e-Arm detector for Transversity Experiments: the BigBite spectrometer

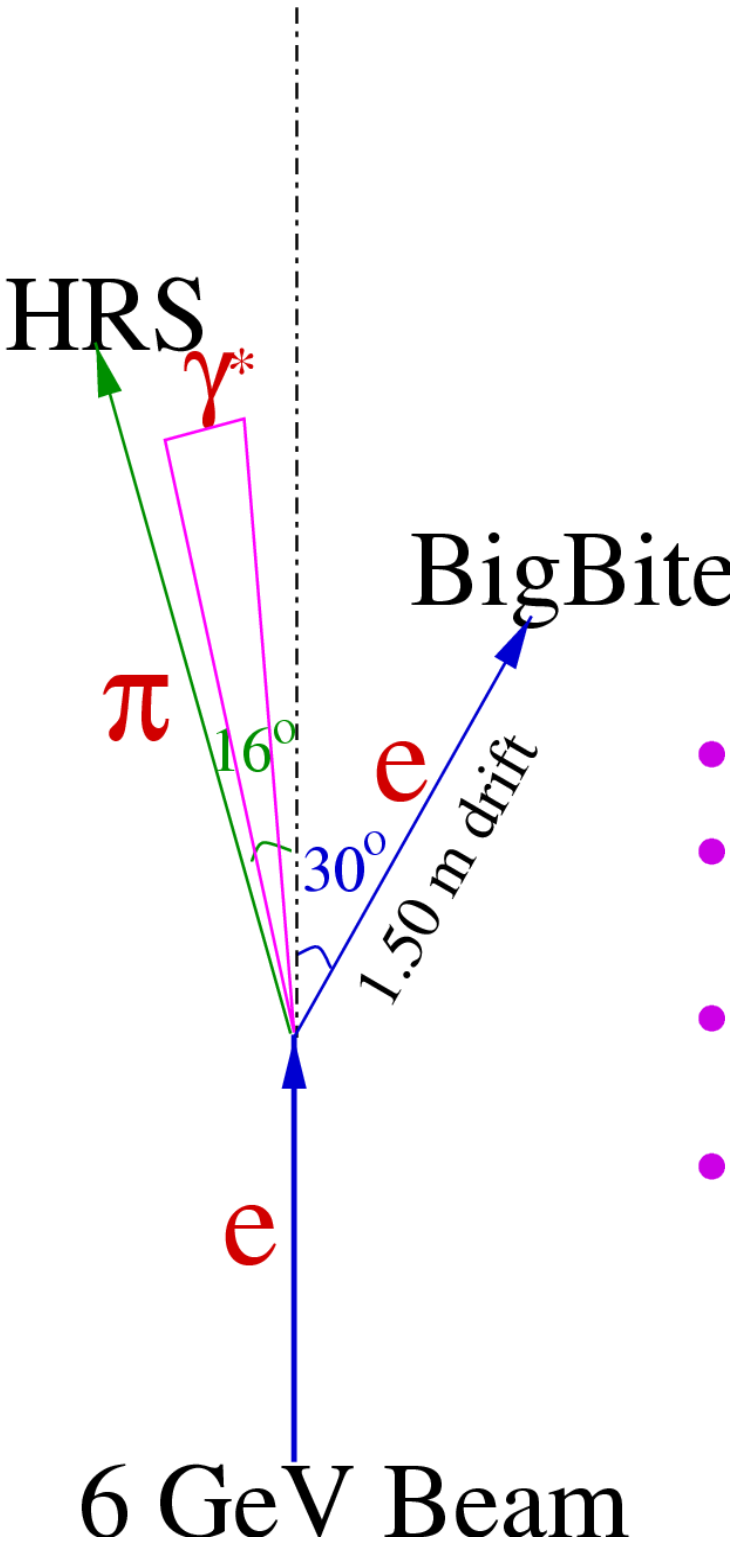
Xiaodong Jiang (Rutgers). March 19th, 2007. Readiness review.

BigBite as the e-arm detector.

Basic requirements and results from a test run.

Detector work and testing.

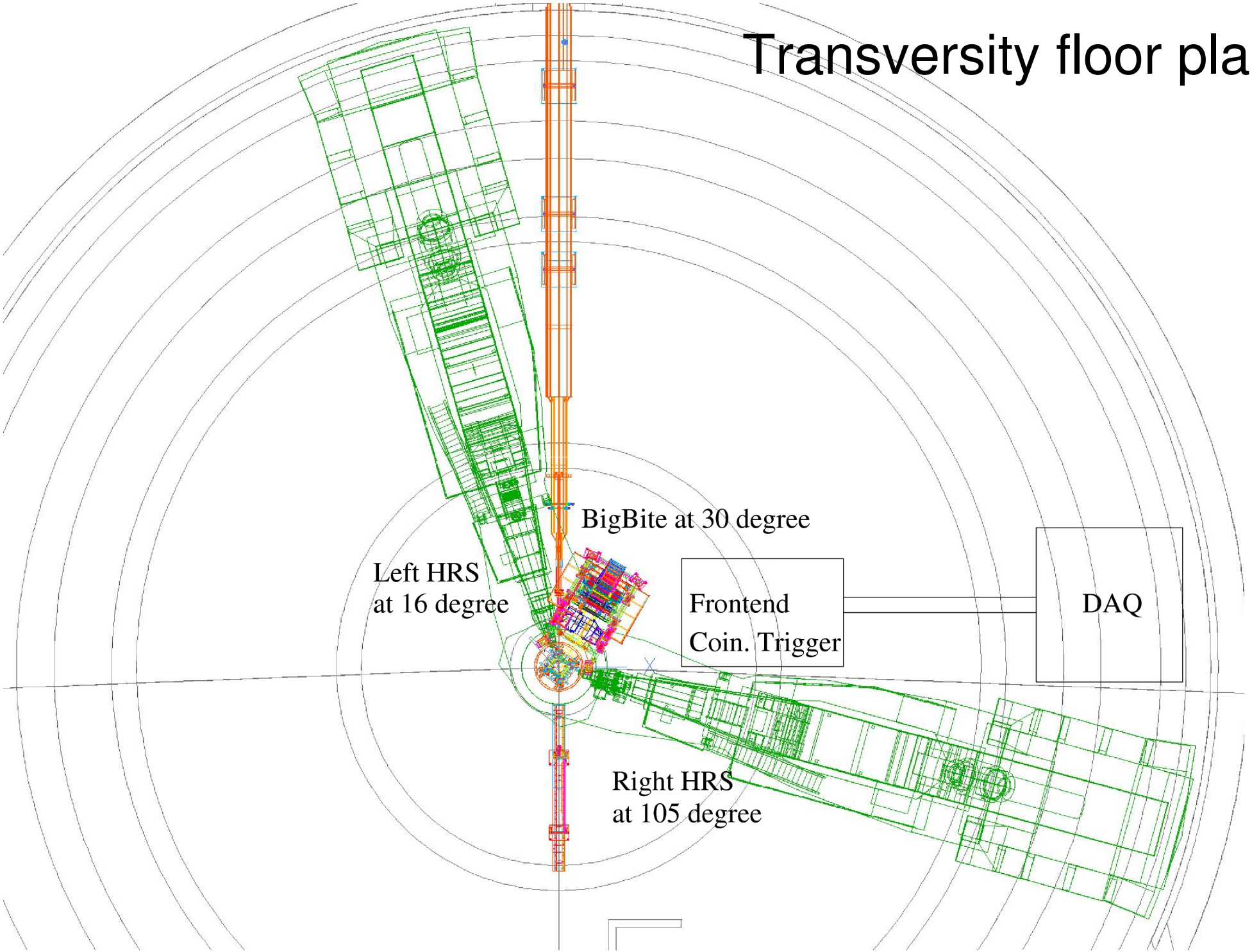
Major design items, hardware work and milestones.



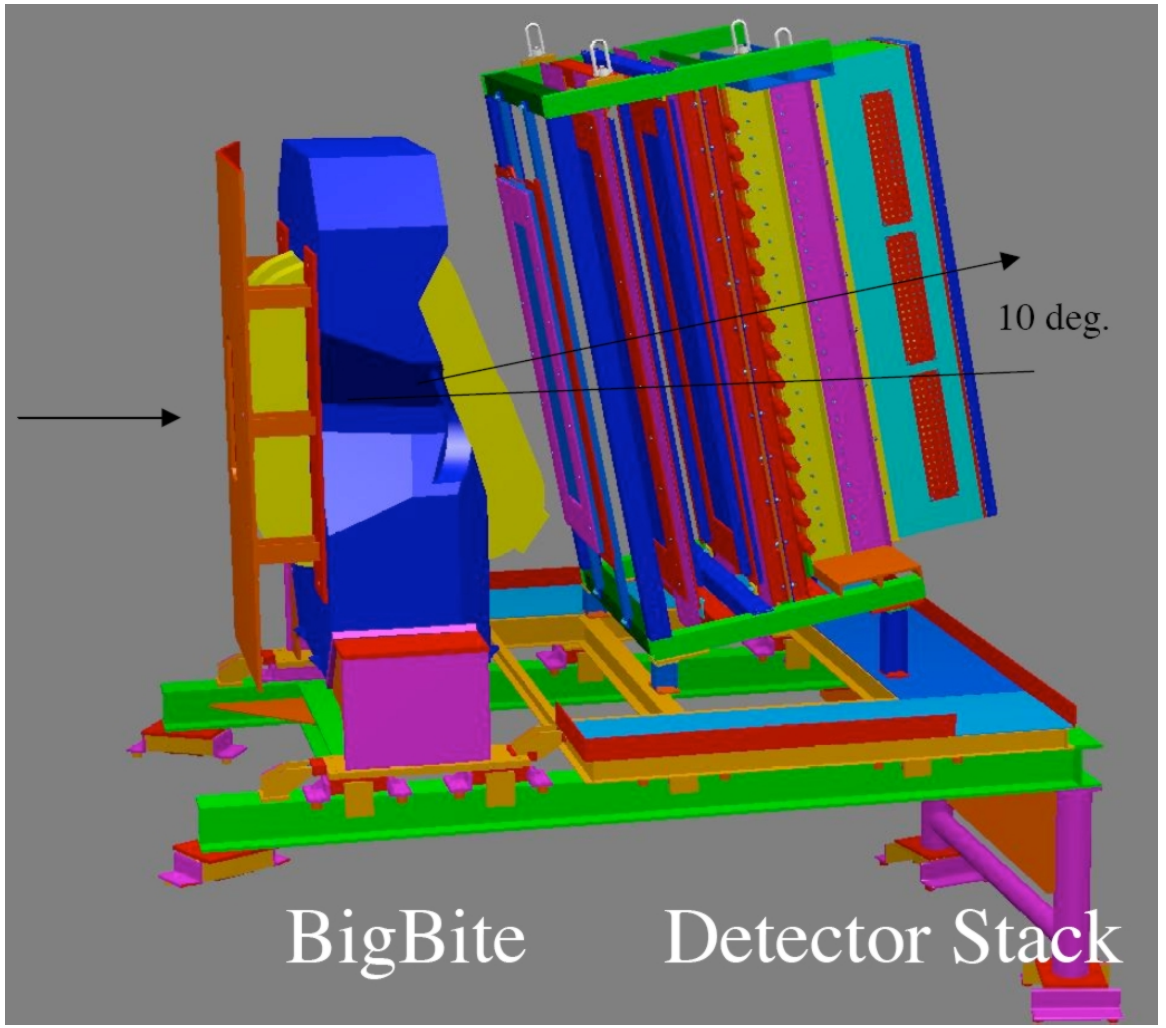
E06-010 and E06-011

- Use existing equipments in Hall A.
- Polarized ^{3}He target, 10 atm pressure.
  $\mathcal{L}(\vec{n}) = 10^{36}$ cm^{-2}s^{-1}.
- HRS$_L$ at 16° as h-arm ($\pi^{+/-}$ or $K^{+/-}$ with RICH for PID.).
  $p_h = 2.4$ GeV/c, $z = 0.5$.
- BigBite spectrometer at 30° as e-arm. $\Delta\Omega = 64$ msr.

