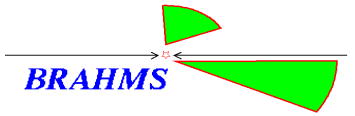
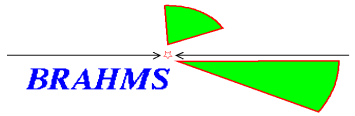
Triggers for pp and dA



Much of the following material has already been shown at several meeting as well as postings to the mailings lists. Never the less I thought it useful to summarize both what triggers were used during last years pp run, as well as issues in this regards for the upcoming run, and what still has to be implemented.

Since all of the FY03 running will be with dA and pp the system should be setup initially to deal with this.The structure of these slides are

- Physics goals for dA and pp (in general terms)
- Triggers used in pp (January 02) and their performance.
- Issues and why dA and pp triggers has to be improved over past experience.
  - Level 0 and min bias determination
  - Spectrometer triggers (and timing)
  - Vertex determination.
  - Electronics..
- Documentation material

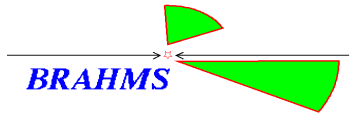


Physics Goals

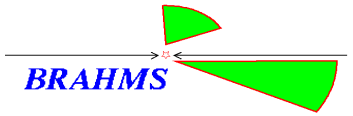
- dA
  - The expected physics run is 11 weeks
  - Survey of soft physics d2n/dptdy 0~0-3.5
  - High pt spectra & comparison in cold nuclear matter; compare peripheral to more central; comparison to AuAu and pp.
  - (y~2/3) with FS. Possibly looking for signatures of gluon saturation.
  - Y~0 (1?) identified pion out 6GeV/c utilizing new Cherenkov.

- Pp
  - Completion of survey (many missing settings, marginal statistics in run-2 data set)
  - High pt spectra as for d-Au.
  - Investigating feasibility of transverse asymmetry in pion production at large x(f) – part of this can be done concurrently with high pt data sample.

January 2002 pp running



- The tracks per pp (and dA) event is low so it is/was essential to deploy spectrometer triggers. The interaction rate ~20-40K/sec.The nominal luminosity of
- The Min bias trigger was formed using the INEL counters with a left+right coincidence (additional information in back)
- For MRS two special counters was build. A front start counter TMRSF as well as a 5 slat 80 cm long counters placed behind the TOFW. The trigger was formed as INEL*TMRSF*BACK*RC (RC being the rhic clock)
- For FS one counter was build TD1 (3 slats in front of D1) was defined by From both H1 and H2 we formed in the FEH using NIM electronics an or of up/down discriminator signals. For data-taking exclusively the following was used INEL*TD1*H1, but a FS trigger INEL*TD1*H1*H2 was commissioned and a trigger bit set for part of the run.
- The trigger were effective in selecting events with tracks. Under most (but not all beam conditions) there were ~.4-.6 track per FS trigger and in MRS ~.3 per trigger. The factor is dependent on the angle settings.
- The in-efficiency of the trigger I.e. how often was a good track missed is not studied in detail but from online it was concluded to be > 90%.Most of this presumably comes mainly from the inefficiency also seen in regular FS analysis of H1,H2.

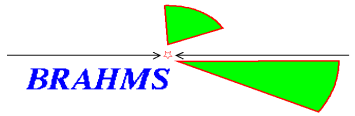


Issues for dA and pp running

The running of dA and pp raises several issues. For each of the species one needs to have

- Level 0 (luminosity, min bias) trigger systems. Requirements are high efficiency, and needs timing at ~1 nsec level.
- Vertex determination for most events, 4 cm requirement s deal (8-9 as from INEL may not be sufficient with the 200MHz re-bunched beam)
- Spectrometer system needs trigger counters for track selection.
  - The pp setup used last year for MRS will not work for dA.

- Centrality selection in d-Au.
  - Select on charged particles using existing Tile array + left BB.
  - Should we add additional coverage? In array and/or outside?
- Beam expectations
  - dA: 56 bunches beta*=2; .9mrad angle for both beams;I.e 0.06 degree thus neglible in terms of y-pt. L<av>~1.6.10**28; ie.interaction rate of (2.2b) => 40K/sec.
  - Pp 112 bunches beta*=2 ; L<av> 10.10**30 => interaction rate of 400K/sec



Spectrometer triggers

- This is the almost easiest part of the trigger issue.

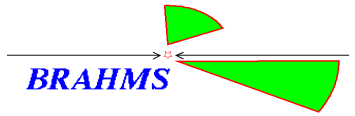
FS

- The evaluation is that even at 3 deg the TD1 front triggers will have a small double hit probability (3 segments). The expected dN/deta in the forward region is ~2*pp in dA.
- The timing of TD1 is satisfactory, and the combination with H1,H2 worked well in pp . There is no reason this should not be the case for dA too. The electronics is already setup in FEH, though one could use the VME modules described below to simplify setup.

MRS

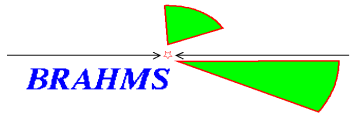
- The pp setup was not optimal since the back trigger counter restricted the solid angle (smaller than TOFW).
- Solution: Use the TOFW-panel hits to generate part of the trigger. This will be done on the platform, feeding one output from the discriminators to a NIM/ECL converters (housed in a CAMAC crate) and then into VME modules that performs a parallel AND between up/down hits and a final Or.The prototype has been tested. A second (modified) version will be available in about 1 week after which production of the 8 modules needed can start. The insertion time is as good as the equivalent NIM circuits. (RAS,DB)

Spectrometer Triggers continued

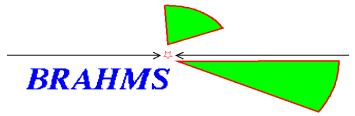


- A front start & trigger counters has to be segmented to handle dA.
- The present design is to have a slats ~ 3 cm tall 5 cm wide and 1 cm thick with a single PMT tube on each. There will be 6 slats with Tubes + 5 cm light guide alternating up/down. This arrangement will be right in front of TPM1 but placed on its own stand. Track projections to correct for transition time within the scintillation material for offline analysis.
- Online the trigger logic (a simple Or) will be made in FEH.
- DB is responsible for getting this detector build and installed.
- Thus the final MRS track trigger will be made from an AND of this TMRF trigger (or whatever name it will have) and the grand or from the TOFW panels.

