Alignment

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Old pages for SSD/SVT are here:

http://phys.kent.edu/~margetis/STAR/HFT/Survey/Alignment How-To.html

Working directory:

/star/institutions/ksu/margetis/hft/align

```
lrwxrwxrwx  1 margetis rhstar       26 Sep  4 10:55 data1 -> /star/data03/daq/2005/073//
lrwxrwxrwx  1 margetis rhstar       26 Sep  4 10:55 data2 -> /star/data03/daq/2005/076//
-rw-r--r--  1 margetis rhstar  32801490 Sep  4 19:38 Event_6073006_raw_2020004.root
-rw-r--r--  1 margetis rhstar  32148513 Sep  6 11:00 Event_6076003_raw_1030001.root
-rw-r--r--  1 margetis rhstar      1237 Sep  6 08:27 history.txt
drwxr-xr-x  4 margetis rhstar      2048 Sep  5 10:22 plots/
drwxr-xr-x  3 margetis rhstar      2048 Aug 31 09:28 StarDb/
-rw-r--r--  1 margetis rhstar 971656435 Sep  4 19:38 st_physics_6073006_raw_2020004.event.root
-rw-r--r--  1 margetis rhstar  12047357 Sep  4 19:38 st_physics_6073006_raw_2020004.log
-rw-r--r--  1 margetis rhstar 891354647 Sep  6 11:00 st_physics_6076003_raw_1030001.event.root
-rw-r--r--  1 margetis rhstar  10721763 Sep  6 11:01 st_physics_6076003_raw_1030001.log
drwxr-xr-x  3 margetis rhstar      2048 Aug 31 09:28 StRoot/
-rwxr-xr-x  1 margetis rhstar      1512 Aug 31 09:50 subm.pl*
```

Procedure:

