Considerations about the Coordinate Detector

B.Wojtsekhowski, 3/18/2012

7.1 Coordinate Detector vertical position resolution

Recommendations #5.5a: Clarify the pattern recognition in the CD, taking into account showers in the 20 cm thick Al absorber in front and the backsplash from the calorimeter.

Response

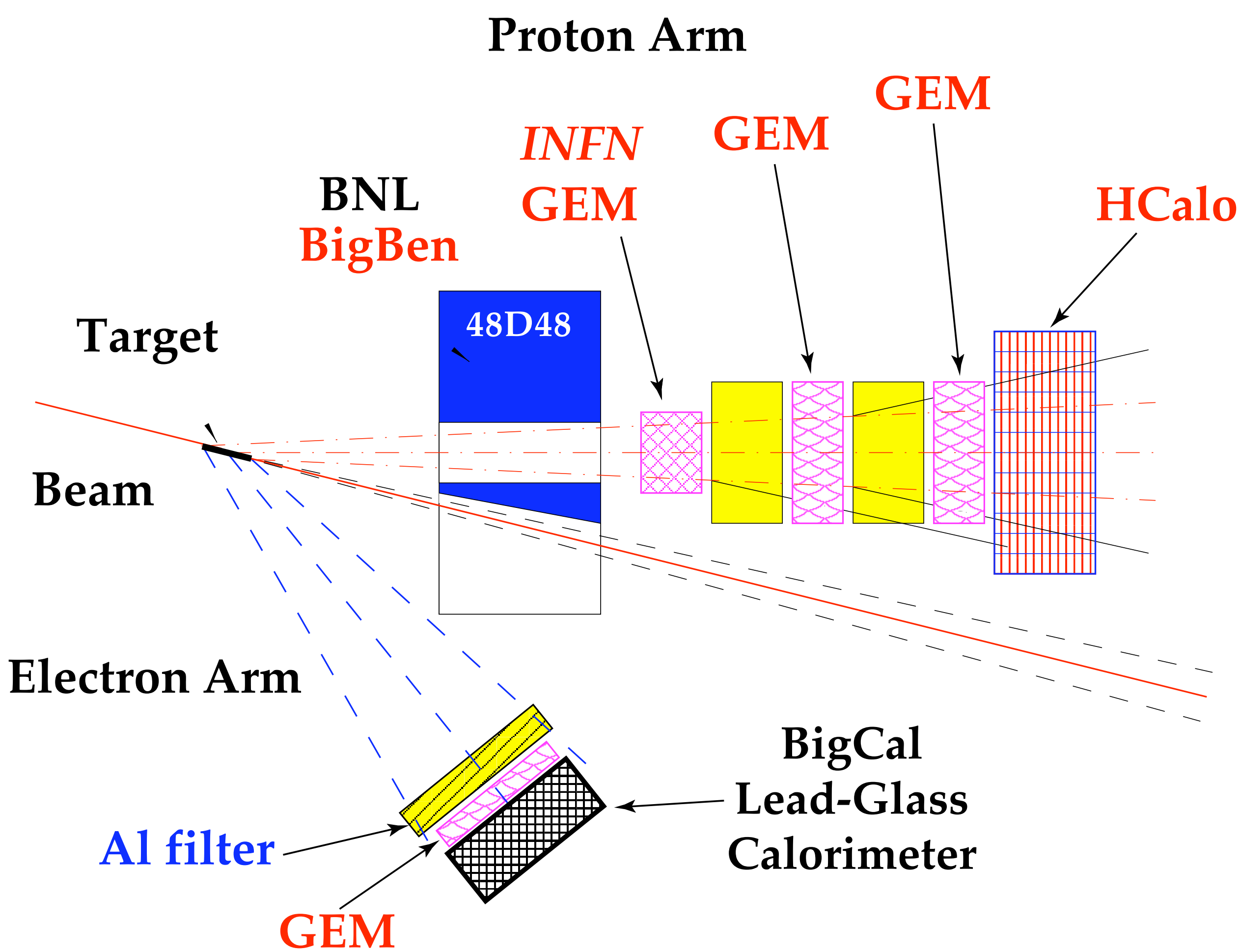
The coordinate detector (CD), preceded by a 20 cm thick aluminum plate to absorb low energy photons, will be placed in front of the BigCal electron detector. The CD consists of two planes with horizontal strips at a pitch of 1 mm, separated by 4 cm. The function of the CD is to measure the electron vertical coordinate in order to reduce the search region for tracking the proton using the constraints of elastic kinematics. Almost every electron will start a shower in the aluminum absorber.

