

## **Milagro Meeting at UCI**

### **As recorded by Brenda (Apologies to anyone misinterpreted)**

**Sunday 25 February 2001**

#### **Jordan: Budget**

Took \$100K from MD grant to give to Milagro operations. Just got Milagro operations money last Wed. We're getting \$600K for operation starting 1 Feb and \$545K for the following 2 years. LANL operating money \$250K/yr for next 3 years should start soon; need it within next 3 months. Outrigger money is ~\$200K short, but has been made up with other sources and student labor.

Need to buy TDCs. 2 LeCroy 1877S TDCs in budget for \$8.8K each. Need more?  
Replace Kahuna? Gene supportive. \$10K/yr maintenance for Kahuna.  
Gene supports upgrade proposals. More bottom layer PMTs?

#### **Cy: LANL NSF grant**

Promised, check's in the mail.  
Milagro has 2 IGPP: Cy with Ben, Gus with NMSU.  
New IGPPs due next week.  
DoE capital \$ went to computing and outriggers.

#### **Cy: Status of PMTs**

PMT deaths per month. Spikes after repair and/or when cold weather? Recently, most all losses in shower layer only, i.e. muon layer fixes worked. Currently 35 dead tubes in shower layer and 6 in muon. How many do we fix this summer? We'll discuss tomorrow.

#### **Allen: Survey**

Connecting grid survey to corner bolt survey. 3 methods tried, and not quite consistent within errors. Suggest use new corner bolt survey for outriggers and WACT. Need to look at photographs. Allen promises memo, which is needed before new outrigger survey.

#### **David W.: Calibrations**

Are there BAD tubes which should always be thrown out of fit? Some tubes are used too often in the fit and these tubes always have lots of pes, i.e. wrong calibrations. Compare deleo with and without these tubes (taken out one at a time). Deleo always best with all tubes, so these pmts are probably weighted wrong, but timing is still good enough to improve deleo.

Plot ADC vs ToT used looks bad between 5 and 20 pes. LoTot should not be used when long times due to late light, and no HiTot tells us that the pulse height is not that large. ~5% of hits have this problem. Crude correction improves deleo from 1.960 to 1.947. Can look at pulsing by comparing LoToT and HiToT starts.

### **Bussy: Laser Calibration**

Nov 99 first full cal

March 00 timing cal

Sep-Oct 00 with Laser Photonics (BAD LASER, i.e. no good data)

Nov-Dec 00 LSI Sealed Cartridge Nitrogen Laser (1 dead laserball)

Jan-Feb 01 full analysis done. Can't do laser shots now because of ice?

43 PMTs have insufficient HiTot calibration (near weak fiber balls). Bottom layer is better (smaller angle to fiber ball?). See late light for some balls (could ball be facing wall?).

Slewing and timing: Fit Tstart vs ToT with 4<sup>th</sup> order polynomial. Use different balls to get pedestals. Gives reasonable speed of light in water. Difference between previous timing calibration has offset of 6 channels, but narrow width of ~1 channel (excluding replaced pmts). Don't have as much light as Nov 99 calibration.

pe calibration: Bug because we didn't exclude the pedestal (i.e. need to exclude fraction of events which don't exceed HiToT level). Use reverse occupancy to get HiTot to lower pe (i.e. use constraint of % events which don't have HiTot as well).

### **Eric: Extending HiTot to lower pe**

Look at LoTot values when have HiTot as well. Get 3 points (HiTot vs pe as determined by LoTot) to add to HiToT laser calibrations.

### **Bussy: continued**

Pe calibration (cont): Use 1999 data to extend to higher pes, but allow normalization change (i.e. just use shape). Not done on all pmts. See transparencies for complicated algorithm. Need more photons from laser, but this laser had old Ni cartridge (new one should be available soon). However, broader pulse (~4ns) is OK. Calibration takes only 2 days and can be run while EAS data is taken. Plan to cal every 6 months?