Trigger efficiencies.



- A small set of simulations was made to evaluate the trigger rates, vs track rate per collisions in dA.



Min Bias counters

The INEL counter system (from pp2pp) has as designed a high efficiency for detecting min bias double diffractive pp events (~95%).

Two issues

1. The timing difference between station 1 in left+right is only 5 nsec, so it is difficult to discriminate between halo events hitting first Left then right from collision events that took place with the +-78 cm between the detectors.
2. Part of the station 1 (and 2) in the right hand side sits in the path of particles towards the FS, and should preferably be removed. This will lower the efficiency somewhat by another 10% for pp

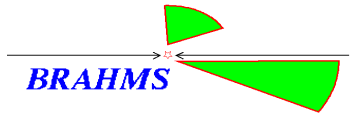
For dA the efficiency is quit high using these counters (see later plots), although it has yet to be studied how the eff it is for more peripheral dA (which most be like 2*pp in right array.)

In terms of overall efficiency for making both Level 0 , as well as for luminosity measurements these counters are satisfactory. The real issue is how to improve the timing information such a ‘vertex’ can be reconstructed with a good sigma (~5 cm).

Possible solutions could be

- Add another tubes to each module of the INEL + ADC information
- Replace some of the station with large solid angle scint. Slats with multiple tubes for readout.

This is important to resolve this soon



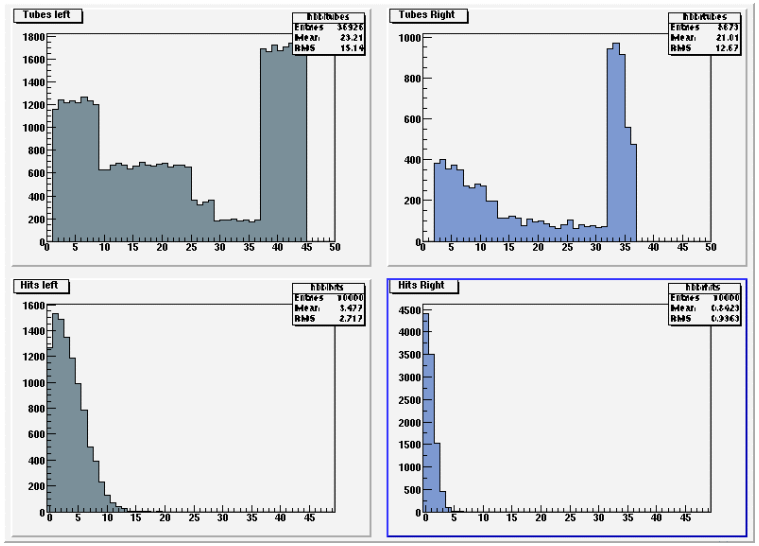
Vertex information

It is important to have event by event vertex information for the following purposes

1. Acceptance depends on vertex position – typically done in 5 cm bins. The MRS track do point to this accuracy to the beam line, but the FS tracks NOT in particular at the more forward angles.
2. The position of tracks are compared to the event vertex and used to reject background tracks.
3. The vertex is used to count min bias (or centrality selected) events within each vertex.

- The resolution of ~8-9 cm was obtained from the INEL. Such resolution is probably ok for normalization purposes, but is not so good for rejection of FS and MRS tracks (I.e. we will get a larger background contribution to tracking). Too with the expected 200 MHz re bunching of the beam the vertex distribution becomes narrower with faster falloff; thus increasing the requirement for
- For dA the left array (beam-beam) should have a reasonable probability to give information for all data. This may be used to impose constraint on track selection.

pp beam beam counters



The efficiency is quite low ~15% for having more than one hit in each side.

On the other hand the vertex determination is pretty good although not as for Au-Au.

Typical numbers are ~1.9-2.6 cm for N~2 and 1 respectively.

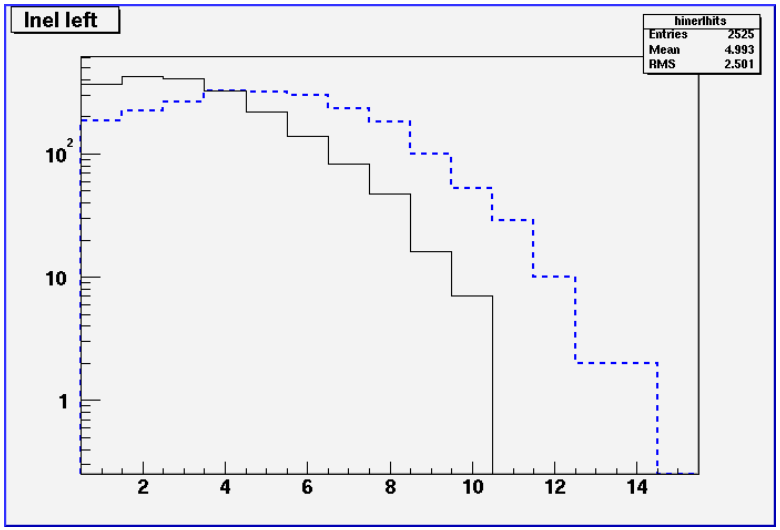
This may be used for checking, but can not be used in general due to the low efficiency.

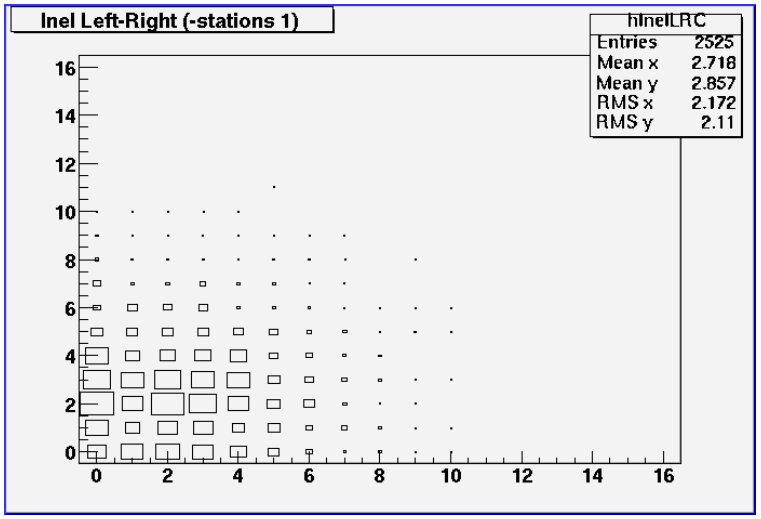
Inel w/o station 2 in pp

For pp Inel counters is claimed to be ~95% efficient for double diffractive events. Assumes all 4 stations enabled on each side of IP.

