# Electron reconstruction at a Muon Collider

**A noisy path to the frontiers of physics**

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# About me


## Bachelor Degree at University of Padua

Experimental heavy ion physics at INFN-LNL

## MsC internship

ENUBET collaboration, monitored neutrino beam, lepton/hadron/muon calorimetric tagging

## MsC thesis

Muon Colllider Detector study: isolated electron reconstruction for 10 TeV muon collisions

**R&D**
challenge
novelty
space

**Future**
discovery
purpose

**Skills**
software
analysis
design

## How did I end up here?

# A backdoor to the TeV frontier

Colliding muons could pave the way to
Beyond Standard Model physics

**Fundamental particles**
full energy available
no QCD background

**Large(r) mass**
no synchrotron radiation

**Second generation**
possible LFV phenomena
muonphylic new physics

**... and much more!**
just ask your favorite
phenomenologist

# Not only a high energy explorer

## 10+ TeV COM energy

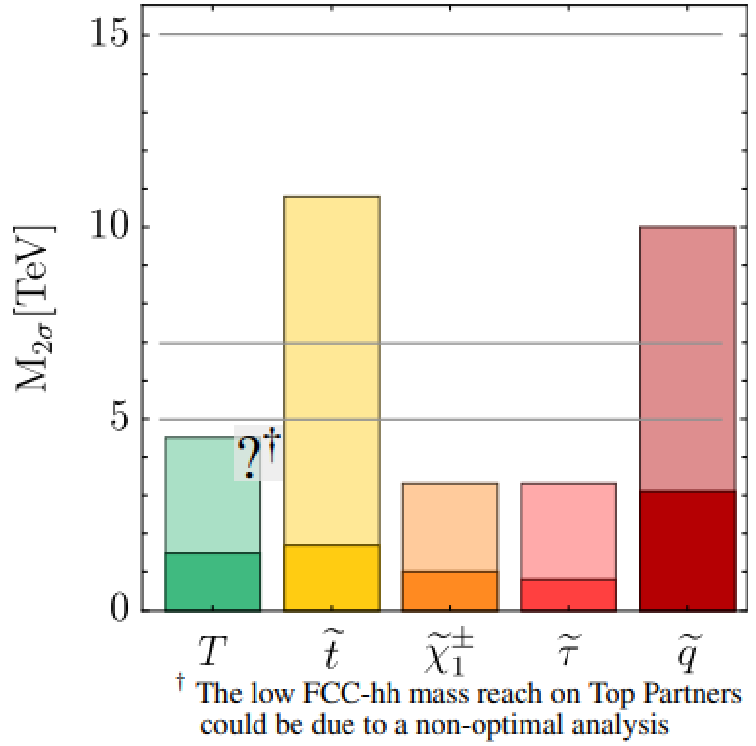
MSSM particles, Y-universal Z’, composite Higgs/Top, WIMPs

