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The ATLAS tau trigger and the first LHC collisions

20th Nordic Particle Physics Meeting,
Spåtind, January 7th 2008

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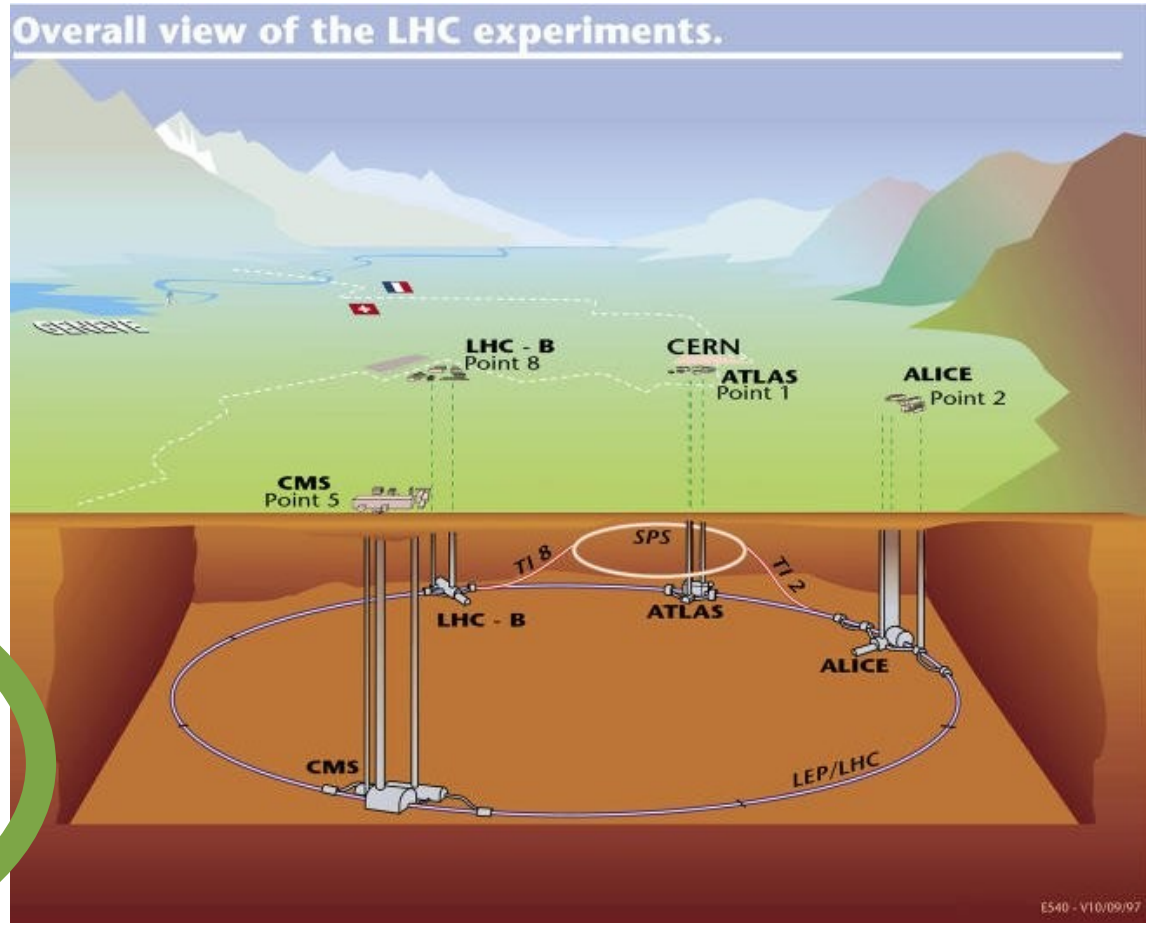
Outline