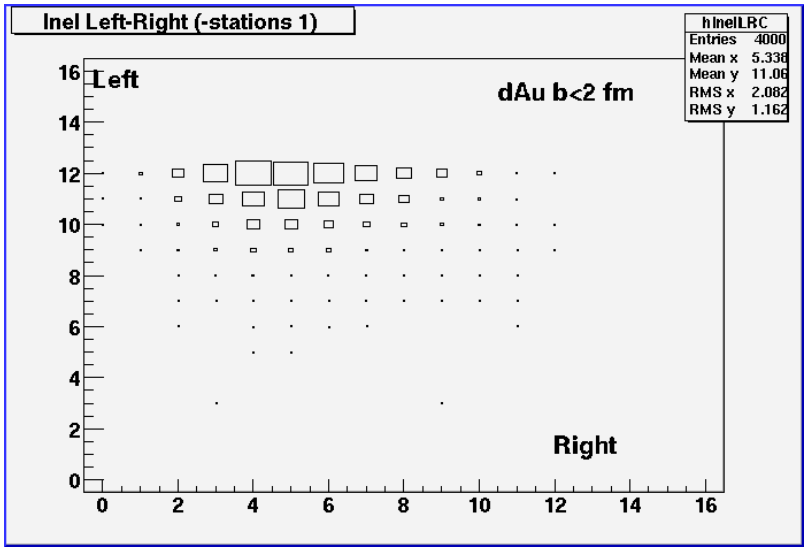
Pythia+Brag simulation are somewhat different. In the specific example ~ 2000 events out of 2525 gives a signal in both left+right. Is this consistent with single diffractive vs double diffractive cross sections Seems as a ~20% loss.

Going to a configuration w/o station 1 one looses another 15%. This is though likely satisfactory for pp.





Efficiency for d-Au



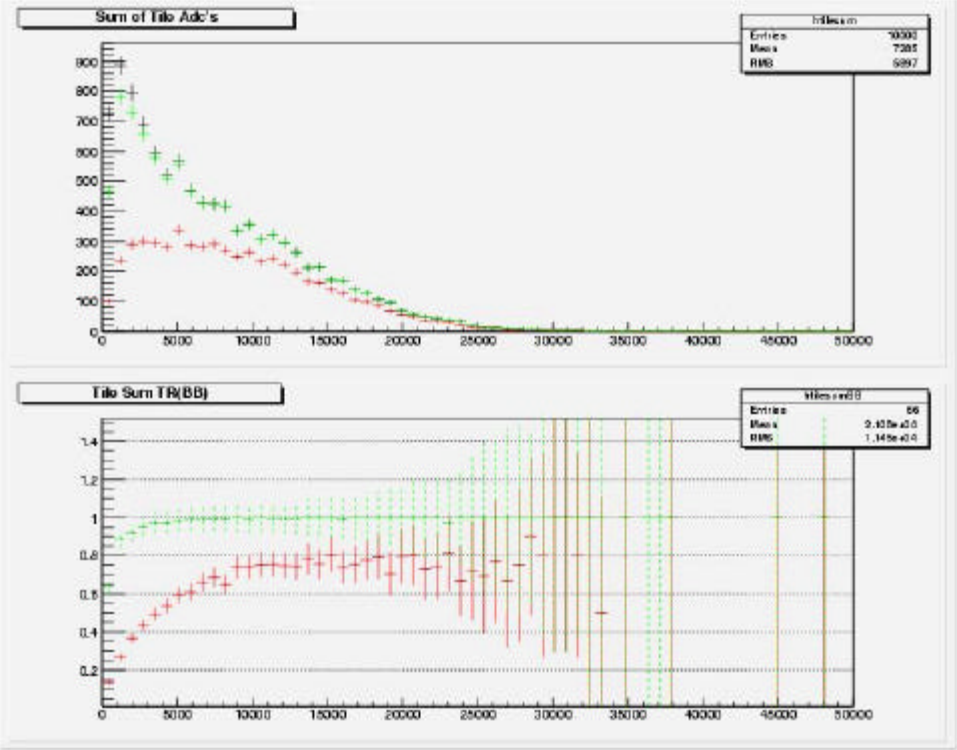
For central d-au the combination of Inelastic station 2-3 (each side) is very efficient for central d-Au. See upper slide.

For min bias an overall efficiency is about 90% - slide still to come.

The efficiency for present Beam-Beam counters is about ~49%; It can be increased to ~58% by adding a Pb-converter (1 cm) on the front of each rube. The real problem is that even this has an centrality dependent efficiency which as best is ~80%. The next slide shows this.

Min bias trigger counter eff.

Yield from 10,000 dA Hijing min bias data of Tile ADC sum, as can be seen later this is not an unreasonable centrality selection method. The curves plotted are total dist (black), events where the INEL counters has N>=1 hits in both side (stations 2-4) (green) and finally for events with N>=1 in both BB (red). The lower panels shows the efficiency (0-1) for the two trigger selection conditions.

