

Online Beam Spot in HLT

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SLAC ATLAS Forum

Beam Position and Profile

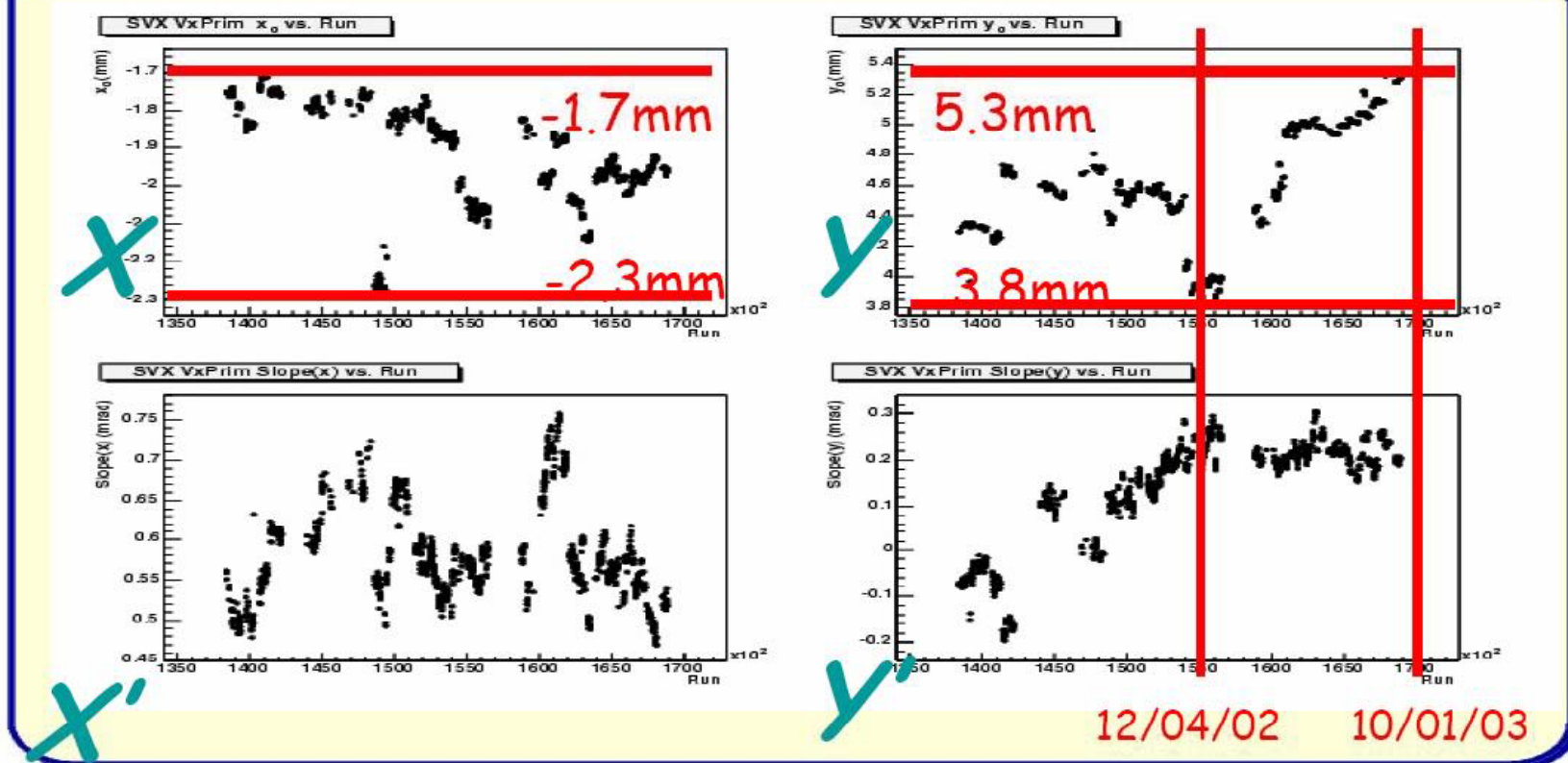
| | Luminous Region |
|---|----------------------------------|
| Design Luminosity (10^{34} , $\beta^* \sim 0.55\text{m}$) | $\sigma_{xy} \sim 12\mu\text{m}$ |
| Startup pilot run (10^{31} , $\beta^* \sim 4\text{m}$) | $\sigma_{xy} \sim 32\mu\text{m}$ |
| Luminous region length (Z) | $\sigma_z = 5.3\text{cm}$ |
| Crossing angle | $285\mu\text{rad}$ |

Needs for beam position/profile constants in HLT:

- 1) Quality track selections for all types of tracking triggers.
- 2) Crucial constraint for primary vertex finding.
- 3) Reference point for b-tag slice.
- 4) Measured beam position and profile are very important feedback to LHC. Instantaneous delivery online is even more valuable.

