Neutron Detector Tests and Background Characterization Using the TOF Technique

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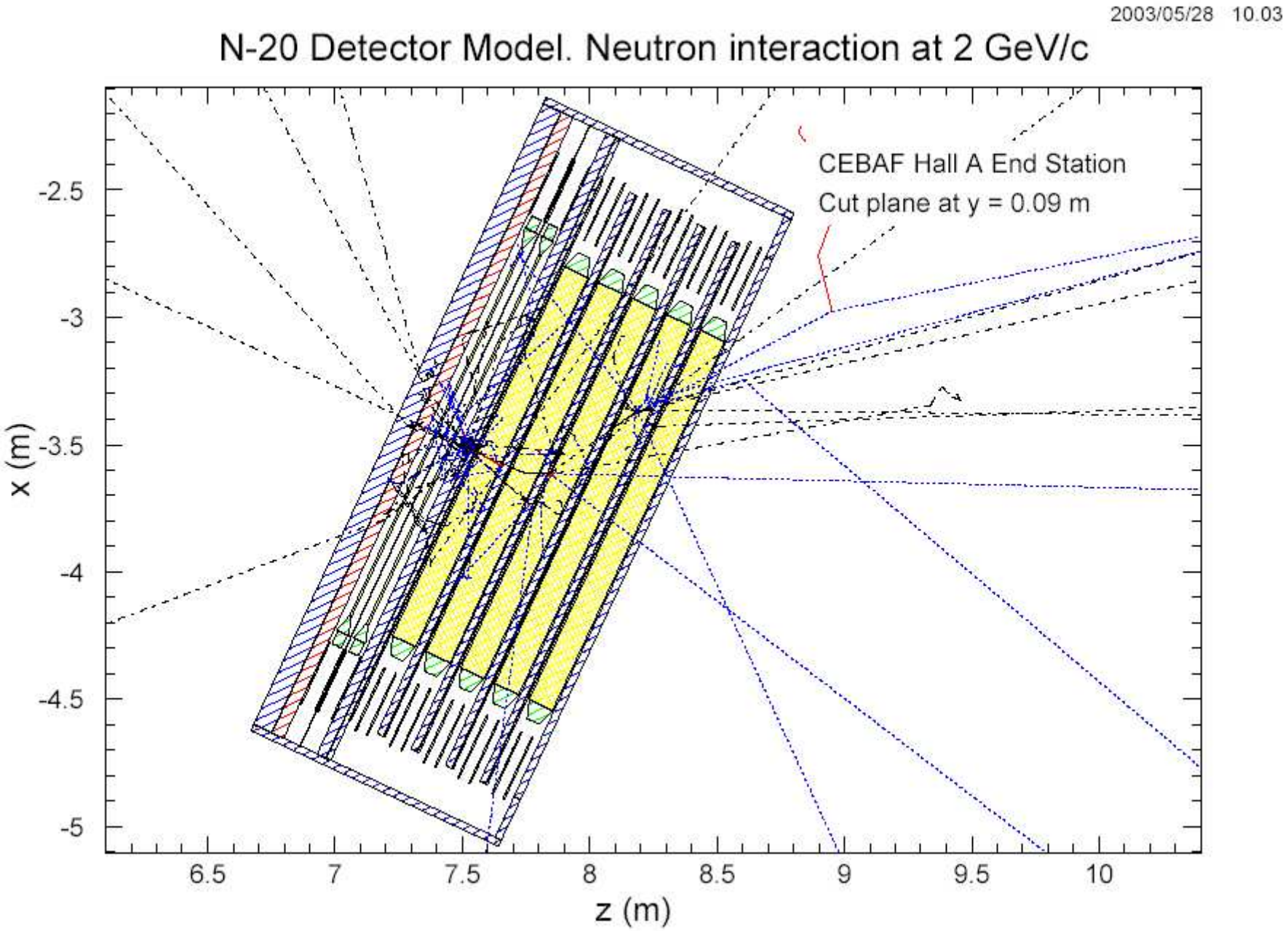
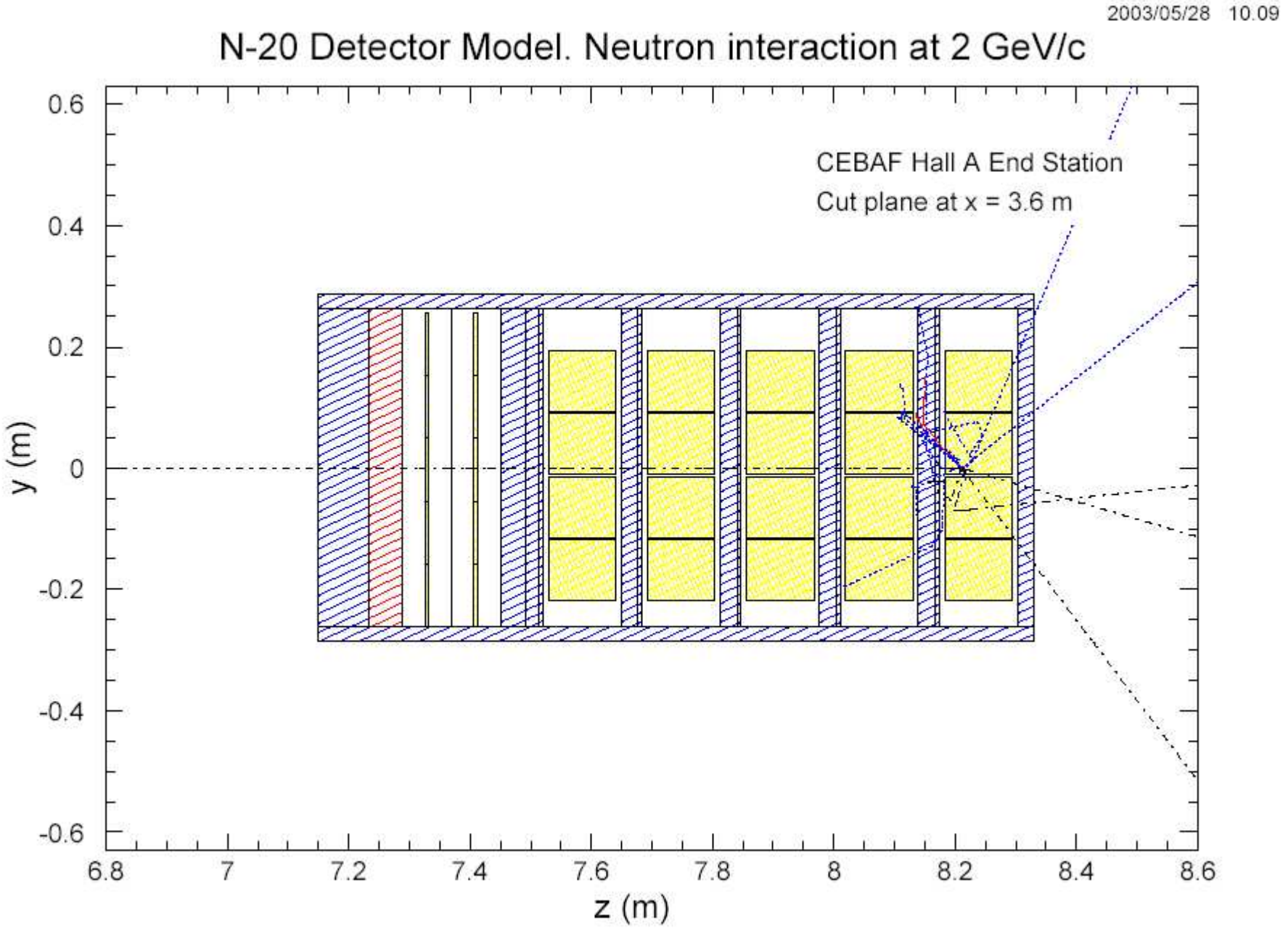
N-20 Neutron Detector prototype tests

- Test and optimize detector design
- Measure detector background loads
- Optimize trigger conditions
- Develop calibration procedures
- Develop data analysis and presentation software

Time of Flight technique utilizing G0 beam time structure

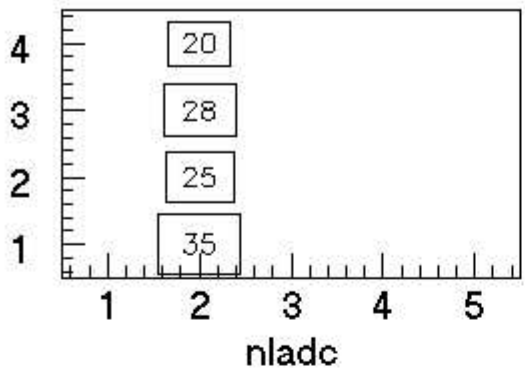
- 30 ns interval between beam bunches
- Ideal start time for TOF measurement
- Detector calibration / background characterization
- Possibility to measure inclusive particle production

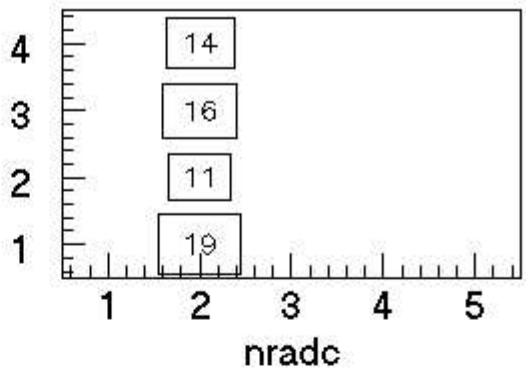

2003/05/28 10.03
N-20 Detector Model. Neutron interaction at 2 GeV/c
CEBAF Hall A End Station
Cut plane at y = 0.09 m
x (m)
-2.5
-3
-3.5
-4
-4.5
-5
6.5
7
7.5
8
8.5
9
9.5
10
z (m)

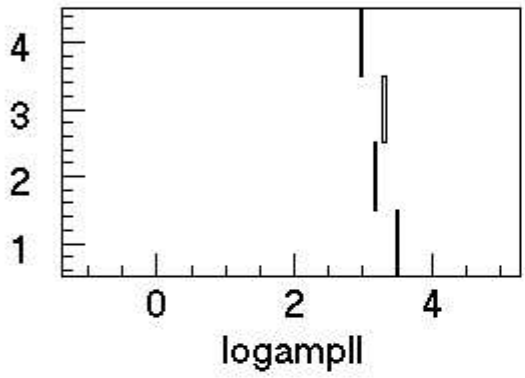

2003/05/28 10.09
N-20 Detector Model. Neutron interaction at 2 GeV/c
CEBAF Hall A End Station
Cut plane at x = 3.6 m
y (m)
z (m)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
6.8
7
7.2
7.4
7.6
7.8
8
8.2
8.4
8.6

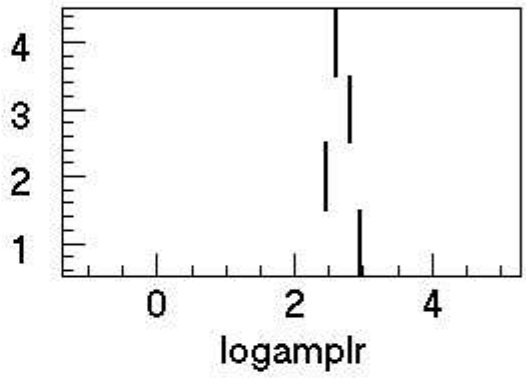
2003/05/28 12.12

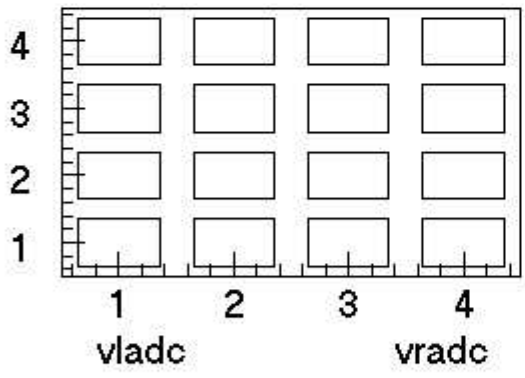
Cosmics event: signal in the second column, left portion

