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Jefferson Laboratory Hall B

G1C Data Calibration and Cooking
Procedures, characteristics, information

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Contents

Chapter 1

Introduction

The G1C data was acquired in October-November, 1999. The tagged photon beam was incident on a hydrogen target and the final reactions products detected in CLAS. The run list created by shift workers during data acquisition can be seen at http://clasweb.jlab.org/rungroups/g1c/oct99.html.

Hall B raw data is acquired in units called runs. During data acquisition, every run is split into files of 2GB size; in g1c data sets there were about 10 files in each run. One run is expected to have uniform characteristics, because planned changes to experimental set-up were done in between runs. The information in the raw data files is grouped in banks, as described in CLAS Note 1993-002 [1]. By 'cooking' is denominated the processing of the raw information to identify and group quantities suitable as input to physics analysis. The most time-consuming part of this processing is the reconstruction of charged particles tracks in the drift chambers. Due to the long computing time (in the case of the G1C data set processing one file takes about 8 CPU hours), the cooking has to be done by one 'cooking chef' for each data period, when the group agrees that subsystems calibration has achieved desired quality.

The cooking process model is presented in CLAS Note 1999-016 [2]. The present document aims to describe the steps and characteristics of G1C data set calibration and cooking as a follow-up of the above mentioned note, with the changes in the computing and software development conditions in which this processing was done. Cooking and monitoring is done on individual file basis. The G1C cooking web address is

http://clasweb.jlab.org/rungroups/g1c/g1c_gata.html.

Chapter 2

Calibrations

2.1 Photon Data Calibration Order

The ideal calibration order is presented in Table 2.1. Calibration has to be done at every beam energy change or when the monitoring indicates drifts. A general feature of all calibrations is the need to align their timing with CLAS timing - the detector as entity. Data acquisition is common start, meaning once a trigger was detected time counters start measuring the time until a signal is detected and then they stop and record the data. It is important when processing the raw detector information to account for all time offsets or propagation times in order to be able to rebuild the physics event. The trajectory in drift chambers can be rebuild in a first stage without information from other detectors in a hit-based (HB) track. Going from the rough HB track to a complete time-based (TB) track, requires timing alignment of the drift chamber within CLAS detector. The TOF scintillator is the pivot for the time-of-flight measurement. However a second time reference is necessary to calculate the speed of a particle detected in CLAS. In the case of electron runs, the electron trajectory correlated with the beam RF signal are the second time reference. In the case of photon runs (as G1C) the start-counter detector with the beam RF signal provides the second time reference. The G1C trigger required then hits detected in the tagger counters, start-counter and TOF scintillators.

Device	**Purpose**	**Particularities**
Tagger	Align T-counter and E-counter timing against the RF beam signal.	Any physics data can be used for tagger calibration.
Time-of-flight (TOF) Scintillators	Optimize the time and hit position reconstruction, align the 48 paddle timing with each other and within the CLAS detection timing scheme.	Prior starting TOF calibration a reasonable DC calibration is necessary. In TOF calibration, dedicated data as well as physics data are used at different stages.
Drift Chambers (DC)	Optimize charged tracks reconstruction	Prior starting TOF calibration a reasonable TOF calibration is necessary. Any physics data can be used for DC calibration.
Electromagnetic Calorimeter (EC)	Optimize the time and energy reconstruction	EC time calibration uses comparison with the TOF time and therefore has to be done after TOF calibration is complete. Any physics data can be used for EC time calibration. The EC energy calibration is done by optimizing the reconstructed the neutral pion mass out of two EC detected photons.
Large area calorimeter (LAC)	Optimize the time and energy reconstruction.	LAC is physically located at bigger deflection angles than the EC. It is essentially same type of detector and uses same techniques for calibration as EC.
Start-Counter (ST) Calibration	Align the ST paddles reconstructed within the CLAS detection timing.	Initially during G1A run period the start-counter was hardware aligned. For G1C we made small adjustments by comparing the pion timing with the TOF timing.

Table 2.1: Ideal calibrations order for the photon data.

2.2 Tagger Calibration

There are 4 sets of constants used in the tagger reconstruction software as presented in Table 2.2.

In August 2000 we started with the belief that the tagger calibration was done. The tagger calibration software wasn't working anymore and overall the tagger times seemed aligned. In the summer of 2001 Ji Li (RPI) rewrote and enhanced the tagger calibration software. Using the new tool we enhanced the g1c tagger calibration too. In the context of using *gflux* photon flux calculation method, requirements for accurate counter-by-counter tagger calibration were higher. The 2.4 GeV and 3.1 GeV data sets were already cooked at that time. The re-cooking of these data is not necessary as long as during the analysis the tagger results bank (TAGR) and physics banks that use tagger results (such as PART bank, and the respective SEB banks) are rebuilt. However we re-run the filters because event selection was directly impacted for few counters by the change in the calibration.

Name	Map	System(item)	No. items
TDC slopes	TAG_CALIB	tag_t/slope_left(right)	2*61
E Pedestal position	TAG_CALIB	tag_e/dt	384
T Pedestal position	TAG_CALIB	tag_t/dt_left(right)	2*61
RF offsets	RF_OFFSETS	F(1-4)/low/high/p(1-4)	4*6
Ci Tagger-RF	TAG_CALIB	tag_t/ci	121
Time alignment	TAG_CALIB	tag2tof/value	1

Table 2.2: Values established in the tagger calibration procedure.

For each cooked file we have checked from the photon monitor output histograms as shown in Figure 2.1 and 2.2.

2.3 Time-of-flight Calibration

During the time-of-flight (TOF) scintillator paddles calibration work we used the CLAS Note 1999-011 [4]. In g1c data set TOF calibration the coupled-paddle correction was implemented and done for the first time by Jim Ball (ASU) and Eugene Pasyuk (ASU). Contribution to improvement of the guidelines for TOF calibration by g1c team were included in the revised version of CLAS Note 1999-011[4].

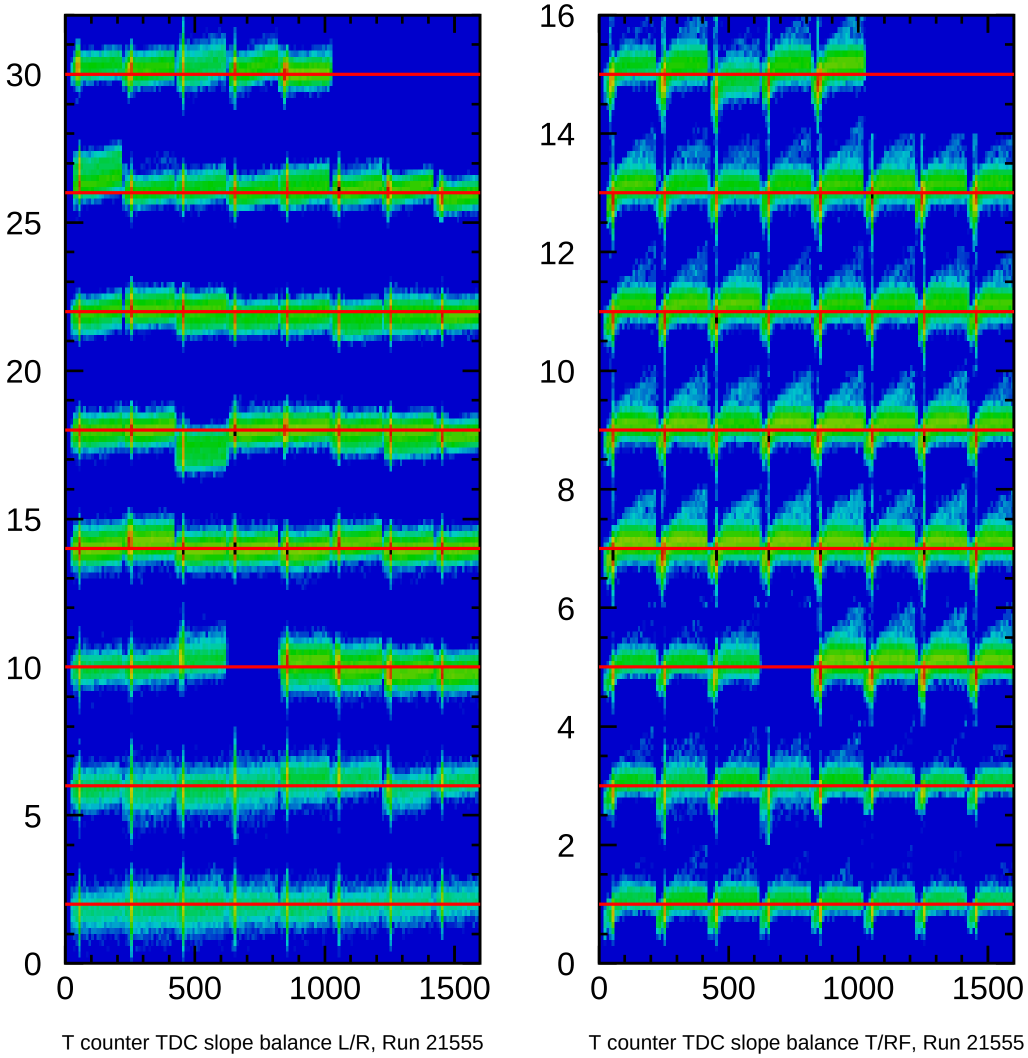
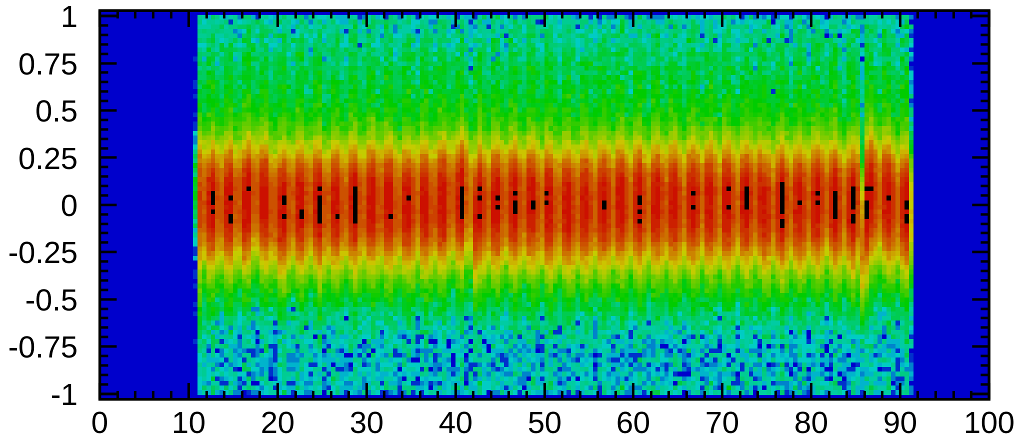
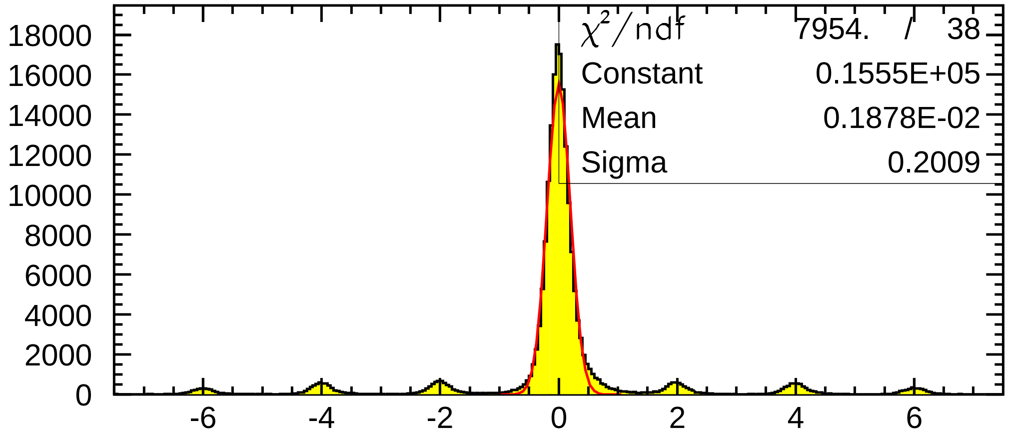


Figure 2.1: Ideally all counters should be aligned with the RF (on the red line) independent of the geometrical position of the hit in the counter.



T tag - RF time vs good RF, Run 21555



tagger time - pion vertex time, Run 21555

Figure 2.2: The upper plot shows the RF calibration quality; in the lower plot can easily be seen the accidental coincidences from the neighbor beam bunches at 2ns intervals.

For each cooked file we monitored the TOF quality. On this purpose besides visual check of the π^+ timing in each sector (Figure 2.3), we have compared to a reference the hits fraction in each paddle (Figure 2.4).

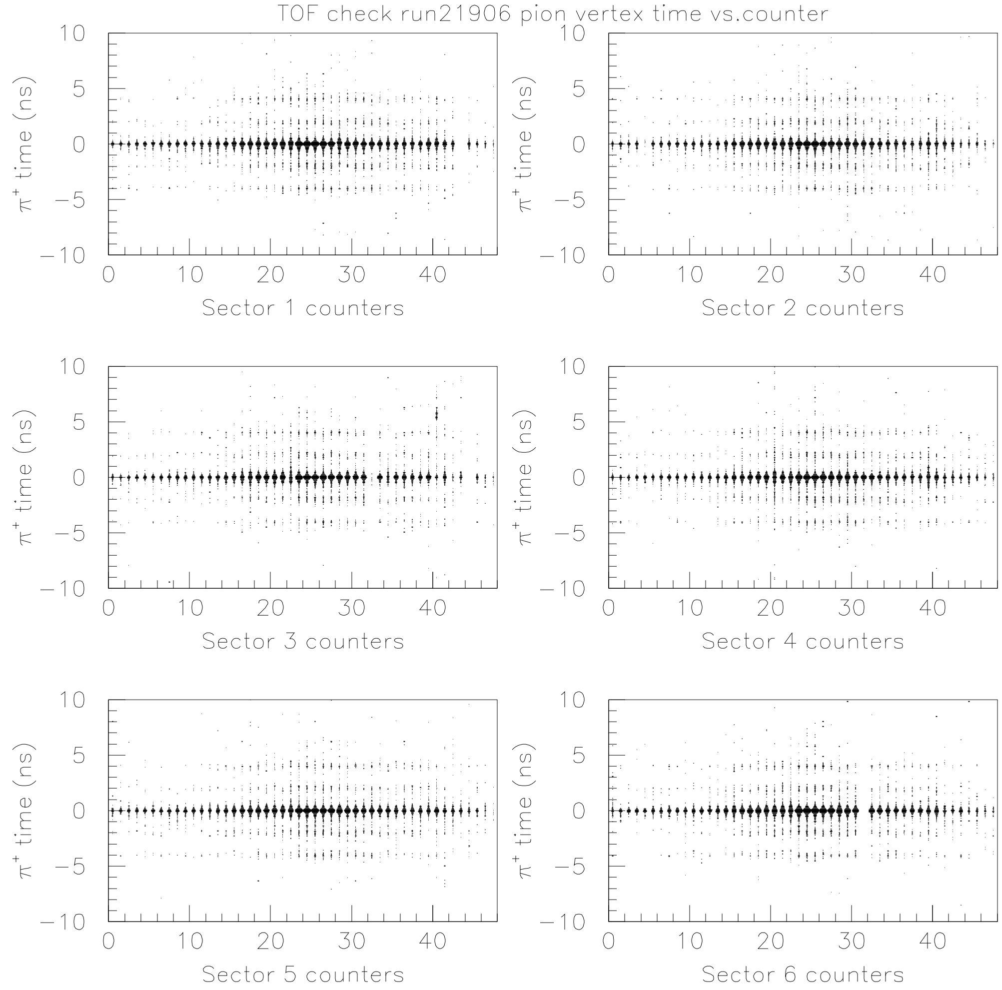


Figure 2.3: The TOF check in the 6 CLAS sectors.