### **Eric: Comparison of MC and data**

New calibration gives different pmax distribution in bottom layer from last calibrations. Better but still not good correlation with MC especially at lowest X2. Data still has 2 peaks in pmax, but MC doesn't. However, early version of MC did give 2 peaks? Jordan pts out Crab file was used. GRB file would give same zenith distribution as MC. Discussion deferred to MC session.

### **Don: Water Monitoring**

Need to correct for reflections off various surfaces (especially Si diode) in apparatus. Slight change of geometry (rotate diode) reduces reflections considerably. Don recommends semi-skilled person needed to do measurement once per month.

### **Michael: Water**

Limited to 70 psi pressure. Causes filter to run out fast. Need \$3K to buy additional filter. Will pay for itself in 20 weeks.

**Cy: Shifts**

UNH and UCR both are low, but also unfunded. Should we pay for them to come?

**Michael: Air Conditioning**

AC on walls are not functional (at least some of them and the rest are old). Polar Spot Cooler is possible new approach. Total cost is \$15K and installation is simple (includes \$2K for electrician).

**Gus: Online Software**

Live time is good. Tape drive troubles resulted in tape drive being replaced. Julie is looking into other tape options. Shift takers need to pay more attention to details; for example, watch for bad tubes in bottom layer. Can we write second hottest tube into recon file (plus the pmt #s of it and the hottest)? Improve monitoring program. New computer at site (sparky) is, or soon will be, making daily maps for moon and all sky.

**David W.: Offline Software**

Version 50 is being used (has Greg's core fitter & 7ns/100m curvature). In Jan 01 v51 is being used ( $X2 > 1.5$  or  $NTOP > 310$  written to SAVE files). Other changes will be installed soon, but no major changes. Need to add bad tube cleaning algorithms, a la Gaurang, but David doesn't have code yet.

**Andy: Data Archive**

43.9 billion events and 416.6 Andy days. Recon data sent to UMD within ~45 min of collection. Andy plans to provide a better analysis starting point than example.c and stripped files of different source classes.

**Bob: Moon**

Using recon data from Sept through Jan, find  $\sigma \sim 0.75$  and right deficit for  $N_{fit} > 75$  with  $\sim 12$  sigma. If  $N_{fit} > 25$ , then not enough of a deficit.

Study of magnetic deflection: Dipole B is OK for Earth as compared with Navy software. Max deflection is 1.66 degree at 1 TeV if Milagro at the equator. If Milagro at true location, then shift in "theta" (not zenith) is  $\pm \sim 1.5$  deg and is asymmetric. "Theta" is zero the same time of day (i.e. same Moon position) for all energies.

**Abe: Solar**

Sun is at solar max now. There are Forbusch increases in data that Abe knows about but has no desire to analyze. July 14<sup>th</sup> was very big CME, but spectral index was very steep (i.e. 9 vs Nov 6 event with 5). Milagro should do upper limit.

**Liz: Crab from Online Rec**

Dec 15 (when v50 was implemented) to Feb 17 data (runs 2681-2773) with 2.1 degree bin,  $n_{fit} > 20$ ,  $X2 > 2.5$  gives 79579/79494 or 0.31 sigma. Is she using the right location?

**Why is Andy so Crabby**

Data through Feb 15 gives 4.8 sigma with  $X2 > 2.5$  and  $N_{fit} > 20$ . Nothing significant without  $X2$  cut. We get  $\sim 10$  Crab events/day.  $N_{fit} > 80(150)$  with smaller bins gives 4.6

(3.0) sigma. Slice data in different Nfit ranges and look at MC angle fits. Notice that cut on X2 accentuates difference in angular resolution with Greg core vs center of mass (i.e. X2 throws out events on pond which is only place where center of mass fitter is correct). Gaussian weighting gives 4.8 sigma—no improvement, but del angle isn't getting better much after Nfit >150.

**Andy: Mrk421**

XTE ASM sees big flare (2x Mrk 501 flare in x-rays). Also, bright in optical. Sees 2.4 sigma for Dec 20 to Feb 11. Expect 0.25 sigma /day from Crab. CAT/HEGRA say -3.0 spectral index, but Whipple sees -2.6. What we'll see depends on this a lot.

