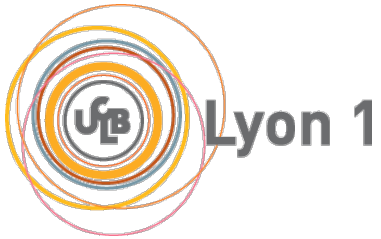
PAPAS

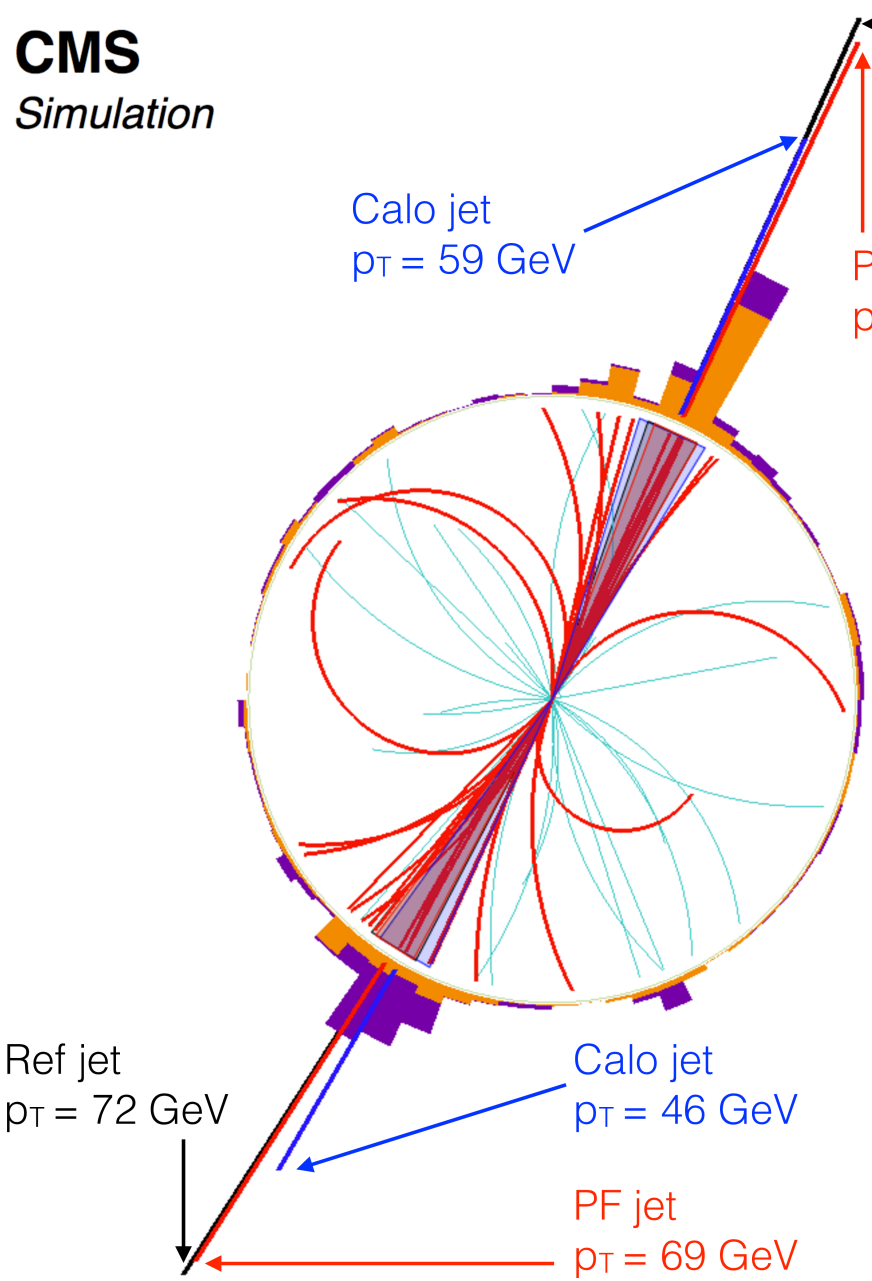
The Parametrized Particle Simulation

Colin Bernet (IPNL)

