SD development

Goals

- Identify needs in Offline to support UUB/SSD/sPMT analysis (data + simulations)
- Create list of requirements for AugerPrime Offline release
- Plan for continued development after workshop

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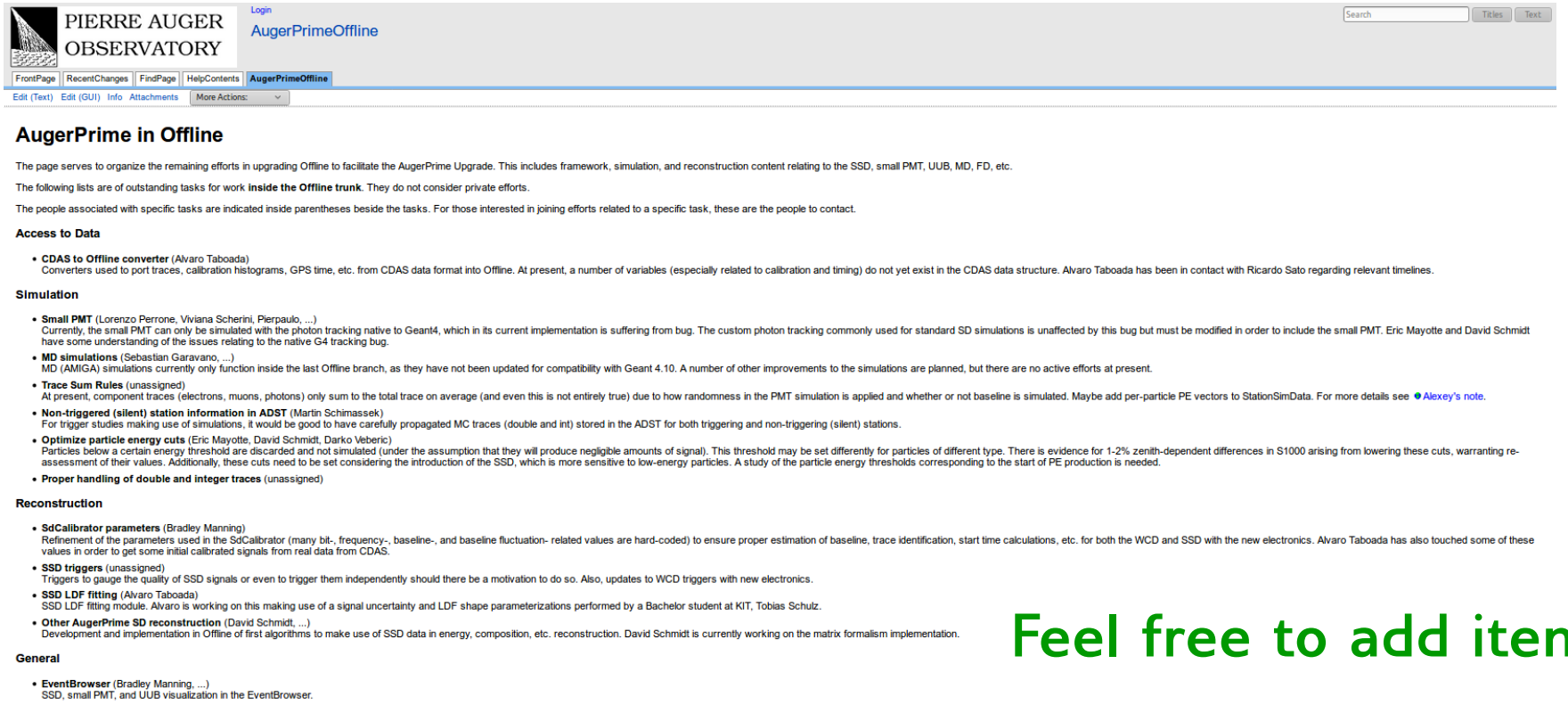
https://www.auger.unam.mx/AugerWiki/AugerPrimeOffline



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FrontPage | RecentChanges | FindPage | HelpContents | AugerPrimeOffline

Edit (Text) Edit (GUI) Info Attachments More Actions:

AugerPrime in Offline

The page serves to organize the remaining efforts in upgrading Offline to facilitate the AugerPrime Upgrade. This includes framework, simulation, and reconstruction content relating to the SSD, small PMT, UUB, MD, FD, etc.