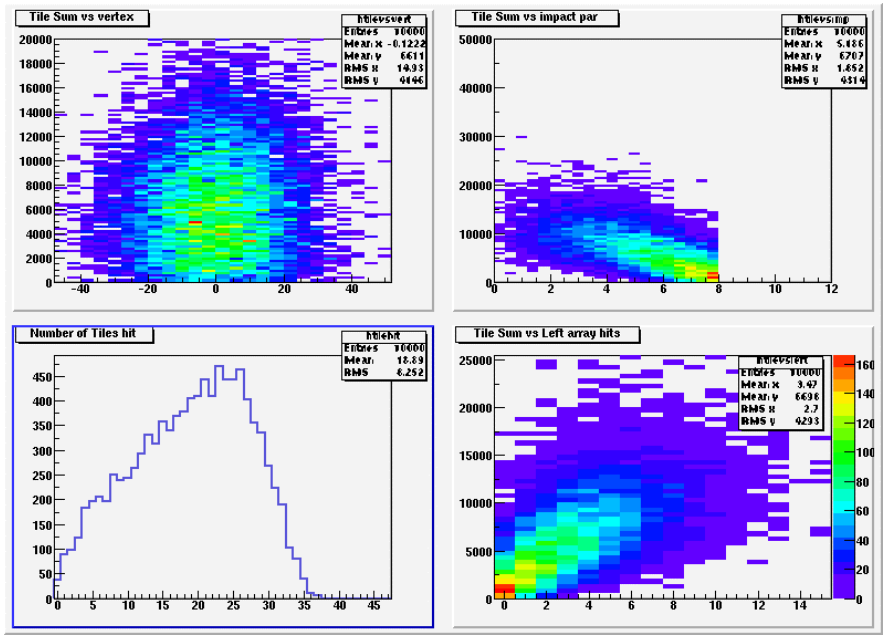


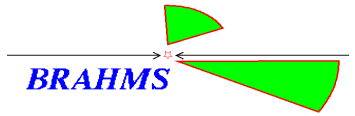
These calculation were with events digitized in a brag-digitization-analysis chain.

Centrality

It seems that a combination of the Tile ADC (I.e. multiplicity in –1<e<2 and Left BB may do reasonable well for centrality selection.

Adjacent plots illustrate the features

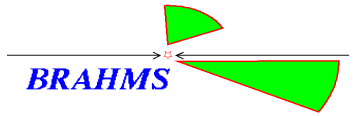




Additional information and documentation

- Inelastic counters
- FS TD1 timing
- Beam Beam performance

Inelastic Trigger Counters



The BB counters only give a ‘valid’ vertex for about 10-15% of the events.

The pp2pp inelastic counters are used instead to define an event vertex and to normalize between spectrometer triggered events and min bias events.

The counters consists of 4 stations (rings) each with 4 modules I.e. 16 on each side of the IP. The basic geometry parameter are given below. For more check the Brahms detector web pages (pp counters)

Only the tdc signals were read out for analysis; due to the large scintillateor and the readout with only one tube a rather poor resolution is expected.

The Inel counters are included in the brag.

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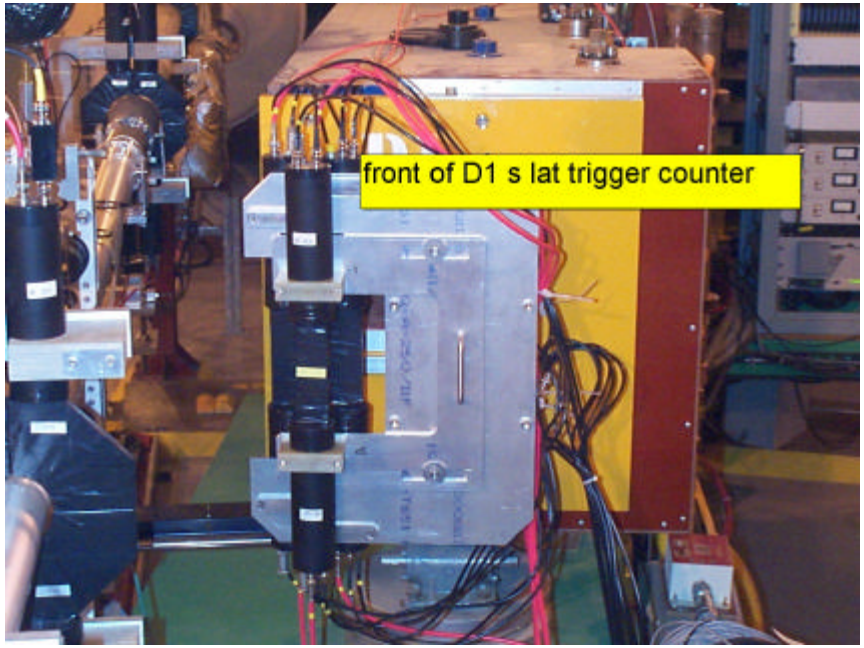
Z meter	Rinner (inches)	Router (inches)	Eta(min)	Eta(max)	dt (nsec)
0.75	1.625	5.00	2.48	3.59	2.50
1.55	1.625	5.00	3.20	4.32	5.17
4.16	2.625	5.00	4.18	4.83	13.87
6.60	2.625	5.00	4.64	5.29	22.01