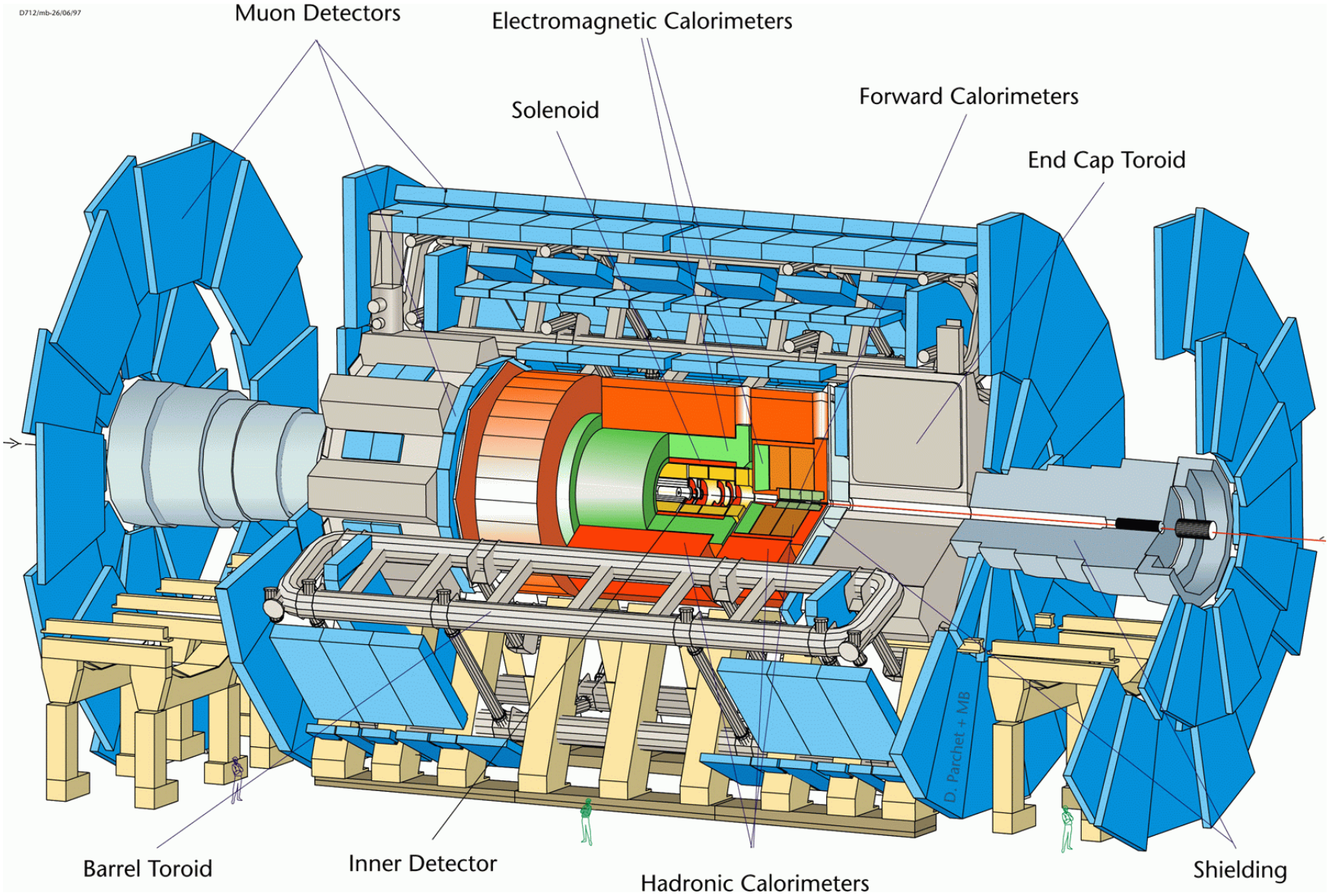
- The LHC and ATLAS in a nutshell
- Overview of the ATLAS trigger
- The tau trigger
- Plans for first collisions

The LHC

- Under the French-Swiss border near Geneva.
- Length of 27 km.
- Proton-proton collisions at 14 TeV or heavy ions.
- 4 main experiments.
- Bunch crossing of 25 ns.
- 20-25 interactions per bunch crossing.

