beam particles i.e. photon flux. Additional monitor for photon flux has been performed by Pair Spectrometer (PS) which was counting number of e+e- pairs produced in the target during the experiment. The number of these pairs strongly correlates with the number of beam particles in photon flux. Relation between the number of e+e- pairs in PS and number of particles in flux (in tagger) is so called relative tagging ratio. We suppose that relative tagging ratio is constant run to run.

PS layout

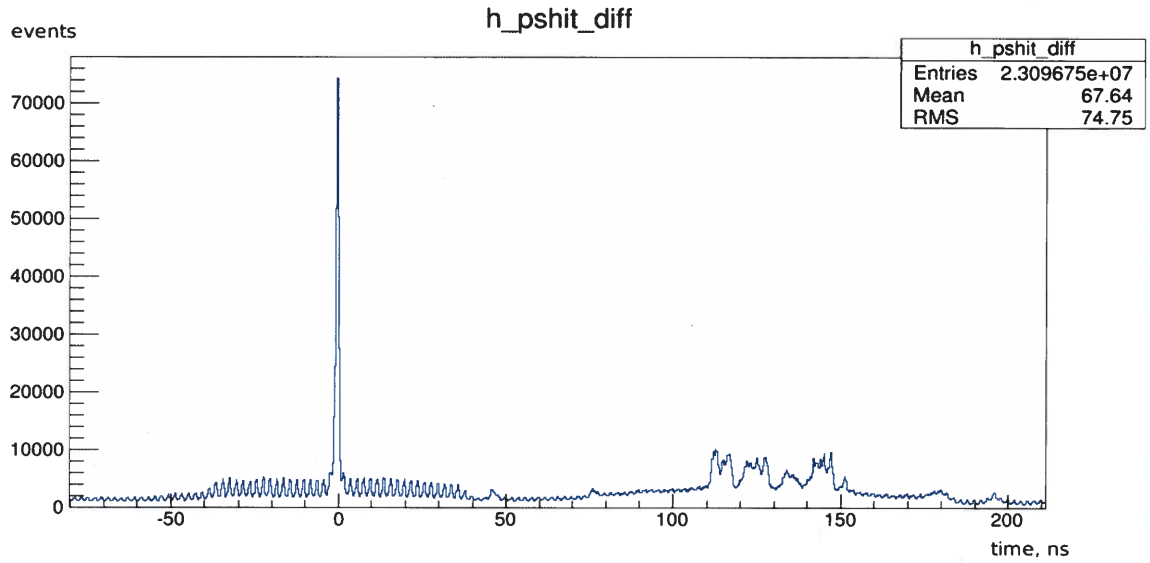
Effective scheme of Pair spectrometer presents on Pic #1. Spectrometer includes dipole magnet situated downstream of target and vertical scintillation hodoscopes. Hodoscopes make four shoulders situated from the left and right side of beam direction. Each hodoscope consists of 8-15 planes. Each plane overlaps side one(except edges) and detects e+e- pairs which were burn in target or beam scanner. Stability of magnet field provides quantity of e+e- pairs during experiment.

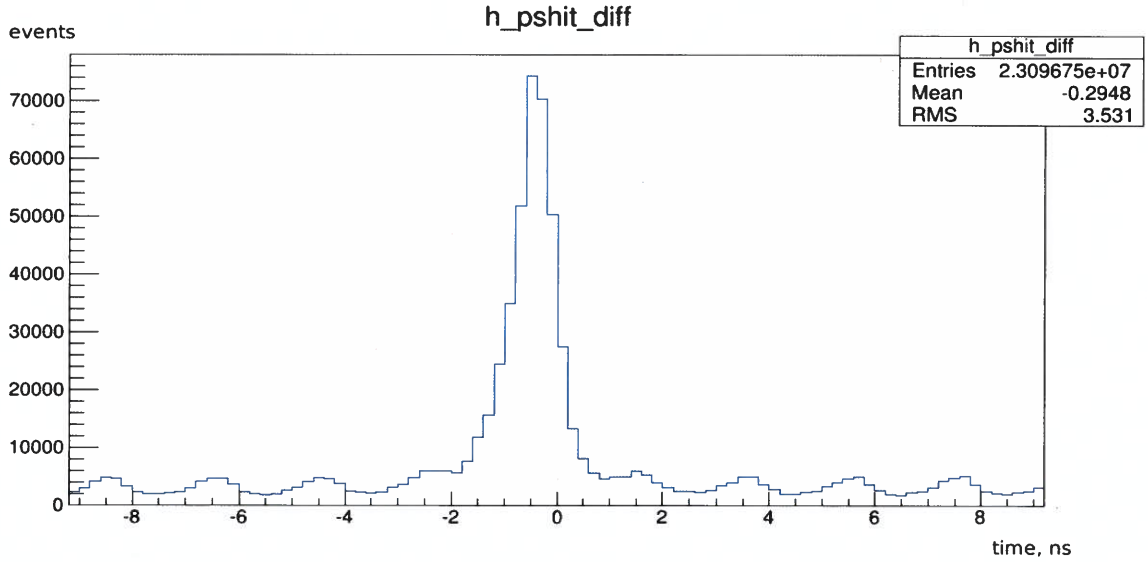


Pic #1. Schematic layout of the pair spectrometer.

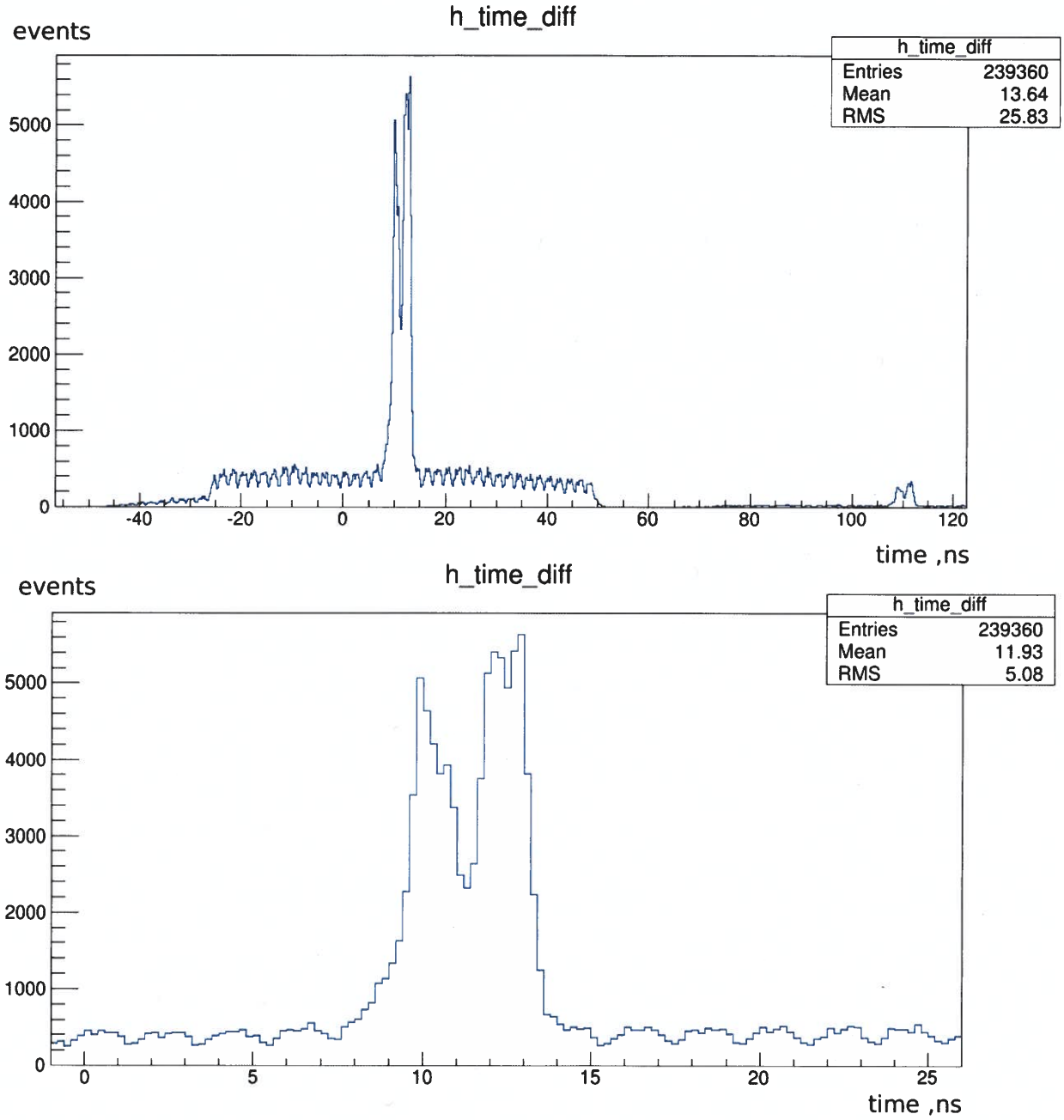
First look at Pair Spectrometer

Effective cuts:
1) 1st T-counter;
2) T-diff<10ns (TRIGPHOTON->trigphoton[i].tdiff<10);
3) analyzing files: skim files for PS;
4) looking for time difference between tagger (at the beginning of analysis we took data from TRIGPHOTON bank to determinate tagger time, then we took data from TAGM_LR bank which is correct) and PS.
result:





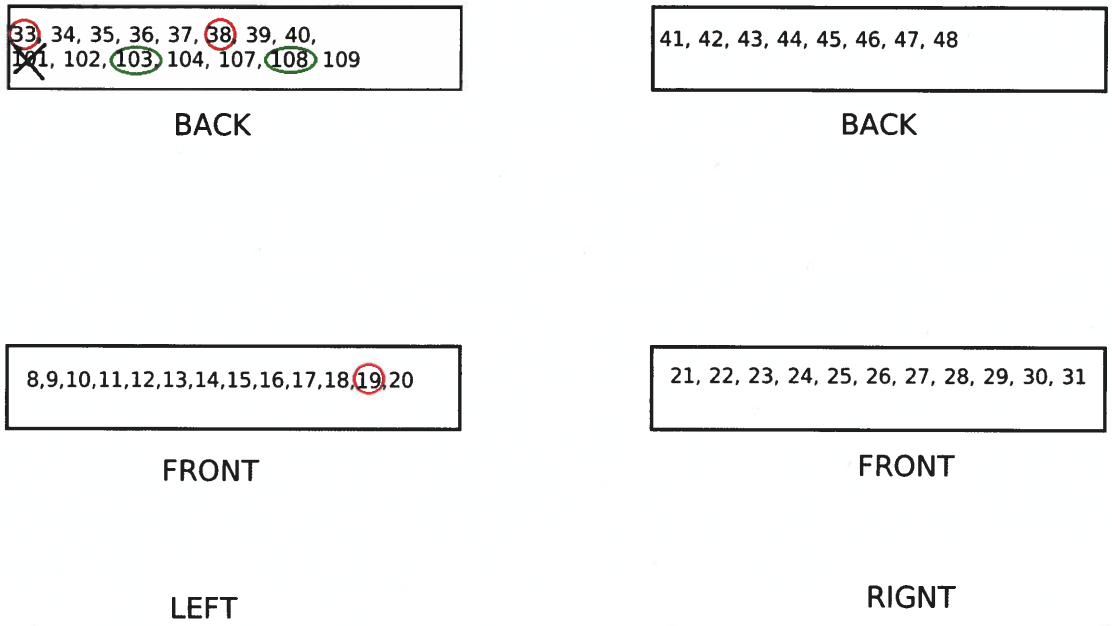
Pic #2. Difference between time from tagger and time from PS (before reconstruction, PSHIT bank) for 1st T-counter (bottom – more detail picture).



Pic #3. Time difference between time from tagger and time from PS (after reconstruction, PSR bank) for 1st T-counter (bottom – more detail picture).

Should make alignment for each T-counter (we will see follow that they aren't changing run by run).

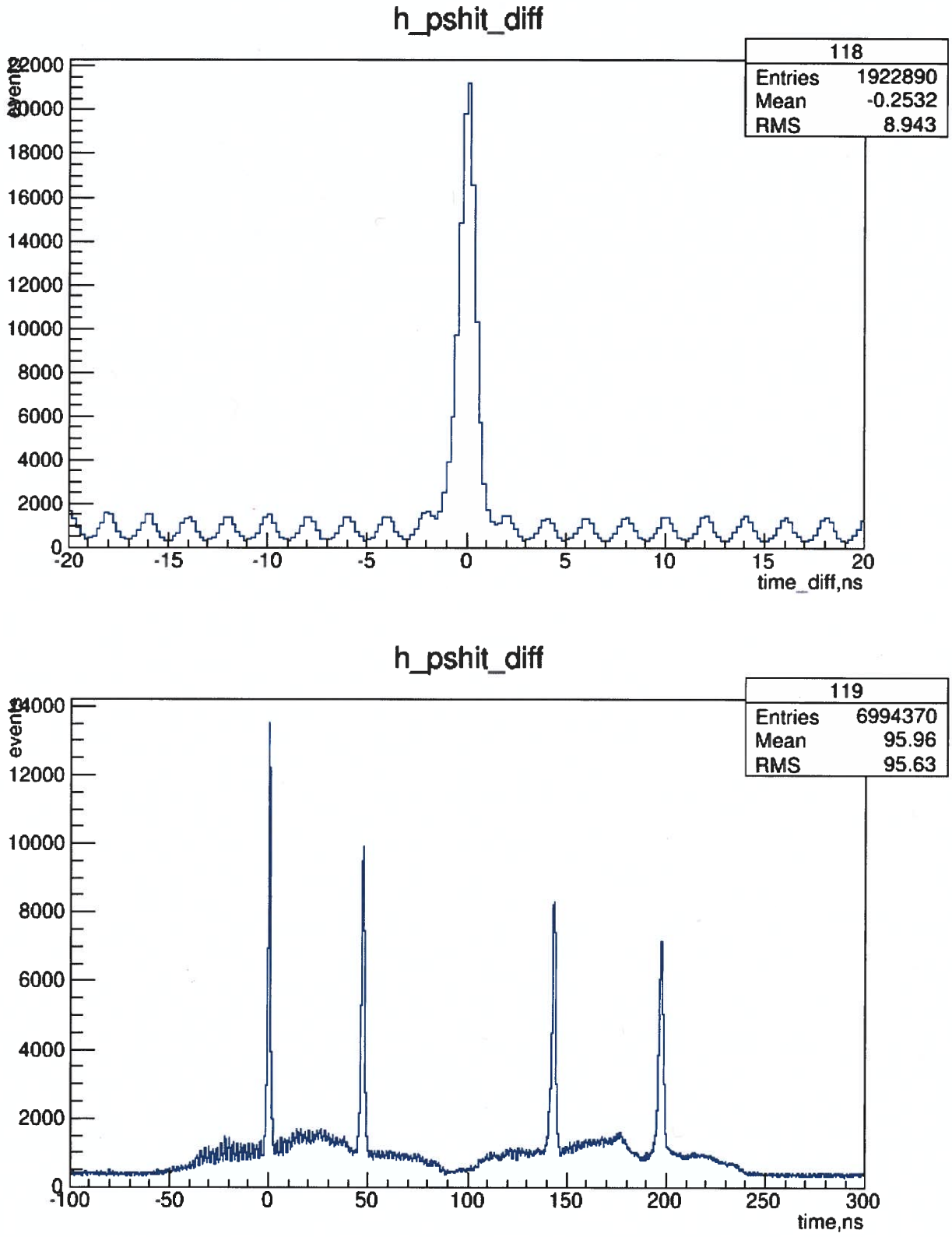
When we were checking all PS modules for time difference (tagger – PS) we found that some of them has "strange/bad" form (see pic #4 and #5-#15)



Pic #4. PS each module ID. Marked – "bad" or "strange" ID.

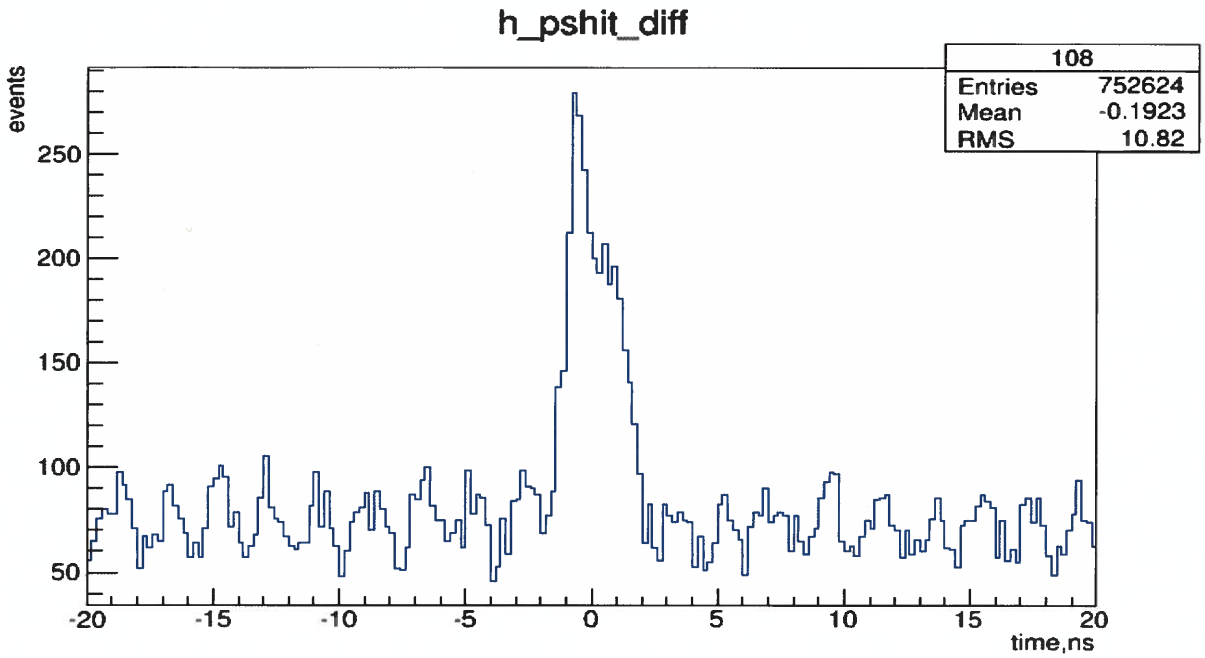
Description of "bad" and "strange" ID.