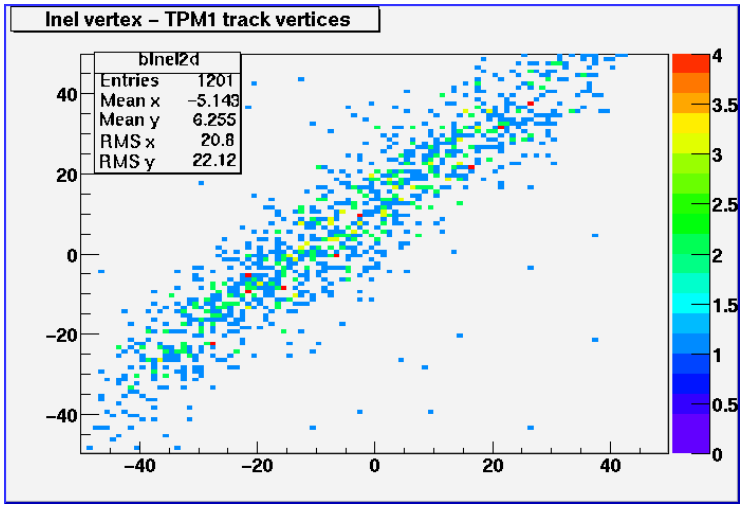
Inel Counters

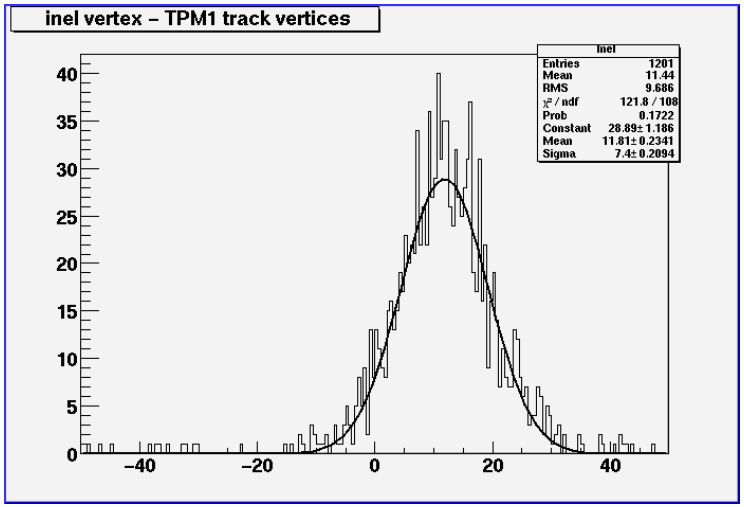
The Inel counters are build by pp2pp. Each scintillator is read out by a single PMT. In the picture below the station 2 on the right hand side is seen adjacent to TD1. This proximity is one reason not all panels can be use in dA and pp running (creating background for spectrometer)



pp and dA triggers

Vertex comparison





Summary

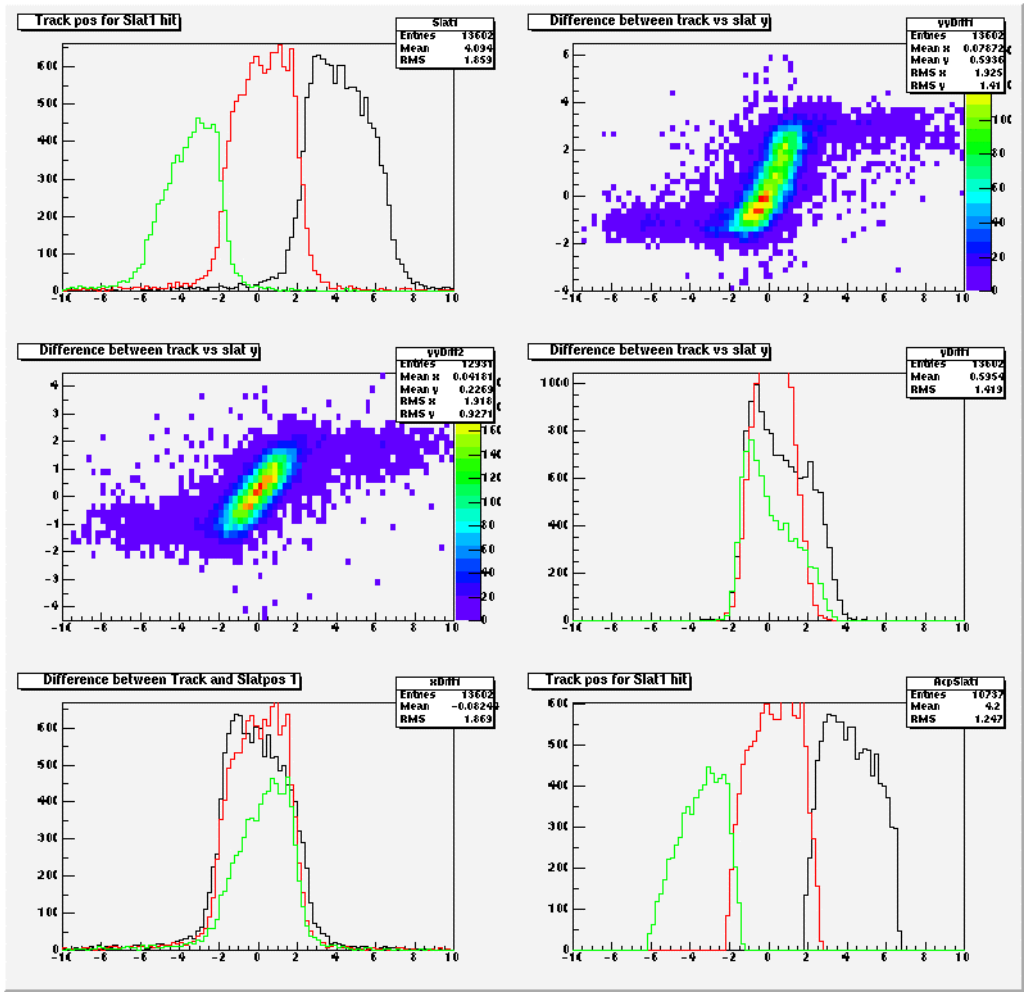
- The vertex resolution is ~9 cm – constant over run 6249-6756
- The offsets do vary slightly with runs, but actually better than resolution.
- Such resolution is probably ok for normalization purposes, but is not so good for rejection of FS and MRS tracks (I.e. we will get a larger background contribution to tracking)

TD1 start counter

The TD1 consists of 3 slats with a small overlap placed ~25 cm in front of D1.

Projection of tracks to 3 td1 slats.

- y distortions
- Tails (edge scattering) likely cut out in some target y cuts.