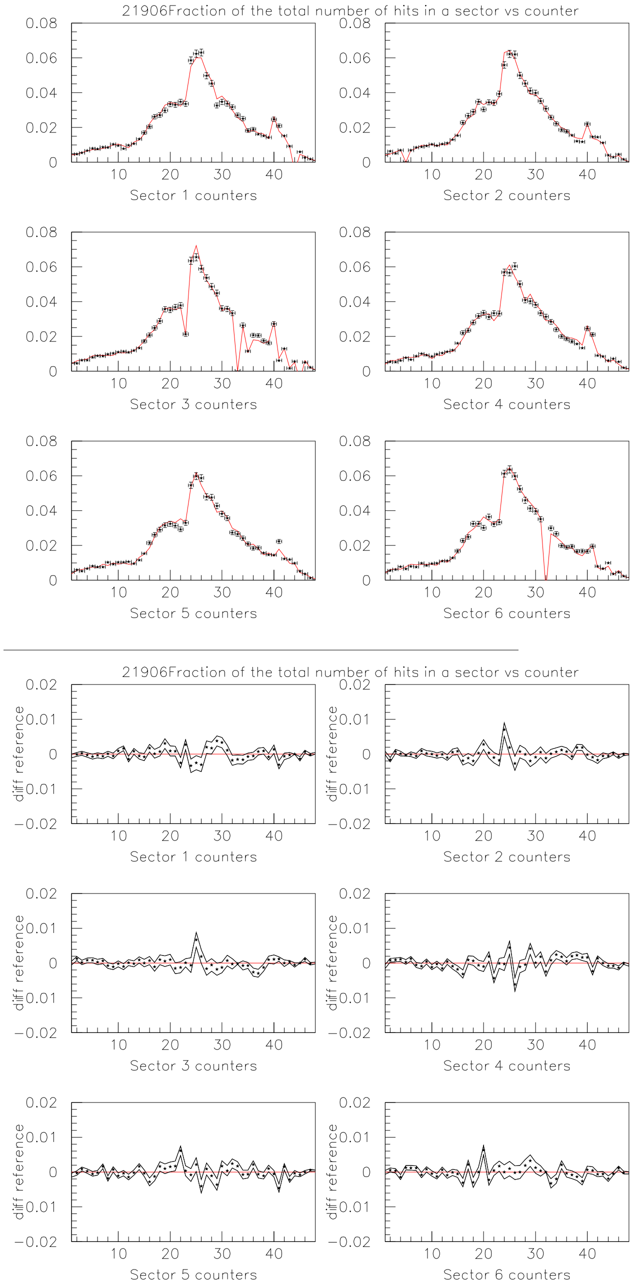


Figure 2.4: The fraction of good hits in each counter. The red line is the the fraction determined for a reference file. This fraction is determined by geometry of the counters, detection efficiency and $\gamma + p$ total cross-section angular distribution.

2.4 Drift Chamber Calibration

Drift chamber calibration converged reasonably most of the time although it is a very tedious procedure involving multiple time-consuming re-cooking. Both software and strategies were continuously improved in the period in which g1c data set was calibrated and then cooked (see CLAS Note 1999-018[5]). The calibration stability was monitored continuously in parallel with the cooking. For each wire we have a time measurement. The distance of closest approach (DOCA) of the charged particle to the wire is calculated using a drift velocity function. The clustered wires hits are then fitted with a track and based on this another fitted DOCA is estimate. In case of a correct calibration the relation between calculated DOCA and fitted DOCA is illustrated in Figure 2.5.

The quantity that we usually refer to when checking the DC tracks reconstruction is the difference between calculated DOCA and fitted DOCA called residuals. The residuals histogram is fitted with a sum of two Gaussians; the mid position is expected to be at 0, the width of one Gaussian should be around 300 μm and the other 800 μm. A typical file sheet for checking DC calibration is presented in Figure 2.6. Using a single optimized set of parameters we can see that during g1c 2.9 GeV data set the residual width and position remained reasonably stable (figures 2.7,2.8).Additional figures can be seen in the appendix.

2.5 Start-Counter Calibration

Without having a standard procedure for start counter timing calibration, we have changed offsets (see Table 2.5)s such as aligning the start counter paddles with TOF and tagger as shown in Figure 2.9.

Name	Map	Location (system/item)
Individual paddles offsets	ST_CALIB	delta_T(value) 6
Offset vs CLAS	ST_CALIB	st2tof(value) 1

Table 2.3: Values established in the start counter calibration.

The good timing calibration of tagger, start counter, and TOF scintillators , together with good drift chambers calibration contribute to a good particle ID and reconstruction as shown in Figure 2.10.

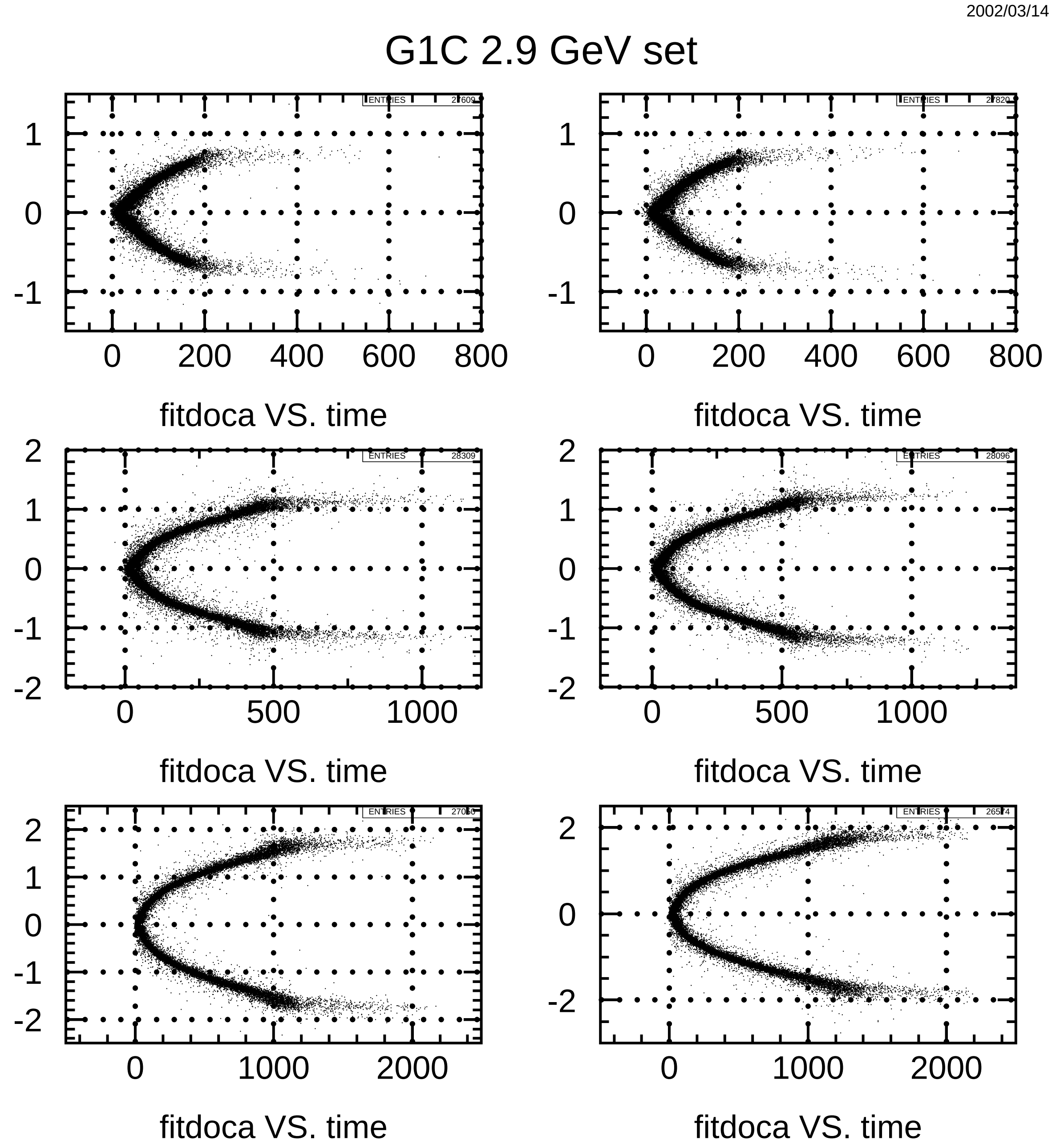
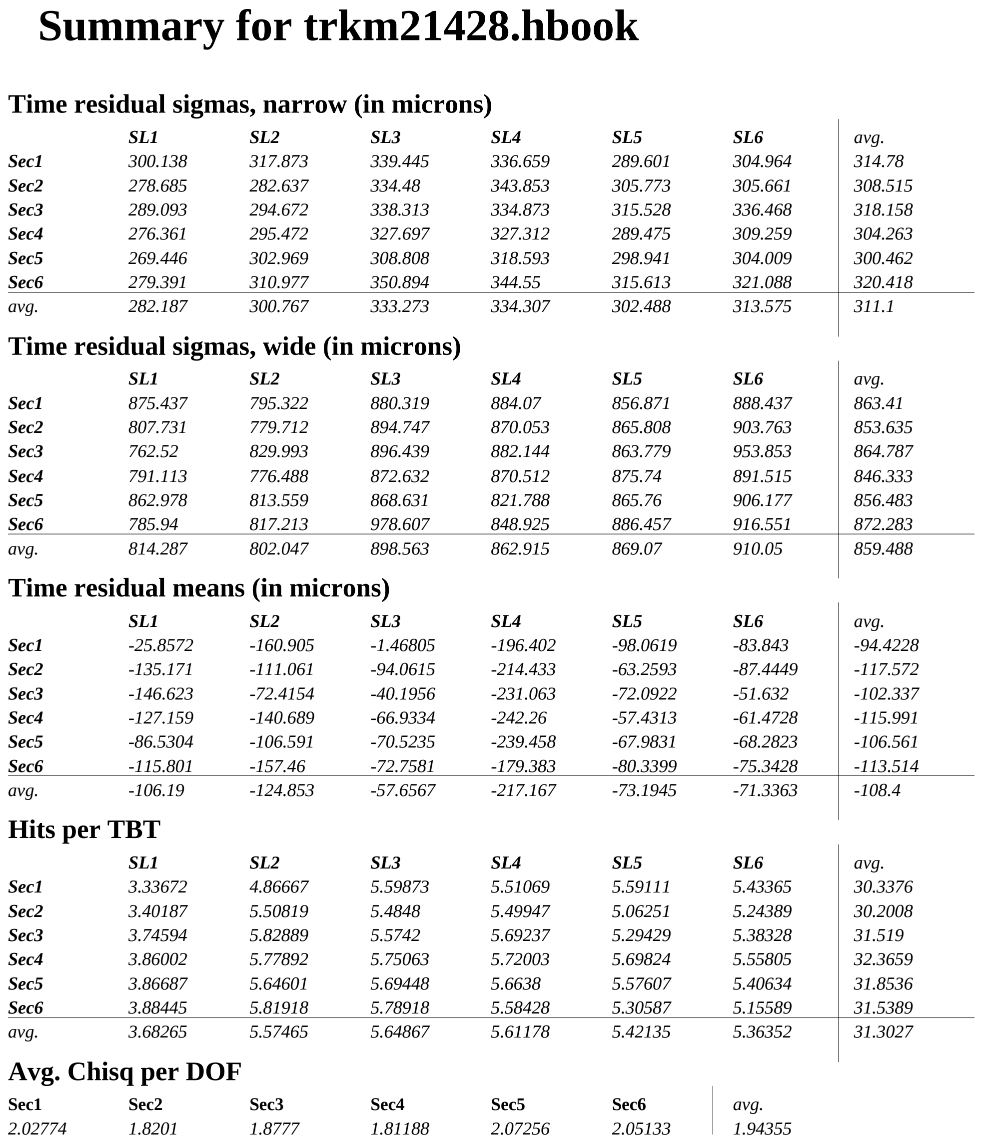


Figure 2.5: The fitted distance of closest approach (DOCA) versus time.



Summary for trkm21428.hbook

Time residual sigmas, narrow (in microns)

	SL1	**SL2**	**SL3**	**SL4**	**SL5**	**SL6**	*avg.*
Sec1	*300.138*	*317.873*	*339.445*	*336.659*	*289.601*	*304.964*	*314.78*
Sec2	*278.685*	*282.637*	*334.48*	*343.853*	*305.773*	*305.661*	*308.515*
Sec3	*289.093*	*294.672*	*338.313*	*334.873*	*315.528*	*336.468*	*318.158*
Sec4	*276.361*	*295.472*	*327.697*	*327.312*	*289.475*	*309.259*	*304.263*
Sec5	*269.446*	*302.969*	*308.808*	*318.593*	*298.941*	*304.009*	*300.462*
Sec6	*279.391*	*310.977*	*350.894*	*344.55*	*315.613*	*321.088*	*320.418*
avg.	*282.187*	*300.767*	*333.273*	*334.307*	*302.488*	*313.575*	*311.1*

Time residual sigmas, wide (in microns)

	SL1	**SL2**	**SL3**	**SL4**	**SL5**	**SL6**	*avg.*
Sec1	*875.437*	*795.322*	*880.319*	*884.07*	*856.871*	*888.437*	*863.41*
Sec2	*807.731*	*779.712*	*894.747*	*870.053*	*865.808*	*903.763*	*853.635*
Sec3	*762.52*	*829.993*	*896.439*	*882.144*	*863.779*	*953.853*	*864.787*
Sec4	*791.113*	*776.488*	*872.632*	*870.512*	*875.74*	*891.515*	*846.333*
Sec5	*862.978*	*813.559*	*868.631*	*821.788*	*865.76*	*906.177*	*856.483*
Sec6	*785.94*	*817.213*	*978.607*	*848.925*	*886.457*	*916.551*	*872.283*
avg.	*814.287*	*802.047*	*898.563*	*862.915*	*869.07*	*910.05*	*859.488*

Time residual means (in microns)

	SL1	**SL2**	**SL3**	**SL4**	**SL5**	**SL6**	*avg.*
Sec1	*-25.8572*	*-160.905*	*-1.46805*	*-196.402*	*-98.0619*	*-83.843*	*-94.4228*
Sec2	*-135.171*	*-111.061*	*-94.0615*	*-214.433*	*-63.2593*	*-87.4449*	*-117.572*
Sec3	*-146.623*	*-72.4154*	*-40.1956*	*-231.063*	*-72.0922*	*-51.632*	*-102.337*
Sec4	*-127.159*	*-140.689*	*-66.9334*	*-242.26*	*-57.4313*	*-61.4728*	*-115.991*
Sec5	*-86.5304*	*-106.591*	*-70.5235*	*-239.458*	*-67.9831*	*-68.2823*	*-106.561*
Sec6	*-115.801*	*-157.46*	*-72.7581*	*-179.383*	*-80.3399*	*-75.3428*	*-113.514*
avg.	*-106.19*	*-124.853*	*-57.6567*	*-217.167*	*-73.1945*	*-71.3363*	*-108.4*

Hits per TBT

	SL1	**SL2**	**SL3**	**SL4**	**SL5**	**SL6**	*avg.*
Sec1	*3.33672*	*4.86667*	*5.59873*	*5.51069*	*5.59111*	*5.43365*	*30.3376*
Sec2	*3.40187*	*5.50819*	*5.4848*	*5.49947*	*5.06251*	*5.24389*	*30.2008*
Sec3	*3.74594*	*5.82889*	*5.5742*	*5.69237*	*5.29429*	*5.38328*	*31.519*
Sec4	*3.86002*	*5.77892*	*5.75063*	*5.72003*	*5.69824*	*5.55805*	*32.3659*
Sec5	*3.86687*	*5.64601*	*5.69448*	*5.6638*	*5.57607*	*5.40634*	*31.8536*
Sec6	*3.88445*	*5.81918*	*5.78918*	*5.58428*	*5.30587*	*5.15589*	*31.5389*
avg.	*3.68265*	*5.57465*	*5.64867*	*5.61178*	*5.42135*	*5.36352*	*31.3027*

Avg. Chisq per DOF

Sec1	**Sec2**	**Sec3**	**Sec4**	**Sec5**	**Sec6**	*avg.*
2.02774	*1.8201*	*1.8777*	*1.81188*	*2.07256*	*2.05133*	*1.94355*

Figure 2.6: This results are generated and checked for each cooked file using histograms from trk_mon program output.

