IdScan Performance and Validation

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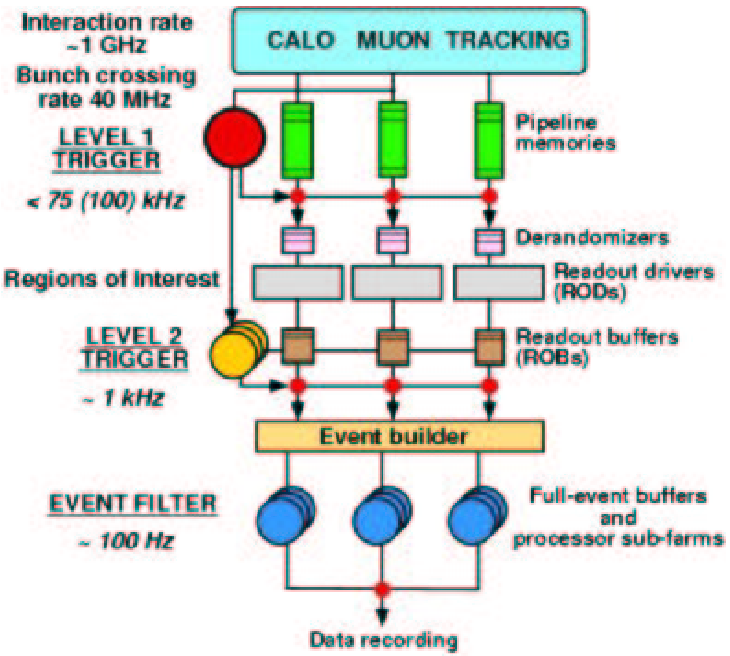
Overview

- ATLAS Trigger
- IDSCAN algorithms
- Software Environments
- Validation with single μ events
- Validation with single *e* events
- Latest Results for Trigger version
- Summary
- Future Work

ATLAS Trigger



- 40MHz bunch-crossing rate
  - 23 interactions per bunch-crossing
- Must reduce this to ~200Hz
- Based on 3 levels of event selection:
  - **LVL1**: Reduced granularity data from calorimeter and muon trigger chambers (latency 2μs, reduction to 100kHz)
  - **LVL2**: Full-granularity, full-precision data in Regions of Interest (ROI) identified by LVL1 (latency 1ms, reduction to 2kHz)
  - **LVL3**: Full event data, calibration and alignment information (1s)

LVL2

- LVL2 uses a combination of:
  - Feature Extraction algorithms
    - These reconstruct objects representing candidate electrons, muons, jets etc
  - Hypothesis Algorithms
    - These evaluate formed objects, creating a signature for the event if certain selection criteria are fulfilled.
    - Signatures for which an event can be selected are contained in a Trigger Menu
- **e/γ selection**:
  - Take LVL1 EM ROI seed
  - Use LVL2 clustering algorithm
  - Perform selection cuts on shape variables
  - Reconstruct tracks in the Inner Detector inside the RoI
  - Perform track/cluster matching
  - Use the refined ROI to seed the Event Filter (LVL3)

IDSCAN Algorithms

IDSCAN is a LVL2 Inner Detector Track reconstruction algorithm

INPUT: space-points

ZFinder	**HitFilter**	**Group Cleaner**	**Fitter**
Find z position of interesting interaction	Select only groups of space-points consistent with the z value	Remove noise space-points from the groups	Standard kalman-type fitter

