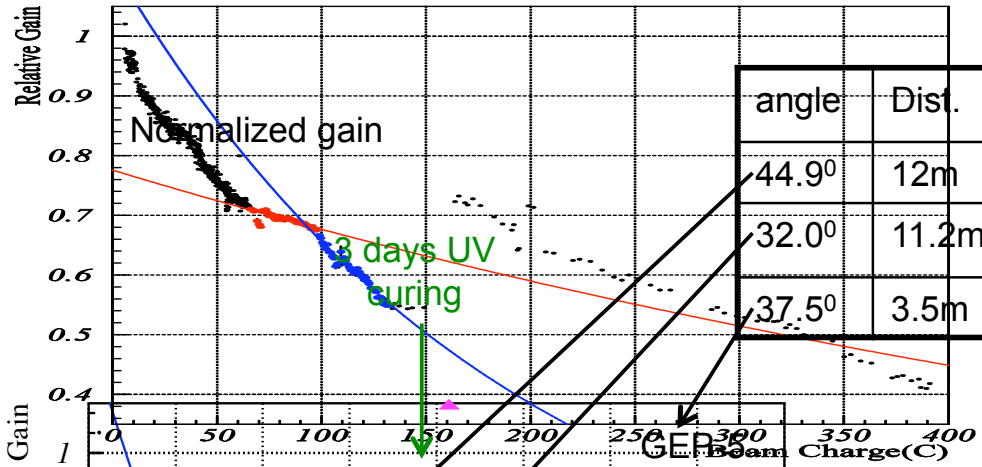
Electron Arm

- New name (former electromagnetic calorimeter) because we added tracking device in front of the calorimeter
- Radiation requirements – critical for GEp5
- Position resolution – the most important parameter for background/ elastic separation
- Energy resolution - needed for triggering
- Three (maybe two) possible solutions for e.m. calorimeter
    - using existing BigCal adding permanent UV curing system
    - “shashlyk” type calorimeter
    - lead-tungsten crystal calorimeter
- Conclusions

Radiation hardness requirement

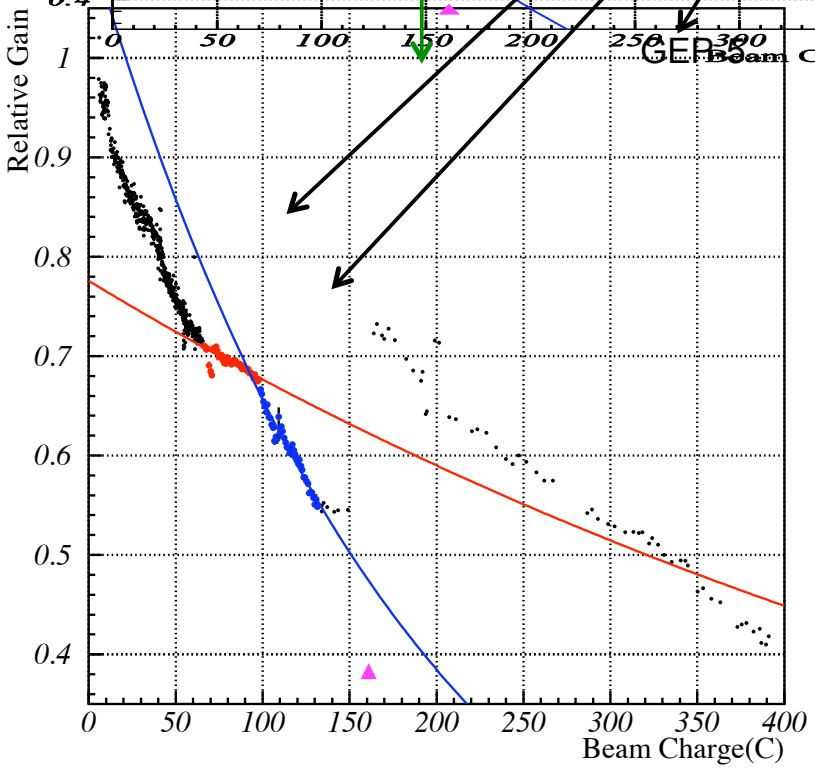


Using 4” Al absorber

angle	Dist.	Targ.	E,GeV	Gain loss	E dep. J/C/cm^2
44.9^0	12m	20cm	2.839	0.14%/C	0.0039
32.0^0	11.2m	20cm	3.539	0.53%/C	0.013
37.5^0	3.5m	40cm	11.0	~6.7%/C	0.17