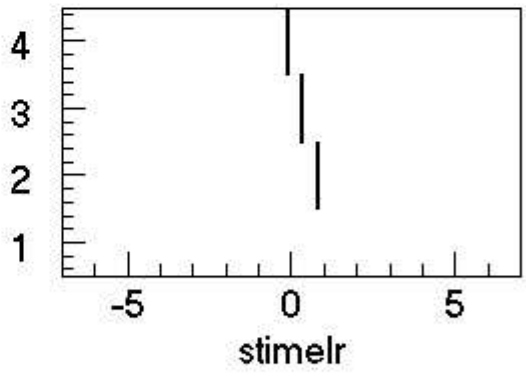


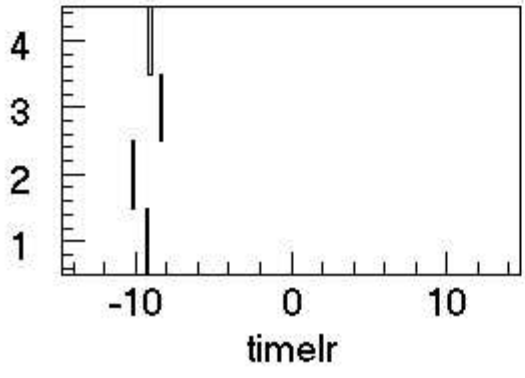


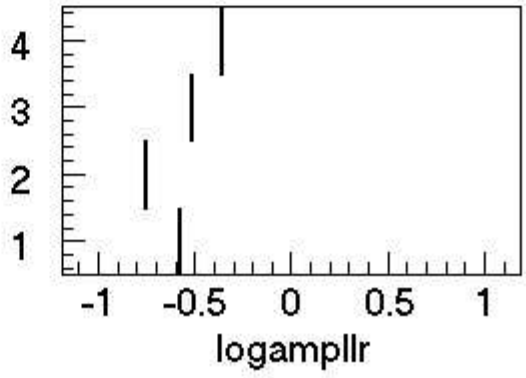






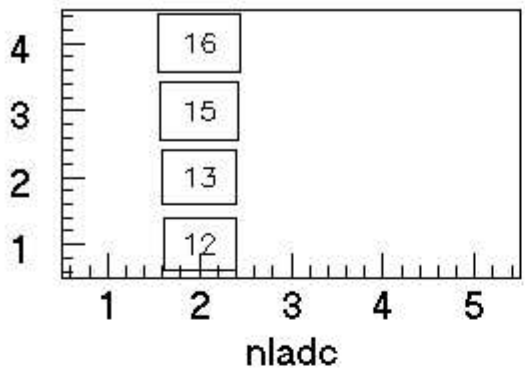


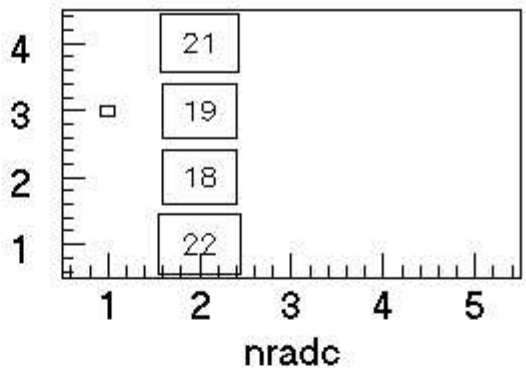


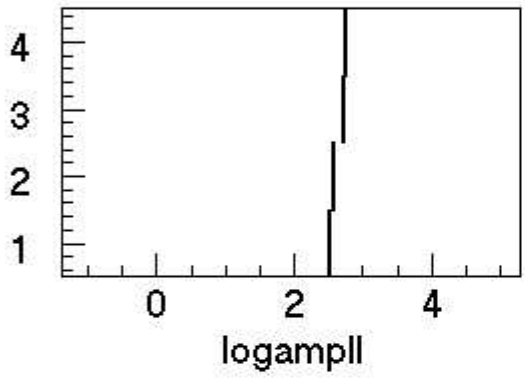


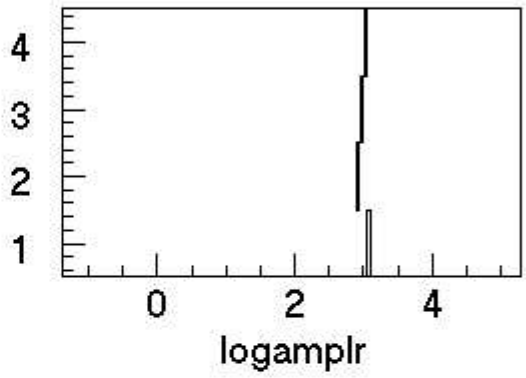
2003/05/28 12.29

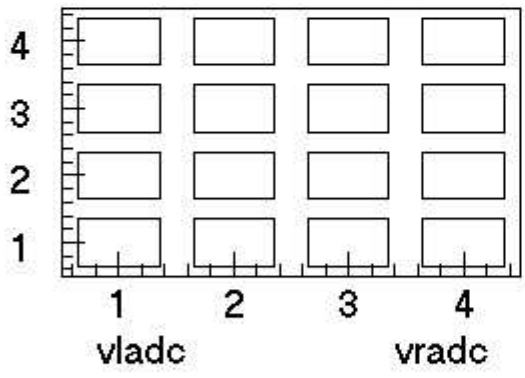
Cosmics event: signal in the second column, right portion