OUTPUT: Track parameters and space-points

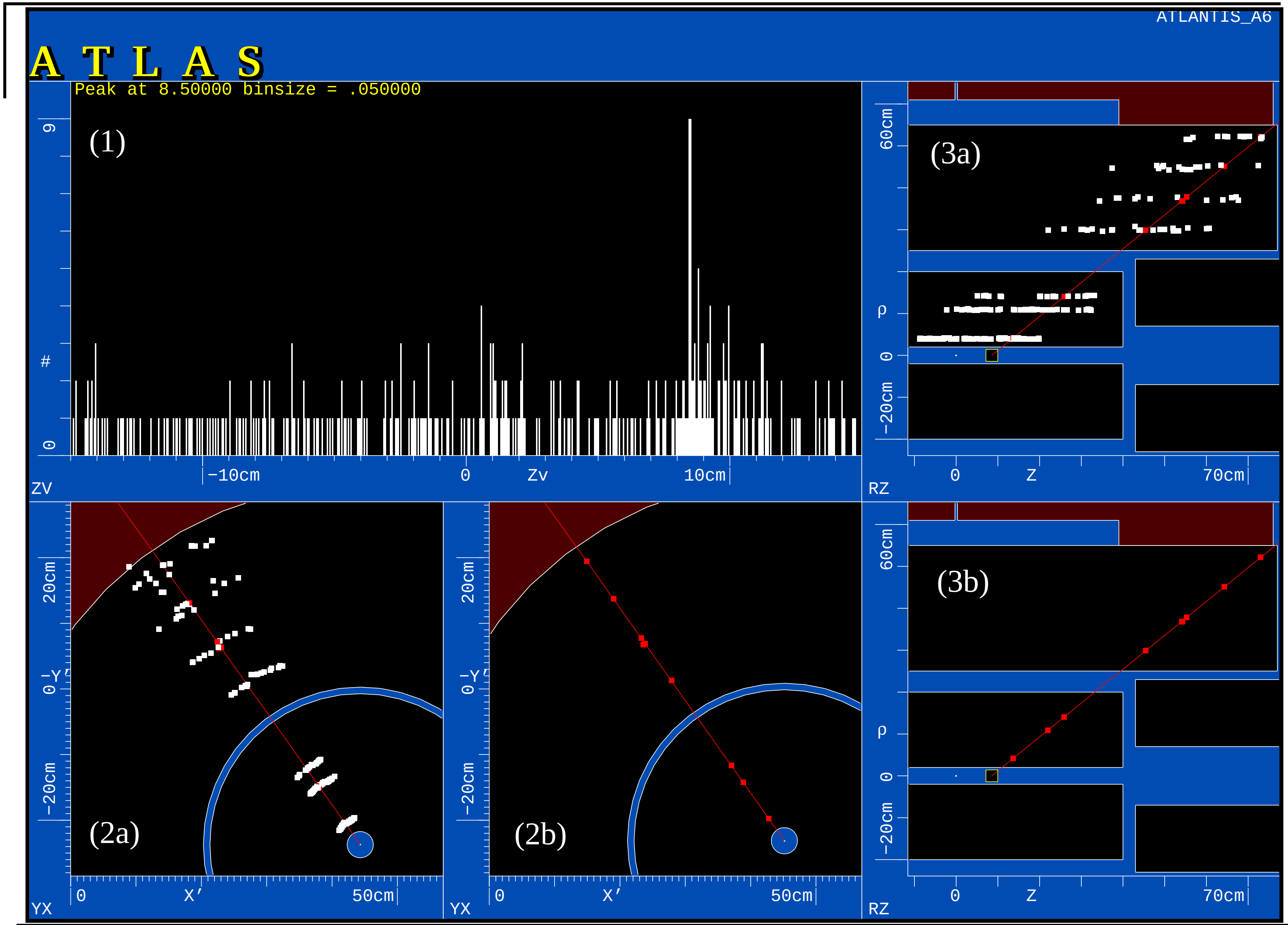
IDSCAN Algorithms - ZFinder

Utilises track properties:

- Tracks are straight lines in **r**–z. Using simple linear extrapolation, the z_0 of a track can be determined from the **r**, z values of a pair of space-points.
- High-p_T tracks are almost straight lines in **r**–φ.

Steps:

- Make very thin slices in φ (0.2-0.3 degrees)
- In each slice:
  - Combine all pairs of space-points from different layers
  - Calculate z_0 by linear extrapolation
  - Fill a 1D histogram
- The bin with the max. number of entries corresponds to the z_0 value of the high-p_T track.


ATLANTIS_A6
ATLAS
Peak at 8.50000 binsize = .050000
(1)
(3a)
(2a)
(2b)
(3b)
ZV
Zv
-10cm
0
10cm
RZ
Z
70cm
60cm
-20cm
ρ
YX
X′
50cm
20cm
-Y′
#

