Imperial College London

Electron Identification with Early Data for the CMS Experiment at CERN

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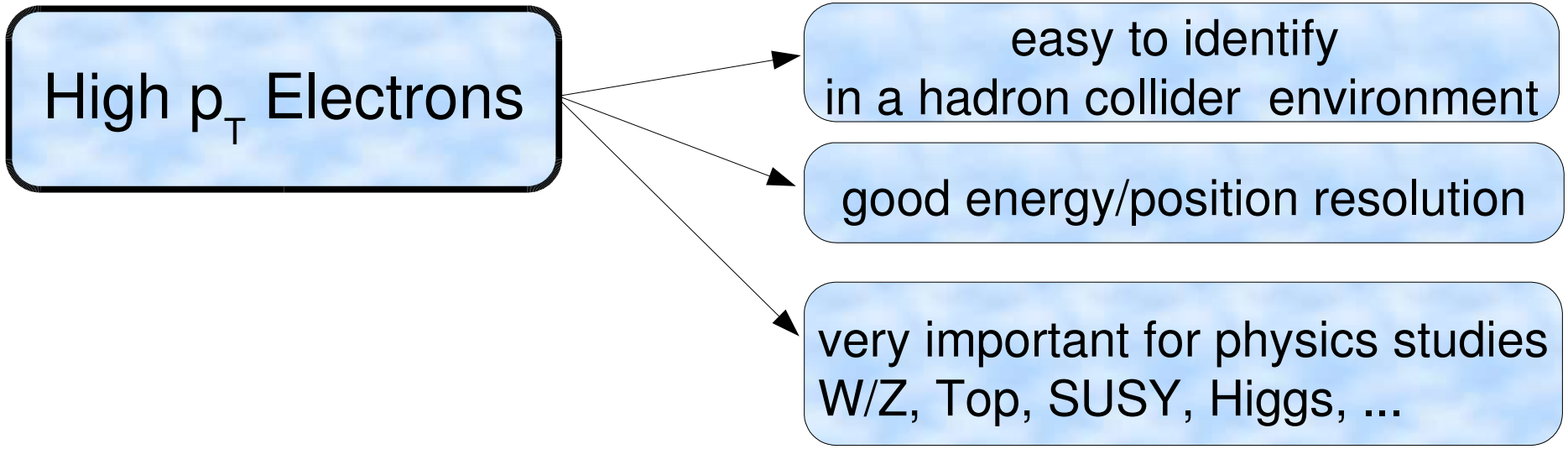
Introduction: Motivation for Electron Identification

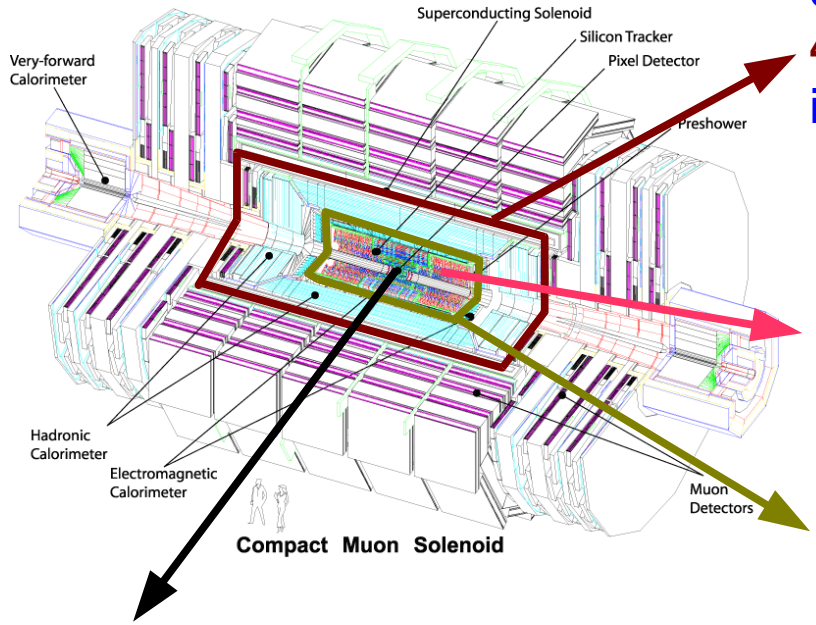


In this talk I will briefly describe:

- how one can define a **selection procedure for electrons** in the context of CMS experiment
- how to **tune** it with early LHC data

The CMS Experiment at CERN

- The Compact Muon Solenoid (CMS) is a general purpose detector designed to study LHC proton-proton collisions



cylindrical geometry:
4T solenoid magnet that encloses inner tracking and calorimeters

for electrons most important parts:

Inner Tracker: all-silicon, large solid angle coverage $|\eta|<2.4$, excellent position and momentum resolution

ECAL: homogeneous, crystal ($PbWO_4$) calorimeter, highly segmented, excelent energy resolution

Electron Objects at CMS

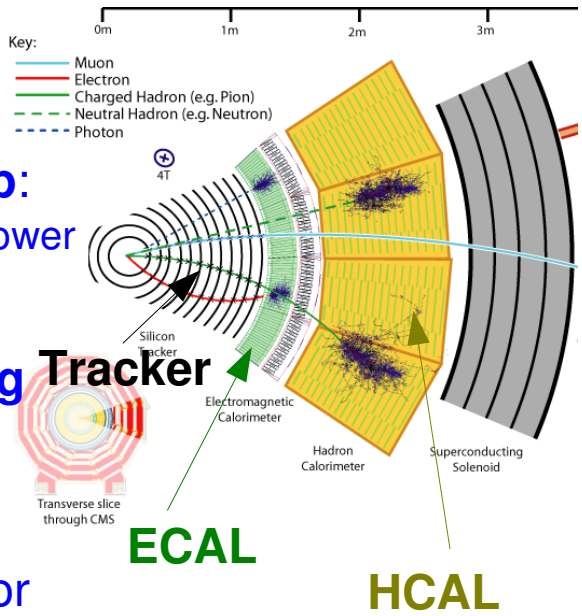
Electron Candidate:
particle that leaves tracker hits and a short/narrow shower in the calorimeters

Signature can be faked!

Charged hadron - π^0 overlap:
matched in space with a photon shower from π^0

Charged Hadrons showering early in ECAL, Charge exchange ($\pi^+ n \rightarrow \gamma p$)

Electrons from **conversions** or from **heavy flavor quark decays** (real electrons)



Electron properties indicate how to reject fakes

Shower properties:
longitudinal and latitudinal shape of the shower match the electron expectations

Tight Track – Shower matching: rejects accidental matches

Isolation: if we are interested in processes with electrons that don't belong to jets

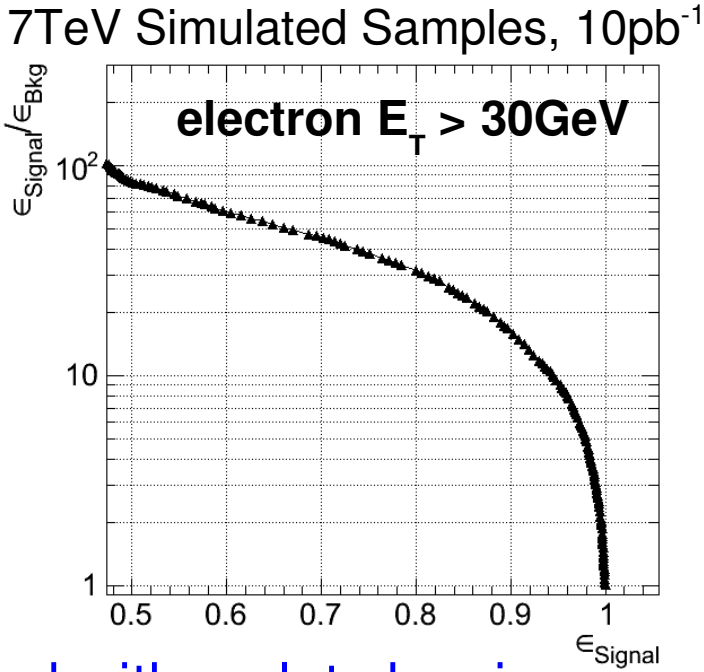
Introduction to Selection Tuning

- Task: separate “interesting electrons” from a sample of electron candidates
  - we will refer to “interesting electrons” as “signal” and all the rest as “background” (bkg)
  - Selection: a rule to select a “signal” sample
  - **Selection Tuning: define the selection parameters such that you get for a given signal efficiency the highest bkg rejection**
- For the start-up
  - we will try a simple cut-based selection
    - » robustness
    - » powerful handle for understanding detector issues
  - tuning strategy: preferable to be **data-driven**

