Discussion and Overview of projects

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Triggering on Long-Lived Particles workshop

Apr 18th, 2017

Introduction

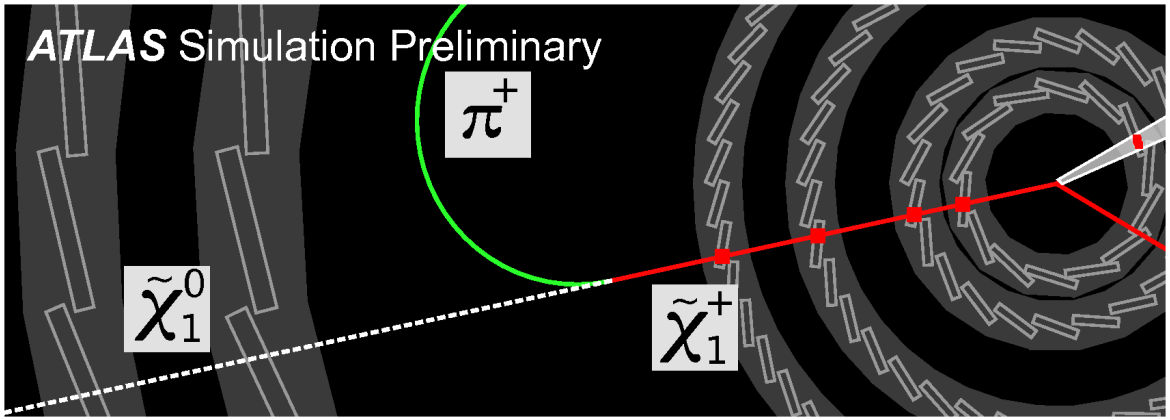
- During the next two days we'll kick-off few feasibility studies to implement new triggers in the ATLAS menu
  - help from ATLAS trigger experts invaluable!

- We will give now a quick overview of the proposed projects
  - Gather input and discuss ideas / variations
  - Your chance to push your ideas to be implemented in the ATLAS trigger!

- For ATLAS folks: please sign-up on what project you'll be working on before 9:00AM tomorrow morning
  - click HERE or go to:
    https://docs.google.com/document/d/1wf29M4-17fbHYMB2lle9w9ppiWCnHzhi-feDV373BJI/edit?usp=sharing
  - Full list of projects available on the twiki page:
    https://twiki.cern.ch/twiki/bin/view/AtlasProtected/LBLTriggerLLPWorkshop2017

Isolated tracks with FTK+HLT

- Aims at direct detection of LLP that traverse (part of) ATLAS detector
- Current triggers mainly based on Missing Transverse Energy (L1+HLT)
  - coming from a combination of neutralinos (χ_1^0) and initial-state radiation



High-Level-Trigger

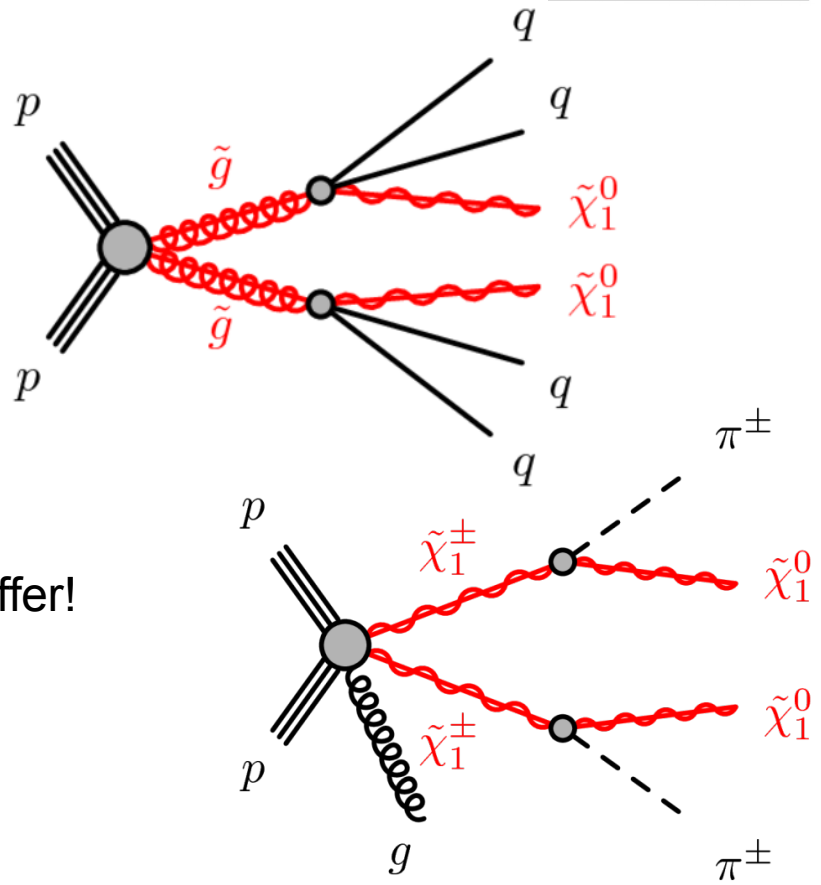
- High p_T isolated FTK track
  - Confirmation by HLT possible
- Do we gain on top of the current L1-MET?
- What p_T/isolation thresholds do have a rate that is sustainable?