Transversity floor plan



BigBite Spectrometer as e-Arm of the Coincidence



A 1.2 Tesla dipole magnet, 3 drift chambers,
a pre-shower+scintillator+shower package

As in the Gen experiment.

1.5 m drift (rather than 1.1m).

Requirements:

Takes “high” luminosity.

15 uA beam on 40 cm pol. He3 target.
At 30◦ with 6 GeV beam.

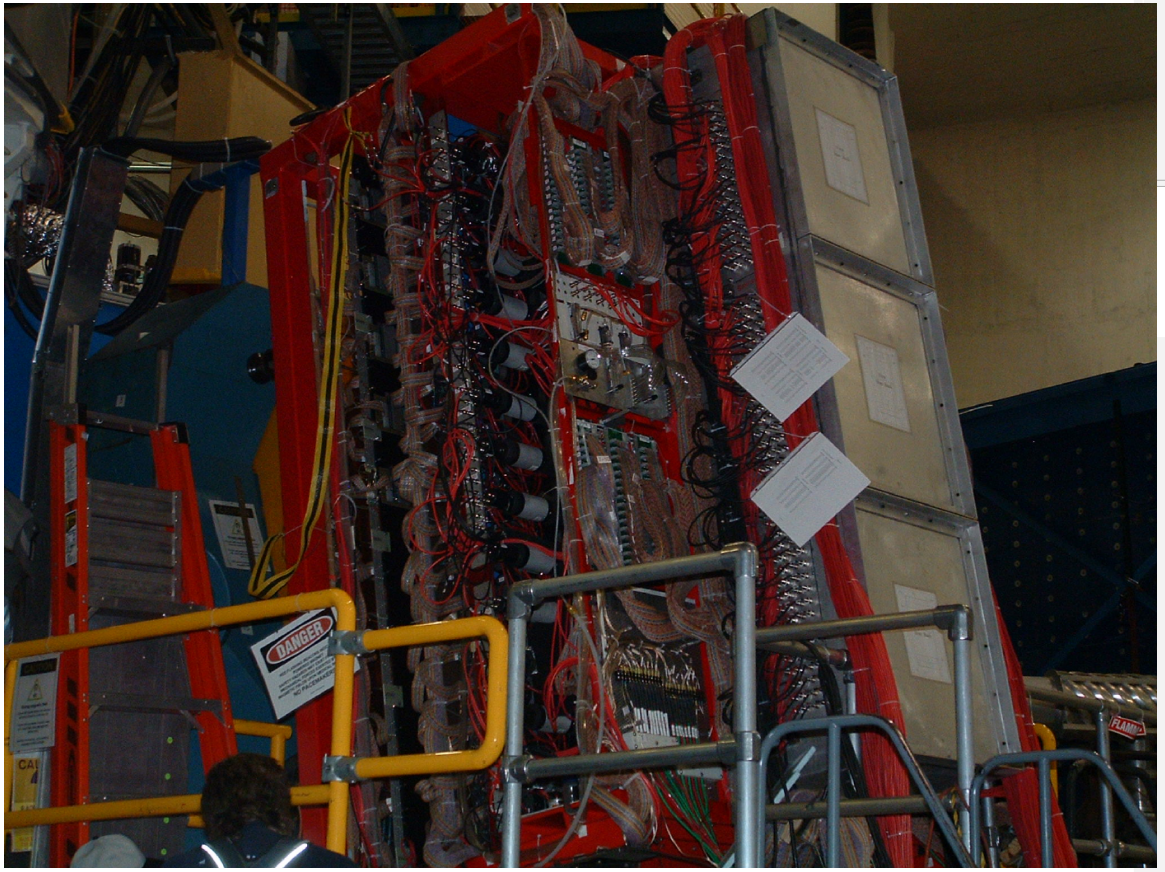
Modest resolution:

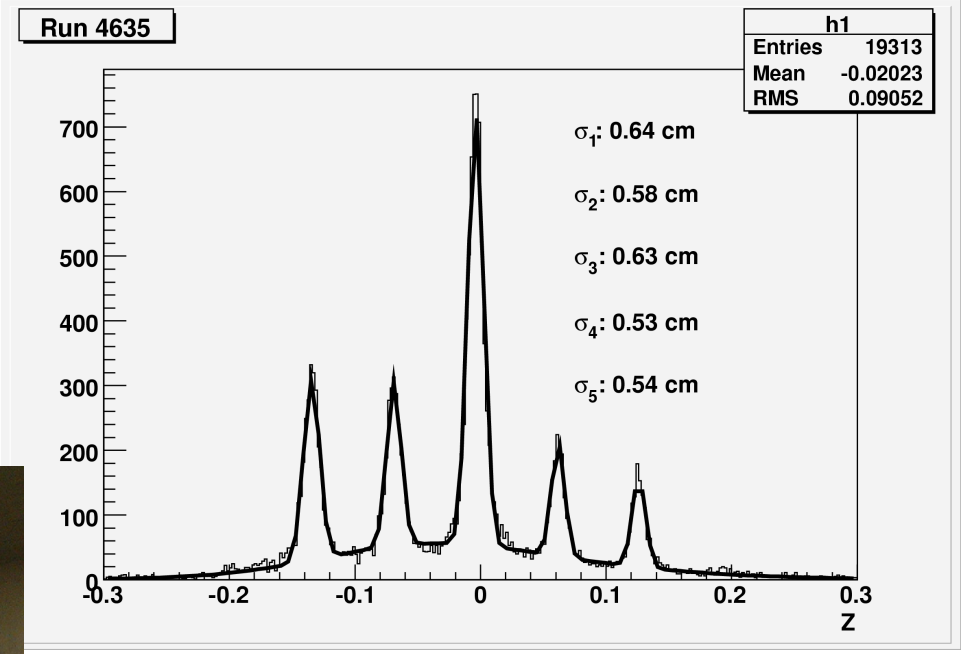
Momentum: <2%.
Hor. angle: <5 mrad.
Ver. Angle: <10 mrad.

Particle ID (off-line):

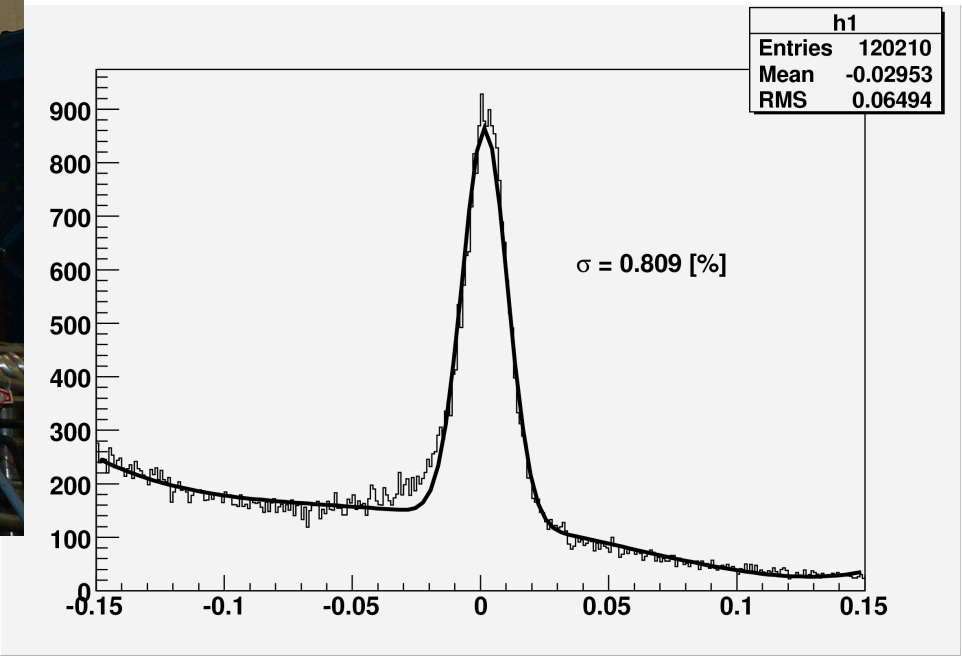
reject pions by preshower/shower 30:1.

Understanding BigBite optics at 1.5m drift. A test run in 2006.