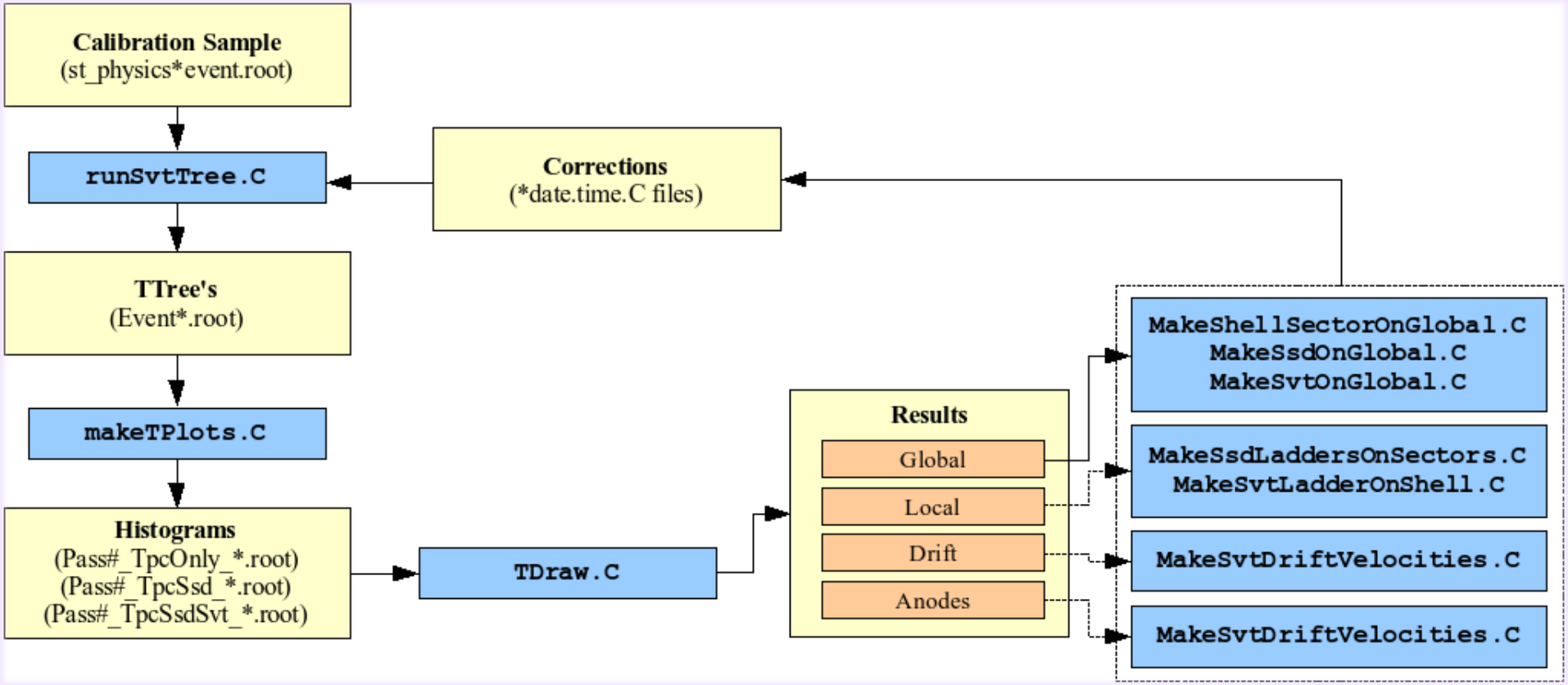
OLD SSD/SVT

TPC only tracks
- Global alignment of SSD (+SVT) with respect to TPC
- (Local) Alignment of SSD ladders:

TPC + SSD tracks
- (Global) Alignment of SVT Clam Shells
- (Local) Alignment of SVT ladders

TPC + SSD + SVT tracks
- Check consistency and
- re-evaluate SVT & SSD hit errors

Statistics needed:
1 mm → ~20 micron: reduction factor 50
→ ~2,500 tracks per SVT sensor
→ data sample with ~250,000 tracks -> 250K CuCu events



The sequence to be followed for each detector is:

1) **SSD Alignment**: (TPC tracks Only)
   Global - SSD on Global and Sectors on Global;
   Local - SSD Ladders on Sectors;
2) **SVT Alignment**: (TPC+SSD hits on tracks)
   Global - SVT on Global and Shells on Global;
   Local - SVT Ladders on Shells; (Drift Velocities);
3) **Consistency Check**: (TPC+SSD+SVT hits on tracks)
   Global;Local (ladders);Drift Velocities;

Procedure:

HFT

Remember: PXL detector is a big asset (avoid TPC distortions):

1. **Global Alignment of PXL sectors**
   - **Relative alignment of PXL halves using overlap region AND using Event vertex found by each half (hit level)**
   - **Global positioning in STAR (TPC) using primary TPC tracks**

2. **Primary tracks with TPC+PXL hits**
   - **Alignment of IST ladders with respect to PXL**

3. **Primary tracks with (All – SSD) hits**
   - **Alignment of SSD ladders**

4. **Check**

- We assume that ladders on sectors and sectors in halves are pre-surveyed to specs
- Other methods (Millepede) should be developed in parallel

BackUp

Alignment methods (outline only)

- There are 'Global' and 'Self' Alignment methods
  - use 'external' track info or 'internal'

- We lack a hardware monitoring system. Once detectors are installed we rely on survey and alignment software

- We have successful 'Global' methods already in place
  - Software can be re-checked with simulations [->need (now have) geometry]. In SVT era precision was 10 microns and 0.1mrad
  - In PXL era should practically vanish
  - Specific alignment procedures might be different (next slide)

- We now have significant sensor overlap to make use of 'Self' alignment methods. Industry standard is '*Millepede*' code which was successfully used in Alice and elsewhere

- For alignment we use "good" (well defined) tracks fitted with the primary vertex.
  - Use of primary tracks significantly improves precision of track predictions in Silicon detectors and reduces influence of systematics.

- In order to minimize TPC space-charge distortions (and PXL pileup) we will need to use low luminosity data

Figure of merit for HFT alignment.

- Pointing accuracy, aka Impact parameter resolution:
  - DCA resolution (in bending XY $\equiv\rho\phi$ plane: σ_{DCA}), and resolution in non-bending plane: σ_z, is figure of merit
  - $\sigma^2_{DCA} = \sigma^2_{vertex} + \sigma^2_{track} + \sigma^2_{MCS}$ (the same for non-bending plane),
  - primary vertex resolution: $\sigma_{vertex} \sim 3\mu m + (120\ \mu m / \sqrt{N_{ch}})$; for central Au+Au collisions turns out to be ~5 μm
  - track pointing resolution: $\sigma_{track} \sim 1.5\ \sigma_{XY}$ in our case, where σ_{XY} is intrinsic detector precision (~10μm) $\oplus$ alignment errors,
  - Multiple Coulomb Scattering (MCS): $\sigma_{MCS} \sim 20\mu m / \beta p$ (GeV/c) (for thin PXL)
  - Overall mis-alignments of < 10 μm are acceptable (no big impact)