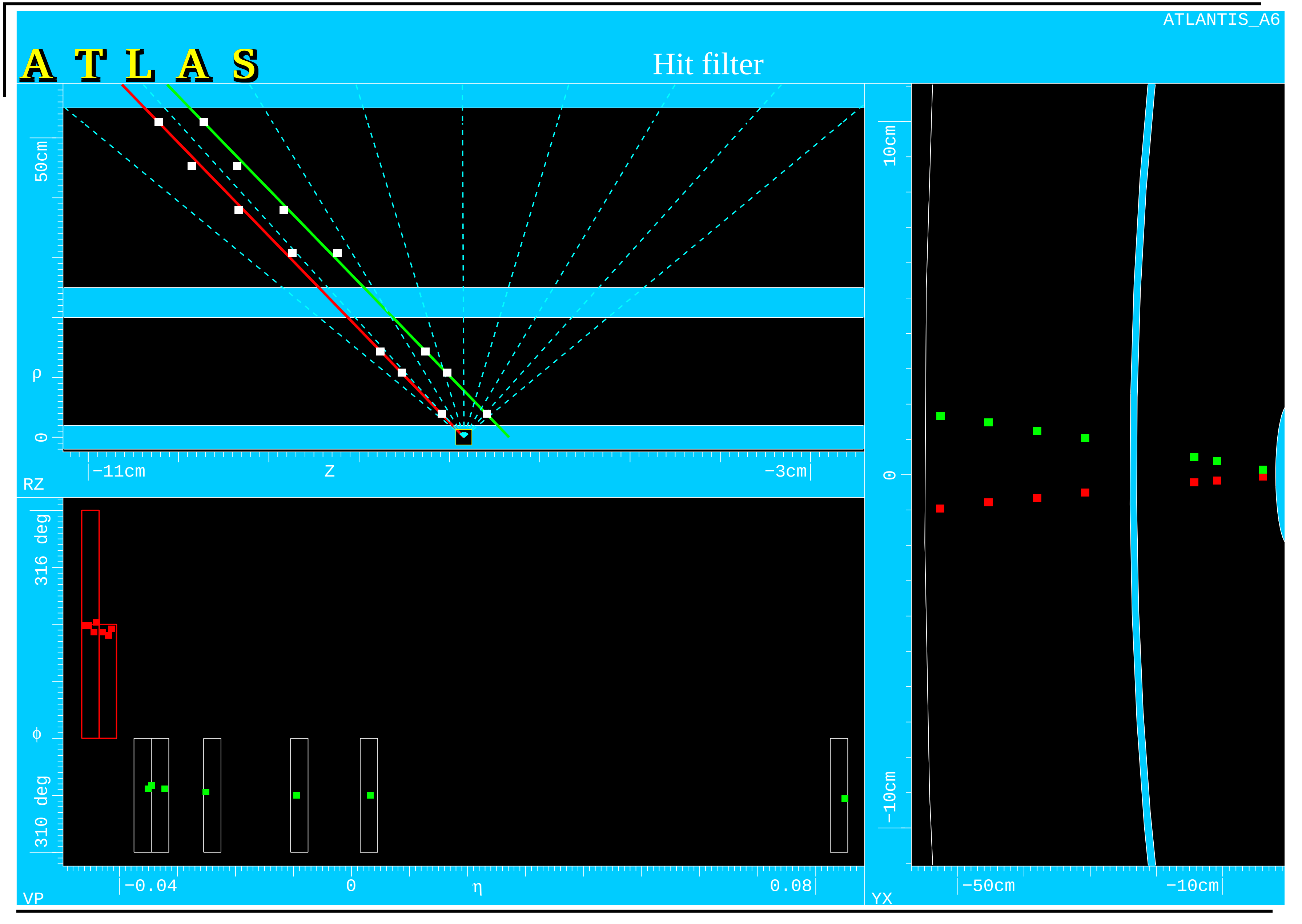
IDSCAN Algorithms - HitFilter

- All space-points from a track originating at this z_0 will have the same η

Steps:

- Put all space-points in a 2D histogram in (η, φ)
- Accept all space-points in a bin if this bin contains space-points in at least 5 (out of 7) different layers
- Reject all other space-points

- Returns groups of space-points



ATLANTIS_A6
ATLAS
Hit filter
50cm
ρ
0
-11cm
Z
-3cm
RZ
316 deg
φ
310 deg
-0.04
0
η
0.08
VP
10cm
0
-10cm
-50cm
-10cm
YX