**Gus: Mrk 421**

X-rays high since October 2000. Uses MARS cut (different gamma/hadron cut which will be discussed later). Dec 15 to last Wed gets 3.5 sigma with average sigma per day of 0.47. Fraction excess is about 1% which is  $1.46 \pm 0.3$  Crab.

**Tony: X-ray Binaries**

Several catalogs exist for XRBs and 61 selected in Milagro dec band. Made all sky daily maps MJD 1747-1936. Times 10 background time sloshing, 0.2 degree bins, Nfit>20, X2>2.5, 3.1 MB/file (source or background). Files are written in FITS format. No DC excess from any of the 61, and no daily excess either. More work will be done to look into ephemerides.

**Julie: Trigger GRBs**

Since last meeting there have been 8 GRBs of which we've saved raw data for 3 (1 IPN and 2 SAX). We have 1.5 days of disk storage space at site, but could double that if we can figure out how to mount another disk. We have ~2 GRBs /month, but we have no excess in any of these GRBs.

**David N.: GRB Predictions Poster for Gamma 2001**

Lower E threshold of trigger to see more distant GRBs. Used Primack's model of gamma-gamma absorption for E-2.4 spectrum. Vary Nhit for trigger and see number of events we'd detect. Looks like we could double the z at which we can get gammas from GRBs by lowering E threshold. The sensitivity depends on ang res and background rate, and preliminary numbers were shown.

**Andy: Transient Sources**

Almost ready to run on sparky (computer at site) with 4 minute delay.

**Gus: Hadron Rejection**

21% of hadron showers are purely electromagnetic (i.e. no muons or hadrons). Look at X2 for 4 classes of hadron showers—muons only, hadrons only, hadrons & muons, only electromagnetic. Energy per particle is much less for gammas than hadrons, even if particles are muons. Even protons with pure electromagnetic have higher E particles than gammas and the shower is more concentrated. MARS (Multivariate Adaptive Regression Splines) takes X2, Nbottom2 and return prob(gamma)/prob(hadron) for all values of X2

and  $N_{\text{bottom}2}$ . This takes into account situations such as low  $N_{\text{bottom}2}$  are always more likely to be gammas independent of  $X_2$ . MARS value give  $Q=2$  using MC protons and gammas. Crab looks good with recent data, but not earlier. Bad detector then? Gamma/hadron paper in the works.

### **Miguel: Unbinned Analysis Technique**

Simple (computationally) algorithm for weighting events. If use psf as single Gaussian of 0.7, then Crab is 4.3 sigma. Future work will use real Milagro psf. Also can use  $X_2$  and  $N_{\text{fit}}$  cuts. Wants to implement for transient searches.

### **Tony: Sky Maps in FITS format**

FITS (Flexible Image Transport System) is used by astronomers and has lots of support software. Milagro all RA and Dec (within 45 deg of zenith) is 1800 x 450 pixels and takes 3.1 MB / map. Did Crab analysis by adding together many (~150) single day maps.

### **Institutional Reps Meeting**

We will pay out of operation \$ for Jim Ryan, Rich Miller, and Tumay Tumer to take shifts. Airfare, car rental, and hotel will be paid, and Jordan will look into how to do this. Julie and Andy are assigned to investigate alternative/additions to make tape archiving more reliable.

### **Monday 26 February 2001**

#### **Joe: Blind Search**

1,3,10,30,90,270,810,2430, 7290,21870 sec searches. Investigated best bin size /  $n_{\text{fit}}$  cut again. Calculate upper limits by looking at hottest bin vs zenith angle (declination) for short (long) time intervals. Trigger threshold was determined by looking at  $N_{\text{hit}}$ . MC sims of Ne check with approx B. Notice that ang res bad for highest energies (e.g. 5 deg at 175 m core distance), because most showers have large core distance. Searching 6hr database of hot spots ( $P < 1e-4$ ) for x-ray selected BLLacs. Found 4 days for Mrk 501, and more work is in progress.