FCC Week, Amsterdam

April 2018





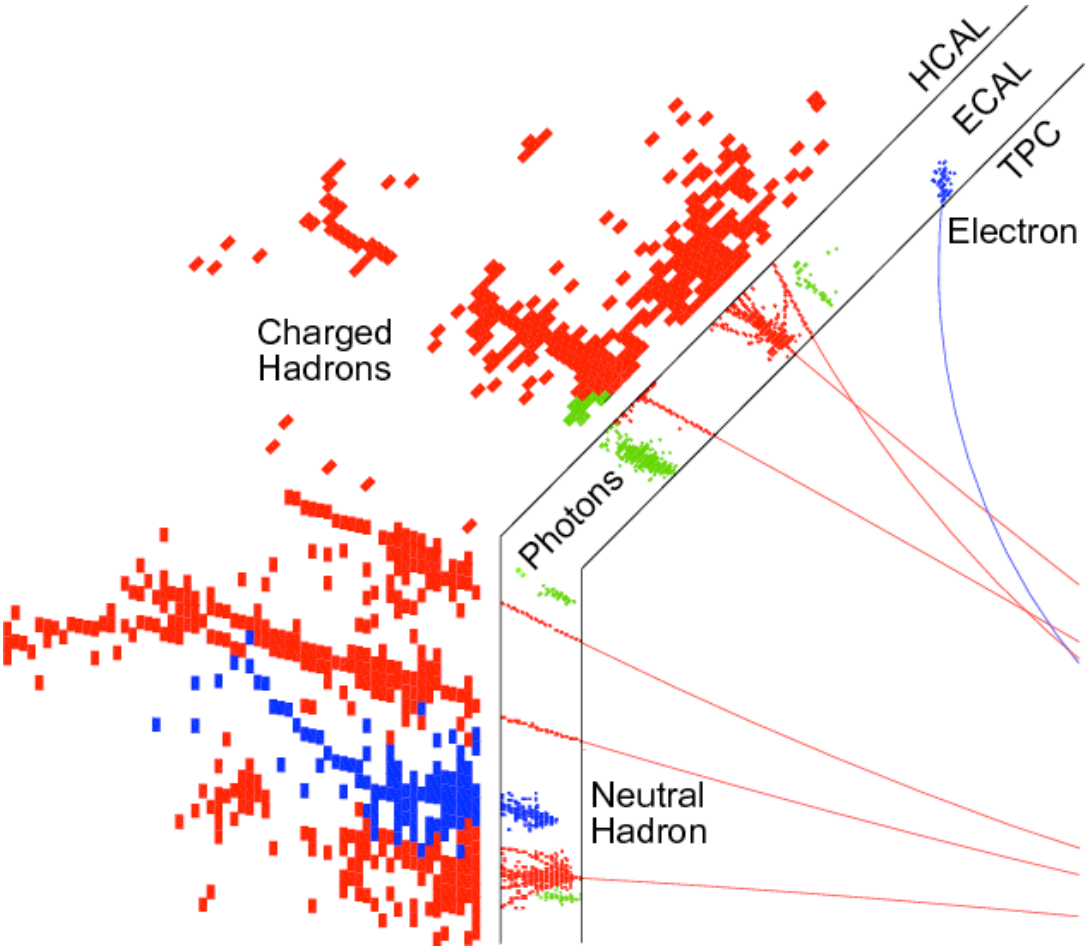
Particle Flow:

reconstruct all stable particles

- charged hadrons
- photons
- neutral hadrons
- electrons, muons

Then make jets, taus, MET, …

Particle Flow is the Future



CLIC

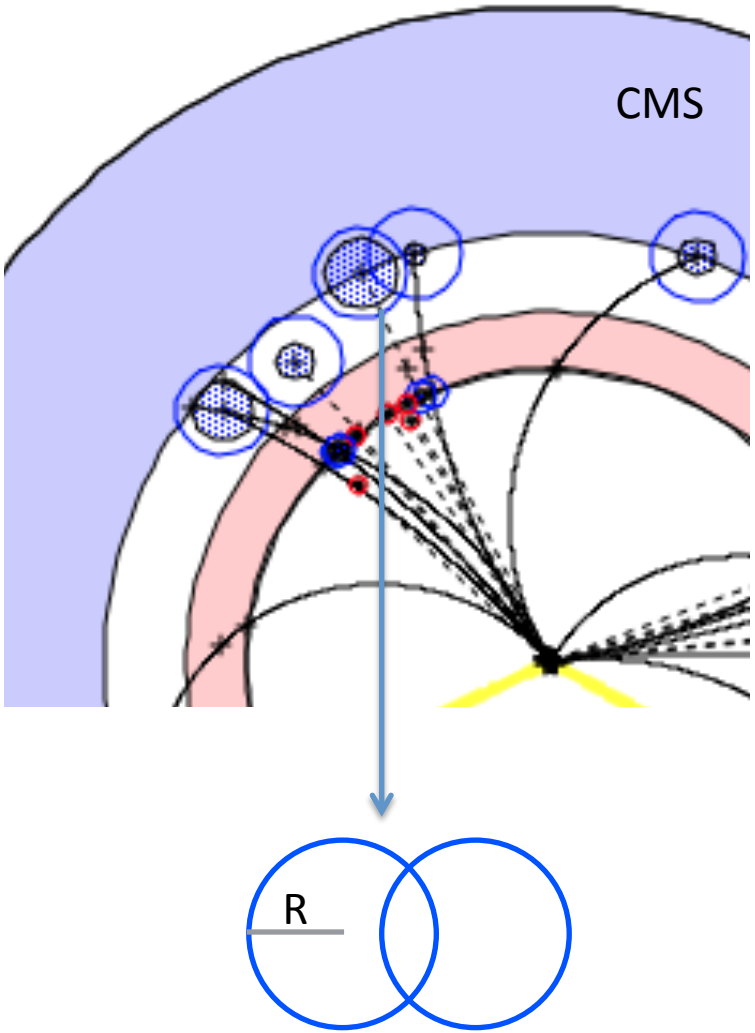
Need to resolve the energy deposits of nearby particles

Future detectors designed for this: pixel calorimeters

FCC detector design:
Need detailed fast simulation of the particle flow

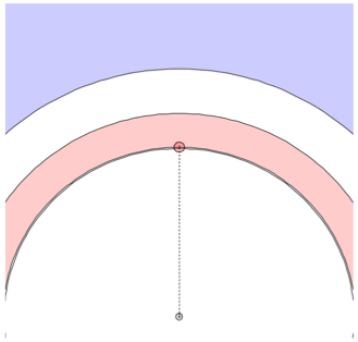
Papas

- Simple geometry (cylinders)
- Material
  - for hadron shower in ECAL
- Energy resolution Response
- Acceptance
  - thresholds
- Cluster size R
  - models calorimeter granularity