Typical good and bad ID presents on picture #5 (top – good, bottom -bad) for modules #18 and #19 (see pic #4).

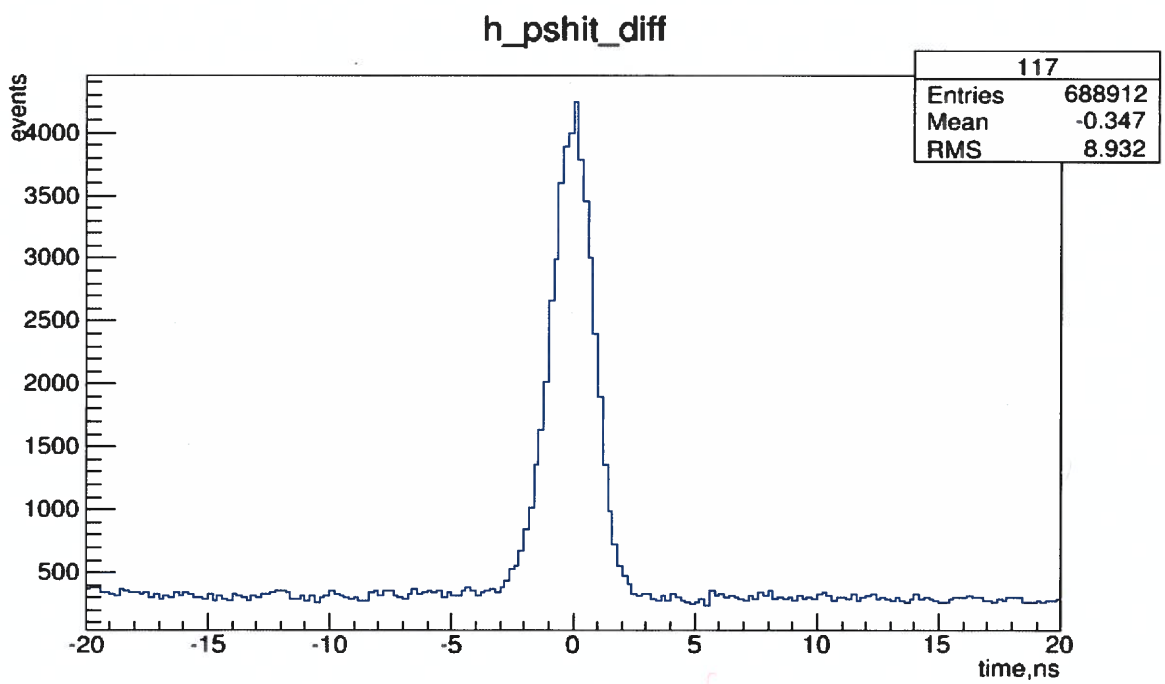


Pic #5. Typical good (top - id #18) and bad/strange (bottom - id #19).

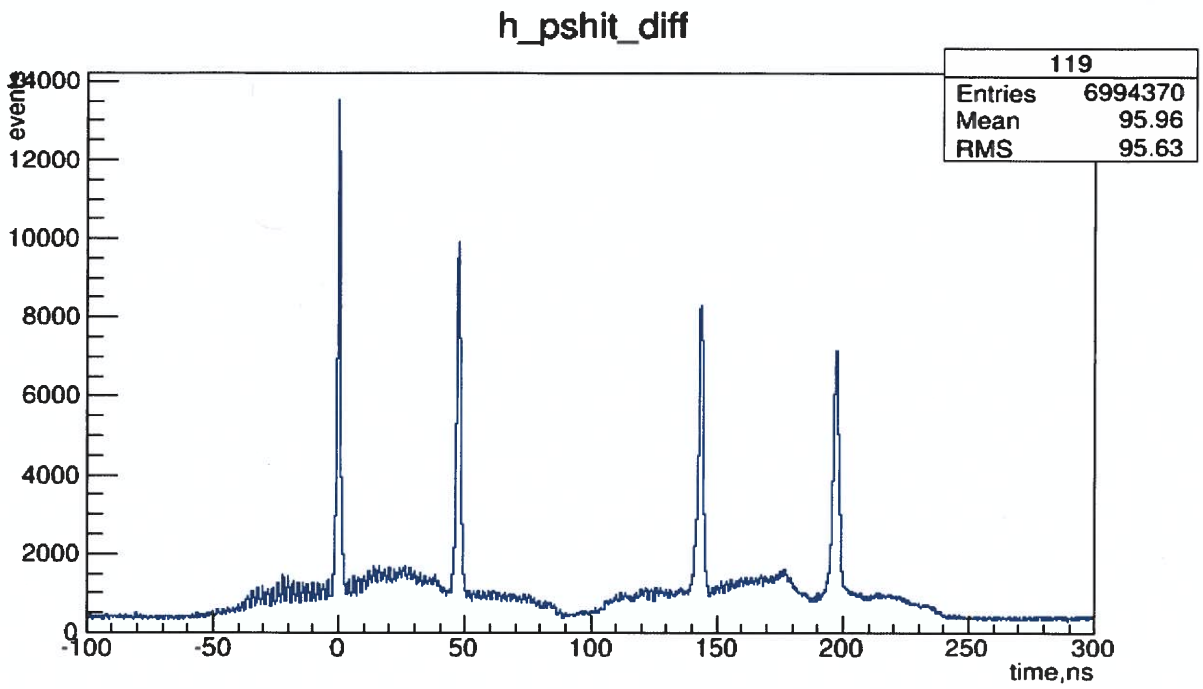
Another deviations:



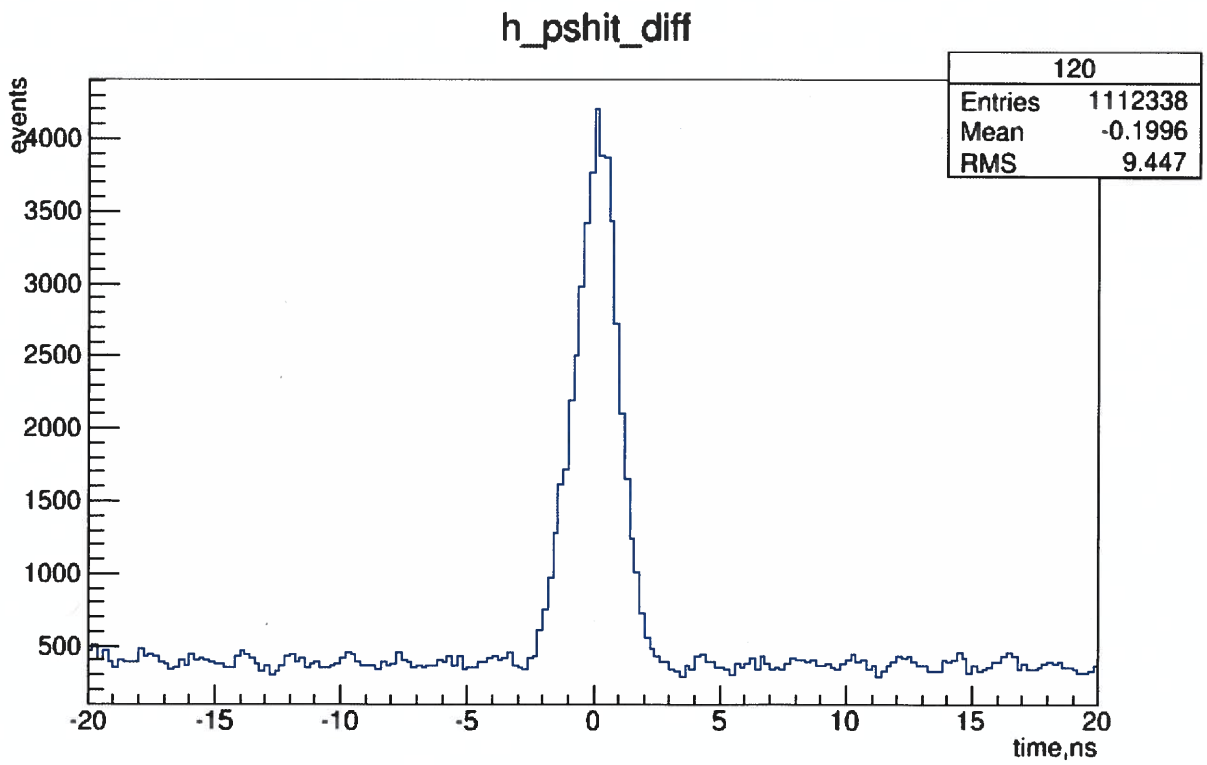
Pic. #6. Wide peak (ID #8).



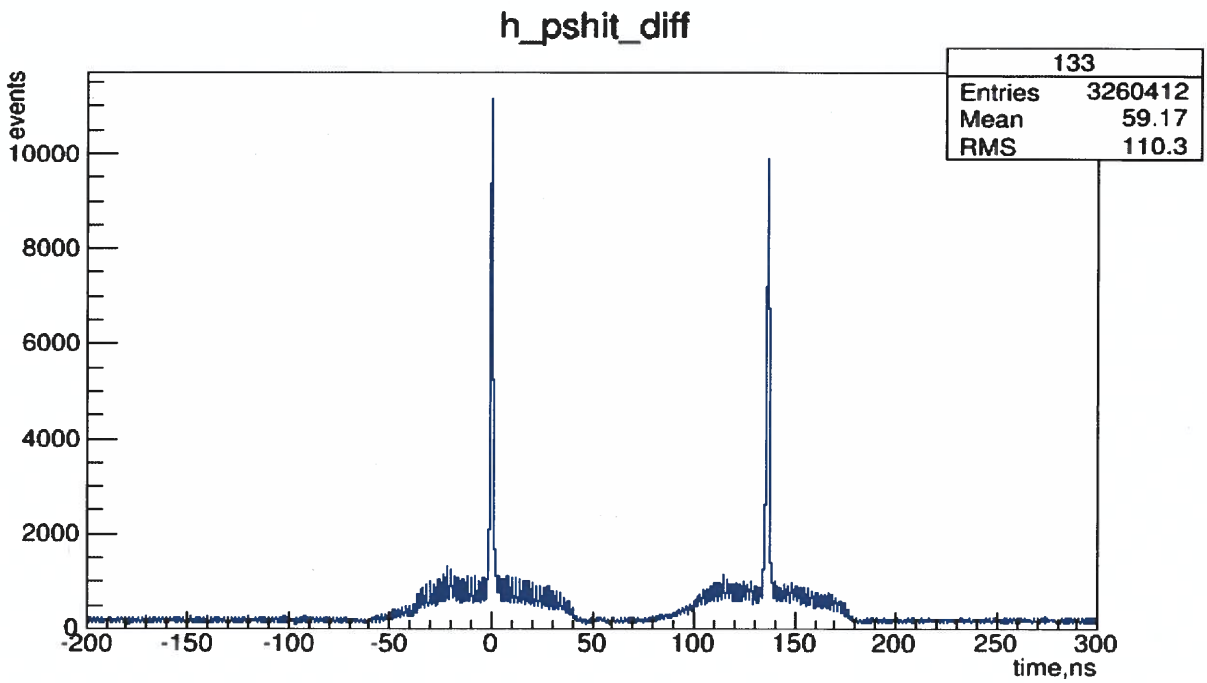
Pic#7. Flat backgroun (ID #17). Possible explanation – bad time resolution of this module.



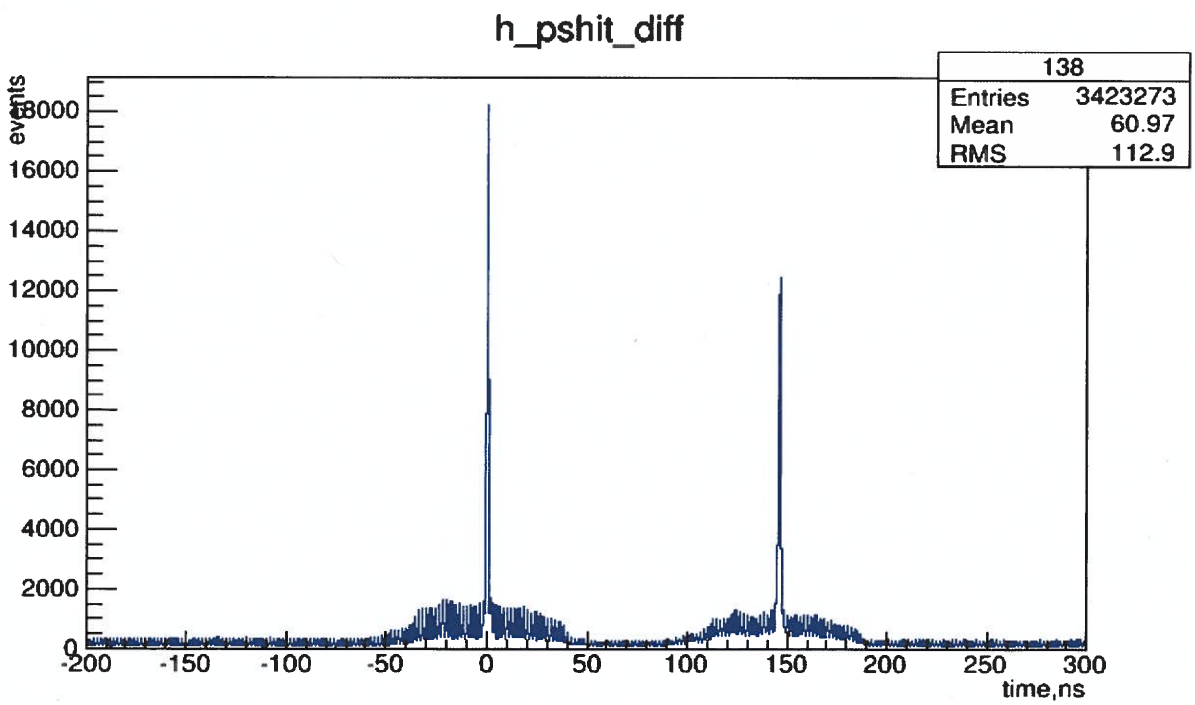
Pic#8. Too many peaks (ID #19).



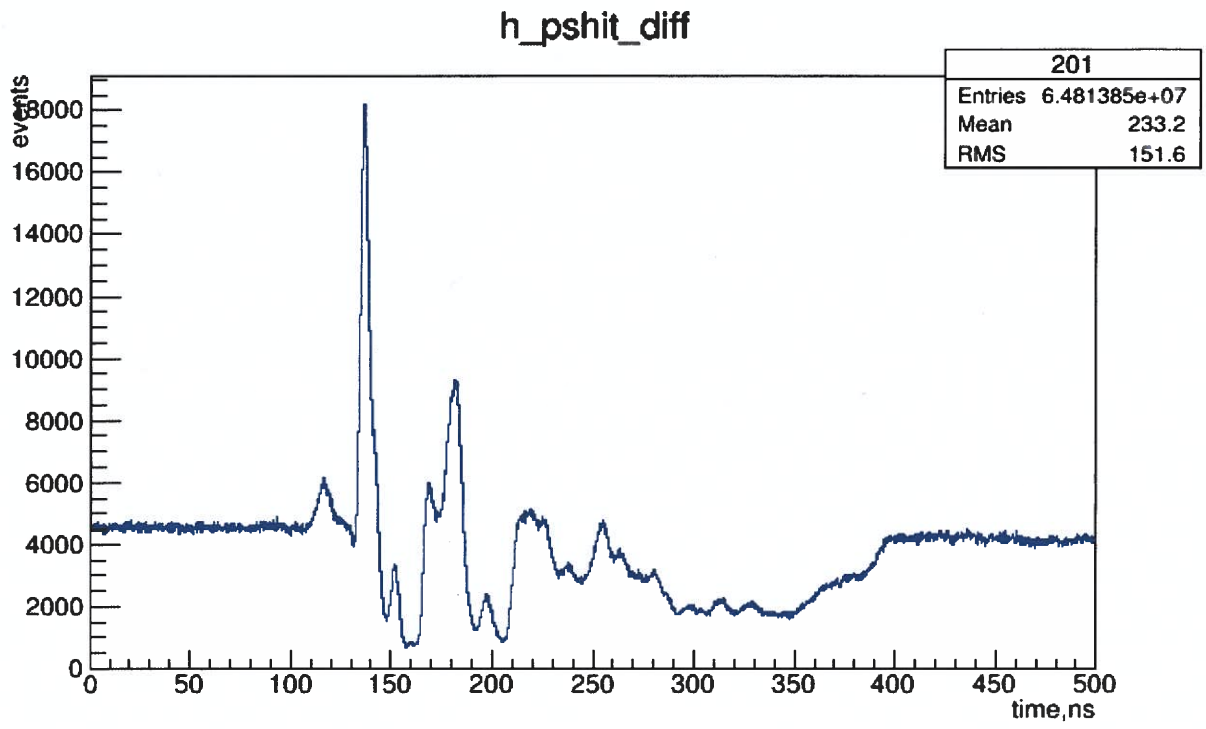
Pic#9. Flat background (ID #20).