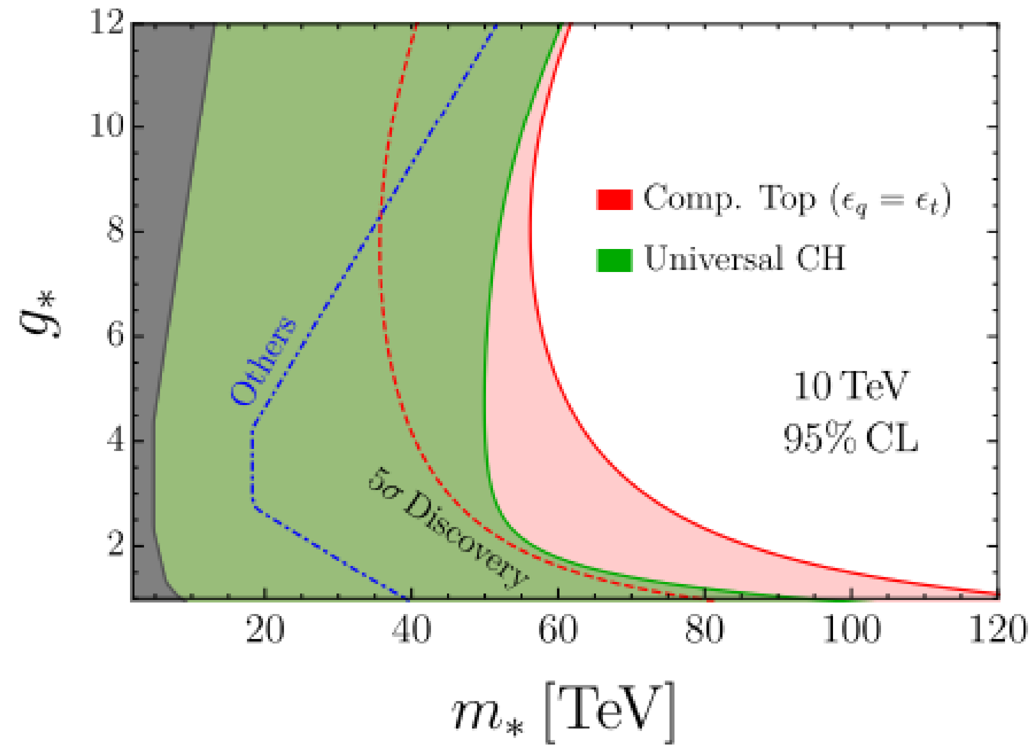
with similar reach to 100Tev pp

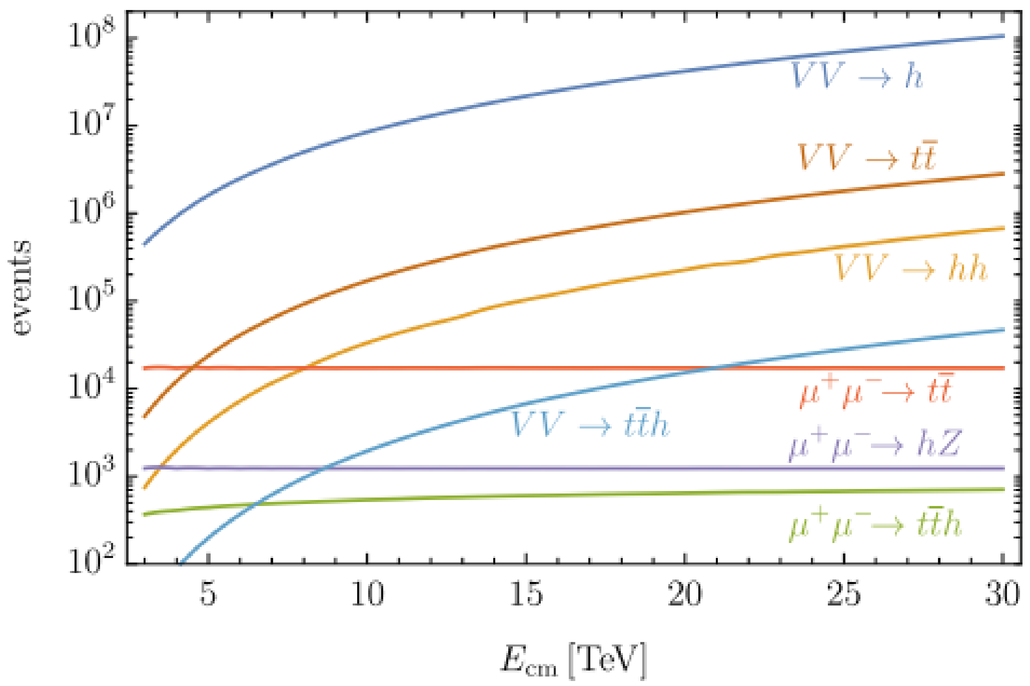
## High intensity EW factory

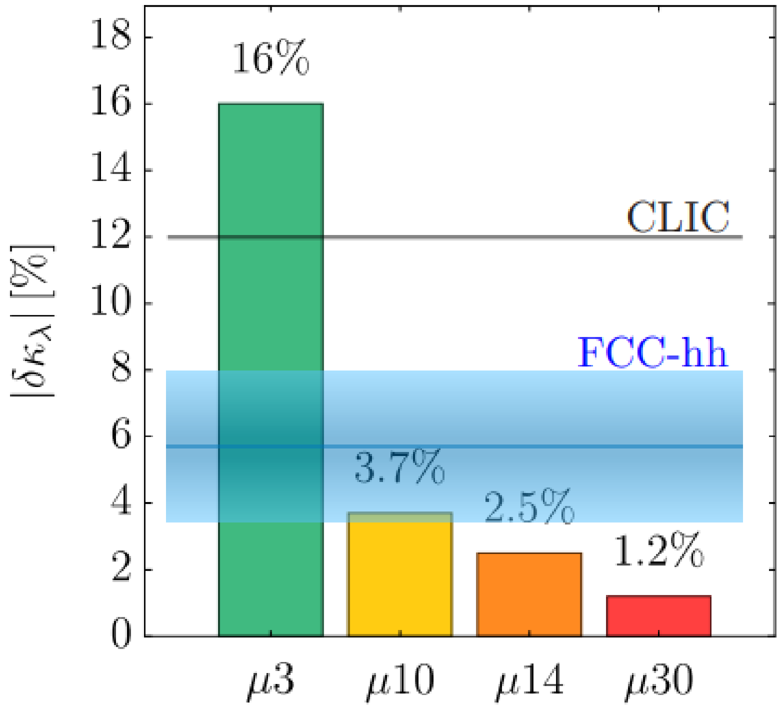
Large VV fusion cross section
10M h, 10k hh, 100k tt

10x higgses wrt FCC-ee

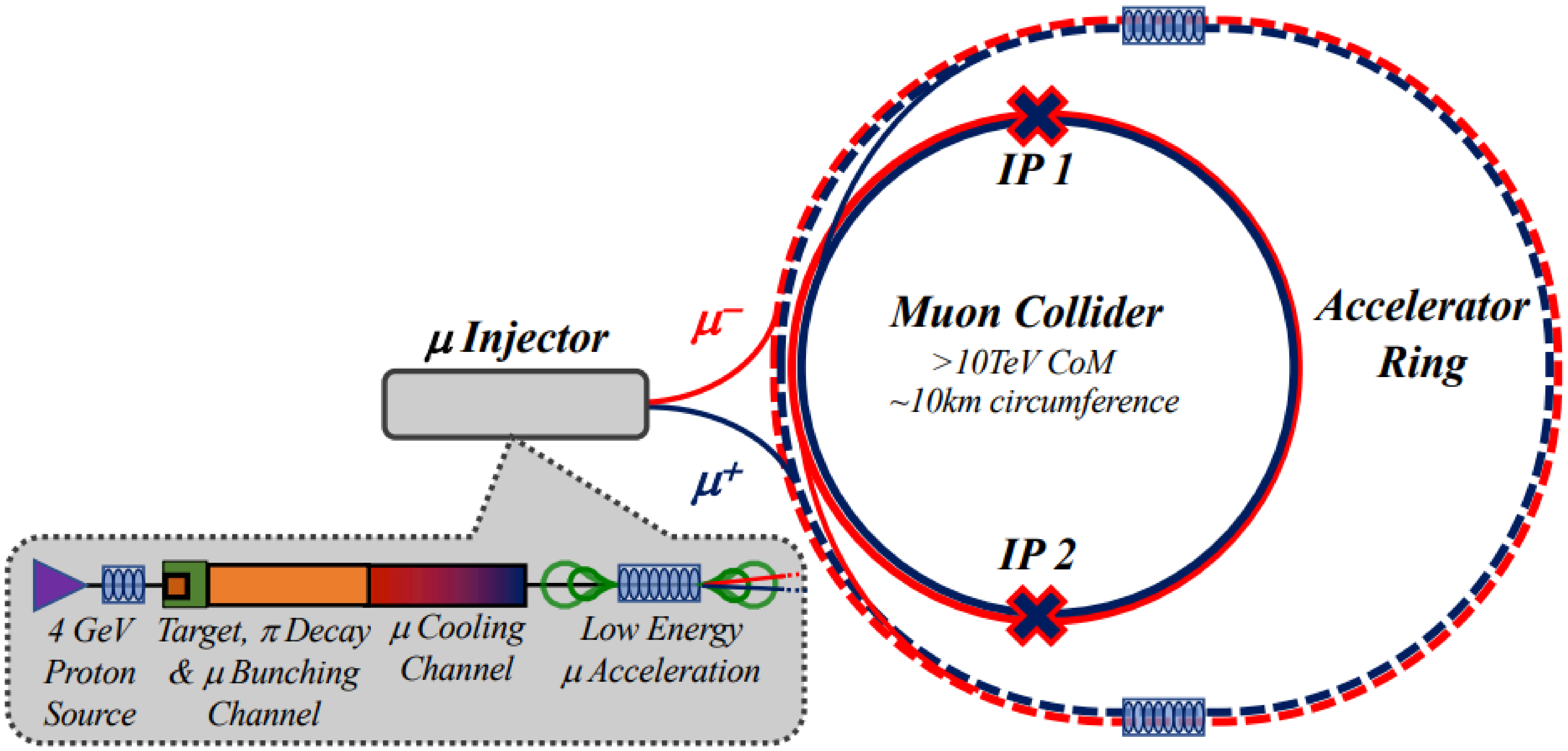


# The Muon Collider facility



# So why doesn't a Muon Collider exist yet?

Unfortunately, muons only live 2.2 us at rest, decaying in an electron and two neutrinos

## Machine challenges

- proton target power dissipation
- target region radiation dose
- muon cooling
- quick beam re-acceleration
- accelerator/collider rings radiation dose
- neutrino flux
- ...

## Detector challenges

- Beam Induced Background
- ...

# The Beam Induced Background

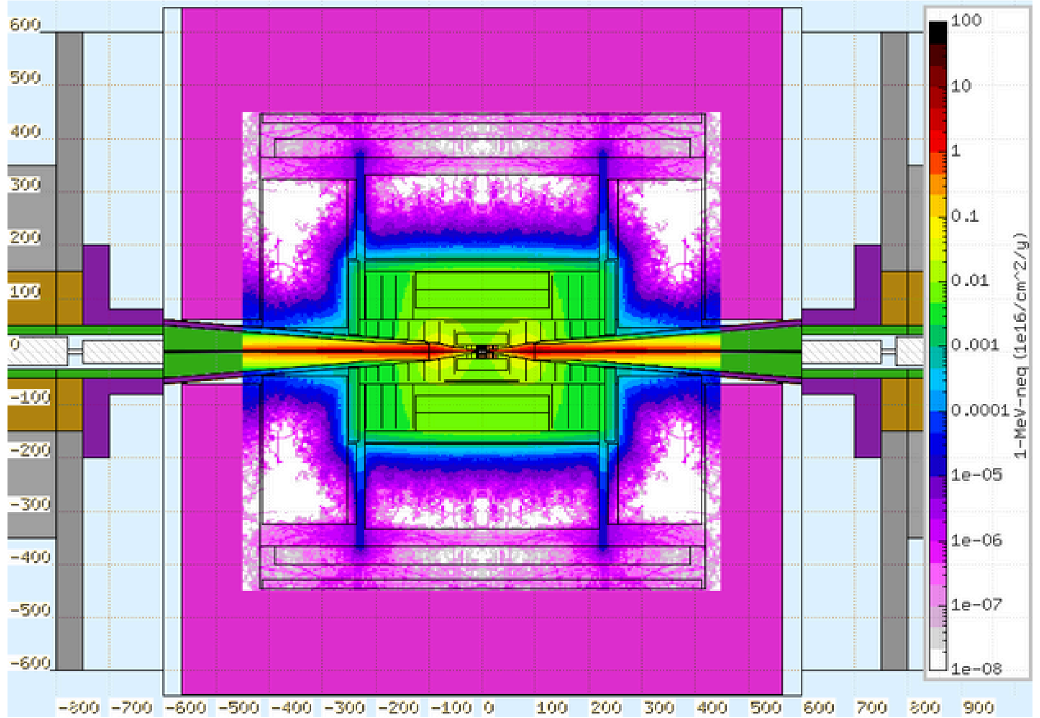
Electrons and positrons of few TeV hit the detector, generating an unsustainable background

