

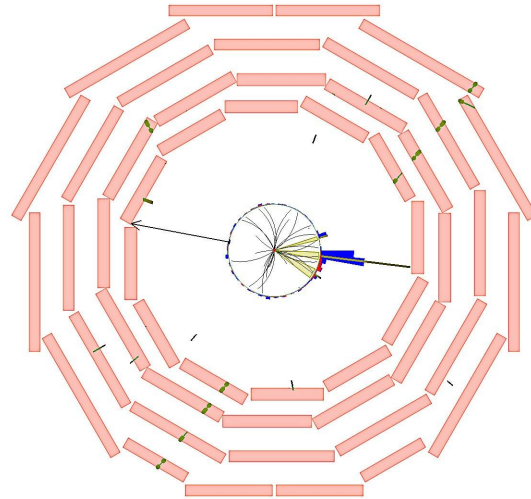
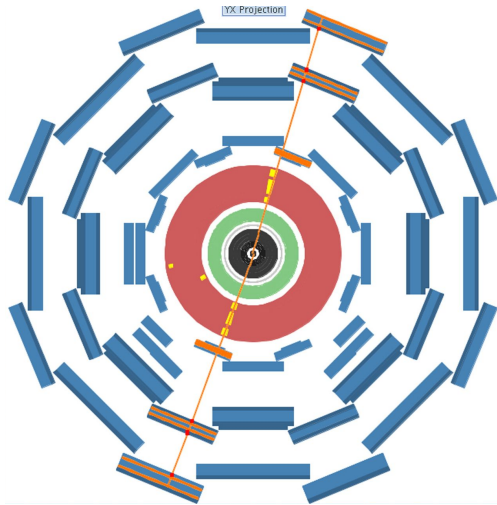
Discussion slides for
non-standard backgrounds

Reminder (inspired by the white paper)

- *Long-lived particles in the Standard Model*
- *Real particles produced via interactions with the detector*
- Real particles originating from outside the detector
 - *cosmic-ray muons*, beam halo, cavern radiation, satellite-bunch particles, ...
- Fake-particle signatures
- Algorithmically induced fakes
 - Random/merged vertices, randomly crossing tracks

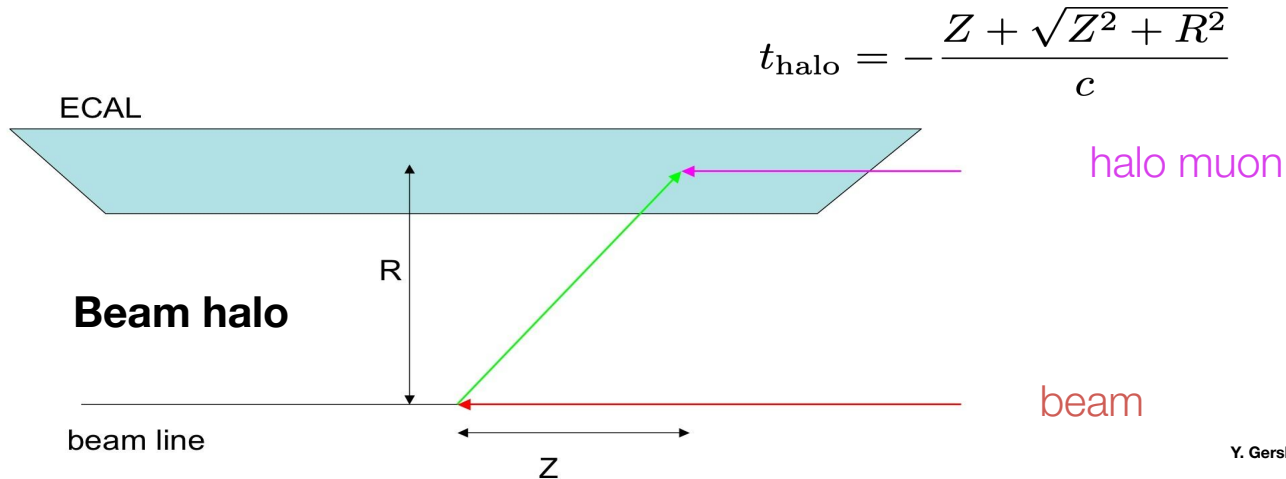
Real Particles Originating from Outside the Detector

- Cosmic-ray muons
 - What – if at all – impact will MS upgrades have on ability to reject such backgrounds?
 - ...
 - Simulation?



Real Particles Originating from Outside the Detector

- Beam halo
 - Due to interactions of the beam with upstream collimators
 - Discussed in dedicated talks
 - Simulation?