IDSCAN Algorithms –Group Cleaner

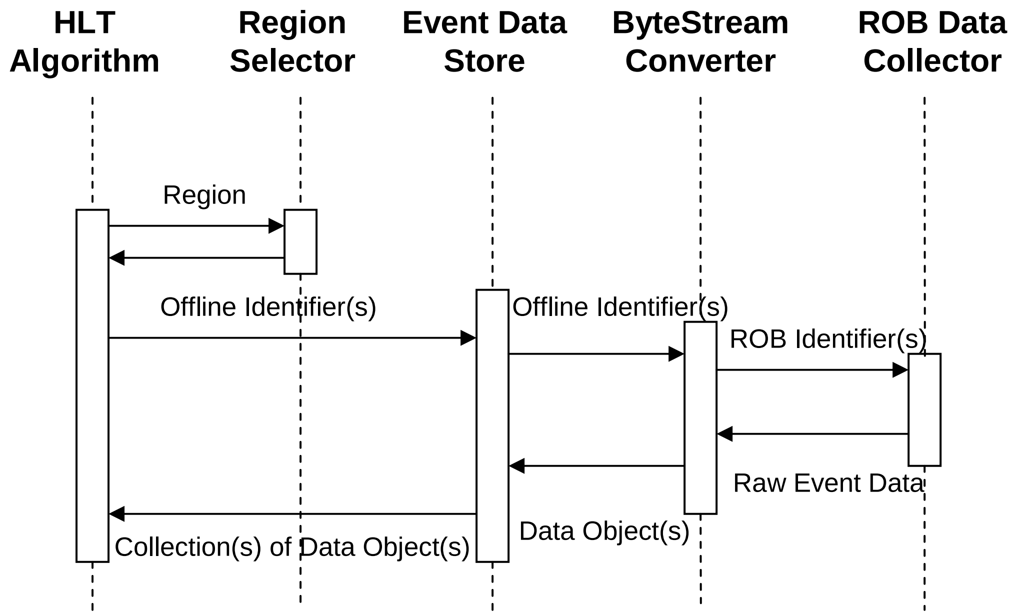
- Split groups into tracks and remove noise space-points from group.

Steps:

- Each triplet of space-points forms a potential track
  - calculate P_T, φ_0, d_0.
- Put accepted triplets (certain cuts on parameters) into 2D histogram in φ_0 and 1/ $P_{T.}$
- If in a bin there are enough space-points in different layers, accept as good track candidate.

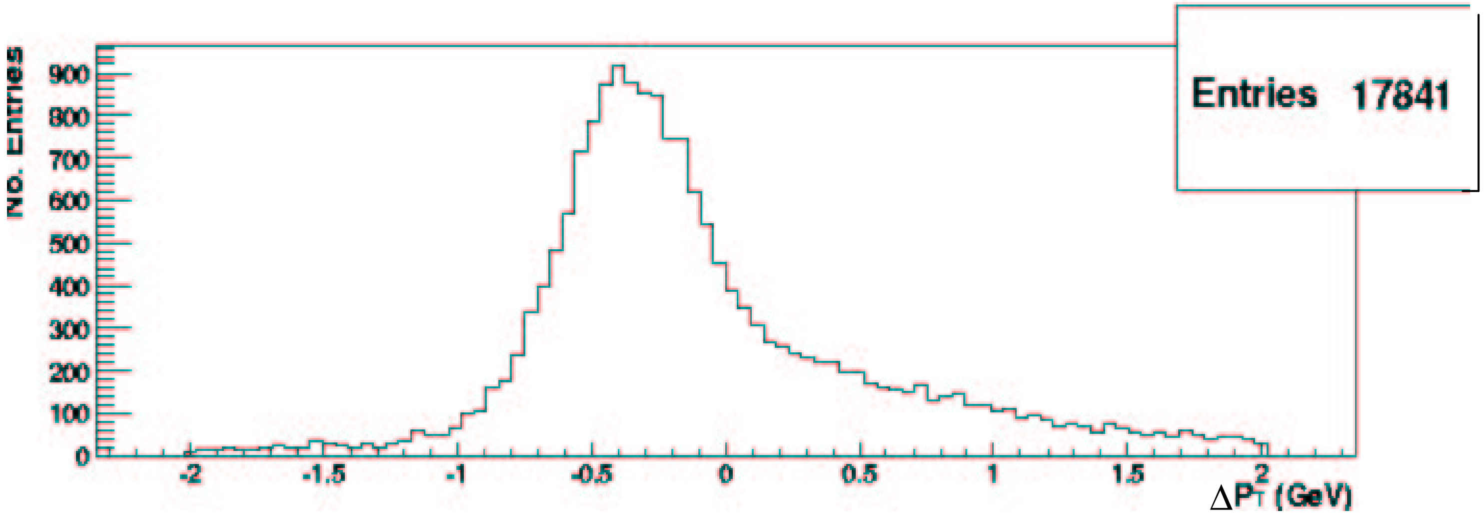
Software Environments

- **OFFLINE**
  - Runs directly in ATHENA control framework
  - Retrieves space-points from Event Data Store
  - Constructs ROI from truth data, and accepts space-points within this
  - Run only one per event
- **ONLINE**
  - ATHENA is used by LVL2 in the modified form supplied by the PESA Steering Controller
  - Can be executed several times per event, once for each ROI
  - Space-points created by different method to offline