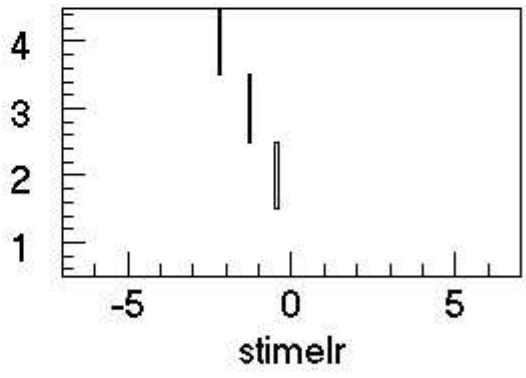


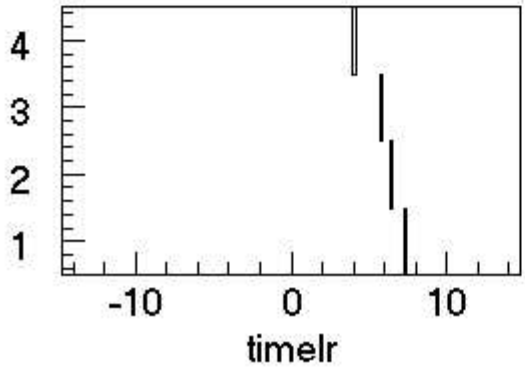


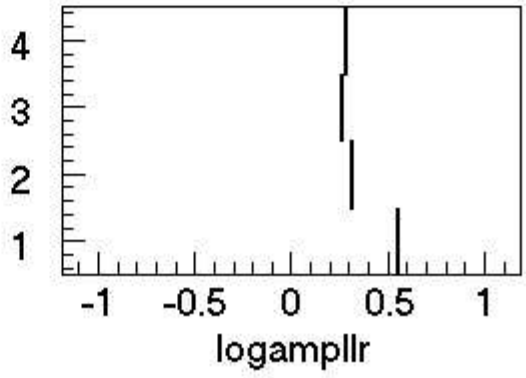






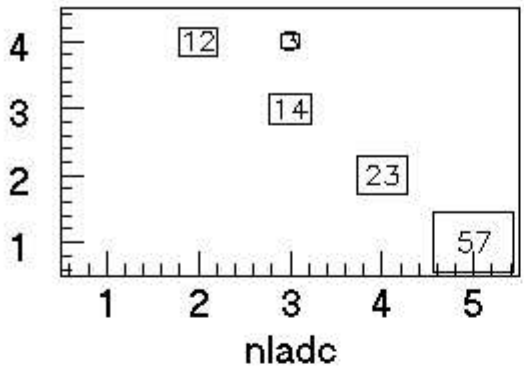


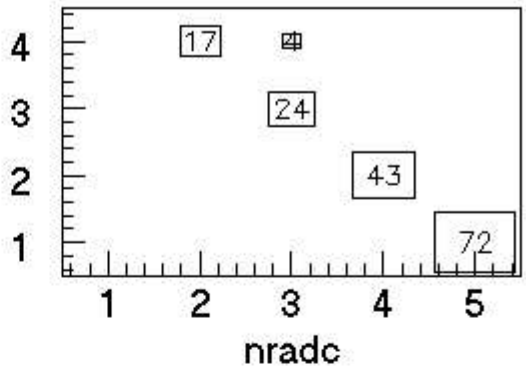


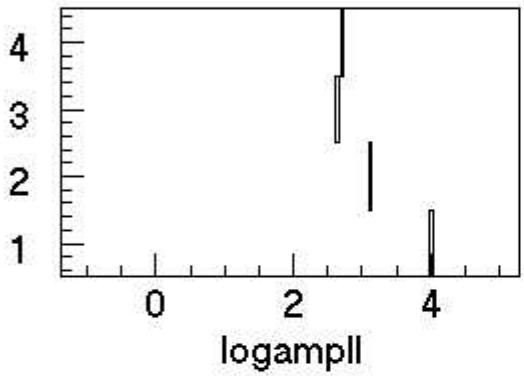


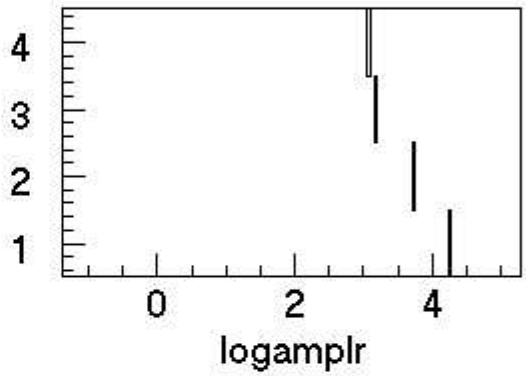
2003/05/28 12.26

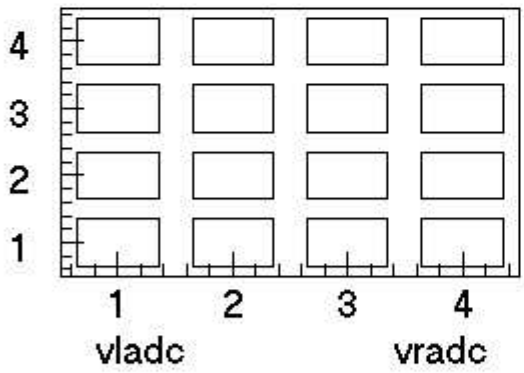
Cosmics event entering at an angle

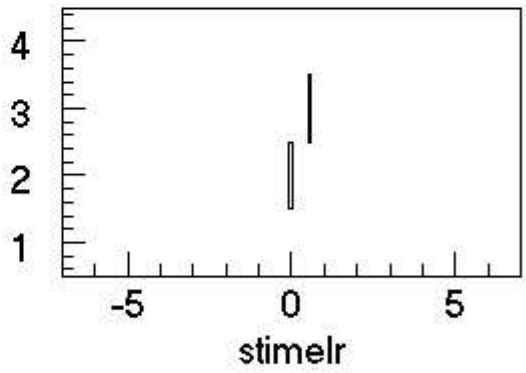


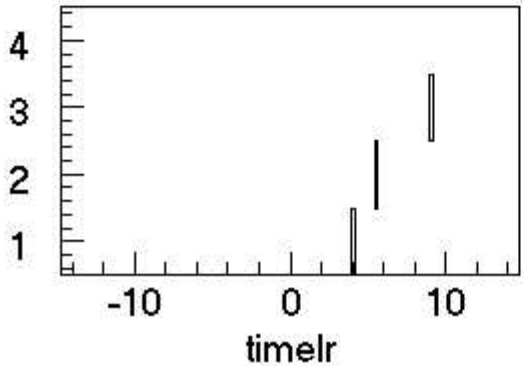


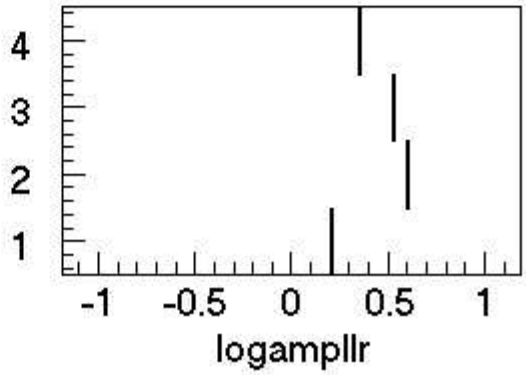






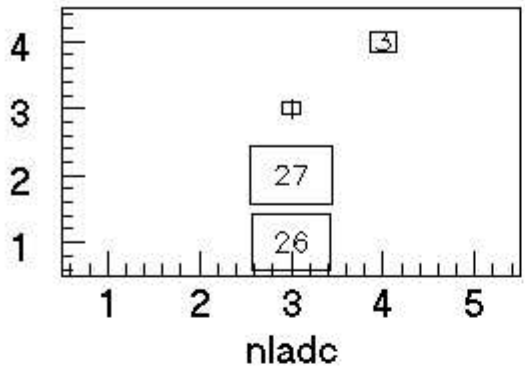


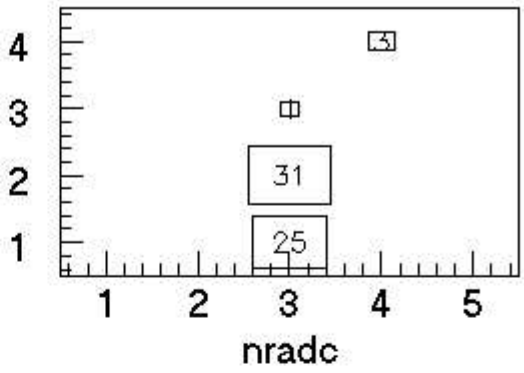


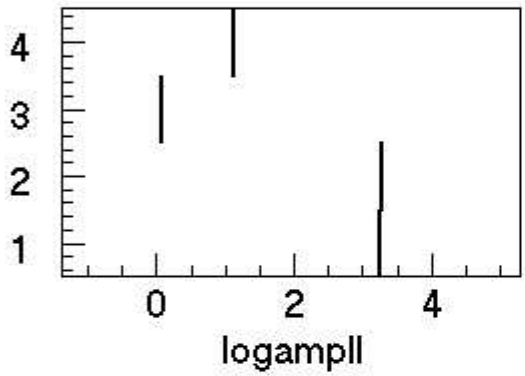


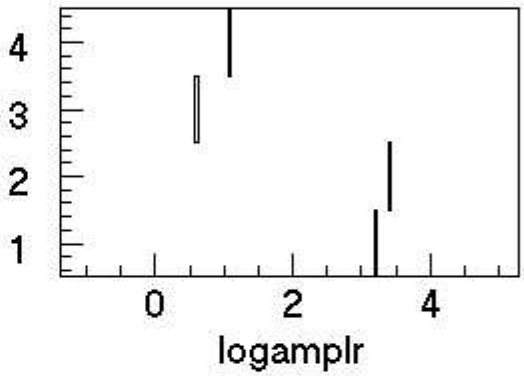
2003/05/28 12.30

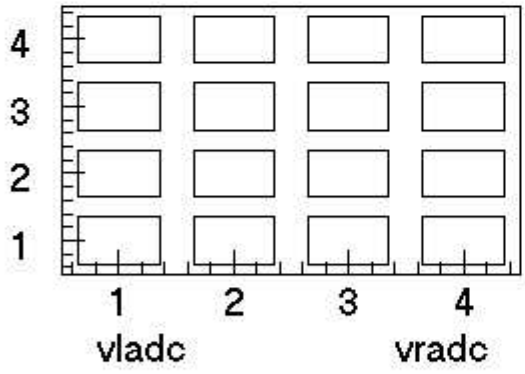
Cosmics event in the third and fourth column, iron wall