L1 Trigger

- Can we also trigger on other features of the event at L1?
  - **leptons**, forward jets,…
  - can make use of L1Topo to exploit kinematic correlations

Highly (or low) ionizing particles

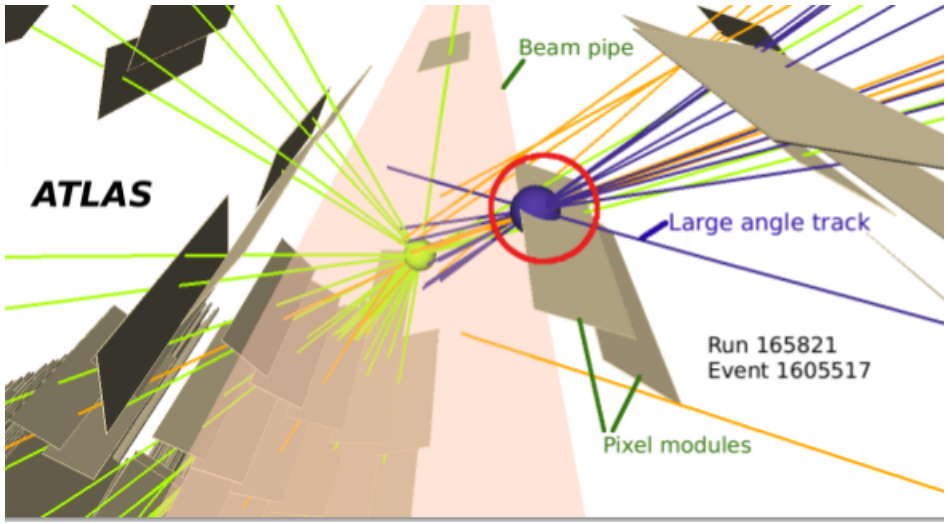
- Direct detection of LLP
- If particle mass O(1TeV)
  the energy loss in the pixel detector becomes very large
  - e.g. pixel dE/dx analysis
- Build on previous project
  - Similar questions apply, however aim to additionally exploit large dE/dx
  - answers to the same questions may differ!
- Test new HLT chain with:
  - high p_T isolated FTK track
  - Match FTK track to HLT track
  - Evaluate dE/dx for matched HLT Track

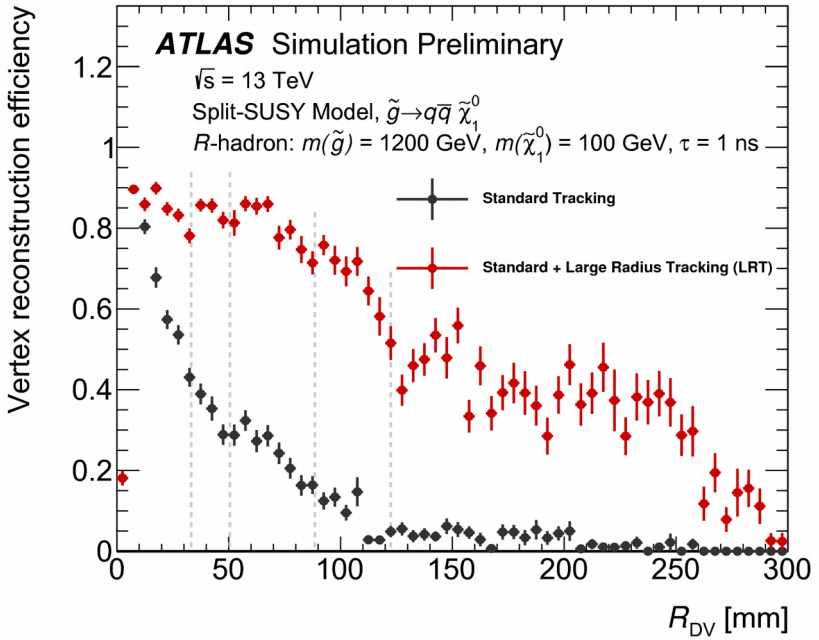


- How much additional gain does the use of dE/dx offer in rate reduction?
- FTK may be upgraded to store charge information too, if there's a case!
- Bonus: Low ionizing particles offer a similar set of problems to attack