A GEANT3 simulation was run for 3.4 GeV electrons into a 20 cm aluminum plate, a gap of 10 cm and the lead-glass bars. The particle type and its position and energy were recorded at the location of the GEM planes, where it was found that on average 65 photons passed through the GEMs per shower. Given the low efficiency (less than 1%) for photon detection, the probability of detecting a photon from the shower in both GEM planes is near zero. The average multiplicity of electrons (positrons) in the shower was 5 (3.3). The position of the hit was determined from the average of the hit positions for all charged particles at the GEM. The track of the initial electron, projected to the first GEM assuming no interactions with material, is taken as the predicted position. In Fig. 7.1, the difference between the measured and predicted position of the hit at GEM1 is plotted. The red line in the Fig. 7.1 represents a fit by a Gaussian with a σ of 0.18 cm.

7.2 Determining the track search region in SBS

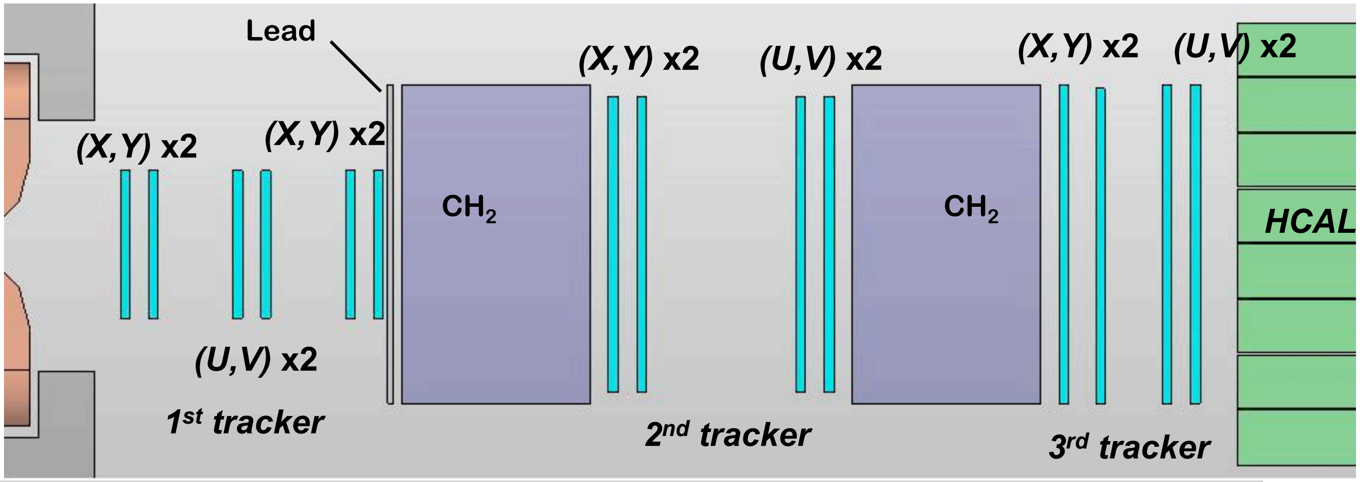
The resolution in the CD vertical coordinate defines a search region in the first chamber of the SBS. A simple Monte Carlo that randomly selected the electron angle in the center of