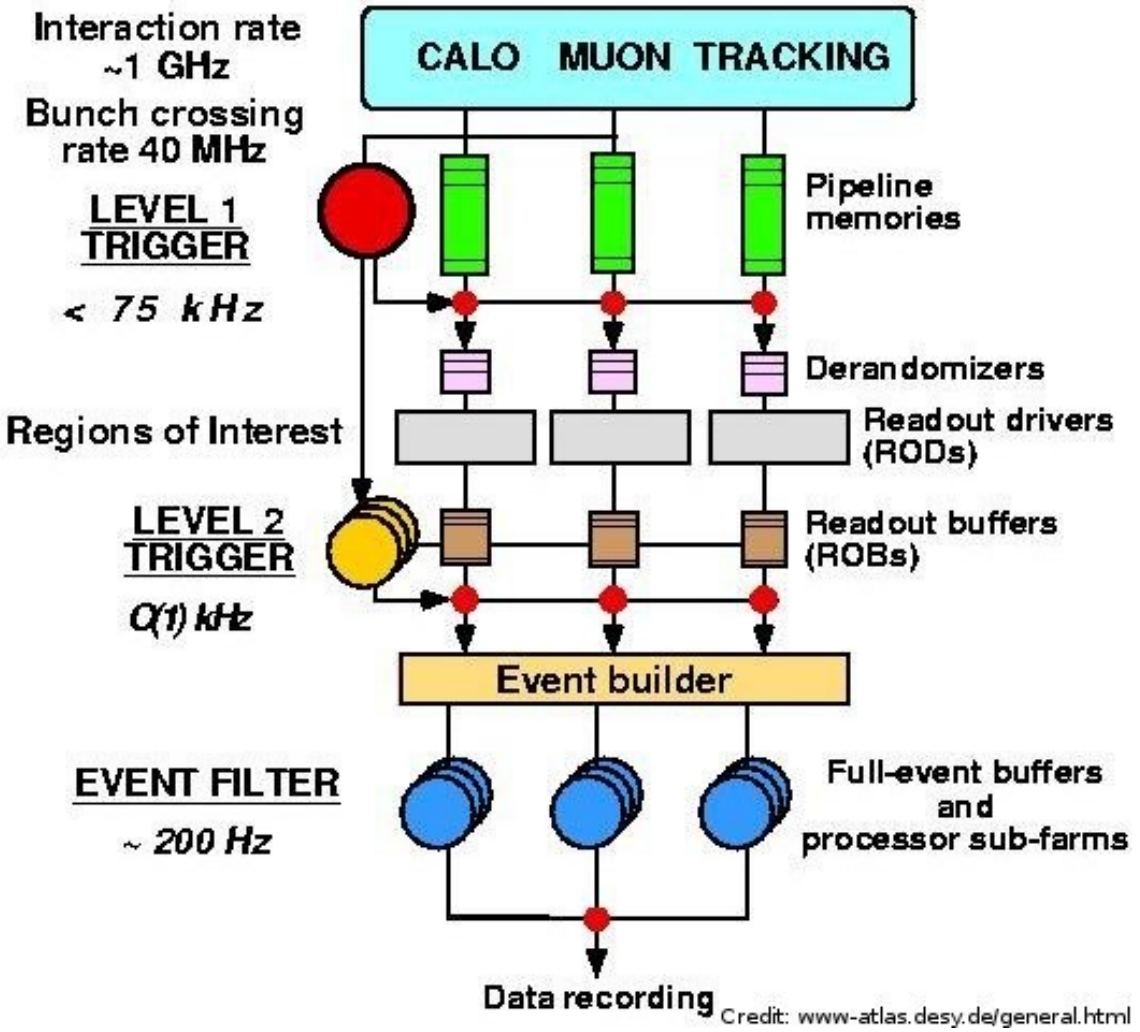


ATLAS detector



The ATLAS trigger

- Goal: real time selection of events registered for analysis at 200 Hz.
- Multi-layered and based on regions-of-interest (RoI).
- Identify interesting events through energy deposition in detector subsystems.



