# Workflow & Data Processing Requirements

- Computing-physics needs
  - Dataflow
  - Requirements:
    - Reconstruction
    - Stripping
    - Simulation
    - Analysis

# Dataflow

Real Data:

RAW data produced via Event Filter Farm at the pit - 280 TB

Categorise in TDR: b-exclusive; dimuon; D*; b-inclusive

LHCb will no loger stream from pit

Simulation:

Simulated data hits produced with GEANT4-based application (Gauss). Hits digitised & spillover added (Boole application)

Format of simulated data are similar to those from DAQ - additional history info. also stored

# Dataflow

RAW data is reconstructed:

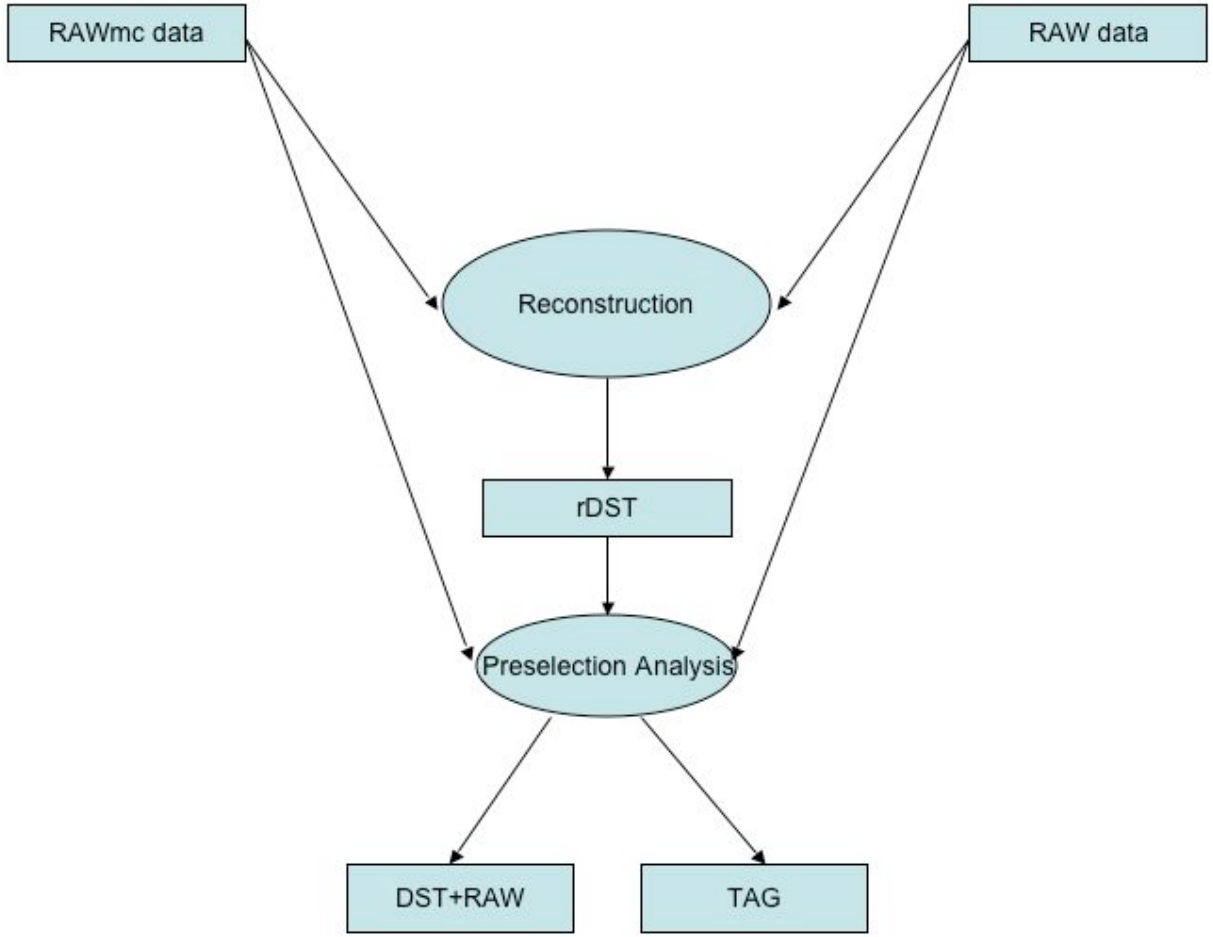
e.g.