The following lists are of outstanding tasks for work **inside the Offline trunk**. They do not consider private efforts.

The people associated with specific tasks are indicated inside parentheses beside the tasks. For those interested in joining efforts related to a specific task, these are the people to contact.

Access to Data

- **CDAS to Offline converter** (Alvaro Taboada)
  Converters used to port traces, calibration histograms, GPS time, etc. from CDAS data format into Offline. At present, a number of variables (especially related to calibration and timing) do not yet exist in the CDAS data structure. Alvaro Taboada has been in contact with Ricardo Sato regarding relevant timelines.

Simulation

- **Small PMT** (Lorenzo Perrone, Viviana Scherini, Pierpaulo, ...)
  Currently, the small PMT can only be simulated with the photon tracking native to Geant4, which in its current implementation is suffering from bug. The custom photon tracking commonly used for standard SD simulations is unaffected by this bug but must be modified in order to include the small PMT. Eric Mayotte and David Schmidt have some understanding of the issues relating to the native G4 tracking bug.
- **MD simulations** (Sebastian Garavano, ...)
  MD (AMIGA) simulations currently only function inside the last Offline branch, as they have not been updated for compatibility with Geant 4.10. A number of other improvements to the simulations are planned, but there are no active efforts at present.
- **Trace Sum Rules** (unassigned)
  At present, component traces (electrons, muons, photons) only sum to the total trace on average (and even this is not entirely true) due to how randomness in the PMT simulation is applied and whether or not baseline is simulated. Maybe add per-particle PE vectors to StationSimData. For more details see Alexey's note.
- **Non-triggered (silent) station information in ADST** (Martin Schimassek)
  For trigger studies making use of simulations, it would be good to have carefully propagated MC traces (double and int) stored in the ADST for both triggering and non-triggering (silent) stations.
- **Optimize particle energy cuts** (Eric Mayotte, David Schmidt, Darko Veberic)
  Particles below a certain energy threshold are discarded and not simulated (under the assumption that they will produce negligible amounts of signal). This threshold may be set differently for particles of different type. There is evidence for 1-2% zenith-dependent differences in S1000 arising from lowering these cuts, warranting re-assessment of their values. Additionally, these cuts need to be set considering the introduction of the SSD, which is more sensitive to low-energy particles. A study of the particle energy thresholds corresponding to the start of PE production is needed.
- **Proper handling of double and integer traces** (unassigned)

Reconstruction

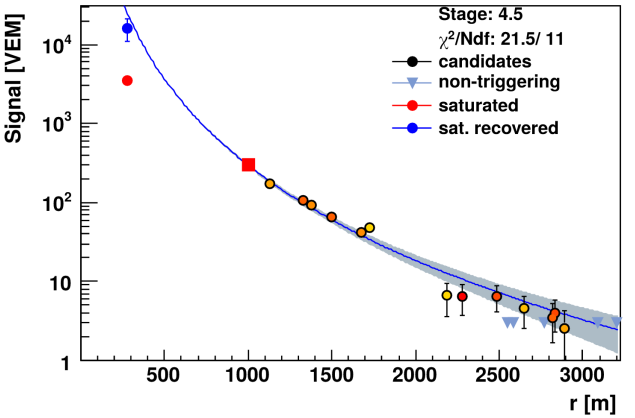
- **SdCalibrator parameters** (Bradley Manning)
  Refinement of the parameters used in the SdCalibrator (many bit-, frequency-, baseline-, and baseline fluctuation- related values are hard-coded) to ensure proper estimation of baseline, trace identification, start time calculations, etc. for both the WCD and SSD with the new electronics. Alvaro Taboada has also touched some of these values in order to get some initial calibrated signals from real data from CDAS.
- **SSD triggers** (unassigned)
  Triggers to gauge the quality of SSD signals or even to trigger them independently should there be a motivation to do so. Also, updates to WCD triggers with new electronics.
- **SSD LDF fitting** (Alvaro Taboada)
  SSD LDF fitting module. Alvaro is working on this making use of a signal uncertainty and LDF shape parameterizations performed by a Bachelor student at KIT, Tobias Schulz.
- **Other AugerPrime SD reconstruction** (David Schmidt, ...)
  Development and implementation in Offline of first algorithms to make use of SSD data in energy, composition, etc. reconstruction. David Schmidt is currently working on the matrix formalism implementation.