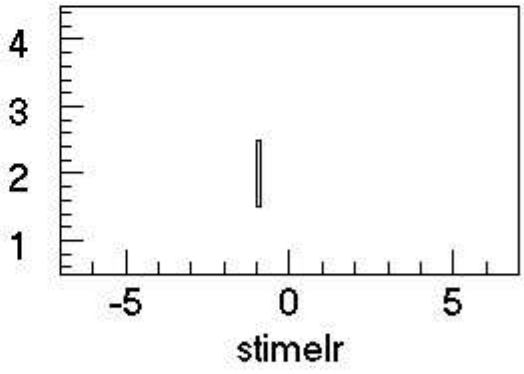


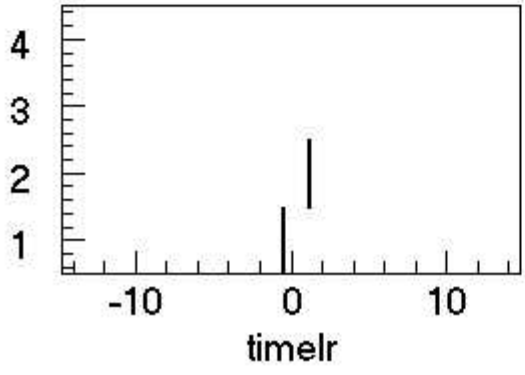


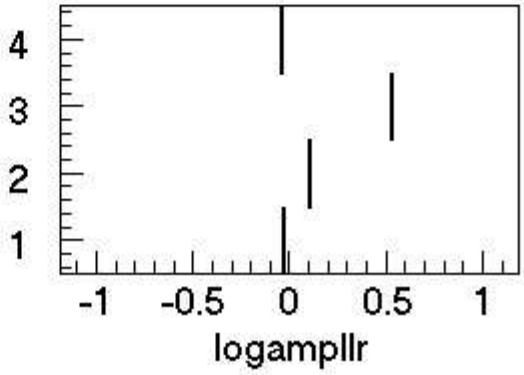




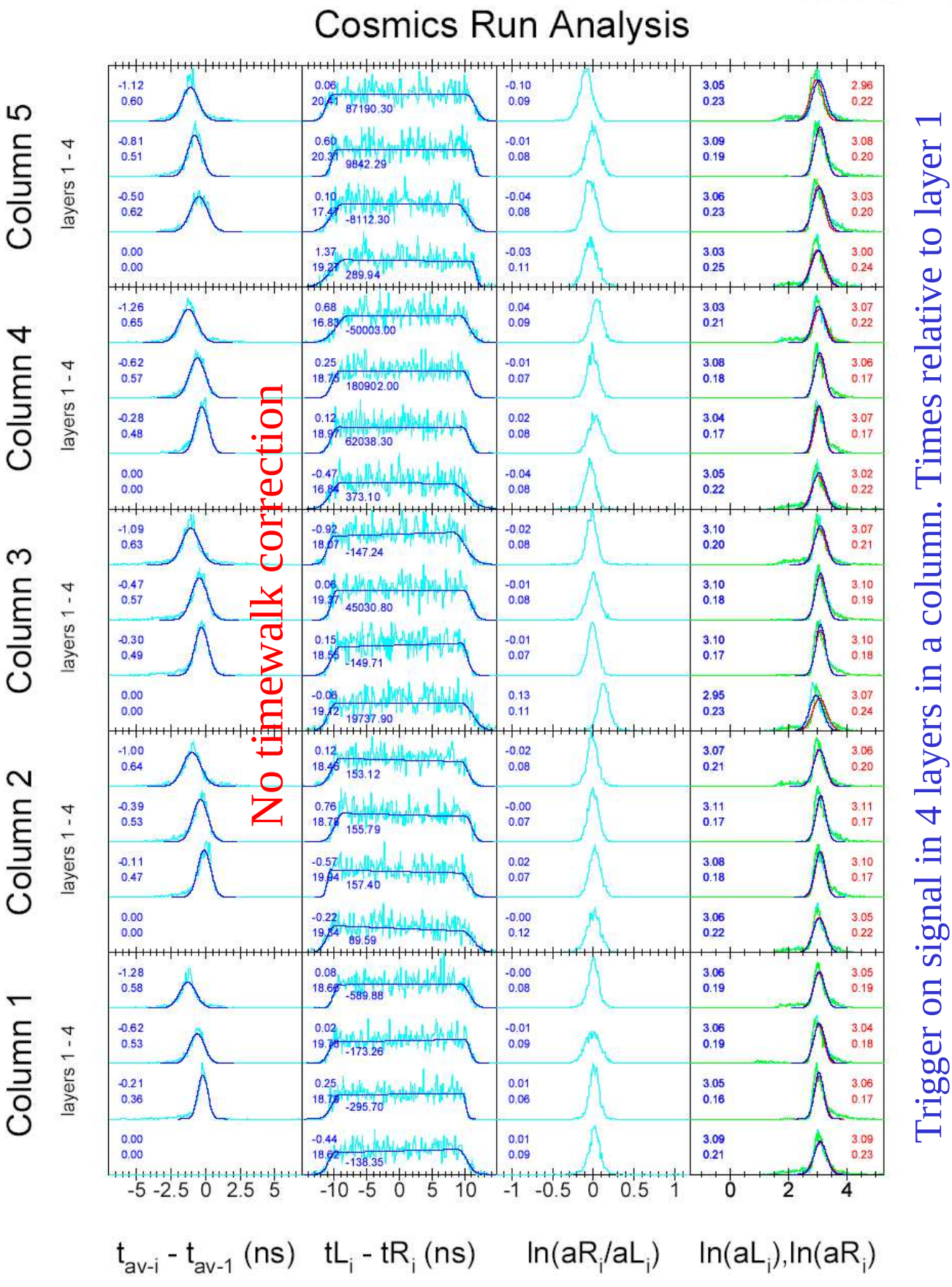








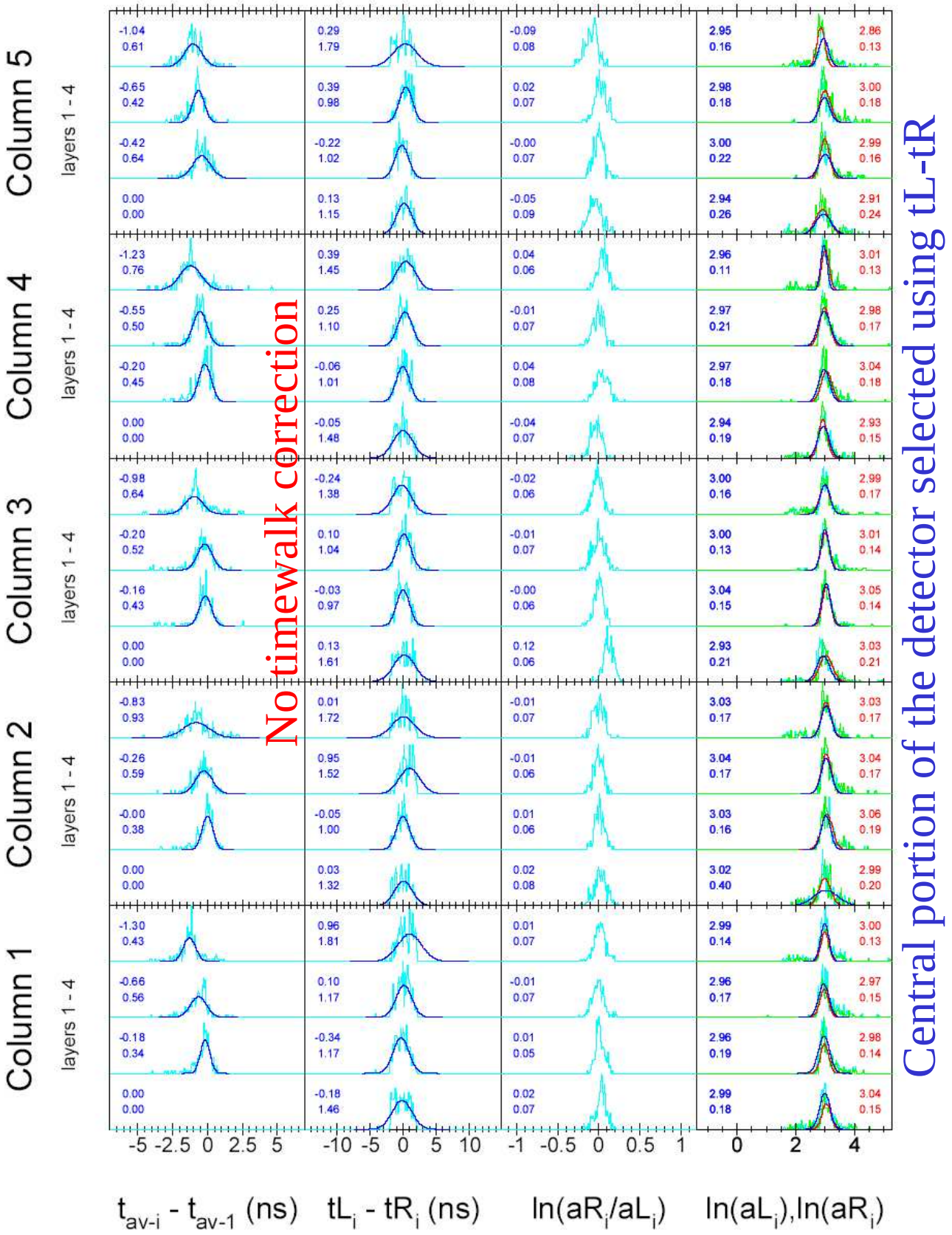
2003/05/28 12.32



Trigger on signal in 4 layers in a column. Times relative to layer 1

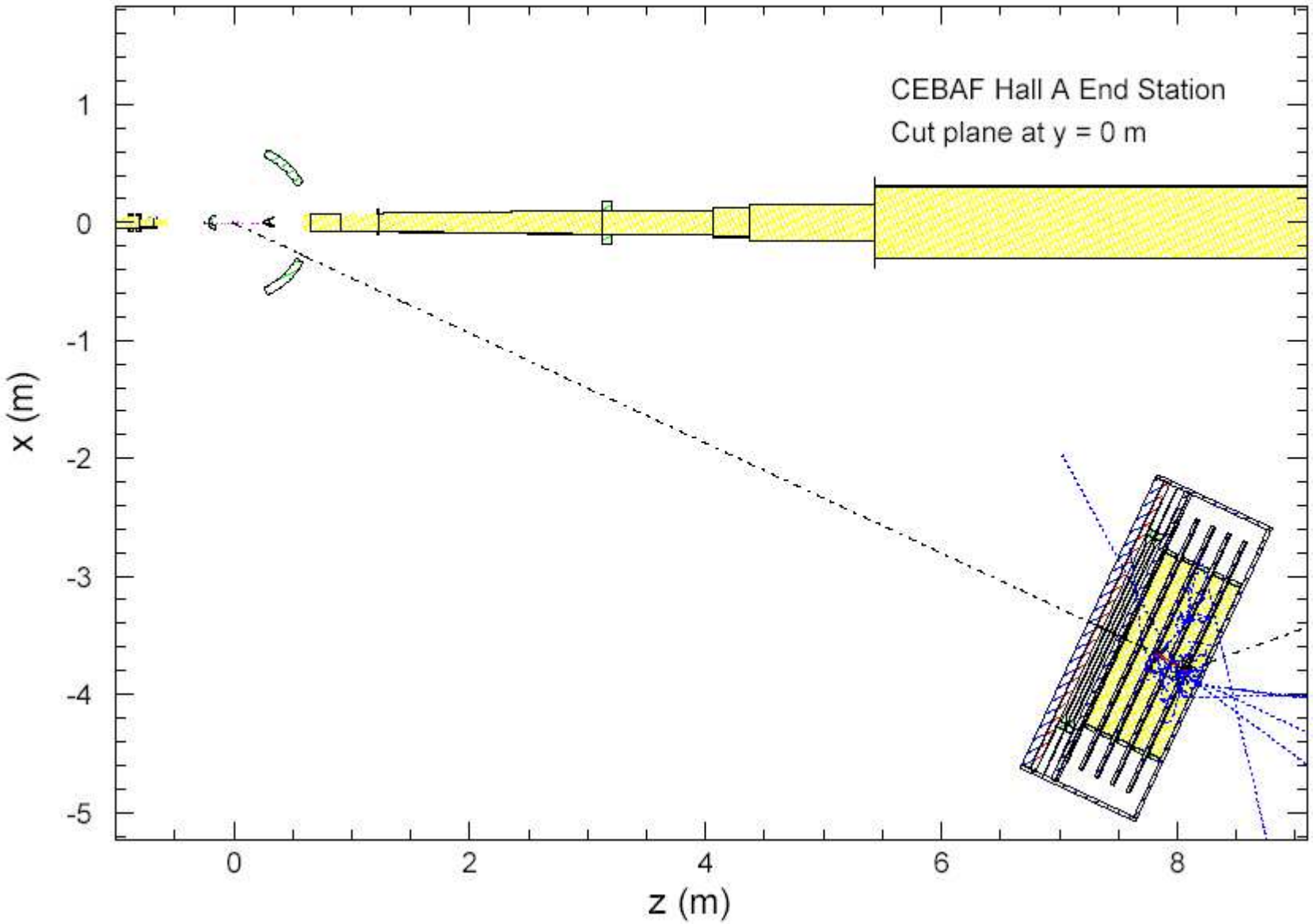
2003/05/28 12.40

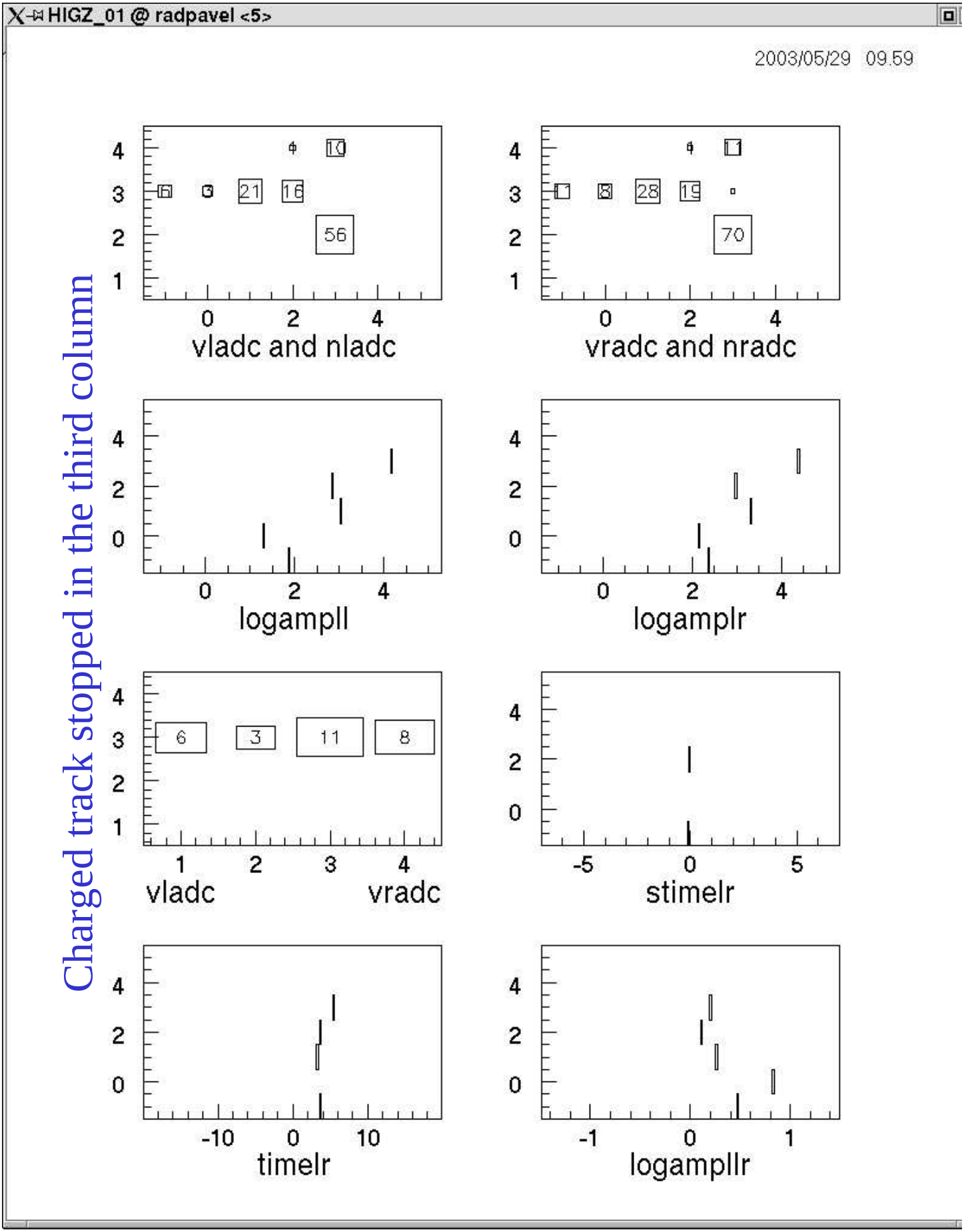
Cosmics Run Analysis

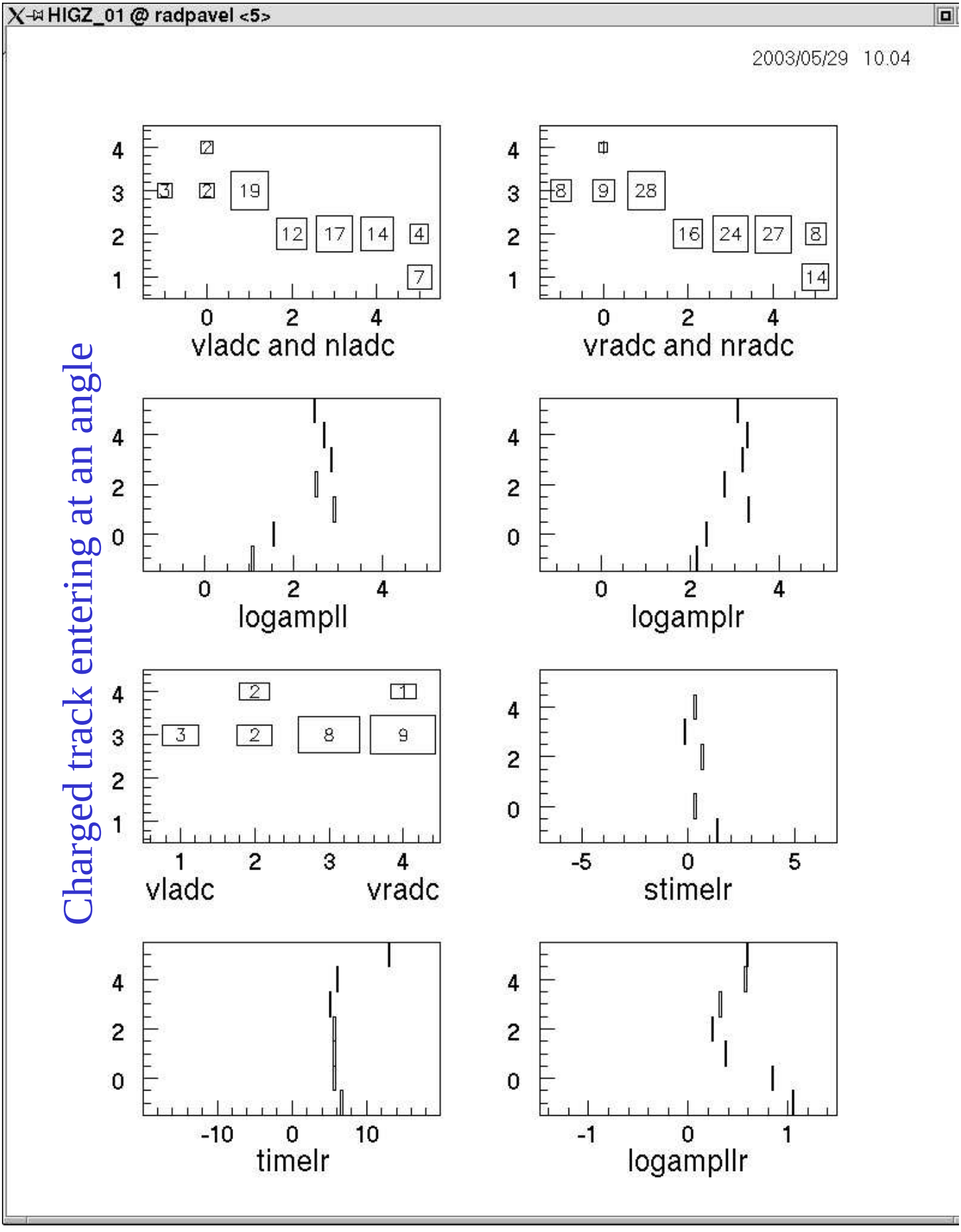


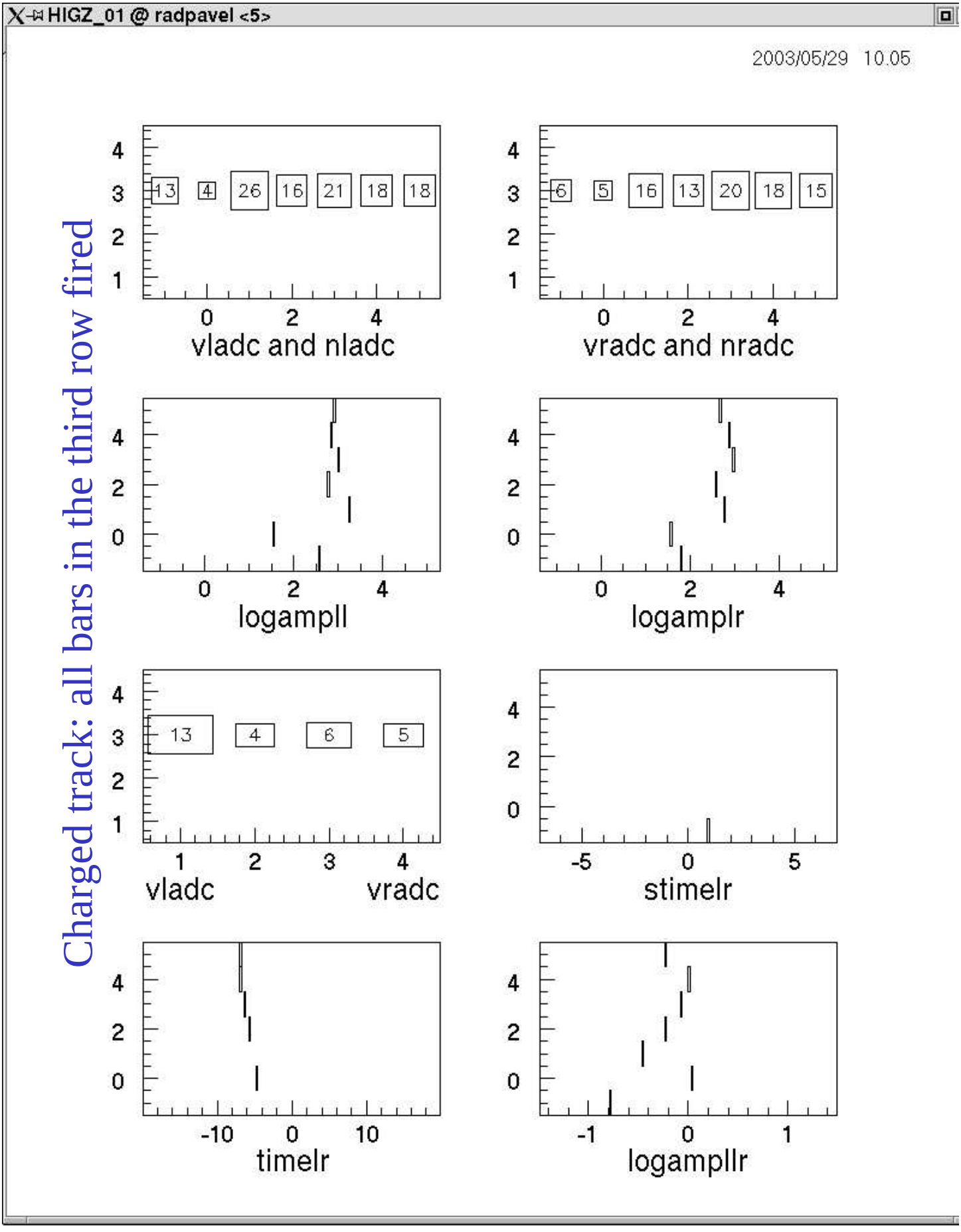
2003/05/28 09.30

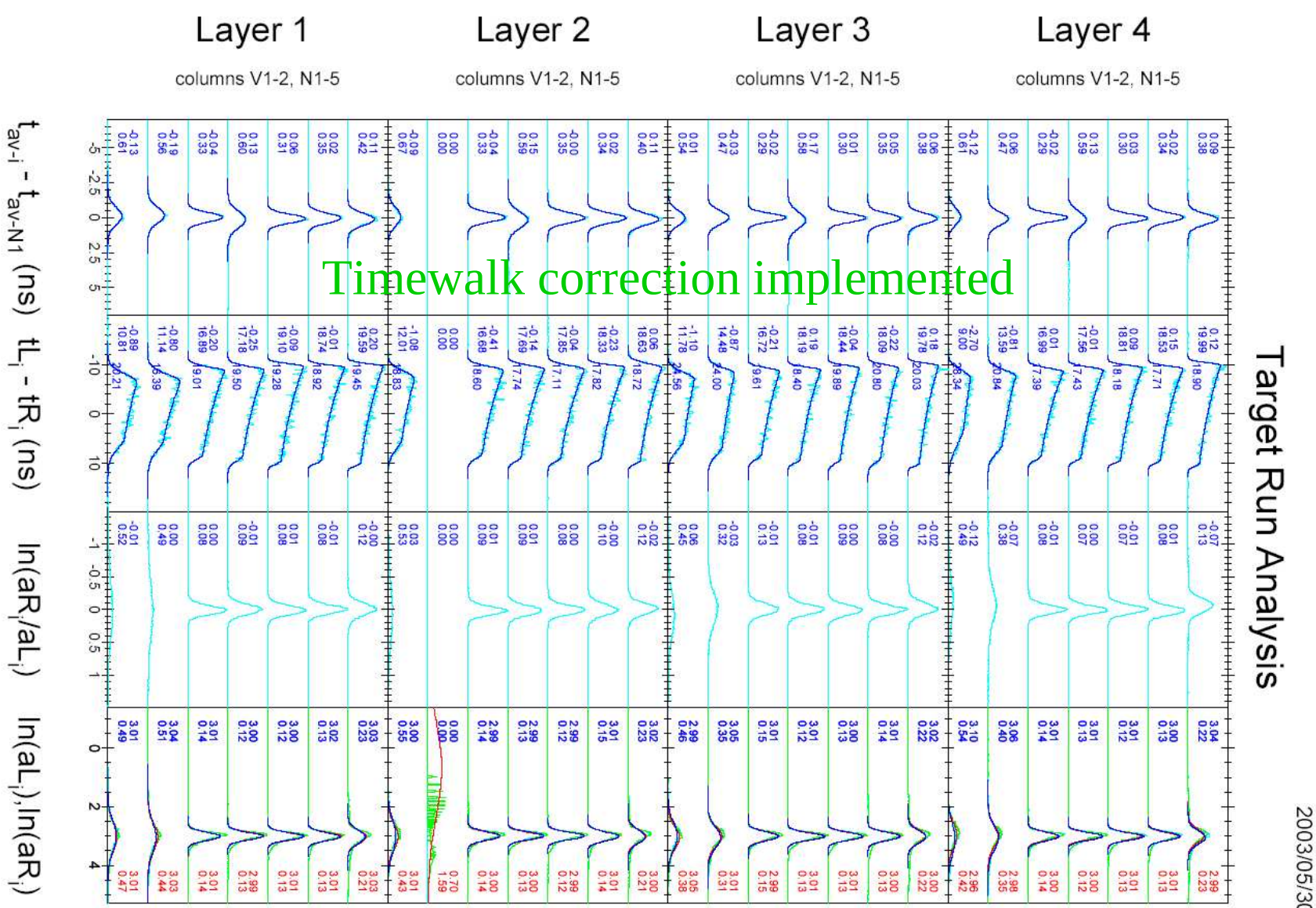
N-20 Detector Model. Neutron interaction at 2 GeV/c




HIGZ_01 @ radpavel <5>
2003/05/29 09.59
Charged track stopped in the third column