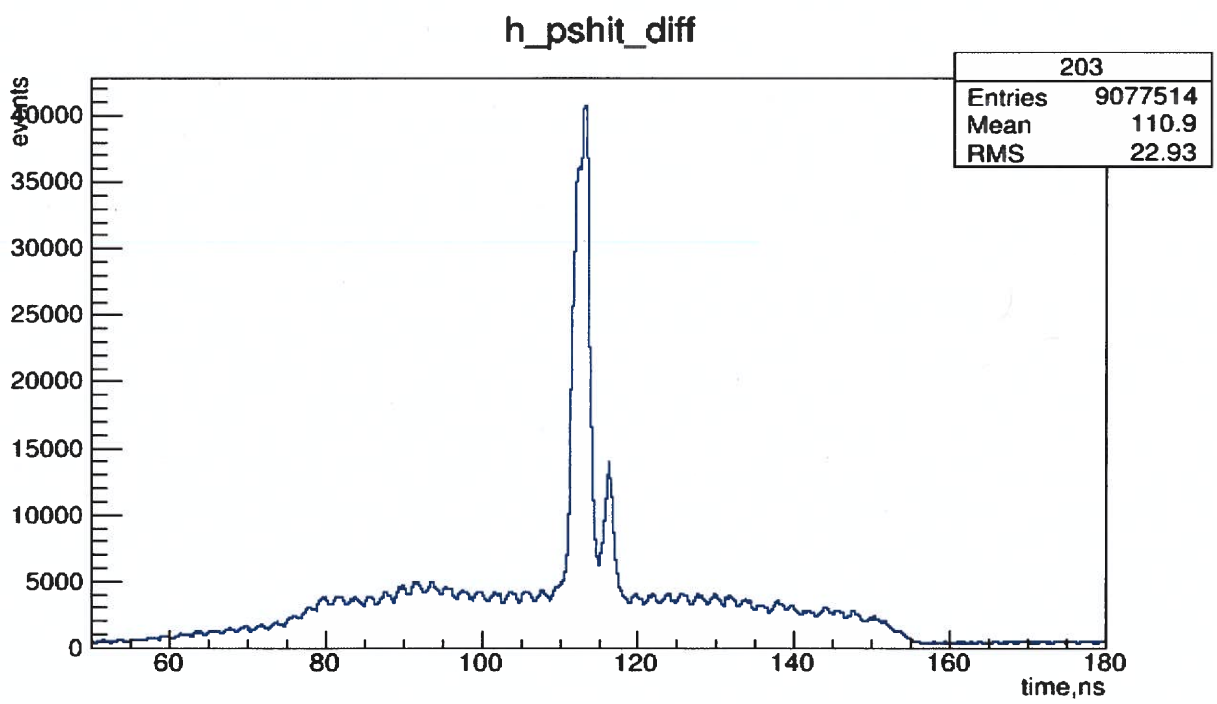
Pic #10. Too many peaks (ID #33).



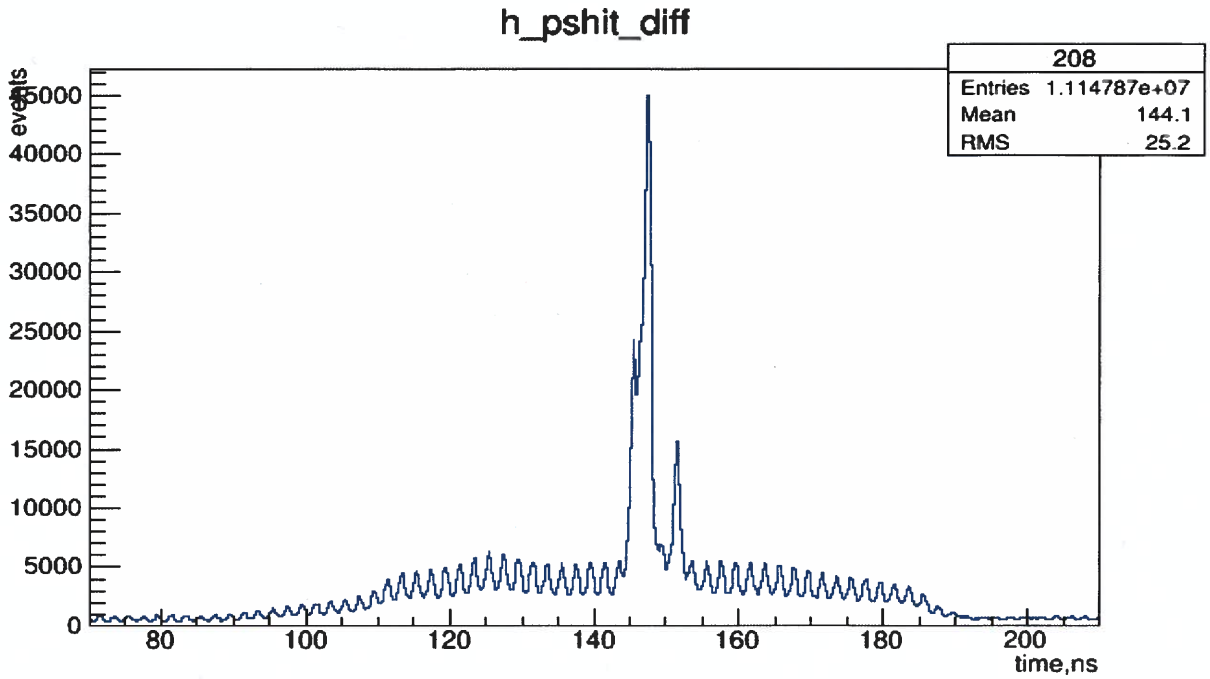
Pic#11. Too many peaks (ID #38).



Pic#12. Inexplicable (ID #101).

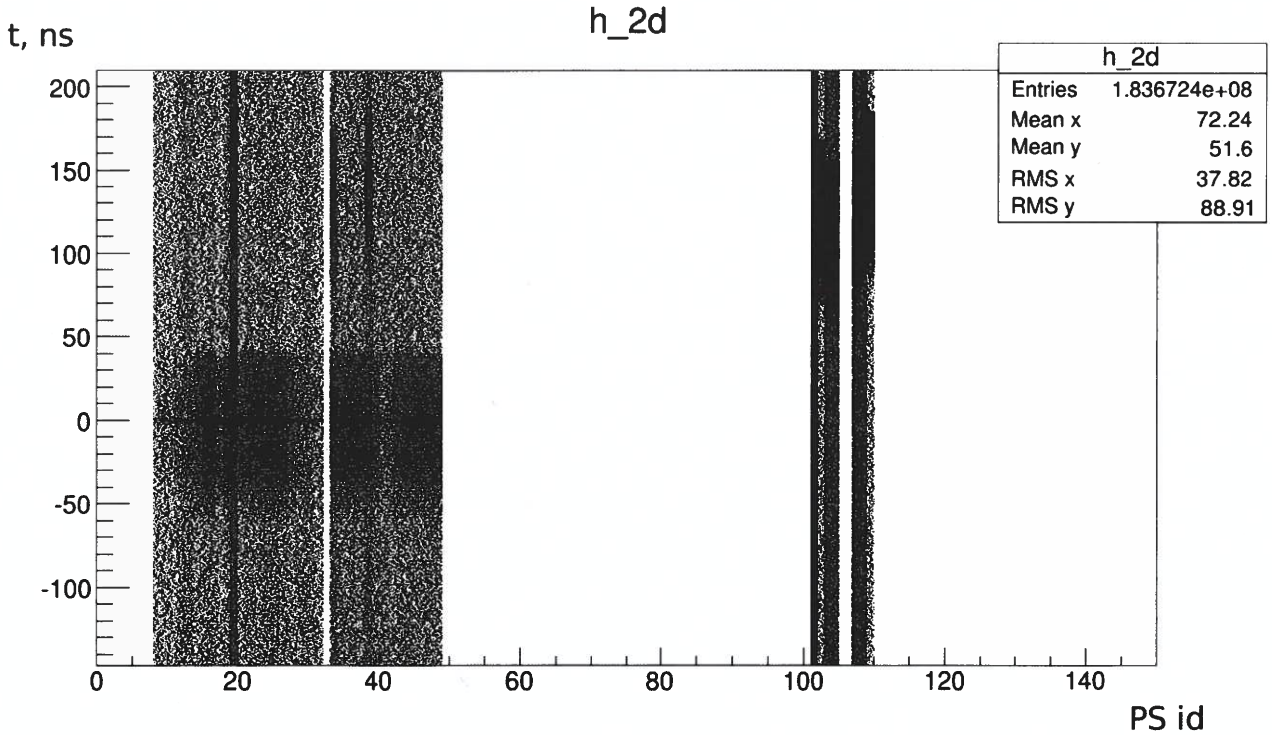


Pic #13. Double peak (ID #103).



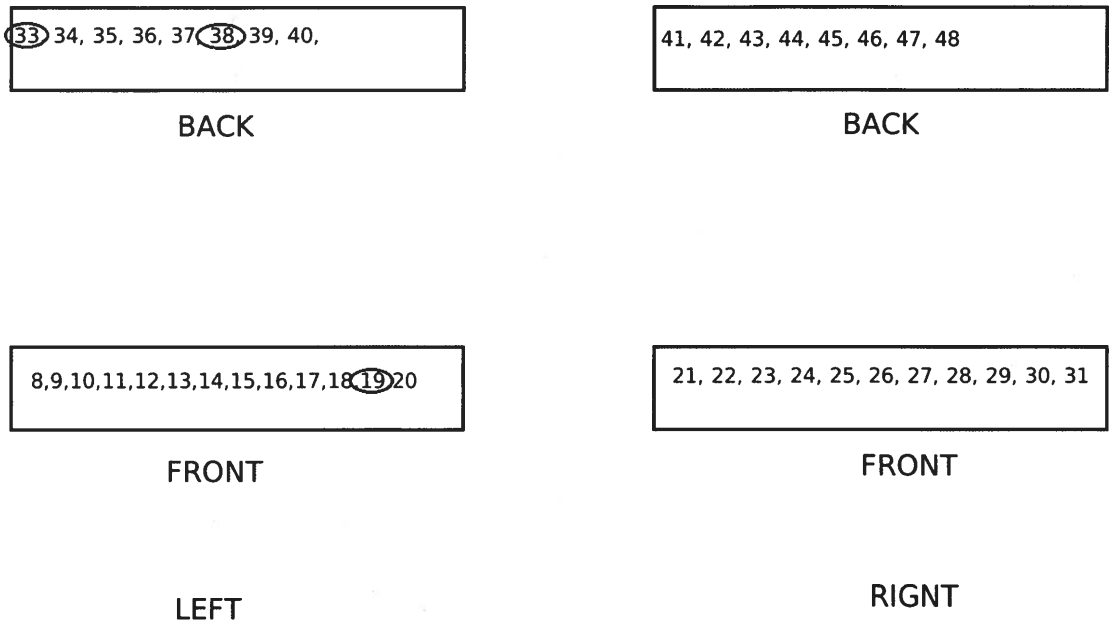
Pic #15 Double peak(ID #108).

Picture #16 presents 2d plot which shows time difference versus PS id number.

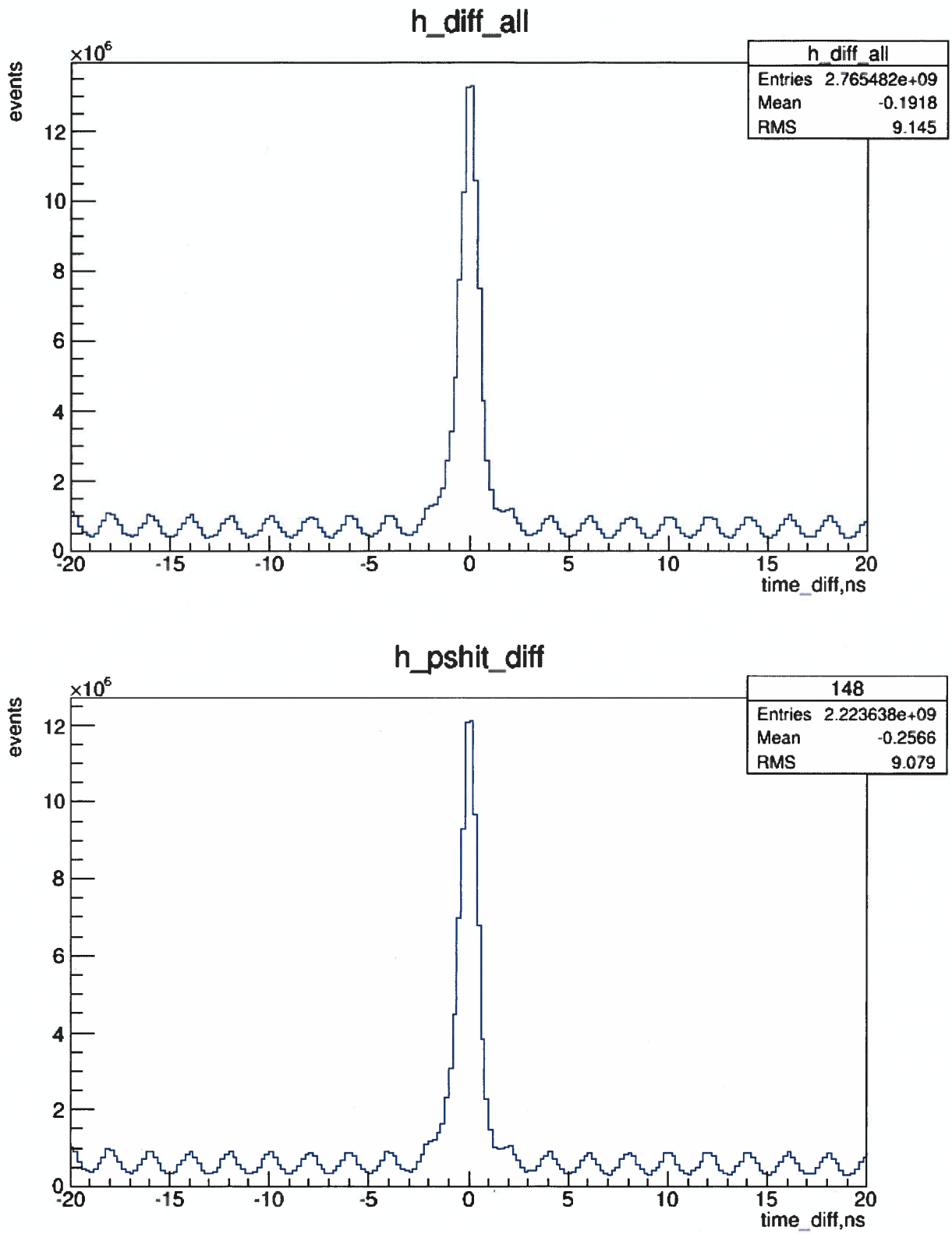


Pic #16. Time difference versus PS id number.

We excluded "bad" and "strange" modules from analysis. Additional modules (#100-108) were also deleted after discussion on weekly PrimEx meeting at March 25th. Remain modules presents on picture #17.

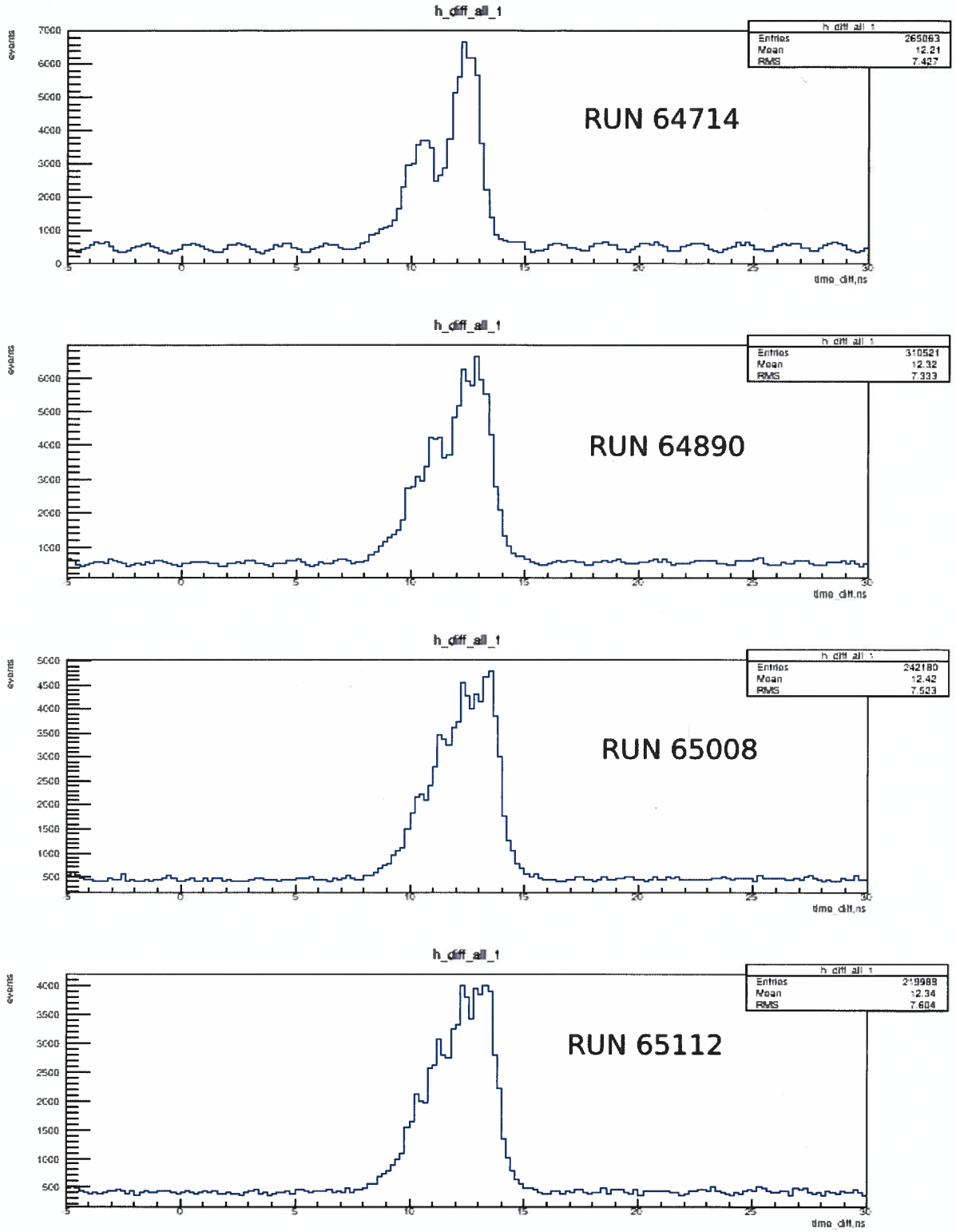


Pic #17. Modules which were stayed in analysis. Red circles – still in analysis with many peaks (analyzing only peak near zero position) but will be removed from analysis soon (see follow).