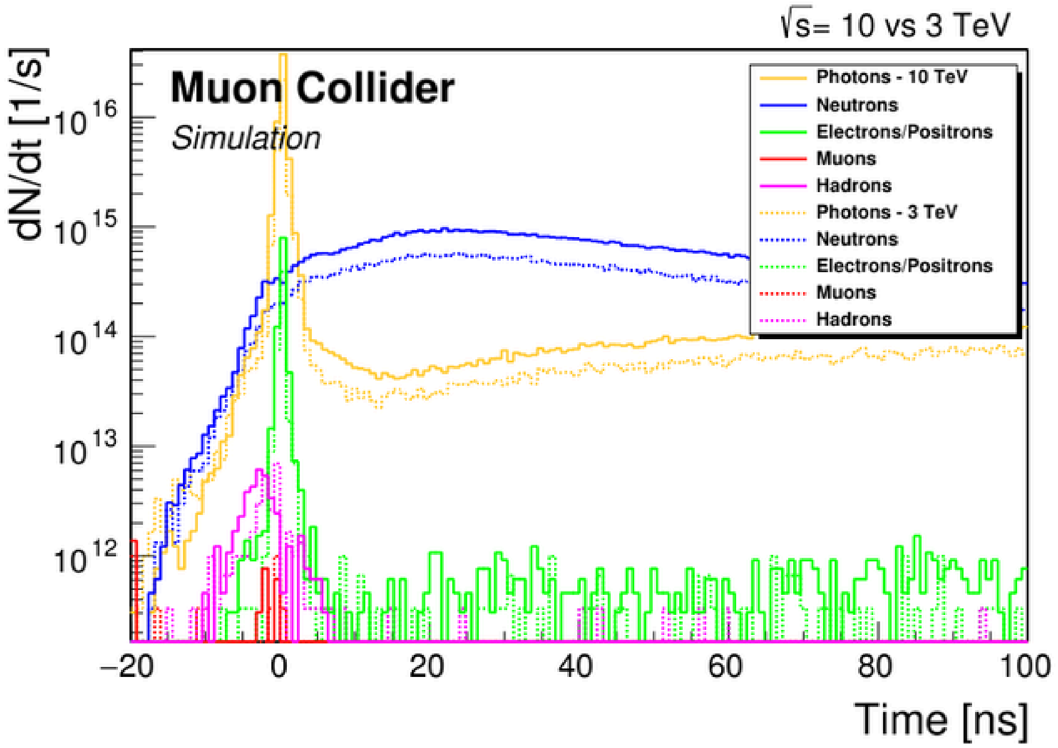
**MITIGATION** →

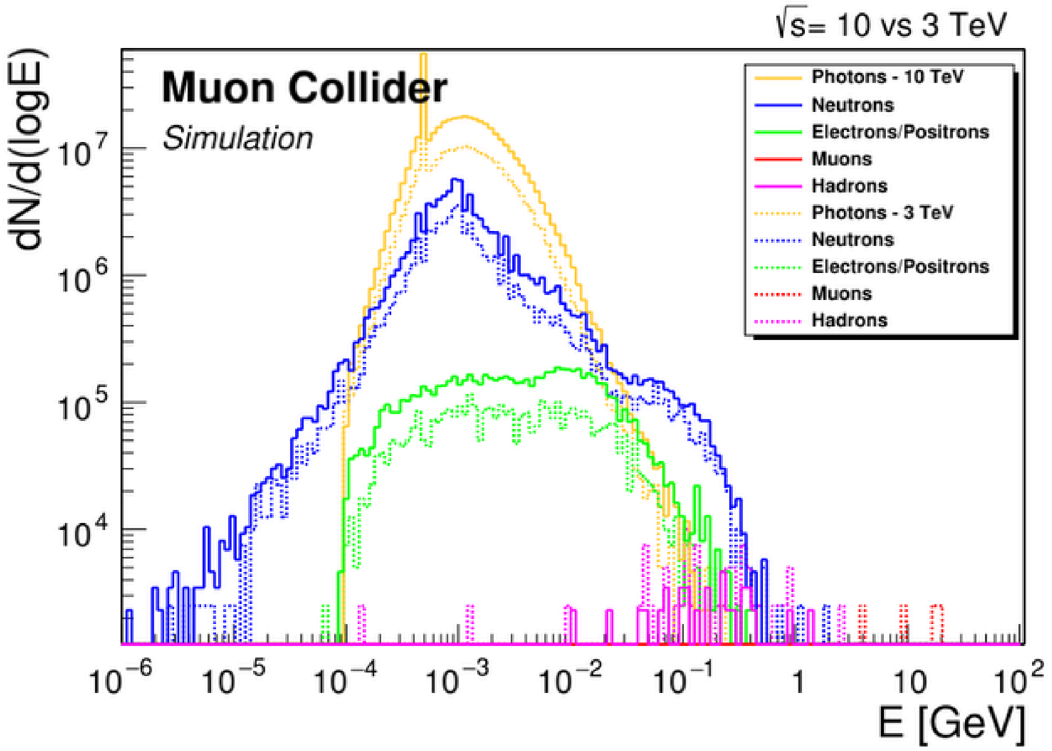
**PASSIVE**
- Dedicated machine lattice and optics
- Tungsten shieldings

→

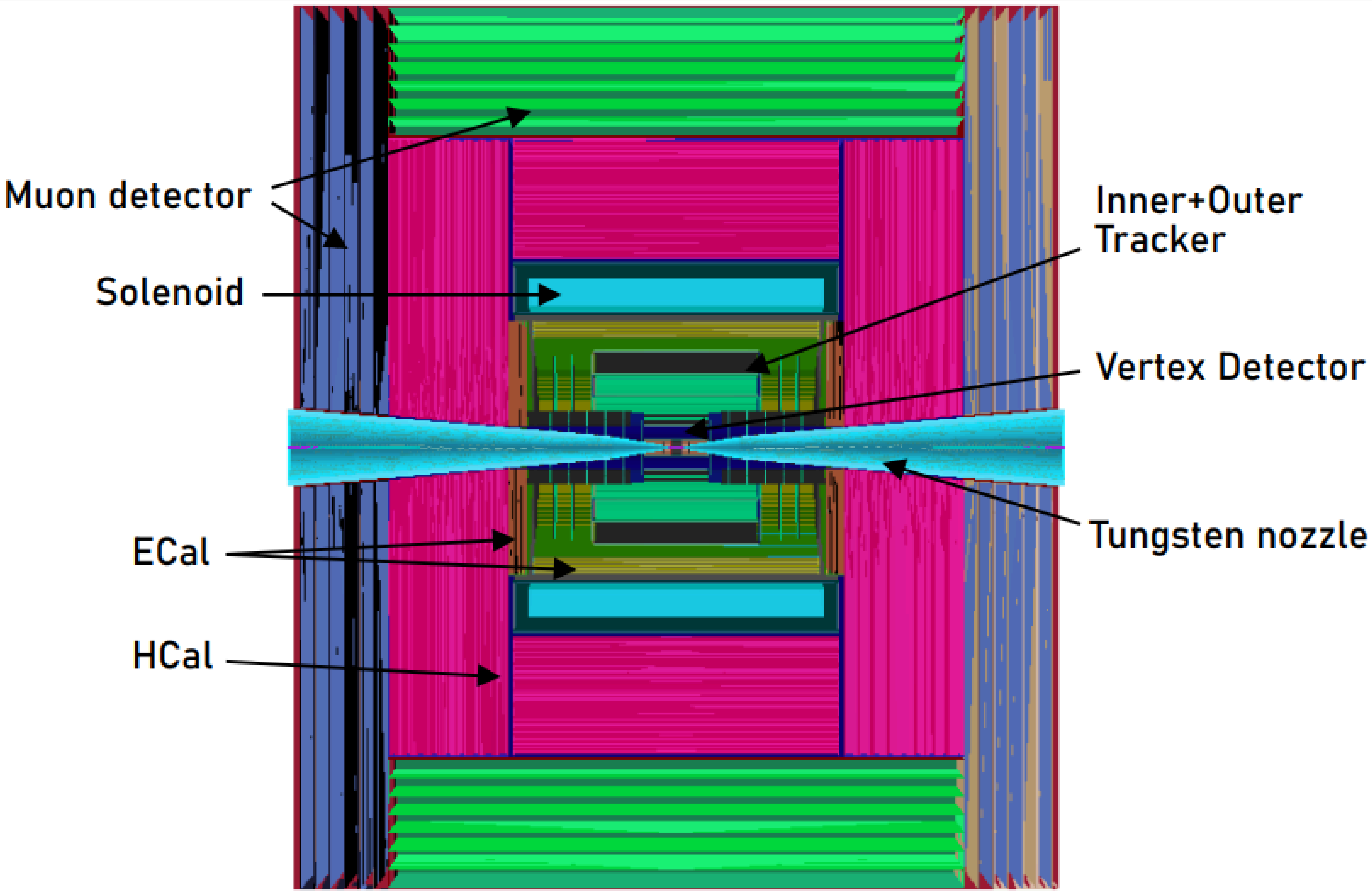
**ACTIVE**
- Exploit (r,t,E) features of BIB vs signal
- Filter/reconstruction