#### **Morgan: Moon**

Likelihood analysis of moon shadow gives 10 (13) sigma for data (simulation). Deficit is not big enough especially at low  $N_{\text{fit}}$ . This is similar to Bob E. trouble with Milagro moon shadow. Is difference in psf or ang deflection at low  $N_{\text{fit}}$ ? Gets angular resolution of  $0.90 \pm 0.11$  degrees. Antimatter search simulated and see shift of position in RA with increasing fraction of antiprotons, but not much change in shape. Upper limit for antiproton/proton fraction is 13% with median energy is 3 TeV. Gaurang points out published numbers are at 5 GeV and much lower limit, and theorists don't predict this large a fraction at TeV energies.

#### **Alan: Roman and Lazar thesis**

Roman: (Galactic Plane) Doing systematic error studies of background. Expect to need 35 days of CPU time. Results Spring-Summer. Plans to do ICRC talk.

Lazar: (Neutralinos from Sun) Theorist at NYU says cross section could be higher. Doing simulation of particle orbits. Also testing analysis code. Plans to present talk at conference in Budapest in July.

### **Gus: Conferences**

Snowmass 9-13 July is not on list. Send other conferences to Gus to go on web page.

### **Brenda: Pub Committee (PC)**

PC will and has set deadlines for comments and author response. Generally giving 2 weeks for a response. PLEASE RESPOND BY THESE DEADLINES. The PC will archive all comments on the UCI web page, so send comments to Tony AND the author. Conference papers will in general not be dealt with by the pub committee unless an irresolvable conflict develops. Conference papers must be sent to the collaboration one week prior to submission, and if they contain new material an extra week (2 weeks prior to submission) is required.

### **Cy: All Sky Paper**

Nfit cut changed from Mrk501 paper. Calculated significance is about same for both Nfit cuts and 2<sup>nd</sup> draft of paper has additional wording to explain this difference. The search uses 4319 bins in 4 all-sky map in each of 4 overlapping bins. MC says  $4319 \times 2.5$  is number of trials. Figure 2 is plot of average upper limit vs declination. Could use the bin with the largest deviation which would give larger upper limit, but might be difficult to extract from Kellin in a reasonable amount of time.

### **Abe: Solar Paper**

Review paper which was circulated last week. Collaboration requests that the probability of EAS excess be given.

### **Cy: ICRC**

ICRC attendees and paper topics are Jordan, Gus (gamma/hadron), Andy (untrig GRB), Bussy, Greg(status+outriggers), Roman (Galaxy), Gaurang (single hadrons), Frank (Moon), Jim (solar), Rob(WACT), Wytan (AGN, Mrk421). Abstracts due March 16 and should be circulated to the collaboration by March 9.

### **Cy: Eminent Papers**

Cy (Moon), Gus (Gamma/Hadron), Julie (GRB energy scales), Isabelle (GRBs)  
Joe ( untrig search)

### **Julie: MC Archive and Comparison**

GRB sensitivity plots should be put on official plots page. Comparison of different versions of Milagro simulations. Don't use v23 for Milagrito. Milagrito MC has 7000 gamma-ray triggers at Wisconsin. Milagro v22 has Milagrito water and tchi doesn't agree well. Milagro v23 delecto and cosmic-ray trigger rate match data, but problems with pe distribution. V23 has layer of air which is necessary to match data. V24 same as 23, but has minor bug fixes. V25 allows showers to be reused, but same as 23 basically. V26 has no saturation correction and has unsmeared value of pes also in output file. At Wisconsin

there are ~5000 (~9000) proton (gamma) triggers with >55 pmts in AS layer. Unreasonable assumptions include that 18 meter absorption with no scattering, and there is probably not a continuous layer of air between water and cover.