Calo. Energy clusters

Particle ID

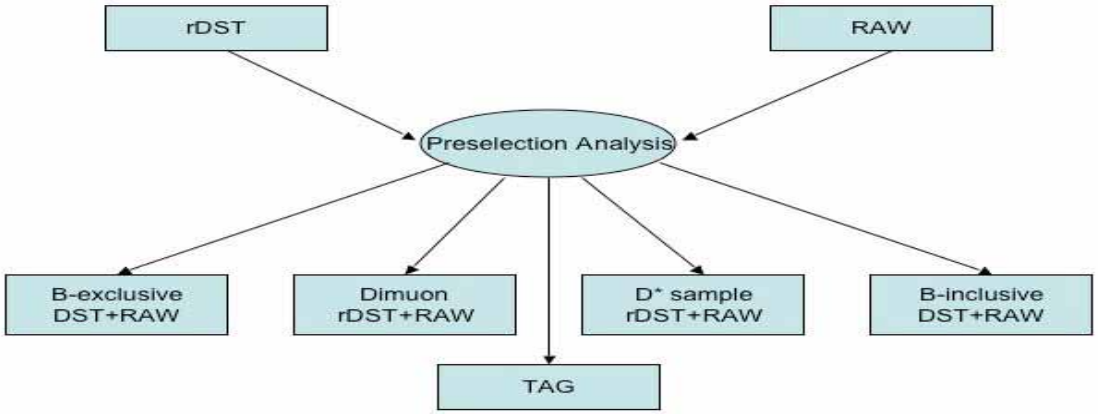
Track momentum

…




At recons time only enough info is stored to allow physics pre-selection to run at a later stage - reduced DST (rDST) - stored separately from RAW