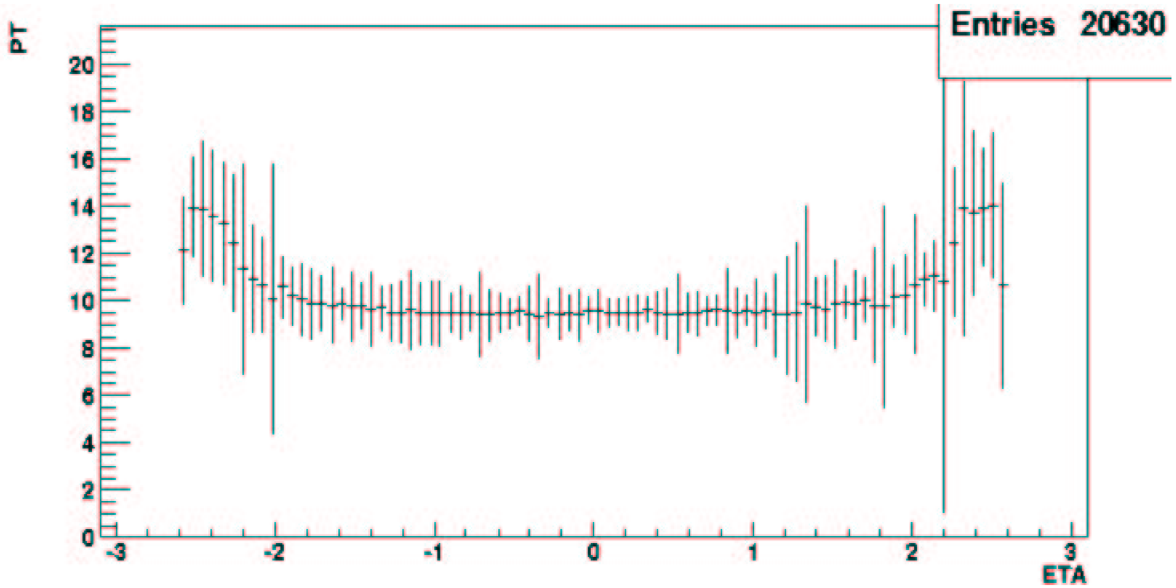
Validation with Single μ Events

- 3, 10, 100GeV events used without pile-up
- Problems:
  - Reconstructed p_T value offset from the true μ p_T by 5% of the true value
  - Large tail overestimating the p_T



Validation with Single μ Events

- Overestimation in end-caps
- Due to improved detector model DC1. Magnetic field drops from B=2T at η=0, to B=0.4T at η=2.5



- Fitting package assumes constant magnetic field
- Carried out event by event comparison between Offline version and old CTRIG version for electron events (no μ events available)
- 5% underestimation is a feature of the fitting package used

Validation with Single Electron Events

- 1000 Low Luminosity events (4.6 minimum bias events)
- 200 High Luminosity events (23 minimum bias events)

ZFinder Efficiency

- Calculated using cut $|z_0 - z_{0true}| < 0.5cm$

	Low Luminosity		High Luminosity	
	20GeV	30GeV	20GeV	30GeV
Efficiency (%)	96.9	98.3	89	95.5
Resolution (μm)	190	170	220	210

- **Problems:**
  - Small sample size
  - Changes to Detector Model
    - Increased material in Inner Detector
    - B-layer of pixel detector moved to 5.0cm instead of 4.3cm from beam-pipe

Efficiency of HitFilter and Fitter

Using Z_{true} instead of ZFinder Step

Track Selection

- Matching in η and φ used to select tracks for IdScan and xKalman
- Selecting track with minimum
  - $\Delta r = \sqrt{((\eta - \eta_{true})^2 + (\varphi - \varphi_{true})^2)}$