Pic# 18. Time diff (Tagger – PS) for all T-counters and for all(top) and for all without 19, 33, 38 PS modules(bottom) before reconstruction (PSHIT bank).

Check after reconstruction (time difference from PSR bank).



Pic #19. Time diff for all T-counters and all PS-modules after reconstruction for different runs.

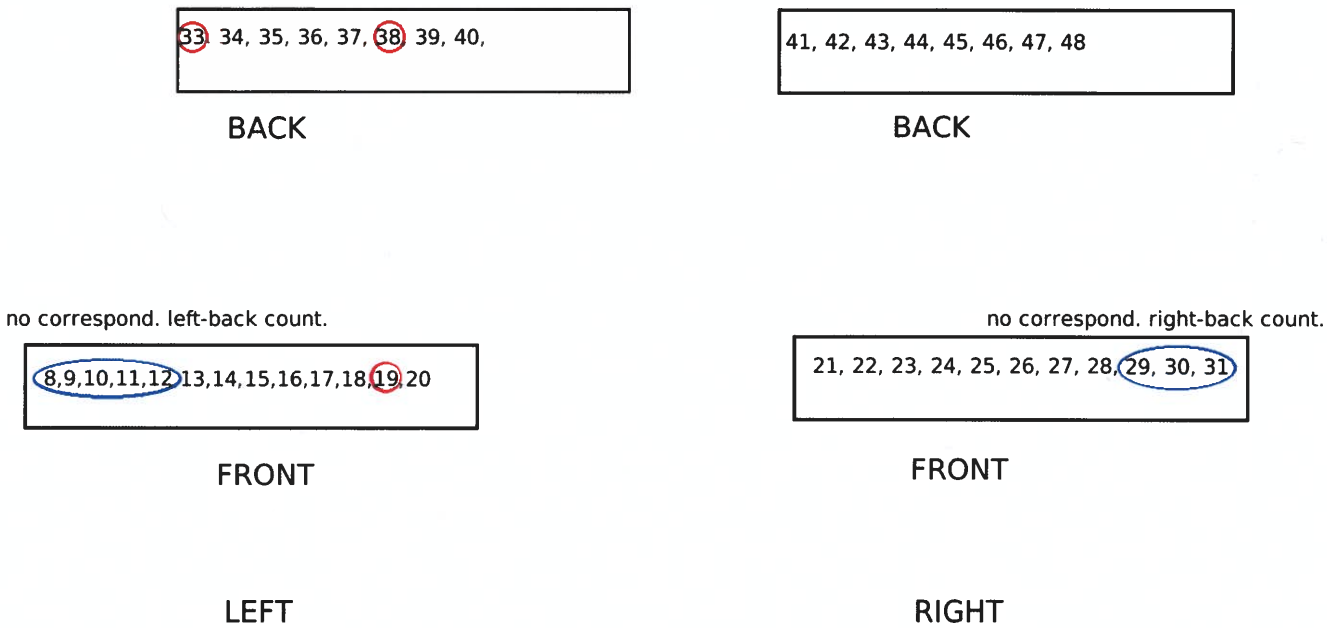
Alignment for each PS module run by run

We made alignment for all T-counters and for all PS-modules run-by-run (28 tables were written to DB).

#table	Run range
1	64711 - 64743
2	64744 – 64809
3	64810 – 64842
4	64843 – 64844
5	64845 - 64847
6	64848 - 64850
7	64851 - 64855
8	64856 - 64861
9	64862 - 64866
10	64867 - 64885
11	64886 - 64932
12	64933 - 64938
13	64939 - 64947
14	64950 - 64960
15	64961 - 64965
16	64969 - 64973
17	64974 - 64981
18	64982 - 64986
19	64987 - 65008
20	65009 - 65013
21	65014 - 65018
22	65019 - 65032
23	65033 - 65037
24	65038 - 65042
25	65043 - 65048
26	65049 - 65053
27	65055 - 65107
28	65108 - 65112

Then we checked reconstruction and have same pic (like pic #18) → reconstruction doesn't work correctly. Should change reconstruction code.

Meeting discussion – remove from analysis modules in red and blue circles:

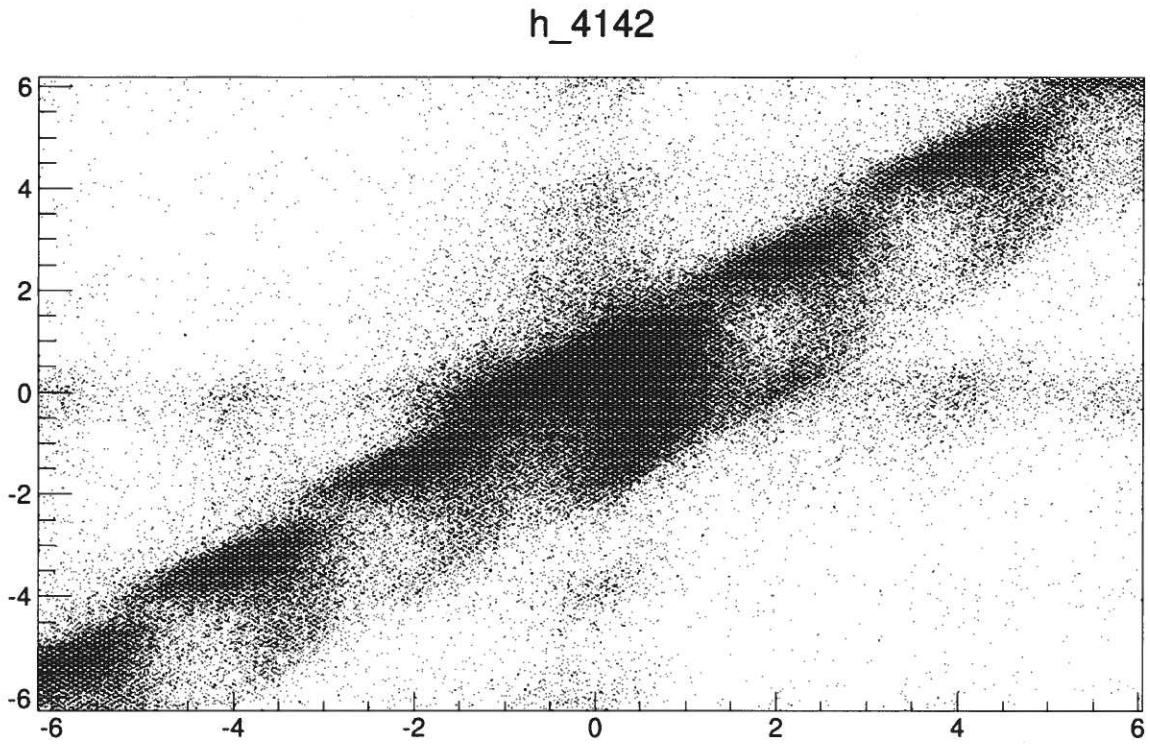


Pic# 20. Scheme of PS. In blue circles present modules which have no corresponding back PS counters (we exclude them from analysis too).

Reconstruction consist of three parts:
1) Overlapping part.
2) Front-Back coincidence part;
3) Left-Right coincidence part.

Check Overlapping. As we clearly know that modules are overlapping, so we should understand which module we need to take into analysis if we will see both "in work" during event.

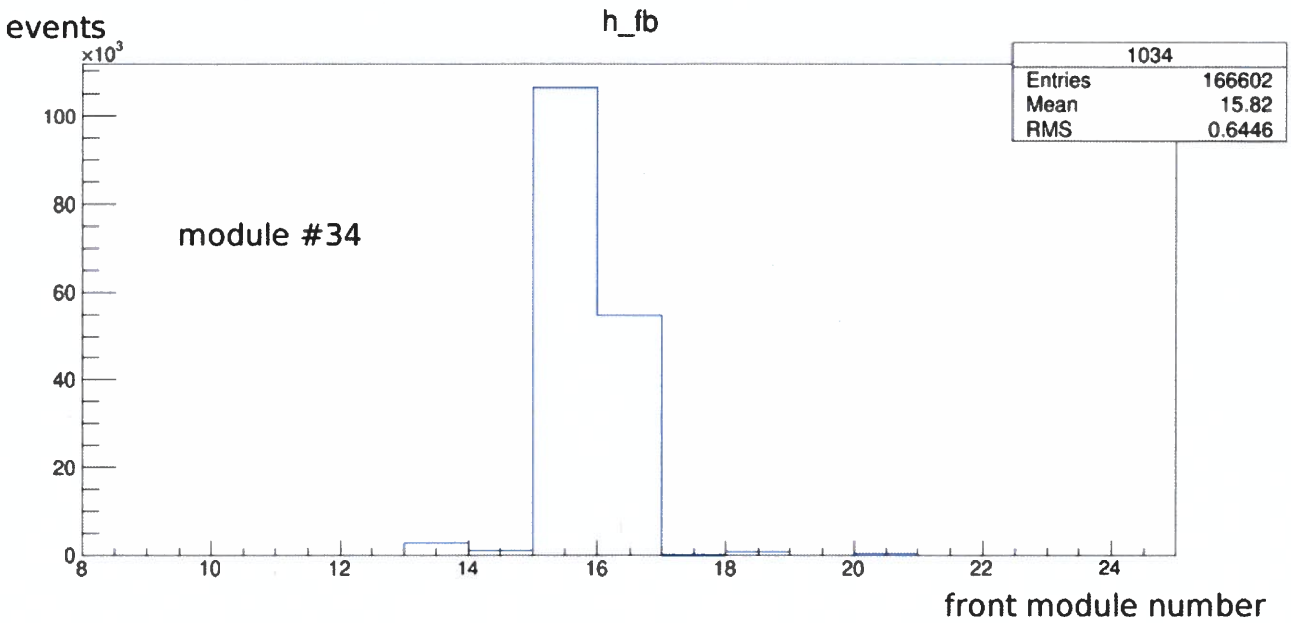
In picture #21 presents 2-d plot of time diff (tagger-PS) for modules 41 (x axis) and 42 (y axis). Clearly see that we have some regular "physical structure" and it means that overlapping part doesn't work.

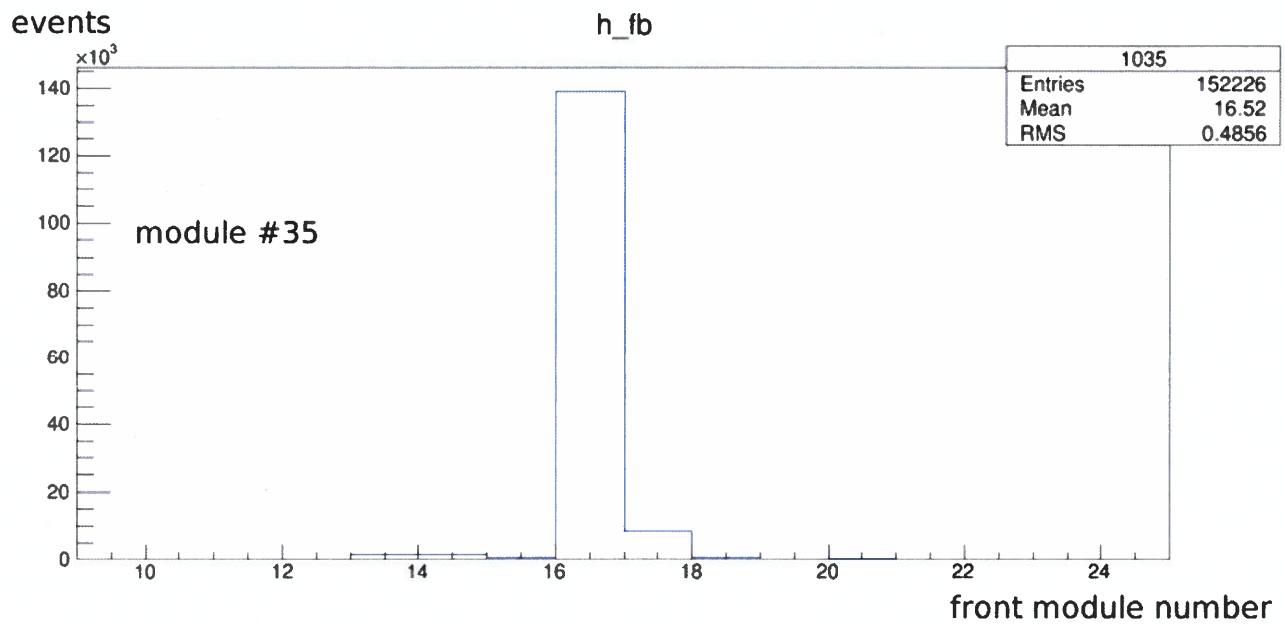


Pic #21. 2-d plot of time diff for modules 41 (x axis) and 42 (y axis).

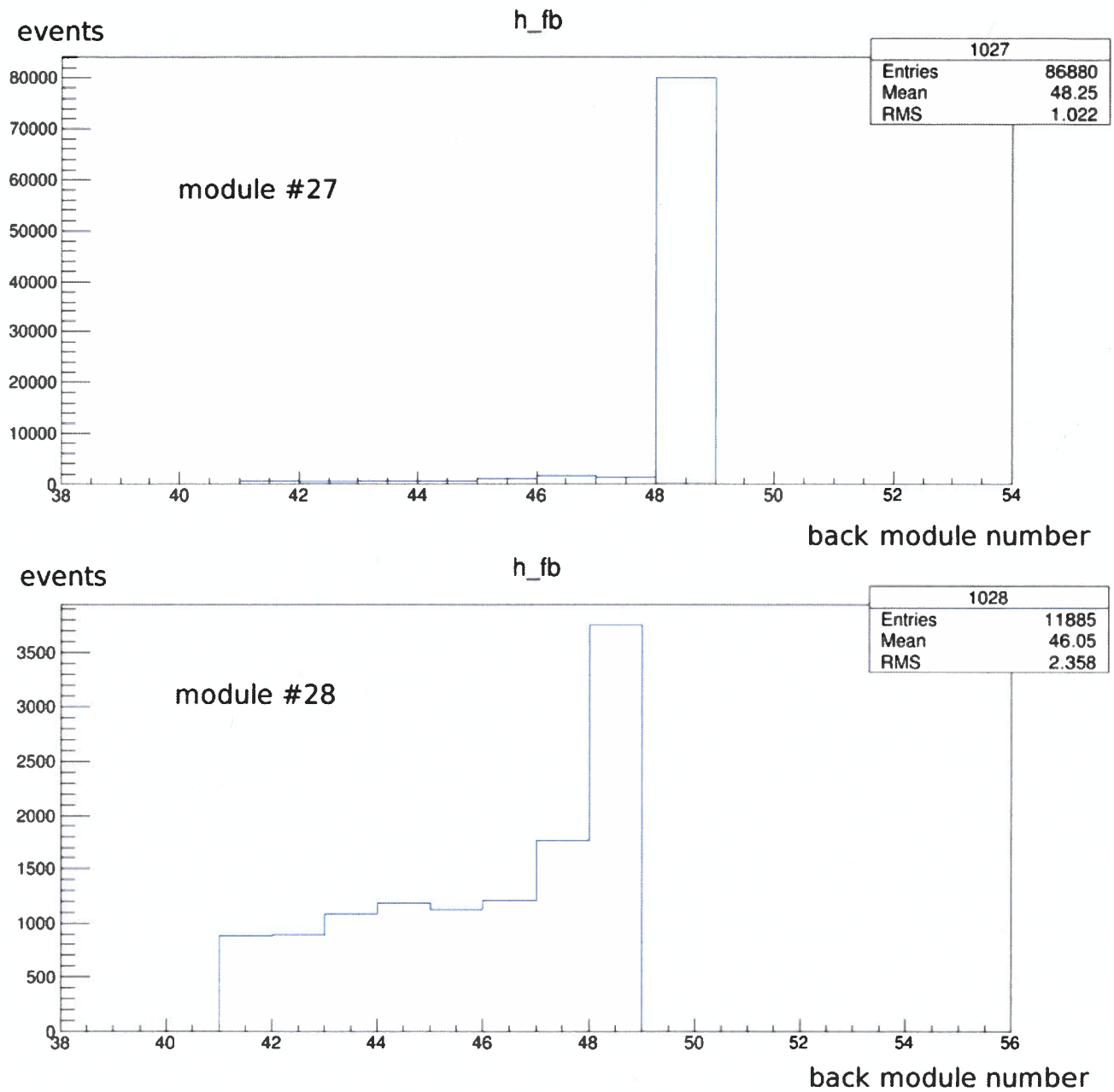
So, we assume that we need to remove overlapping part from reconstruction and look on matching modules which situated not close to each other.