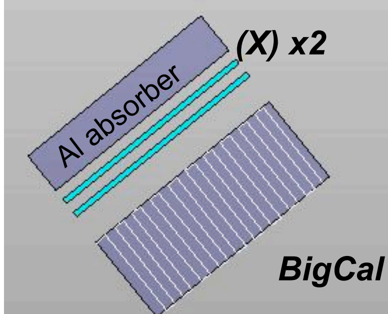
Proton form factors ratio, GEp(5) (E12-07-109)



12 GeV^2 => 28 degrees

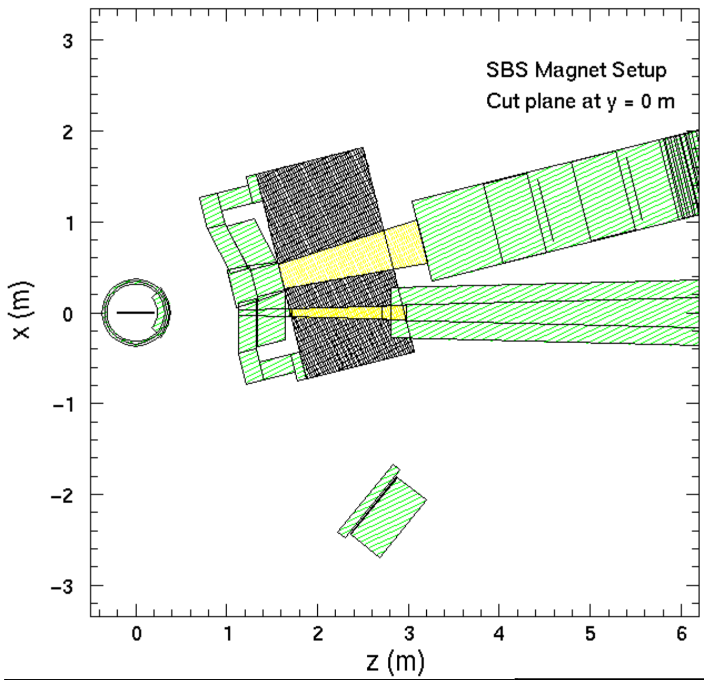
Tracking Detector Configuration

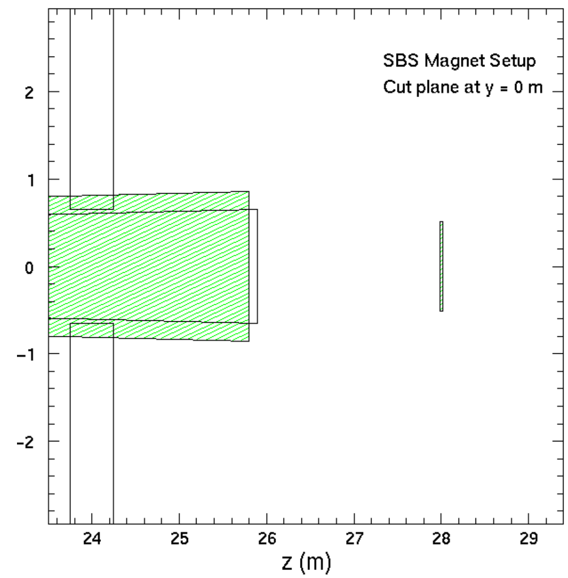