Triggering on taus

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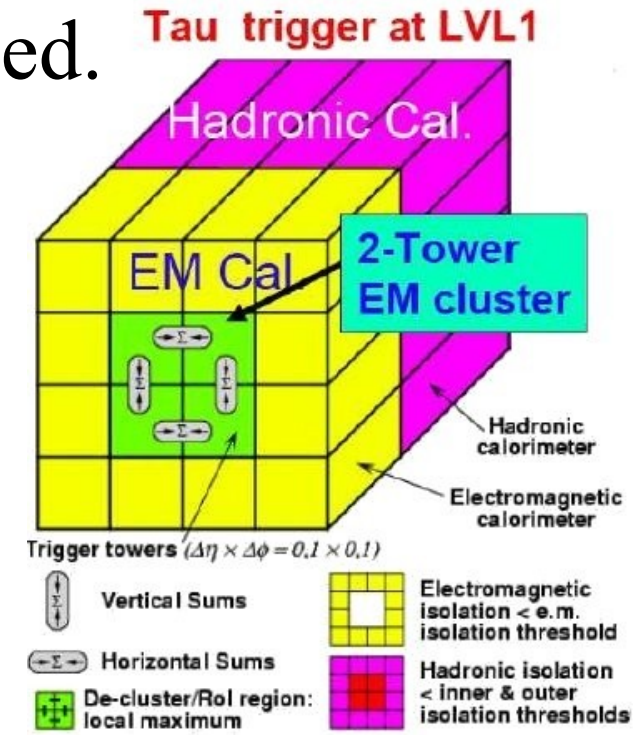
- A challenge in the busy environment of the LHC.
- The tau lifetime of 10^{-13}s means tau decay before reaching the detector.
- However, of high interest:
  - Many interesting event signatures for beyond the Standard Model physics include taus, including Uppsala Universitet's own interest: the charged Higgs boson.
  - Many SM measurements also require the identification of taus in the final state.

Triggering on taus

- Events with taus that decay leptonically are selected directly via electron and μ triggers.
- Selection of events with hadronically decaying taus is done via the tau trigger.
- At Level 1 the trigger is hardware based.
- No access to the tracking info, use calorimeter clusters only. Define RoI of 0.2x0.2 in η-φ space.
- Set energy threshold and (optional) isolation requirement.



Triggering on taus

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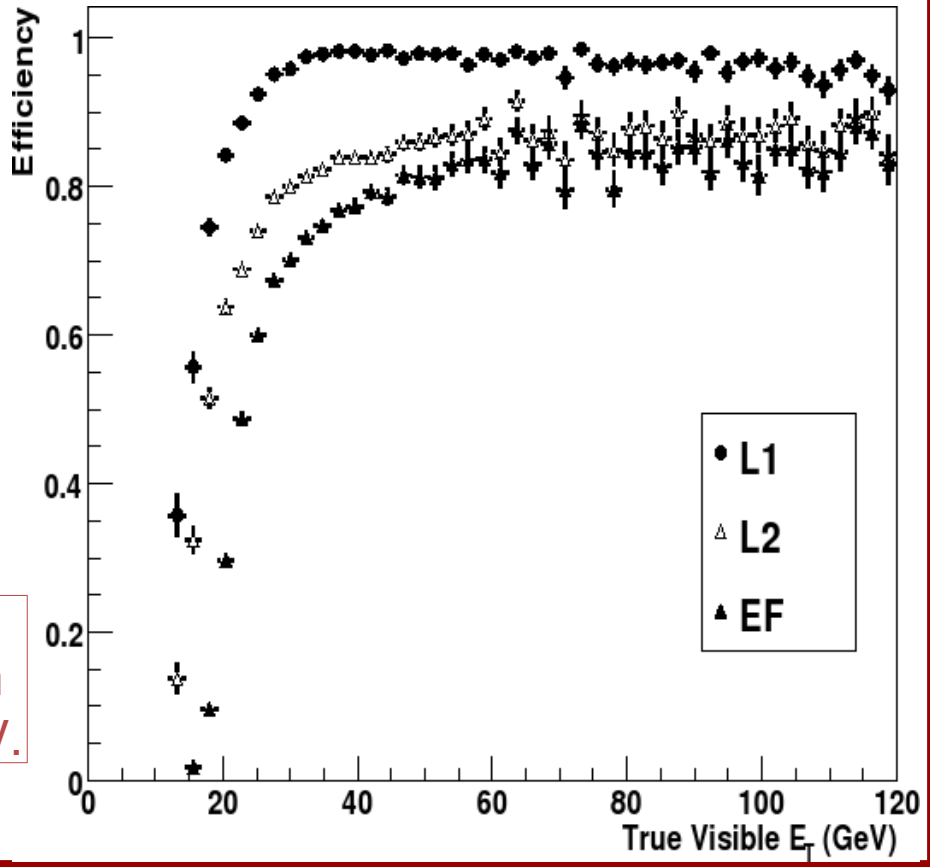
- Level 2 and Event filter are software based triggers.
- Full granularity of calorimeter and tracking.
- Level 2: more refined tau candidate in RoI from Level 1.
  - Impose energy threshold, isolation, low number of charged track, cluster shape.
- Event filter: reconstruction-like procedure, choice of two algorithms.
  - Calorimeter-based, shower-shape algorithm with track matching.
  - Tracking based, leading track is used to “seed” calorimeter clustering.