Calculating Efficiency

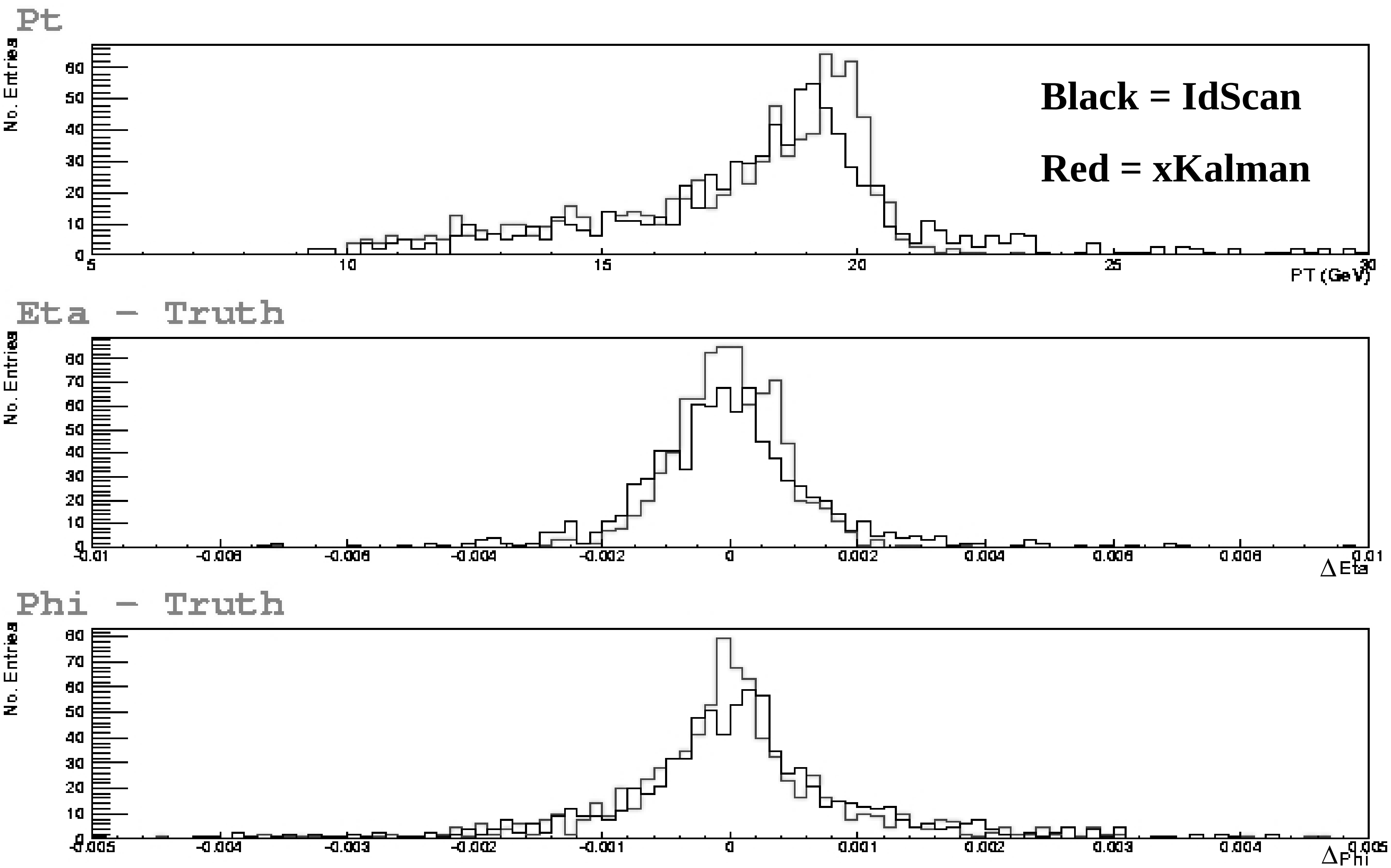
- xKalman track must satisfy:
  - $\Delta r < 0.1$
  - $\Delta z < 0.5$
  - $|P_T - P_{Ttrue} / P_{Ttrue}| < 0.5$
- If xKalman track ok, IdScan track must pass same cuts