vladc and nladc
vradc and nradc
logampll
logamplr
vladc
vradc
stimelr
timelr
logampllr


HIGZ_01 @ radpavel <5>
2003/05/29 10.04
Charged track entering at an angle
vladc and nladc
vradc and nradc
logampll
logamplr
vladc
vradc
stimelr
timelr
logampllr


HIGZ_01 @ radpavel <5>
2003/05/29 10.05
Charged track: all bars in the third row fired
13 4 26 16 21 18 18
vladc and nladc
6 5 16 13 20 18 15
vradc and nradc
logampll
logamplr
13 4 6 5
vladc
vradc
stimelr
timelr
logampllr

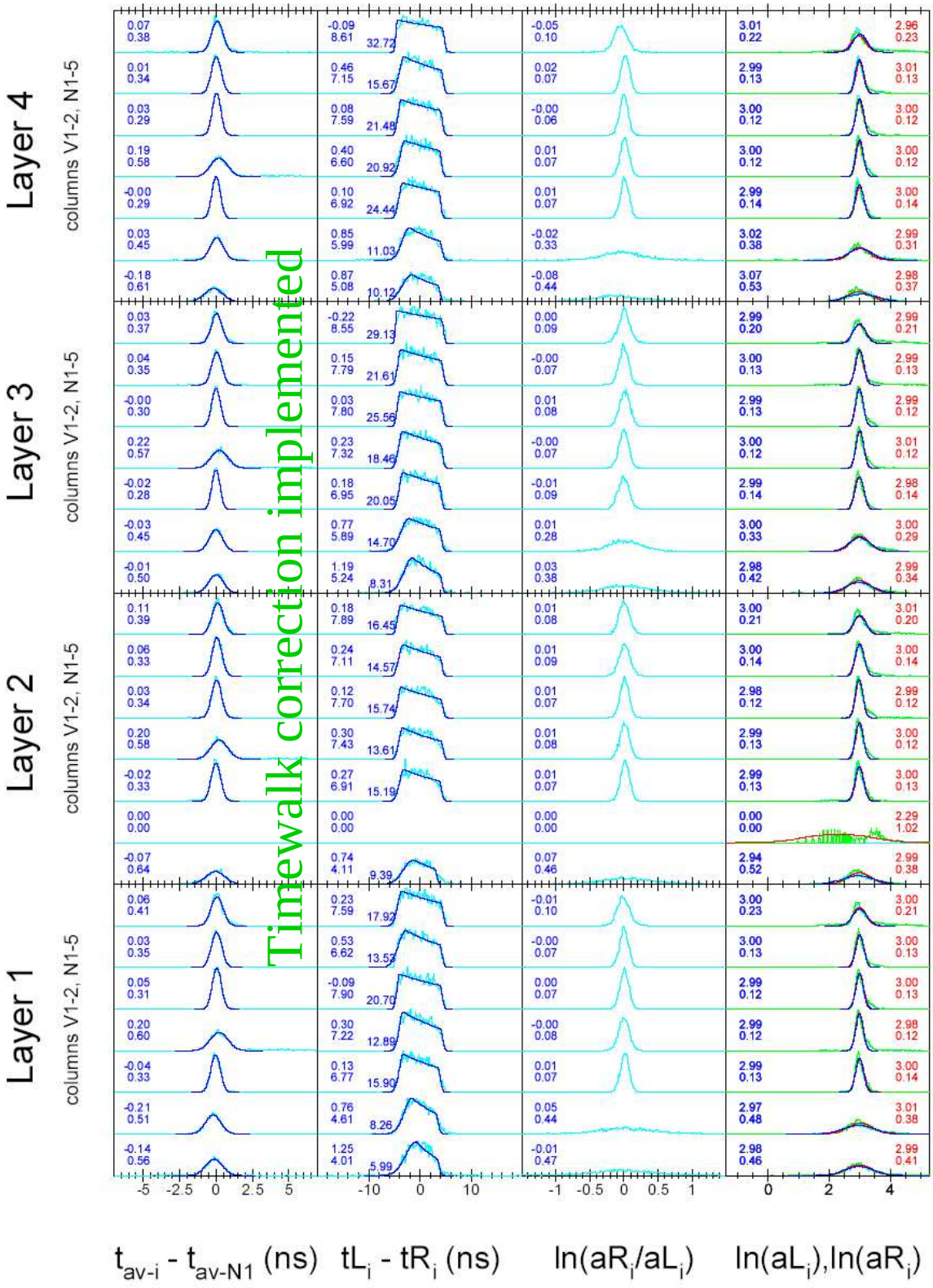


Trigger on signal in 5 columns in a layer. Times relative to column 2

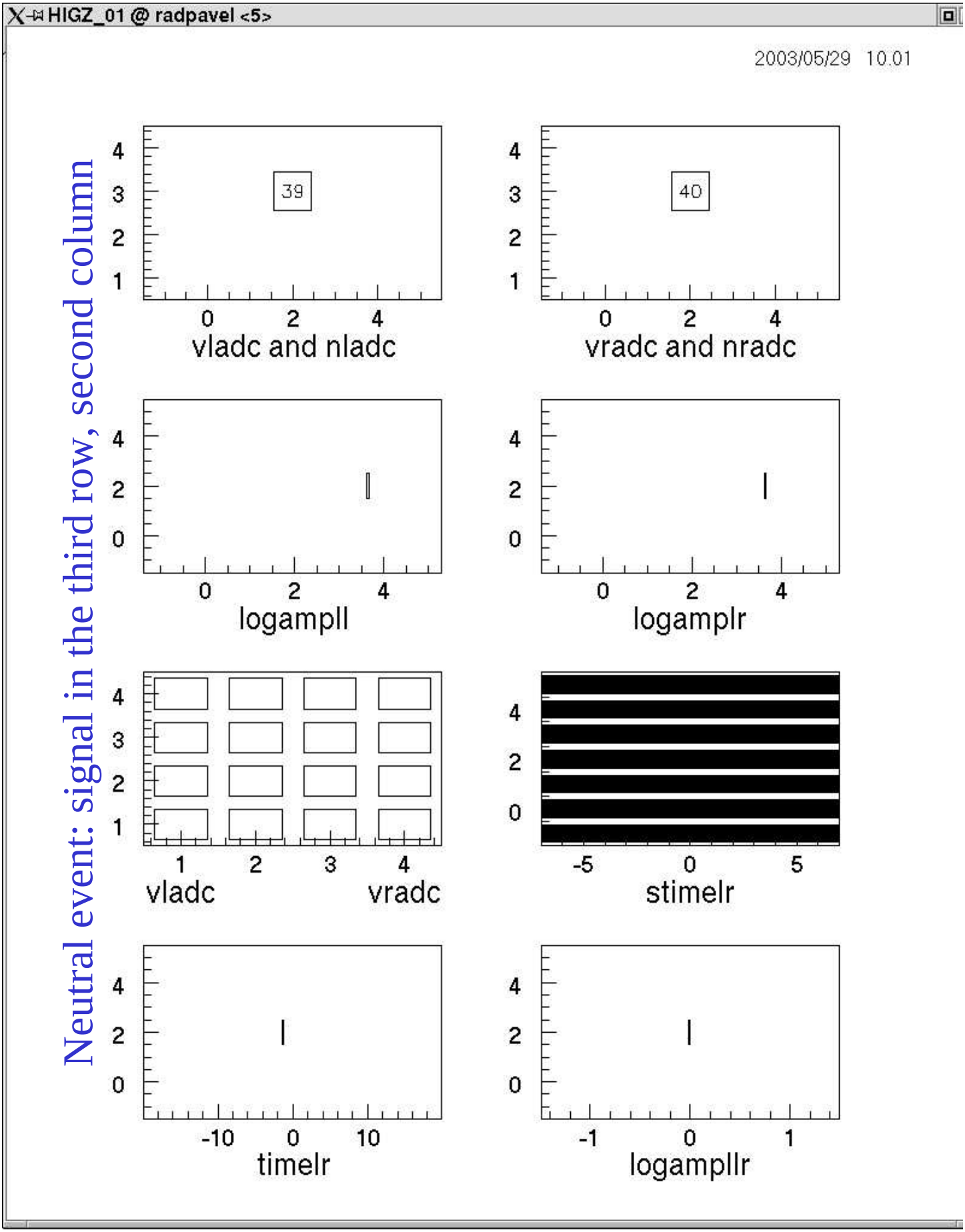
Column 2 time is relative to the 30MHz beam start time