Trigger efficiency

- Measure of the performance of the trigger system as a function of tau characteristics.
- In simulated events, after simple selection:

$$\epsilon = \frac{Number\ of\ matched\ tau\ candidates}{Number\ of\ simulated\ taus}$$



Example: Trigger efficiency for criteria requiring an isolated tau with tranverse momentum above 20 GeV.

Trigger efficiency on data

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- In real data, two difficulties:
  - Must select a data set unbiased with respect to tau content.
  - No knowledge of real number of taus.
- Task of our group:
  - Develop the strategy to be used to evaluate the tau trigger efficiency on first data.

Data set selection

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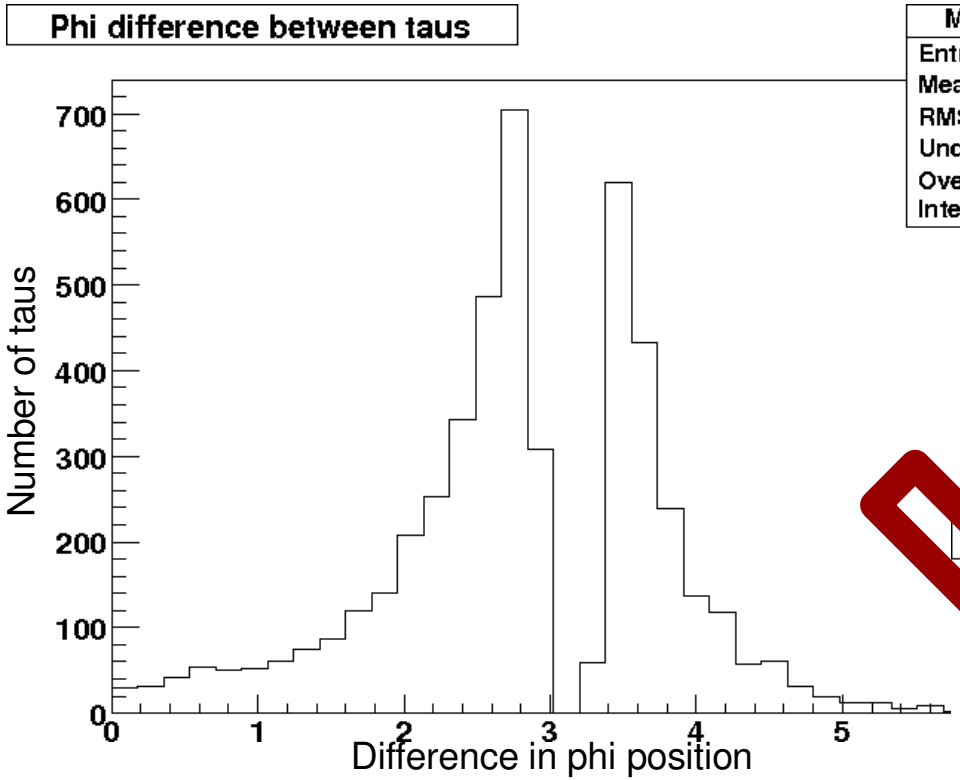
- Compare data sets selected with different trigger requirements to properties of taus:
  - Minimum bias simulated events.
  - When available, real data.
- No tau triggers.
- No calorimeter trigger or no track trigger, according to trigger algorithm studied.