Geant3 simulations

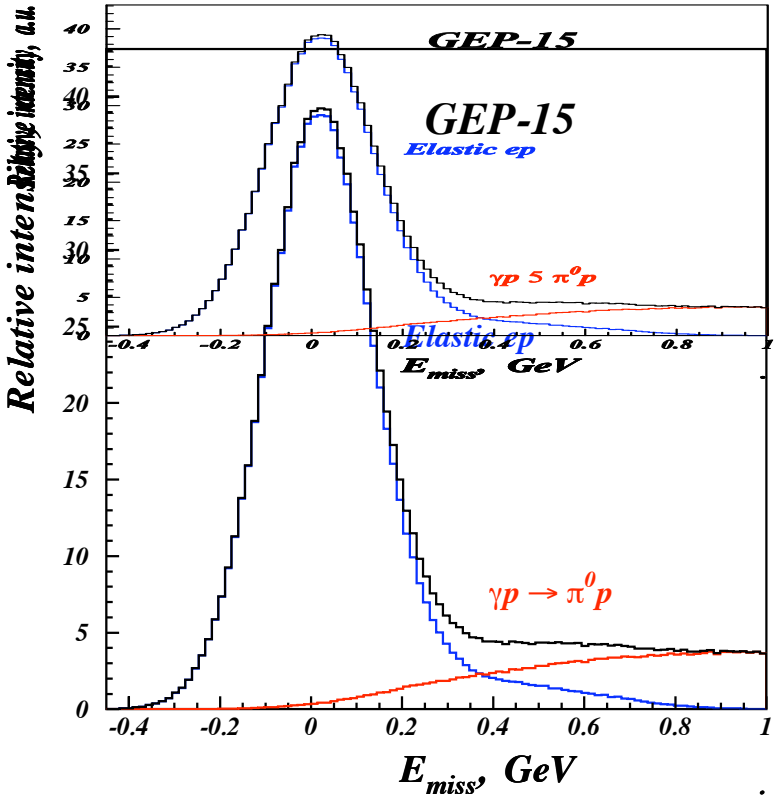
estimation



Radiation hardness: 55 J/cm2

approx. 100 Krad

Coordinate resolution



Physical background: cut on reconstructed missing energy

Energy resolution requirements: related to the triggering scheme, hadron calorimeter resolution, and rate estimates

•Previous estimations with toy MC showed that 7mm (at 3.5m from the target) coordinate resolution and 3.3% energy resolution for 2.5 – 3.5 GeV electrons, cut the background to approx. same percentage.

• Achieving such good resolution much more difficult and expensive than improving the position resolution

• Very important: position resolution needed for defining the area on the front tracker where the elastic proton is expected; note: y_target at this stage of reconstruction is unknown and only vertical resolution helps

• After reconstructing the proton track, y_target is reconstructed with 1.1 mm resolution which corresponds to 2mm resolution on the electron arm

• Conclusion: adding tracking device with about 1mm resolution will greatly improve background separation

• Drawback: need shielding in front which reduces energy resolution; requires prototyping

Possible E.M. calorimeters

1. BigCal

- Has been operational, used in four experiments
- Requires building of permanent UV system
- Requires UV curing once per shift for about one hour
- Need about 1 rad length absorber -> reduced resolution, expect about 12-15% per sqrt(E)