Check front-back matching:





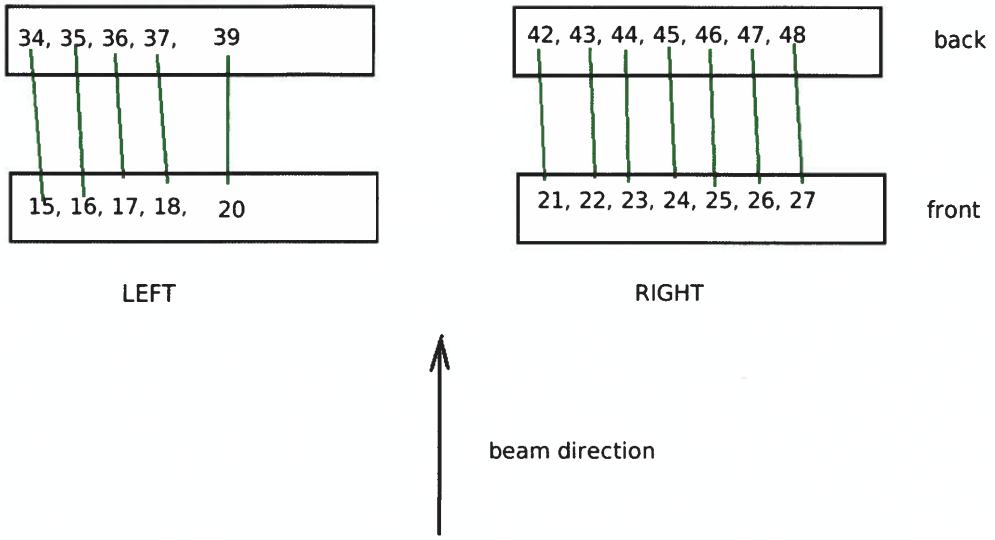
Pic # 22. Matching of back modules #34 (top) and #35(bottom) with front modules.



Pic #23. Matching of front modules #27(top) and #28(bottom) with back modules.

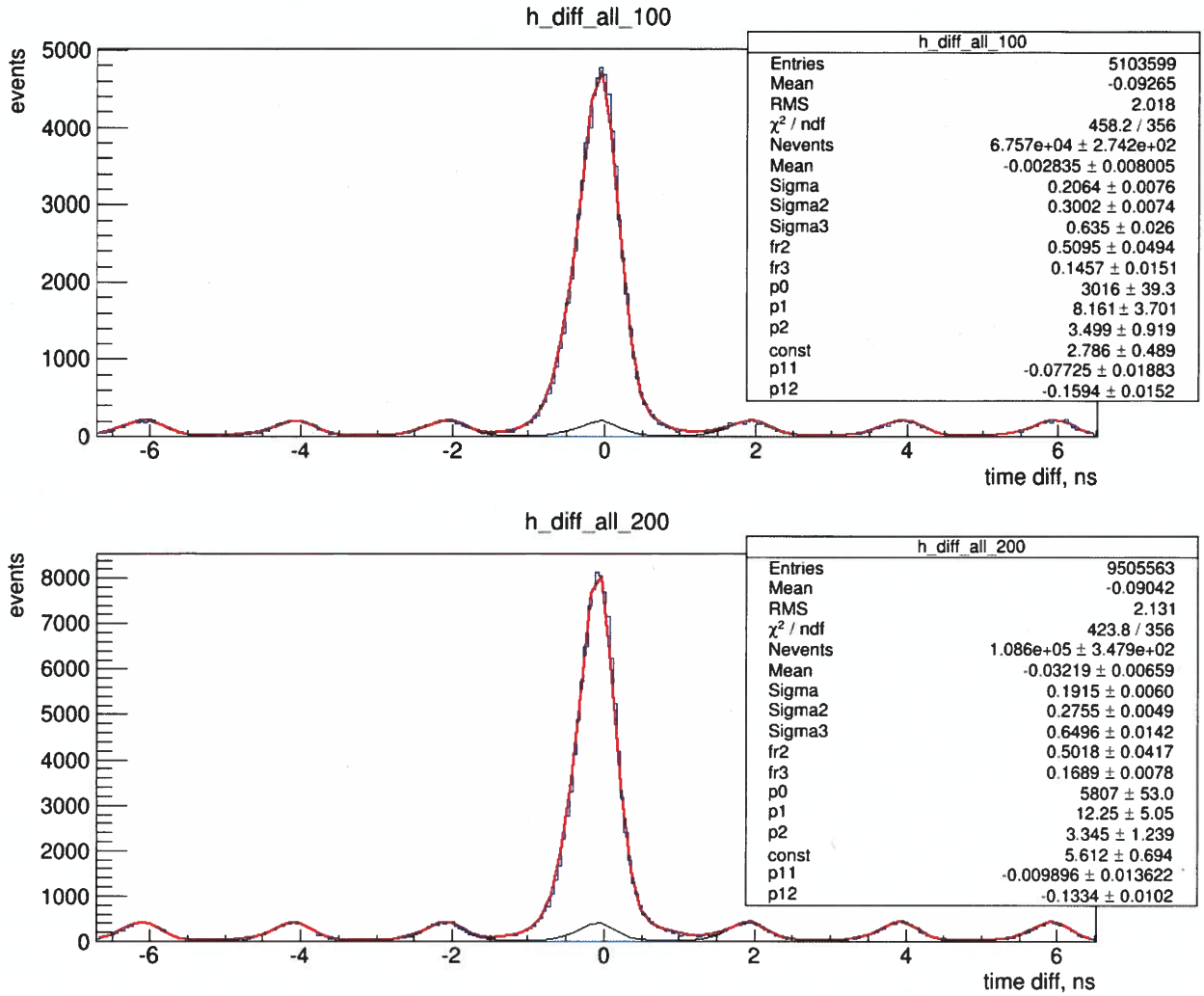
We see that modules 27, 34 and 35 strongly matching with modules 48, 15 and 16 correspondingly. And module #28 matching with many modules. We find that modules #13,14,28,40, 41 matching with many modules during reconstruction, so we removed these modules from analysis.

At this point Front-back give us follow picture (see pic #24):



Pic. #24. Modules which stay in analysis after matching front-back modules.

Now we will check idea to matching odd left(front) modules and even right(front) modules (and opposite) and see what we have. For run #64970, for example, for even (bottom) and odd(top) modules we have (see pic # 25).



Pic #25. Time diff (after changing reconstruction) between tagger and PS for even(bottom) and odd(top) PS-modules.

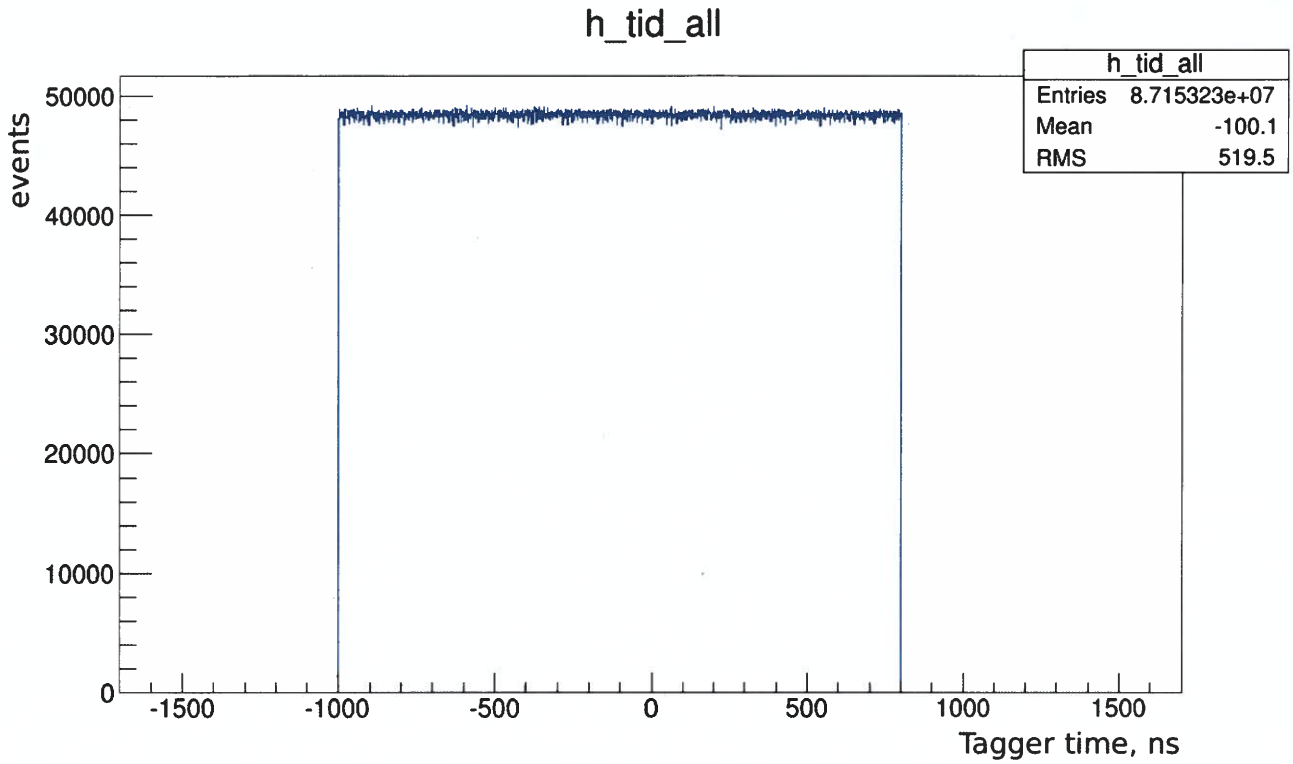
Where is fitting function is:

const +bin*Nevents * (G1(M1,S1)+fr1*G2(M2(p11),S2)+fr2*G3(M3(p12),S3))*(p0+p1*x+p2*x*x)

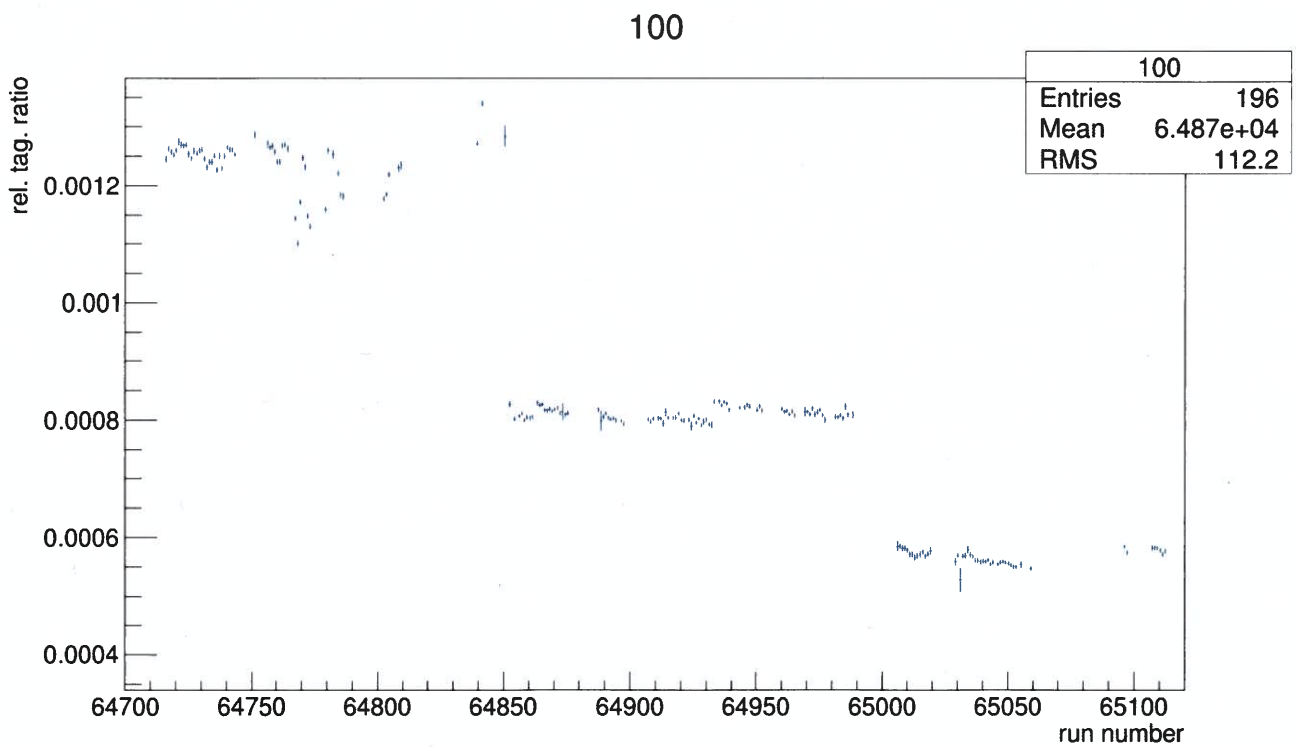
In this case relative tagging ratio will be = Nevents/N ev. In tagger. Rel. tag. Ratio depends run number presents in pictures #27 (for odd front-left PS counters), #28 (for even front-left PS counters), #29 (for even and odd PS counters).

Our final cuts:
1) CLOCK trigger;
2) tagger time is time from TAGM_LR bank;
3) T-counters from #1 to #36;
4) tagger time range from -1000ns to 800ns is ok (we take this range because time window was

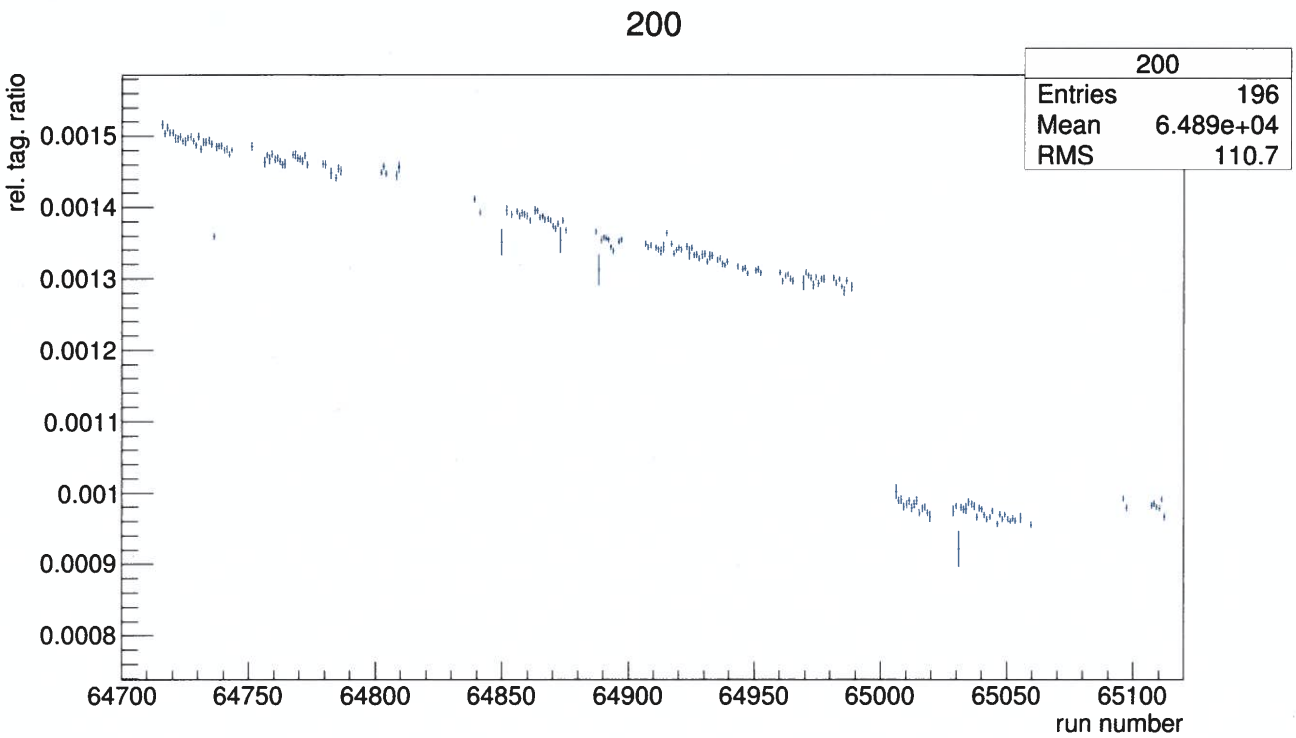
changing run-by-run and only time values from -1000ns to 800ns existed during experiment, see pic #26).



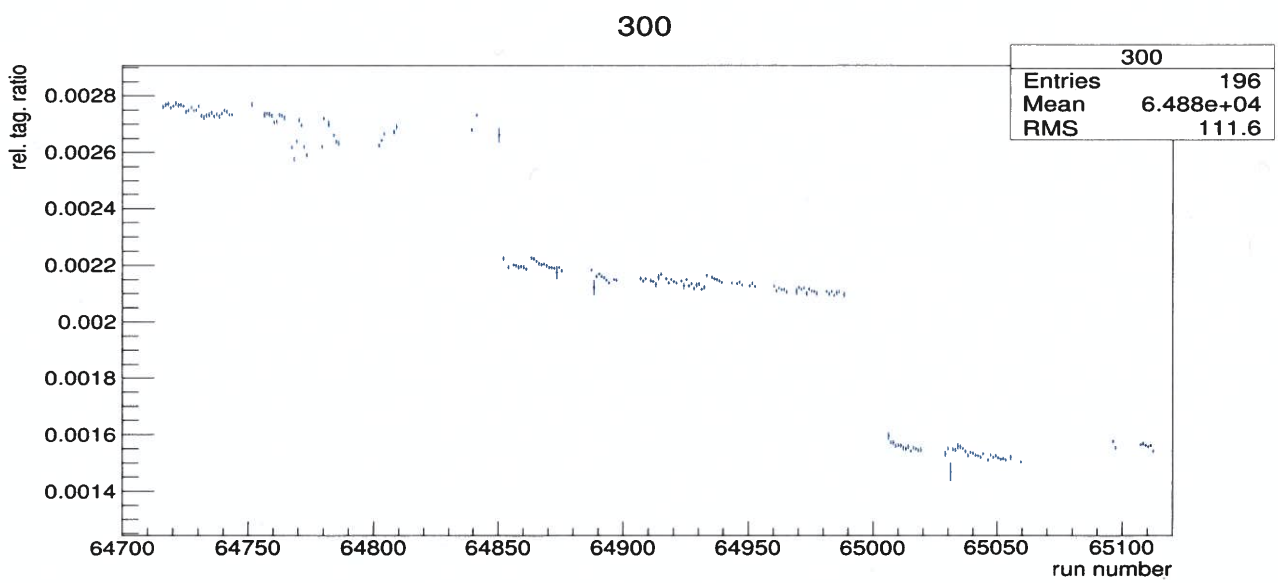
Pic #26. Time from tagger (for run #64757, example).