An Iterative Technique to Tune Cut-Based Selections

- We have developed an iterative technique for cut-based selection tuning
  - Steps:

1. start from a configuration with very loose cuts
2. define a target in bkg rejection that is slightly tighter than the current one
3. find which cut can achieve this bkg rejection target alone with the highest signal efficiency
4. move the cut only and obtain a new selection
5. iterate



- the outcome of the method can be traced with a plot showing the signal efficiency vs some measure of background rejection

An Iterative Technique to Tune Cut-Based Selections

- It can be shown that in the context of statistical hypothesis testing this technique approximates the optimal solution, i.e. the solution that maximizes the bkg rejection for a given signal efficiency
- Demonstration of the technique
  - » CMS preparation for W→eν cross section measurement

CMS PAS EWK-09-004

    - signal sample: reconstructed electrons from W→eν simulated samples
    - bkg sample: reconstructed electrons in simulated samples of QCD dijet and various EWK processes that are backgrounds in the W→eν cross section measurement

The Iterative Technique as a Data-Driven Method

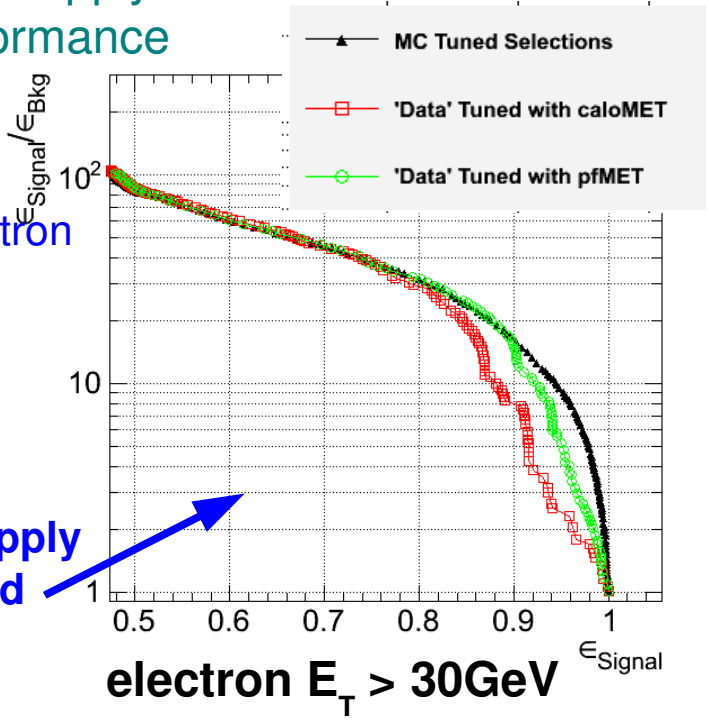
The method is tolerant to some contamination in the input samples

from DATA: tuning using MET-driven samples and apply the selections on pure MC samples to see the performance

signal sample:
- ✓ from Z→ee events, if luminosity permits
- ✓ with a missing ET cut (e.g. MET>30GeV) in an inclusive electron sample