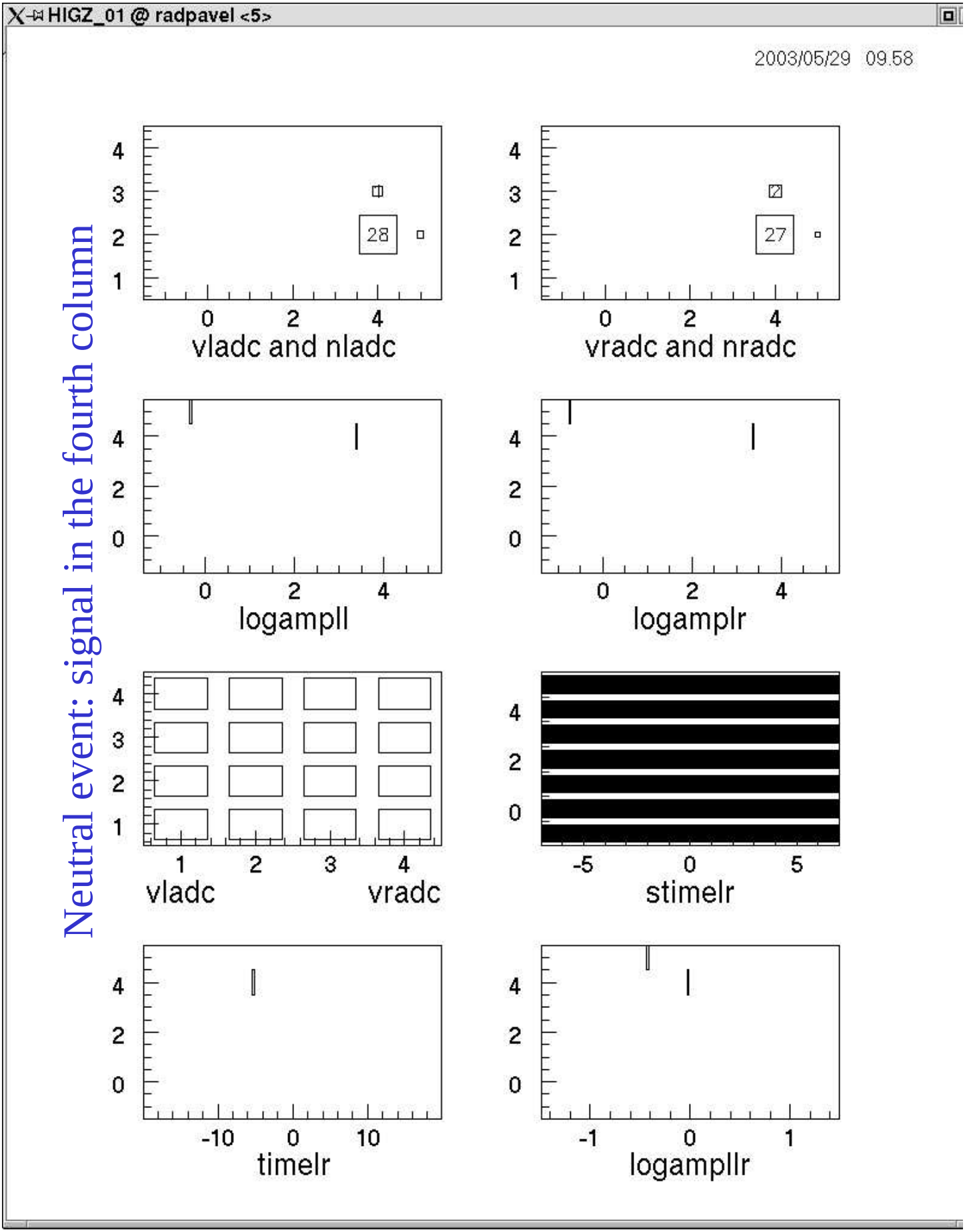
2003/05/29 23.35

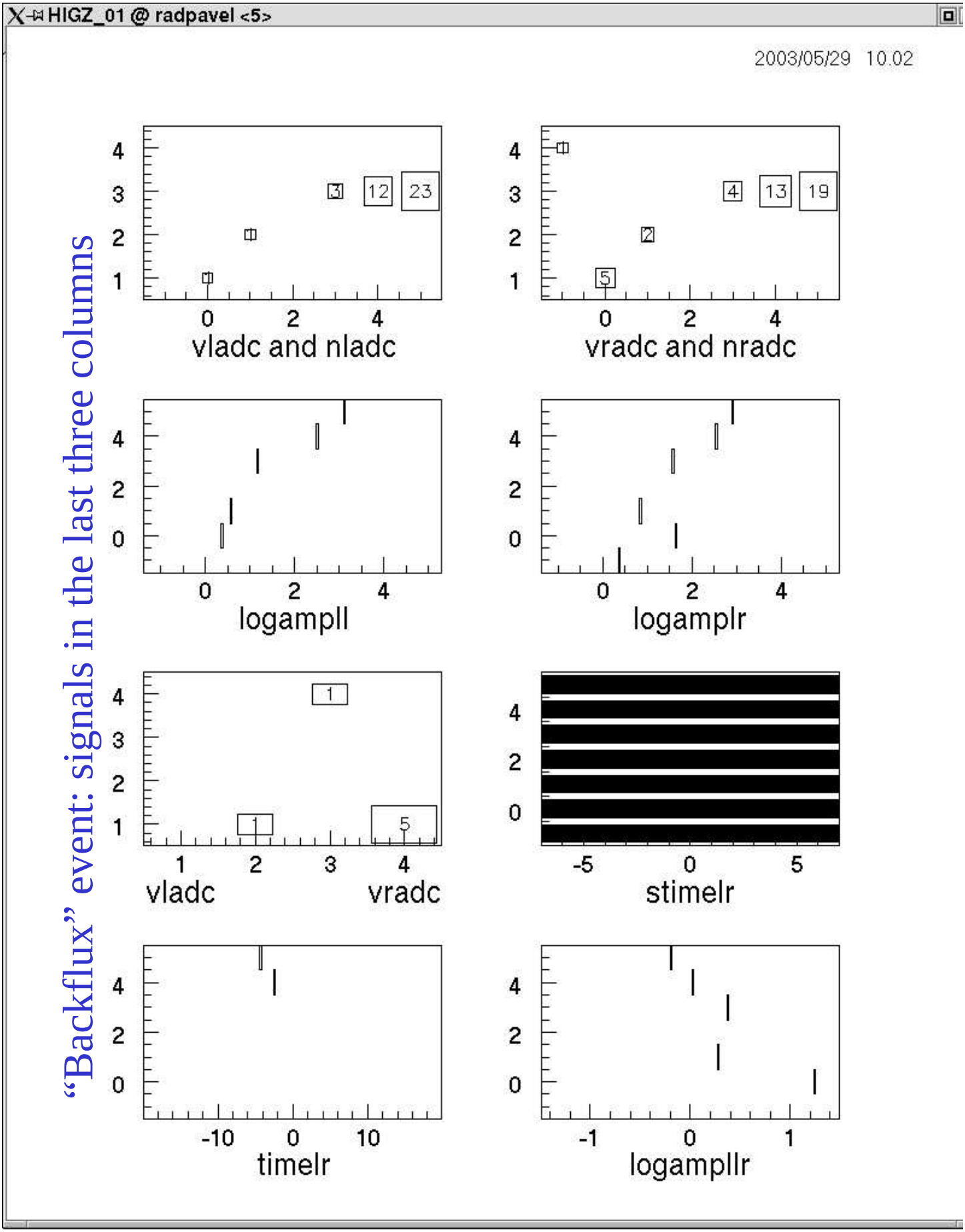
Target Run Analysis



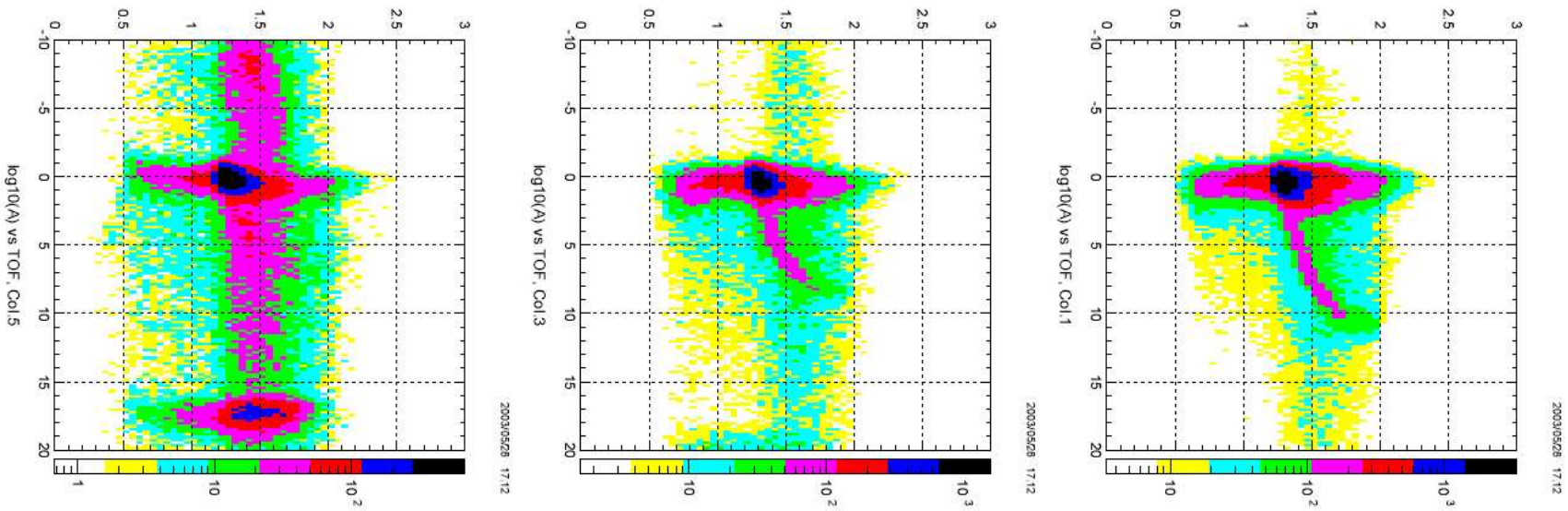
Central portion of the detector selected using tL-tR


HIGZ_01 @ radpavel <5>
2003/05/29 10.01
Neutral event: signal in the third row, second column
39
vladc and nladc
40
vradc and nradc
logampll
logamplr
vladc
vradc
stimelr
timelr
logampllr


HIGZ_01 @ radpavel <5>
2003/05/29 09.58
Neutral event: signal in the fourth column
28
vladc and nladc
27
vradc and nradc
logampll
logamplr
vladc
vradc
stimelr
timelr
logampllr