# Dataflow - Stripping



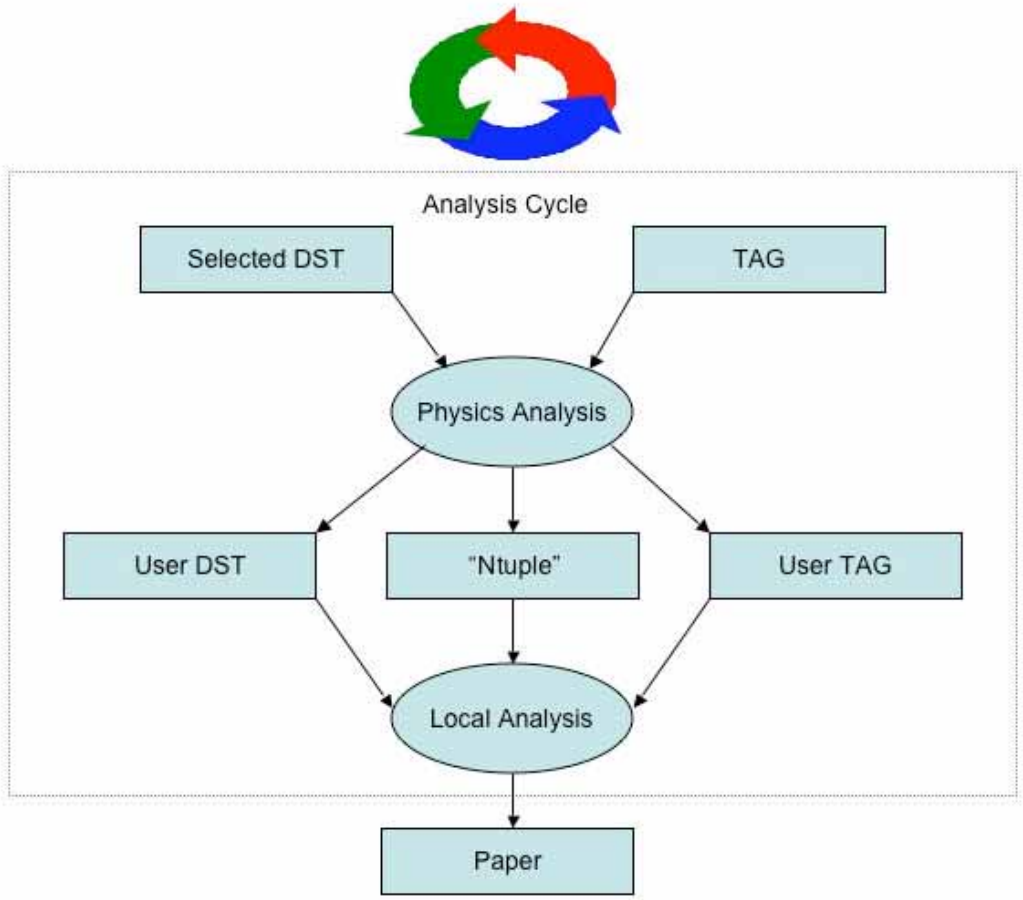

rDST is analysed in production-mode → event streams for further analysis; 4 high level categories (≡ min. 4 streams)

Algorithm developed by physics working groups - use as i/p rDST & RAW

Event to be output will have additional reconstructed info added: (full) DST+ RAW data

Event Tag Collection - created to allow "quick" access to data; contain "metadata"

# Dataflow - Analysis




User physics analysis will be primarily performed on the output of the stripping

Output from stripping is self-contained i.e. no need to navigate between files

Analysis generates quasi-private data e.g. Ntuple and/or personal DSTs

Data publicly accessible - enable remote collaboration

# Event Parameters

| | TDR estimate | Current estimate |
|---|---|---|
| Event Size | kB | |
| RAW | 25 | 35 |
| rDST | 25 | 20 |
| DST | 100 | 110 |
| Evt processing | kSI2k.s | |
| Reconstruction | 2.4 | 2.4 |
| Stripping | 0.2 | 0.2 |
| Analysis | 0.3 | 0.3 |

All sizes corresponds on storage

Implementation of rDST didn't exist at time of TDR

# Reconstruction

| | b-exclusive | Dimuon | D* | b-inclusive | Total |
|---|---|---|---|---|---|
| Input fraction | 0.1 | 0.3 | 0.15 | 0.45 | 1.0 |
| Number of events | $8\times10^8$ | $2.4\times10^9$ | $1.2\times10^9$ | $3.6\times10^9$ | $8\times10^9$ |
| MSS storage (TB) | 16 | 48 | 24 | 72 | 160 |
| CPU (MSI2k.yr) | 0.15 | 0.45 | 0.23 | 0.68 | 1.52 |

2 passes per year:

1 quasi real time over ~100 day period (2.8 MSI2k)

re-processing over 2 month period of shutdown (4.3 MSI2k)

Make use of Filter Farm at pit (2.2 MSI2k) - data back to the pit!

# Stripping

Stripping 4 times per year - 1 month production outside of recons

Stripping proposal has ~30 output streams (4 streams in TDR)

Only rDST stored for "non-b" channels+RAW i.e. 55 kB; RAW+full DST for "b" channels* - i.e. 110kB

| | Exclusive-b | dimuon | D* | Inclusive-b | Total |
|---|---|---|---|---|---|
| Input fraction | 0.1 | 0.3 | 0.15 | 0.45 | 1.00 |
| Reduction factor | 10 | 5 | 5 | 100 | 9.57 |
| Event yield per stripping | $8\times10^{7}$ | $4.8\times10^{8}$ | $2.4\times10^{8}$ | $3.6\times10^{7}$ | $8.4\times10^{9}$ |
| CPU (MSI2k.year) | 0.02 | 0.06 | 0.03 | 0.02 | 0.11 |
| Storage requirement per stripping (TB) | 9 | 26 | 13 | 4 | 52 |
| TAG (TB) | 1 | 2 | 1 | 4 | 8 |

# Simulation

- studies to measure performance of detector & event selection in particular regions of phase space
- use large statistics dimuon & D* samples for systematics - reduced Monte Carlo needs

| | Application | Nos. of events | CPU time/evt (kSI2k.s) | Total CPU (MSI2k.year) |
|---|---|---|---|---|
| Signal | Gauss | $8\times10^8$ | 75 | 1.9 |
| | Boole | $8\times10^8$ | 1 | 0.03 |
| | Brunel | $8\times10^7$ | 2.4 | 0.01 |
| Inclusive | Gauss | $8\times10^8$ | 75 | 1.9 |
| | Boole | $8\times10^8$ | 1 | 0.03 |
| | Brunel | $8\times10^7$ | 2.4 | 0.01 |
| Total | | | | 3.87 |