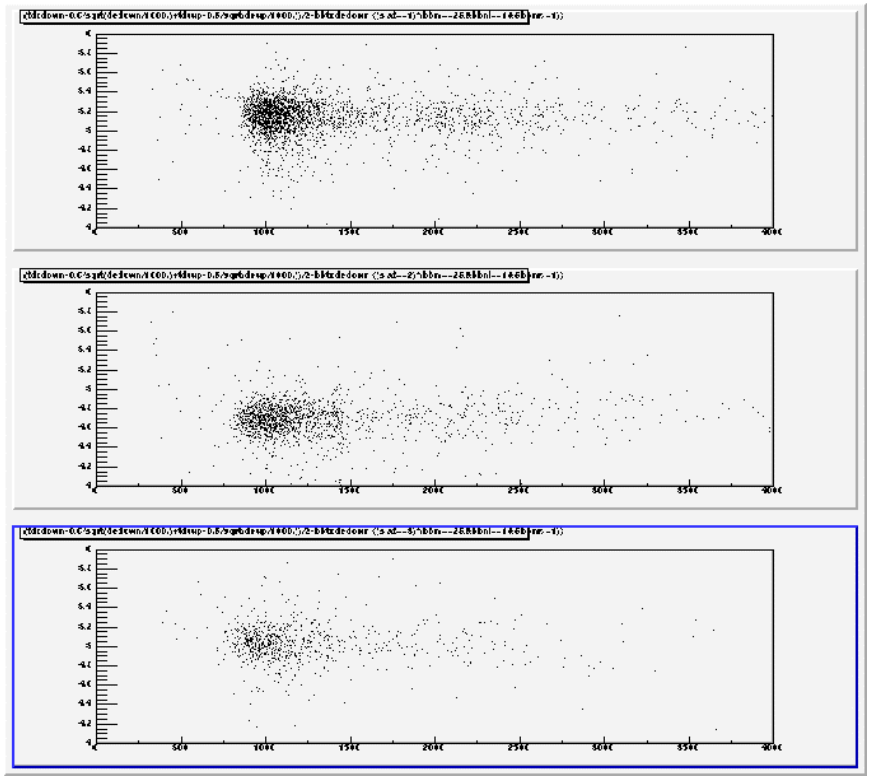
pp and dA triggers

TD1 slewing correction.

- The response of TD1 was re-evaluated.
- Slewing correction are determined from basically looking at scatter plots of tdc-alpha/sqrt(e) and deciding visually on a best value (at least for now).
- Run 6473 (3 deg) –observe multiple hits in each slat.
- The overall slewing looks reasonable.

Technical note – uses Td1RdoModule with ntuple on and usebb on.

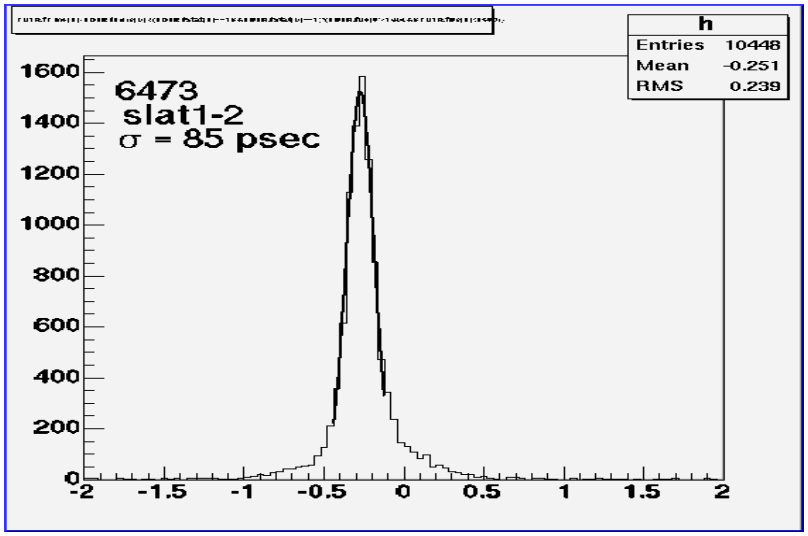
The constants used are different than those used so far in the rdo module and which Kris had used for his analysis.

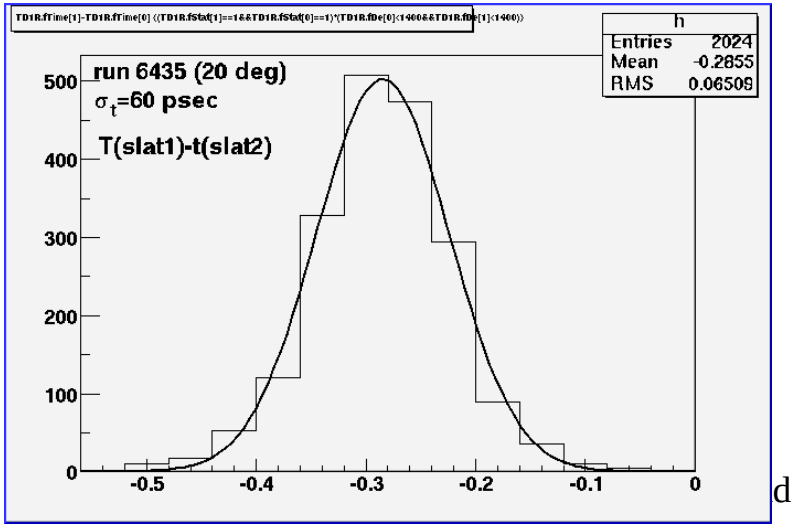


pp and dA triggers

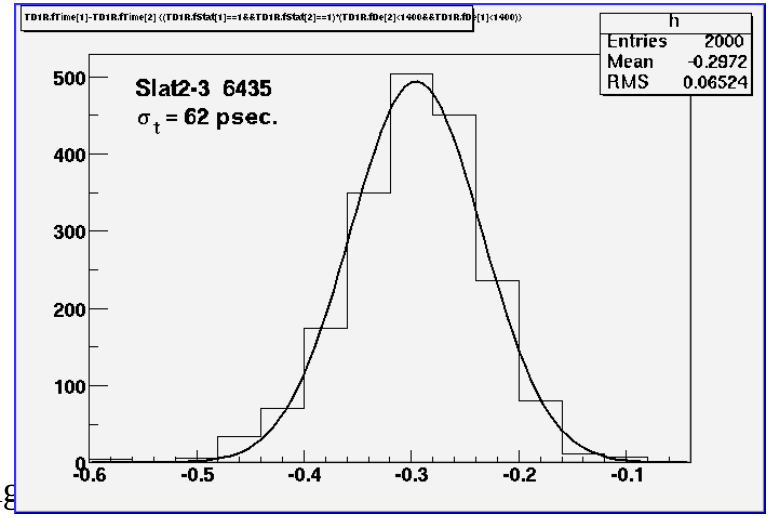
Results of slewing diff.

- Results does depend on angle setting –
- The first plot is for 3 deg requiring a slat1+2 difference time requiring single hit in both. The spectrum is dirty and the resolution 85 psec = 60 psec intrinsic.
- Taking run 6435 (20 deg) results are much nicer see two plots for slat1-2 and slat 2-3 (sigma= 60 psec. equivalent to ~44 psec. Per slat)





d dA trig



TMrsF trigger and T0 counter

40*5 cm right in front of TPM1.