Efficiency of HitFilter and Fitter

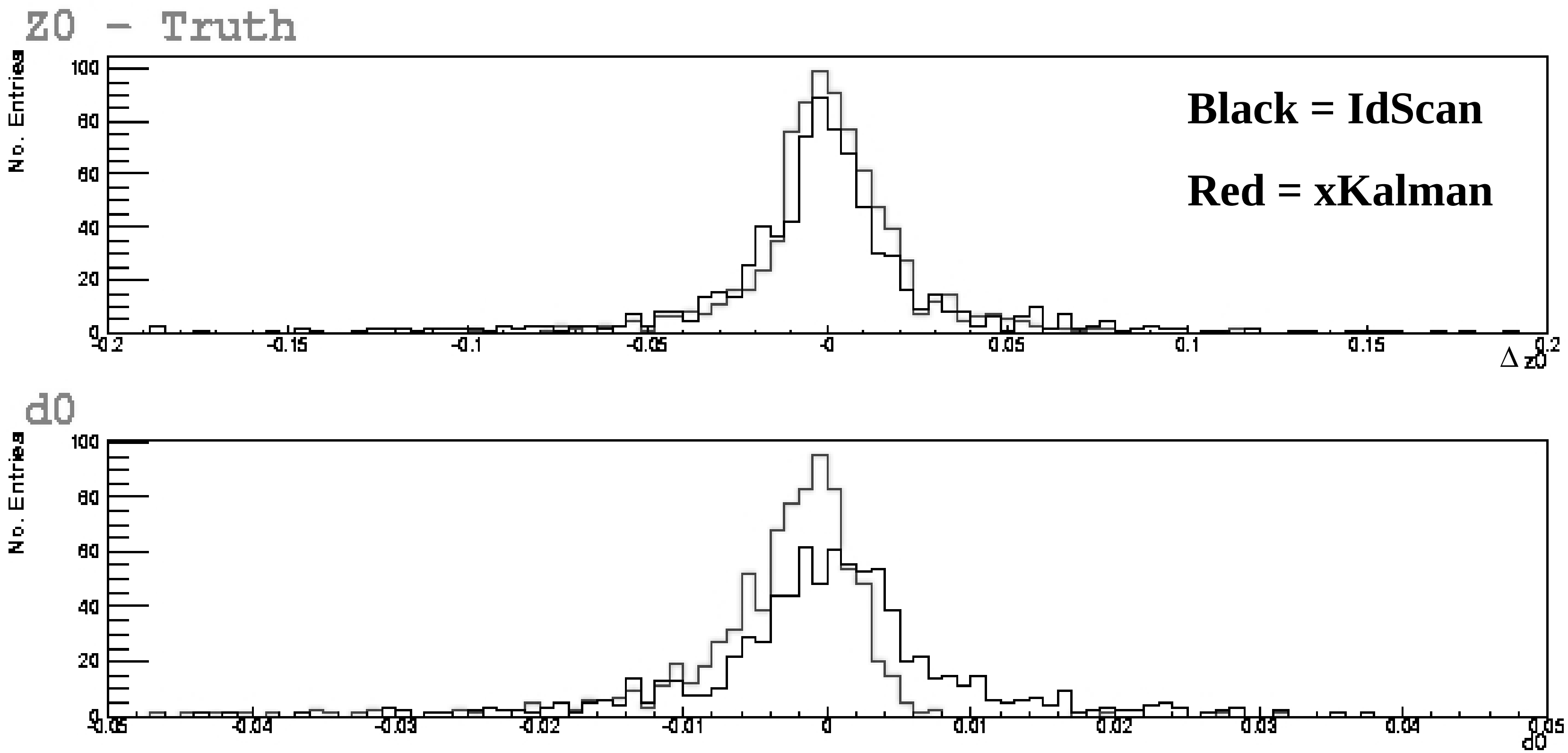
	Low Lumi (Out of 1000 events)			High Lumi (Out of 200 Events)	
	15GeV	**20GeV**	**30GeV**	**20GeV**	**30Gev**
IdScan Events	819	800	810	159	160
xKalman Events	847	829	834	162	165
Efficiency	96.5%	96.5%	97.1%	98.1%	97.9%

- Slight increase in efficiency at high luminosity
  - Pile-up adding extra space-points to tracks that would fail requirement of space-points in 5 out of 7 layers
- Remaining 3% events:
  - Few space-points in event from electron candidate
  - Track at high η ($\eta>2$)

