# Calorimeter Ground Software Status

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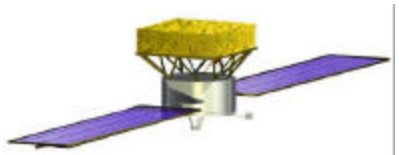


Calorimeter

# Manpower



- Calorimeter Subsystem Manager
  - W.N. Johnson (NRL)
- CAL Software Manager
  - J.E. Grove (NRL) [60%]
    - Current work: eCalib, GCRCalib, Position/traj. alg.
- CAL software team at NRL:
  - D. Wood (Elec/Software Eng.) [30%]
    - Current work: Position/traj. algorithms
  - M.S. Strickman (Astroph) [60%]
    - Current work: Simulations, GTOCC
  - W.N. Johnson (Astroph) [10%]
    - Current work: Reqmts, GTOCC
  - B. Phlips (Astroph) [10%]
    - Current work: Bkg rejection
  - D.P Sandora (Tech, Analyst) [20%]
    - Current work: Light yield calib analysis
  - D. Messina (Analyst) [20%]
    - Current work: Electronic calib analysis
  - D. Wagner (Elec/Software Eng.) [30%]
    - Future work:
  - I.M.A. Person (Postdoc)
    - Tony Crider has left NRL
    - Budgeted 100% for "Cal Design and Verification"
- CAL software team in France
  - A. Djannati-Atai (CdF, Physicist) [50%]
    - Fr. Instrument Scientist, Fr. S/W Manager
    - Current work: Recon; Energy alg.; CAL-TKR feedback; GTOCC
  - A. Chekhtman (CdF, Physicist) [100%]
    - Current work: TBRecon
  - R. Terrier (CdF, grad student) [50%]
    - Current work: Recon; Energy alg.; CAL-TKR feedback; Science analysis (unbinned ML)
  - P. Espigat (CdF, Physicist) [30%]
    - Current work: Computing logistical support
  - T. Hansl-Kozanecka (Saclay, Phys) [50%]
    - Current work: Code mgt, Gaudi
  - T. Reposeur (CENBG, Physicist) [50%]
    - Future work: BT analysis
  - S. Incerti (CENBG, Physicist) [50%]
    - Future work: GCR Calib
  - B. Lotte (CENBG, Physicist) [100%]
    - Future work: GCR Calib?

# Manpower



## CAL software team at NRL

- Personnel change:
  - Sacha Chekhtman transferring from CdF to NRL
    - begins 5 February 2001
    - 100% for CAL s/w development and simulations

- Astrophysicists
  - J.E. Grove [40%], M. Strickman [60%], W.N. Johnson [10%], B. Phlips [10%]
- Elec./Software Eng.
  - D. Wood, D. Wagner
- Tech/Analysts
  - D.P. Sandora [30%], D. Messina [20%]

# Schedule



- Calorimeter software development is driven at highest level by a number of Project-wide Milestones.

| | | |
|---|---|---|
| • System Requirements Review | Oct 2000 | ✓ |
| • Beam Test '99 paper | Nov 2000 | ✓ |
| • Calorimeter internal review | Dec 2000 | Feb 2001 |
| • Balloon Flight | May 2001 | Jun 2001 |
| • Instrument PDR | Aug 2001 | |
| • Instrument CDR | July 2002 | |
| • Launch | ... | |

- Balloon flight is opportunity to begin putting CAL s/w (from MC Hits classes to recon) in context of complete Production Data Analysis process.

# Scope of Task



## Production Data Analysis (PDA)

- PDA will eventually occur at Instrument Operations Center (IOC)
- PDA is a process that generates standard data products.
- CAL State Tracking
- CAL Calibration
  - Electronic calibration
  - GCR calibration
- CAL Recon (evolving into Global Recon), an iterative procedure
  - Energy reconstruction
  - Trajectory reconstruction
  - Background Rejection
- Instrument Response Fcn/Matrix

Items in color (and their subtopics) are discussed here. Green means it exists. Red means new item.

# Work Plan, Schedule



- High priority, short term
  - Cal S/W Requirements Spec — 14 Jan 2001
    - Highest priority item
  - Assign responsibilities for Functional Units/processes — 14 Jan 2001
  - Document existing *sim and *recon s/w — 10 Nov 2000
  - Incident energy algorithms — 3 Nov 2000 (??)
    - Pick best so far, implement for BT99 paper
  - Complete BT99 analysis — << coordinate with E.d.C.e.S. >>
    - Finish the paper
  - Build instrument.xml (and more) for French CAL concept — 3 Nov 2000 (??)
    - Lots of similarities, but it *is* different.