2. Shashlyk

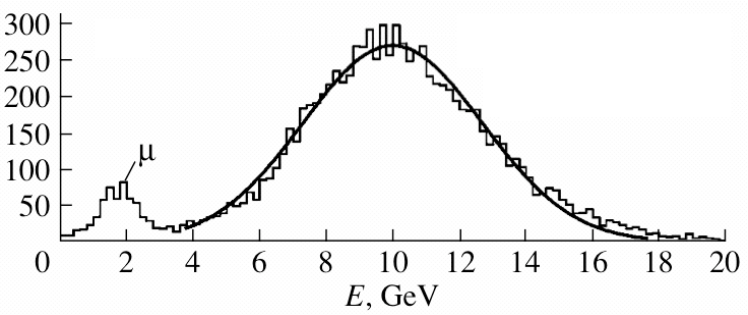
- Offer from Protvino for 5.5 x 5.5 cm2 blocks with 300 scint and lead layers: $530 per block
- We need 1600 of these (area of 4.84 m2 at 7m from the target) + 10% spare = $933K
- In addition $40K for the scintil. injection mold = about $1M (doesn't include PMTs. Frame transportation)
- Excelent energy resolution, but if we add tracker it will depend on the shielding thickness (prototyping!)
- Radiation hard; we started tests of the special scintillators used in shahslyk (8 samples were tested here and sent to ARGON for irradiation bewteen 30KRd and 3MRad)

3. Lead-tungsten crystals ??? (not sure it is still an option)

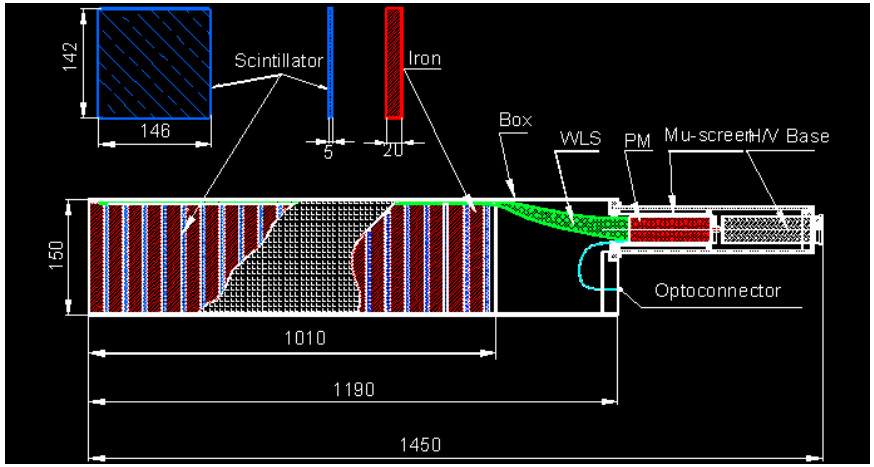
Conclusions

- Most important parameter of the elctron arm is coordinate resolution: adding tracking device will improve significantly (order of magnitude) elastic/background ratio, but requires shielding
- Radiation hardness is also critical for GEp5 (100KRad)
- Energy resolution could be moderate, still need to estimate the trigger rate if it is acceptable
- Two/three possible solution, one of which requires more than $1M, therefore we need to make our choice as soon as possible

Triggering



Calorimeter response for 10 GeV protons from test for Compass experiment



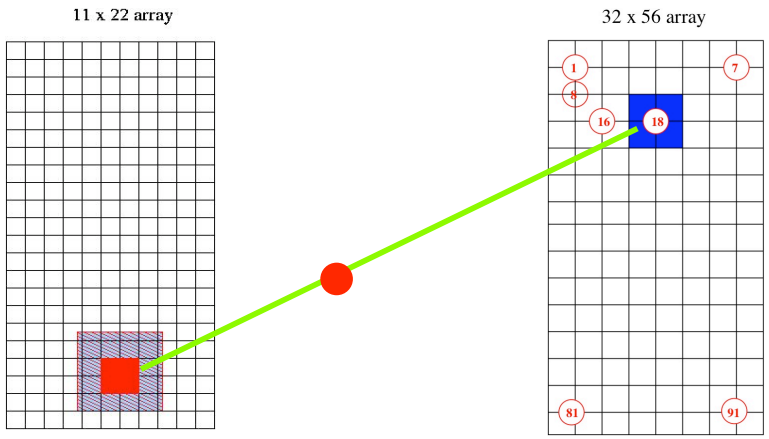
trigger threshold is 4 GeV from hadron calorimeter