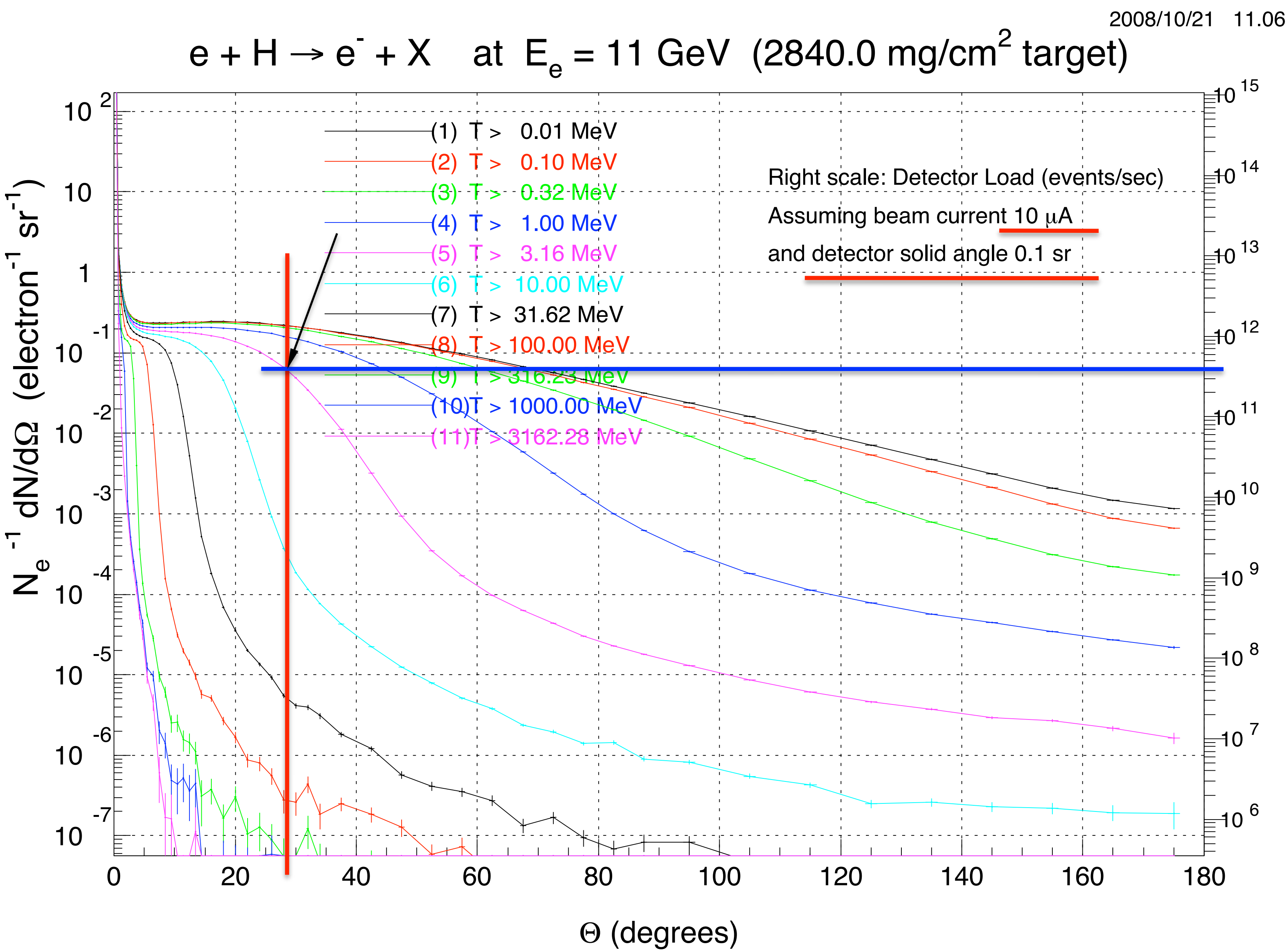
	Number of Layers	Area (cm^2)	Pitch (mm)	Channels
Front Tracker	6	40x150	0.4	62.5k
2nd Tracker	4	50x200	1.6	13.6k
3rd Tracker	4	50x200	1.6	13.6k
BigCal	2	80x300	1.0	12k