General

- **EventBrowser** (Bradley Manning, ...)
  SSD, small PMT, and UUB visualization in the EventBrowser.

Feel free to add items!

Real Data



Access:

CDAS2Offline converter needs update (Alvaro Taboada)

Upstream dependencies (Ricardo Sato, CDAS developers):
→ requires values/traces to be available in CDAS data
→ requires their implementation in local station software

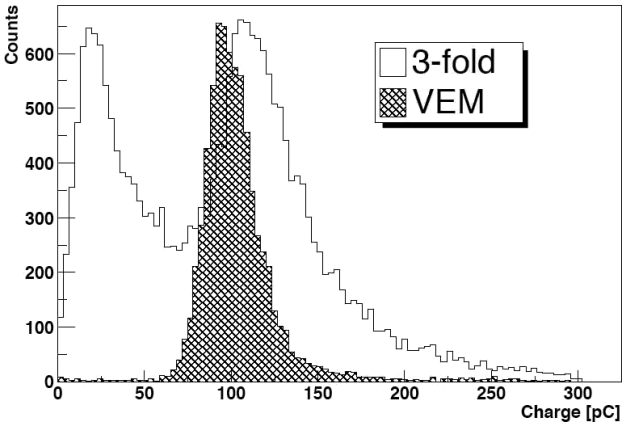
Downstream dependencies (David Schmidt):
→ requires existing classes or ability to generate classes in Framework (incl. det)

Analysis:

Module needed to clean up and fill in variables missing in EA data (Alvaro Taboada)

Module sequence for EA/production reconstruction

Reconstruction



SdCalibrator (Bradley Manning)

Many bit-, frequency-, and baseline- related values hard-coded

Storage and use of many values require significant changes

SSD LDF fitting (Alvaro Taboada)

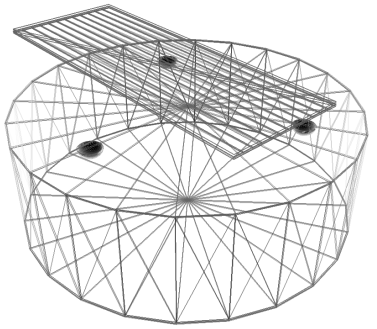
ScintillatorLDFFinderKG module committed

- Uses modified NKG LDF and uncertainty model parameterized for SSD (Tobias Schulz)

Triggers

SSD readout whenever WCD triggers
Independent triggers to gauge quality of SSD signals necessary?

Simulation



SmallPMT (Lorenzo Perrone , Vivana Scherini)
Future: Francesco, Alessio, Pierpaolo

- Currently can only be used with native Geant4 photon tracking
- Suffers from Geant4-related bug (Eric Mayotte, David Schmidt)

Optimization of particle energy cuts for the scintillator
(Eric Mayotte, David Schmidt, Darko Veberic)