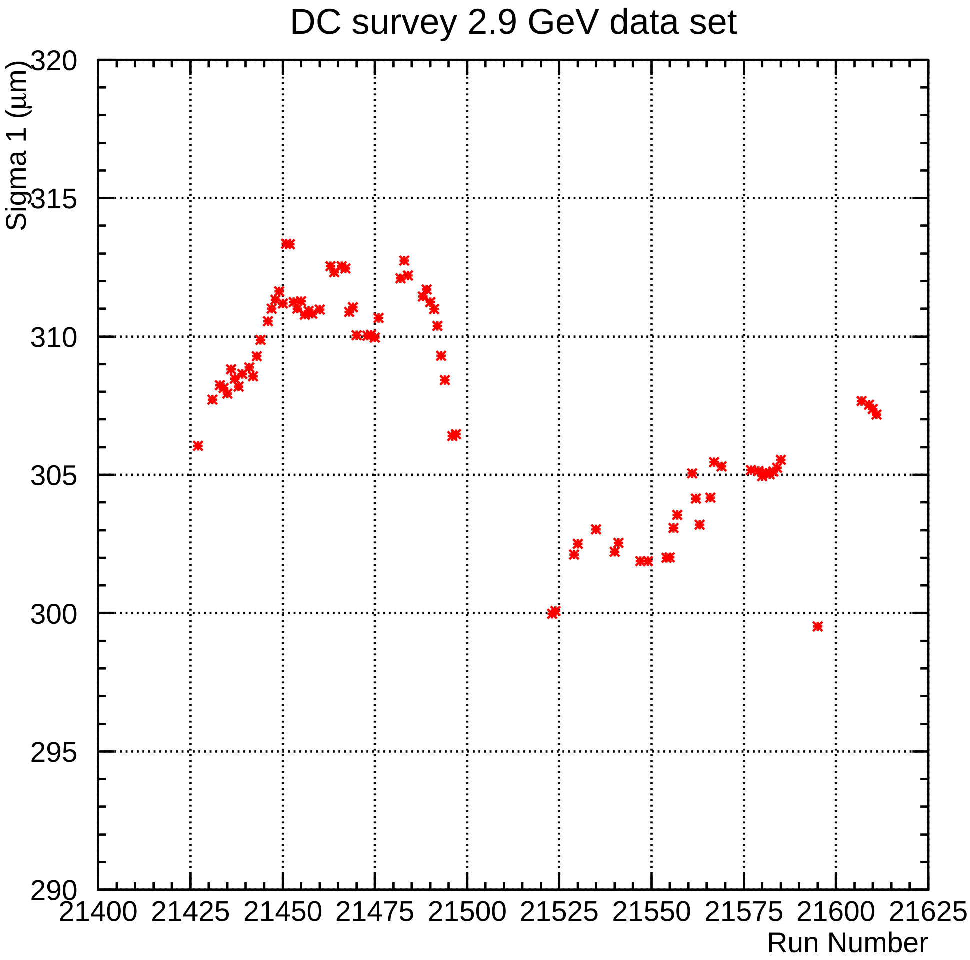


Figure 2.7: The average narrow sigma during 2.9 GeV data set. There are continuous drifts due to humidity and temperature variations. Major jumps were associated with to change of gas mixture - a new bottle with higher pressure for instance.

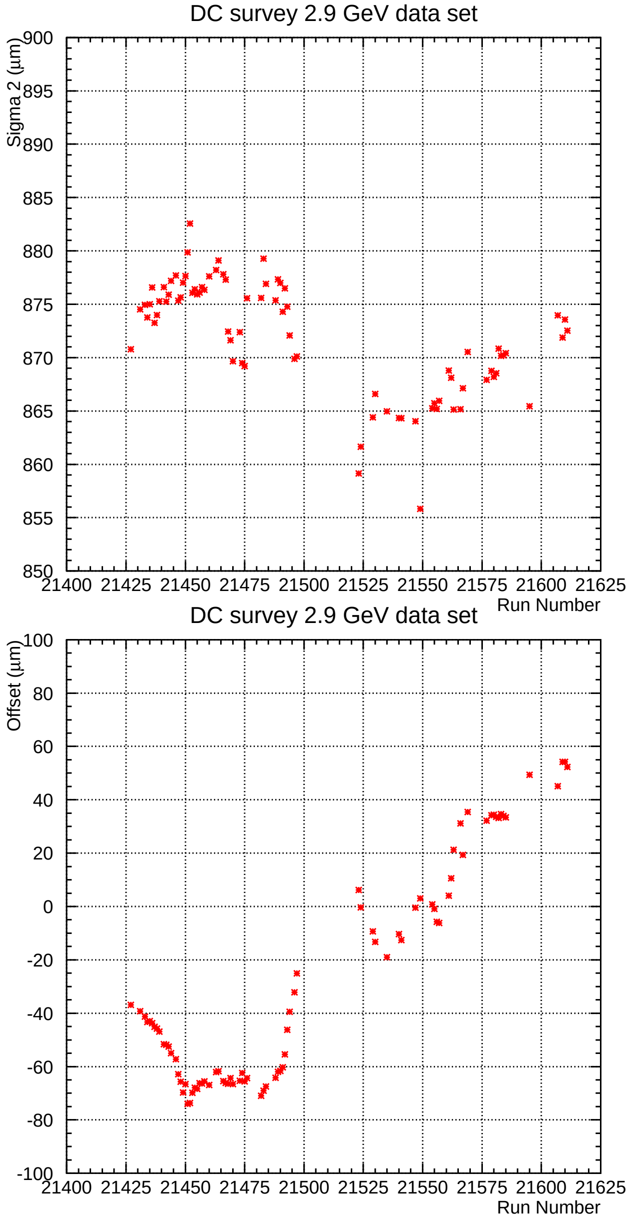


Figure 2.8: Stability of average parameters wide sigma and Gaussians mid-position in g1c 2.9 GeV data DC calibration.

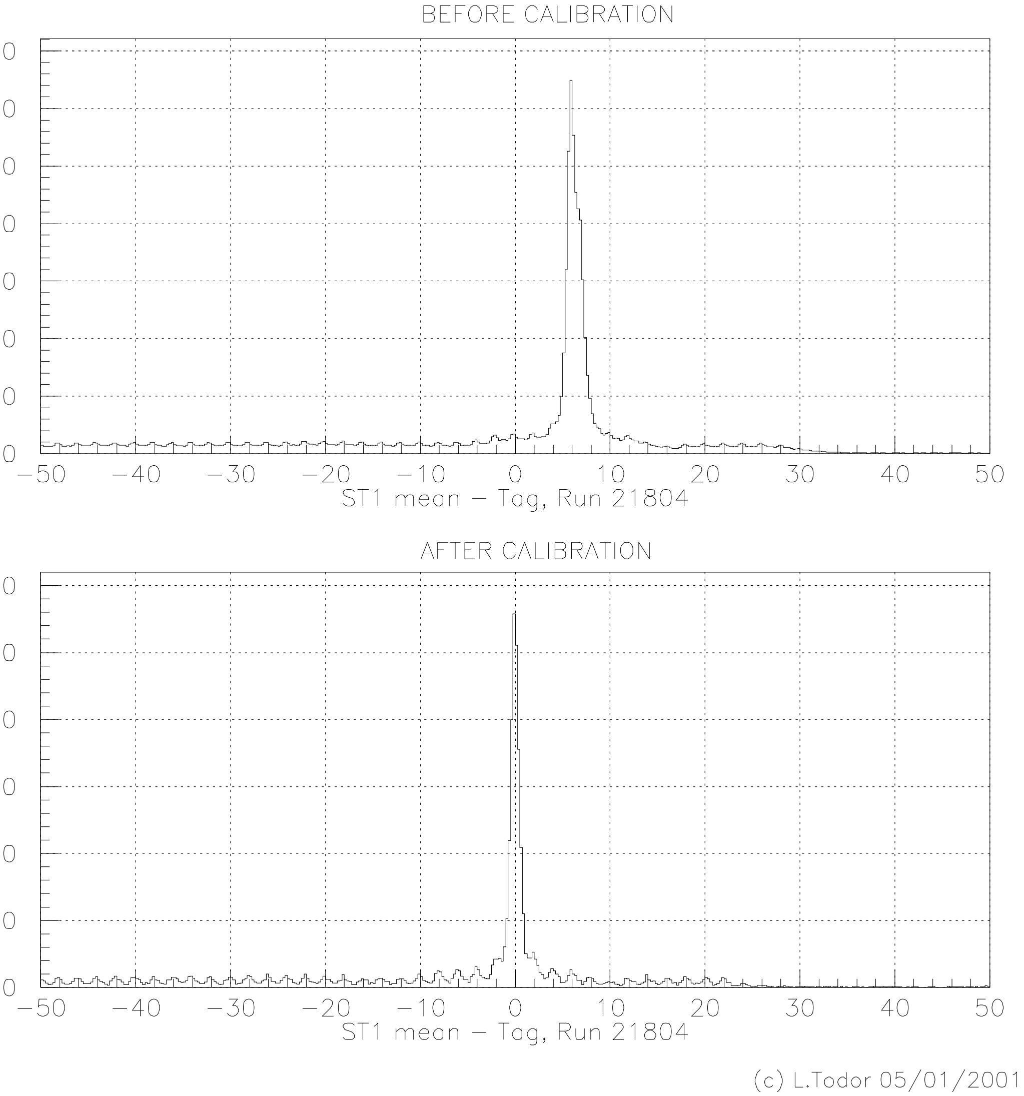


Figure 2.9: Start counter timing alignment.

2.6 Electromagnetic Calorimeter Calibration

The forward electromagnetic calibration has two aspects: timing calibration and energy calibration. Timing calibration is done using the TOF as reference. The quality of this calibration in illustrated in Figure 2.11.

2.7 Large Area Calorimeter Calibration

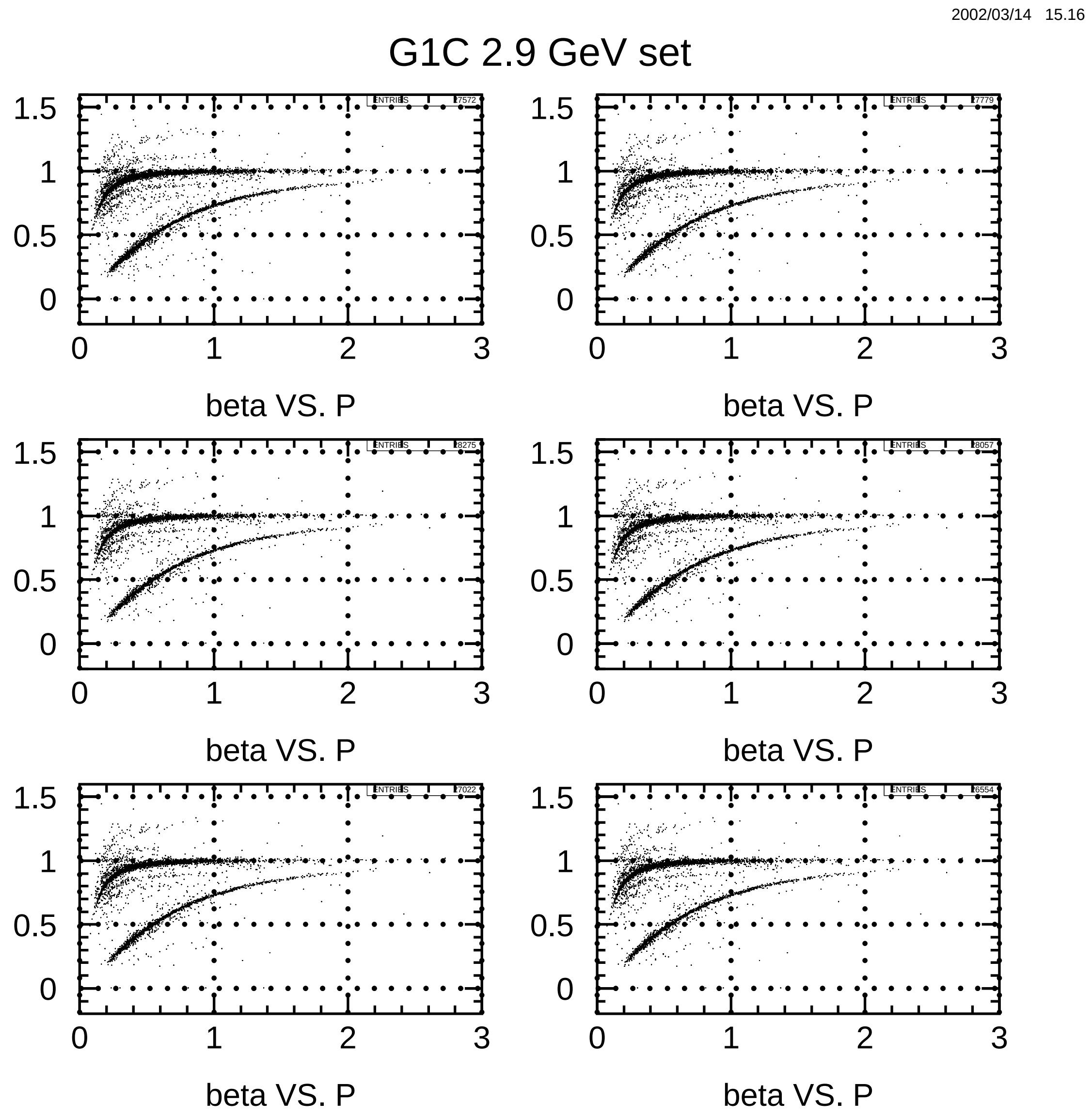


Figure 2.10: Typical β versus momentum spectra obtained in g1c from CLAS information.

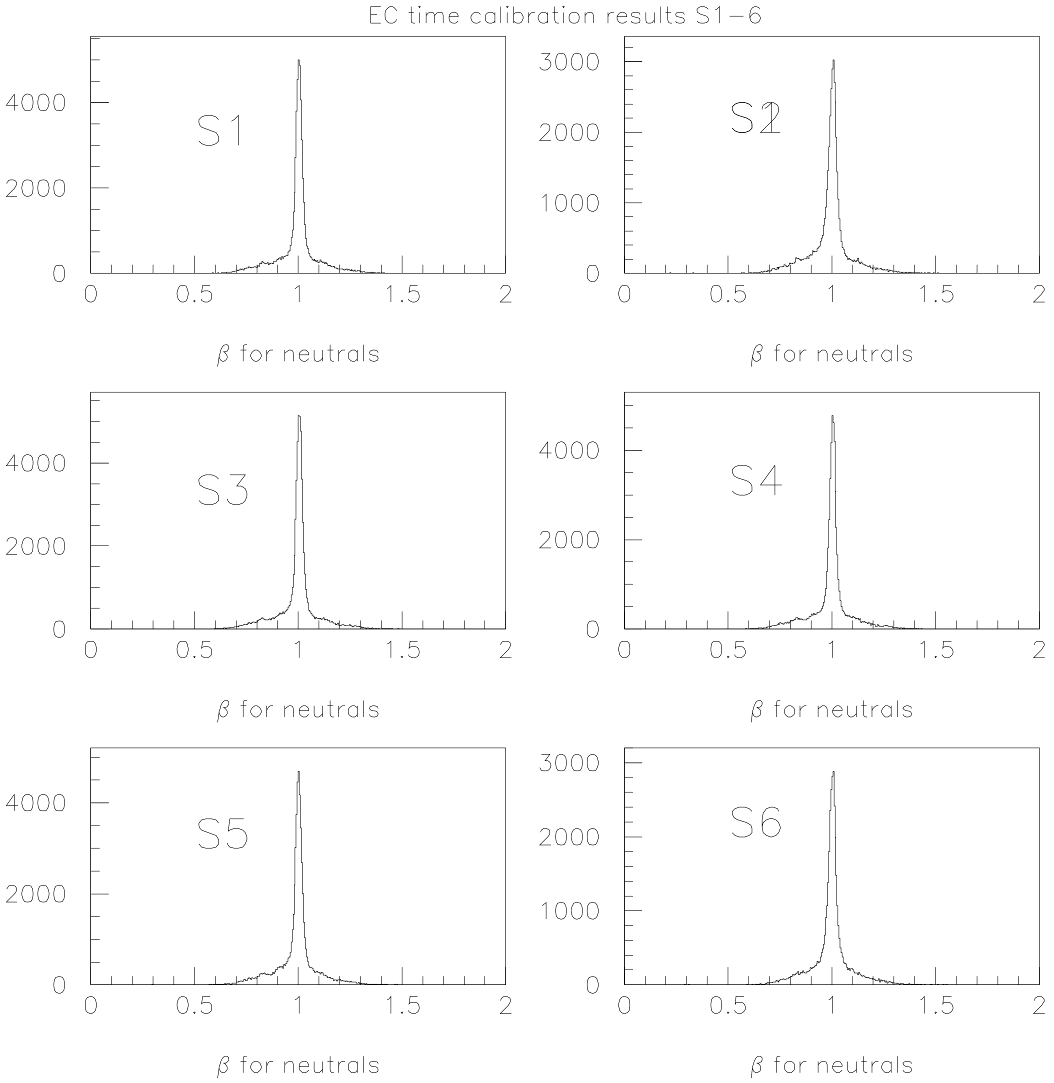


Figure 2.11: EC timing calibration ensure that the neutral particles (mostly photons) that are detected only in EC have correctly defined value for β.