Set-up configurations: whole set-up including beam dump

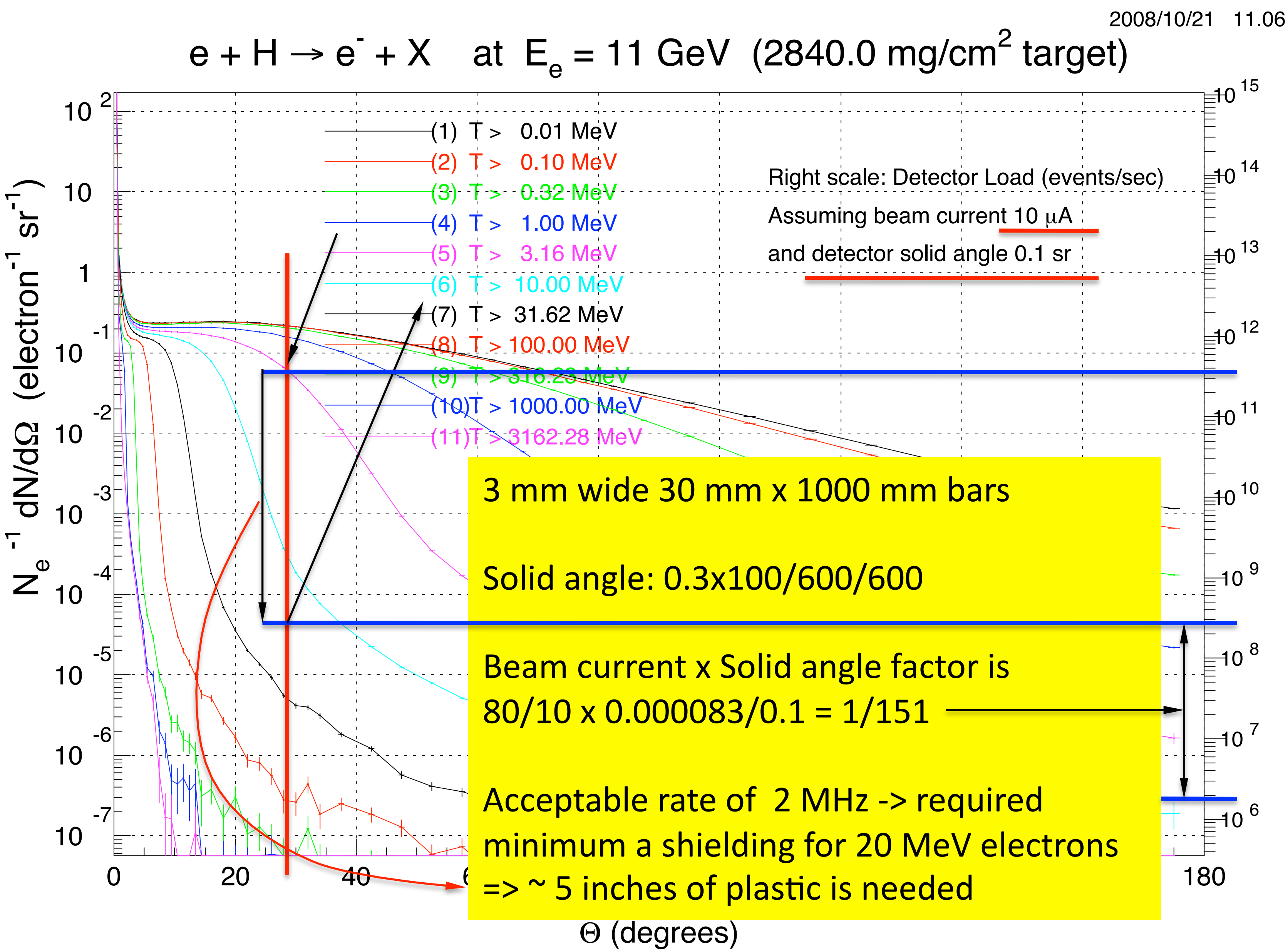




	γ induced hits, kHz/cm²	charged, kHz/cm²
First Tracker	437	119
Second Tracker	7.2	352
Third Tracker	1.0	124
BigCal Coordinate Detector	34	96