Displaced vertices with FTK and/or HLT

- Indirect detection of LLP from their decays: displaced vertices
- Current analyses use a mix of MET, jets, leptons triggers
- Could one envisage an HLT part based on direct detection of a displaced vertex using FTK (and/or HLT) tracks?





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FTK

- Efficiency for large d_0 poor by design
- Efficiency increases fast for a low number of banks used in FTK
- Can we reach a reasonable (10-50%) efficiency using a small (10%) fraction of the available patterns?
- Problems, e.g. hadronic interactions

Trigger-Level Analysis

- if fake rate too high, could provide a way to still look for a signal

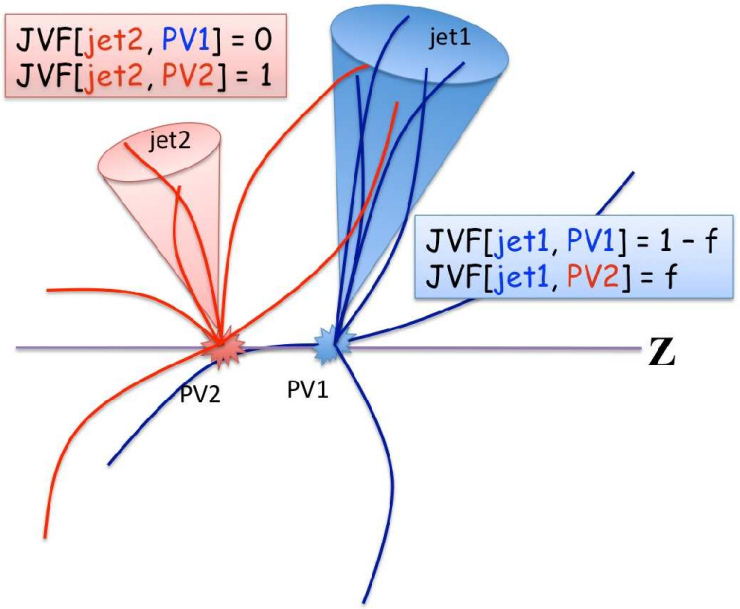
High-Level Trigger

- Increasing maximum d_0 requirement for HLT tracks require CPU time
  - Feasibility study?
- Can be afforded in a very small subset of events or one needs to implement something faster
- Unassociated hits in ROI
  - ratio b/w layers

  (fast-tracking for quirks?)

Trackless jets with FTK + HLT

- This project also targets displaced decays of a LLP
- Different approach: calorimeter jets reconstructed from the LLP decay with no prompt charged particle associated



- Any efficiency gain?
- What requirements on the tracks are needed to keep signal acceptance high
- Effect of pileup?
- Do noise bursts kill this (and possible signals)?
- Would calorimeter substructure (gFEX in the long term) help?
- How to keep the rate low using other handles at HLT?
- Would having an ISR jet help?