Pic #27. Rel. tagging ratio for odd PS counters.

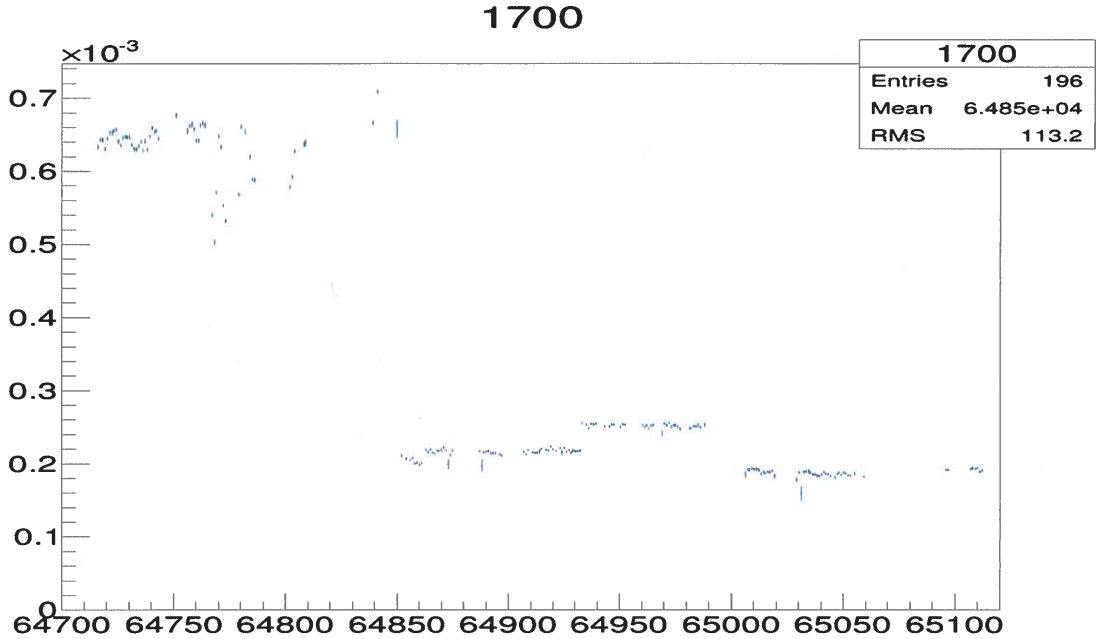


Pic #28. Rel. tagging ratio for even PS counters.



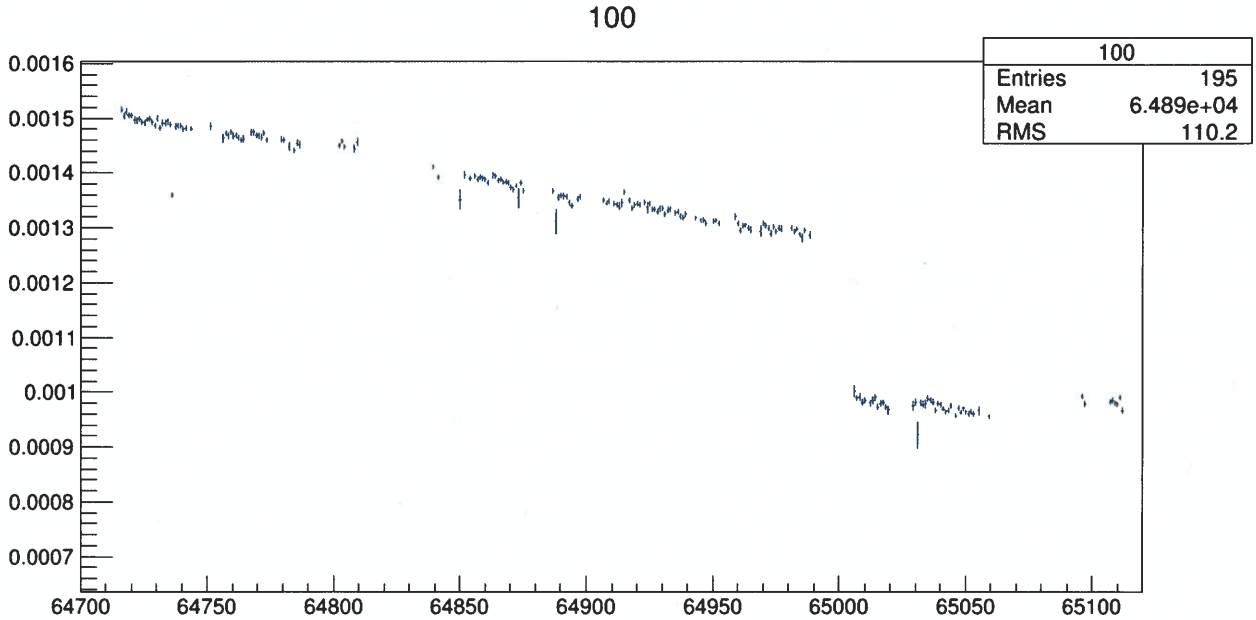
Pic #29. Tagging ratio for both cases together (pic 26+pic 27).

If wee see carefully in pic #27 we can observe that there is some drop of relation in run range near run #64850. Then we look carefully for rel. tagging ratio for each PS counter separatelly and found that for counter #17 exists ratio dramatically drops (see pic. #30) then we remove this module (and module 15 which stayed only one "odd" in left arm) and continue analysis.

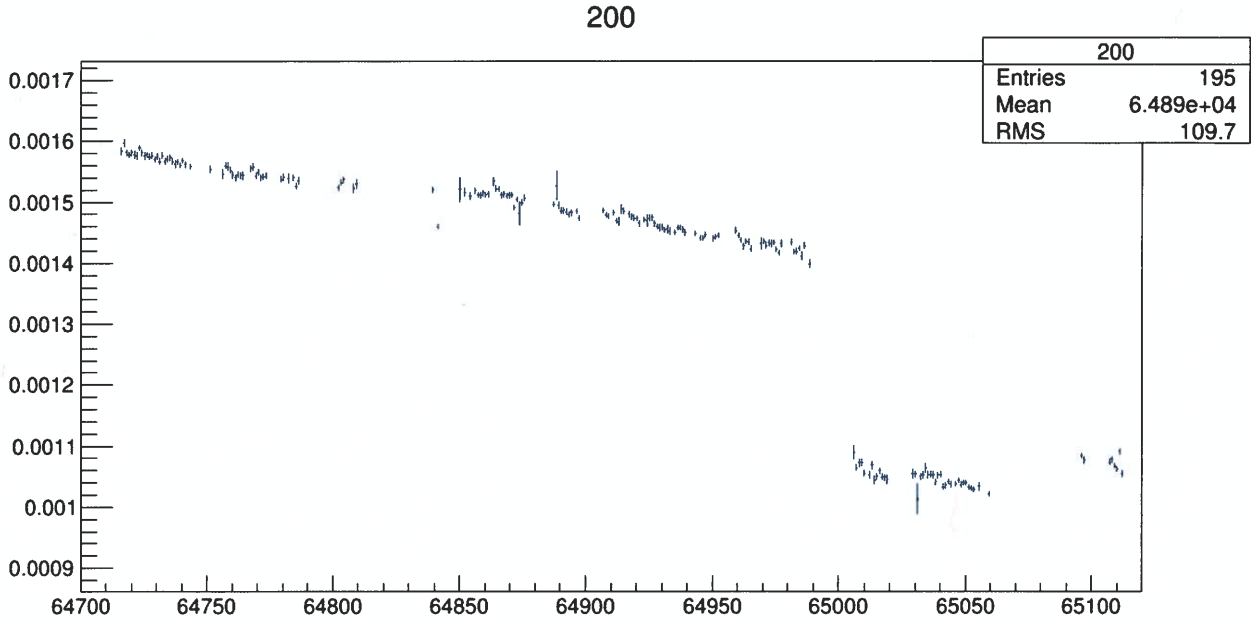


Pic #30. Rel. tagging ratio for PS module #17.

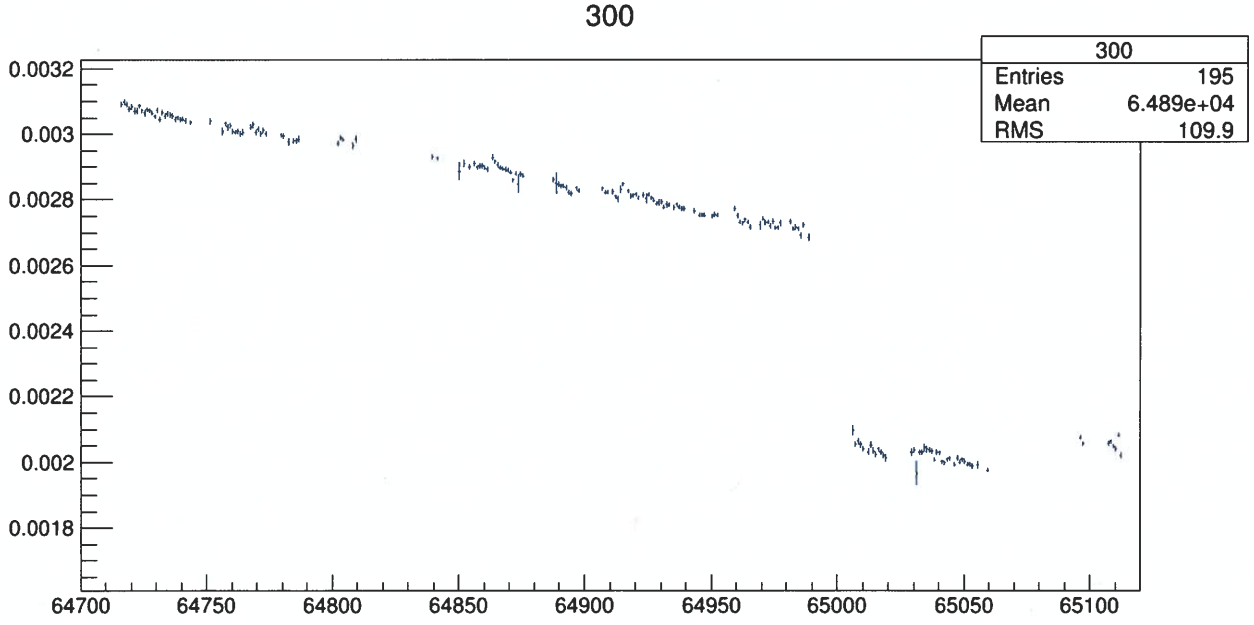
And receive:



Pic #31. Rel. tagging ratio for odd PS counters.



Pic #32. Rel. tagging ratio for even PS counters.

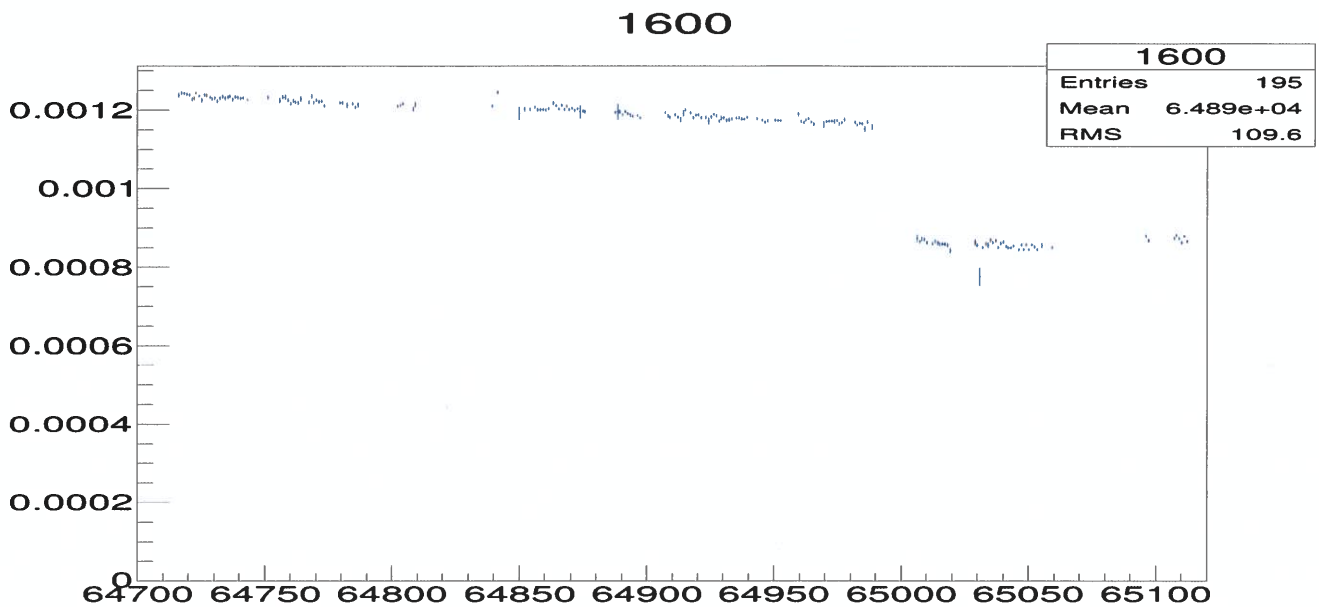


Pic #33. Rel. tagging ratio for all cases PS counters.

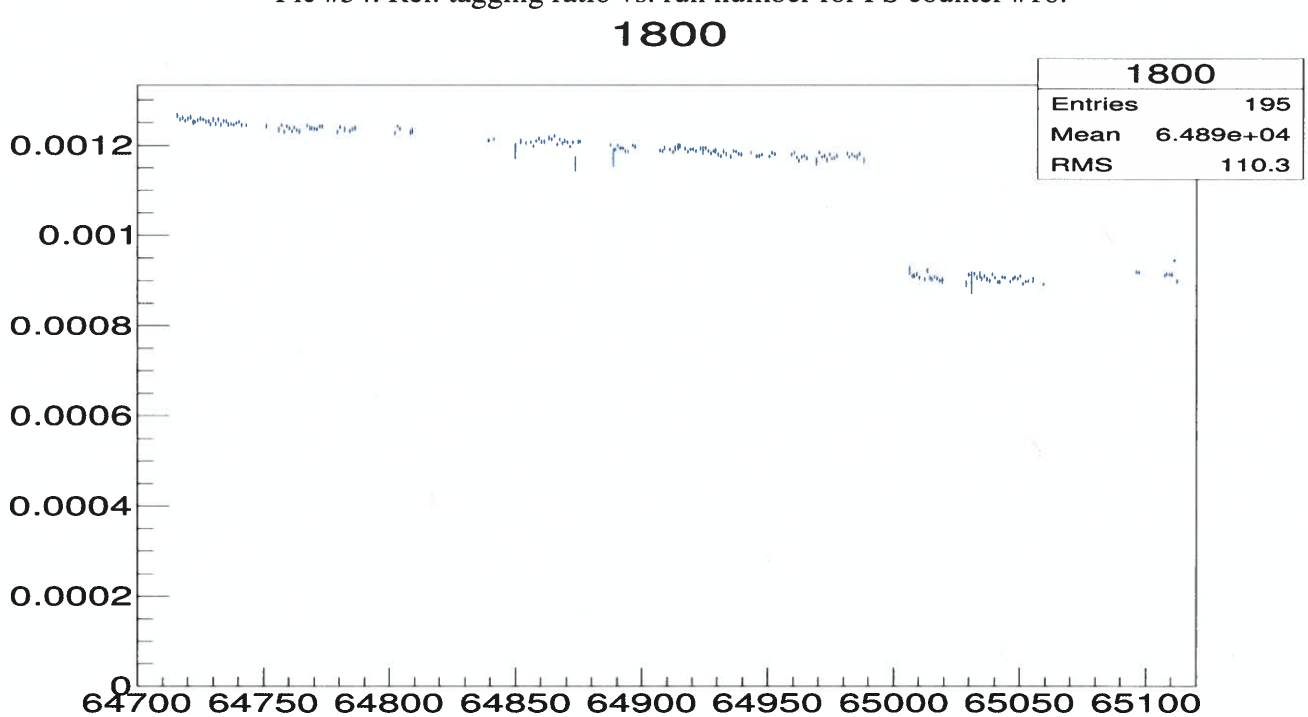
Shift down near run #65000 exist because in that moment Si target was changed to C12 target. That means that number of interaction particles/production particles are different so relative tagging

ratio also should be different.