2008/10/21 11.06
e + H → e⁻ + X at E_e = 11 GeV (2840.0 mg/cm² target)
(1) T > 0.01 MeV
(2) T > 0.10 MeV
(3) T > 0.32 MeV
(4) T > 1.00 MeV
(5) T > 3.16 MeV
(6) T > 10.00 MeV
(7) T > 31.62 MeV
(8) T > 100.00 MeV
(9) T > 316.23 MeV
(10) T > 1000.00 MeV
(11) T > 3162.28 MeV
Right scale: Detector Load (events/sec)
Assuming beam current 10 μA
and detector solid angle 0.1 sr
N_e⁻¹ dN/dΩ (electron⁻¹ sr⁻¹)
Θ (degrees)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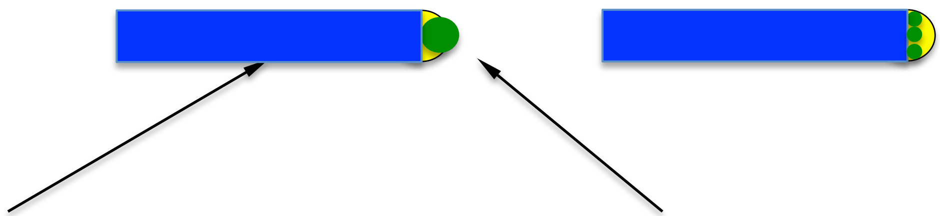
Θ (degrees)
3 mm wide 30 mm x 1000 mm bars
Solid angle: 0.3x100/600/600
Beam current x Solid angle factor is
80/10 x 0.000083/0.1 = 1/151
Acceptable rate of 2 MHz -> required
minimum a shielding for 20 MeV electrons
=> ~ 5 inches of plastic is needed

Proposed configuration of the Coordinate Detector:

0. A detector element:



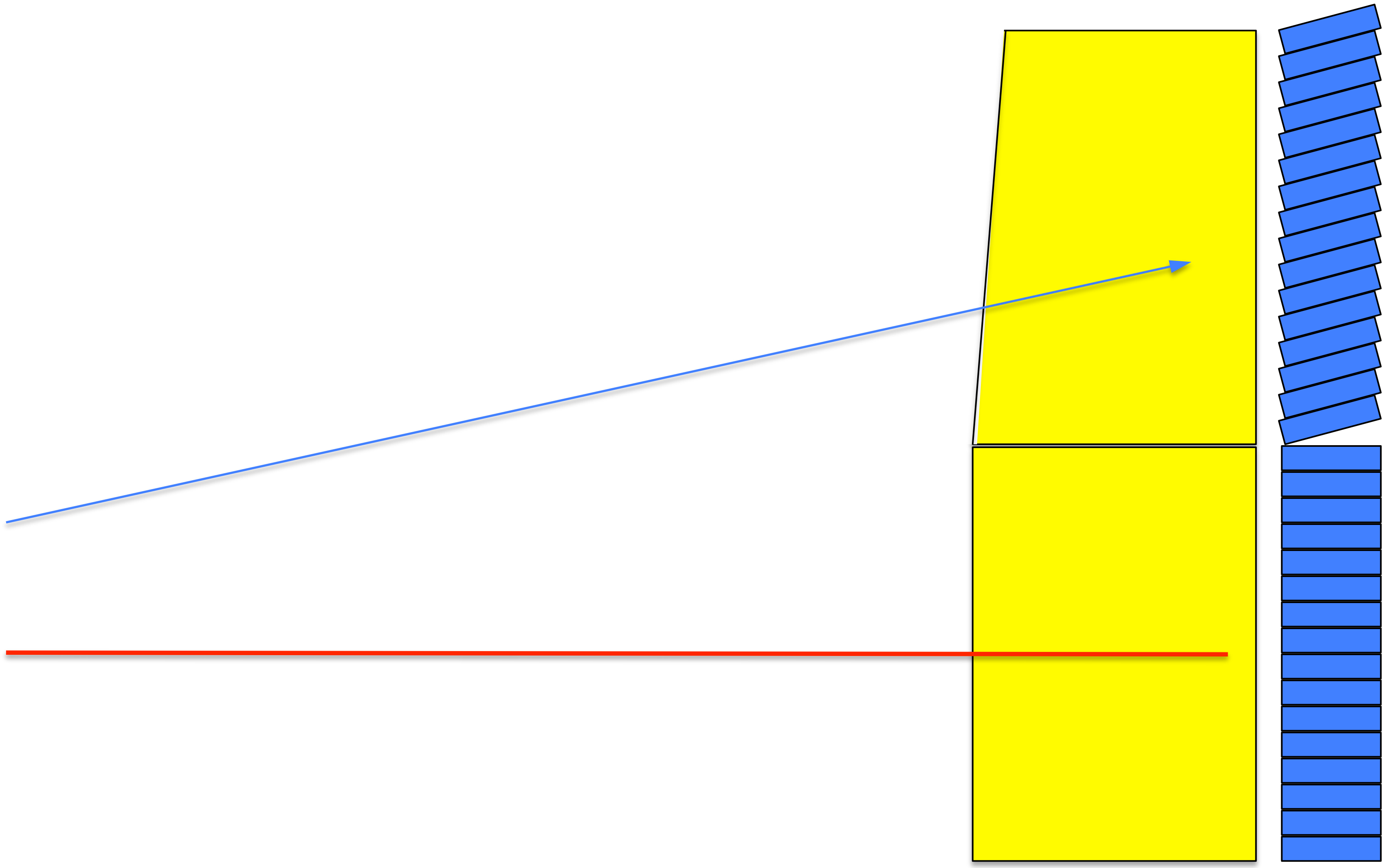
1. 3 x 30 mm cross section with 2 mm round WLS double cladding fiber (glued).The number of ph.e. = 6 x 10^6/100 x 0.15 x 0.03 x 0.2 = 54