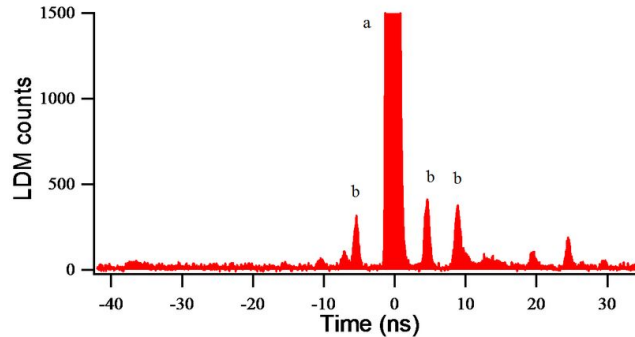


Real Particles Originating from Outside the Detector

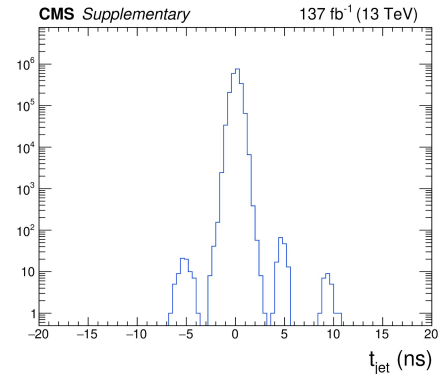
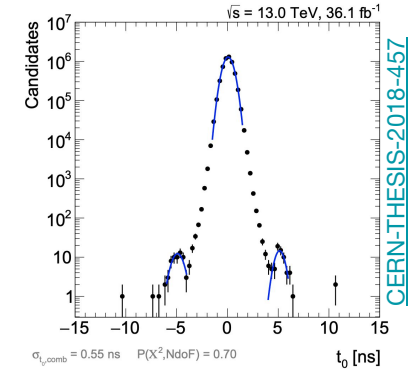
- Satellite-bunch particles
 - Collisions of very low luminosity bunches at ~ 5 ns steps from main bunches
 - Important background source, but also calibration tool, for timing-based searches



SPS RF cavities operate at 200 MHz \rightarrow bucket spacing 5 ns



<http://inspirehep.net/record/1113506/?ln=en>



<https://doi.org/10.1016/j.physletb.2019.134876>

Real Particles Originating from Outside the Detector

- Satellite-bunch particles

- From LHC side - current target no more than 1% satellite-bunch luminosity not to affect physics goals
- What would this mean for timing search? From PRL 122.131801:

$$N_{\text{bkg}}^{\text{PU}} = \sigma_j \mathcal{L}_{\text{int}} \epsilon_{\text{trig}}^{\text{MTD}} \left(\bar{n}_{\text{PU}} \frac{\sigma_j}{\sigma_{\text{inc}}} \epsilon_{\text{fake}}^{j,\text{MTD}} f_{\text{nt}}^j \right) \approx 2 \times 10^7$$

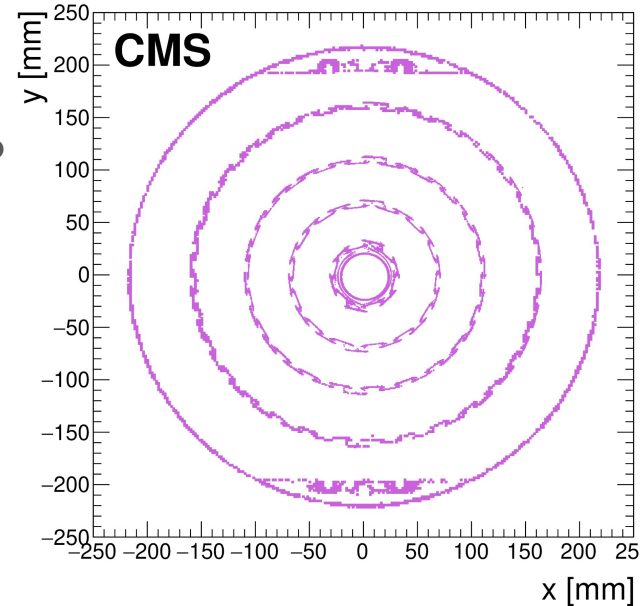
- For satellite bunches implies total background of (up to) $2\text{E}7 \times (1\text{E}-2)^2 \times 0.5 = 1000$ events!
- Can satellite-bunch population be pushed lower? Or will it be necessary to reject events peaked around 5ns multiples?

Fake-Particle Signatures

- Calorimeter and MS noise
 - Will detector/read-out improvements affect noise levels and background suppression?
 - Can cosmic-muon runs be used to estimate backgrounds for searches from noise?
 - ...
- Can a reasonable estimation of rates be made prior to data taking?
- ...