# MUSIC: a detector for the 10 TeV Muon Collider



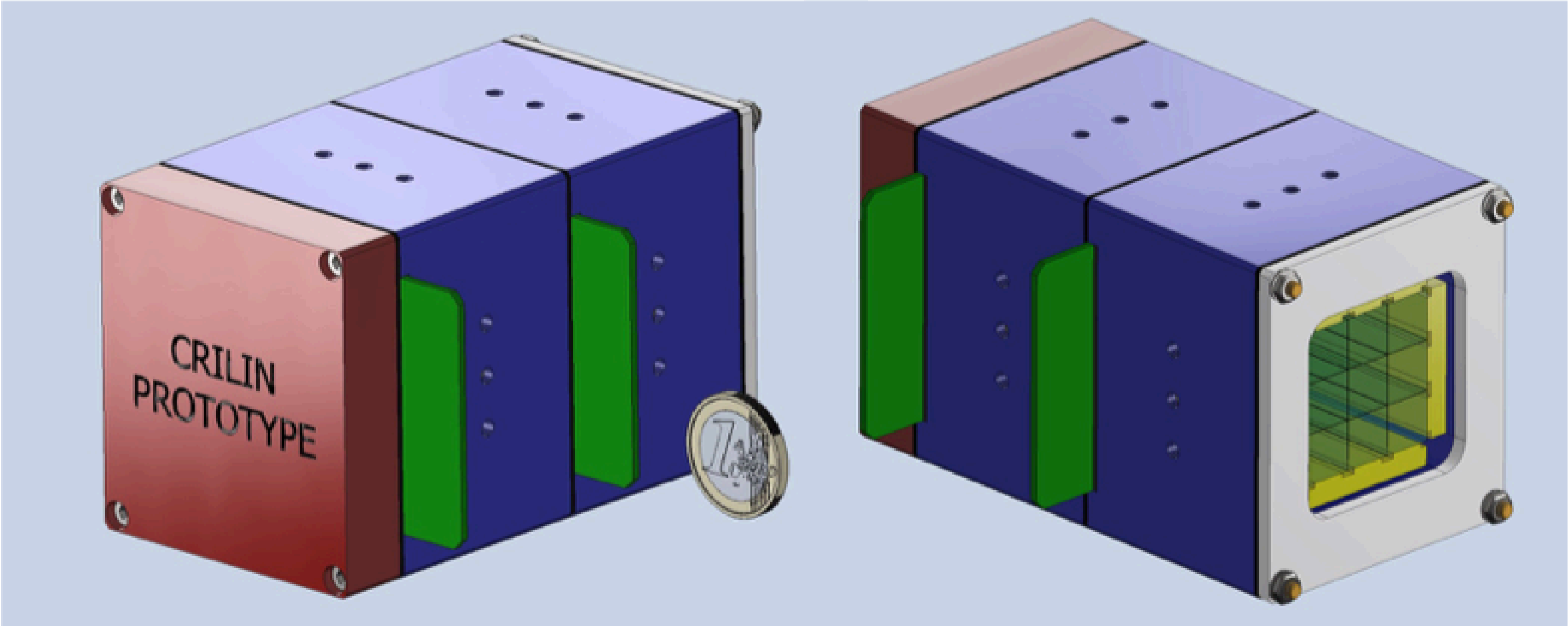
# The difficult task of energy measurement

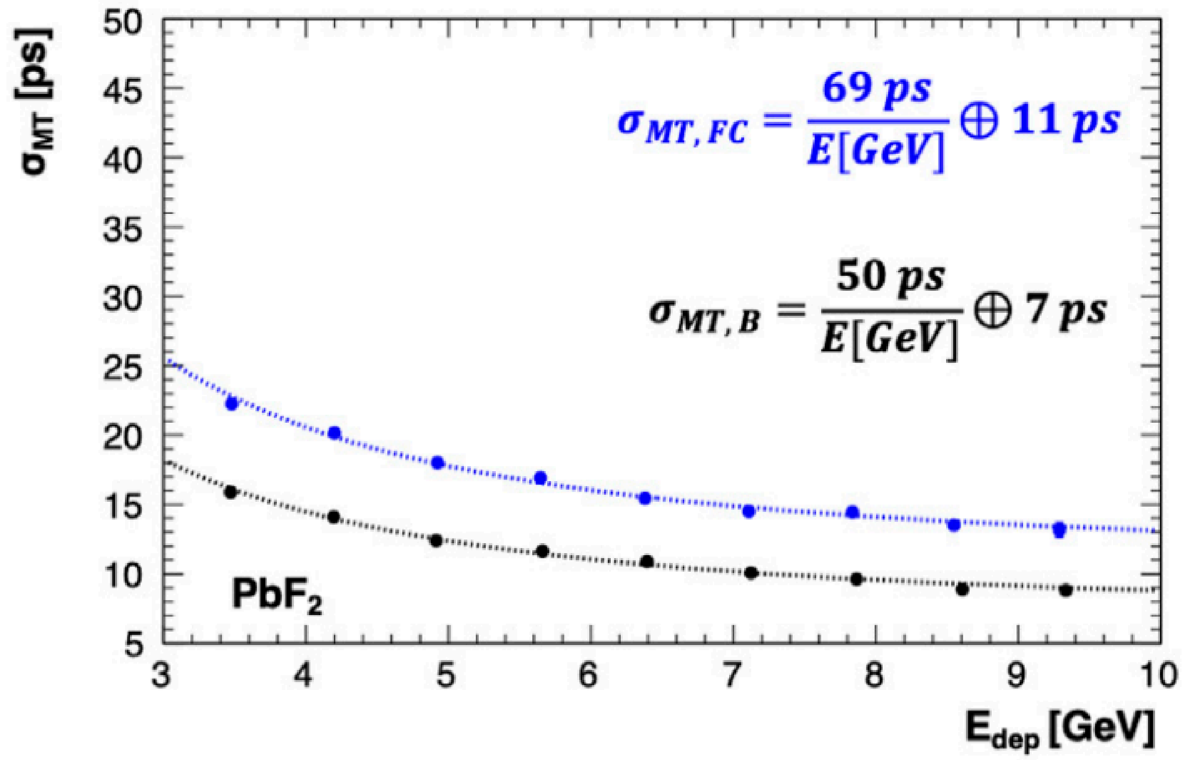
The EM calorimeter is the first “dense” subdetector encountered by BIB particles (photons).
On average, 10^6-10^7 hits are generated in ECal, of which 10^3 from signal particles.