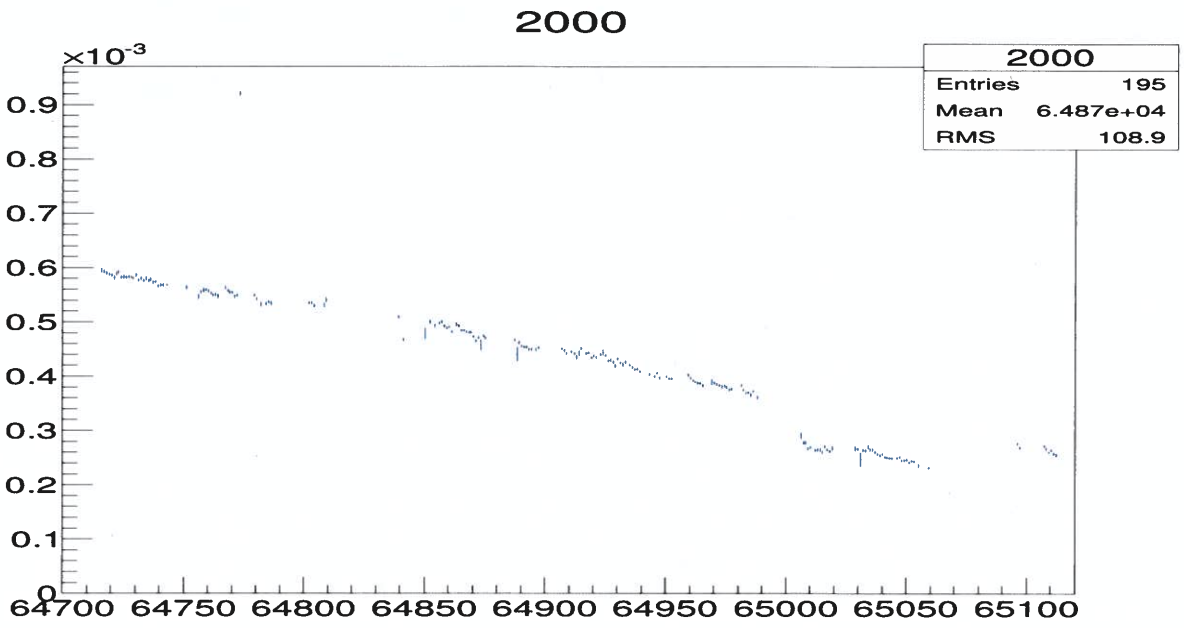
For each PS module relative tagging ratio presents on follow pictures:



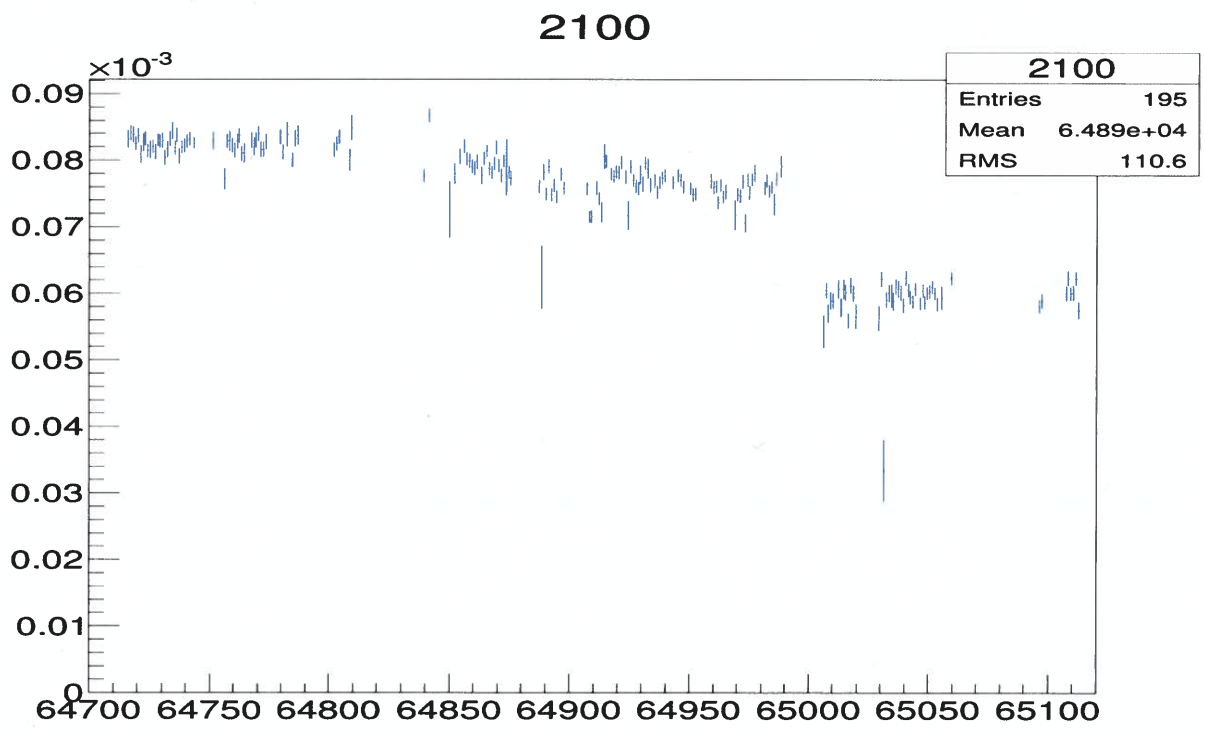
Pic #34. Rel. tagging ratio vs. run number for PS counter #16.



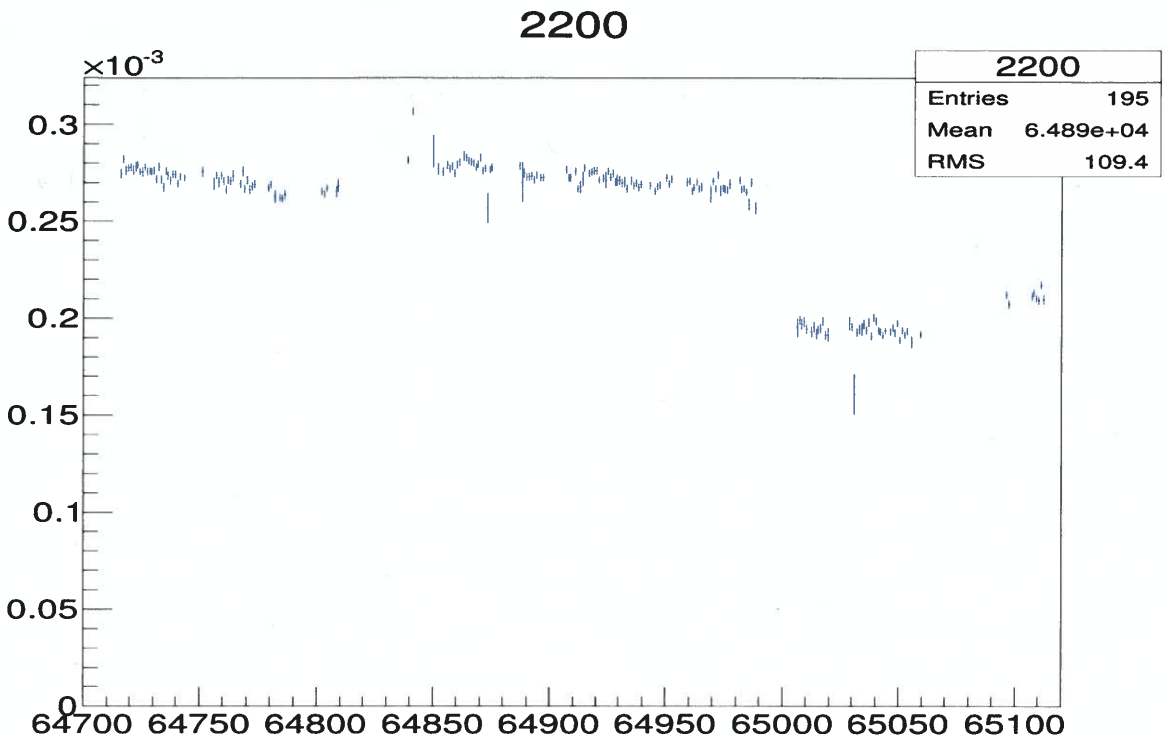
Pic #35. Rel. tagging ratio vs. run number for PS counter #18.



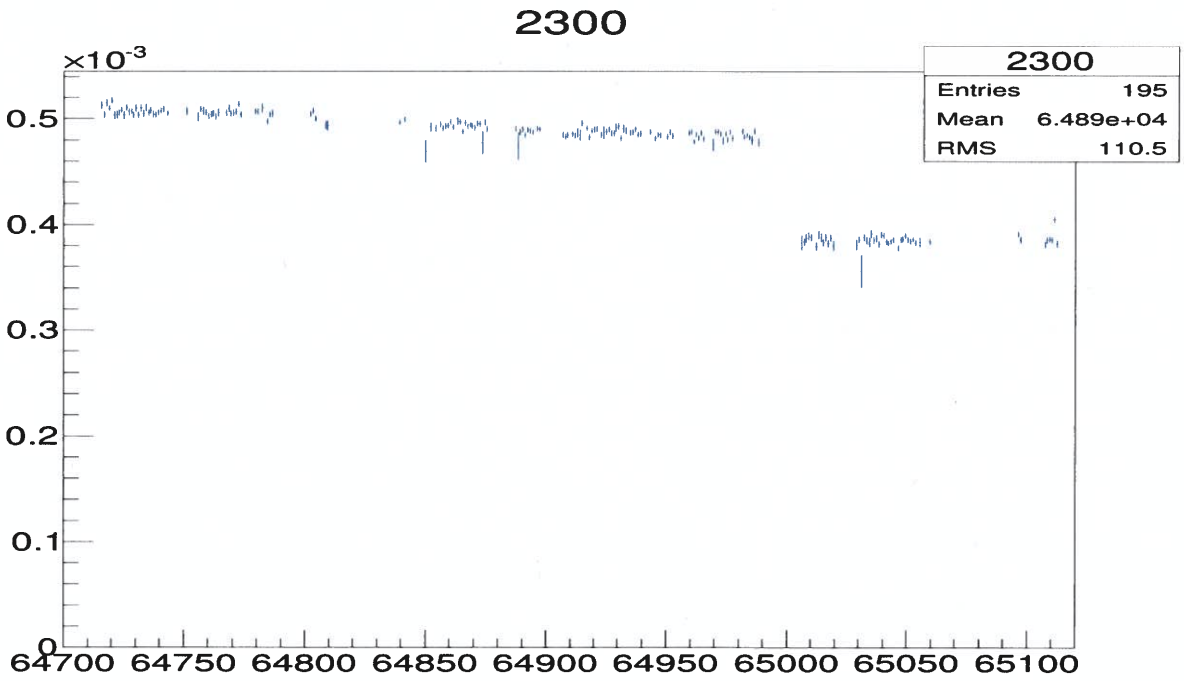
Pic #36. Rel. tagging ratio vs. run number for PS counter #20.



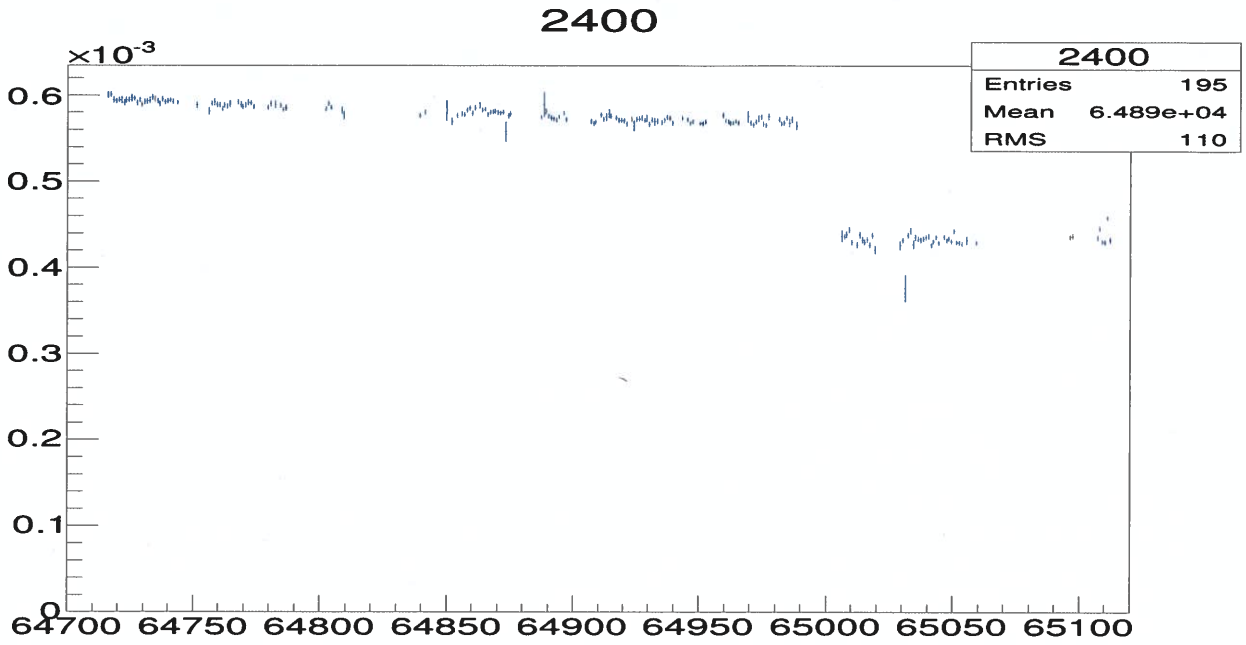
Pic #37. Rel. tagging ratio vs. run number for PS counter #21.



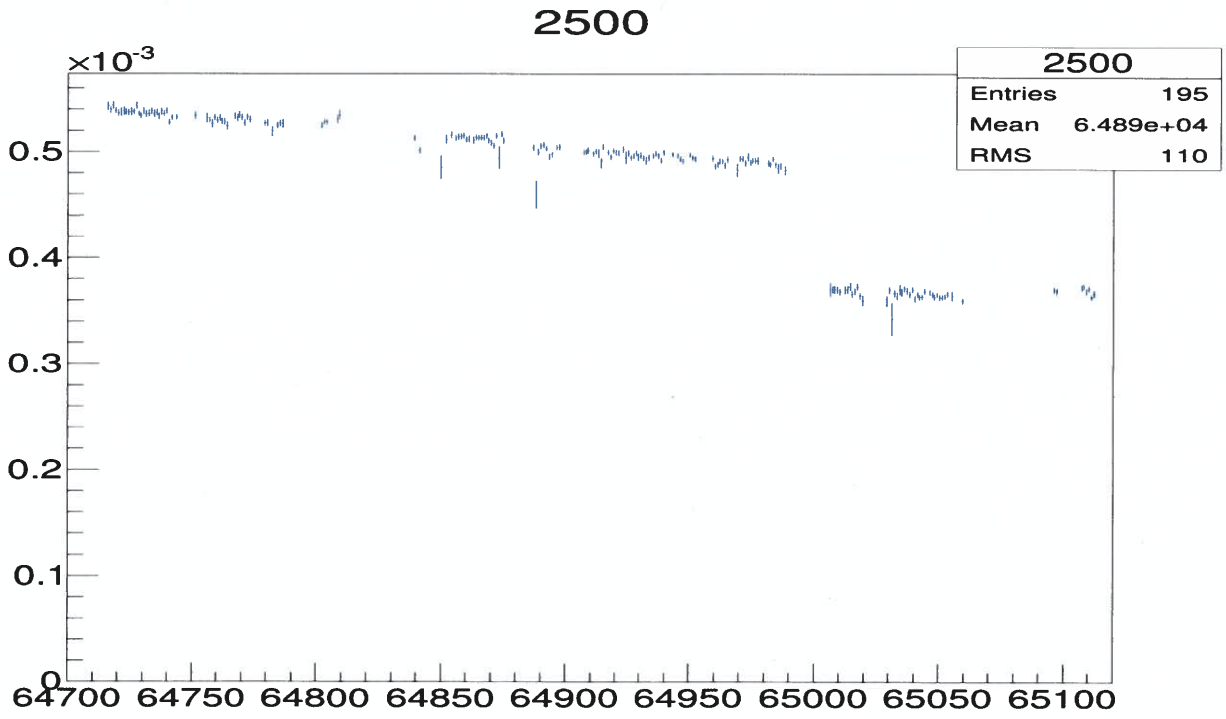
Pic #38. Rel. tagging ratio vs. run number for PS counter #22.



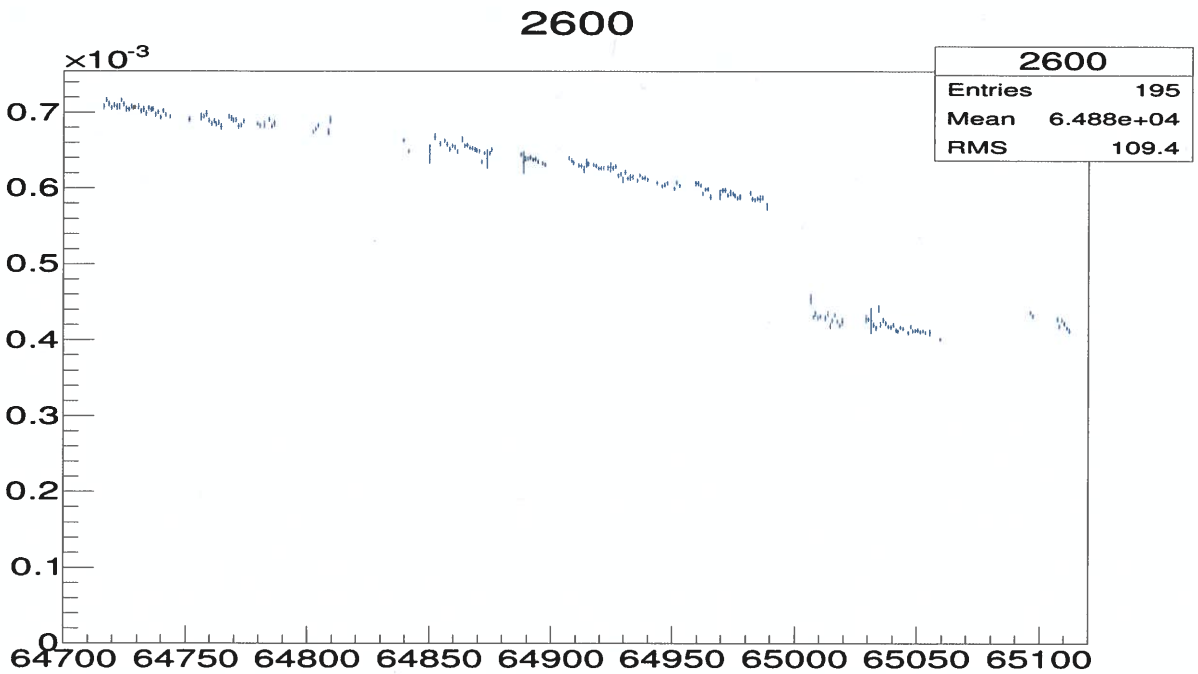
Pic #39. Rel. tagging ratio vs. run number for PS counter #23.