Can only work with single hits

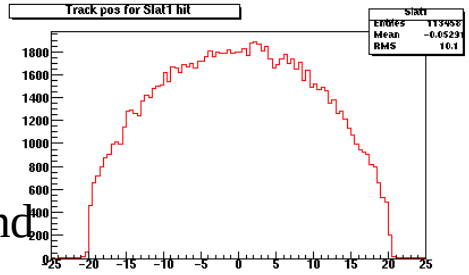
Double Hits ~ few percent of events

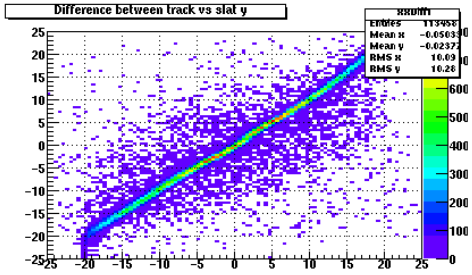
Can not have two tracks per event and PID.

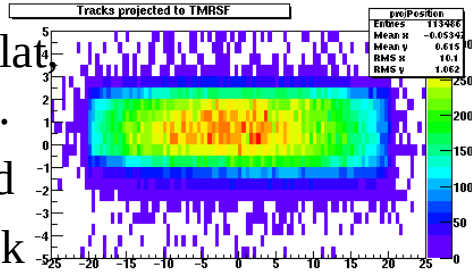
Picture shows track distribution on slat, position relative to timing of slat.

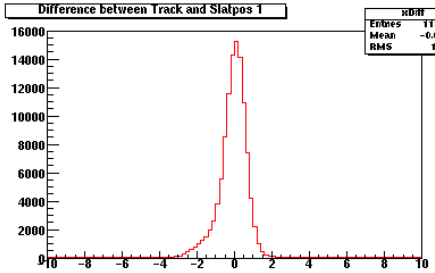
Simple slewing correction performed

Non-linear effect in (tL-tR)/2 vs track projection.



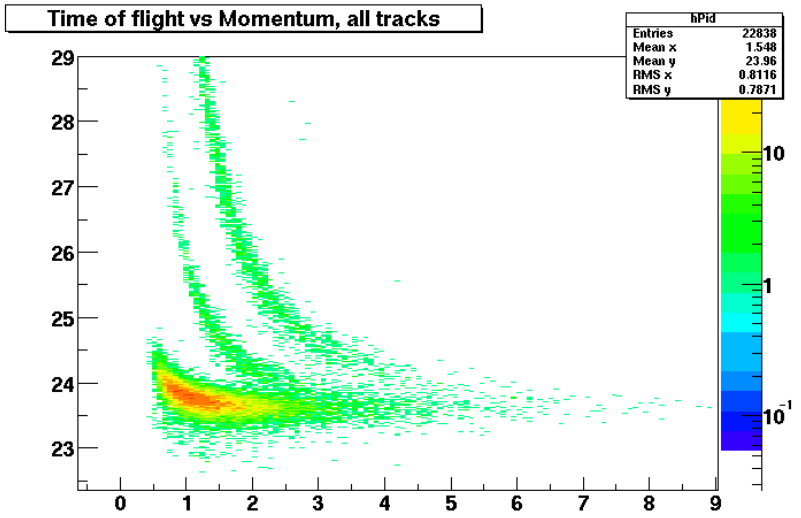


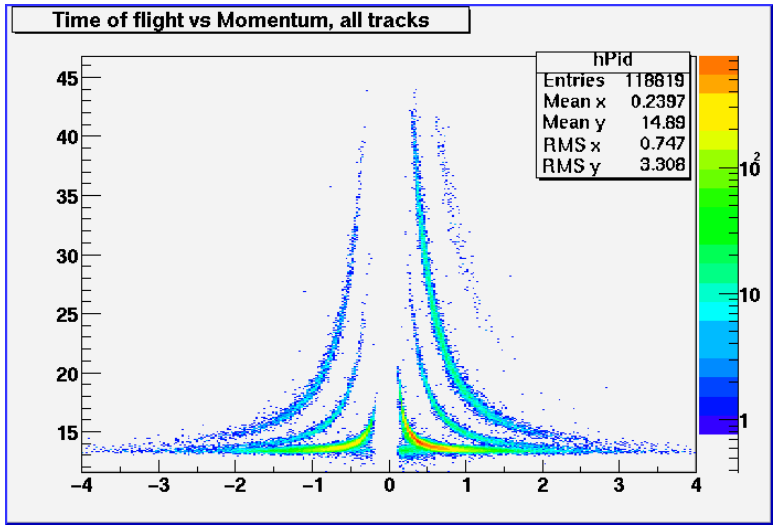




PID with H1, TD1, and TMRSF

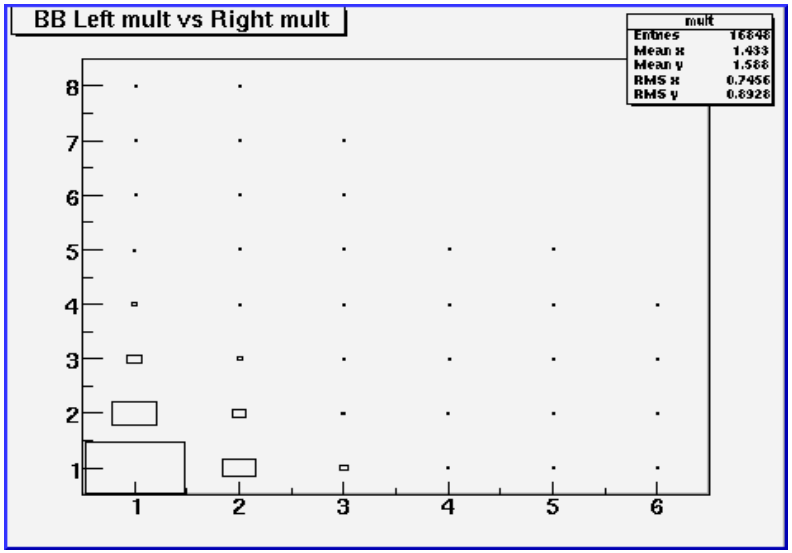
- Start time from Td1, Flight path reduced
- Using default timeOffsets from DB but add additional Toffset
- Of course no requirement on BB vertex.
- Much more systematic work and analysis has been done recently by Kris.
- For many runs the L is only ~430-50-45 ~ 335 cm.
- The timing offsets has been determined from pp runs –
- Slewing is an overall correction (-1.1-1/sqrt(A/Again))
- The d-band presumably come from background in the scintillator trigger slat, not physics