Trace Sum Rules

- Component traces only statistically add up to total trace

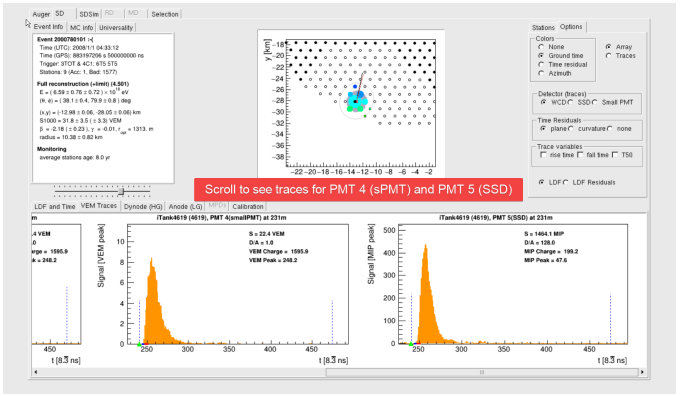
Non-triggered (silent) station information in ADST (Martin Schimassek)

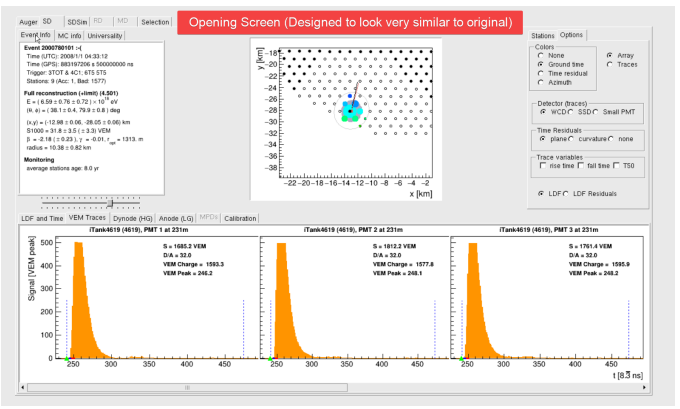
Proper handling of double and integer traces

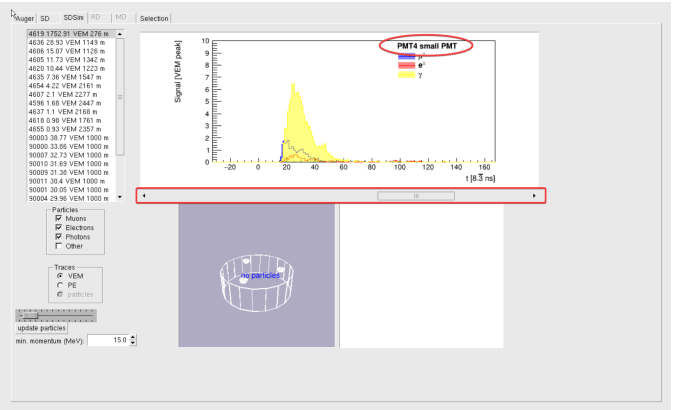
General

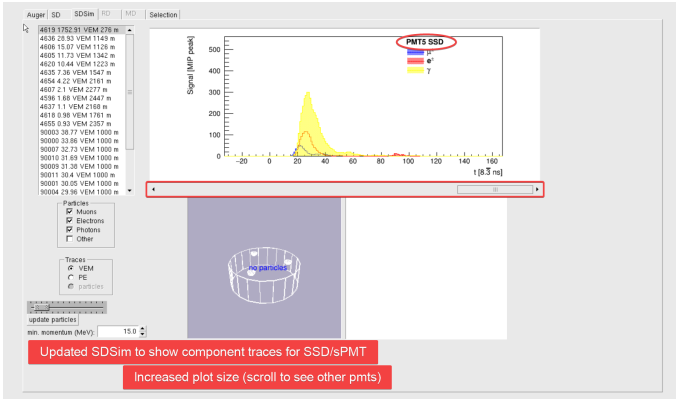
EventBrowser (Bradley Manning)