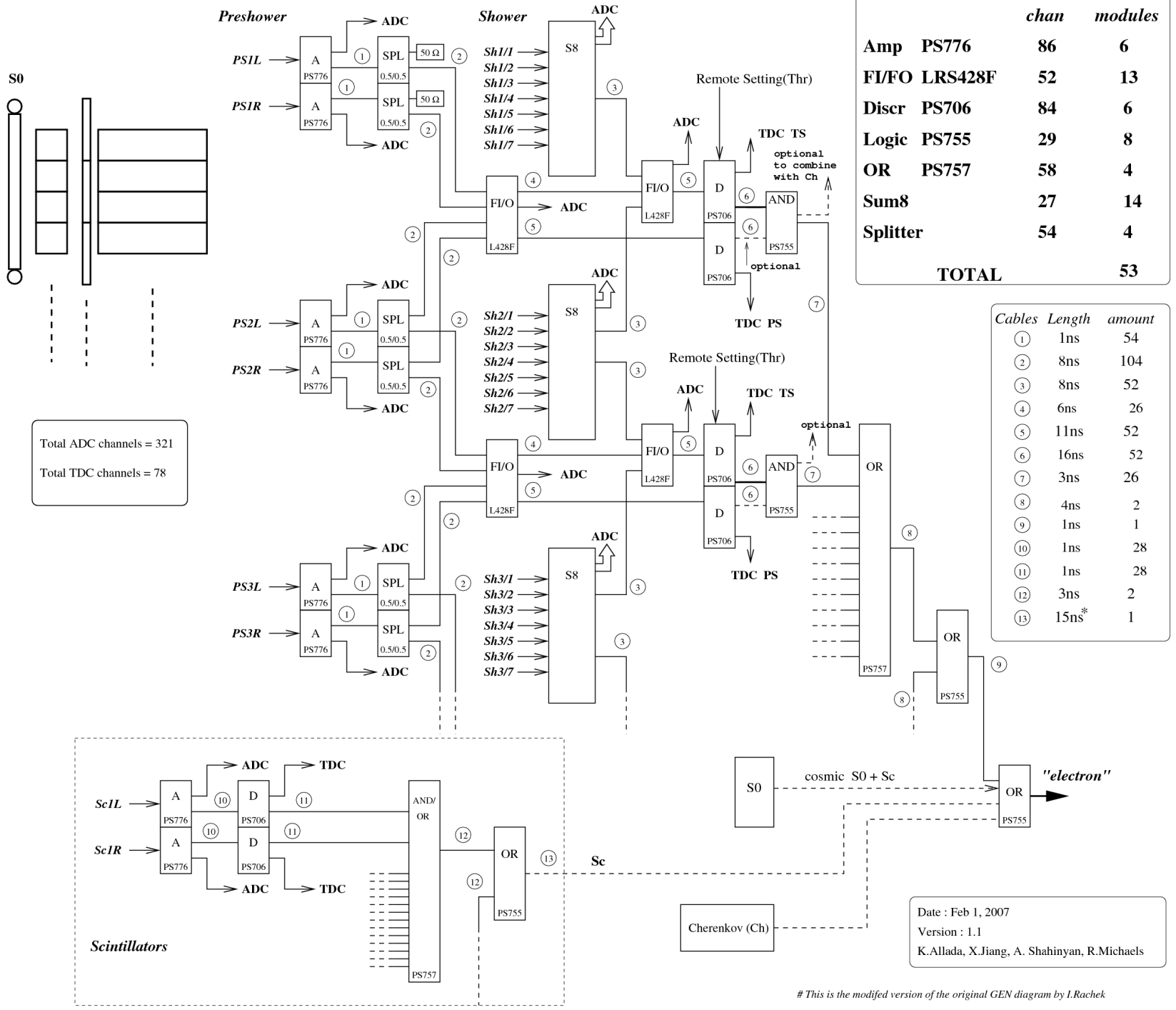


5-carbon foils in the beam.
Interaction point resolution 5mm



Reconstructed momentum in p(e,e') elastic scattering.

BigBite Trigger Logic for Transversity Experiment (Based on GEN)



Total ADC channels = 321

Total TDC channels = 78

		chan	modules
Amp	PS776	86	6
FI/FO	LRS428F	52	13
Discr	PS706	84	6
Logic	PS755	29	8
OR	PS757	58	4
Sum8		27	14
Splitter		54	4
TOTAL			53

Cables	Length	amount
1	1ns	54
2	8ns	104
3	8ns	52
4	6ns	26
5	11ns	52
6	16ns	52
7	3ns	26
8	4ns	2
9	1ns	1
10	1ns	28
11	1ns	28
12	3ns	2
13	15ns*	1

Date : Feb 1, 2007
Version : 1.1
K.Allada, X.Jiang, A. Shahinyan, R.Michaels

 # This is the modifed version of the original GEN diagram by I.Rachek

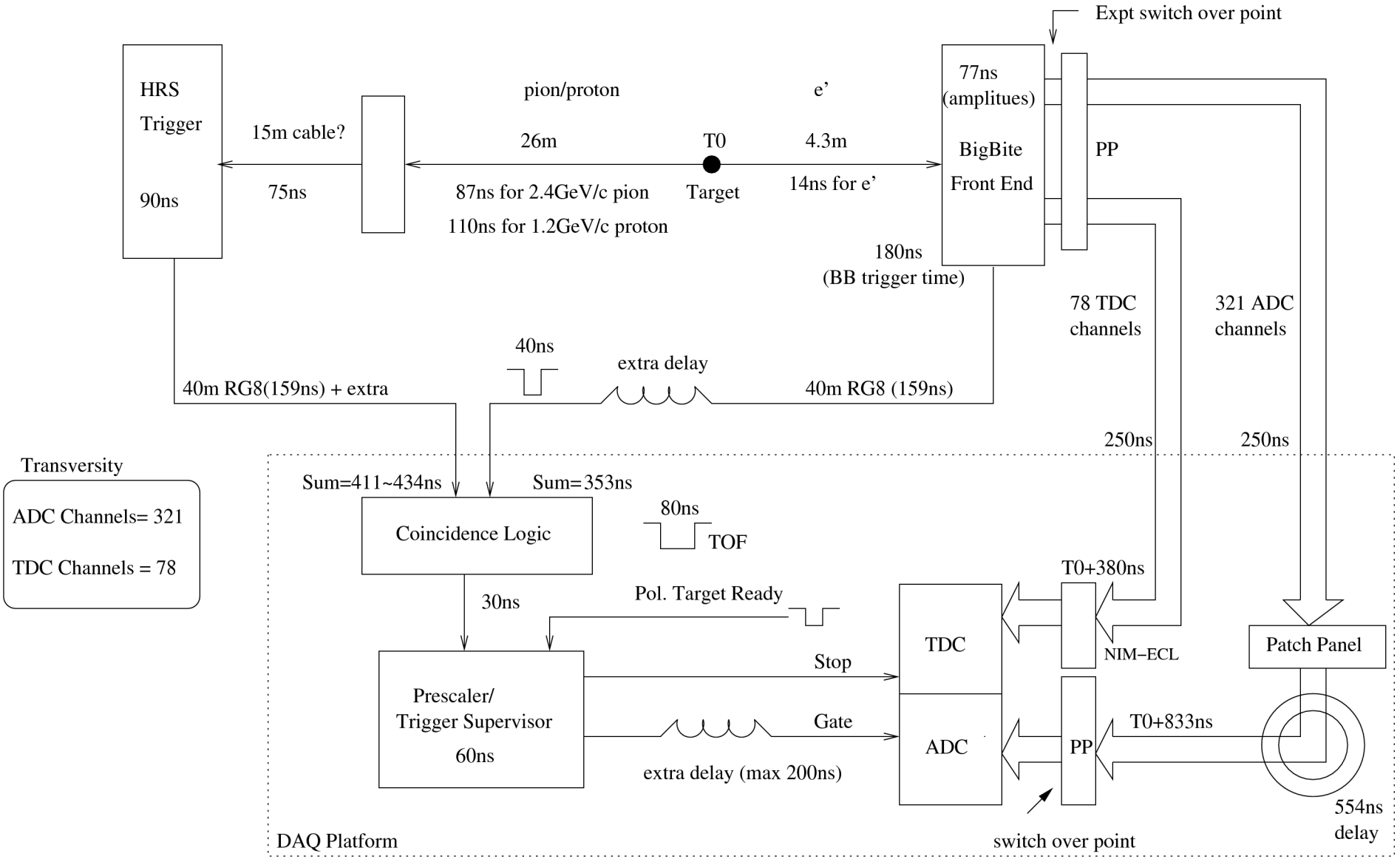
e-Arm Trigger

sum of energy deposit on lead-glass blocks

to combine with HRS to form coincidence trigger

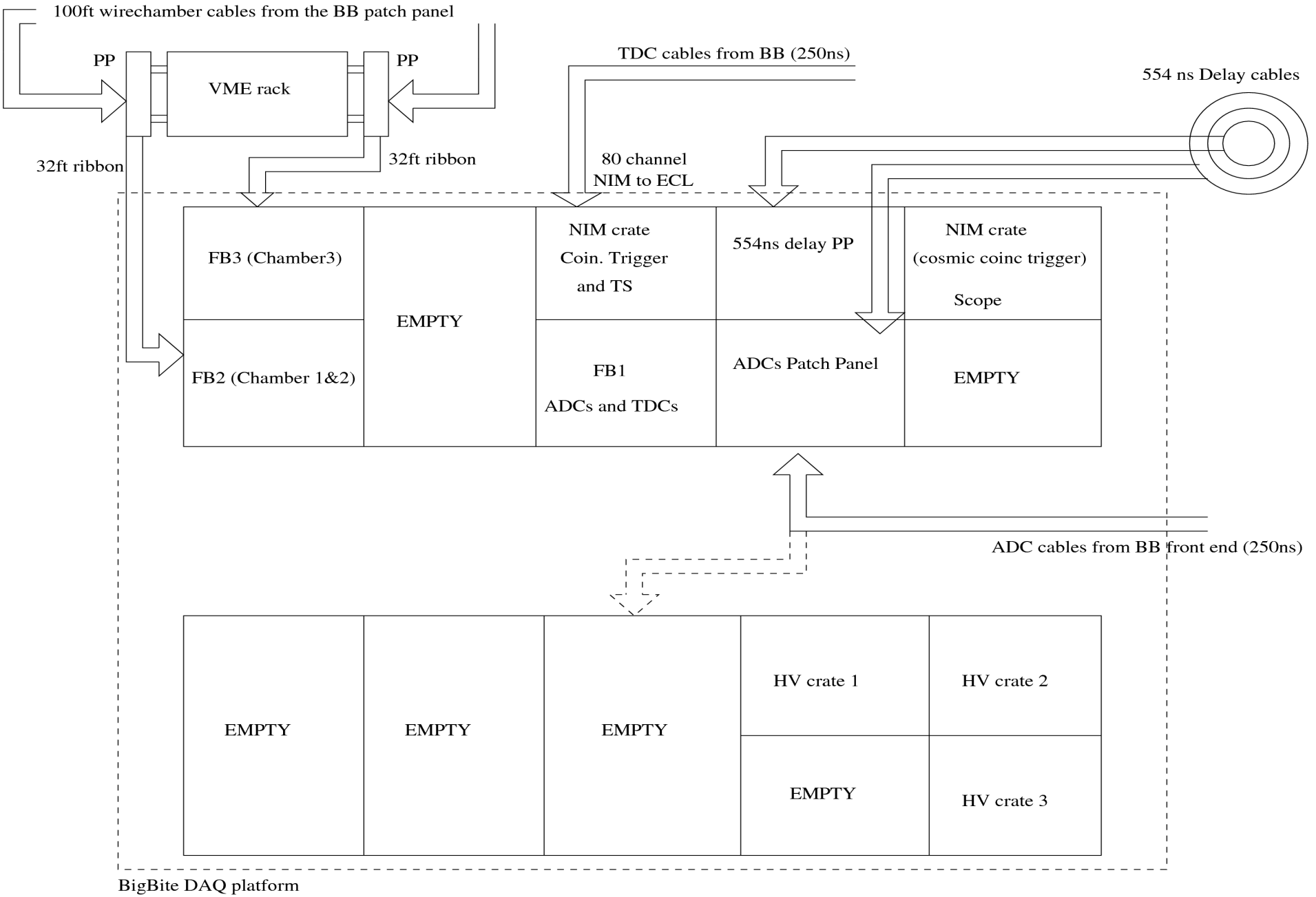
Date: Feb 2nd, 2007
Version: 1.1
K.Allada, X.Jiang, R.Michaels