Two level electronic trigger

Level 1 from Electron arm forms gate for ADC

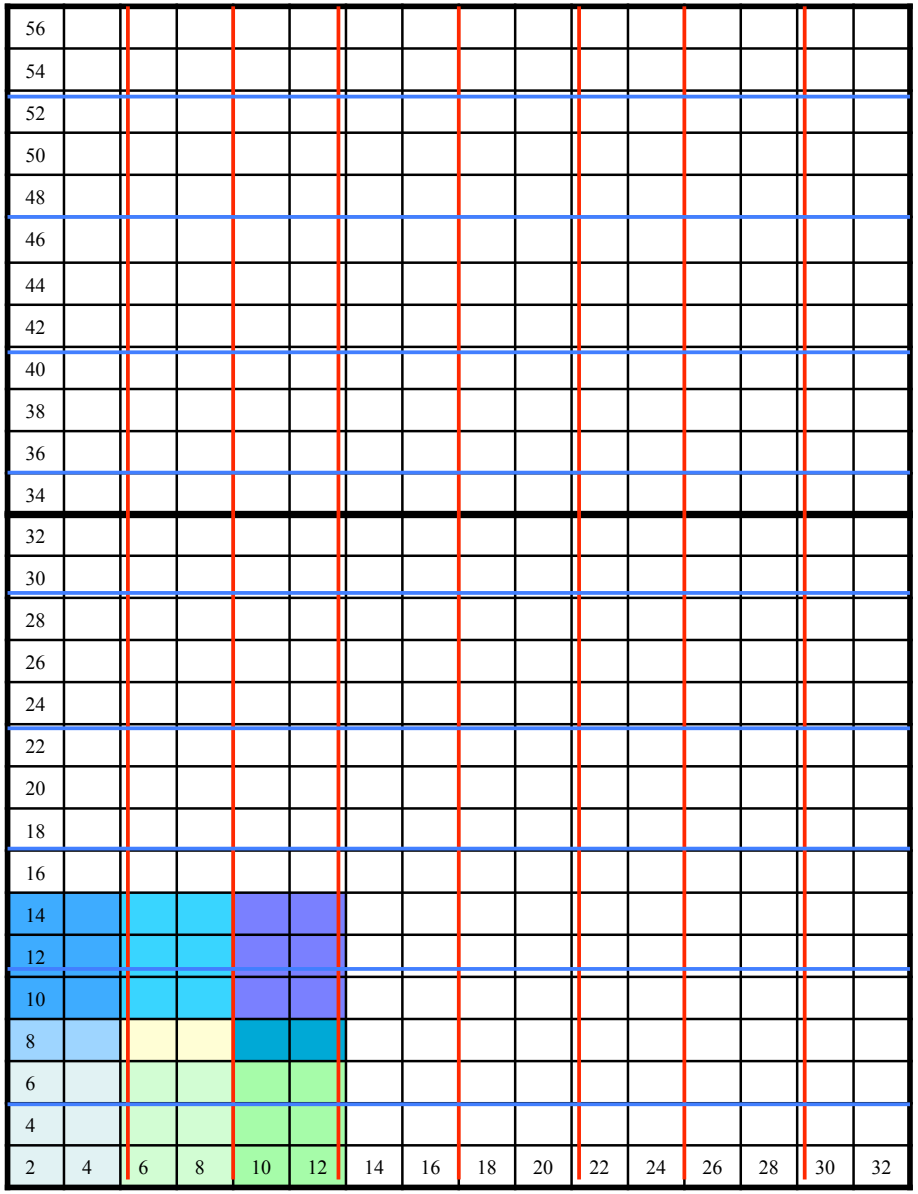
Level 2 from coincidence between two arms with pre-programmed angular correlation between arms. Coincidence time window is 50 ns, resolution of 5 ns.

Expected DAQ trigger rate is < 1 kHz



HCAL (proton arm) **BigCal (electron arm)**

EM Calorimeter: Trigger



- each box 2x2 Pb glass blocks
- first level: 8x28 groups, each 4x2
- second level: 7x9 groups, each having 2x4 first level groups or 64 blocks (8x8):
  - ✓ horizontal overlapping of 4 blocks
  - ✓ vertical overlapping of 2 blocks
- such overlapping is needed when having threshold at 3σ (~15-20%) below the elastic peak (normally we had 50%)

Need 5% energy resolution at 2.5 GeV ($8\%/E^{1/2}$) to keep trigger rate acceptable for DAQ