**Stringent R&D requirements for a candidate EM calorimeter system:**

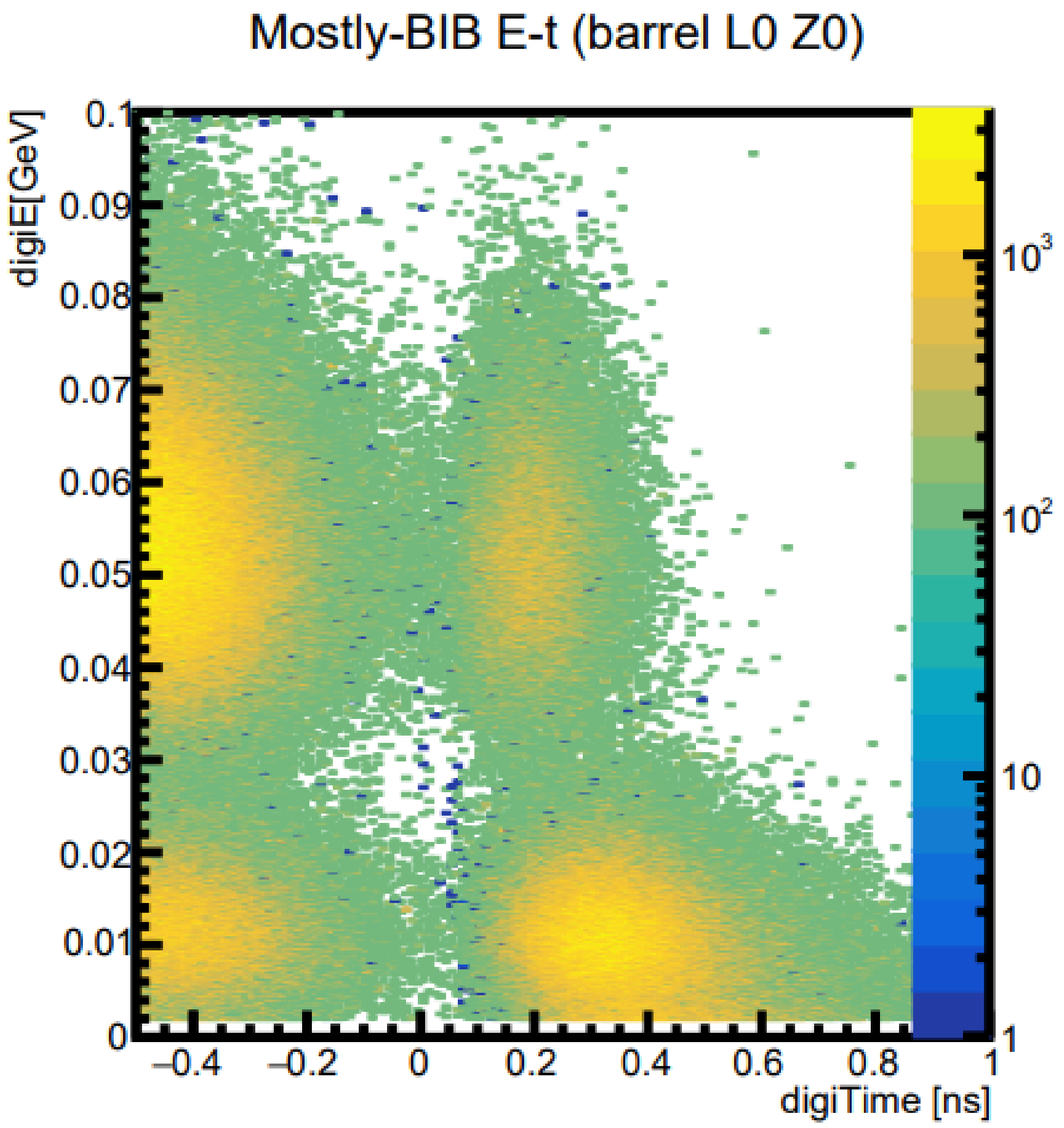
- **superior time resolution < 100 ps**
- **good energy resolution**
- **longitudinal segmentation and high granularity**

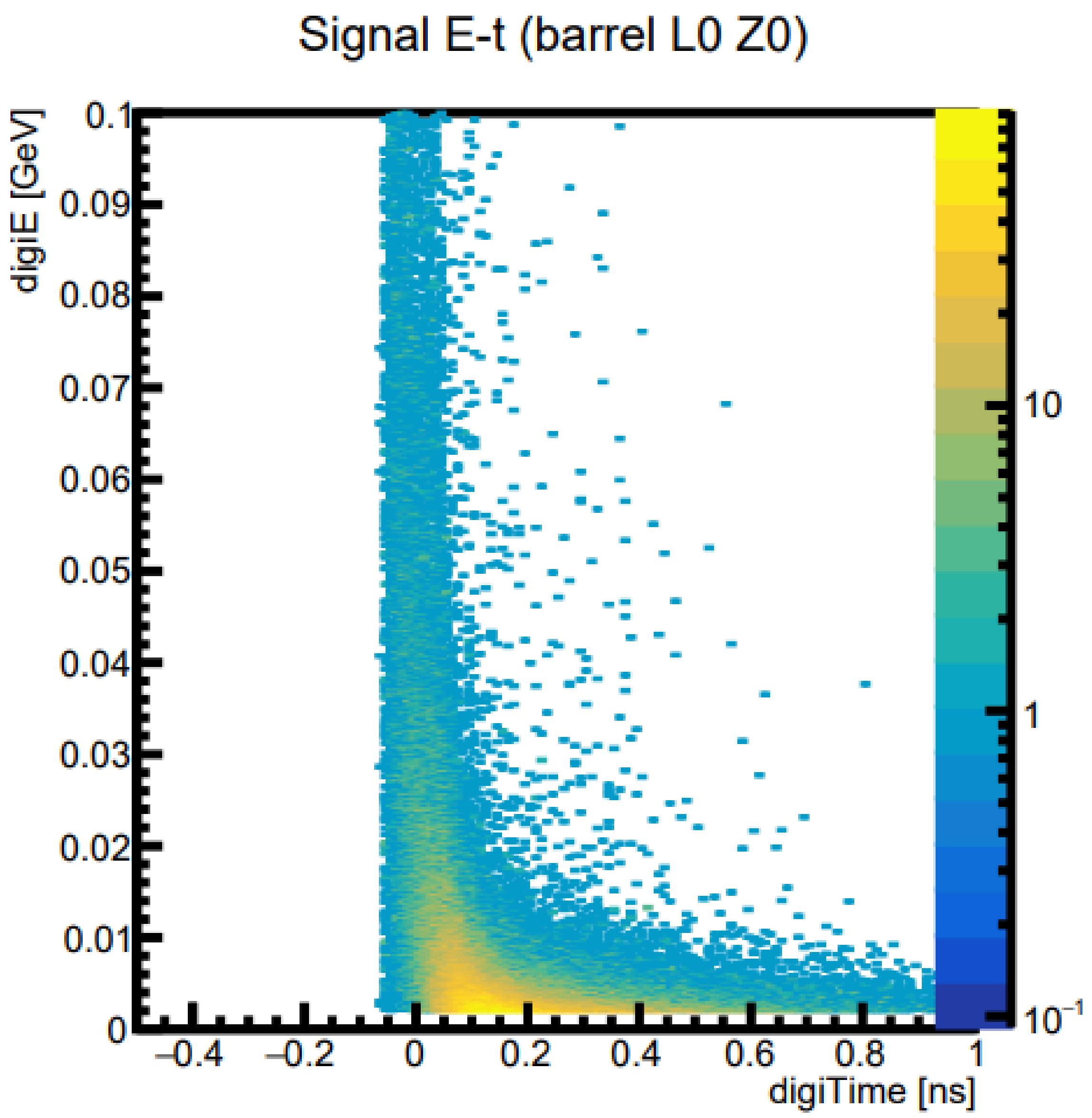
**CRILIN** (CRystal calorImeter with Longitudinal InformatioN) is the system of choice.



