TRACK TRIGGERS FOR EXOTIC SIGNATURES

SNOWMASS EF09 MEETING: GENERAL LONG-LIVED PARTICLES
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LLPS NEED BETTER TRIGGERS

- **We're focusing on studies with ATLAS/CMS-like detectors**
  - HL-LHC and beyond (FCC-hh?)
- **Current dedicated LLP triggers largely focus on very long lifetimes**
  - Unusual energy fractions in calorimeter
  - Decays in the muon spectrometer (or displaced enough to be identified in MS)
- **Otherwise, forced to use triggers without any LLP specificity**
  - MS-only triggers, MET, photon triggers for electrons
- **For intermediate lifetimes (a huge portion of LLP phase space) unable to target these signatures in the trigger**
  - This could change with the addition of **hardware tracking**

BUT HOW…?

Using 30% of the FTK patterns for long-lived particles

ATLAS Preliminary
Simulation
single muon
$|z_0|<110$ cm
$|\eta|<2.5$

- **Clear that many signatures would benefit from displaced tracking**
  - Proved possible by FTK on ATLAS
 - -1% efficiency for prompt tracks, 1 cm d_0 coverage
- **Also signatures where prompt tracks are useful**
  - Stable charged particles, SUEPs, all "standard" physics
- **Want to do both - how to optimize coverage?**
  - If you want to extend e.g. d_0 range, need to make sacrifices in p_T range, overall efficiency
  - Different trade-offs make sense for different models, but need to choose working points for future hardware
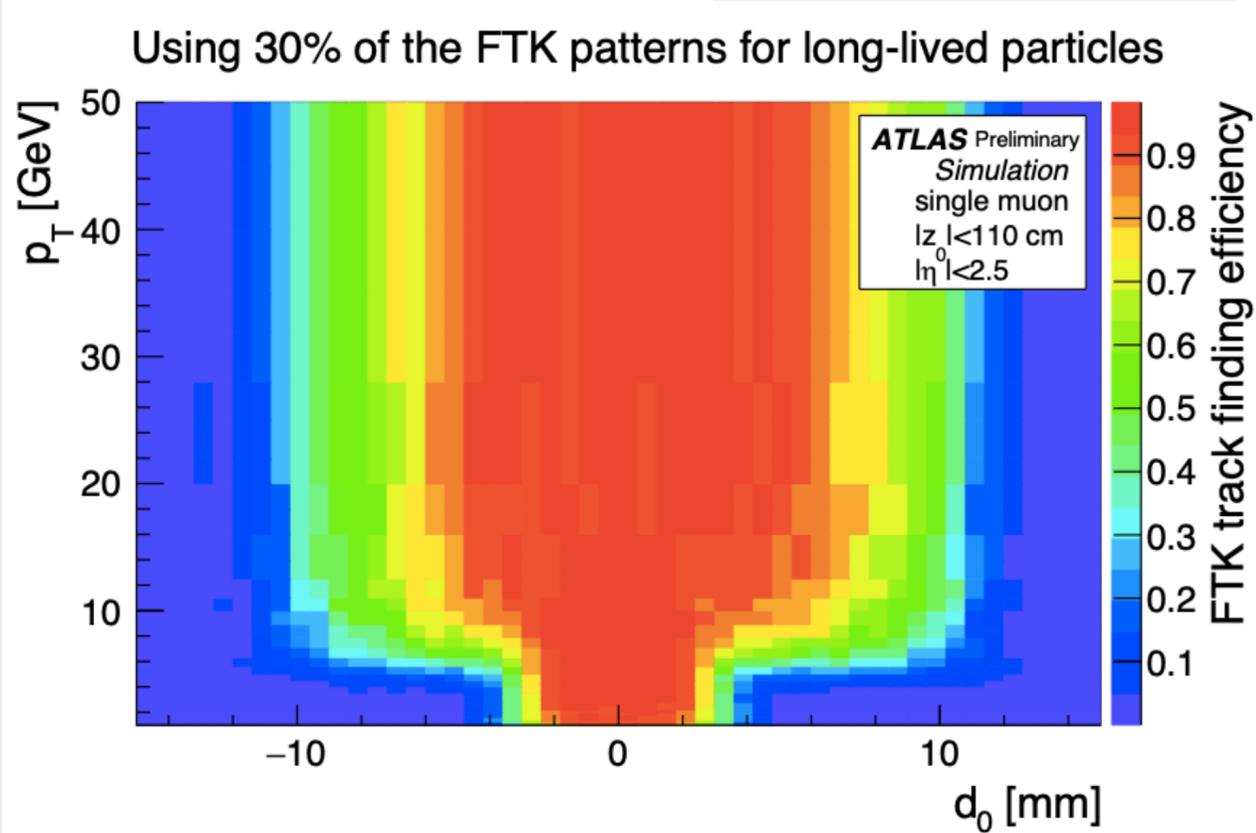
CAN OPTIMIZE DIFFERENTLY FOR PROMPT, DISPLACED