Real Life Example CDF

SVX beamlines(HC21, 5.1.0)



October 14, 2003
Beamline Meeting



Quality of 5.1.0 Beamlines



Alexey Ershov

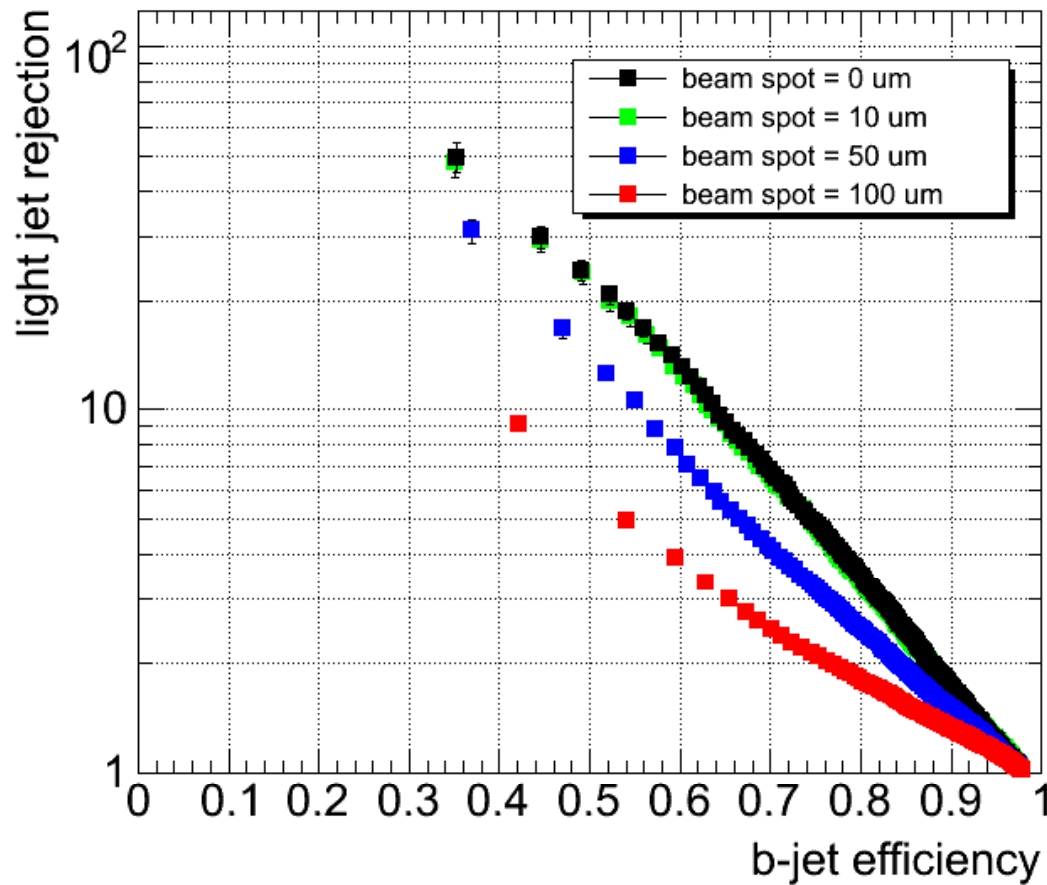
Page 3

Longer time scale variation: jumps can be ~1mm in x,y; ~0.3mrad tilt
Shorter time scale variation: can drift ~50μm in x,y during run

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Effect of Beam Spot



- Trigger algorithms still using (0,0) as interaction point and need to migrate to real beam spot.
- HLT tracking effect vs offset beam spot ?
- Some offline analyses too ?