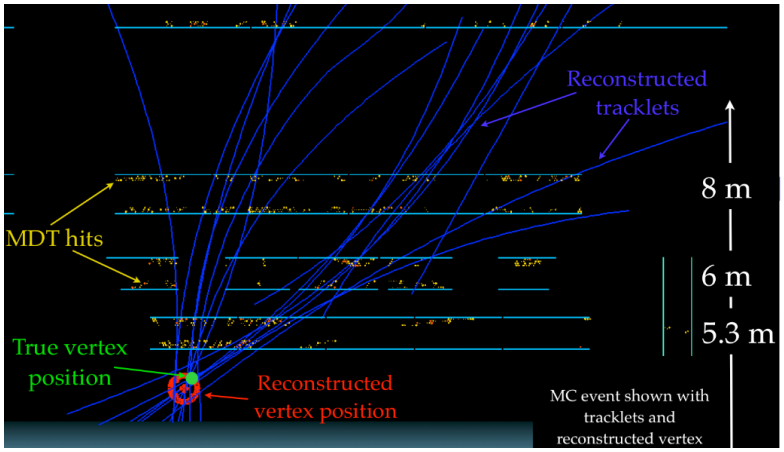
Displaced leptons at HLT

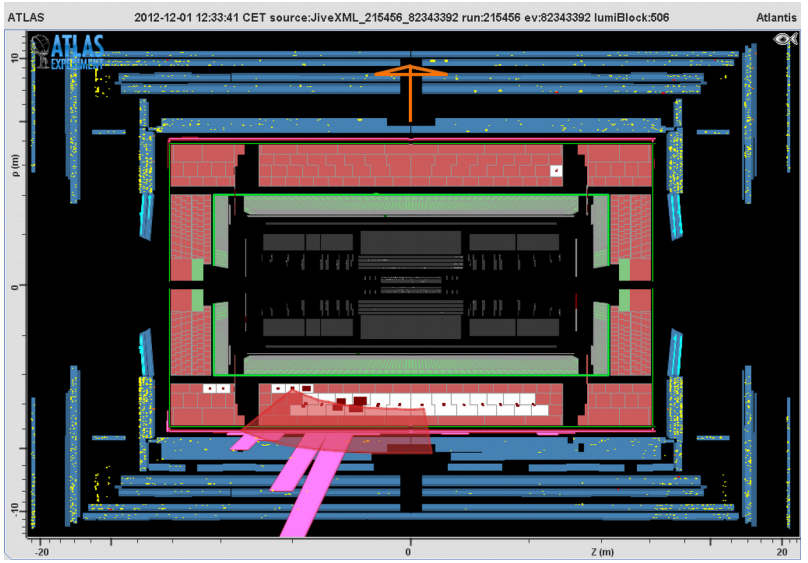
- Expand the reach of searches for displaced vertices
- Consider decays with at least one lepton (e, μ or τ)

- What is the limiting factor at HLT why we loose efficiency for displaced electrons/muons?
- What other requirements can be placed if relaxing the ones that kill the most the efficiency to keep background under control?
- What impact on CPU requirements?
- In case of **taus**, what handles could be additionally used to take advantage of their unique topology? Do they offer significant advantages with respect to a general approach?

Displaced vertices in HCal and MS

- Aim to detect decays of LLP into hadronic calorimeter or muon spectrometer
- The project aims to review current triggers (CalRatio trigger and MS Muon RoI Cluster (muvtx) trigger

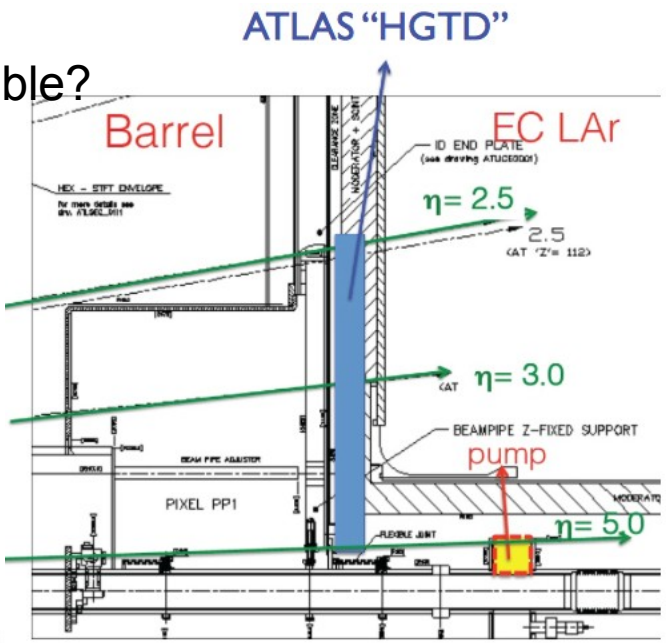




- Work on improving efficiency of CalRatio trigger
- Will review the Muon RoI Cluster trigger (and MS-only triggers used by displaced muon searches) in the context of the phase-2 upgrade, and changing "L1" Muon RoI reconstruction.

Slow Particles using Calorimetry or HGTD

- Aim to detector slow-moving LLP from a time-of-flight measurement
  - Because of the relatively long lever-arm of the calorimeter, low-beta particles are significantly behind the prompt particles in that detector
- Investigate both low-level as well as high-level triggers
- Calorimeter timing information already available at HLT
  - and may be available at L1 after upgrade
- Does the current/expected time resolution offer a sustainable efficiency/rejection working point?
  - what timing resolution would be desirable?
- HGTD currently is only proposed to cover the forward region (2.5 to 4 or so in eta)
  - physics applications? quirks and double-coincidence of late deposits?
  - what if it covered the central/ barrel too?