- Moderate priority, intermediate term
  - Performance State — after balloon flight
    - Create, link to sim
  - Calibration process (GCRCalib) — after balloon flight
    - Inc. analysis of GSI '00 beam test data
  - Energy per log
    - Update algorithms, incorporate maps, Perf State, Calib State

# Work Plan, Schedule

- Position calculation
  - Update sim and recon models
- CAL trajectory reconstruction
- Clustering algorithms
- Background rejection algorithms

- Low priority, long term
  - Calibration process (eCalib)
  - Instrument Response Matrix
    - Requires extensive Sim running.
    - Wait until after Sim is revamped.



# Documentation

- Collaboration chose Doxygen
  - Grove suggested standard contents and general form for CAL
  - If you write it, you document it.
  - Glastsim and TBrecon
    - PIN diodes, calibration [A. Chekhtman]
    - Energy recon [R. Terrier]
  - Energy recon is complicated, deserves more detail
    - http://cdfinfo.in2p3.fr/~terrier/tb_doc/class_CalClustersAlg.html
    - Explains process and give sample results
  - To do:
    - More details in Tbrecon [A. Chekhtman]
    - Gaudi version…
- NRL web site http://gamma.nrl.navy.mil/glast/CalSW [P. Sandora]
  - Presentations (like this one!)
  - Weekly status reports, action items
  - Supporting docs (e.g. figures, status reports I used to create this)

# Energy reconstruction



## Correlation method [R. Terrier (CdF)]

- Correlation exists between total $\Delta E$ in CAL and $\Delta E$ in last layer
- Can be used to give simple, effective estimate of incident E.

## Correlation coefs are fcn of $E_0$ and $\theta$.

- How do we find them?
  - Run bunch of energies and angles.
  - Automatically fit and extract coefs.
  - Special output format for glastsim
  - Ran energies 1–300 GeV and several angles (~$10^7$ events)
    - Uniform illumination, azimuthally averaged
  - Prototype auto fitter exists.
    - Needs better event selection (keep well-behaved events, reject outliers)
    - Geometrical effects, shower length, barycenter depth.
- To do: fix it, then create interpolation algorithm.

# Simulation studies



- Done
  1. What is rate of multi-MIPs in ACD from proton splats? [B. Lott]
     - Significant or negligible increase in data volume? Negligible.
- In progress
  2. Energy corrections, measured $\Delta E$ to incident energy.
     - TKR passive material. [M. Strickman]
     - CAL passive material.
       - Implement Carbon-cell calorimeter geometry file. [A. Chekhtman]
  3. Calorimeter imaging [R. Terrier]
     - Systematics in longitudinal positioning.
     - Trajectory algorithms.
  4. Triggering and bkg rejection. [M. Strickman]
- To do
  5. Optimize CAL-only triggers. [AI: A. Chekhtman]
     - Simulation needs new flexibility to define triggers.
  6. Need to model system performance with failures (PIN, xtal, DAQ pipe,...).
     - Implement Performance State.

# Simulations: Multi-MIPs in ACD



- What is the rate of multi-MIP ΔE in ACD for everything but heavy GCRs?
  - CAL will use Z>4 GCRs for in-flight calibration.
  - ACD will veto events with tile hits near track, except veto will be suppressed if tile ΔE > a few MIPs.
  - Question: What is the rate of protons – which should be rejected – going splat in or near instrument that falsely suppress the ACD veto because they satisfy the GCR calibration event criterion?
  - Bordeaux group [B. Lott, S. Incerti, T. Reposeur] used GLASTSIM and CHIME proton spectrum.
  - Answer: Rate of false suppressions ~ few Hz
    - Does not stress data downlink rate
    - Note: True only if veto suppression is **one and only one tile** > few MIPs
  - See http://doc.in2p3.fr/themis/CELESTE/vrvs/index.htm and draft report.