Transversity Experiment Coincidence Trigger Block Diagram

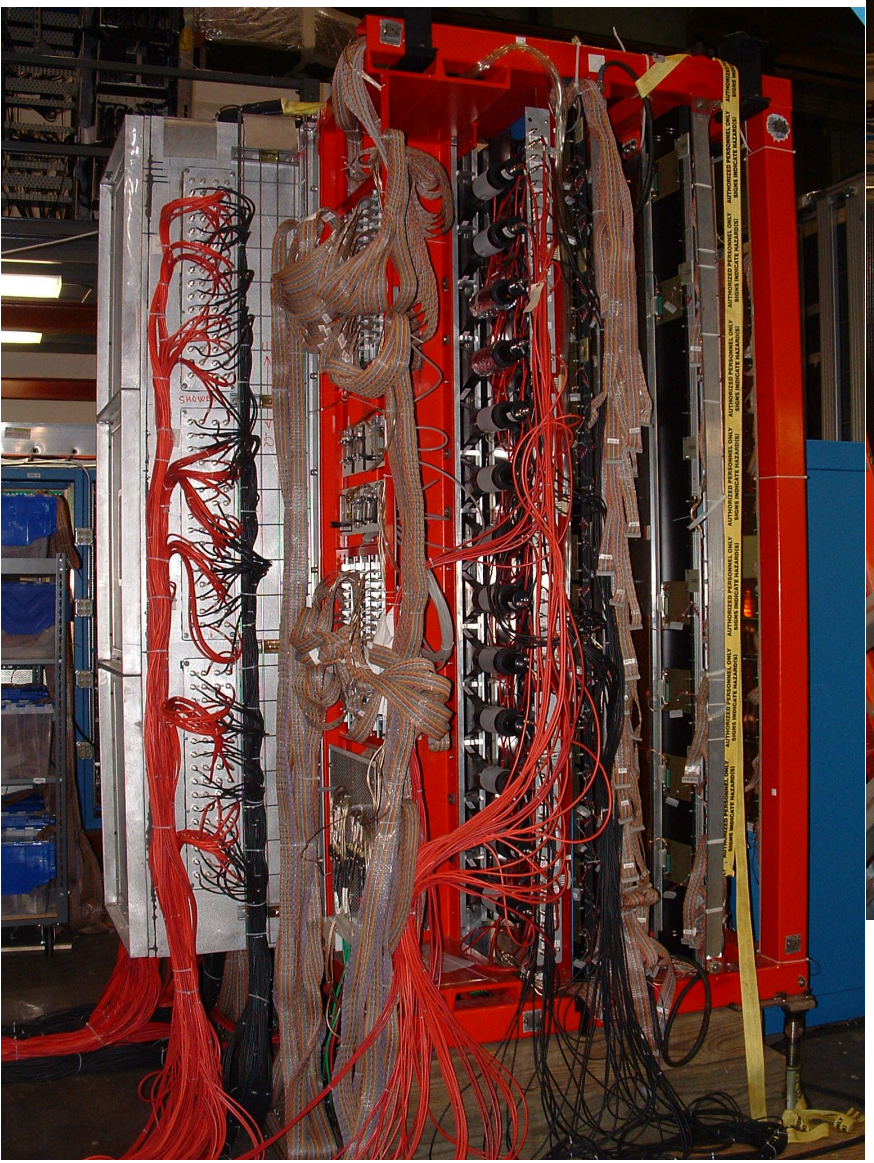


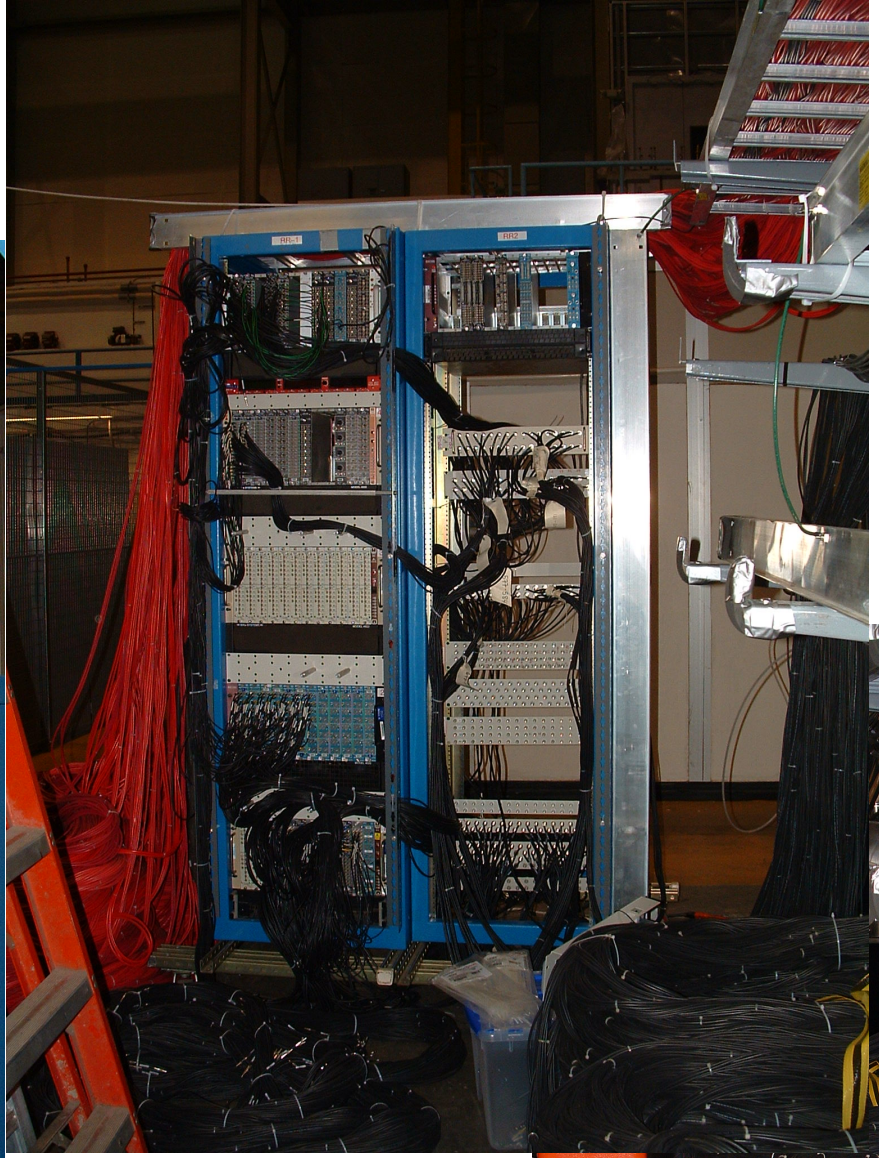
At the BB DAQ platform

easy to switch between experiments



Set up BigBite detectors in the test lab (as of 3/19/07).





... to reproduce Gen set up by the end-of May. Take cosmic ray data.

Goals

Test all detectors. Training of a new group of on-site experts:

2 experts on wire chamber/readout/tracking/optics.

2 experts on shower detectors/trigger/DAQ.

Completed tasks at the test lab (K. Allada, X. Qian, et al.):

Check/fix cables.

Pre-shower and shower each block signal check.

Scintillator cosmic ray test using DAQ.

Arranging delay cables and patch panels.

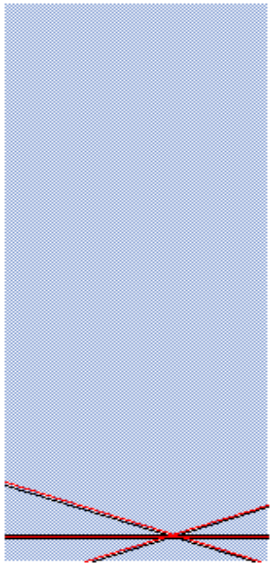
Three wire chamber HV tests.

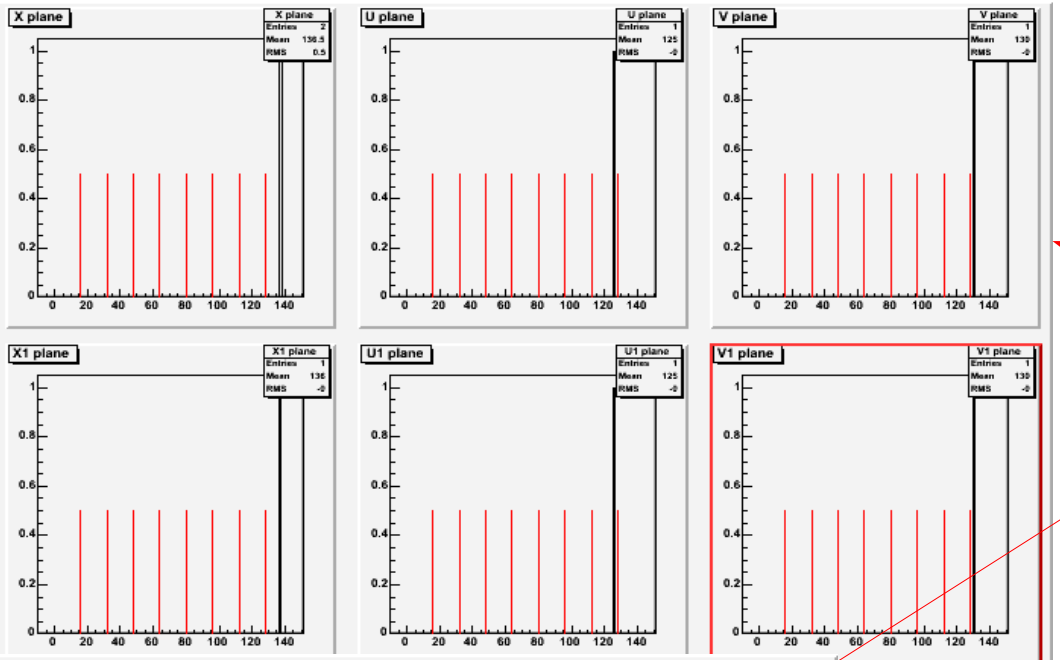
Readout of chamber-1.