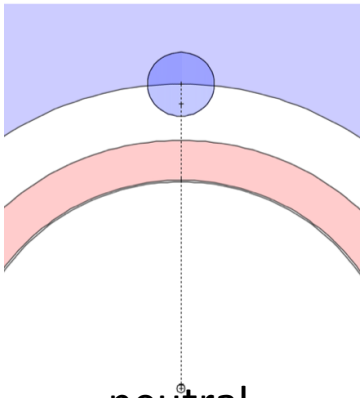


Sum energy and create a merged cluster

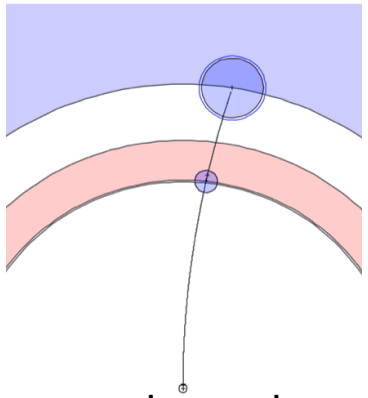
Papas: Particle Flow



photon

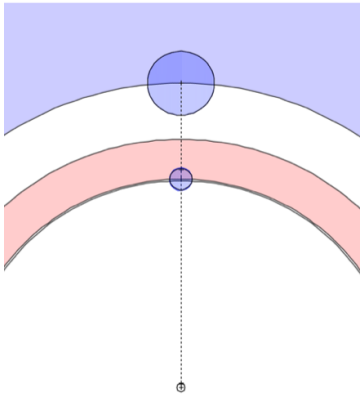


neutral hadron

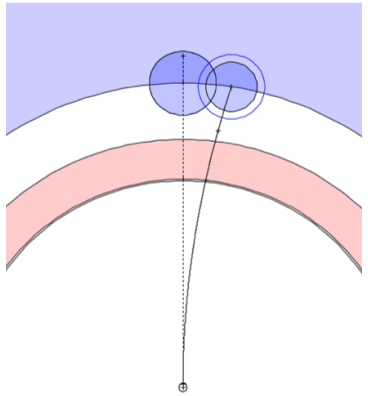


charged hadron

Full PF algorithm similar to CMS

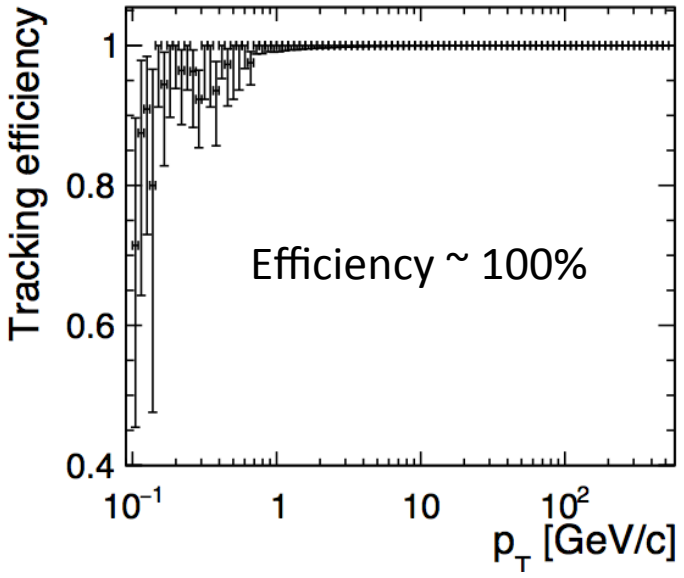


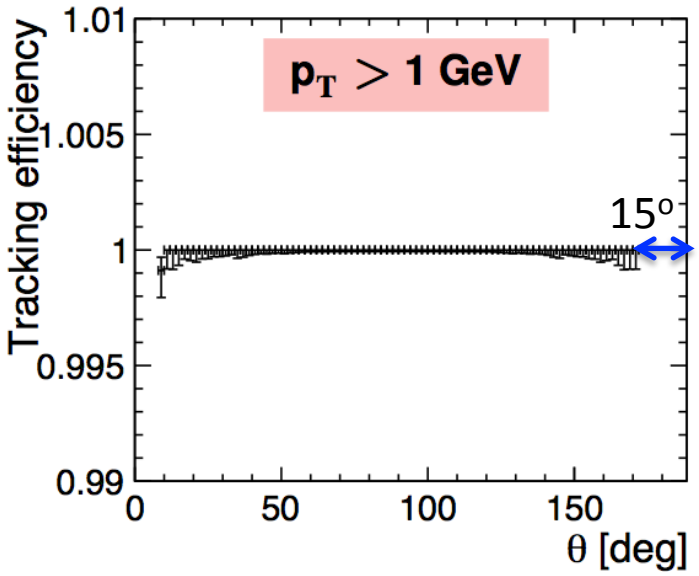