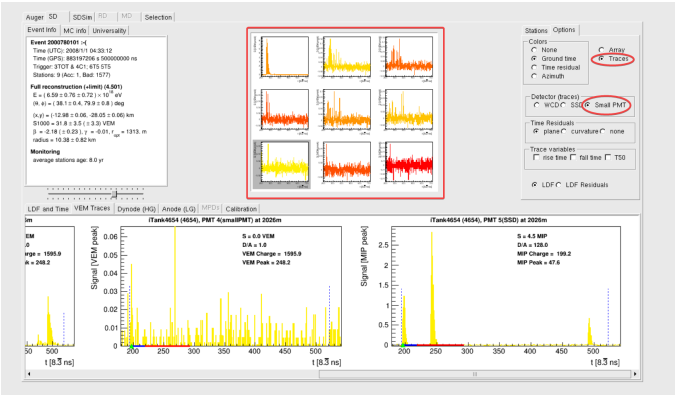
New and updated displays of UUB/SSD/sPMT variables, traces, etc.

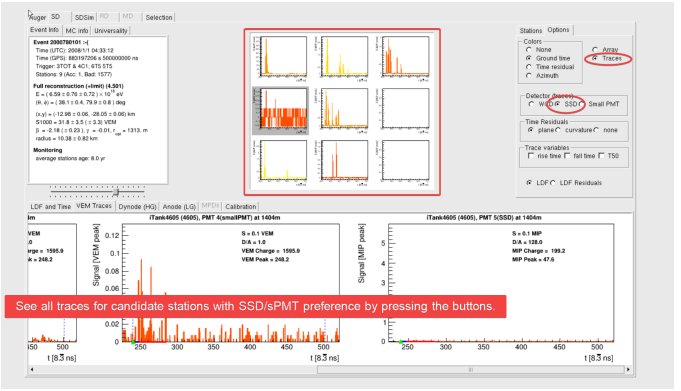


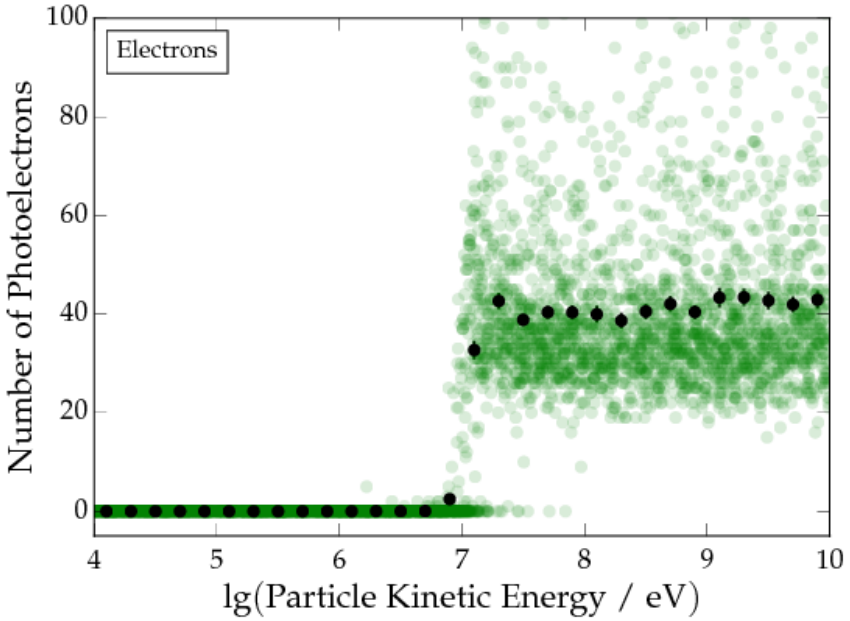


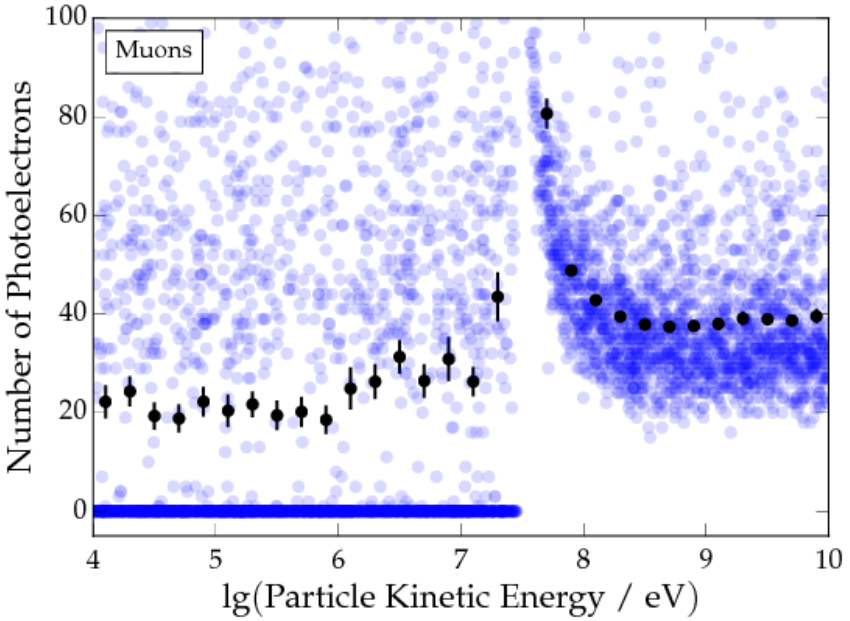