A common ground of all components.

Software tools: event display, HV controls etc.

Wire chamber-1 hit event-display: cosmic ray

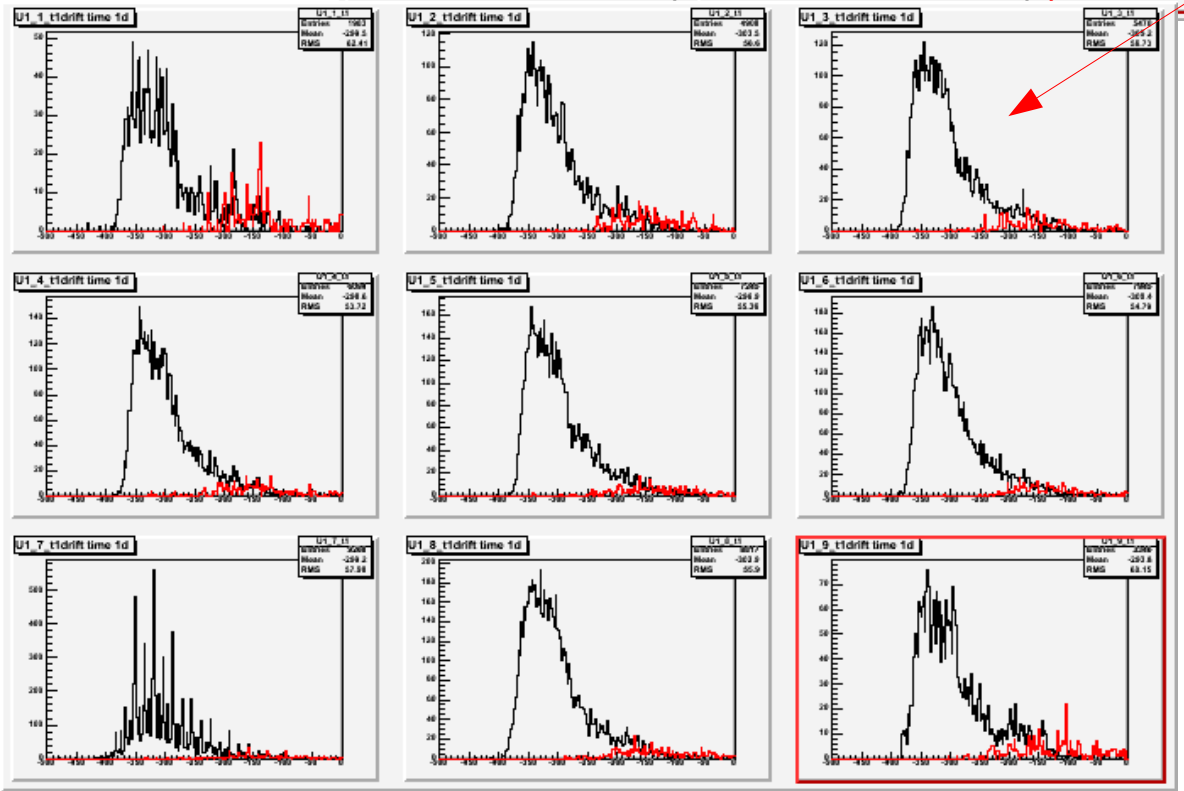


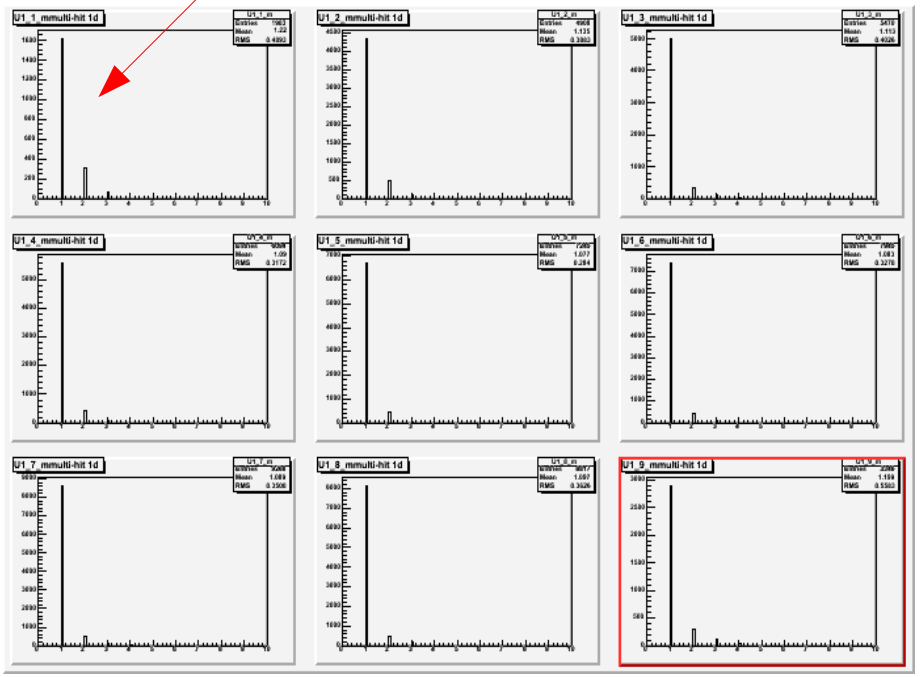


Hit location.

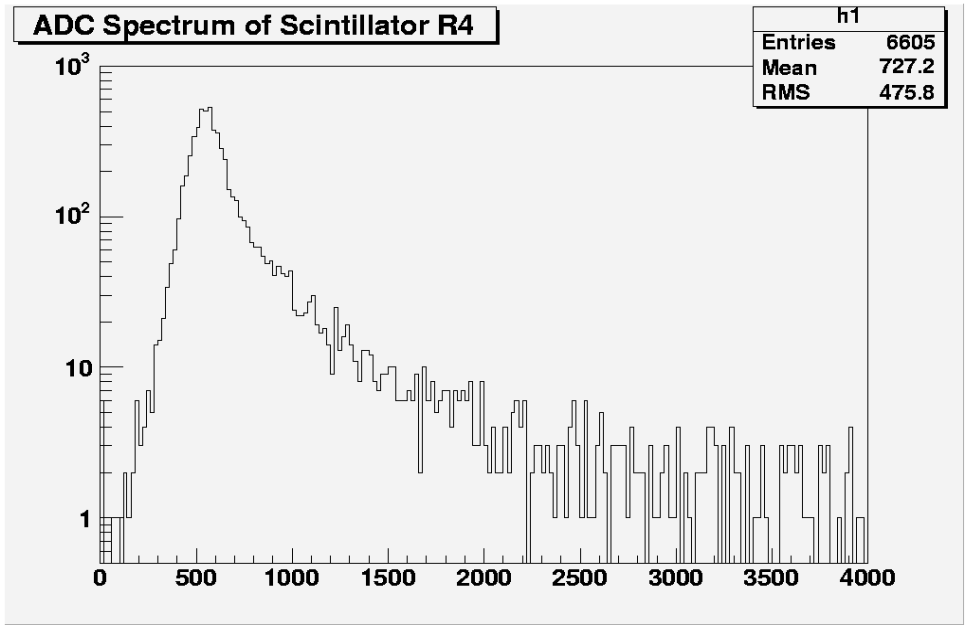
Drift time.

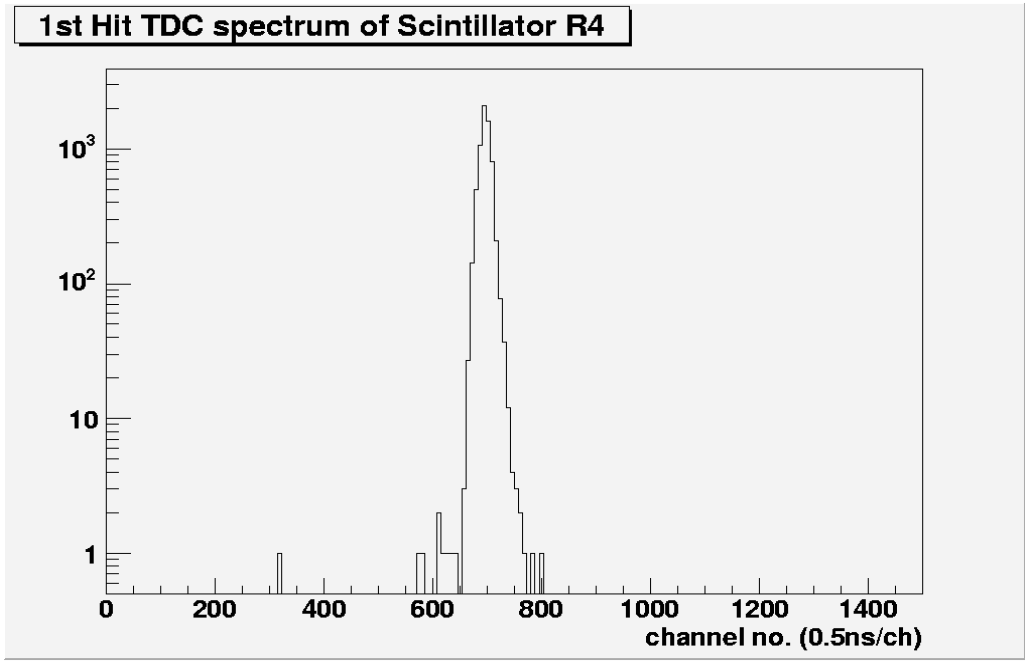
Multiplicity.