20GeV Electron Low Luminosity

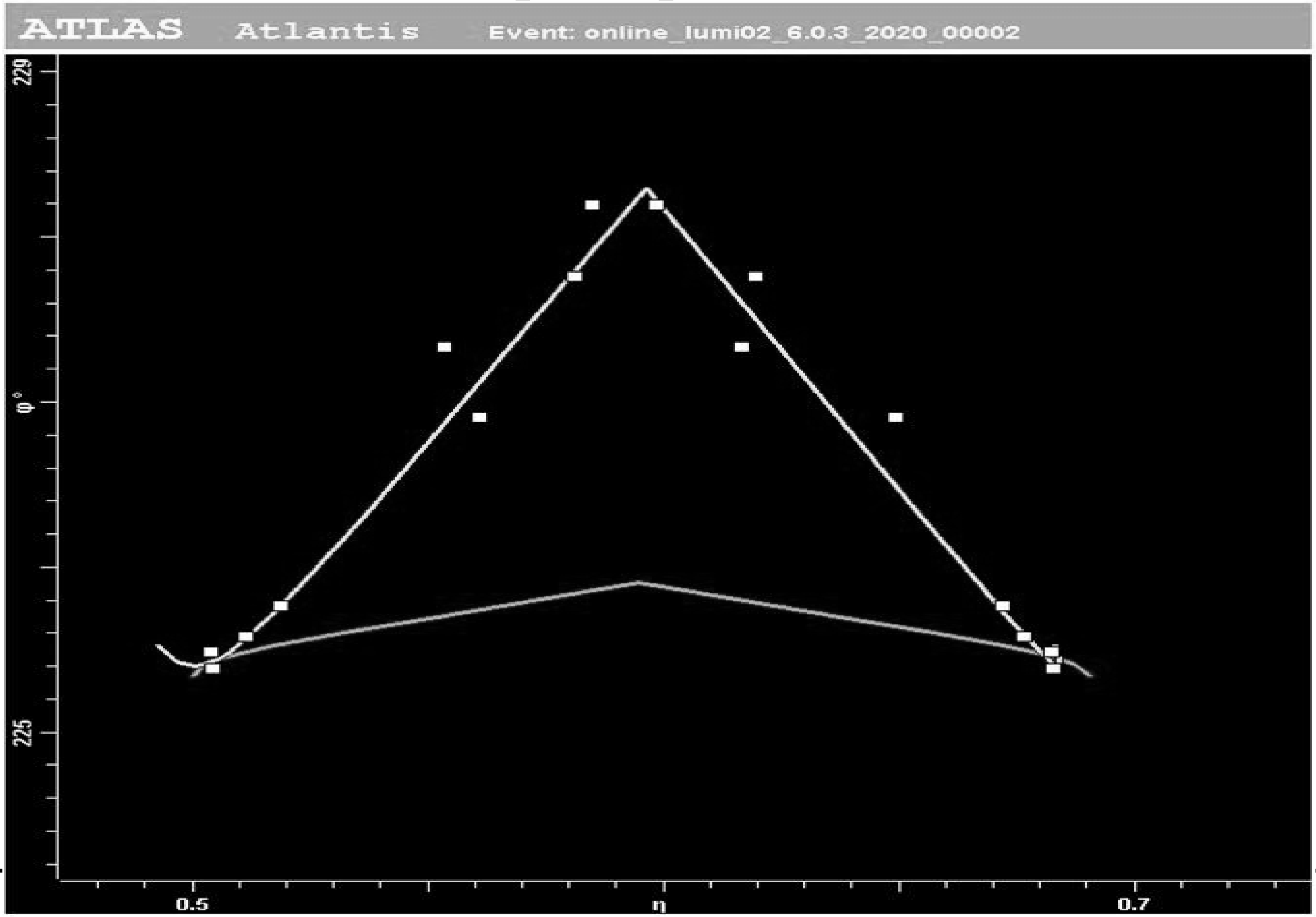


20GeV Electron Low Luminosity



Trigger Version – Latest Results

- Online version performing poorly until June (15%)
- Problems with online space-points



Trigger Version – Latest Results

	20GeV Electron		30GeV Electron	
	No Pile-Up	Low Luminosity	No Pile-Up	High Luminosity
Online	95.7%	90.3%	96.4%	83.3%
Offline	95.4%	95.6%	95.2%	93.3%

- Major issues with space-points have been resolved
- Still problems with efficiency at high luminosity
  - A few small differences with offline space-points still remain
  - Possible problem with ZFinder (modified form used in online)
  - Z resolution from fitter is 195μm for online and 153μm for offline

Summary

- Offline version:
  - Efficiency 93.3% at high luminosity
  - Not performing as well as CTRIG version - updated detector model
  - Needs a new track fitting package
- Online version:
  - Efficiency 83.3% at high luminosity
  - Need to understand problems – at present thought to be issues with the ZFinder stage.

Future Work

- **IDSCAN**
  - Understand and Improve efficiencies for TDR review (Sept.)
  - Trigger Test Beam next year
- **Atlantis**
  - Writing Design Document (next 4 Months)
  - Adding RoI to Atlantis
- **ttH, H$\rightarrow$bb Channel**
  - Important channel for low mass Higgs Boson
  - Will provide half significance for discovery
  - 94% of background after analysis from ttjj
  - Aim to study this background