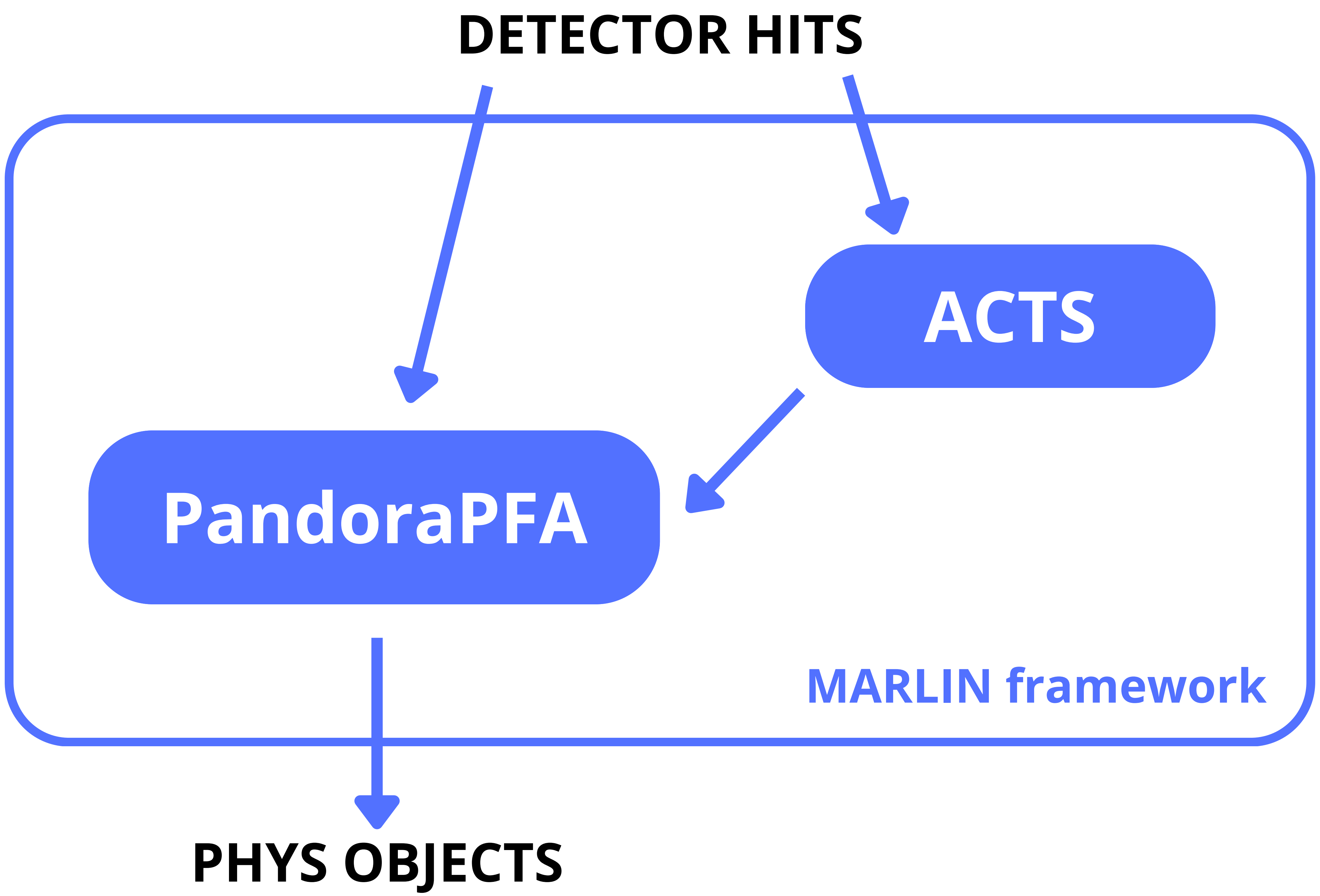



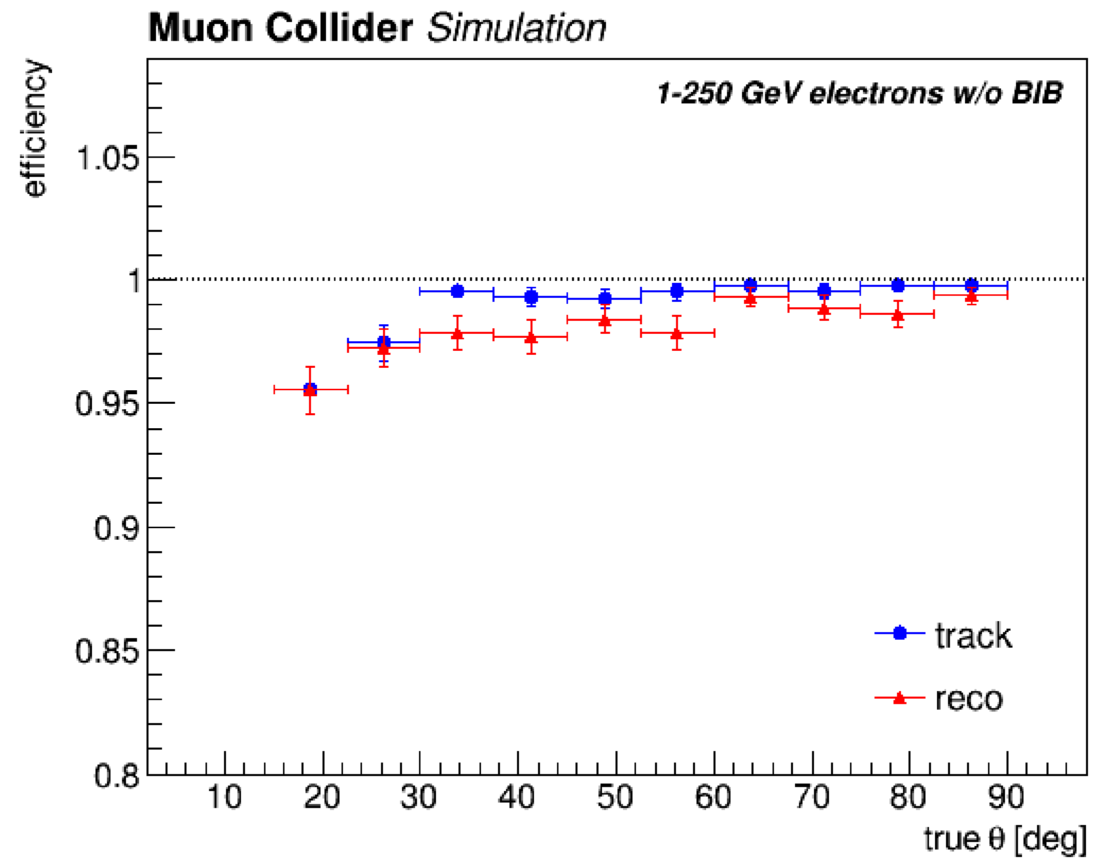
# How does the BIB look in CRILIN?