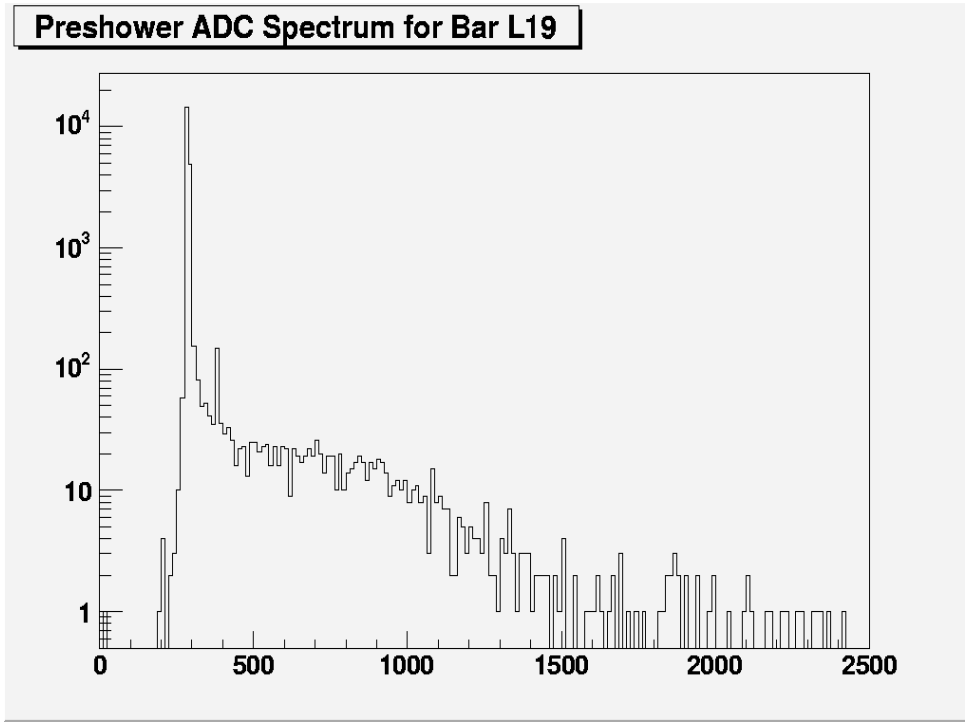


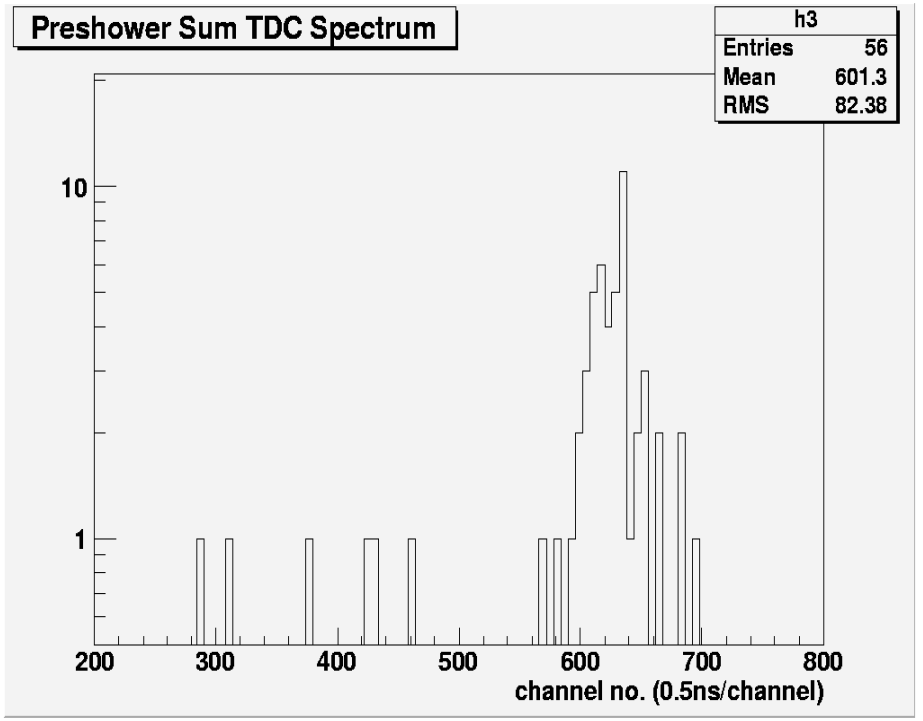


Scintillators and pre-shower blocks









Milestones on BB detector/DAQ test:

April 30, 2007:

Trigger and DAQ set up, pre-shower+shower DAQ check completed.

May 30, 2007:

chamber-1+chamber-3 readout check completed.

All preAmp card delivered and checked (210 + 30).

July 1, 2007:

6 shower PMTs fixed. If we have money+manpower, refurbish pre-shower blocks and PMTs.

... milestones on BB detector

Sept. 1, 2007:

three chamber read out check, demonstrate clear cosmic tracking.

Nov. 1, 2007:

Gas Cherenkov integrated into detector package. Whole-package cosmic ray test. ch1+ch2+gas-C+preshower+Scint+shower.

Dec. 1, 2007: Ready for installation.

To run BigBite at the maximum luminosity allowed by the pol. He-3 target. Planned improvements:

Replace old preAmp cards with the new type.

Add 3-planes to chamber-2 (6-plane).

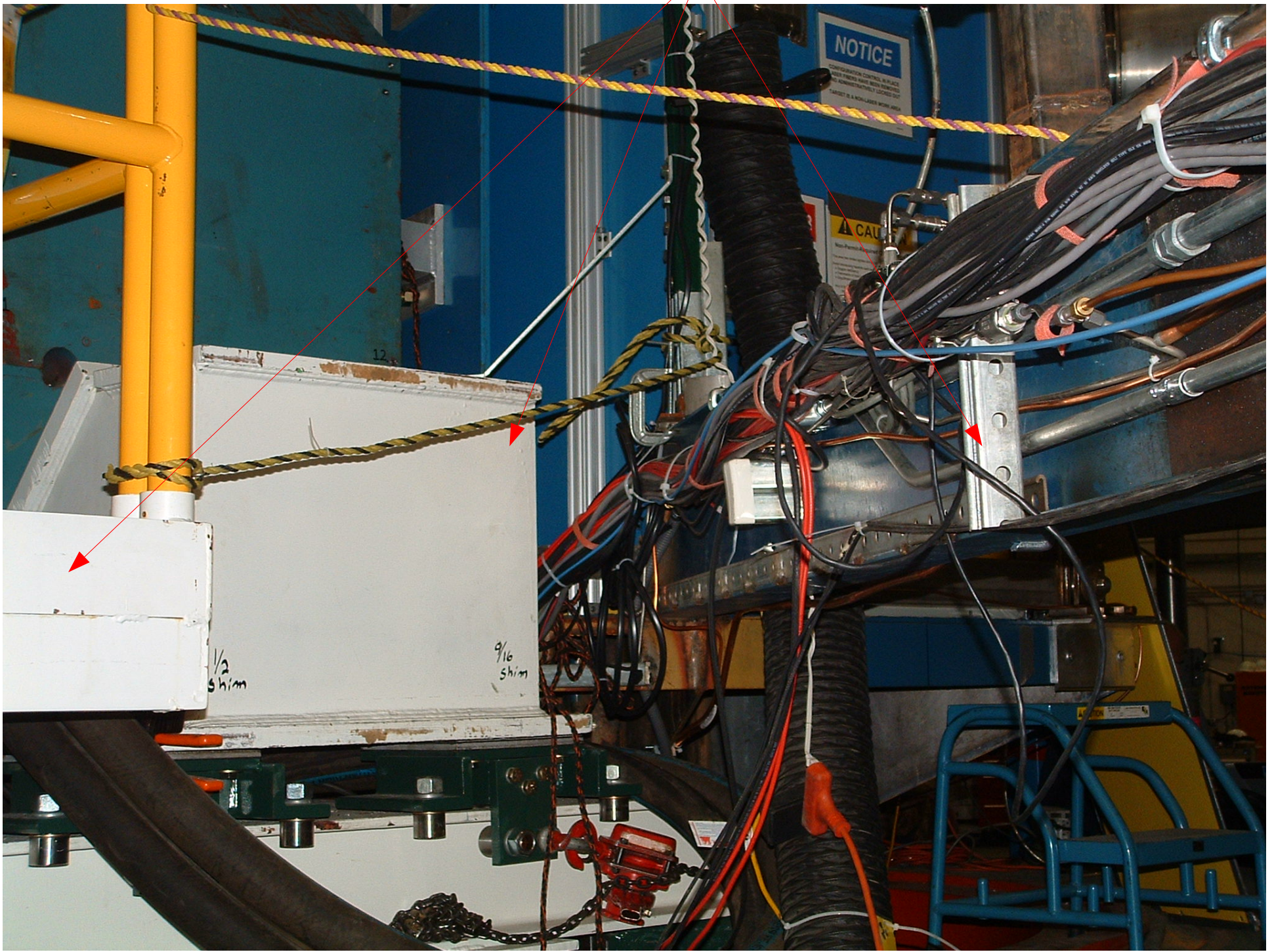
Shielding and collimation (designs needed).

1. A 3” (st. steel) front collimator at the magnetic clamp.
2. Two boxes to hold 2”-thick lead pieces inside BigBite magnet to block low field regions.
3. A light-weight near-detector shielding.
4. A 6”ID downstream pipe section (design done).
5. Near beam height downstream shielding.
6. Concrete blocks as far-shielding.