Low-Level pixel trigger

- Use existing or future capabilities of the pixel detector to trigger at the very first-level on highly ionizing particles

- Maurice just explained the idea, so we won't repeat it here :)
  - the good news is that we have (almost) all the samples available to answers these questions here now

Conclusions

- A flavor of the projects we've setup to explore
- Some of them won't be feasible, but some may lead to a new trigger chain in the ATLAS trigger menu now or in the future

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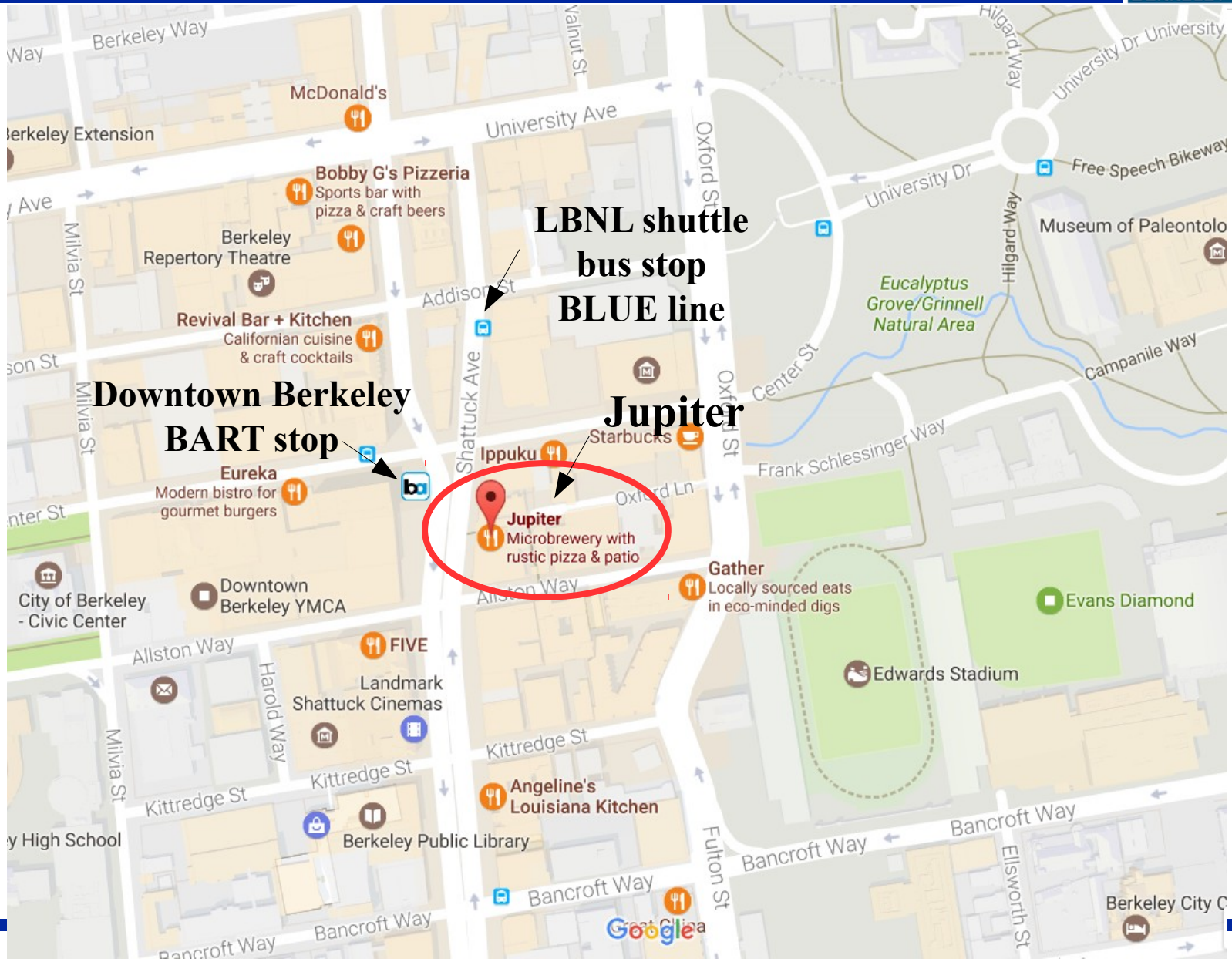
Dinner at Jupiter, 6:45PM