pp and dA triggers

Performance of BBC in pp collisions



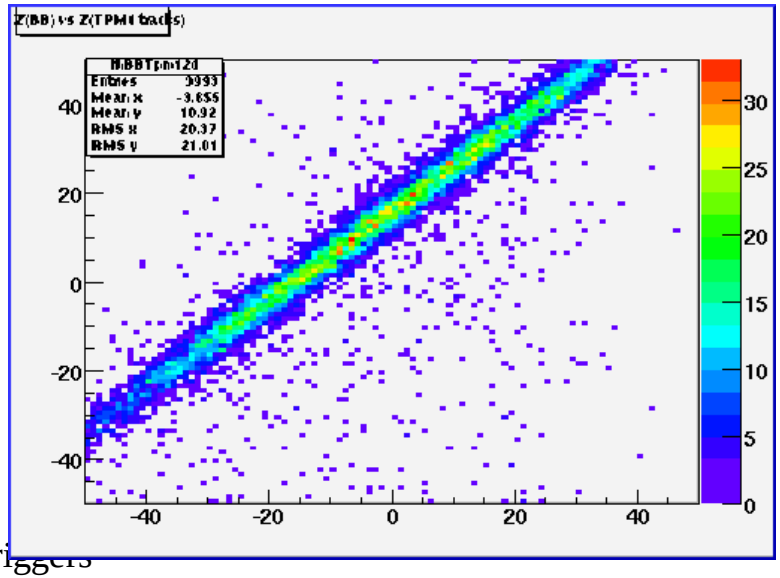
- Analyzed pp runs from January.
- Modified the BbVertex to use all tubes to extract a t0 and Z vertex.
- Correlation to TPM1 tracks (Run 6473)

Analyzed 78K trigger 3 (FS) and 30K trigger 6(MRS)

The BB counter has low efficiency – The first figure shows the hits in left vs right. Note that the total number of events is ~ 16.8K out of a total of 106K i.e.. an efficiency of ~15%. Of these the majority has only one hit in left and right,

The overall resolution in time and z determination is though still pretty good.As can be seen in the correlation plot to TPM1 tracks.

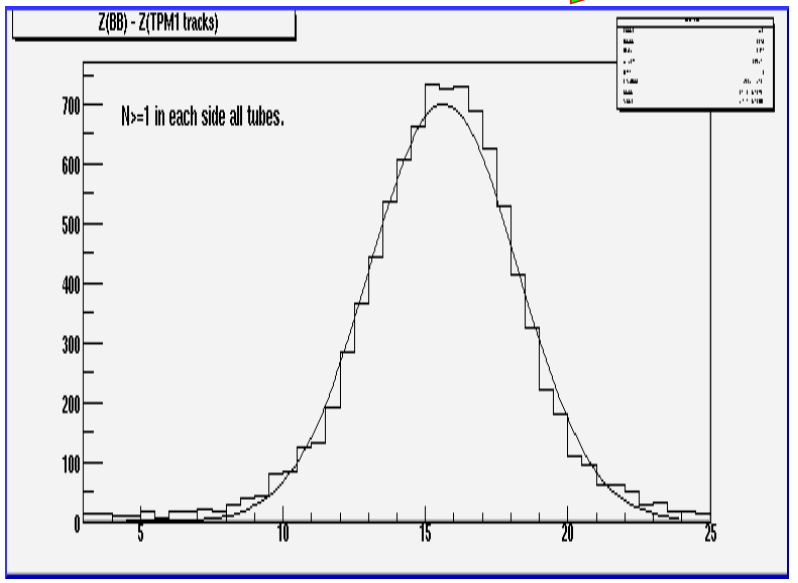
The resolution is not nearly as good as in Au-Au but reasonable for checking average vertex distribution- quality of event sample where timing and vertex is derived by other methods.

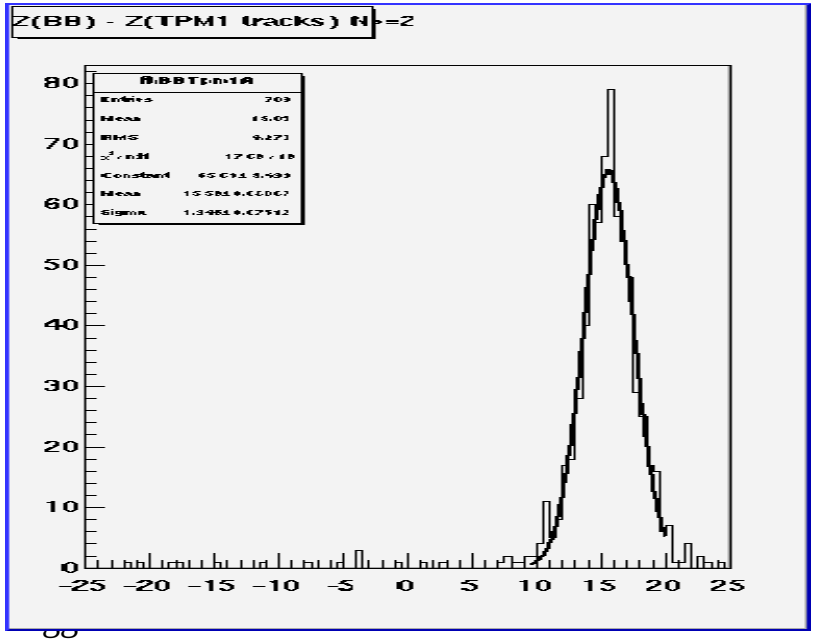


pp and dA triggers

Vertex resolution

- Z(BB)-Z(TPM1) for N>=1 and n>2 hits respectively.
- The resolution is ~ 2.6 and 1.9 cm respectively; this is to be compared with the AuAu resolutions of ~ 0.8 cm.





pp and dA