neutral hadron + photon

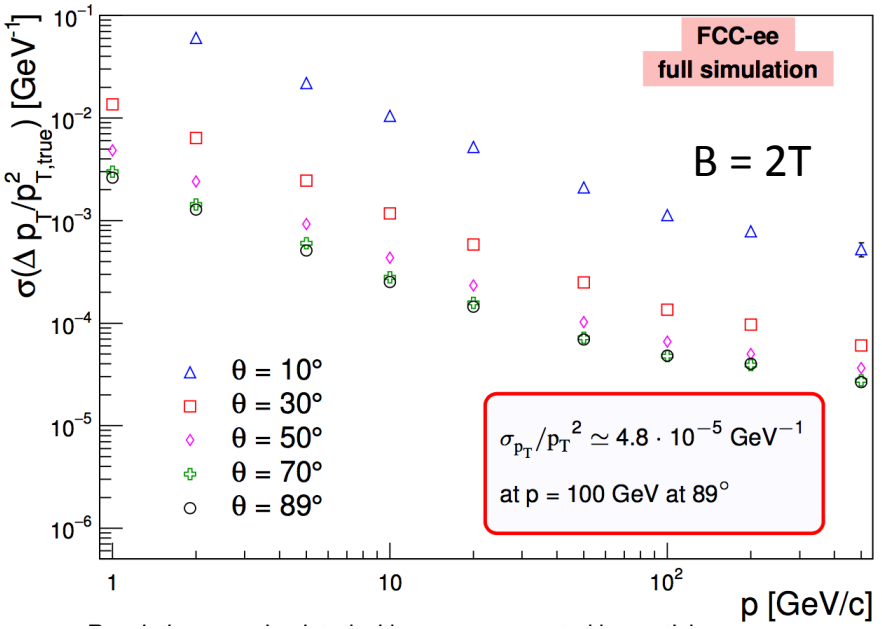


charged and neutral hadrons

CLD : Tracker







Very small amount of material

→ using these efficiencies and resolutions for charged hadrons, e, mu

Emilia Leogrande

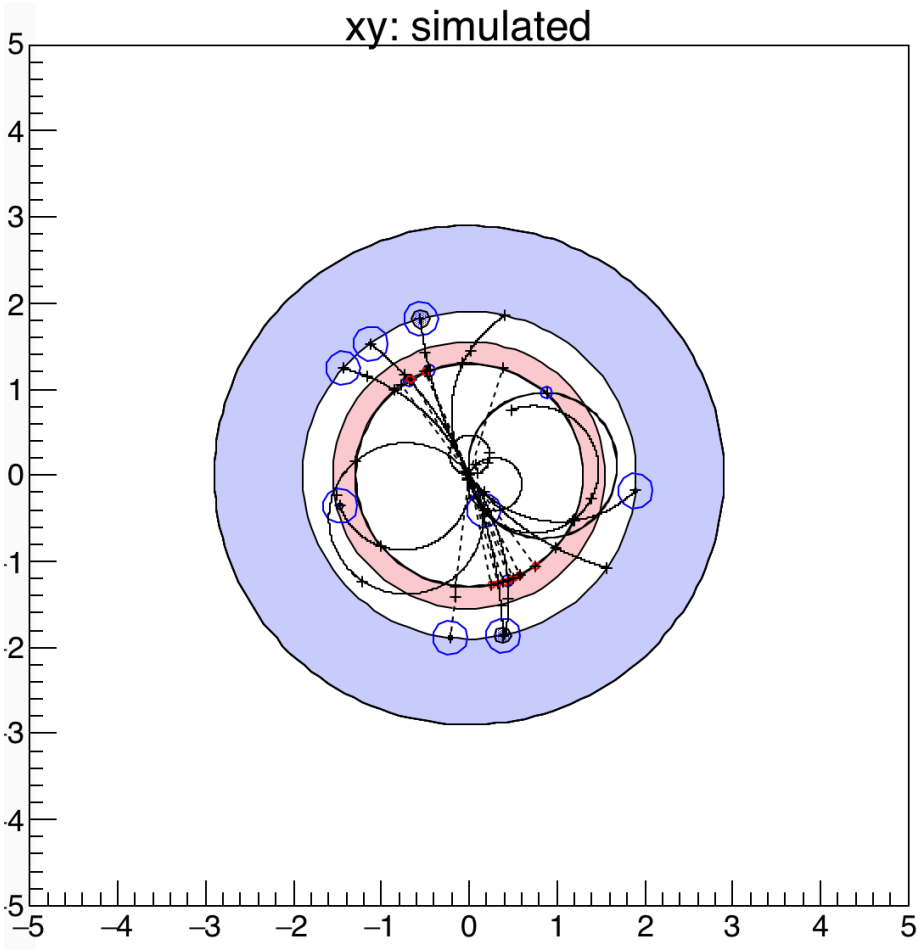
https://indico.cern.ch/event/638354/contributions/2626453/attachments/1478996/2292486/FCCeeDetDesMeeting.pdf