Efficiency calculation from data

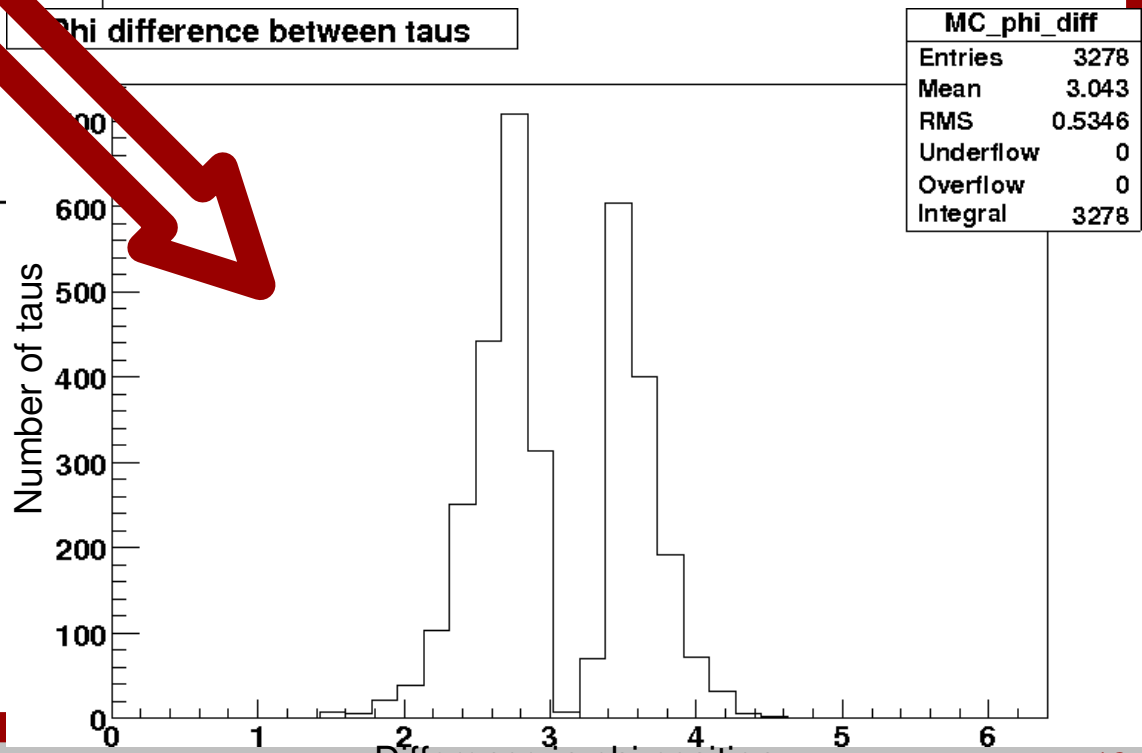
- Use $Z \rightarrow \tau\tau$ events where one of the taus decays to a muon.
- Probe opposite to the muon for an hadronically decaying tau.
- Discard events where an electron or a muon is in the probed region.
- Cut on the Z transverse momentum (for example at 40 GeV) to limit boost.
- Newly started work, in progress...
- Other ideas also under consideration, in particular for high transverse momentum taus.