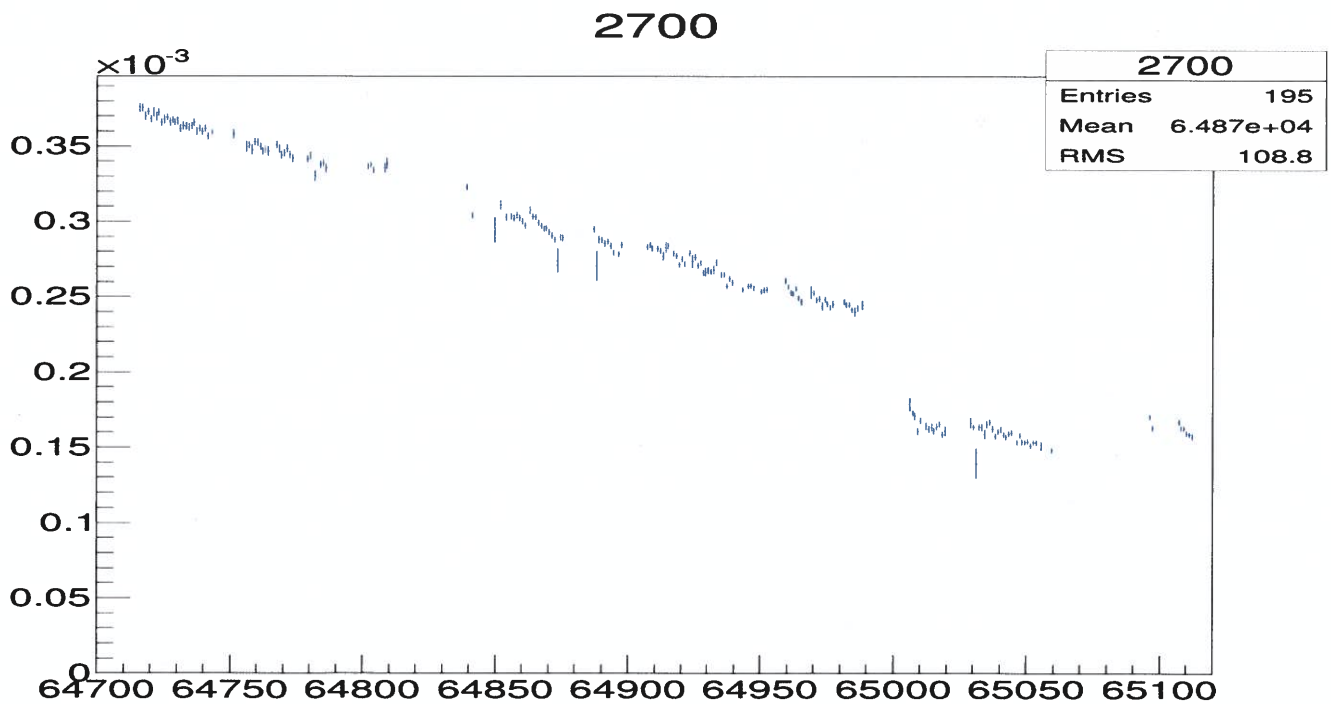
Pic #40. Rel. tagging ratio vs. run number for PS counter #24.



Pic #41. Rel. tagging ratio vs. run number for PS counter #25.



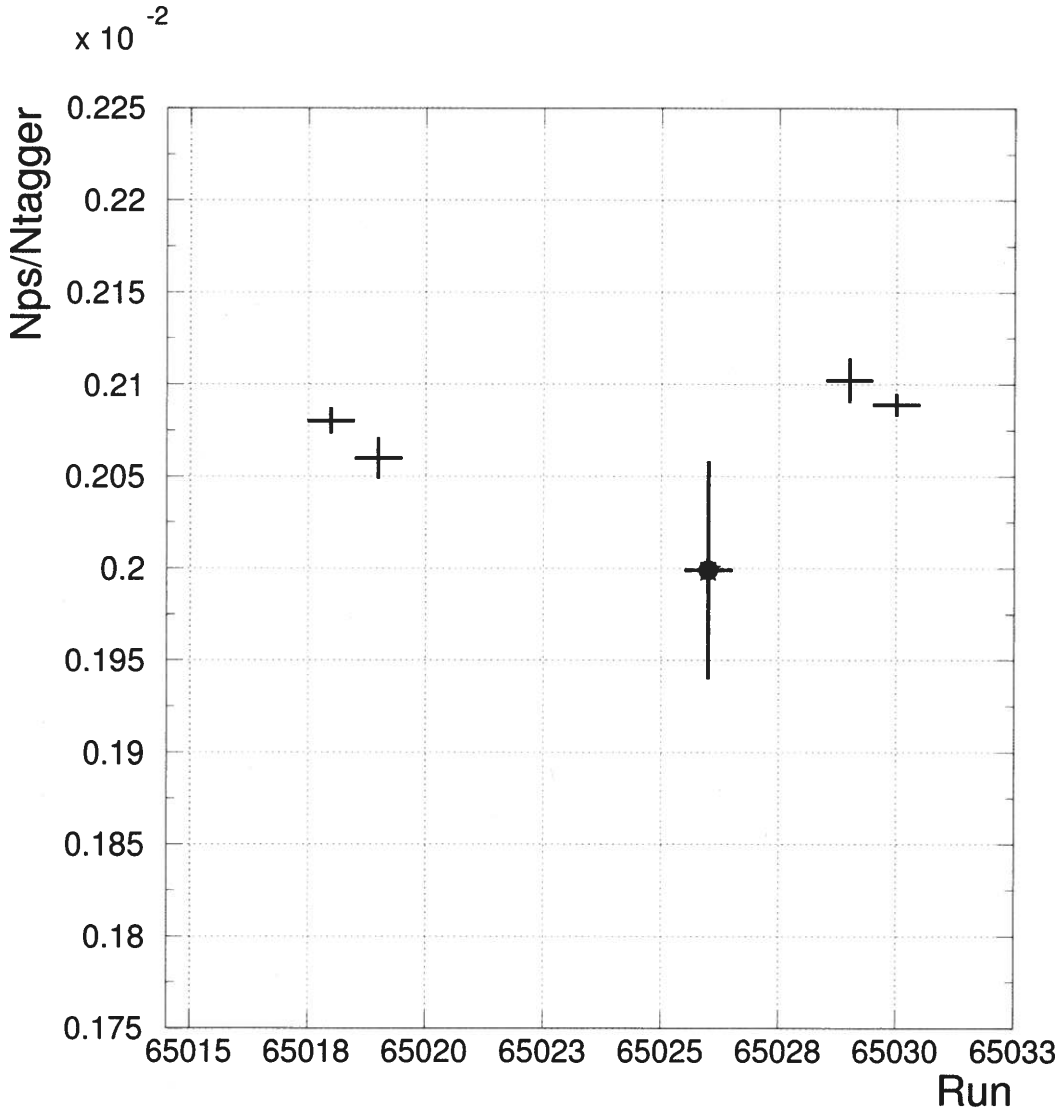
Pic #42. Rel. tagging ratio vs. run number for PS counter #26.



Pic #43. Rel. tagging ratio vs. run number for PS counter #27.

Relative tagging ratio in TAC runs

As we saw earlier, relative tagging ratio has a slope during experiment so we decided to continue our study and include in analysis TAC run data. The idea that could shed some light onto the problem was to compare ratio for TAC runs and adjacent production runs. Performance of PS scintillators could be more stable and possibly usable in that case. Does this ratio look similar in TAC and production runs? For that purpose we selected production runs 65018-65019, 65029-65030 and adjacent to them TAC run #65026 with credible statistics. In pic 44 we presented this ratio versus Run number.



Pic. 44. Dependence between run number and ratio of events in PS and in tagger.

As we see from pic. 44 TAC run approximately 4.4 sigma down versus adjacent production runs. Distinction between ratio in TAC and production runs directs us to study deeper, so our next step was to check this ratio for each T-counter. In pic 45 and 46 we presented dependence between Tid and ratio of events in production (65029) and TAC(65026) runs for C target and for production (64970) and TAC(65104) runs for Si target respectively.

Applied cuts for selected events:

1) tagger time intervals: [-650, 350]ns and [360, 1360]ns excluding interval [-100, 100]ns;
(for Si run#64970: [-780, 220]ns and [250, 1250]ns also excluding range [-100,100]ns);
only hits with status Ok (tagm_status = TAGM_ET);

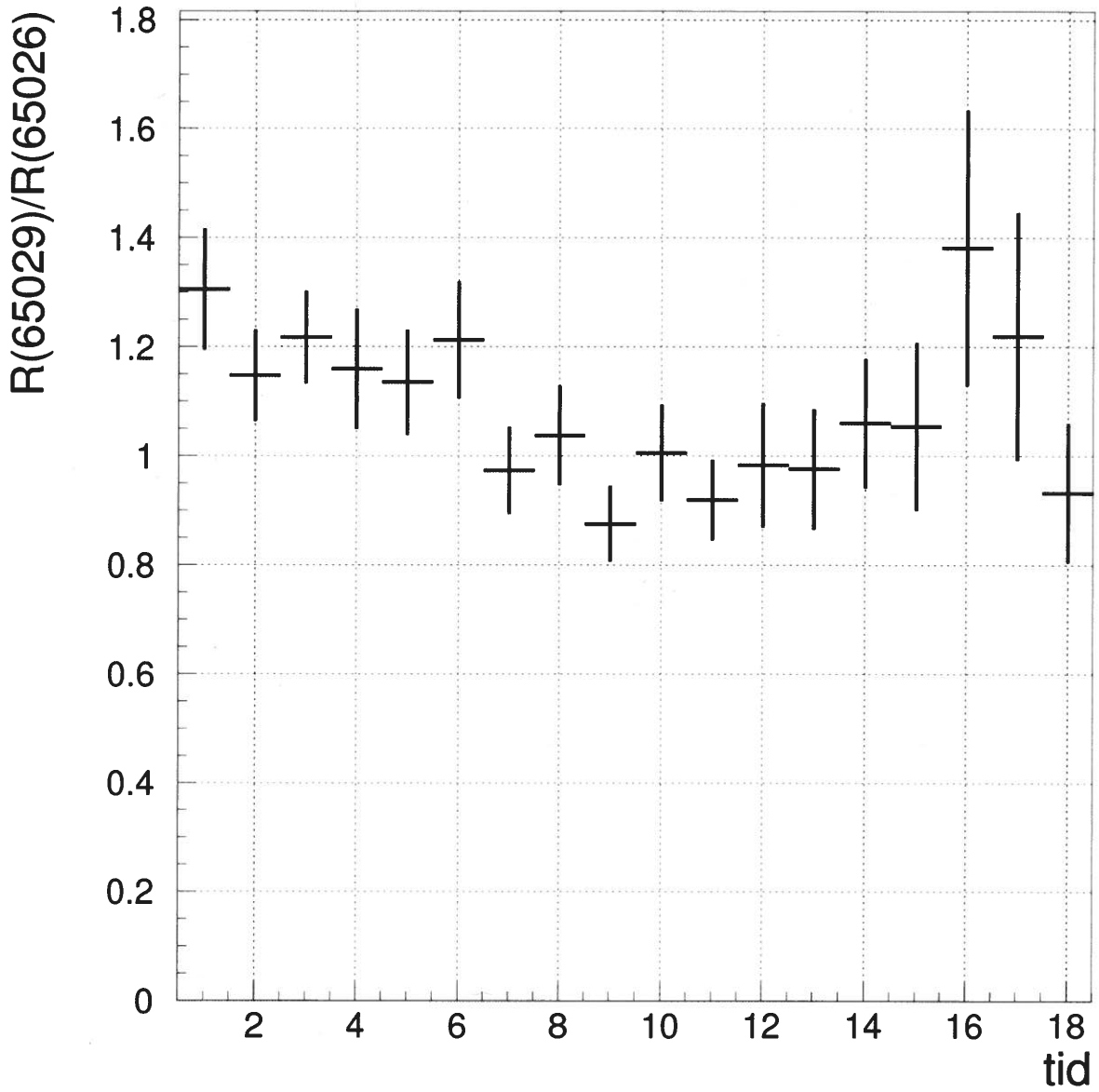
2) Trigger = MOR ((latch >> (1-1))&0x0001) = 1;

3) T counters from 1 to 18;

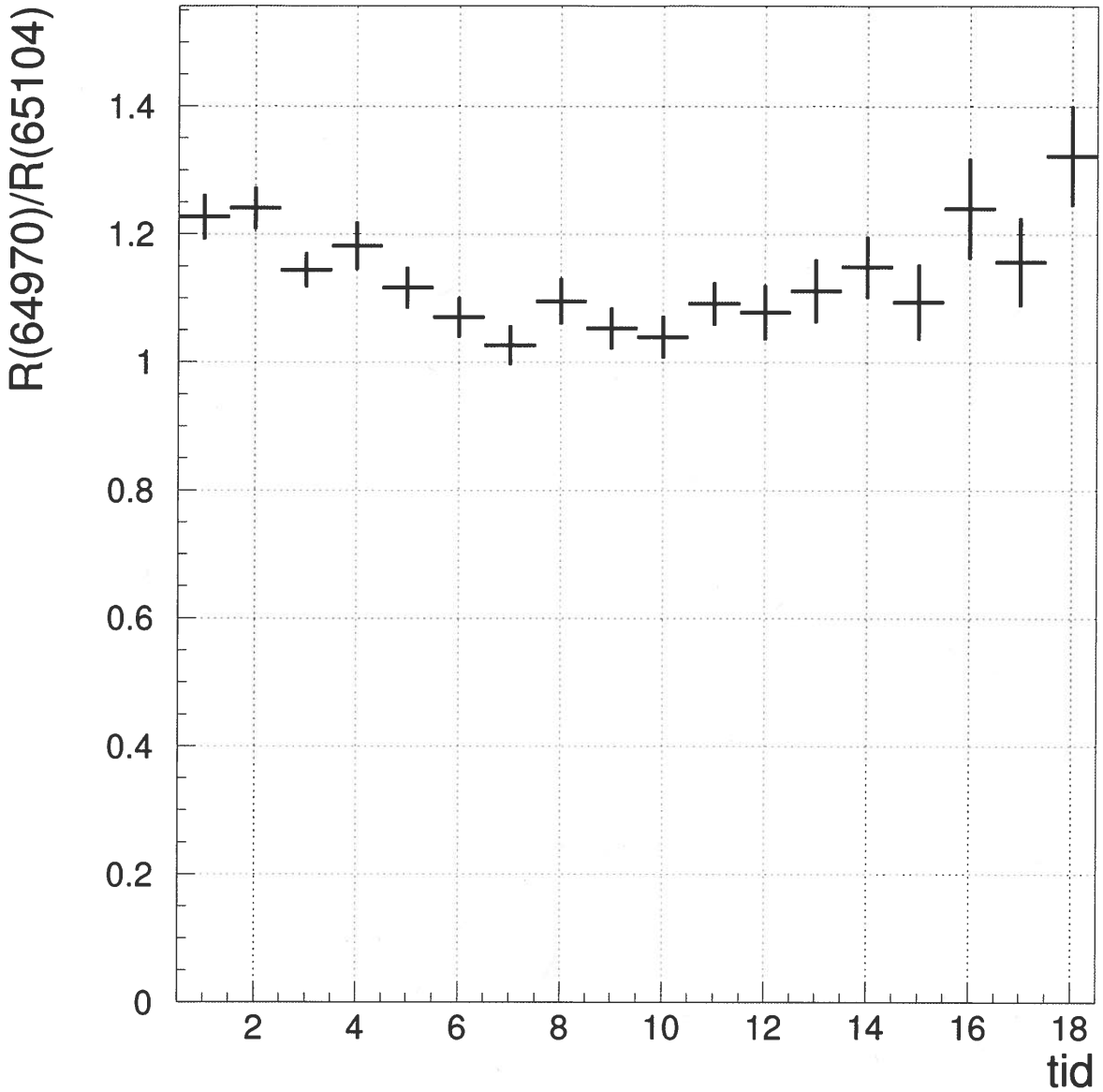
4) MOR trigger time within 30ns;

5) time from TRIGTHIT bank must be within [-100;100]ns range;

The obtained values show that relative tagging ratio is close to the unit in the middle of the beam energy range and growing up to 1.4 at the edges. The possible reason is and additional contamination with the accidentals. From another hand this study shows that we don't observed relative tagging ratio drop below 1, which is important.



Pic. 45. Dependence between Tid and ratio of number of events in production (65029) and TAC(65026) runs for C target.



Pic. 46. Dependence between Tid and ratio of number of events in production (64970) and TAC(65104) runs for Si target.

Conclusion

We obtained relative tagging ratio which has a linear structure with slope during experiment. It is interesting that slope increasing with increasing PS counter number. Nature of this slope is not clear.

We performed additional analysis for PS events which can provide us more information, knowledge and understanding about relative tagging ratio during PrimEx-II. We compared this ratio for production and TAC runs, for carbon and silicon targets and also for each T-counter individually. We haven't observed relative tagging ratio value drop below 1. The higher values at the edges of the energy range is most likely caused by accidentals.