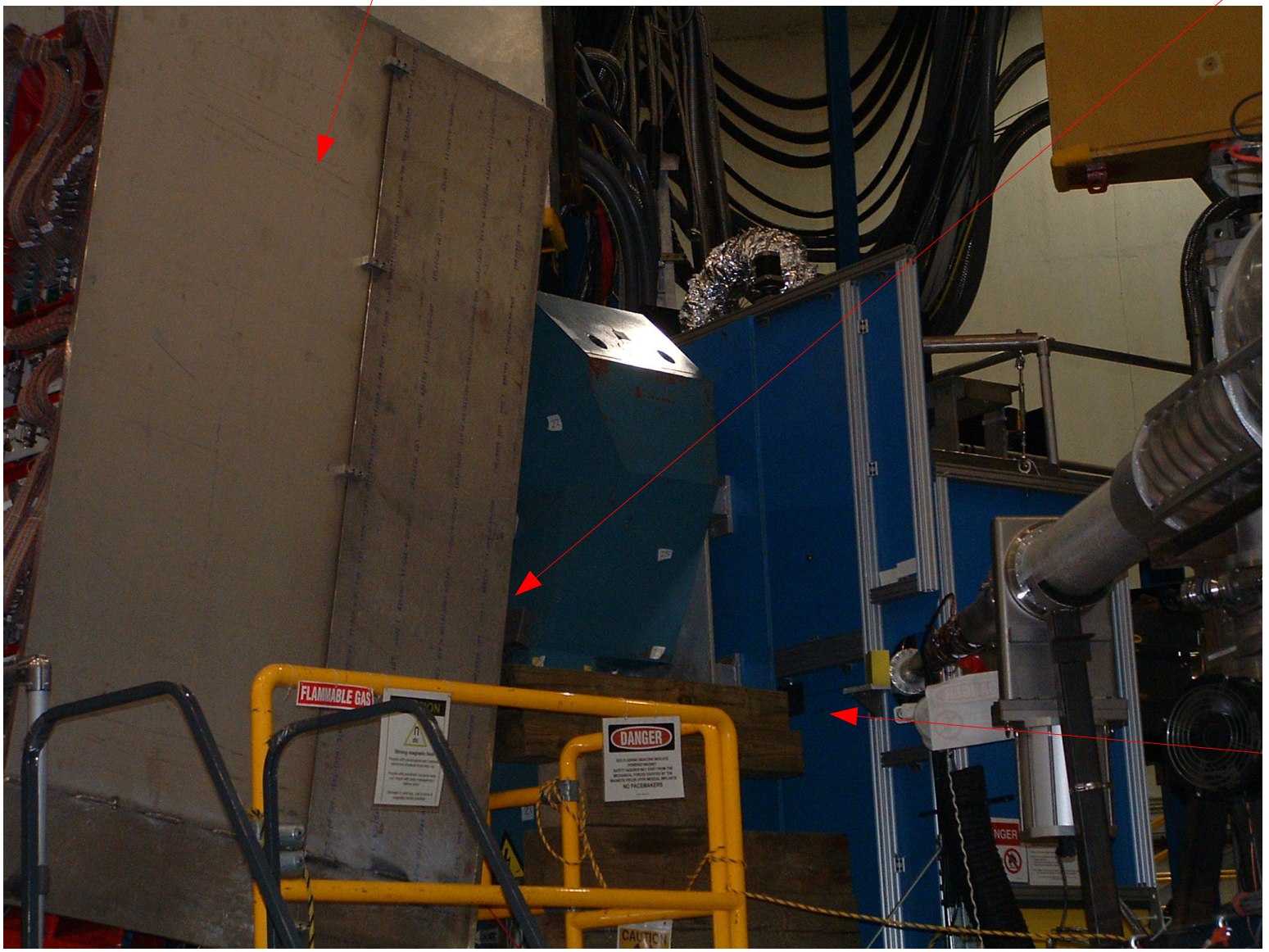
Hardware works to be completed during the July-Oct 2007 down to speed-up transversity installation

1. BigBite magnet support, mount the new right foot, clear interferences with the downstream section.
2. Mount the new BigBite magnetic clamp piece.
3. Test mount the collimation boxes inside the magnet.
4. Measure the BigBite fringe field with the new field clamp on.
5. Modify BigBite platform right wring, clear downstream interferences.
6. Prepare the near-beam shielding pieces.

Need to check/clear interferences for BB at 30^{o}



Need to modify near-detector shielding, allow easy access to the detectors



Fill in gaps, block direct view of beam line from detectors.

Improve design of near beam height shielding.

Design Items and budget

1. ~80 chips + new preAmp card. ~ $10k
2. Frame to mount two front chambers. ~$6k.
3. A light-weight near-detector shielding hut. ~$12k.
4. Upstream and down stream beam pipe sections+windows. $15k.
5. Optics slit and BigBite front collimator + mount. $8+2k.
6. Collimation box inside BigBite magnet. $6 k.
7. Modification of BigBite downstream side platform + support for near beam pipe shielding. $8k.
8. Cables, connectors. $20k.

above total: $87k.

9. 60 new PMTs to replace the old ones on pre-shower blocks. $20k.
10. 6 new PMTs to replace bad ones on shower blocks. $2k.
11. Cherenkov mirrors, cones. $45k.
12. Cherenkov box, structure. $15+k.

these items: $82+k, can be partially covered by University groups.

Summary on BigBite

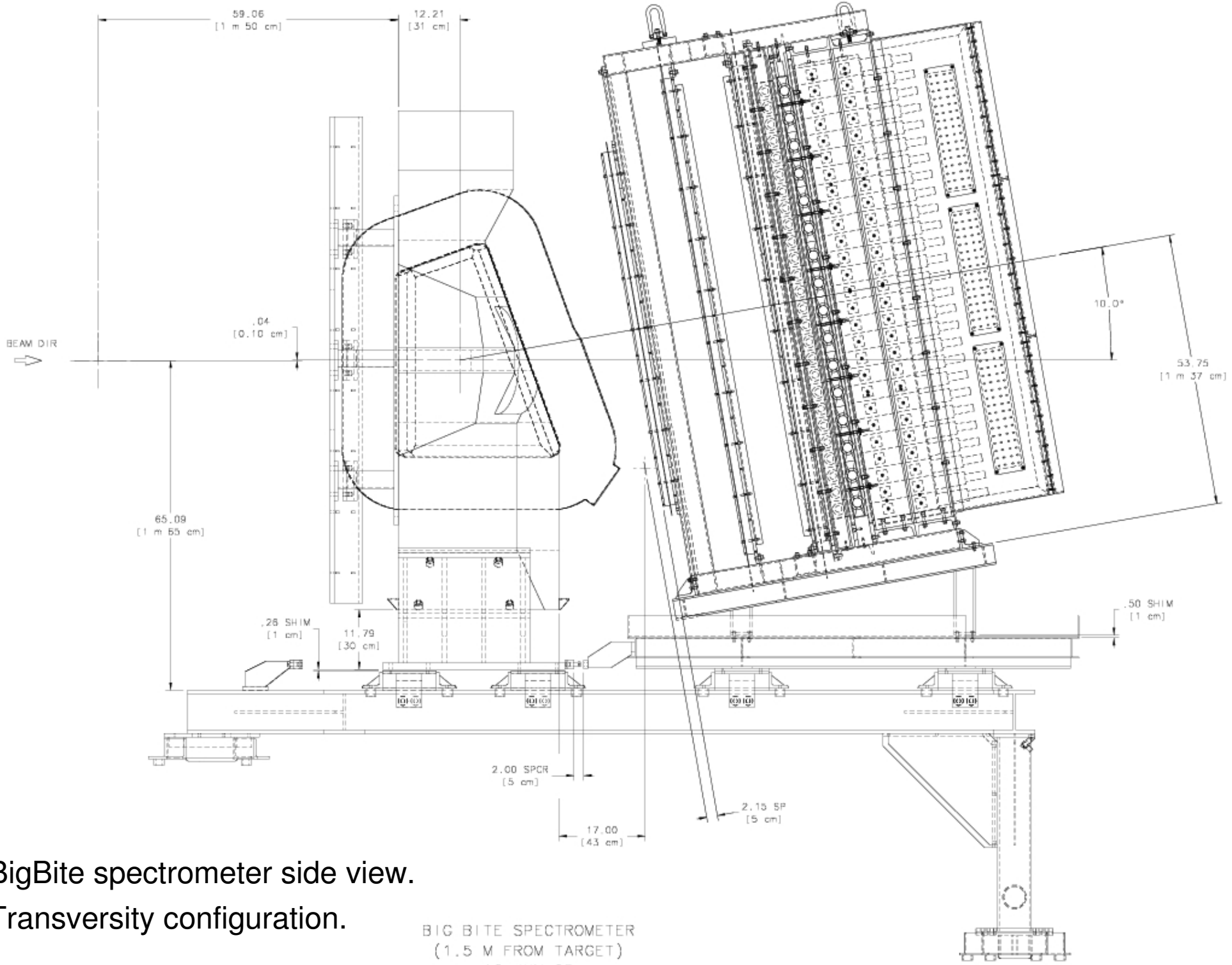
1. Many progresses on BB detector testing. On track for installation-ready on Dec. 1st, 2007.
2. BB design items identified, many pieces.
3. Hardware pre-installation preparation works need to start during the summer-07 down time.
4. Need strong technical/staff supports from JLab.

... need to clear interferences

BigBite Magnet Collimation Pieces

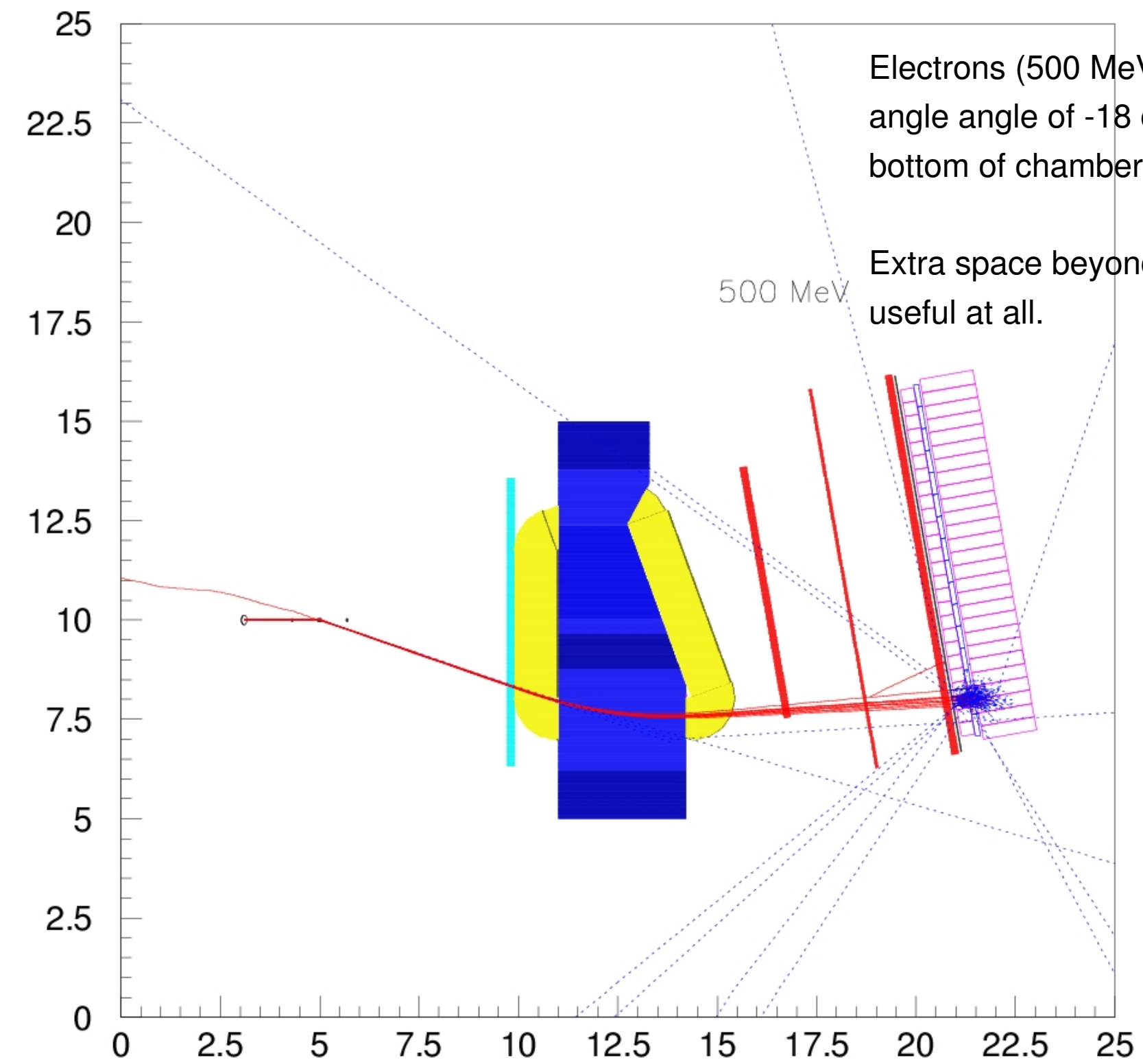
Design needs.