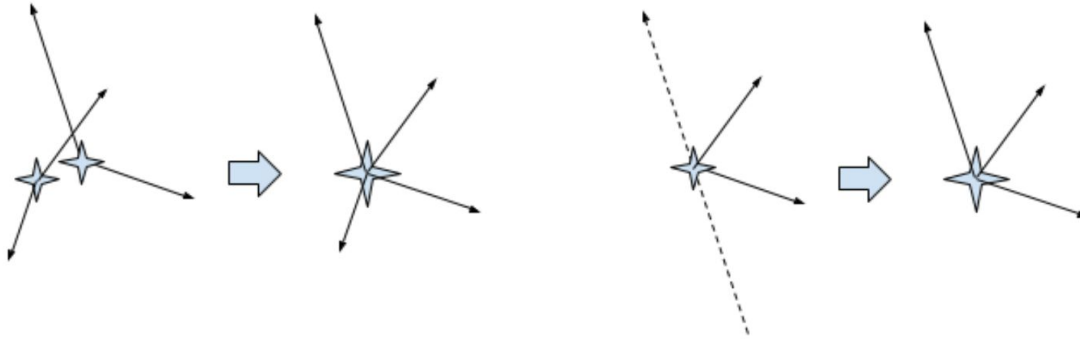
Interactions of particles with the detector

- Material interactions can cause displaced vertices
 - Typically veto with “hit map” and vertex mass cuts
- Will occupancy increase significantly impact this?
- Impact of changes to amount of material in tracker?
- Impact of increased granularity of tracker?
- Can resolution for veto map be improved?
- Simulation?
- ...



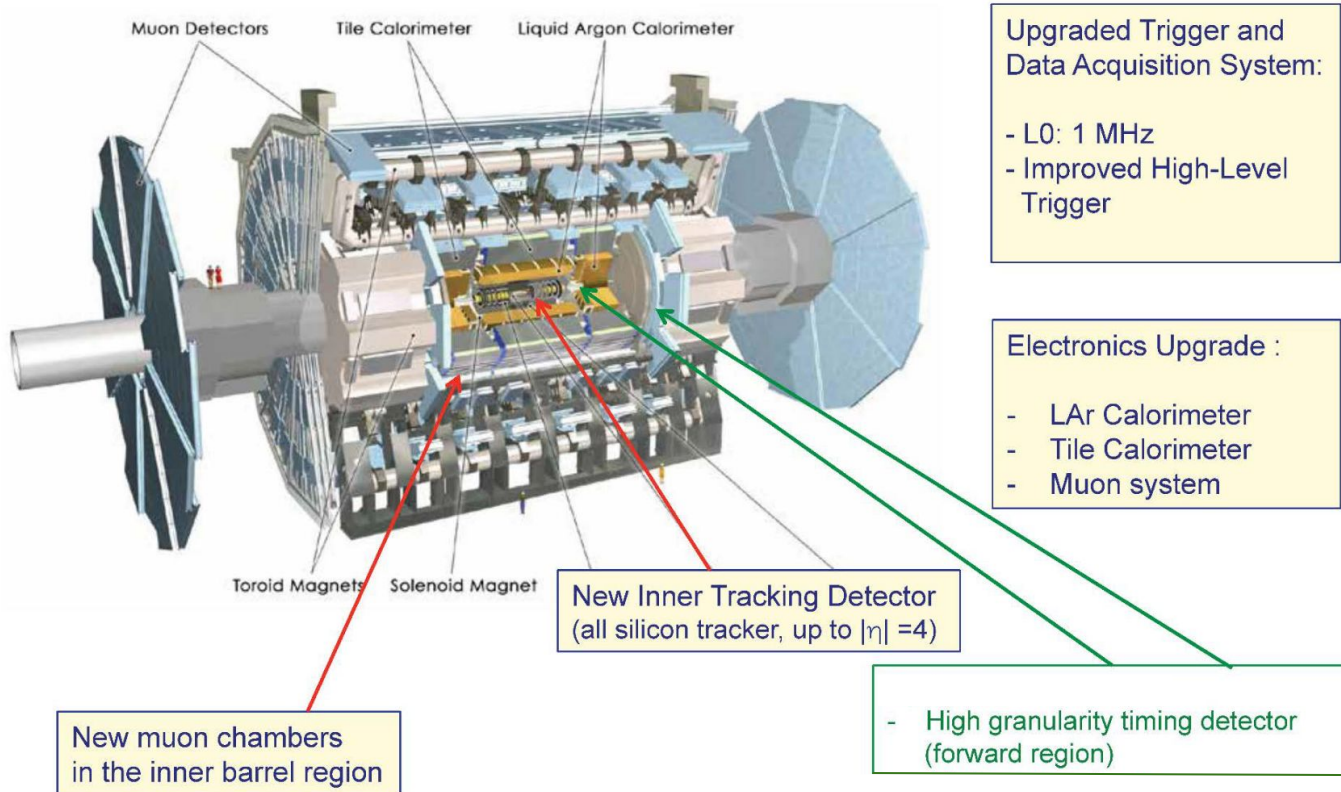
Algorithmically induced fakes

- Random/merged vertices / randomly crossing tracks



- What effect will changes in occupancy, but also detector upgrades have on these?
- Impact of new timing detectors for MIPs?
- Simulation?
- ...

ATLAS Phase-II Upgrade



Upgraded Trigger and Data Acquisition System:

- L0: 1 MHz
- Improved High-Level Trigger

Electronics Upgrade :

- LAr Calorimeter
- Tile Calorimeter
- Muon system

New Inner Tracking Detector
(all silicon tracker, up to $|\eta|=4$)

- High granularity timing detector
(forward region)

New muon chambers
in the inner barrel region