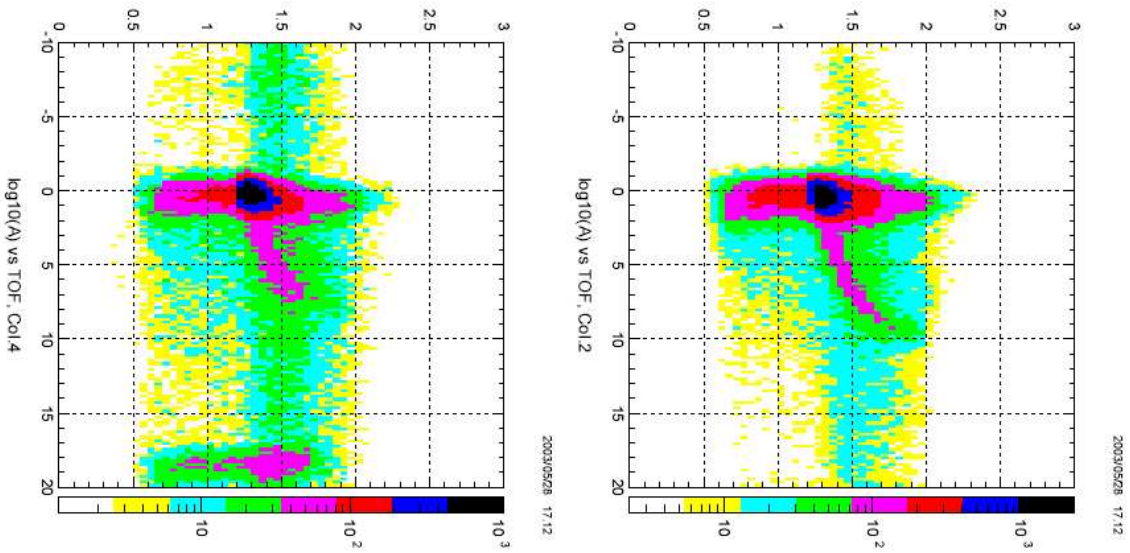


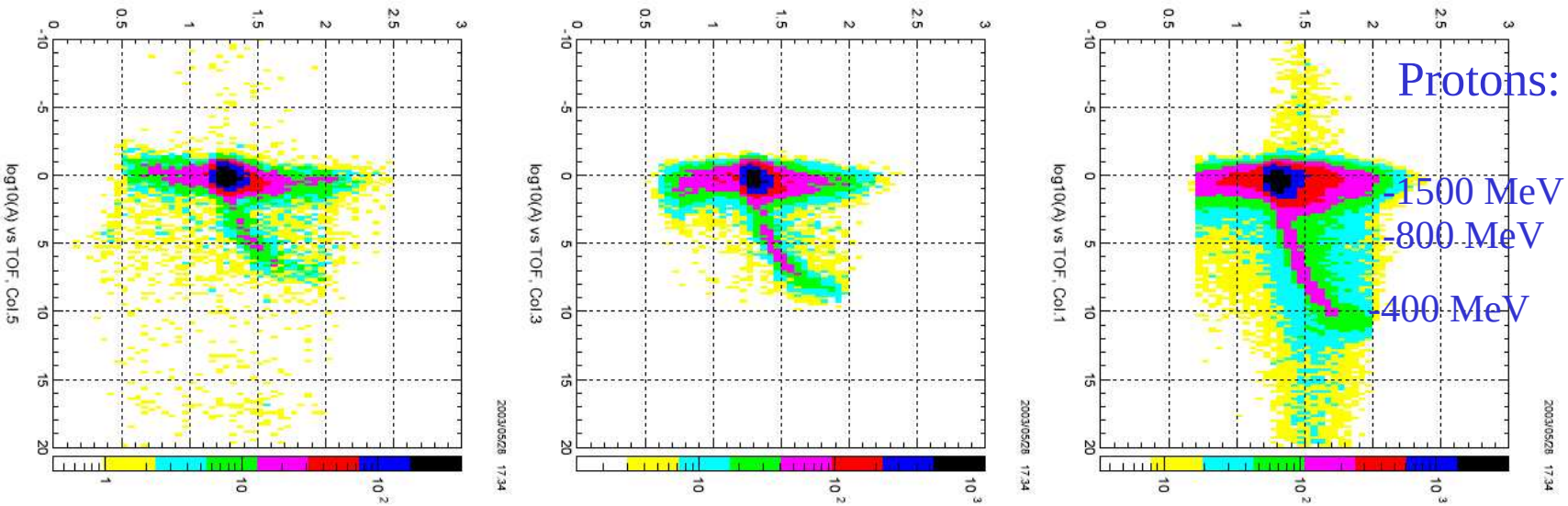
"Backflux" event: signals in the last three columns



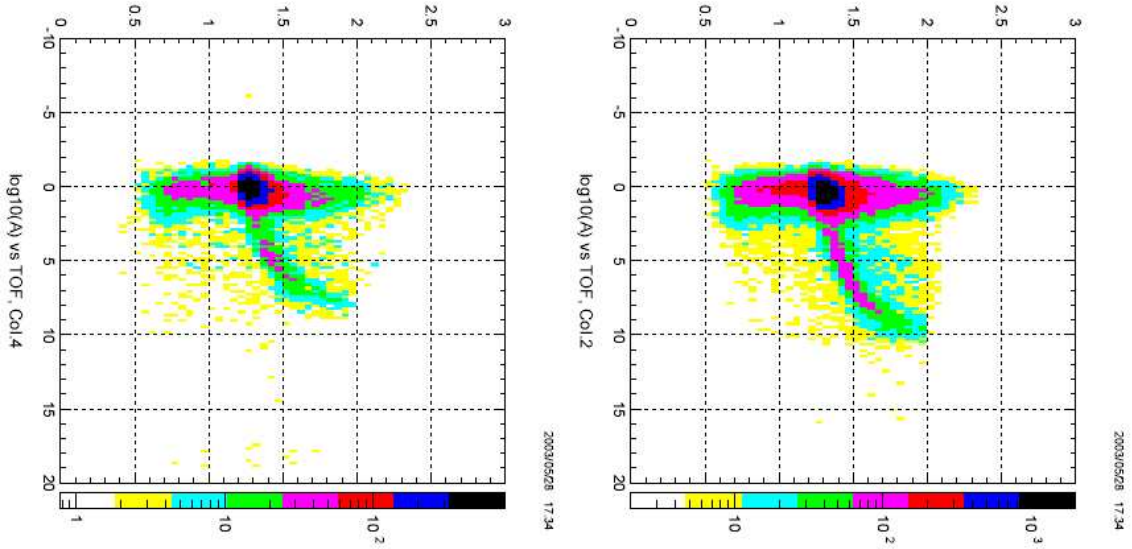
$\log_{10}$(A in MeVee) vs TOF distributions in 5 columns of the N-20

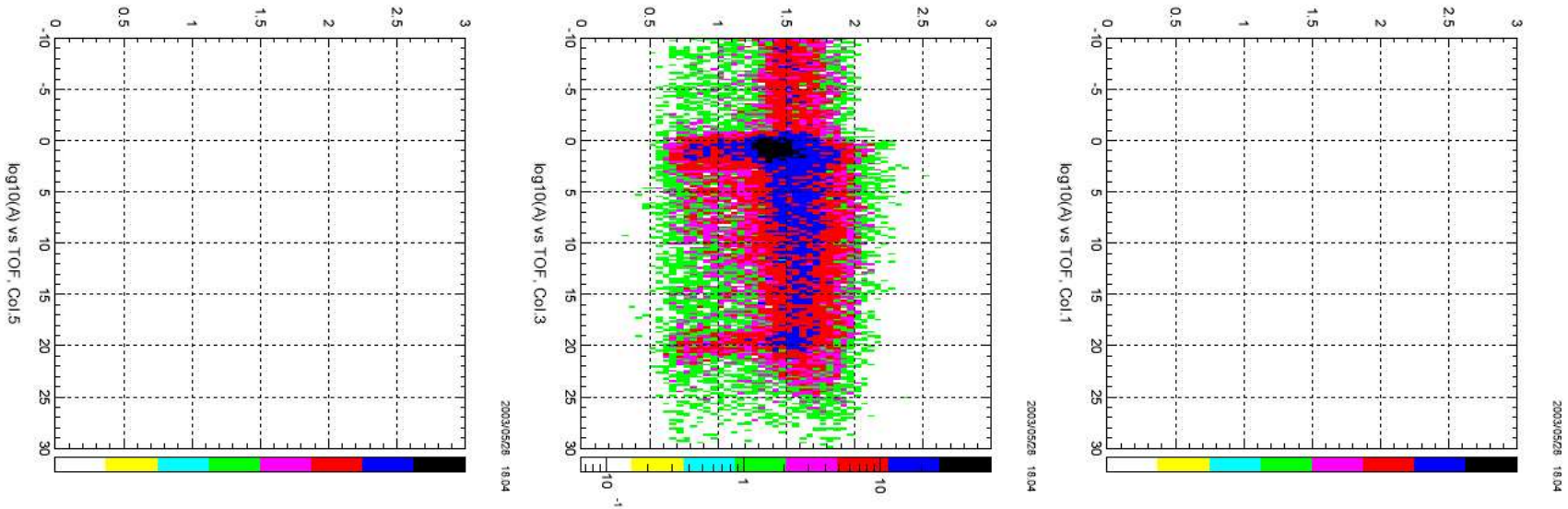
All triggers in the central part of the detector, defined as -5 < tL-tR < 5 ns



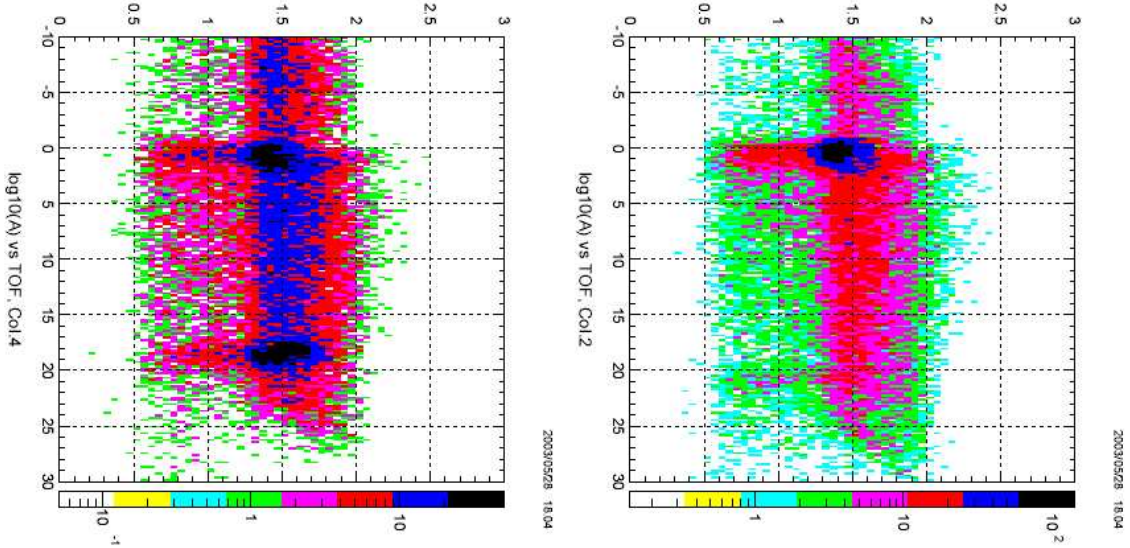


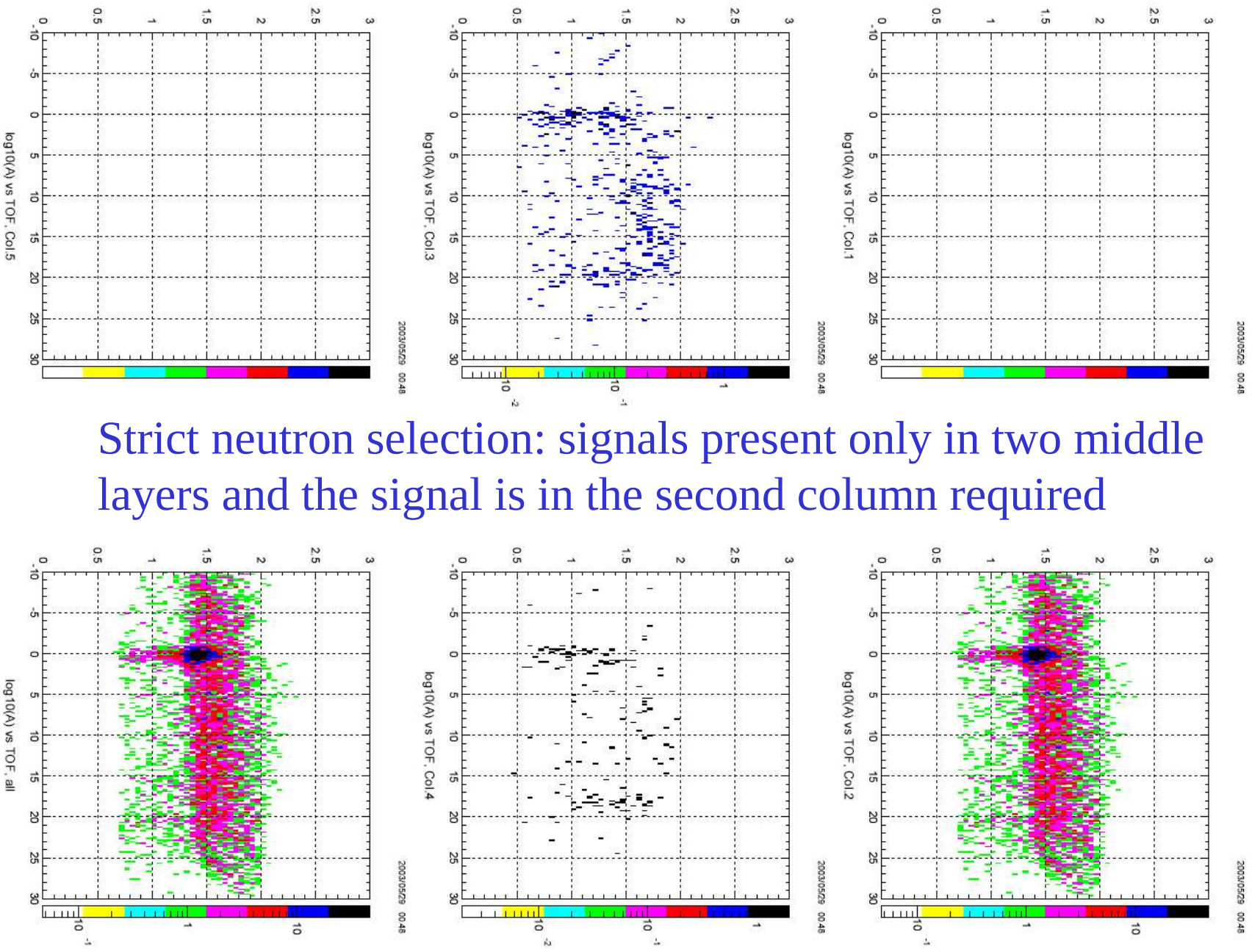
Trigger on signal present in the first column. Proton band observed