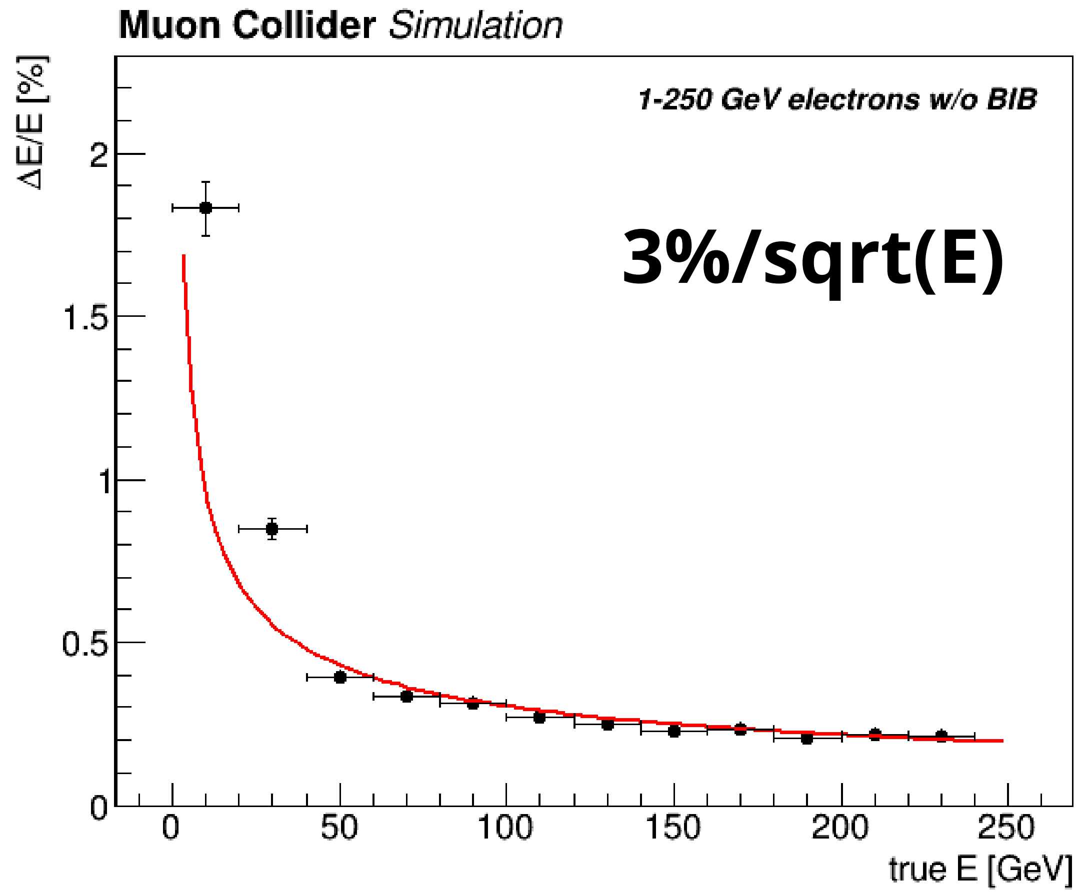


# Physics objects reconstruction



# Preliminary reconstructions with 10 TeV BIB

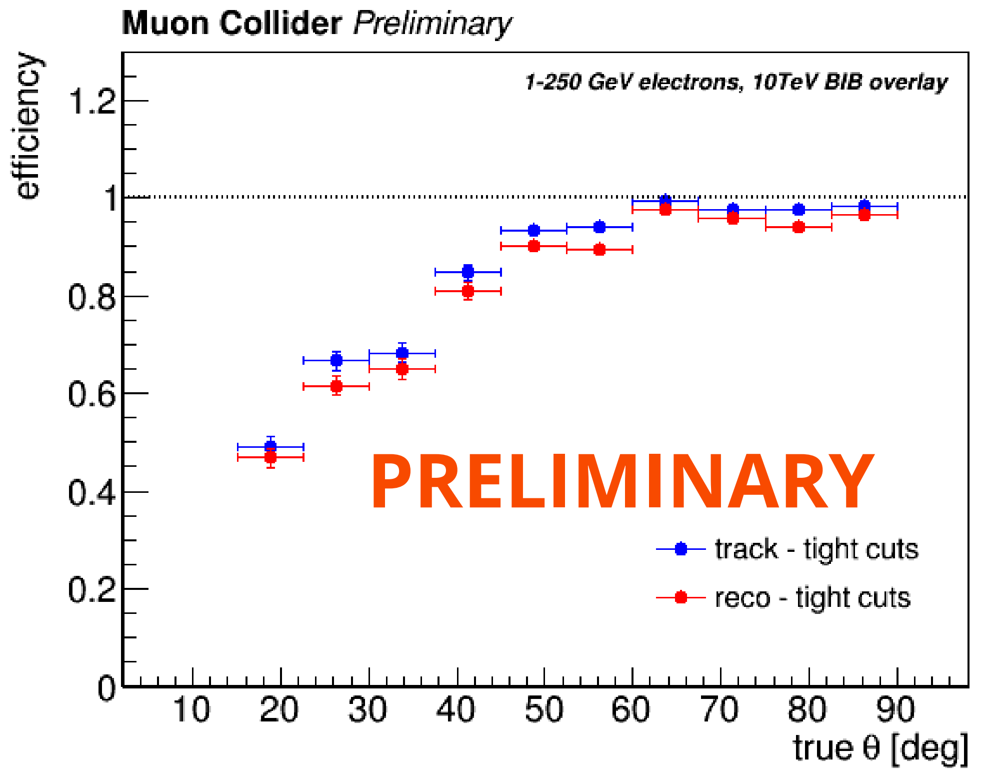
Check the effects of a simplistic BIB-signal discrimination

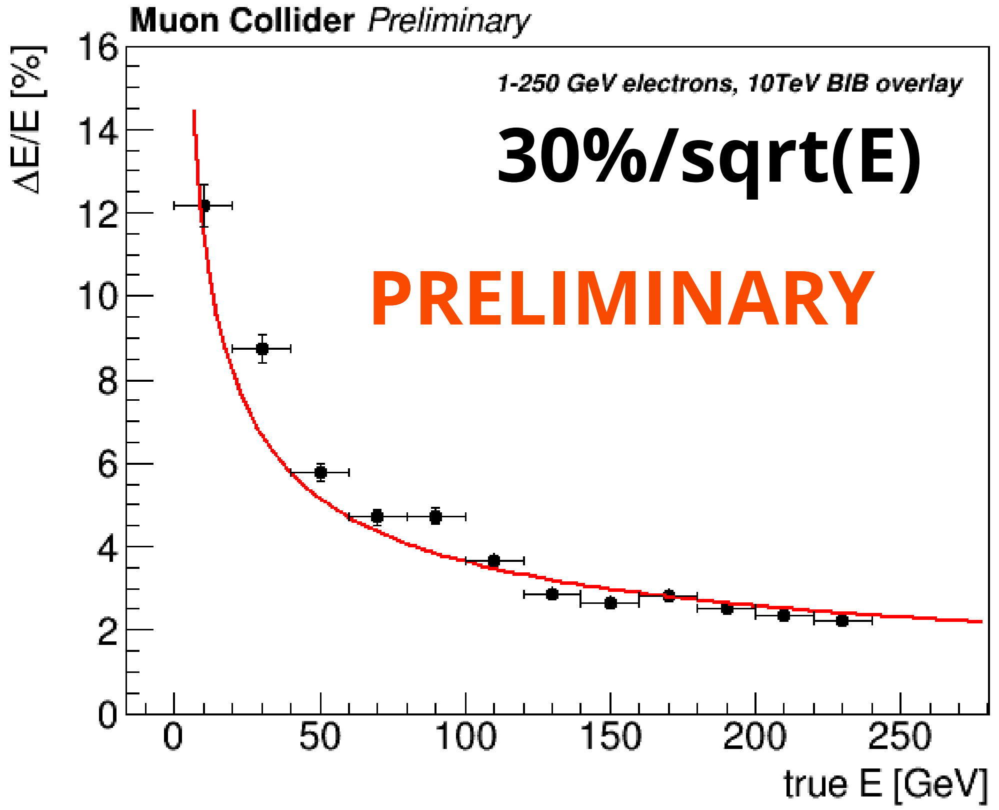
- **Tracks requirements** N(hits) and chi squared
    - from 100K to 200 tracks
- **ECal hit requirements** (t,E) by regions
    - from 6M to 20k hits
- From >40h/evt to few min/evt