### **Gaurang: Comparison with Data**

Compared MC protons (V26) with data from GRB file. Npmt with >2pes on AS layer agrees well, but bottom layer not quite as good. Pemax in bottom for V22 has big second bump (muons?) but no 2<sup>nd</sup> peak in V26. Data doesn't have much of a second peak, but seems to vary with time. Bad pmts? Hypothesis is that second broad peak is muon and should always be there, and lower pe peak can disappear if single pmt is too hot. Totpe on bottom (sum of all pe in pmts with >2pes) peaks at higher pe for data than MC. Do we need to put ToT into MC? Improved cal will help? Should we add nonisotropic scattering? Eliminate/reduce air layer scattering? Is helium important? We should look at igloo triggers and single muons. Change reflectivity of baffles?

### **Gus: New Lower Energy Trigger**

Make a pemax cut on the bottom of <8pe gives good efficiency for gammas near trigger threshold and cuts out most protons (at least gets us a reasonable rate). Could reduce trigger to 30-40 fold coincidence. Requires raising hiToT threshold or add another set of discriminators.

### **Erik/Greg: VME trigger system**

Consists of programmable logic device, A/D for measuring rise time of trigger, scaler, plus more. Over next 2-3 weeks get all parts. Ship to site by start of May. Using VME-PCI bridge via fiber for testing with LINUX box

### **Liz: Risetime as a Trigger Cut**

Additional trigger to get lower trigger thresholds by cutting out large angle muons which are major contributor to rate at low trigger thresholds. Not fit events from GRB file have longer rise time than gamma MC. Added in random hits into proton MC and agrees better with data. Typical cut would require risetime of less than 100-150 nsec, but depends on threshold. What is zenith angle distribution of gammas added?

### **Frank: WACT**

Plot of surveyed positions and Milagro. Rob and Brenda ran 2 WACT with 3 pmts each using standard Milagro trigger. Took a couple of hours of data on Dec 22 (see Frank's memo for run numbers). Showed MC events and is working on analysis algorithms for angle, energy, composition.

### **Tony: Outtrigger Status**

Construction progress: 23 of 66 inner tanks recently installed. 5 of prototypes are also part of 66 array. 9 more about ready to go, and all 66 have cables and fibers to site. Scott and Tony were installing 2-3 per day.

New Tank Data: Outtriggers have more 4 edge events than 2 edge events (opposite is true of pond pmts). On average 4.5 of 23 outtriggers are hit per Milagro event (only 6% have no outtriggers). Singles rates are ~ same as pond pmts.

**Michael: Water in Outriggers**

Portable pump with filter can be carried around to outriggers. Cost ~\$1K. Requires 120V and ATV (or wheelbarrow if we can't afford ATV) to carry around.

**Gus: PMT repairs**

Lets just repair broken tubes. Don't fix all AS layer. Probably repair will occur in September. Use Michael's connectors, i.e. no Fischer.

**Don: Lightning protection for outer outriggers and WACT**

Primer: Interconnectivity and area both increase chance of strike. Can't extend current Faraday cage. Too many trees plus grid is too coarse unless we added lots of poles. Use spark gaps which handle 30kA and fire >3000 V. Also need to prevent cross talk and interconnectivity of outriggers (i.e. don't kill other outriggers when one outrigger gets hit). Use 2 spark gaps per coax, beefy connection to ground, each enclosed in small metal box. Price estimate is ~\$170/ pmt with \$80 for 2 spark gaps assuming they're ordered in quantity. Also add ~20 guard wires to run along the ground from inner fence to outer fence. Also add ferrite cores near counting house (already air coils, due to extra cable, exist at most outriggers). Total cost for outriggers only (i.e. not WACT) is ~\$20K.

**Tony: Outrigger Construction Plans**

178 total outriggers: 66 inner, 112 outer. Have received ~83 tanks total to date. Tony's philosophy is to do as much site prep as possible and then deploy next winter. Schedule is to finish inner array by June 15. Need to look at calibration system and decide what needs to be ordered. Outer array purchases include cabling, connectors, ~30 pmts, and 95 tanks. People are needed all summer to help with construction.

**Discussion:** Budget needed to decide how many outriggers we can afford this summer. Money is needed to buy 3 TDCs (~\$25K), air conditioning (~\$15K), spare tape drive? (~\$10K), water filter (~\$3K), plus ....