

MEASUREMENT OF THE ELECTRON FLUX WITH AMS

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JRJC

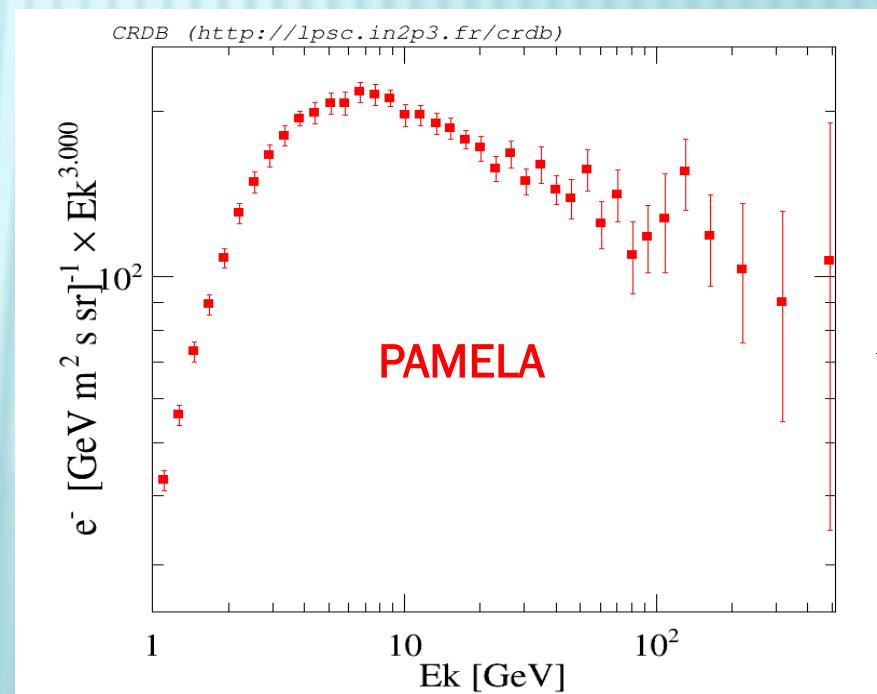
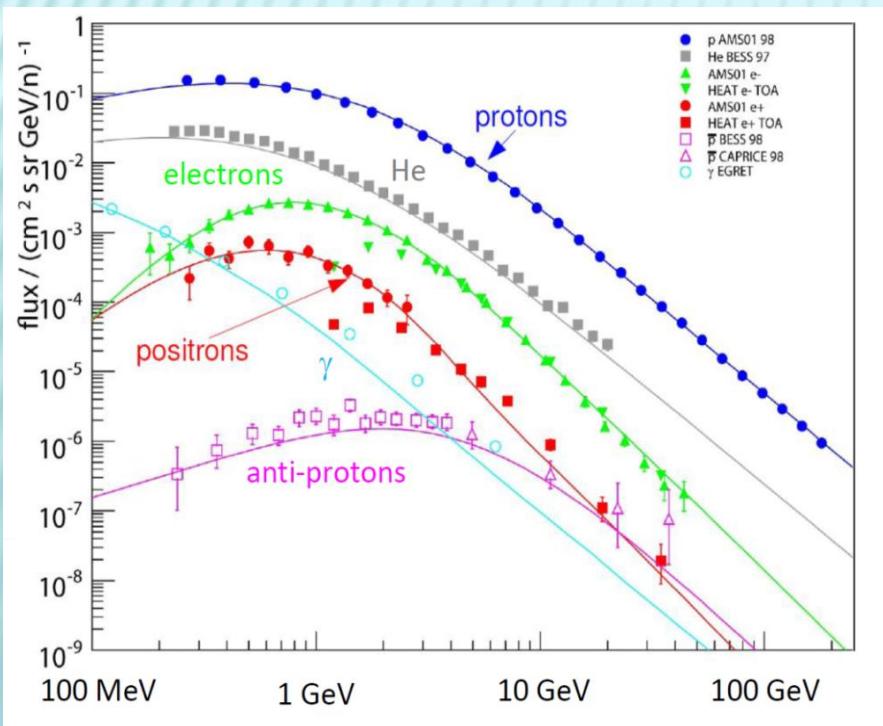


OUTLINE

- ✖ Motivations and status
- ✖ AMS detector
- ✖ Calibration of the calorimeter
 - + Energy scale: E/P
- ✖ **The measurement of the electron flux**
 - + Number of electrons
 - + Acceptance
 - + Trigger efficiency
 - + Exposure time