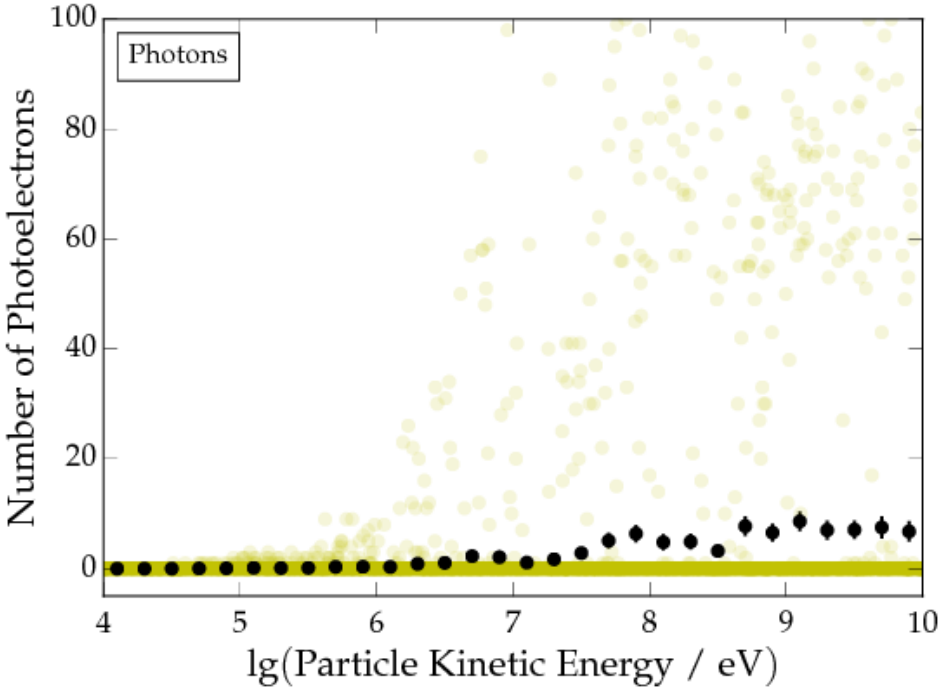







Electrons
Number of Photoelectrons
lg(Particle Kinetic Energy / eV)


Muons
Number of Photoelectrons
lg(Particle Kinetic Energy / eV)


Photons
Number of Photoelectrons
lg(Particle Kinetic Energy / eV)