Future instrument for GRB polarization

POLAR technique is now space qualified

- Compton using only plastic scintillator
- Very fast timing and coincidence insure no random coincidence
- Very bad energy resolution
- Background is known and acceptable: dominated by activation of the platform and of the detector then diffuse then sources
- SAA is a nuisance but just decrease efficiency
- Typical 20% dead time (per module)

background

- Cosmic are rejected in space
- Neutron dont seems to be huge problem
- We see SAA, polar caps
- We see induced radiation from POLAR cap
- Not yet clear if we see diffuse or Crab
- Carbon and Aluminum unavoidable. Nitrogen dangerous and can be minimized. Oxygen in the scintillator.

Absolute timing

- Quartz clock disciplined by a GPS (Every minute)
- Has been shown to be absolute at le 1 ms level
- Probably more accurate then that (100 microsecond)
- Simple, standard, can be reused
- Knowledge of the orbit is important and a job of the platform (GPS again)
- Final performance driven by statistics

Angle measurement

- Mean free path length is long in plastic
- Path length is exponentially distributed
- Neighbor effect will always exists
- Angle precision versus path length can be mitigated by reintroducing position error (standard way in high energy physics, work well, no dependence on histogram binning)
- Driven mainly by bar size
- In POLAR big cross talk. We correct for it but next version could be better

Existing problems

- Cosmic deposit typically 1000 more signal in a bar. Overflow, electronic saturation and recovery will always be a problem.
- Comic can be rejected in space but are indirect nuisance
- Big cross talk. Cross talk limit energy threshold
- Not much dynamic range, dead time
- Silicon PM are better (can sustain direct light, much less cross talk, bigger dynamic range)

Calibration

- Calibration using NA22 was demonstrated in space. Geometrical cut enable very high selectivity
- Calibration add to background be careful
- Calibration for a polarimeter is manly about flatness of the response more then energy.

Other opportunities

- Pulsar navigation
- Pulsar monitoring
- Solar flares

POLAR or something else

- For sure we need more photons. Means more surface and lower energy threshold
- Timing is ok
- Angle precision is ok (my opinion)
- Energy resolution is perpendicular to polarization performance (unless full 3D tacking, could be done with Germanium)
- Polarization increase toward low energy?
- Photoeffect gaseous detector?

Energy resolution

- Could mix high Z and low Z bars but very fast loss of efficiency
- High Z bar have a problem with Rayleigh scattering
- Perhaps equip just a mini skirt all around
- Need idea and then Monte-Carlo
- In a previous study Geant told us that optimal is 0% high Z

Other possibilities

- Better energy reconstruction:

  High Z bars? (slow !)

  Full 3D Compton reconstruction?

- Better angular resolution: smaller bars.
- Do we want to decrease field of view to gain on other aspects. Background is proportional to field of view. Smaller field of view can be treated against bigger efficiency.
- Do we have to do something to increase probability of redshift measurement?

Circular poalrization

- Almost impossible in gamma
- Need polarized electrons

Telemetry

- There is a lot to be gained by having massive CPU power in space or very large telemetry.
- Massive CPU mean we can retain single bars (histograming, light curve for detection…)
- We will probably not have telemetry like in POLAR.

alerting

- Very useful
- Limited telemetry is already very useful
- Iridium, thuraya, SVOM UHF, or Chinese equivalent

Actual thought (POLAR-2)

- Just redo POLAR
- Make it 4 time surface. Height to be optimised using constrains mainly weight. (modulation diminish with height)
- Silicon PMT. Go to single photoelectron, less cross talk, more dynamic range (calibration)
- In the end factor 4 from surface and at least 2 from better technology => ~ factor 10
- Better electronic (less dead time more dynamic range)