# Simulations: Energy loss corrections

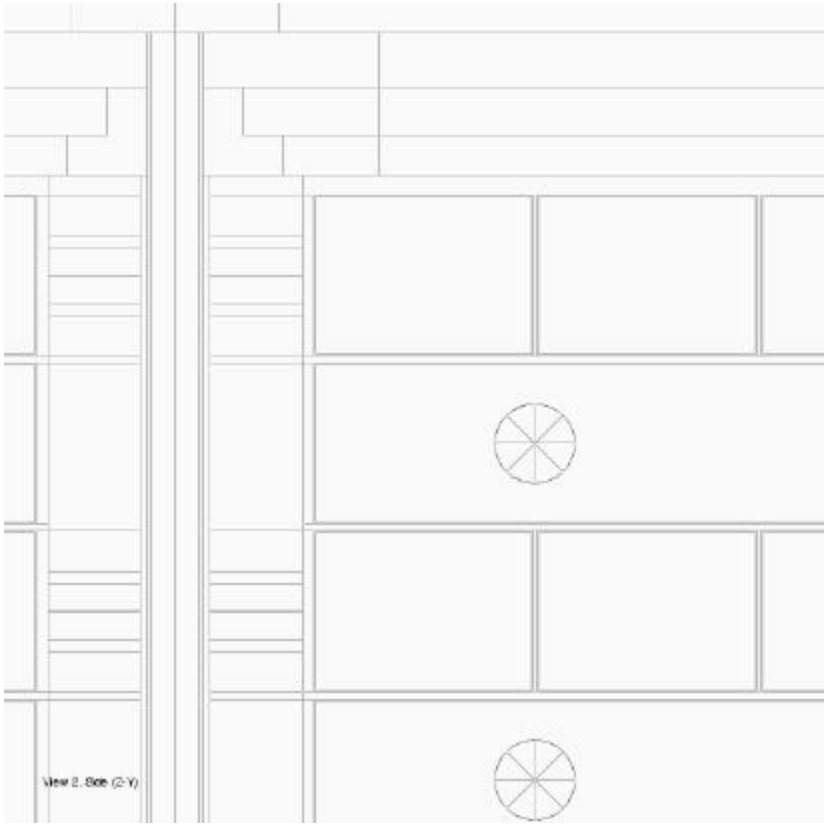


- At low E, much or most of incident energy is deposited in TKR.
  - TKR is a Si-sampling calorimeter.
- How should we scale from number of strips hit in TKR to energy deposited?
  - AO used empirical relationship (E. Bloom, P. Kunz) between TKR hits and energy missing $E_0 - E_{cal}$.
  - A. Djannati-Atai gave iterative algorithm
  - Complementary approach: Use MC Truth [M. Strickman]
    - T. Burnett, H. Arrighi, M. Strickman modified AO glastsim to score energy deposited in passive materials of TKR.
    - Gives detailed knowledge of where energy goes
      - TKR trays
        - » **At low E, bremsstrahlung not dominant, so ΔE goes as grammage, not RL!**
      - Thin v. thick radiators
        - » **Hits-to-ΔE relation is different for thin and thick layers.**
    - See Mark for interesting plots, not quite ready for Prime Time.

# Simulations: Mechanical design



- Calorimeter mechanical design
  - Current glastsim uses “pressure cell” mechanical design (Hytec & NRL)
  - French proposal, carbon cell design, not yet simulated.
- Carbon cell geometry description (Chekhtman, CdF)
  - New version created, glastsim_x
  - Contains
    - c-fiber structure with air gaps between cell and xtal.
    - Correct geometry of top and bottom support frames.
    - PCB geometry on Al support posts, etc.
- To do
  - Add appropriate code to switch between geometry files
  - Review fidelity of pressure cell and C-cell
  - Run simulations



# Simulations: Calorimeter imaging



- NRL demonstrated CAL imaging at SLAC beamtest 1997 and MSU 1998.
  - Longitudinal positioning with light asymmetry.
  - Trajectory reconstruction from longitudinal positions and log ID positions.

- GEANT simulations [R. Terrier]
  1. On axis, sim recreates results of BT97.
  2. Longitudinal position can be biased: energy barycenter (= scintillation barycenter) differs from shower axis.
     - e.g. at 30 GeV and 30 deg zenith, magnitude of bias ~ 1 cm.
  3. Transverse position can be biased: sampling size (= xtal size) is comparable to Moliere radius.
     - e.g. at 50 GeV, magnitude of bias ~ few mm.
  - Must deconvolve both biases to improve CAL imaging for off-axis showers.

- See http://cdfinfo.in2p3.fr/~terrier/Work_Progress.html

# Near-term tasks at NRL



- Palestine balloon flight
  - Prototype the GCR calibration process
  - Assuming 8 hrs at float, estimated GCR population
    - ~4000 CNO
    - ~900 Ne, Mg, Si
    - ~250 Fe
  - Mods to BF recon are required
    - New calibration methods
    - Photon/nucleus discrimination
  - See details in balloon flight talks later this meeting…
- Write CAL s/w requirements doc
- Optimize low-E TKR calorimetry
- Optimize CAL-only triggers

# GCR Calibration Process



## Algorithms

- **Physics inputs:**
  - dE/dx for heavy ions. Code expressions from the literature.
  - dL/dE for heavy ions. Measure it, then code it. Analytic expr. exist.
- **Elements of calibration process:**
  1. Extract multiMIP events.
  2. Identify likely GCRs, reject obvious junk.
  3. Fit tracks.
  4. Accept events with clean track through log, no edges or glancing hits.
  5. Identify charges.
  6. Identify charge-changing interactions.
  7. Identify mass-changing interactions.
  8. Fit dE/dx.
  9. Accumulate energy losses and light asymmetries.