Boost-limiting cut



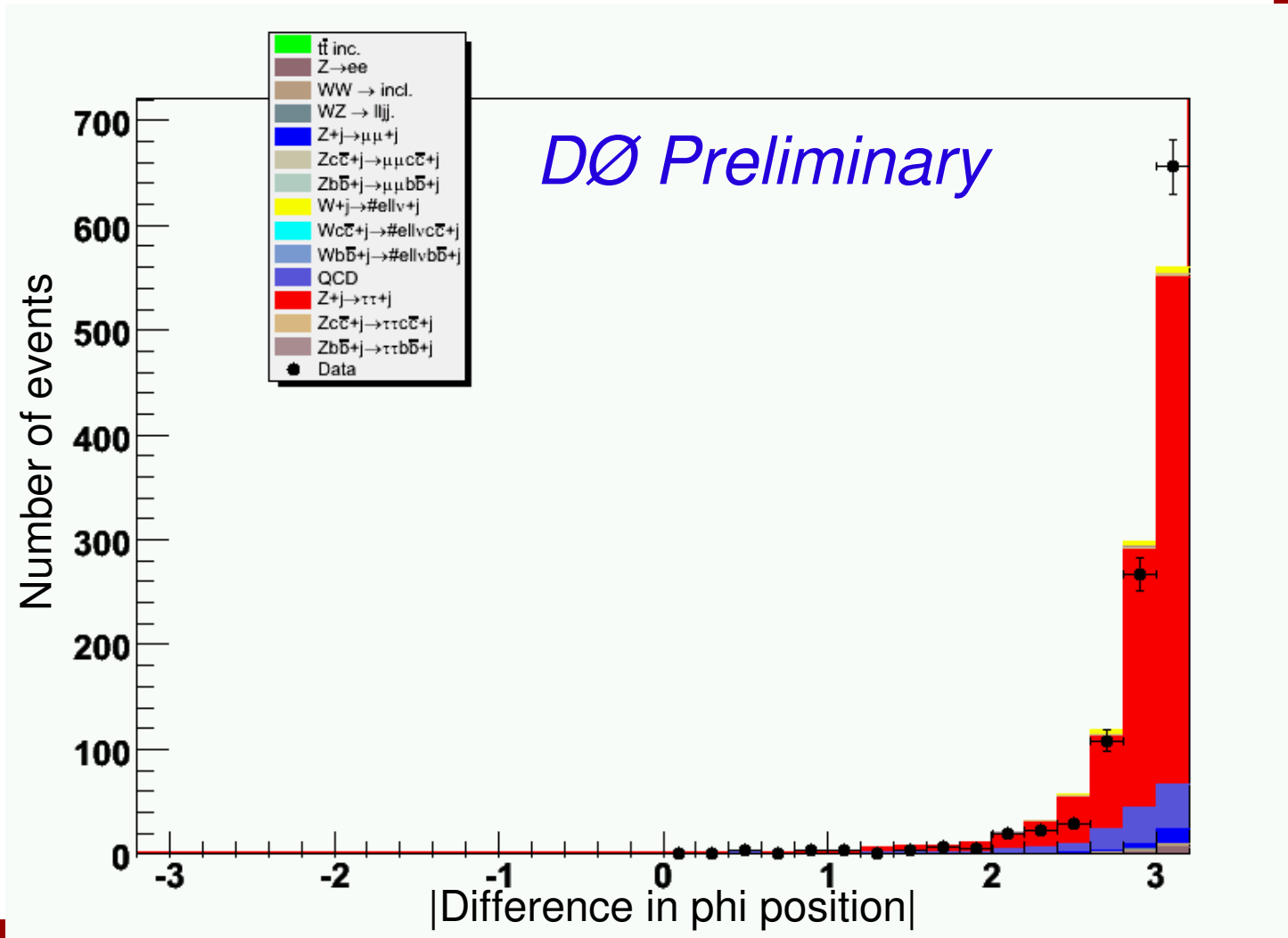
Dip ~π due to MC generator cut: not present in newer data sets.

Preliminary...



Past application at DØ

- A similar method was used sucessfully at DØ. Low boost of the Z meant no transverse momentum cut was necessary.



Outlook

- Tau trigger work at ATLAS is moving from algorithm development to trigger menu choice and planning of activities with first data.
- Uppsala Universitet is contributing to the preparation of efficiency measurements on real data.
- This measurement will be challenging at first but will improve with our knowledge of the trigger system and the detector.
- Future plans include studies of tau combination triggers and data/MC comparisons of tau properties.