Test by Ariel Schwartzman on HLT b-tag

General Considerations

- Needs to be prepared for jumps of \sim mm from previous positions at start of run, and drift of $\sim 50\mu\text{m}$ level during run
 - => Live HLT beam position/profile updated during run.
- HLT fortunately has access of much higher statistics (May be the only place one is thankful to the mountain of QCD background).
- Beam spot algorithms running in thousands of HLT processes independently. EF process usable events $< 0.3\text{Hz}$, L2 process usable events $< 25\text{ Hz}$. => Gathering combined info from all nodes necessary (Calculating beam spot within each process also has bookkeeping issues even statistics accumulation for longer intervals is acceptable)

Goals and Statistics

- Silicon tracking already in HLT is a major boost. Vertex/track resolution comparable to beam spot size makes it less painful on tracking systematics.
- Reconstructing the mean position beam envelope center. This is relatively easy and doesn't need much statistics.
- Slicing beam into a few sections in Z to measure the beam tilt and transverse profile at different longitudinal positions (latter primarily for LHC). Needs more statistics.
- Extracting beam width (primarily for LHC) is a bit trickier: needs to unfold PV/track resolution in a controlled manner.

Algorithms and Steering

Two known effort targeting HLT:

- Alex Cerri implemented CDF L2 algorithm based on the track impact parameter offset vs ϕ method.
- David Miller has been working on a event primary vertex based method.

Where to process ?

- L2 has large input L1 QCD event statistics. More clearly identifiable slice inputs e.g. jet ROIs for b-tag slice, lepton ROIs etc already with tracks reconstructed. Enough resources to host the beam spot processing ?
- EF potentially has more CPU resources, but less clear which slice gives the bulk of tracks needed and has to be careful to steer away from biased inputs. To get more statistics, could also utilize partial event build for ID only with less bandwidth cost.

HLT Algorithm Requirements

- Can only do single pass and use average of previous events to guess into the future.
- Algorithm information accumulation needs to be 'modular' to allow multi-node collection to combine information.
- Very robust algorithm to prevent bad beam position constants choking the DAQ system.
 - Protective self assessment to hold-off execution of applications before beam position settles at begin run, or encountered disturbance during run.
- Minimize sensitivity to misalignment.

Technical Infrastructure Issues

- **Multi-node collection:**
 - current system 1000 histograms from 6 racks in 1 min OK, but scalability to 72 racks ?
 - Gather ~10 histograms at $\ll 1$ minute time scale should be easier, but needs express gather setup ?
 - No guarantee of time boundary => histogram within lumi blocks in HLT.
 - Who does the gathering ? Run control ?
- **Redistribution of collective beam spot back thousands of HLT processes with synchronous activation (but solution can also benefit dynamic prescale, calorimeter hot channel mask etc.):**
 - Use CTP spare DAQ words in data stream (Nick Ellis)
 - Firmware modification. Enough words for general use ?
 - Or doing something at the ROIB ?
 - 'Virtual ROB' to serve `data' in each event (Werner Wiedenman)
 - DAQ hot spot and difficult to work at 100KHz ?

Event Statistics and Steering

- Discussions with Tomasz Bold and Till Eifert led to an ALLTE (Trigger Element) steering arrangements to process on all ROIs with tracks in L2.
- Input event rate ?

Interesting triggers in 10^{31} menu:

| L1 trigger | Rate | prescale |
|------------|-------|----------|
| J42 | 3.7Hz | 100 |
| J70 | 4.2Hz | 15 |
| J120 | 8.7Hz | 1 |
| 3J18 | 140Hz | 1 |
| 3J23 | 55Hz | 1 |
| 4J23 | 8Hz | 1 |

Any mu,tau ROIs usable ?

What's Useful for LHC ?

- Normal running `hour-glass' (beam transverse size vs z) effect small. Can shift timing to move IP by ~0.5m to give ~40% larger beam size for measuring β^* .
- Expect ~20% asymmetry beam size in XY (Y size larger due to vertical crossing angle plane).
- Bunch by bunch beam spot - expect fixed pattern variations and ~10% non head-on offsets.
- Any measurement on crossing angle ?
- The beam spot infrastructure can also serve:
 - online lumi signal (not absolute, but high stat relative)
 - vertex count per event is another lumi indicator

Next Steps

- Get HLT beam spot code into 14.2.0.
- Validation and CPU performance.
- Beam spot user interface to migrate applications in parallel.
- Evaluate sensitivity of various measurements for realistic steering/menu and specific tests.
- Infrastructure work on histogram gathering and beam spot redistribution.

- Online/Offline beam spot algorithm meeting Wednesday May/14 3-7pm CERN.
- Online Beam Spot wiki page to keep track of status:
<https://twiki.cern.ch/twiki/bin/view/Atlas/AtlasTriggerBeamSpot>