CLD : Calorimeters, Leptons

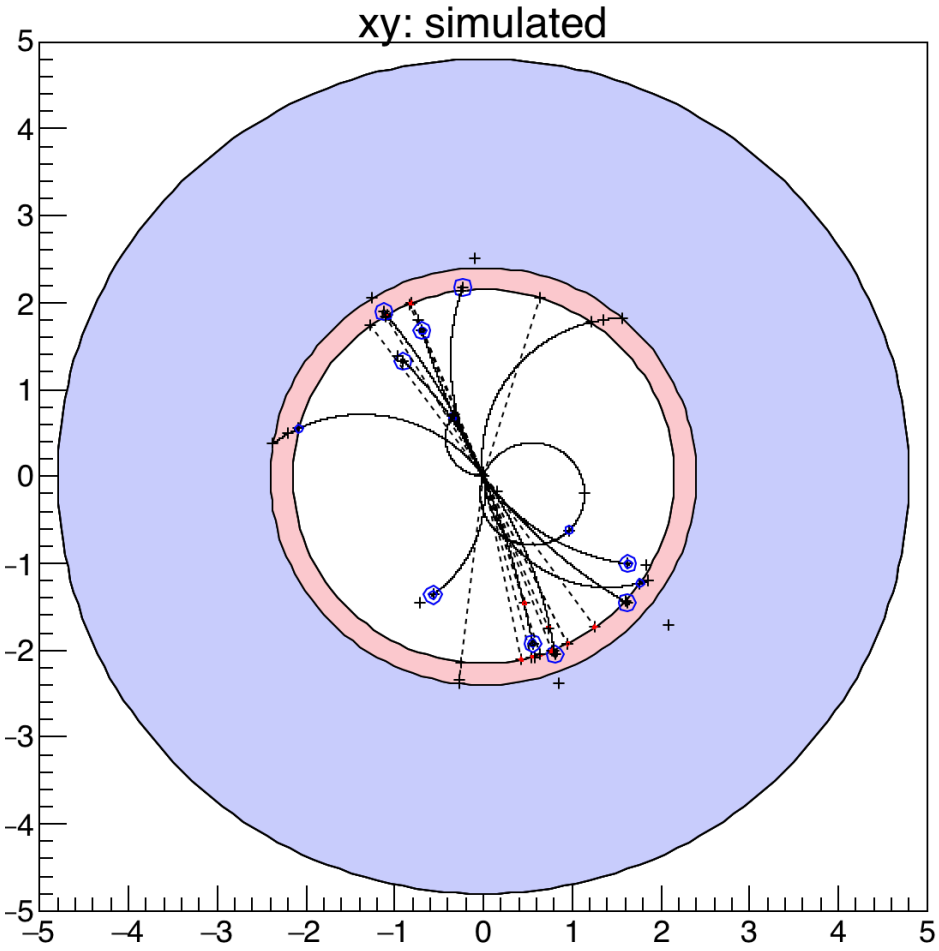
	ECAL	HCAL
n lambda_I	1 CLIC CDR p. 70	n.a.
Cluster size	1.5 cm (EM) 4.5 cm (had)	10 cm CLIC CDR Fig. 6.12
Resolution	$\frac{0.167}{\sqrt{E}} \oplus 0.011$ CLIC CDR p. 123	$\frac{0.5}{\sqrt{E}} \oplus \frac{0.5}{E} \oplus 0.0234$ CLIC CDR Fig. 6.11 (simple software compensation)
Acceptance	|η|<2.76 E. Leogrande	|η|<2.76
Thresholds	0.2 MeV	1 GeV

	e	mu
Resolution	as for charged hadrons	as for charged hadrons
Efficiency	95% for p_T>5 GeV	100% for E>7.5 GeV CLIC CDR Sec. 8.1.1