Performance is ok, but huge improvement margin

- **Target tracking+reconstruction efficiency 90%**
- **Target energy resolution 15% / sqrt(E)**

Possible improvements by exploiting ML techniques

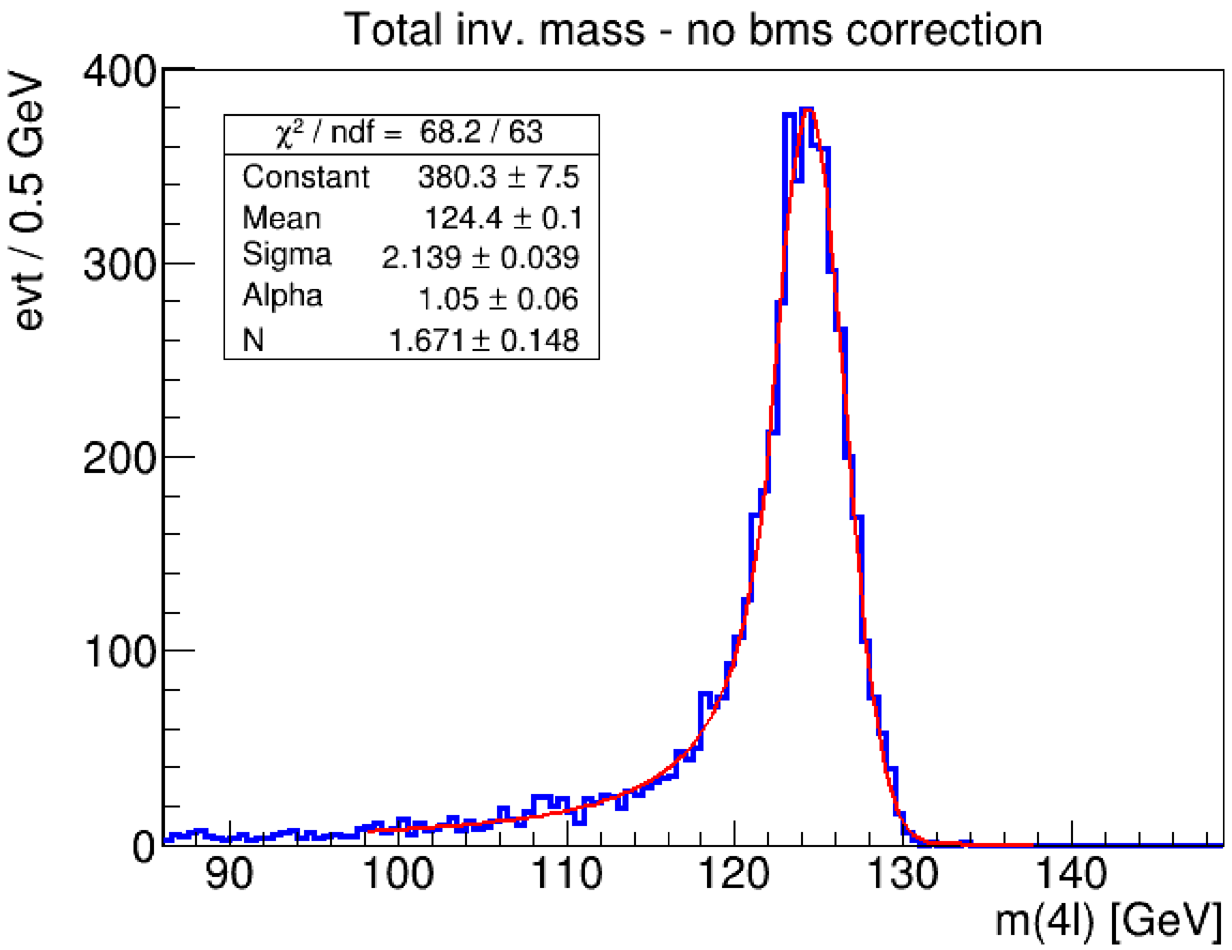


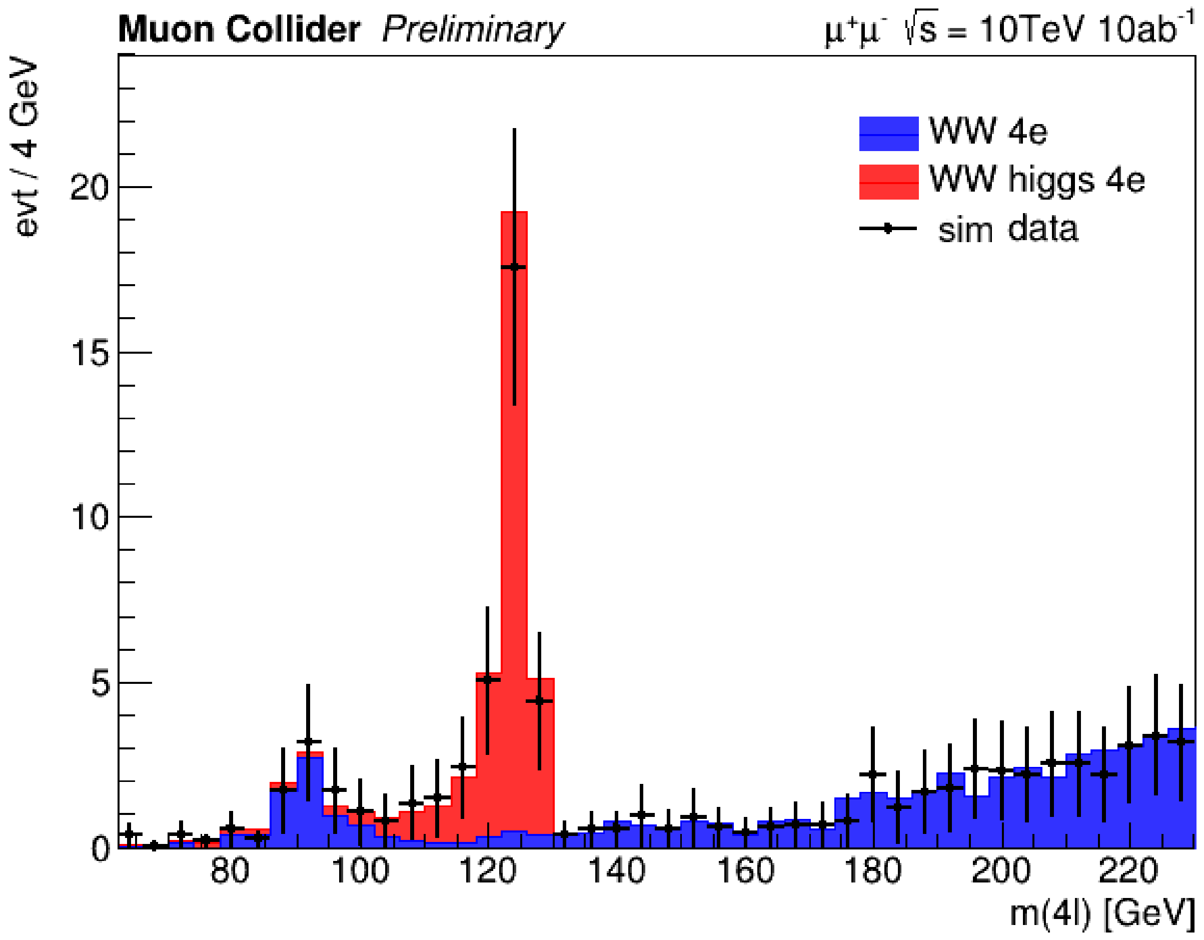



# Preliminary performances in the h > 4e physics case

The physics channel h > ZZ* > 4e will be an important component in the measurement of the **h-Z coupling**. A small BR, together with a large multiplicity, makes it a telltale of detector performance.

- with only ECal and no bms correction, **invariant mass resolution of 2 GeV**
- combining tracking and ECal, statistically significant peak already without ZZ fusion process



**Thank you!**