$1/p_T$

IN AN FTK-LIKE SCENARIO: EQUAL AREAS → EQUAL PATTERNS

d_0
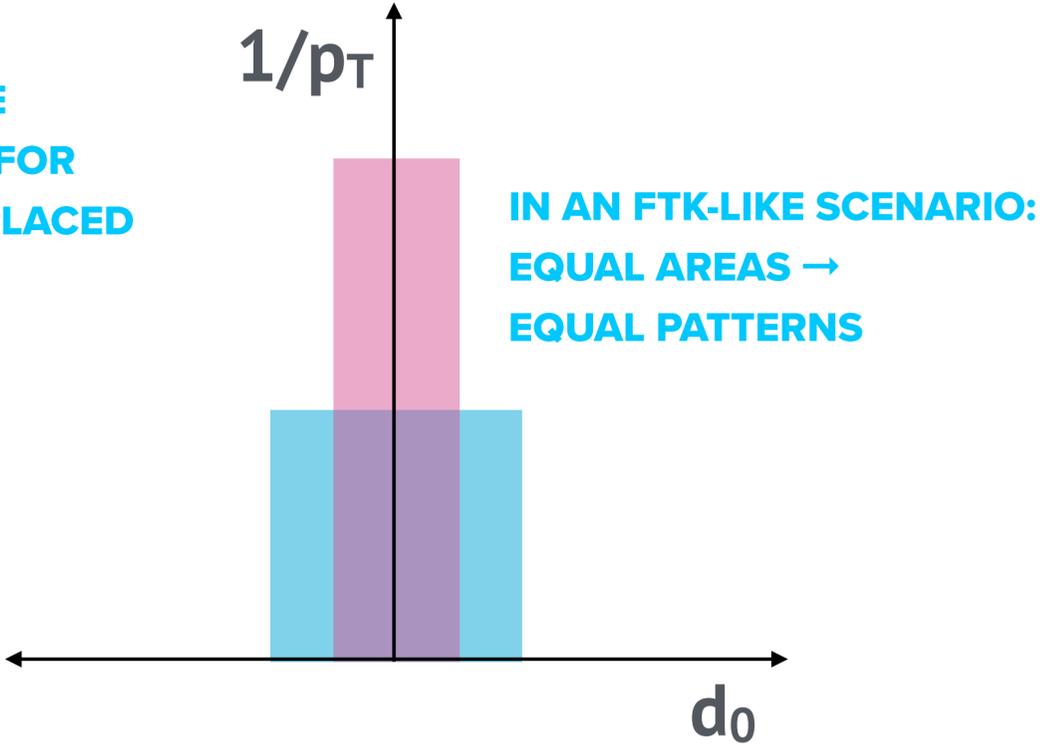
OUR GOAL

- **Broadly study different types of exotic signatures to see what trade-offs make sense**
  - Displaced hadronic and leptonic signatures, via RPV SUSY
  - Higgs-portal specific displaced jets
  - SUEPs
  - Stable charged particles, also RPV SUSY
- **Produce parametrized event-level efficiency as a function of d_0 range, p_T thresholds, targeted efficiency**
  - If time allows, consider possibility of far detector, e.g. MATHUSLA as an external trigger
- **Provide recommendations for design optimization of hardware trackers for future detectors**
  - Full parameterization useful for real trackers, which must consider latency, fakes, etc.

QUESTIONS WE HAVE:

- What formats for MC?
- Standard energies for future colliders?
- How to deal with charged LLPs?

OUR TEAM

- **Currently 4 people:**
  - Me (ATLAS/Chicago postdoc, soon to be CMS/Tennessee faculty)
  - Kate Pachal (ATLAS/Duke postdoc)
  - Karri Di Petrillo (CMS/Fermilab postdoc)
  - Jess Nelson (ATLAS/REU Student)
- **Welcome more people, particularly to expand scope:**
  - Include studies of timing
  - Far detector studies
  - Other models, ideas!