Specifications.



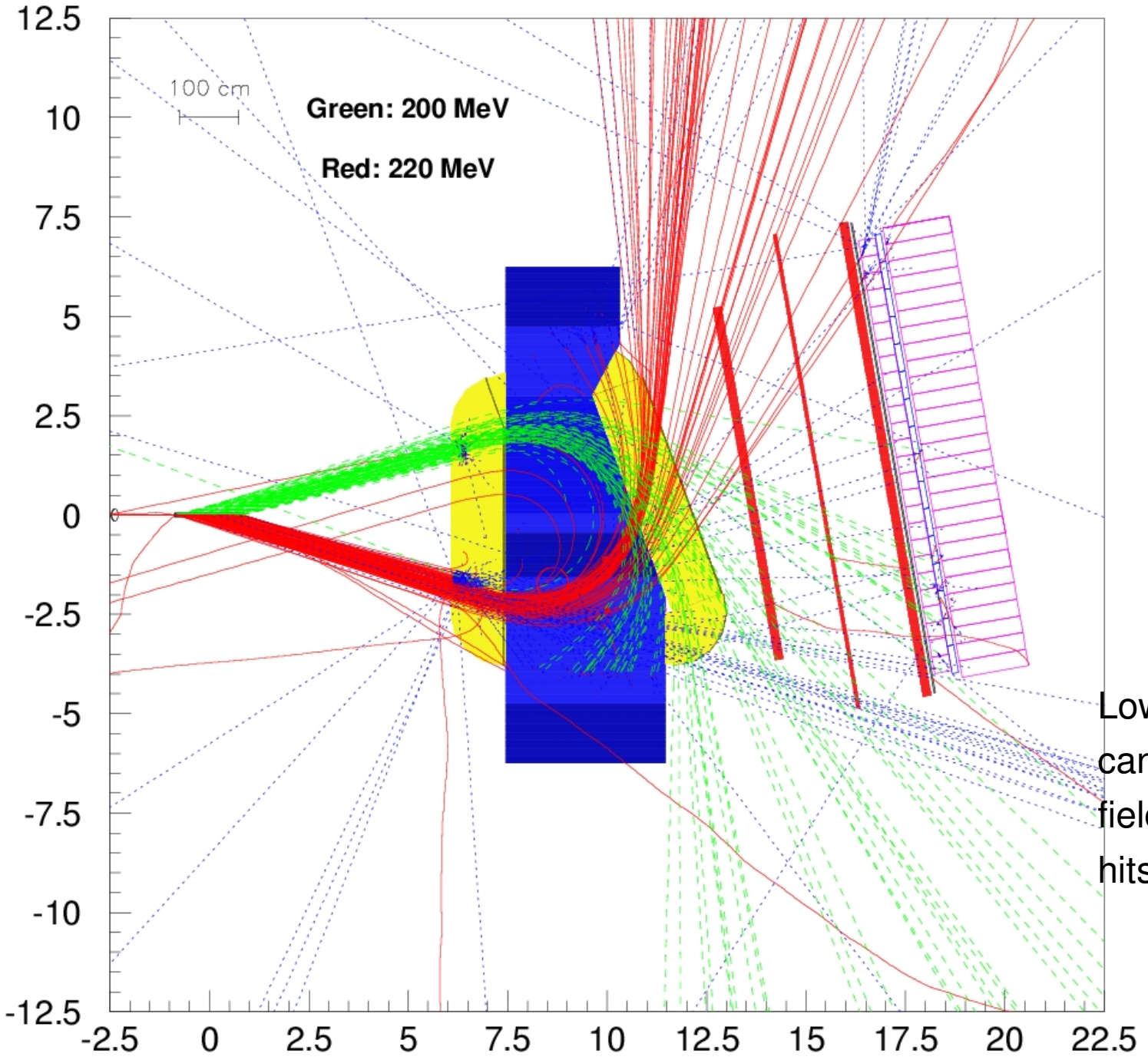
BigBite spectrometer side view.

Transversity configuration.

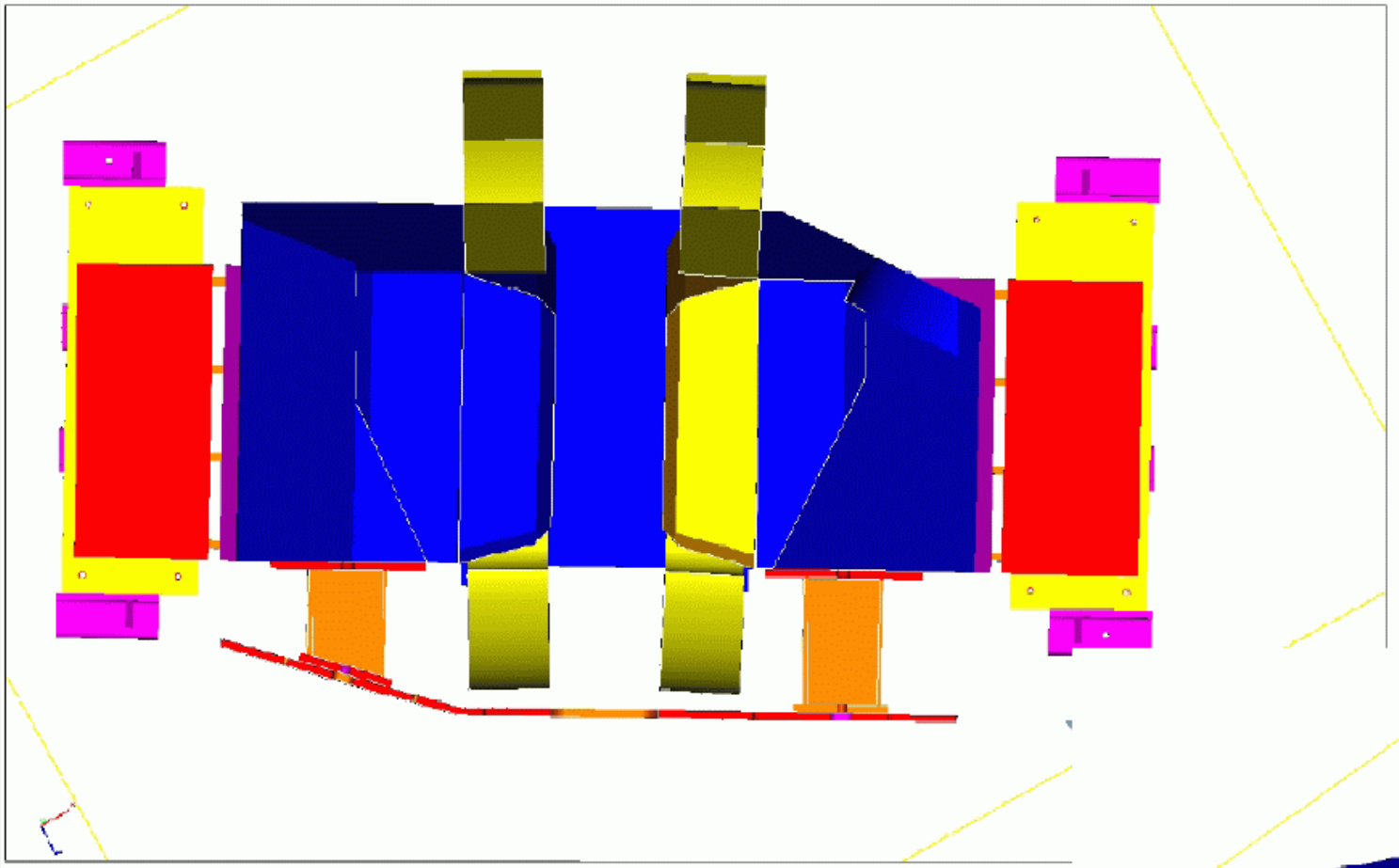


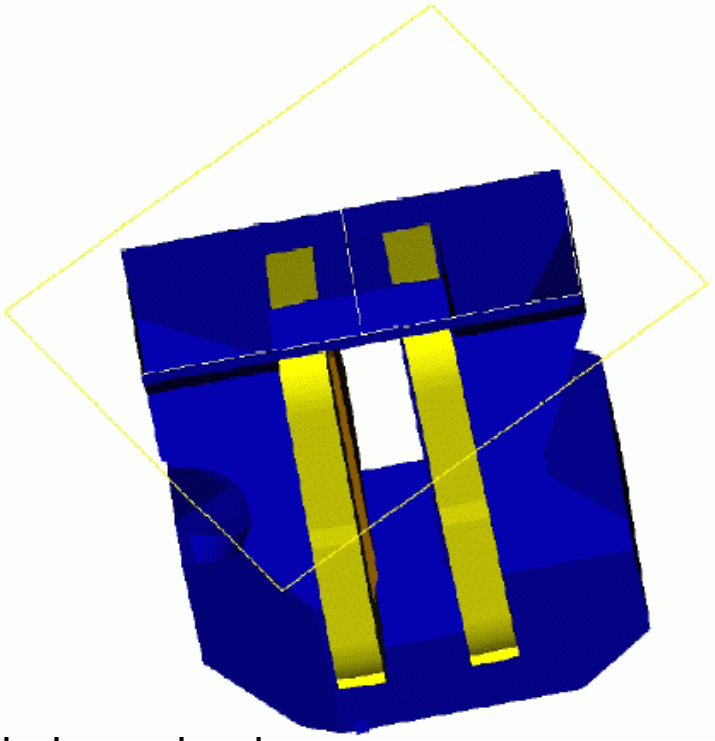
Electrons (500 MeV) at a verticle angle angle of -18 degree hit the bottom of chamber-1.

Extra space beyond this point is not useful at all.



Low energy particles can pass through low field region generating hits at wire chambers.





Fill the empty space:

beyond +/- 18 degree at the top and the bottom from the back of the magnet to the front magnetic shield plate.

2 inches of lead on top followed by Aluminum.

Need to design two Aluminum boxes to hold the lead pieces in place.