Chapter 3

Technical Details of Cooking

3.1 Software Versions and a1c Command Line

In the G1C data set we had three electron energy periods: 3.1 GeV, 2.9 GeV and 2.4 GeV. The bremsstrahlung photon energies detected by the tagger are between 20% and 95% of the incident electrons energy. First we have calibrated and cooked the 2.4 GeV data set. Some enhancements in the cooking process, such as knocking out the dead wires, were implemented and used only for the later cooking. The specific information is detailed for each procedure and data set.

Data set	**Calibration**	**Cooking**	**Gflux**
2.4: 21760-22000	08/2000-01/2001	02/2001-03/2001	01/2002
3.1: 20900-21360	04/2001-07/2001	08/2001-09/2001	01/2002
2.9: 21400-21600	10/2001-12/2001	03/2001-04/2001	04/2002

During calibration sets of constants were determined for each detector system, and correlated to put in value CLAS as a tuned experimental apparatus. Historically, these numbers were organized in files called Maps. The g1c data cooking and calibration happened parallel with the development of another mode to archive these constants in a Calibration database (see CLAS Note 01-003 [3]). There is a one-to-one relation between maps and the Calibration database. Throughout the cooking process we chose to use Maps, however same information was transferred in June 2002 into the official Calibration database. Reference maps can be copied from JLAB-CUE

`/work/clas/production/g1c/PARMS/Maps.`

For track pattern recognition purpose there is a typical tracks (roads) file used in tracking reconstruction. The roads file used in G1C cooking was prlink_50_00.bos. These typical tracks are scaled and evaluated by using an additional magnetic field map. The magnetic field map used in G1C cooking was read from bgrid_T67to33.fpk. The roads file and magnetic field map file are in

`/work/clas/production/g1c/PARMS.`

The cooking command line used for 2.4GeV data set was:

```
a1c -N.pass1 -yclas_0[run].A[file].sync -T1 -st1 -O -D0x103d
-cm0 -ct1921.37 -P0x1fff -i clas_0[run].A[file]
```

The cooking command line used for 3.1GeV 2.9GeV data sets was:

```
a1c -N.pass1 -yclas_0[run].A[file].sync -T1 -st1 -O -D0x103d
-cm0 -P0xffff -i  clas_0[run].A[file]
```

The typical name and location of G1c raw files is
/mss/clas/g1c/data/clas_0(run_number).A(file_number).
The tape directory stub for the cooked files is
/mss/clas/g1c/production/pass1/cooked.
The typical name of a cooked file is
run(run_number)_.pass1.a(file_number).(ext).

The extension is used for the case when the cooked output is bigger than 2GB and has to be split in multiple files (.00, .01, etc).

Before starting processing (cooking) each runs group (according to electron beam energy), we fixed by tagging the software version:

- for **2.4** data set the tag is *g1c-2445* and is based on release-2-4 of CLAS software;
- for **3.1** data set the tag is *g1c-3115* and is based on release-3-4 of CLAS software;
- for **2.9** data set the tag is *g2a-recook* and is based on release-3-6 of CLAS software.

3.2 Cooking Scripts and Monitoring

We adapted the cooking scripts from packages/scripts/cooking_scripts area. The changes in the scientific computing environment made cooking faster and the scripts had to be adjusted accordingly. The ability to specify directly the raw file input by its tape location instead of waiting for the file transfer to the cache disks, lifted the necessity to use cronjob type of scripts when submitting jobs. When the input of a job submitted for processing to the LSF farm is a stub on the tape, the LSF software generates the transfer of the file from the tape while keeping the processing job pending. Once the file is retrieved from the tape on the cache disks serving the farm, the job enters the normal queue.

For each file, the following monitors were executed as part of cooking job: photon_mon, pid_mon, trk_mon,sc_mon, and the sync utility. The SEB ntuples were created using nt10maker. For part of the data ROOT files were also generated. The monitor hbooks can be found on the semipermanent work disks:

/work/clas/production/g1c

/work/clas/production2/g1c.

The most recent SEB ntuples are on tape with the stub directory:

/mss/clas/g1c/production/pass1/v2/data/Ntuples.

The root files are on tape with the stub directory:

/mss/clas/g1c/production/pass1/v2/data/root.

3.3 Cooked File Bank Content Adjustment

The cooking output should keep as much as possible the original raw information for each event. However while cooking the 2.4 GeV data set we noticed that was awkward to manipulate the cooked output that was bigger than the input and bigger than 2 GB, resulting in 2 cooked files for one raw data file. In spite of increasing better technical means, this split output is an additional complication. We reviewed the output banks for the 3.1 and 2.9 GeV G1C data cooking. To evaluate what fraction (percentage) of the file size each bank represents, we used the utility program $fsize$. We decided to remove following banks from the 3.1 and 2.9 GeV cooked data :

Banks name	**Size**	**Representing**	**Comment**
HLS,HLS+	2.34%	helicity scaler banks	not functional in g1c
SC1,SCR,SCRC	8.31%	TOF intermediate banks	can be rebuild with little CPU time expense
HBID	5.11%	Hit-based ID bank	information exists in the TBID bank
TAGI	2.31%	Intermediate tagger bank	the raw (TAGT, TAGE) banks and TAGR result bank presence make TAGI unnecessary
ST1	1.03%	Start counter intermediate results bank	easy to rebuild
STR	1.48%	Start counter results bank	easy to rebuild
ECPI	1.31%	Calorimeter pixels for DISPLAY only	not necessary
ECHB	5.51%	Forward calorimeter result bank	easy to rebuild
ECPC	1.01%	EC Particle Calibration bank	not necessary
CC01	0.05%	Cerenkov Counter hits bank	Cerenkov not used in photon run
CCRC	0.16%	Cerenkov reconstruction bank	Cerenkov not used in photon run
CCPB	0.03%	Cerenkov reconstruction bank (SEB)	Cerenkov not used in photon run

There are two additional banks in the 3.1 and 2.9 GeV cooked data:

Bank name	**Size**	**Representing**
MVRT	1.78%	vertex result bank
RGLK	0.92%	single region hits bank

Limiting the number of output banks decreased the size of the cooked data to about 1.7 GB, lower then the 2GB threshold that requires storing data in multiple files. We kept the raw information banks in the output to allow adjustments or calibration improvements to be performed directly during analysis of the cooked files without having to re-cook.

3.4 Dead-wires Removal at Cooking

After finishing cooking the 2.4 GeV runs we tried to compile a list of dead-wires to be used in simulation. The utility program *pdu* was run for this purpose at cooking phase, yielding outputs with lists of dead and hot wires. Trying to merge this information, we came to the conclusion that most wires were marked as dead at one moment or another. The less frequent hit wires in front and back of a wire plane were almost always declared dead. Ioana Niculescu, Gabriel Niculescu and Luminita Todor developed and used for the first time in g1c cooking a new procedure of identifying and removing before cooking the dead wires. The procedures automatically compares any wire in a layer and sector, with the same wire position in the other sectors. The hot wires are marked and not used when estimating specific wire-layer means. The automatic generated list was checked by analyzing each layer diagram. The purpose of the exercise was besides establishing a unique dead-wire list for each run period, to remove 'partially alive' wires. These wires were not providing useful track-hit information, but the electronic noise they picked was sometime compatible with neighboring cluster hits and were consequently included (see Figure 3.1).

It seemed correct to remove same wires at the time of cooking as during simulation. Therefore we implemented in a1c the option to remove dead-wires before DC track building. For the 3.1 GeV and 2.9 GeV data sets the list of dead-wires was compiled and dead-wires were removed. The information is in map DC_STATUS.map; each sector is a subsystem with the only item status (integer) having 6912 (36x192) integer entries. If a wire doesn't exist at all it is marked -2; is the wire is dead 1; good wires are marked 0.

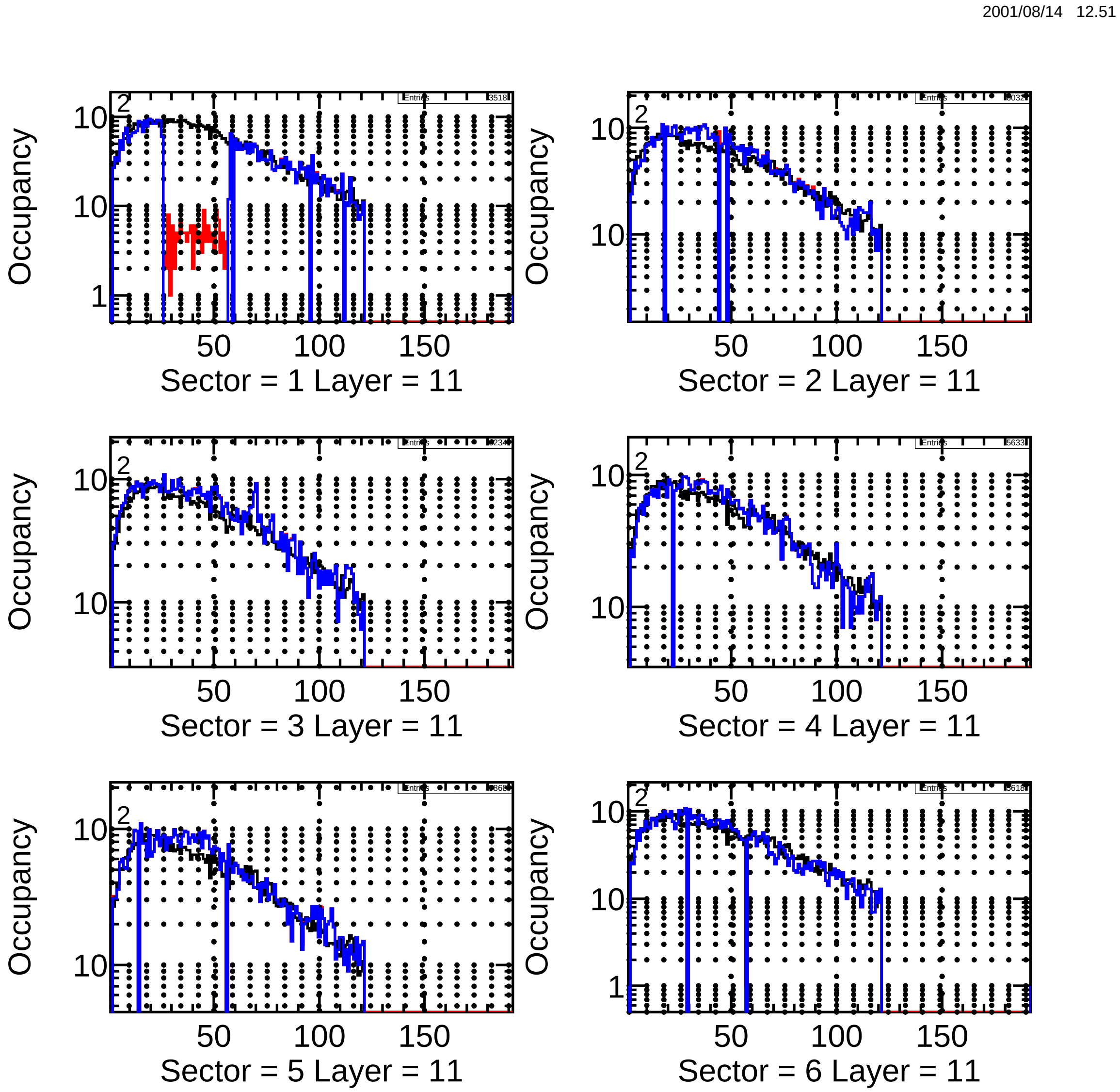


Figure 3.1: Dead-wire removal - proof of principle. The black line represents the calculated other sector average hits. The red line represents the actual sector occupancy without removing dead-wires. The blue line represents the sector occupancy after dead-wires removal. The blue line mostly overlap black and red lines. The change is most visible in sector 1.

Chapter 4

Filtering Cooked Files

4.1 G1_filter Software

A feature of CLAS data analysis is the analysis of different reactions is done using same data files. When the events analyzed by a group represent a small percentage (of order of 10%) of the events in the cooked file, filtering of the events of interest is considered. As different groups may focus on events selected according to different conditions, the *g1_filter* program allows the creation of different skimmed files in one pass over the events in the original cooked file.

The g1_filter command line is:

```
Usage: /work/clas/production2/g1c/bin/LinuxRH6/g1_filter [-o<prefix>]
[-c#] [-R[#]] [-n#] [-i#] [-h] file
```

The options are:

```
-o<prefix> Output filters to <prefix>.<filter>
-c#  Create only some filter files
 As of April 23 the following filter files can be created:
      1 : 0x0001 : 2Pos
      2 : 0x0002 : Eta
      4 : 0x0004 : K
      8 : 0x0008 : KPE
     16 : 0x0010 : Kmiss
     32 : 0x0020 : Ktof
     64 : 0x0040 : Nmiss
```

```
     128 : 0x0080 : PKpKm
     256 : 0x0100 : Phys
     512 : 0x0200 : Pimiss
    1024 : 0x0400 : K0PiP
    2048 : 0x0800 : K0PiN
    4096 : 0x1000 : Scaler
    8192 : 0x2000 : Pim
 Default all filter files will be created.
 For a subset of filters, put after -c the sum of the values.
 note that hex can also be used.
 (example to use filters:  K, PKpKm, Pimiss, K0PiN,
 you would use -c2692 or -c0x0a84)
-R[int#>0]  Rebuild PART and TBID banks
-n<#> read only <#> of events
-i<#> run in batch mode
-h  Print this message.
```

4.1.1 Present Implemented Filtering Functions

The filtering software design is based on use of EventType boolean test functions. All special events like scalers, EPICS events, etc. are saved in all skimmed files. The present implemented filters are:

1. *2Pos* The test function for this filter checks the HBTR bank for at least 2 particles with positive charge. Due to the big number of the cooked events satisfying this condition, only a subset of the banks was saved to limit the size of this filter file. The banks saved were: PART, TAGR, TBID, TBER, HBER, ECHB, ECPB, ST, STR, STPB, HBTR, HEAD, TAGE, TAGI, TAGT, SC, SCRC, CL01, TDPL, DC0, DHCL, HBID).

2. *Eta* The test function for this filter first requires the event to have at least one neutral and an identified proton. The charge evaluation is based on the content of the PART bank q field. The positive charged particle mass m is calculated using the particle momentum p from the PART bank and particle velocity (in speed of light units) β from TBID bank:

$$m = \frac{p}{\beta}\sqrt{1-\beta^2} \tag{4.1}$$

A particle is considered to be a proton if this calculated mass is bigger than 0.688 GeV and smaller then 1.188 GeV. The events are considered only if the incoming photon energy obtained from TAGR bank is bigger than 0.447 GeV. Finally the missing mass off the proton has to be bigger than 0.347 GeV.

3. *K* The events containing positive kaons candidates are selected using a mass squared cut between 0.09 and 0.49 GeV^2. The kaon mass is calculated using information from PART and TBID banks, the same way as explained for the proton mass in the *Eta* filter.

4. *KPE* The first condition used for event selection for this filter, is that the photon energy bigger than 0.85 GeV. The next condition is to have both a proton and a positive kaon in the event. For the positive particles (according to q field in PART bank) the mass is calculated as shown before from PART and TBID banks. If the mass squared is between 0.49 GeV^2 and 1.69 GeV^2 it is considered a detected proton. If the mass squared is between 0.09 GeV^2 and 0.49 GeV^2 it is considered a detected kaon.

5. *Kmiss* In this filter are kept events containing π^+, π^- and proton. The particles are identified using PART and TBID information as previously explained. Events with one π^- and a proton, but no π^+ detected, are kept if the invariant mass of $\pi^- + p$ matches the Λ mass cut (between 1.0 GeV and 1.2 GeV) and the missing mass corresponds to a kaon (between 0.3 GeV and 0.7 GeV).

6. *Ktof* This filter is described in CLAS-Note 01-2001[6].

7. *Nmiss* This filter selects events having one π^+ and the reconstructed missing mass off of the π^+ to match the neutron mass (between 0.7 GeV and 1.1 GeV).