# Simulation

- Simulation still dominate LHCb CPU needs
- Current evt size for Monte Carlo DST (with truth info) is ~400kB/evt;
- Total storage needs 160 TB

| | Output | Nos. of events | Storage/evt (kB) | Total Storage (TB) |
|---|---|---|---|---|
| Signal | DST | $8\times10^7$ | 400 | 32 |
| | TAG | $8\times10^7$ | 1 | 0.1 |
| Inclusive | DST | $8\times10^7$ | 400 | 32 |
| | TAG | $8\times10^7$ | 1 | 0.1 |
| Total | | | | 64 |

# Analysis

- user analysis accounted in model predominantly batch - ~30k jobs/year
- predominantly analysing ~$10^6$ events
- CPU of 0.3 kSI2k.s/evt
- Analysis needs grow linearly with year in early phase of expt

| | |
|---|---|
| Nos. of physicist performing analysis | 14 |
| Nos. of analysis jobs per physicist/week | 4 |
| Event size reduction factor after analysis | 5 |
| Number of "active" Ntuples | 10 |
| 2008 CPU needs (MSI2k.years) | 0.31 |
| 2008 Disk storage (TB) | 80 |

25% of collaboration submitting analysis jobs

Anticipated some analyses will run toy-Monte Carlo for sensitivity studies

Table is for both data & Monte Carlo analysis

## Summary

- CPU needs dominated by simulation needs
- Reconstruction performed of current year's data performed twice
  - quasi-real time
  - 2 month period after data taking
- Production analysis (stripping) to create base analysis sets performed 4 times a year
  - Twice associated with reconstruction
  - Twice in a 1-month period

# Summary

Now includes efficiencies

| MSi2k*year | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Online Farm | 0.00 | 0.36 | 0.90 | 0.90 |
| CERN T0 + T1 | 0.14 | 0.36 | 1.04 | 1.51 |
| Tier1s | 0.71 | 1.77 | 4.87 | 6.74 |
| Tier2s | 1.82 | 4.55 | 11.38 | 11.38 |
| Total | 2.67 | 7.04 | 18.19 | 20.53 |
| | 38% | 100% | 258% | 292% |

| Disk (TB) | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Online Farm | 0 | 0 | 0 | 0 |
| CERN T0 + T1 | 140 | 350 | 991 | 1278 |
| Tier1s | 410 | 1025 | 2759 | 3250 |
| Tier2s | 4 | 9 | 23 | 23 |
| Total | 554 | 1385 | 3773 | 4551 |
| | 40% | 100% | 272% | 329% |

| Tape (TB) | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Online Farm | | | | |
| CERN T0 + T1 | 253 | 631 | 2270 | 4207 |
| Tier1s | 344 | 860 | 3070 | 5864 |
| Tier2s | | | | |
| Total | 596 | 1491 | 5340 | 10072 |

# Summary

Now includes efficiencies

| (TB) | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Full RAW | 0 | 224 | 560 | 1960 | 3360 |
| Full Reduced DST | 0 | 128 | 320 | 1120 | 2320 |
| Stripped RAW + DST | 0 | 219 | 547 | 2019 | 3910 |
| TAG | 0 | 26 | 64 | 241 | 482 |
| **Total** | 0 | 596 | **1491** | **5340** | **10072** |

Tape

| (TB) | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Full RAW | 0 | 30 | 76 | 190 | 190 |
| Full Reduced DST | 0 | 17 | 43 | 109 | 109 |
| Stripped RAW + DST | 0 | 410 | 1026 | 2733 | 3153 |
| TAG | 0 | 50 | 125 | 341 | 414 |
| Analysis | 0 | 46 | 114 | 400 | 685 |
| **Total** | 0 | 554 | **1385** | **3773** | **4551** |

Disk

| MSi2k*year | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Online Reconstruction | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stripping | 0.0 | 0.2 | 0.5 | 1.4 | 1.8 |
| Full Reconstruction | 0.0 | 0.6 | 1.4 | 3.6 | 4.3 |
| MC | 0.0 | 1.8 | 4.6 | 11.4 | 11.4 |
| Analysis | 0.0 | 0.2 | 0.5 | 1.8 | 3.1 |
| **Total** | 0.0 | 2.8 | **7.0** | **18.2** | **20.5** |
| Total (excl farm) | | | 6.7 | 17.3 | 19.6 |

CPU