Tracker Alignment Plan

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TKR Alignment

• **TKR alignment objectives.**
  – Alignment is unnecessary if mechanical tolerance is realized.
    • Important tool to monitor the performance of LAT.
      – Trust, but Verify.
  – SSD alignment.
    • Alignment of individual SSD to verify assembly precision.
    • Performed just once upon receipt at SLAC.
  – Tray alignment.
    • Monitor the location of the trays periodically.
  – Inter-tower alignment.
    • Effect of GRID deformation due to temperature change.
  – LAT&Observatory alignment.
    • Define the LAT location w.r.t. the star tracker.
    • Define LAT scale.

• **TKR alignment requirements.**
  – Track angular precision < 7 arcsec. (TBR)
  – SSD location: < 30µm ~ 1/2 of position resolution.
SSD & Tray Alignment

- **Track based alignment.**
  - Minimize $\chi^2$ of the distance between SSD hit and track by adjusting SSD location and orientation.

- **Parameters: $x$, $y$, $z^*$, rotation around $z$ axis.**
  - Rotations around $x$ and $y$ axes are optional.
  - Overall $z$ length is fixed to avoid under-constraint.
    - Overall $z$ length will be fixed by LAT alignment.

- **Alignment technique.**
  - One large matrix inversion. (SLD)
    - 2304 x 2304 matrix per tower.
  - Iterative procedure. (Belle, DELPHI, ALEPH)
    - Align every SSD (tray) with respect to the rest of SSD (tray).
    - Iterate above procedure until adjustments become sufficiently small.
Inter-Tower & LAT Alignment

- **Inter-Tower alignment**
  - Monitor tower movement by GRID deformation due to temperature change.
    - Temperature dependence.
  - Minimize $\chi^2$ of the distance between SSD hit and track from adjacent tower by adjusting tower location and orientation.

- **LAT & Observatory alignment.**
  - Minimize $\chi^2$ of the distance between the nominal position of known gamma-ray sources and the position measured by LAT.
  - Define absolute z-scale of the LAT.
    - Study the position of the known gamma-ray sources as a function of the incident angle.
Alignment Performance Evaluation

- **Comparison of results from two independent procedure.**
  - Large matrix inversion and iterative procedure.

- **Comparison of tracking parameters from two different part of the tracker.**
  - Inter-tower, Upper-lower layers.
    - Systematics can be studied by angular dependence.
  - Alternative layers.
    - Overall tracking performance.
    - Comparison with MC.

Hiro Tajima, TKR Alignment, Nov 14, 2001
Schedule

• **MC studies. (present~2003/Dec)**
  – Study hit and track selection criteria appropriate for alignment.
  – Evaluate the alignment precision.
  – Figure out number of event necessary to satisfy the requirements.
  – Verification of MC results with Bfem data if we have time.

• **Alignment studies with Calibration unit. (2004/Jan~2004/Dec)**
  – “Verification” of MC results.
    • More like MC tuning.
  – Study temperature dependence.
    • Comparison with mechanical measurements.
  – Establish the alignment procedures for inner- and inter-alignment.