8. *PKpKm* Only events for which incident photon is bigger the 1.5 GeV are considered for this filter. Using PART and TBID information K^+ and proton candidates are identified with mass squared cuts between 0.09 GeV^2 and 0.49 GeV^2, and between 0.49 GeV^2 and 1.69 GeV^2 respectively. An event is written to the skimmed file if the missing mass squared from $\gamma + p \rightarrow p + K^+ + X$ also matches the kaon mass cut.

9. *Phys* This filter is a complex filter that can run in different topologies. The EventTypePhys is actually just a wrapper for a multiple condition selection function physfilter; in the present set-up the *Phys* filter selects events with 3 charged particles.

10. *Pimiss* This filter aim to select $\gamma + p \rightarrow \pi^0 + p$ type of events. The proton is identified from the information in the TBID and PART banks. Using also the photon energy from TAGR bank the missing mass in the final state is calculated; if this missing mass is between 0.0001 GeV and 0.16 GeV, the event is considered a valid candidate for neutral pion-photoproduction.

11. *K0PiP* Using the information from the TBID and PART banks the events we want should have a proton, a π^+ and a π^-. Particles are identified based on their charge and mass squared that has to be between -0.01 GeV^2 and 0.16 GeV^2 for pions and between 0.49 GeV^2 and 1.44 GeV^2 for protons. If the missing mass squared is between 0.02 GeV^2 and 0.3 GeV^2 the events are written to the filtered file.

12. *K0PiN* Using the information from the TBID and PART banks, the events containing two π^+ and a π^- are considered. If the missing mass squared is then between 0.75 GeV^2 and 1.15 GeV^2, the events are written to the filtered file.

13. *Scaler* Some rate studies based on trigger events might be faster if the scaler events are filtered separately. This filter rejects all physics events, keeping only control and scaler events.

4.1.2 How to add a filter to g1_filter

There are two simple steps to take:

- create a new boolean filter function;
- add the new filter in the g1_filter.s wrapper source.

To add the new filter in the g1_filter, one has to do the following:

1. Add your function prototype to the list of prototypes:

```
int EventTypeNew();
```

2. Add an item in FilterNum before MAX_FILTER_f:

   ```
   enum FilterNum {Ktof_f,Kmiss_f,KPE_f,K0PiP_f,K0PiN_f,
   Pos2_f,Eta_f,PKpKm_f,Scaler_f,New_f,MAX_FILTER_f};
   ```

3. Add the function InitFilter:

   ```
     FilterList[New_f].func=EventTypeNew;
     sprintf(FilterList[New_f].name,"New");
   ```

4. Modify the Makefile to compile and link the source of the new filter;

5. Commit your changes to CVS and inform the group about the added filter and its selectivity.

4.2 Location of Output Filters and Ntuples of the G1C Cooked Data

The best version of filtered files (as September 2002) are located on tape in the directory: /mss/clas/g1c/production/pass1/v2/skims. The filtered files are: Eta, K0PiN, K0PiP, KPE, Ktof, PKpKm. The 2Pos filter was executed only once because for its event selection criteria (2 charged particles), re-calibration of the tagger would not have changed selected events. The 2Pos filtered files are in the directory /mss/clas/g1c/production/pass1/v2/skims/2Pos.

Chapter 5

File Tailoring and Normalization

Before cooking the synchronization of event building during data acquisition is checked using the *sync* utility. Blocks of 1000 events are skipped from cooking if synchronization problems occurred.

For g1c data a new method of calculating the photon flux was used. In this new method out-of-time events rate allows the monitoring of changes in the flux of electrons associated with the production of tagged photons. Each time a photon-generated event is detected in CLAS, a TDC window, 200 ns long, is opened for each of the 64 timing detectors in the tagger . Only the correct detector will record the correct time, but the other detectors will see random events, out of time with the true signal as shown in Figure 5.1. This random rate is proportional to the total photon rate in the detector. Because of the high rate in the detectors, this has allowed the measurement of small rate changes (less than 1%) in time periods of less than 5 minutes.

To achieve desired precision when using this method, we remove from the photon flux evaluation the scaler intervals that correspond to beam trips. This means that when using the photon flux calculated with the *gflux* utility, an after-facto tailoring has to be performed during analysis.

A new subsystem to be used with *gflux*was added to NORM.map.

```
Subsystem: gflux,       nitems: 11
   Item: begin_t_window,   length: 1,      type: float
   Item: end_t_window,     length: 1,      type: float
   Item: ngamma_25mev,     length: 100,    type: float
```

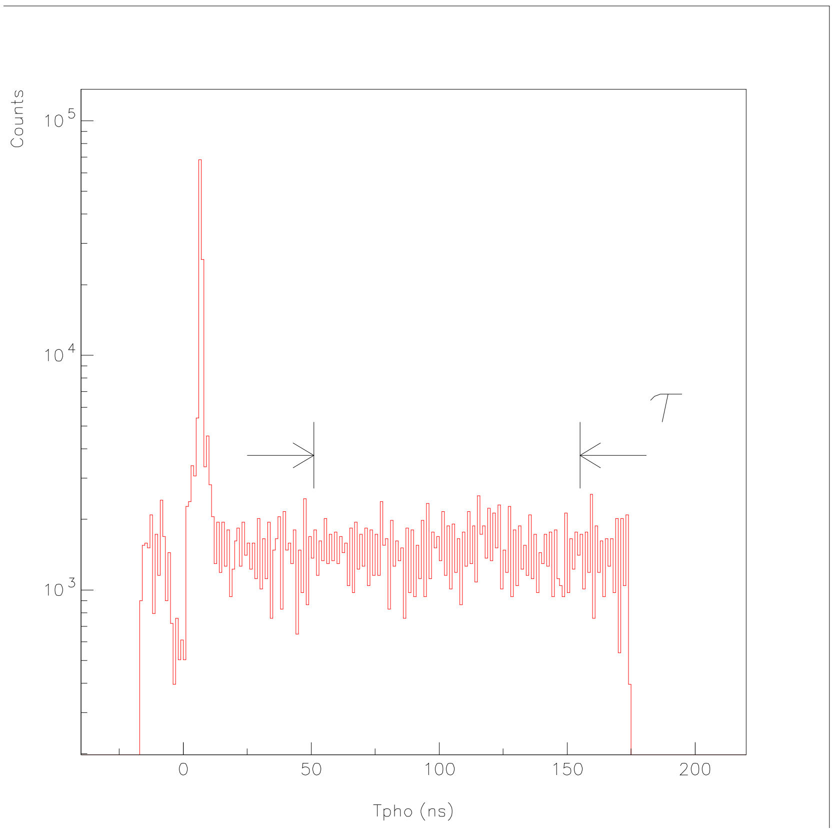


Figure 5.1: Normalization with gflux, the use of out-of-time accidentals.

```
Item: ngamma_25mev_u,   length: 100,    type: float
Item: ngamma_eb_u,      length: 767,    type: float
Item: ngamma_tc,        length: 61,     type: float
Item: norm_run,         length: 1,      type: int
Item: tag_ratio,        length: 61,     type: float
Item: tag_ratio_u,      length: 61,     type: float
```

First normalization runs were processed to established the tagging ratio. The *gflux* output is an hbook called gflux*.hbk. The normalization run analysis also produces the text file gflux*_tag_ratio.dat. The tagging ratio were very stable as shown in figure 5.2. The photon flux evaluation for production runs use the tagging ratio result from normalization runs, reading the values from the NORM.map. In production running besides the hbook also three text files are produced : gflux*_tc.dat, gflux*_eb.dat, and gflux*_eb25mev.dat, which are the photon fluxes binned per T counter, E bin, and energy, respectively. These outputs are located in JLAB CUE:

- **2.4 GeV data set:**
  - gflux outputs are in /work/clas/production/g1c/pass1/gflux_out;
  - trip files are in /work/clas/production/g1c/pass1/monitor/sync;
- **2.9 GeV data set:**
  - gflux outputs are in /work/clas/production2/g1c/pass1.2900/gflux;
  - trip files are in /work/clas/production2/g1c/pass1.2900/sync;
- **3.1 GeV data set:**
  - gflux outputs are in /work/clas/production2/g1c/monitor/gflux_out;
  - trip files are in /work/clas/production2/g1c/monitor/sync.

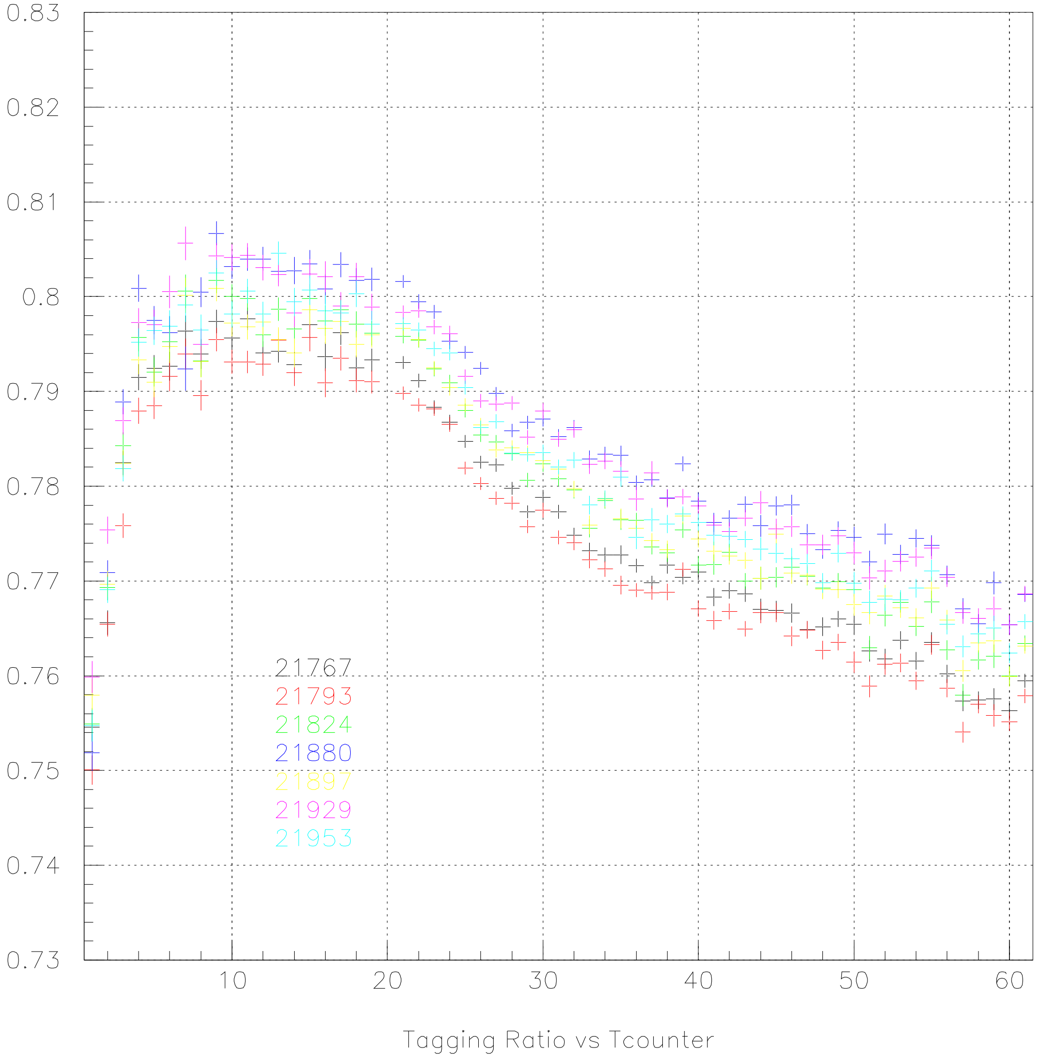


Figure 5.2: Tagging ratio stability for g1c 2.4 GeV data set.

Appendix A

List of runs processed in pass1 for electron beam energy of 2445 MeV

Run	Files	Comments
21763	7	√
21765	7	√
21769	4	√
21772	9	√
21773	11	√
21774	12	√
21775	9	√
21776	8	√
21777	11	√
21779	11	√
21780	11	1 data file lost 03
21781	12	√
21782	11	√
21783	14	√
21784	9	√
21785	12	√
21786	11	√
21790	12	√
21791	11	√
21801	12	√
21802	7	√
21803	13	√
21804	12	√
21805	14	√
21806	11	√
21807	7	√
21808	11	√
21809	3	√
21812	11	√
21813	3	√
21814	14	√
21815	11	√
21816	11	√
21817	11	√
21818	12	√
21819	11	√
21820	11	√
21821	11	√

Run	Files	Comments	Run	Files	Comments
21822	11	√	21867	11	√
21827	11	√	21868	11	√
21828	11	√	21869	4	√
21829	11	√	21871	10	√
21830	11	√	21877	8	√
21831	12	√	21878	8	√
21832	11	√	21881	16	√
21833	11	Bad DC	21882	10	√
21834	13	√	21883	6	√
21835	11	√	21884	15	√
21836	11	√	21885	12	√
21837	11	√	21886	12	√
21838	11	√	21887	12	√
21839	11	√	21888	11	√
21840	11	√	21889	11	√
21841	11	√	21890	11	√
21842	11	√	21891	10	√
21843	11	√	21892	11	√
21844	11	√	21893	11	√
21845	11	√	21894	11	√
21846	8	√	21905	6	√
21847	5	√	21906	12	√
21848	5	√	21907	12	√
21849	11	√	21908	11	√
21855	12	√	21909	19	√
21856	11	√	21910	11	√
21857	11	√	21911	11	√
21858	11	! file 02 Sec.2 TOF	21912	11	√
21859	11	√	21913	9	Bad DC
21860	11	√	21914	11	√
21861	12	√	21915	11	√
21862	11	√	21917	11	√
21863	12	√	21930	11	√
21864	2	√	21931	2	!big fraction of bad sync is 5%
21865	12	√	21932	11	√
21866	12	√	21937	13	√

Run	Files	Comments
21938	12	√
21939	12	√
21940	13	√
21941	10	√
21942	12	√
21943	11	√
21944	11	√
21945	12	√
21946	11	√
21947	11	√
21948	12	√
21949	11	√
21951	11	√
21952	11	√
21955	9	√
21956	11	√
21957	3	√
21958	12	√
21959	12	√
21960	7	√
21963	15	√
21964	12	√
21965	11	√
21967	11	√
21968	14	√
21969	18	√
21970	16	√
21971	16	√
21972	16	√
21973	17	√
21974	17	√
21975	11	√
21979	10	√
21981	3	√
21982	13	√
21983	1	√

Appendix B

List of runs processed in pass1 for electron beam energy of 3115 MeV

Run	Files	Comments
20926	10	√
20927	12	√
20928	11	√
20930	11	√
20931	16	√
20932	13	Cann't analyze A11
20933	12	√
20934	14	√
20935	6	√
20936	16	√
20937	5	√
20941	10	√
20942	10	√
20943	11	√
20944	9	√
20945	11	√
20946	9	√
20948	10	√
20949	11	√
20950	6	√
20951	12	√
20952	11	√
20953	14	√
20954	16	√
20960	14	√
20963	15	√
20964	15	√
20969	11	√
20970	11	√
20971	11	√
20972	9	√
20973	11	√
20978	6	√
20982	17	√
20983	16	√
20984	16	√
20985	17	√
20986	17	√
20987	13	√
20988	11	√

Run	Files	Comments
21015	7	√
21017	12	√
21020	12	√
21021	3	√
21022	2	√
21023	12	√
21024	12	√
21027	13	√
21028	3	√
21029	10	√
21030	12	√
21031	8	√
21034	12	√
21035	11	√
21036	2	√
21037	13	√
21038	12	√
21039	12	√
21040	12	√
21041	12	√
21042	13	√
21043	12	√
21044	12	√
21045	5	√
21057	17	√
21058	15	√
21059	21	√
21060	3	√
21061	13	√
21062	9	√
21063	13	√
21064	8	√
21066	1	empty target run
21067	4	empty target run
21068	5	empty target run
21069	7	empty target run
21070	5	empty target run
21071	7	empty target run
21120	13	Cann't analyze 09
21121	15	√
21122	12	√
21123	11	√
21124	12	√
21125	11	√
21126	9	√
21127	12	√
21128	14	√
21129	12	√
21130	17	√
21134	12	√
21135	12	√
21136	12	√
21138	12	√
21139	12	√
21139	12	√
21140	16	√
21147	13	√
21148	13	√
21149	12	√
21150	11	√
21151	10	√
21152	12	√
21153	5	Cann't analyze file 03
21155	2	√
21157	13	√
21169	11	√
21170	13	√
21172	13	√
21173	12	√
21174	12	√
21175	16	√
21176	12	√