2. Total vertical size = 600 cm => 2000 channels per plane

4. Three planes will require of 375 PMTs out of 634 available.

Detector side view
Coord. Det
Calorimeter
52% X0

Detector side view



Projected parameters of the detector:

1. Rate per channel is 2 MHz
2. Time resolution is about 0.5 ns (10 ns for GEM)
3. Efficiency 92% per layer or 98% for 2/3 (dead time 2 MHz x 40 ns)
4. Coordinate resolution is of 1 mm
5. Suppression of the photo events – factor of 2.5 (15+5 cm CH2 vs 20 cm Al)
6. Probability of an accidental hit in +/- 2.5 calorimeter sigma_x = 0.7 cm => 3.5 cm => 35/3*2 => 23 MHz x 10 ns => 23% (>100% for GEM)

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7. The CD event size for a time window of 20 ns in 1877S is 240 hits
8. Total number of TDC channels is 6000, which will require (6000/96)*2 1877S TDC – 126 in 8 FastBus crates! Data volume 3.8 hits/module/event which made a conversion time is less than 2 μs, the total of 60 hits –> 240 bytes/crate/event => 4.8 MB/s at 20 kHz DAQ rate –> low dead time.

9. The cost of the DAQ CPUs is about $80k. The 375 FEE boards (NINO) is less than $75k. The HV units are from CDF. The plastic bars' cost is??
The WLS fibers' cost is?? The detector frames' cost is ?? The cabling cost is??

NEED ASAP a full project analysis

How to achieve a project approval?

A proposed task force team:
Mahbub Khandaker – overall, cost quotations, PMTs/HV
Adam Sarty – design details/construction schedule/manpower
Mark Jones – MC rate verifications
Charles Perdrisat – document master
John Annand – NINO electronics
Alex Camsonne – DAQ: FastBus, CPUs, CODA

Time line for the document preparation:
May 15 – Internal review (Pentchev, LeRose);
June 15 Proposal with a comparison of the costs (LeRose) sent to R.Michaels;
July 15 Proposal sent to R.Ent;
August 15, 2012 Approval of the PMP modification;
September 15, 2012 Update of the SBS projects WBS (LeRose).

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