bkg sample: with a MET cut (e.g. MET<20) in an inclusive electron sample

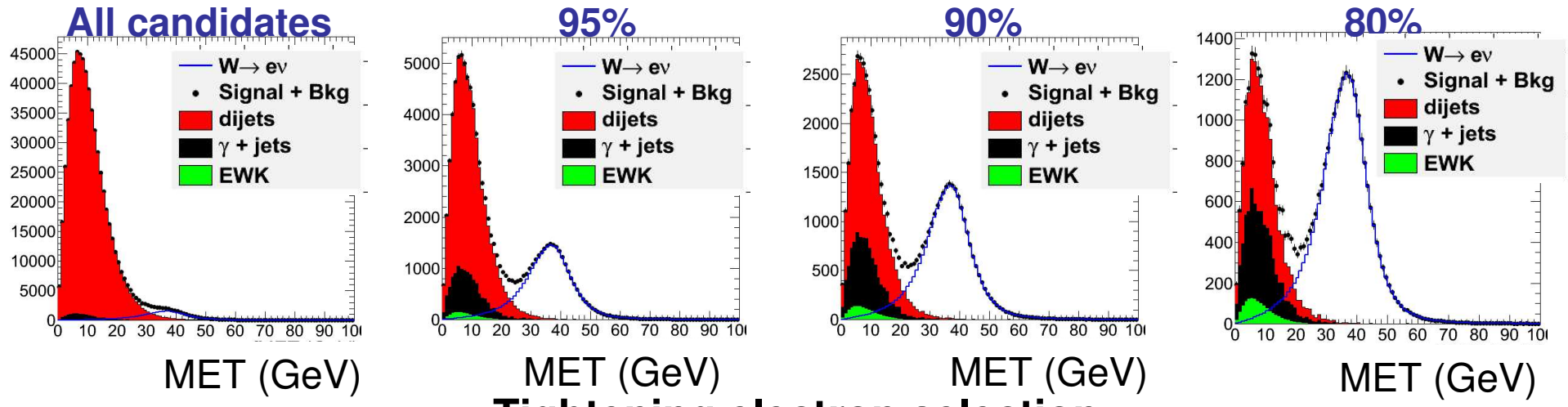
Tune using MET-driven signal and bkg samples and then apply the selections on pure MC samples: compare with MC tuned selections to see the performance



possible to operate with **very low integrated luminosities: ~0.1pb^{-1}**

The Iterative Technique as a Data-Driven Method

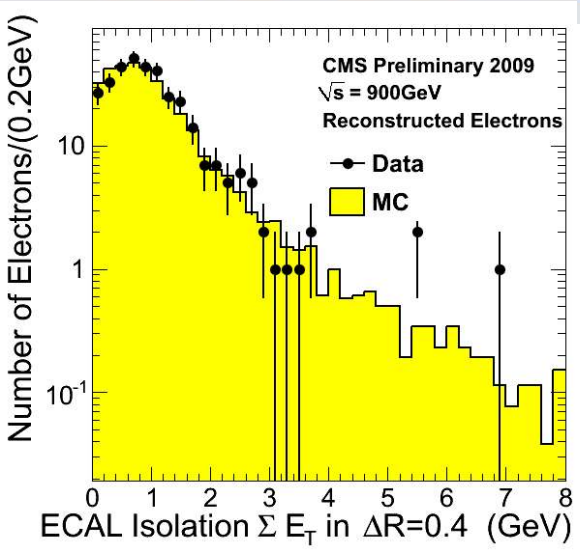
Of course, **we can't see in Data the plot of the previous page**, but we can asses the performance of the method by looking on how well the W peak is visible in a MET distribution

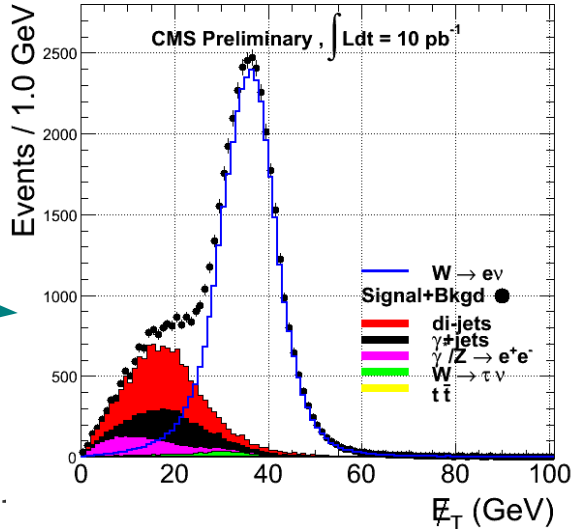


CMS 7TeV Simulated Samples, 10pb^{-1}

Towards the first Data Operations

- Electron related variables behavior has been tested with 900GeV LHC collisions
- The same procedure will be repeated when the first high p_T electrons become available
- Finally, when statistics become adequate the selections will be tuned and applied to the first W→eν cross section measurement





Outlook

- We have presented a general strategy to tune a cut-based an electron selection
  - method suitable for start-up
  - data-driven
  - possible to operate in low integrated luminosities (>0.1pb^{-1})
- We plan to use it for the first W→eν observation / cross section measurement in CMS

Thanks for your attention!

Acknowledgments

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