Run	Files	Comments
21177	6	√
21178	17	√
21185	9	√
21186	10	√
21188	11	√
21189	11	√
21190	15	√
21191	12	√
21192	11	√
21193	11	√
21194	12	√
21203	3	√
21204	17	√
21205	17	√
21206	11	√
21209	11	√
21210	11	√
21212	11	√
21213	12	√
21214	12	√
21215	12	√
21216	11	√
21217	12	√
21218	11	√
21219	11	√
21220	15	√
21222	12	√
21223	12	√
21224	12	√
21225	10	√
21230	7	√
21231	11	√
21232	11	√
21233	4	√
21234	14	√
21235	12	√
21236	11	√
21237	12	√
21238	11	√
21239	12	√
21240	2	√
21241	11	√
21242	12	√
21243	1	√
21255	12	√
21256	20	√
21257	12	√
21258	11	√
21259	11	√
21260	12	√
21261	1	√
21262	11	√
21263	11	√
21264	11	√
21265	8	√
21266	12	√
21267	11	√
21268	12	√
21269	12	√
21272	11	√
21273	11	√
21274	19	√
21276	11	√
21277	10	√
21278	2	√
21282	4	√
21283	13	√
21326	11	√
21327	2	√
21328	12	√
21330	13	√
21331	11	√
21334	12	√
21335	13	√
21336	13	√
21339	11	√
21343	12	√
21346	12	√
21347	13	√
21348	13	√

Run	Files	Comments
21349	7	$\surd$
21350	19	$\surd$
21351	14	$\surd$
21353	10	$\surd$
21357	14	Cann't analyze 13
21358	13	$\surd$
21359	12	$\surd$

Appendix C

List of runs processed in pass1 for electron beam energy of 2897 MeV

Run	Files	Comments
21427	6	√
21428	3	√
21430	11	√
21431	3	√
21433	10	√
21434	11	√
21435	11	√
21436	11	√
21437	10	√
21438	11	√missing raw file 00
21439	9	√
21441	3	√
21442	11	√
21443	11	√
21444	10	√
21445	3	√
21446	13	√
21447	11	√
21448	3	√
21450	11	√
21451	11	√
21452	6	√
21453	13	√
21454	11	√
21455	21	√
21456	21	√
21457	13	√
21458	11	√
21460	23	√
21463	11	√
21464	9	√
21466	13	√
21467	21	√
21468	8	√
21469	6	√
21470	4	√
21473	10	√
21474	21	√
21475	20	√
21476	14	√

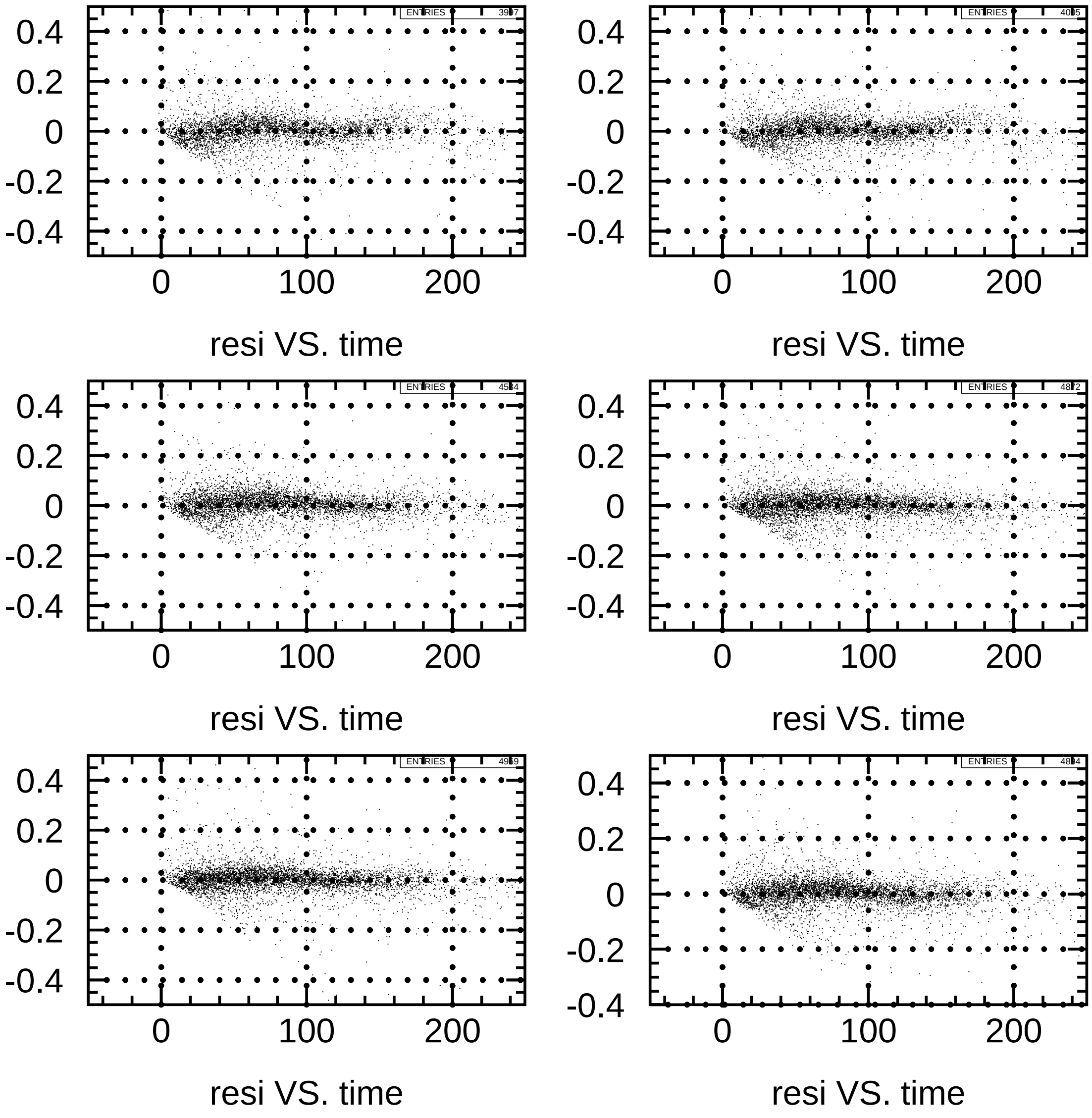
Run	**Files**	**Comments**
21482	7	√
21483	3	√
21484	12	√
21488	11	√
21489	11	√
21490	11	√
21491	11	√
21492	21	√
21493	21	√
21494	4	√
21495	21	√
21496	13	√
21497	20	√
21523	21	√
21524	2	√
21525	1	√
21526	1	√
21527	1	√
21528	1	√
21529	3	√
21530	5	√
21531	1	√
21535	5	√
21540	10	√
21541	5	√
21547	10	√
21548	1	√
21554	3	√
21555	12	√missing 07
21556	12	√RR
21562	9	√RR
21563	3	√RR
21564	1	√
21565	1	√
21566	2	√
21567	2	√
21569	7	√
21577	4	√
21579	11	√
21580	10	√
21582	17	√
21583	17	√
21584	21	√
21585	6	√
21607	10	√
21609	11	√
21610	12	√
21611	22	√
21614	11	√
21615	8	√