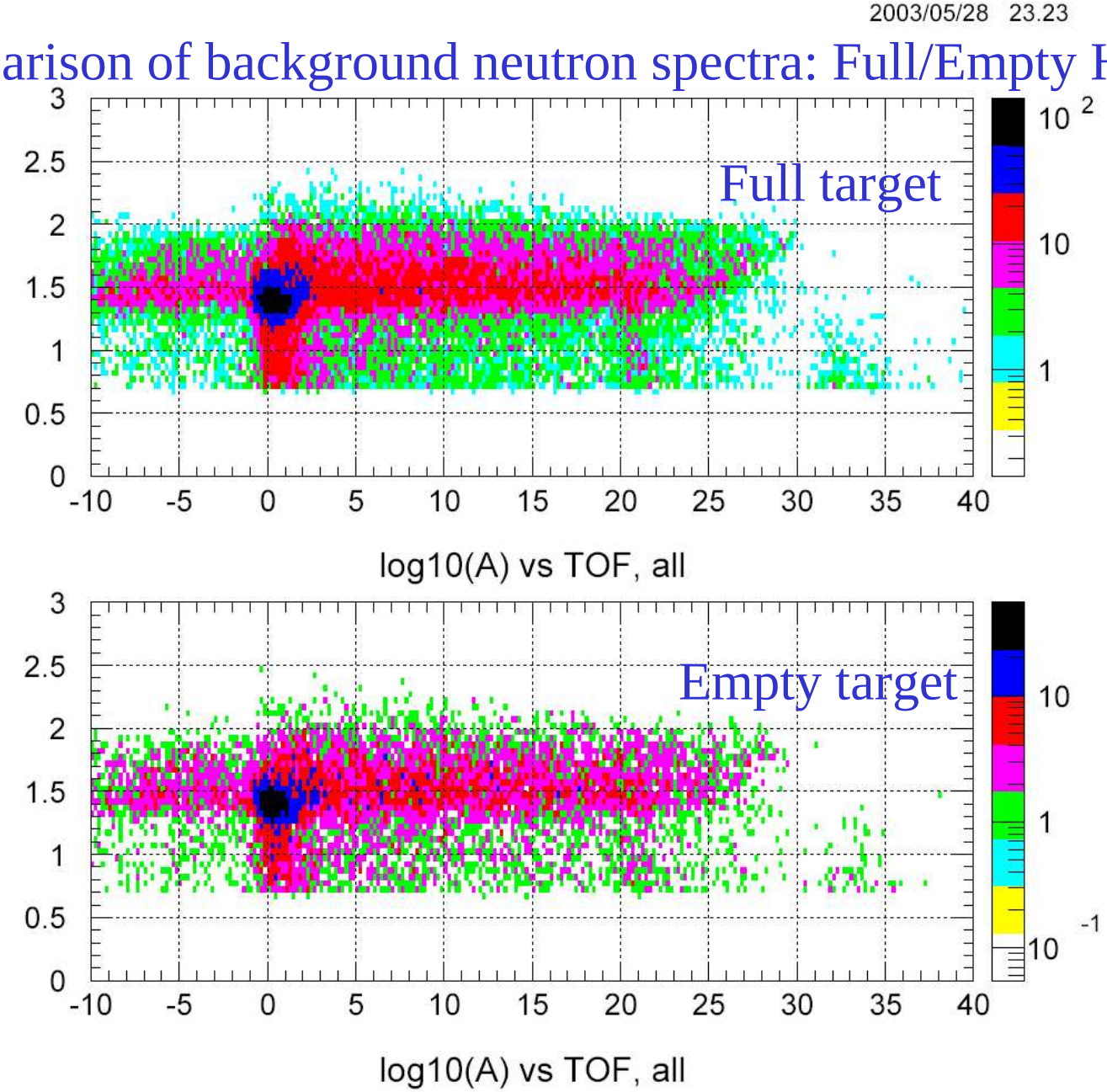
Neutron selection: no signal in the first column and no signal in the last column

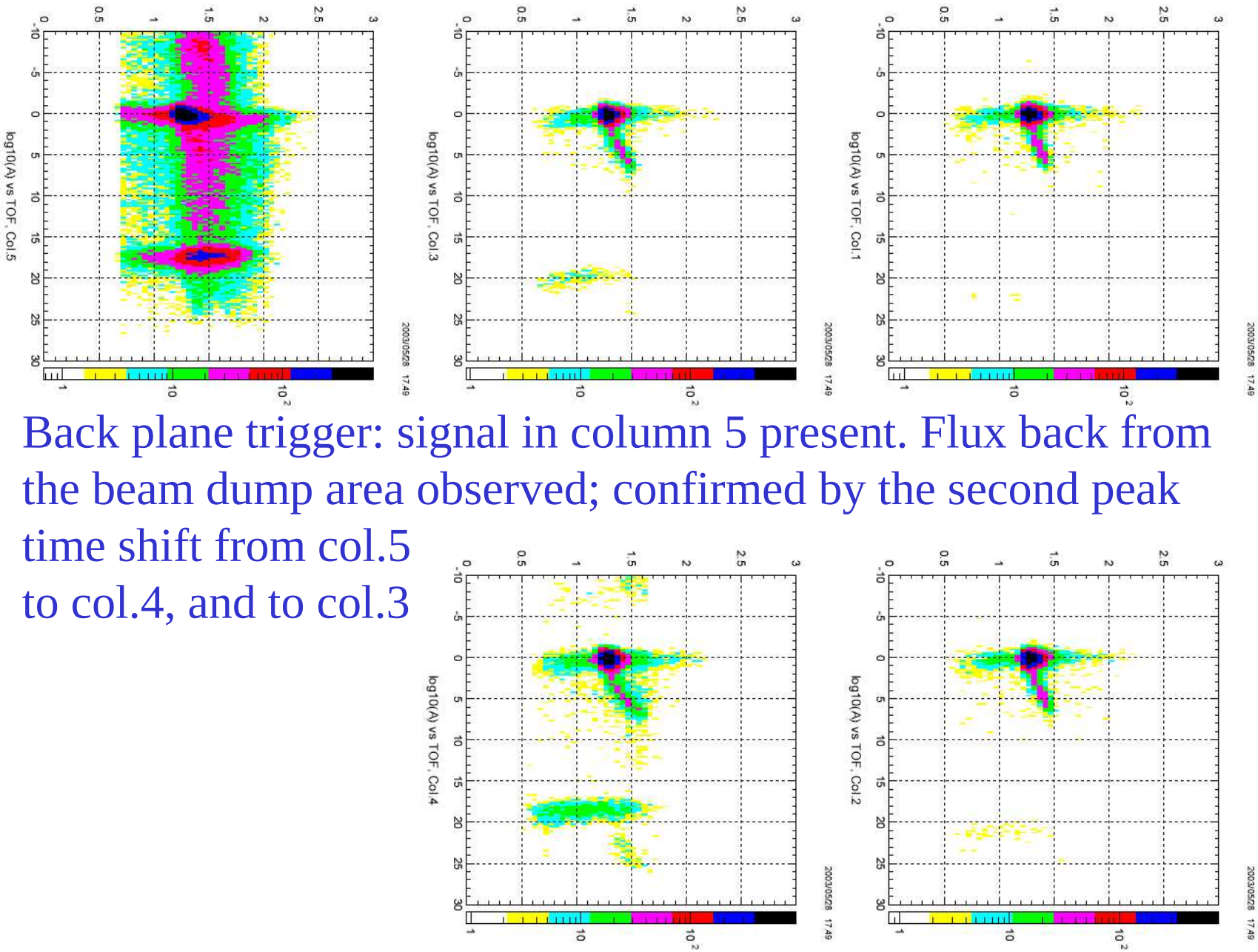




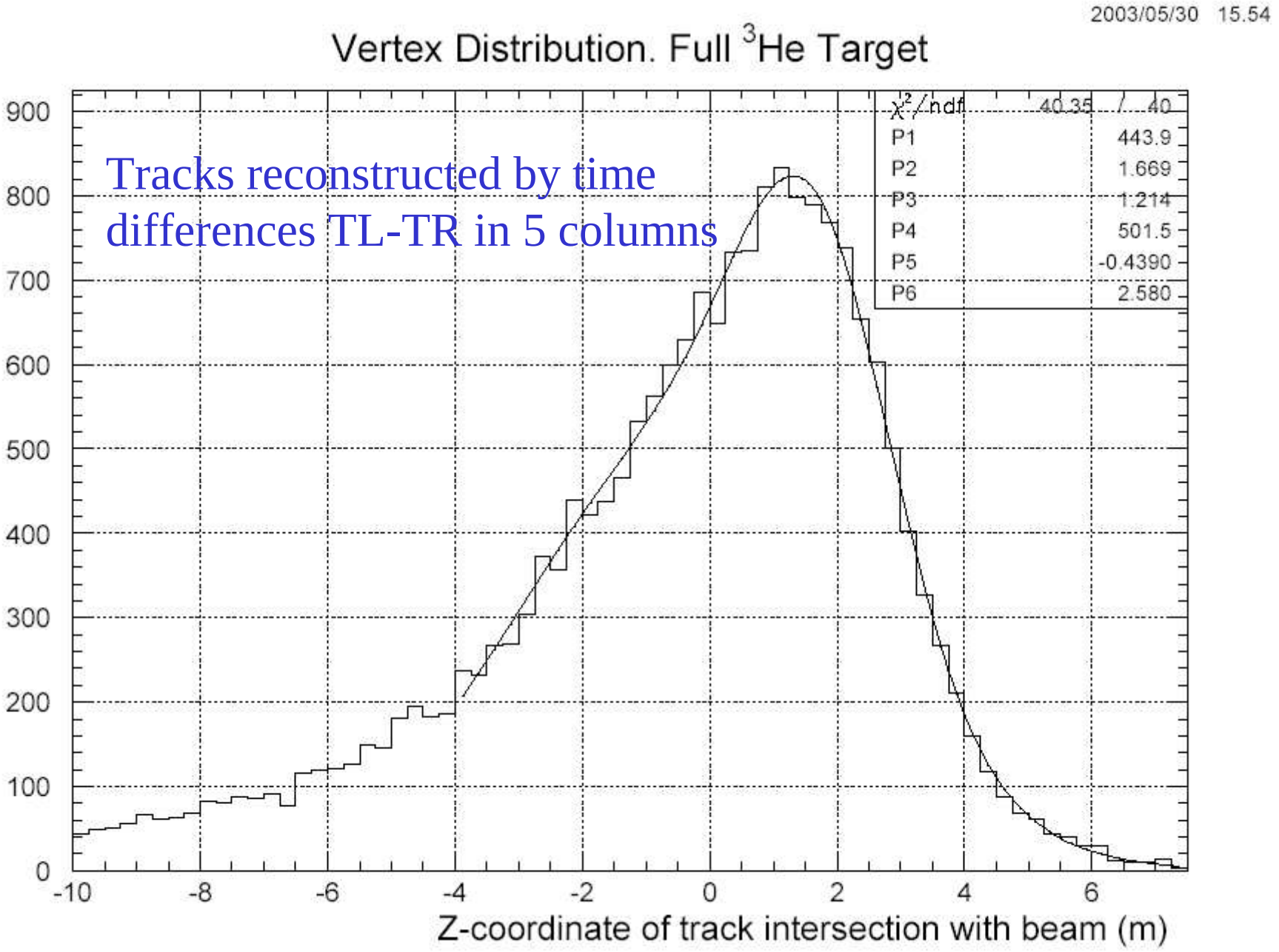
Strict neutron selection: signals present only in two middle layers and the signal is in the second column required

Comparison of background neutron spectra: Full/Empty He target





Back plane trigger: signal in column 5 present. Flux back from the beam dump area observed; confirmed by the second peak time shift from col.5 to col.4, and to col.3


2003/05/30 15.54
Vertex Distribution. Full ^{3}He Target
Tracks reconstructed by time differences TL-TR in 5 columns
χ^2/ndf 40.35 / 40
P1 443.9
P2 1.669
P3 1.214
P4 501.5
P5 -0.4390
P6 2.580
900
800
700
600
500
400
300
200
100
0
-10
-8
-6
-4
-2
0
2
4
6
Z-coordinate of track intersection with beam (m)

Conclusion

- The TOF technique helps
  - Detector calibration
  - Background characterization
  - Information input for the simulation models
- Possibility to measure inclusive particle production
  - Protons
  - Neutrons
  - Pions and relativistic charged particles
- Option to use G0-type beam in a real experiment
  - May help with resolution, PID, background rejection