$Z \to d\bar{d}$



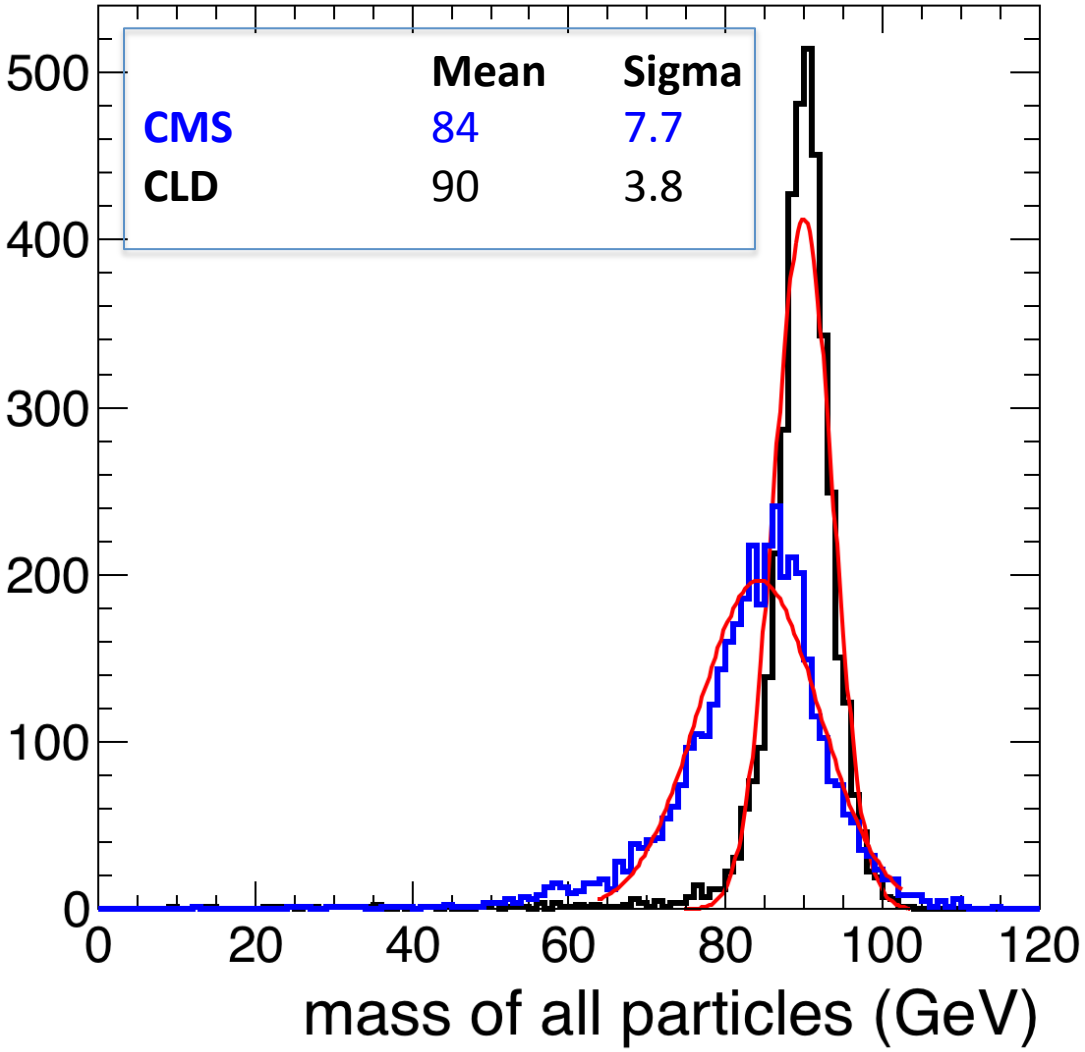
CMS



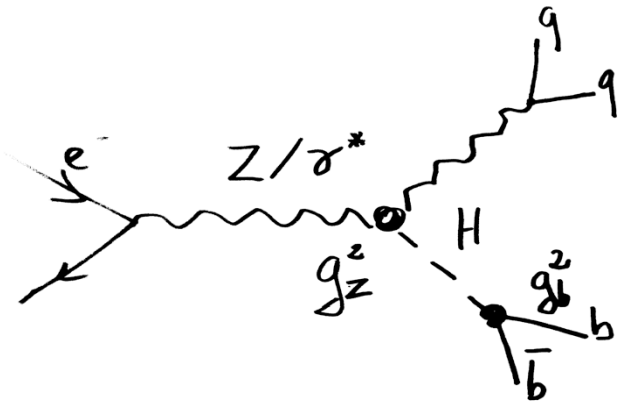
CLD

$Z \to d\bar{d}$ mass reconstruction

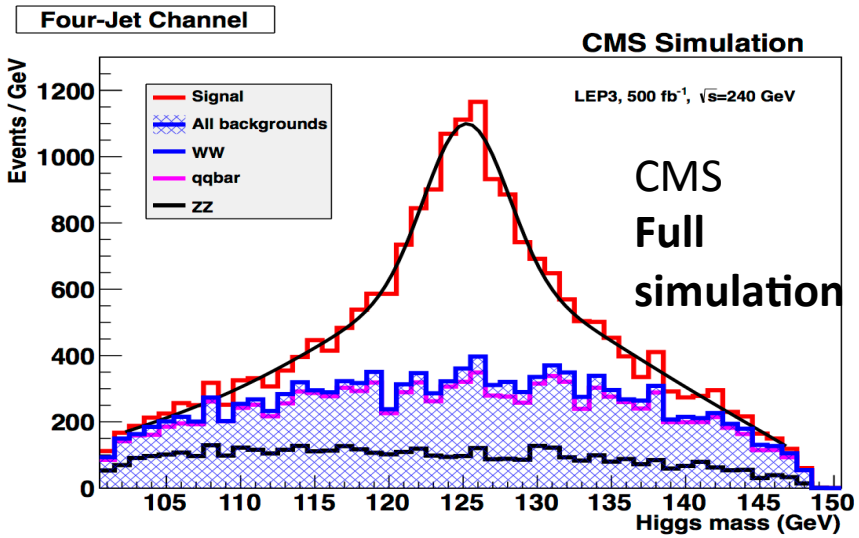
Invariant mass of all reconstructed particles
No jet reconstruction

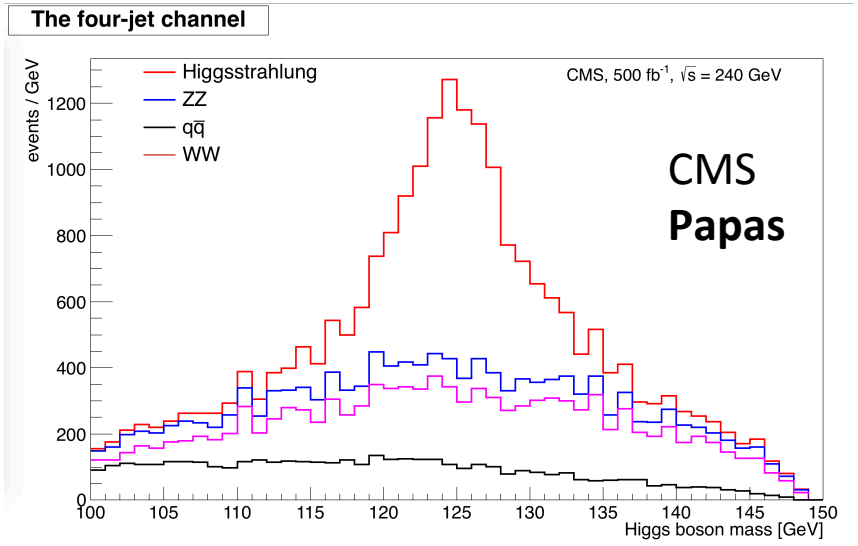


Validation in a physics channel



- exclusive 4 jet reconstruction,
- rescale jet energies for p4 conservation
- reject combinations with di-jet masses - compatible with ZZ and WW
- select best combination for H→bb (b tag)





Software

- Papas available in:
  - python
    - fast prototyping and debugging
    - extreme flexibility
    - ~5-10 events / s
    - https://github.com/HEP-FCC/heppy
  - C++ (standalone and FCCSW) ***Alice Robson***
    - 100 – 150 events / s
    - https://github.com/HEP-FCC/papas
      https://github.com/HEP-FCC/FCCSW

Summary

- Papas is a new fast simulation program
- Features a full particle flow algorithm
- Models precisely the influence of the detector on particle flow reconstruction
- First studies based on papas:
  - C.B. : Higgs coupling measurements at FCC-ee