Appendix D

Additional Drift Chamber Calibration Plots

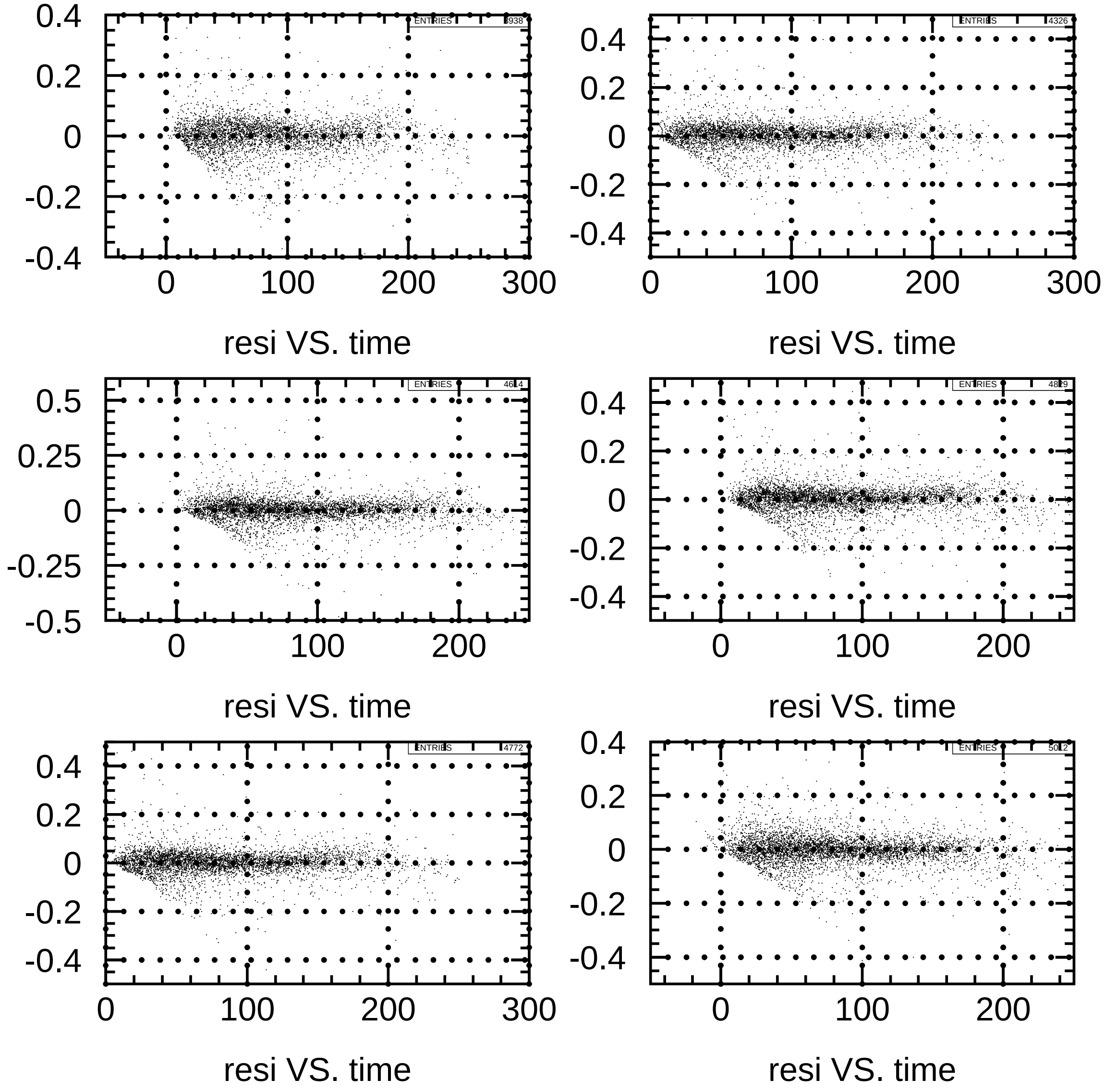
2002/03/14   15.32

G1c 2.9 GeV set SL1



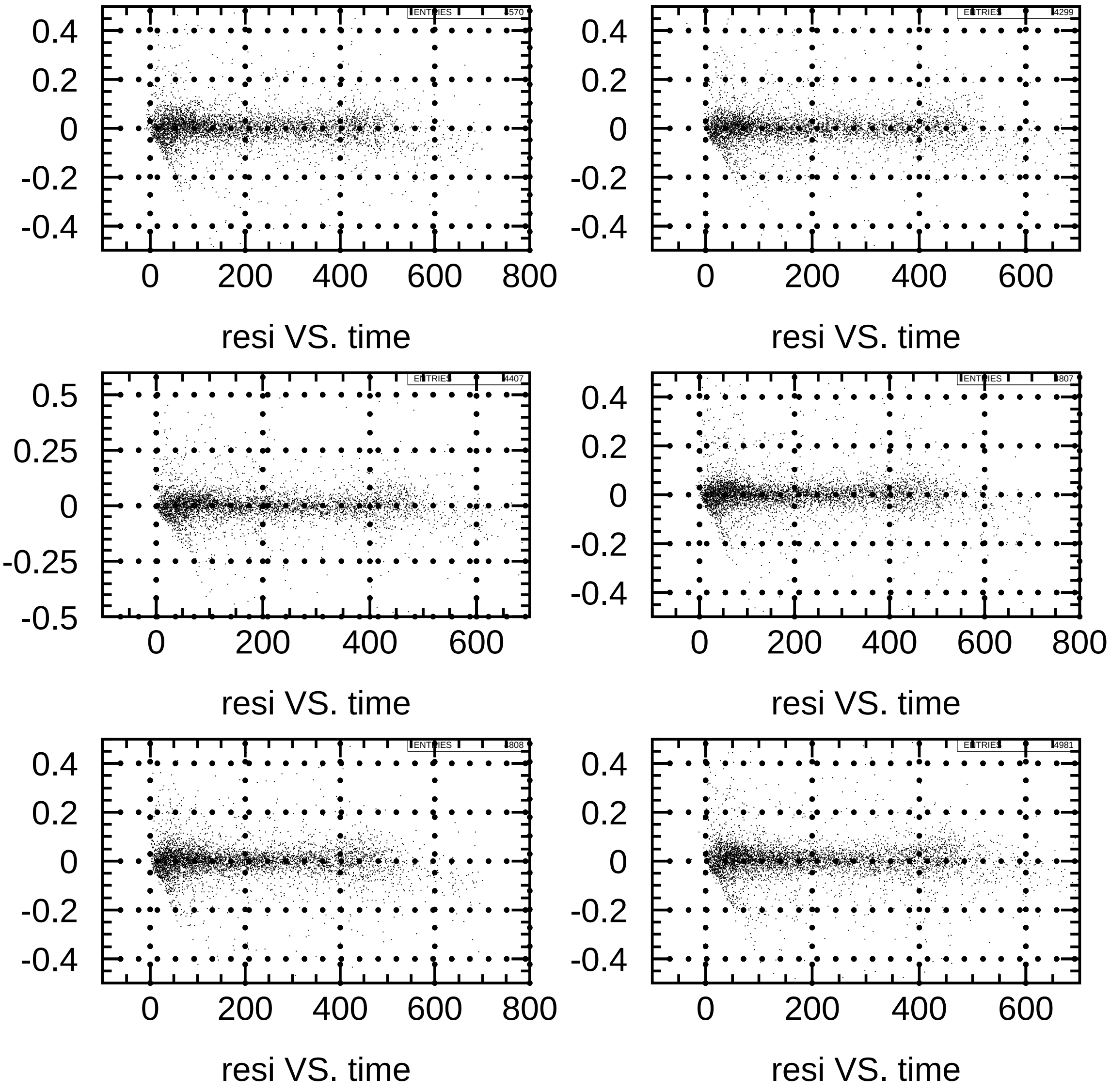
2002/03/14 15.32

G1c 2.9 GeV set SL2



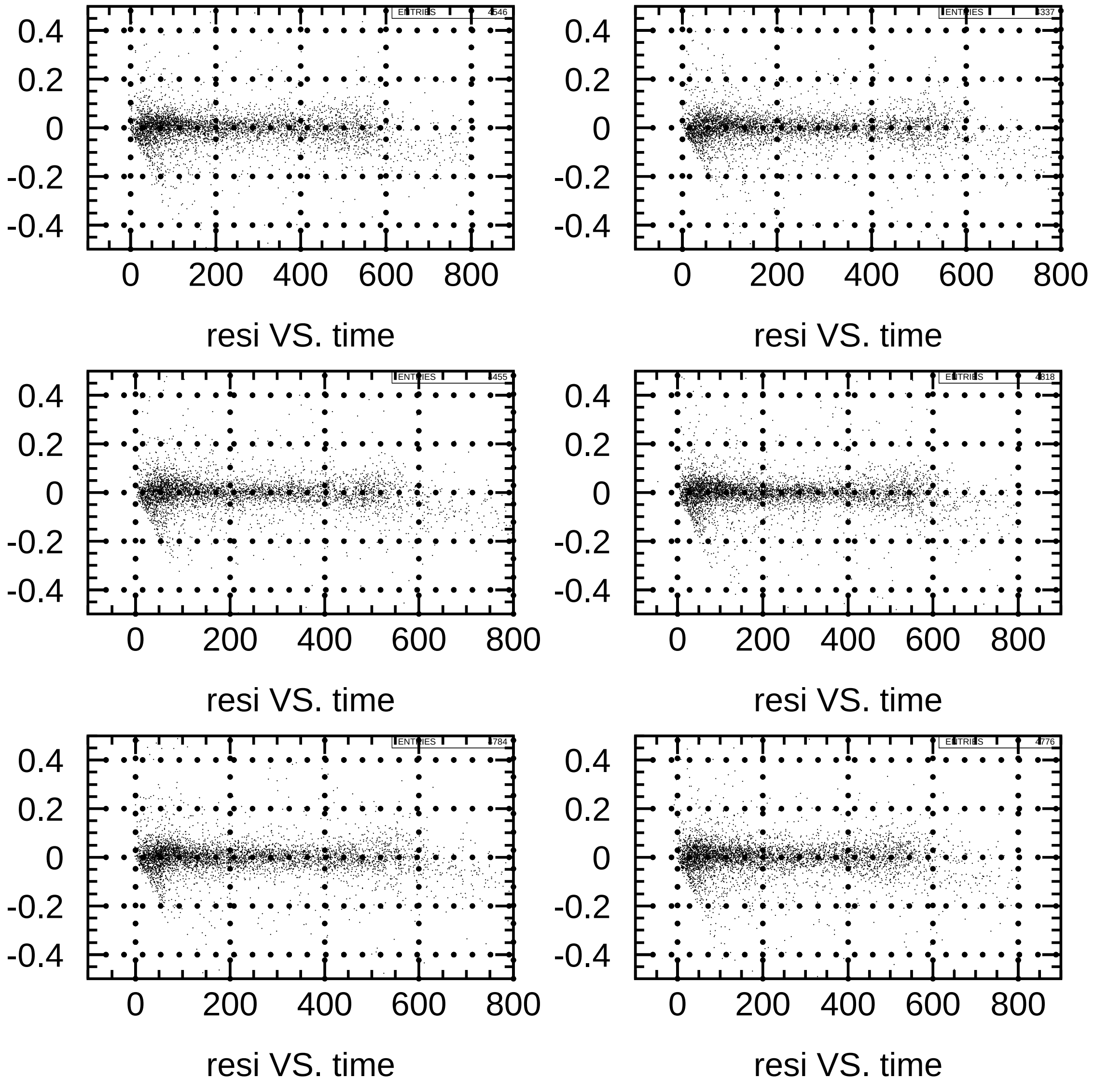
2002/03/14 15.32

G1c 2.9 GeV set SL3



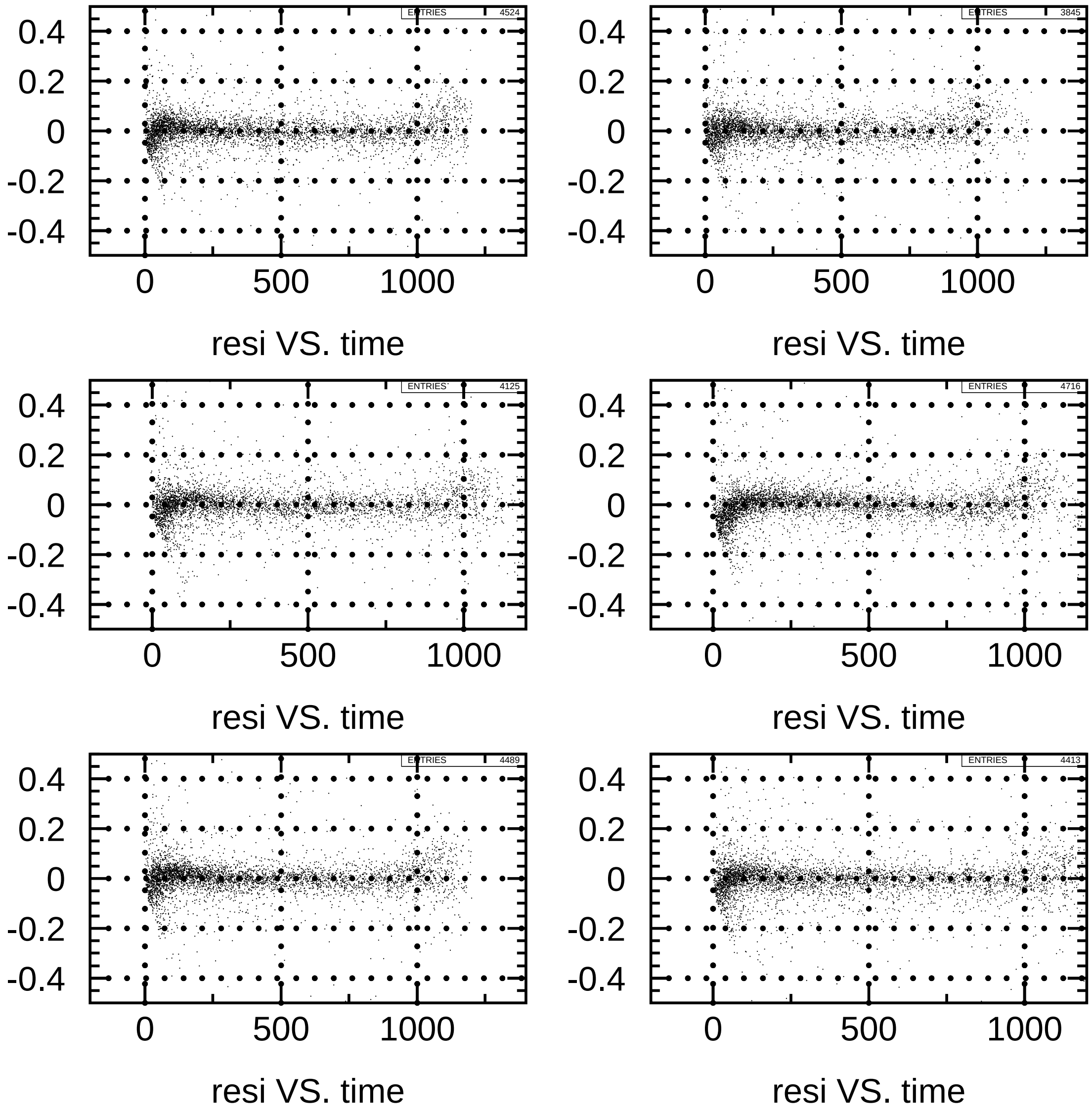
2002/03/14   15.32

G1c 2.9 GeV set SL4



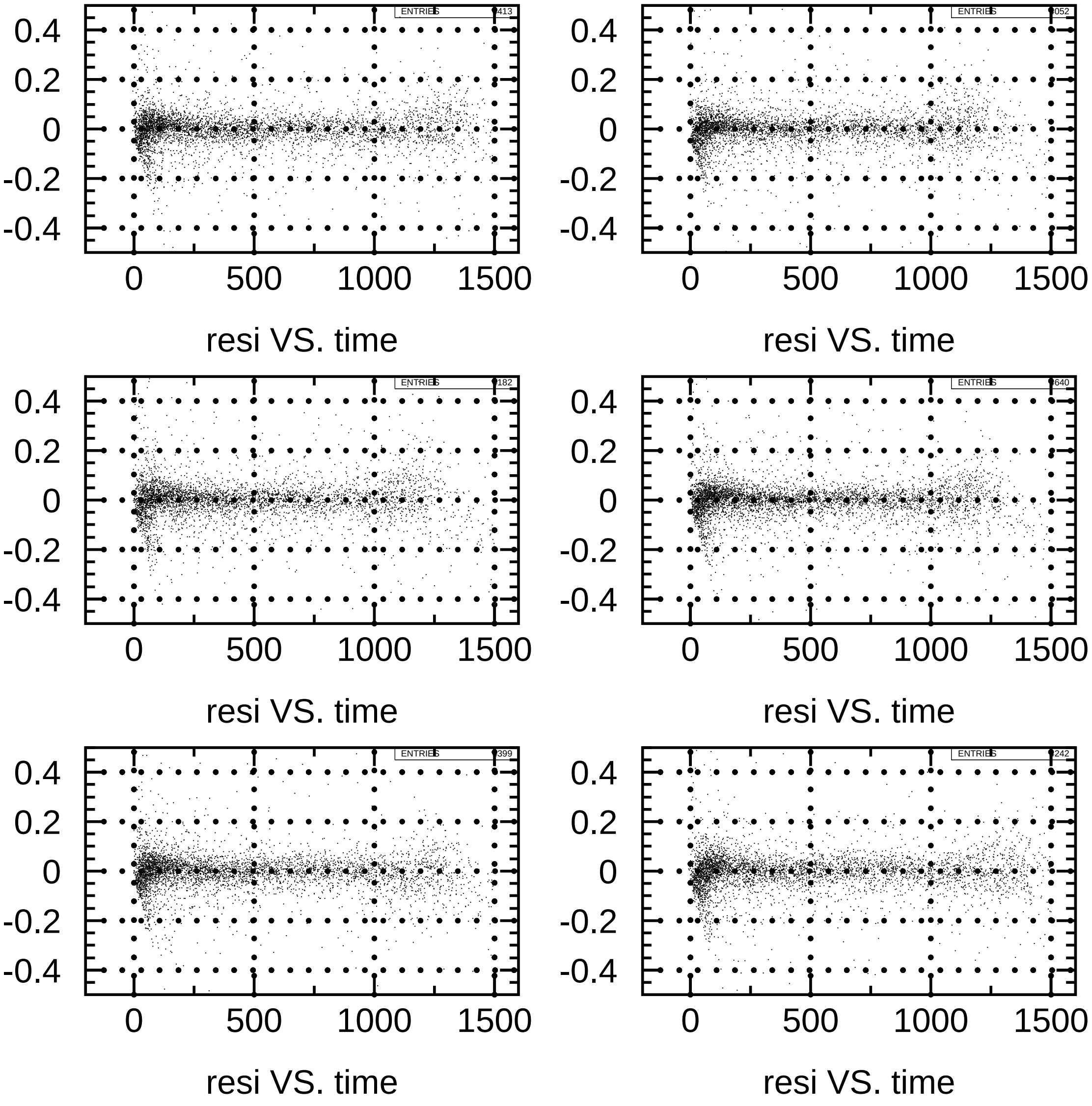
2002/03/14 15.32

G1c 2.9 GeV set SL5



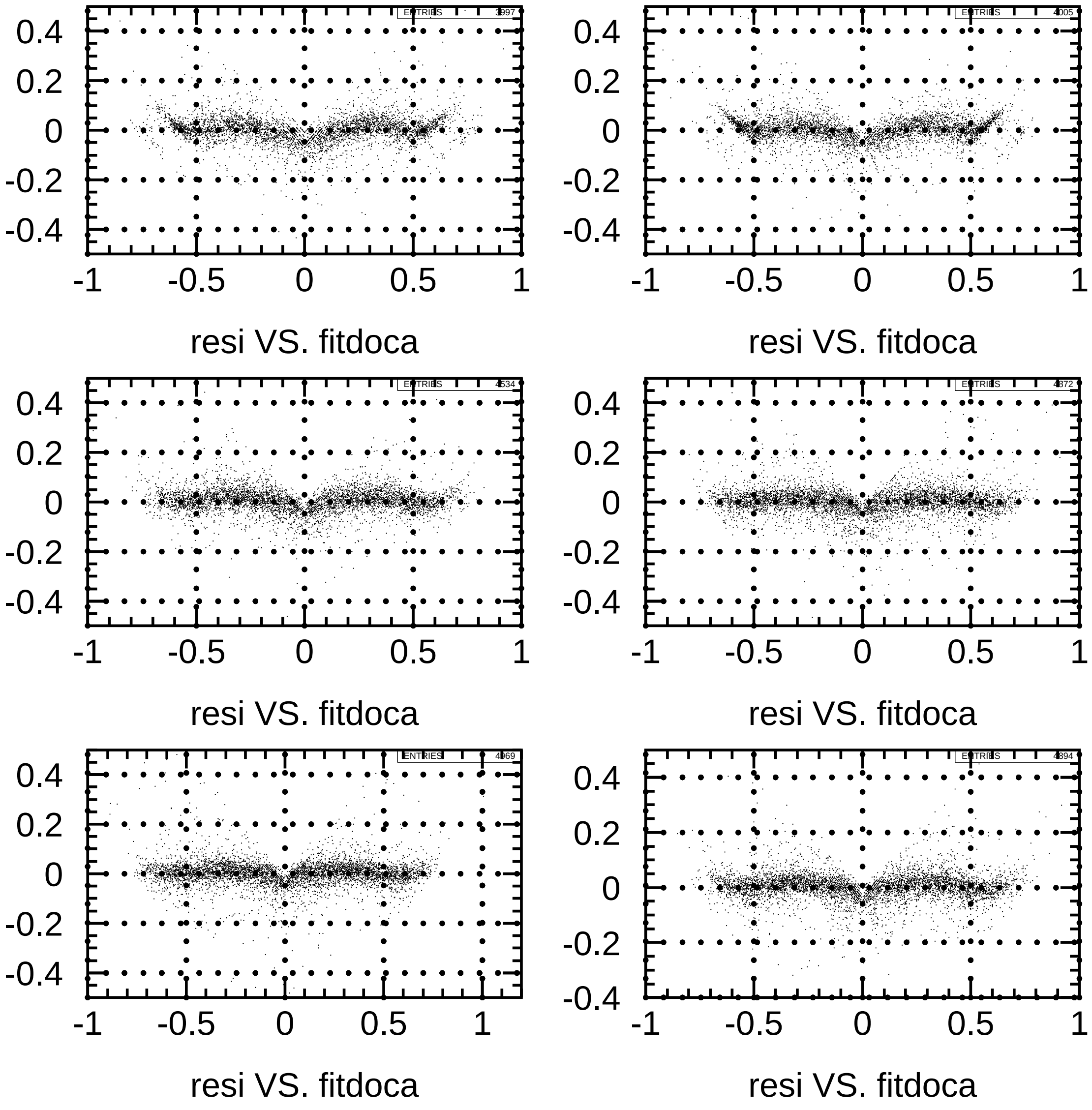
2002/03/14 15.33

G1c 2.9 GeV set SL6



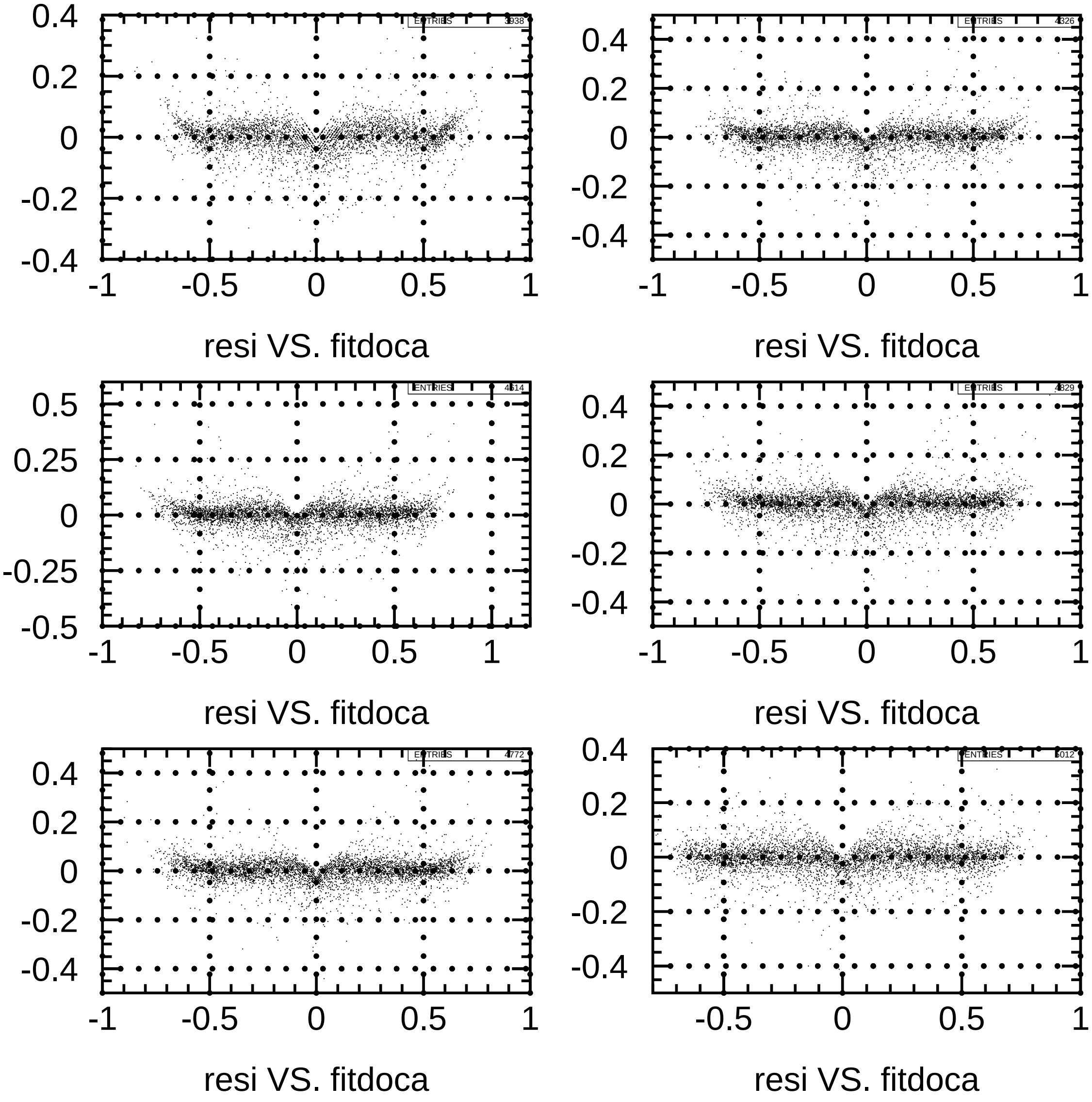
2002/03/14 15.48

G1c 2.9 GeV set SL1



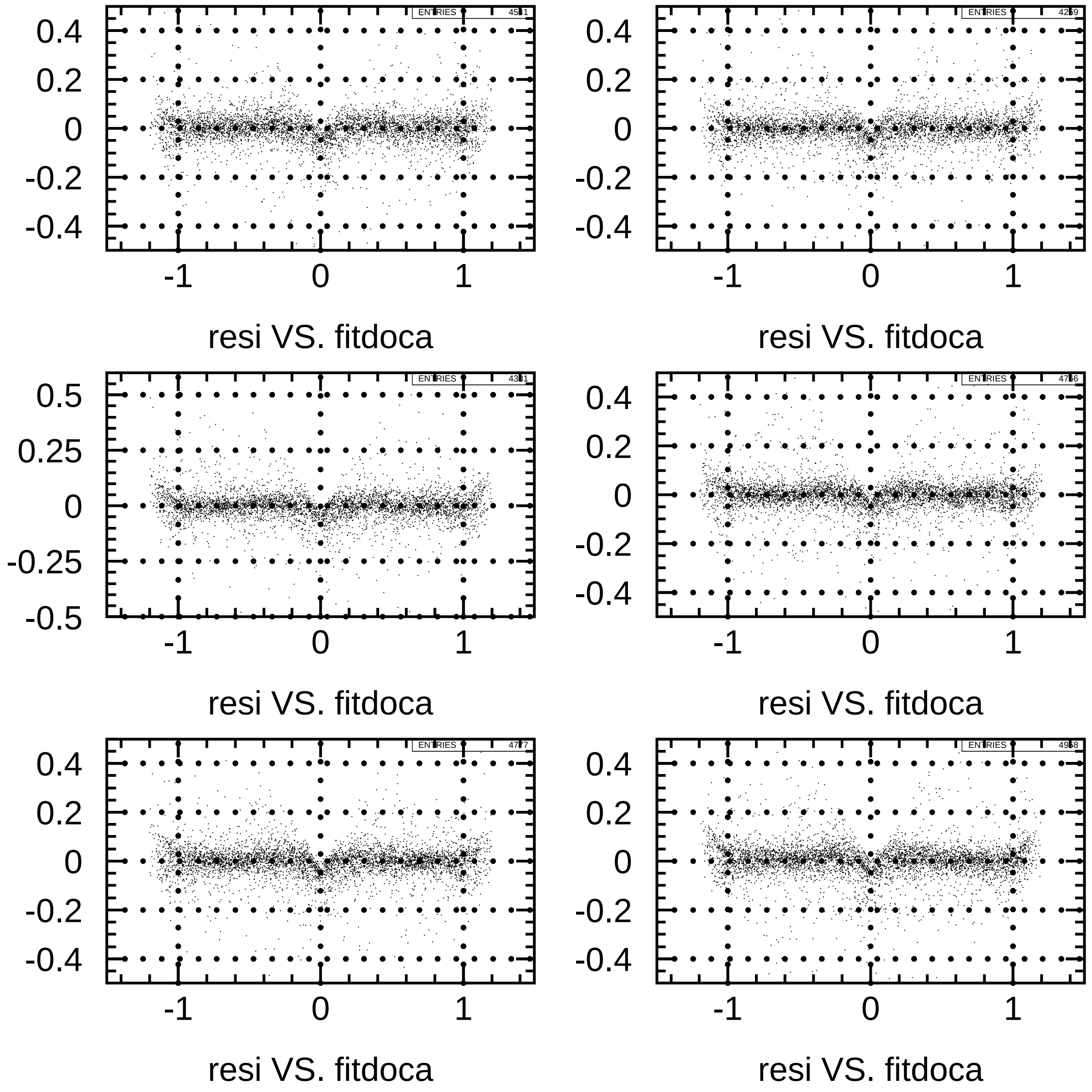
2002/03/14 15.48

G1c 2.9 GeV set SL2



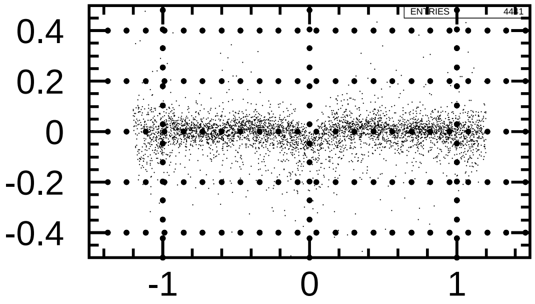
2002/03/14 15.48

G1c 2.9 GeV set SL3

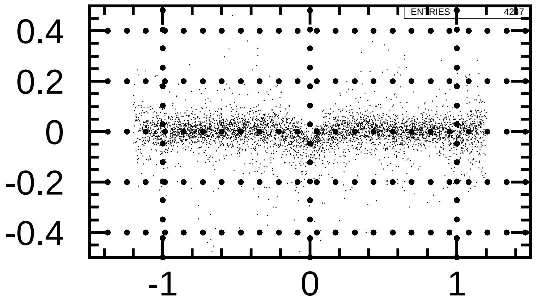


2002/03/14 15.48

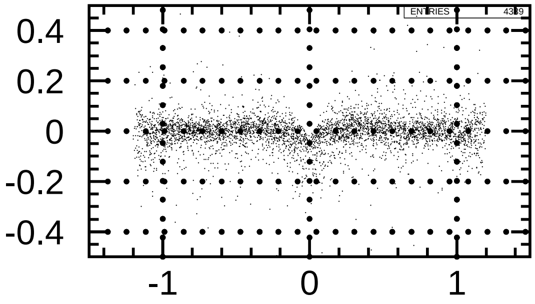
