Data Analysis Tasks
1 and 2 towers

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List of Discussion Topics

- To focus on Data Analysis for 1 and 2 towers we prepared a series of discussions for 4 meetings
  - Meeting 8: Nov 12, 2004
    - Overview of Data Taking Plans
    - How do we retrieve data for analysis?
    - How do we find the register configuration of the instrument when we took the data?
  - Meeting 9: Nov 19, 2004
    - What are the register configurations we will use to take data?
    - How often we will take data?
    - How many events we will record?
    - How many events are needed for calibrations?
    - How many MC events we need to simulate for each configuration?
  - Meeting 10: Dec 3, 2004
    - What are the data analysis tasks we want to do?
    - How to prioritize the data analysis tasks?
    - When and how results from our work propagate into the SAS code?
  - Meeting 11: Dec 10, 2004
    - Which SAS code will be needed to support data analysis?
    - What is the status of the code?
Overview of SVAC tests (1)

• **Outside the flight grid (with muon telescope)**
  – Each tower (CAL+TKR) is tested prior to SVAC tests (the latter occur in the flight grid)
    – CAL and TKR are Timed-in using muon telescope
    – CAL and TKR have the nominal register settings determined
  – SVAC tests (few hours) are only done to verify software infrastructure since we hope to have already debugged it with EM2
    – Scripts and data for end-to-end tests
    – Analysis macros
    – Data Quality Reports
    – Adequacy of Runs database
    – File size issues for pipeline and data analysis
    – Verify information from redundancy paths

For a full list see LAT-MD-00575 in LAT-DOCS. There is a link in our website. Beware that there are typos that will be fixed for the next version.
Overview of SVAC tests (2)

- **Inside the flight grid (without muon telescope)**
  - **After each tower (TKR+CAL) is installed in the Grid**
    - Test duration: ~ 8-16 hours
      » Calibrations (may include charge injections)
  - **After one or two towers are installed in the Grid**
    - Test duration: ~ 16 to 24 hours
      » Detector low level characterization
      » Offline calibrations (NO charge injections) including a short run unsuppressed to calculate CAL pedestals
      » MC comparisons
  - **After two towers are in the Grid**
    - Analyze E2E runs for trigger and data flow tests

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Data Runs – Required Statistical Precision

SVAC Day 2: 24 Hour runs with nominal settings

- 2 tower Data (an example to guide MC generation)
  - Expect about 50 Hz TKR trigger rate
  - 180,000 triggers for 2 towers in 1 hour
  - ~90,000 for a single tower in 1 hour
    - we have on average 1 hit/event/layer
  - ~90,000 per TKR plane in 1 hour
    - We have to account for differences in trigger acceptances at the edges and non-uniformities across the plane
  - To study hit maps and get dead channels
    - ~90,000/1500 channels/TKR plane means 60 hits/strip/hour
  - To study hit efficiency in central areas of the SSD
    - We have still 60 hits/strip/hour
    - assume a MIP selection efficiency of 3% to obtain ~2 hits/strip/hour
  - To study angular distributions
    - assume a MIP selection efficiency of 3% to obtain 2700 evt/hour
    - 90 bins of 2 degrees each gives us 30 events/bin/hour
  - For 24 hours of data
    - Hitmap: 1440 hits/strip, which is plenty...
    - Hit efficiency: ~48 hits/strip
      » 14% statistical error
    - Angular distributions: ~720 events/2 degree bin
      » 4% statistical error

Need to do the same calculation for CAL
Monte Carlo Runs

• Want to compare data with MC at a 10% level
• 2 tower MC (data from the Instrument Analysis Workshops)
  – Generated 4 Million surface muons
  – 200,000 triggered both towers
    – About same statistics as used in previous page for 1 h of data

• MC generation Required for 2 Towers
  – Factor of 2 better statistics than Data
  – ~200 Million surface muons
  – Break it in files of 200 K MC generated events imply in 1000 files
    – Takes about 5 hours for each job
    – Assume we use 75 machines in the farm, it takes about 3 days

• Can SAS check the numbers and propose a date to start generation?
Requests to SAS

• For the same EM release used for data runs we need
  – 200 Million MC surface muons with a 2 tower geometry
  – 100 Million MC surface muons with a 1 tower geometry
    – Probably can do both in a week!

• QUESTION FOR SAS/TKR/CAL/ACD:
  – How are we setting the thresholds in the simulation?
    – Same for every front-end chip?
    – Is this settable through jobOptions? (I guess TKR is...)

• QUESTIONS FOR CAL:
  – Can we make Monte Carlo with High energy muon gain?
  – Should we make Monte Carlo with High energy muon gain?
• Data analysis for these 24 hour runs can be done by dividing data samples according to the following selection
  – TKR triggers (baseline for CAL calibrations when tower is integrated)
    – from tower 8 OR 9
    – from tower 8 AND 9
  – CAL low triggers (Do we need these? See next talks in this meeting)
    – In the past CAL-LO has been set to 8-10 MeV
      » Data was hard to analyze and CAL recommends we disable it
    – There will be a discussion in the meeting today about what to do
  – CAL High triggers (default is to ENABLE it to its nominal flight setting of 1 GeV)
    – Use high energy muon gain to get muon signals in small PIN Diodes. (do not confuse gain with trigger !)

• TEM diagnostics will be ENABLED
  – Trigger primitives will be available

• GASU will be used so
  – GEM word will be used to tell which tower triggered

• NOTES:
  – There is no external trigger from muon telescope while inside the flight grid
  – Need MC two-tower studies to decide whether we divide into groups or not
Data Analysis Tasks - Trigger

- GEM information (GEM makes the trigger decision)
  - Verify that GEM word is in agreement with expectations from TKR trigger primitives
  - Verify that trigger rates are similar for tower 8 and 9
    - Compare with rates measured outside the grid when the muon telescope was used
    - Study shape of angular distributions in TKR
      » Measure trigger acceptance
    - Compare with MC simulations
  - Verify that trigger rates for events that triggered both towers are consistent with geometrical expectations
    - Compare with MC simulations
- TEM information
  - Look at the TKR trigger primitives and check how many events have less than 6 digis (i.e. layers hit) when data was latched
- TKR information
  - Compare Digi results using TriggerAlg for both data and MC
- Study any feature that was caught by the Data quality reports produced at the end of the run, which requires further investigation
Calibrations

- **TKR**
  - **Charge injection**
    - TOT Threshold Calibration
    - TOT Threshold Dispersion
    - TOT Calibration/GTFE
  - **Muons (Can we do these in 16 hours instead of 24?)**
    - TOT MIP Calibration/GTFE
    - Trigger efficiency (using TKR only)
    - Additional dead/noisy channels
- **CAL**
  - **Charge injection**
    - Use all necessary info from previous CAL tests at SLAC
  - **Muons (Can we do these in 16 hours instead of 24?)**
    - Pedestal determination (zero suppression off)
    - Gain measurement/GCFE
    - Light asymmetry measurement/layer

- **CAL**
  - auto-range,
  - four range readout,
  - high energy muon gain,
  - zero suppression on at 1 MeV

- **TKR**
  - 0.25 MIP threshold

- **TEM**
  - diagnostics enabled
Detector Level Characterization

• CAL
  – For example, see recent note from Benoit Lott with excellent suggestions

• We will go through TKR and CAL tests next meeting
  – Meeting 10: Dec 3, 2004
  – What are the data analysis tasks we want to do?
  – How to prioritize these tasks?
  – When and how do results from these analysis propagate into the SAS code?