G1c 2.9 GeV set SL4



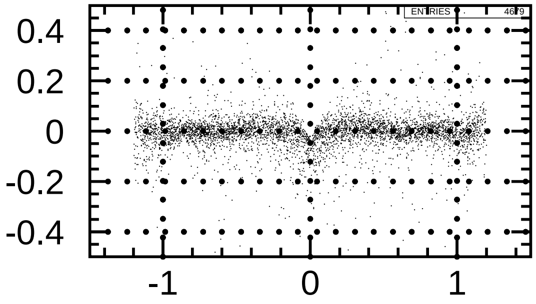
resi VS. fitdoca



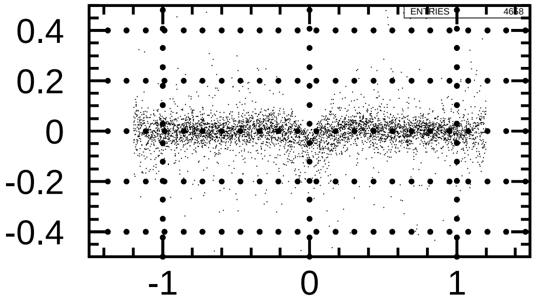
resi VS. fitdoca



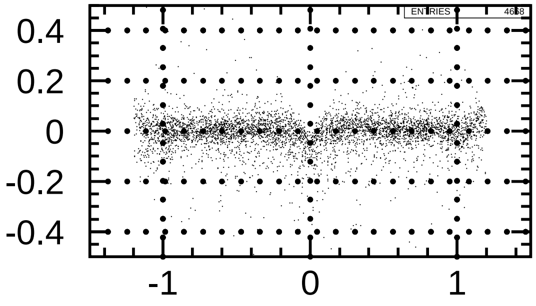
resi VS. fitdoca



resi VS. fitdoca



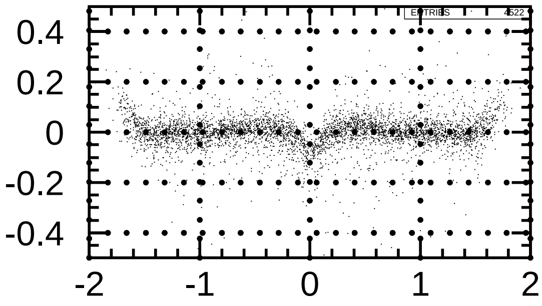
resi VS. fitdoca



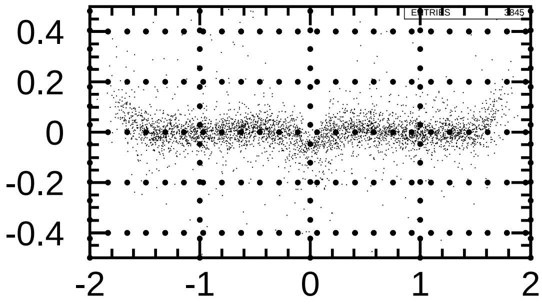
resi VS. fitdoca

2002/03/14 15.49

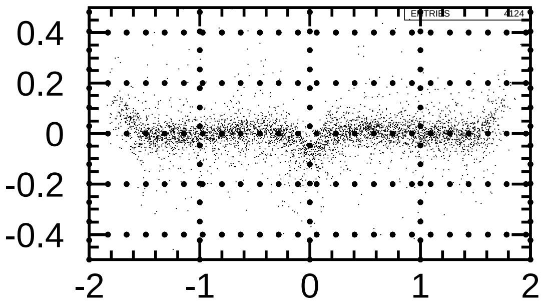
G1c 2.9 GeV set SL5



resi VS. fitdoca



resi VS. fitdoca



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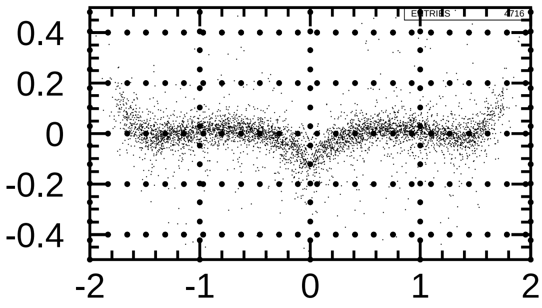

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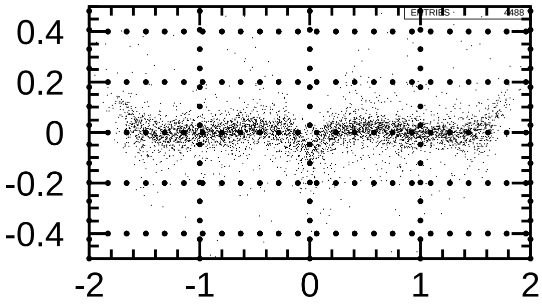
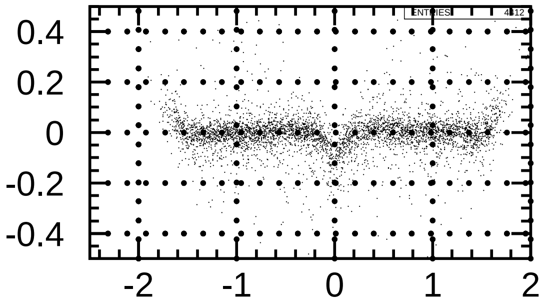


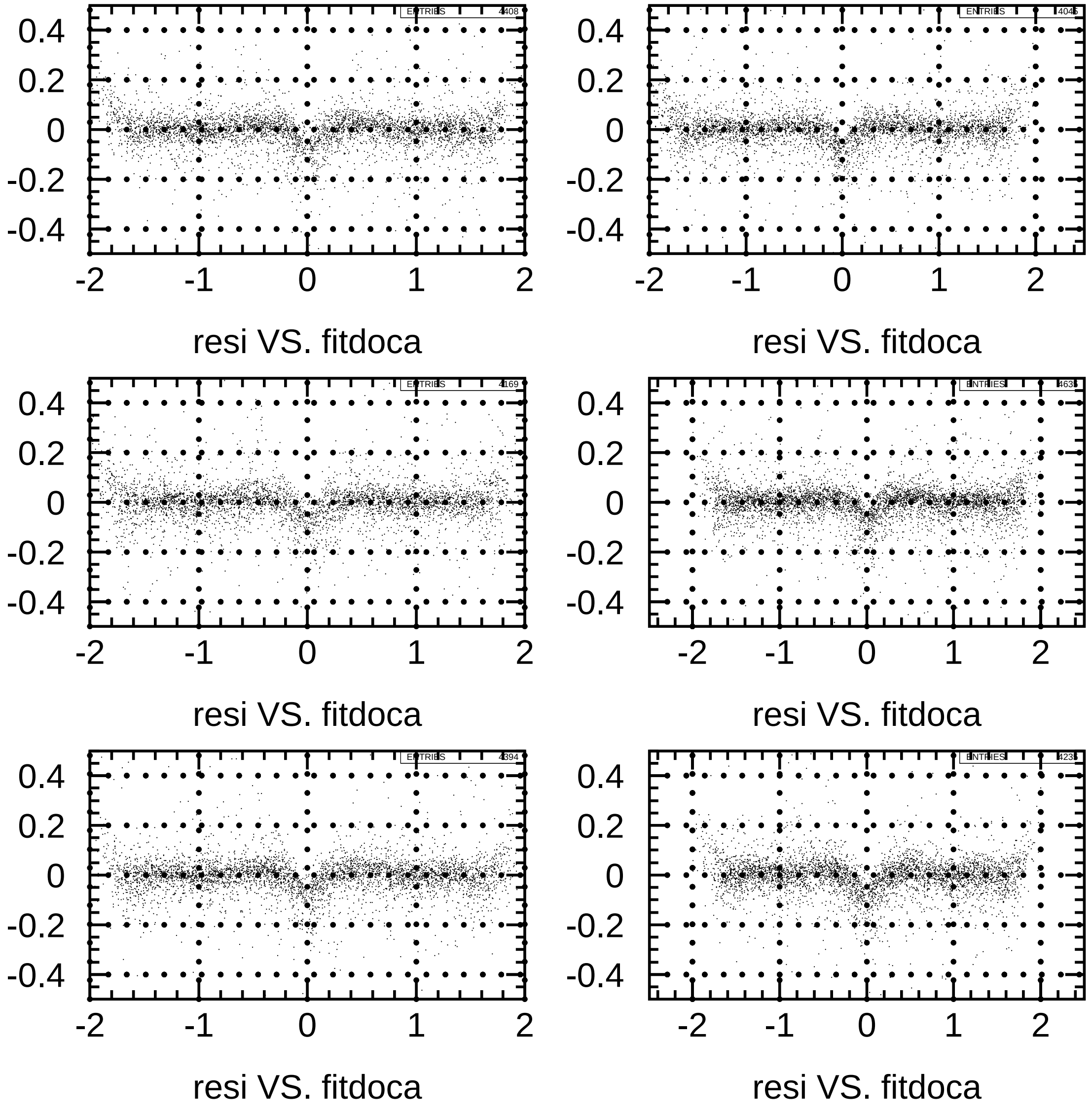
resi VS. fitdoca



resi VS. fitdoca

2002/03/14 15.49

G1c 2.9 GeV set SL6



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