ELECTRON FLUX

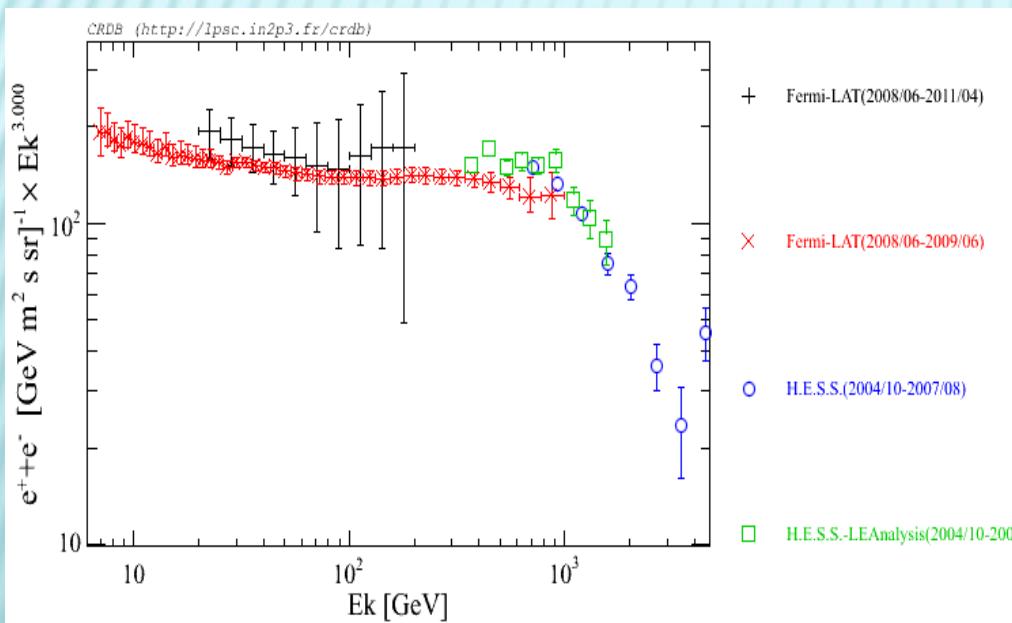
- ✖ Cosmic rays
 - + 99% nuclei
 - ✗ 89% protons, 10% helium and other heavy nuclei
 - + 1% electrons
 - ✗ Important energy loss through synchrotron and inverse compton -> propagation & acceleration
- ✖ PAMELA: measurement of the electron flux up to 625GeV.



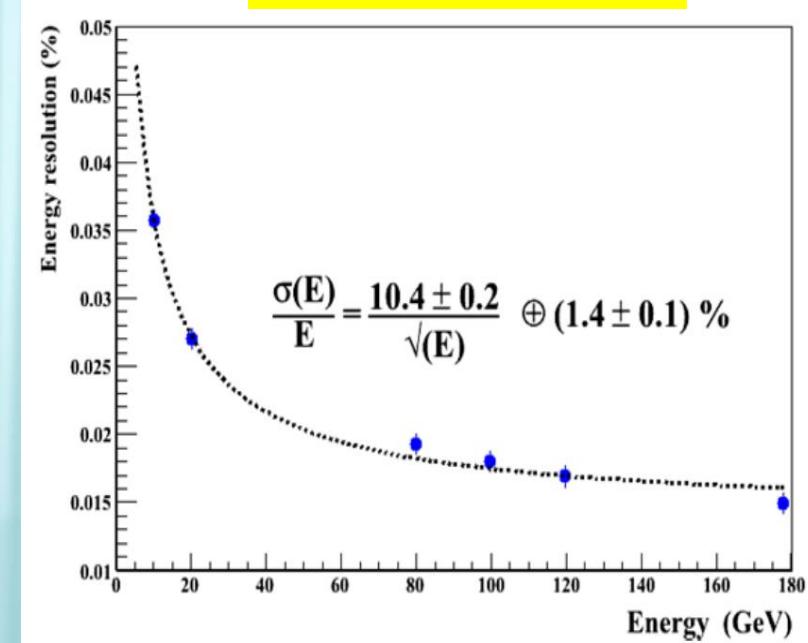
ELECTRON FLUX

- ✖ H.E.S.S., Fermi, up to TeV, but no separation e+ et e-
- ✖ AMS up to TeV
 - + Separation of e+ et e-
 - + Better energy resolution

Resolution of the
calorimetre of AMS



-- Database of charged cosmic rays



ALPHA MAGNETIC SPECTROMETER (AMS)

- ✖ Particle detector of cosmic rays
- ✖ Mounted on the main truss of the International Space Station (ISS)
 - + Orbiting the earth at an altitude of 300km



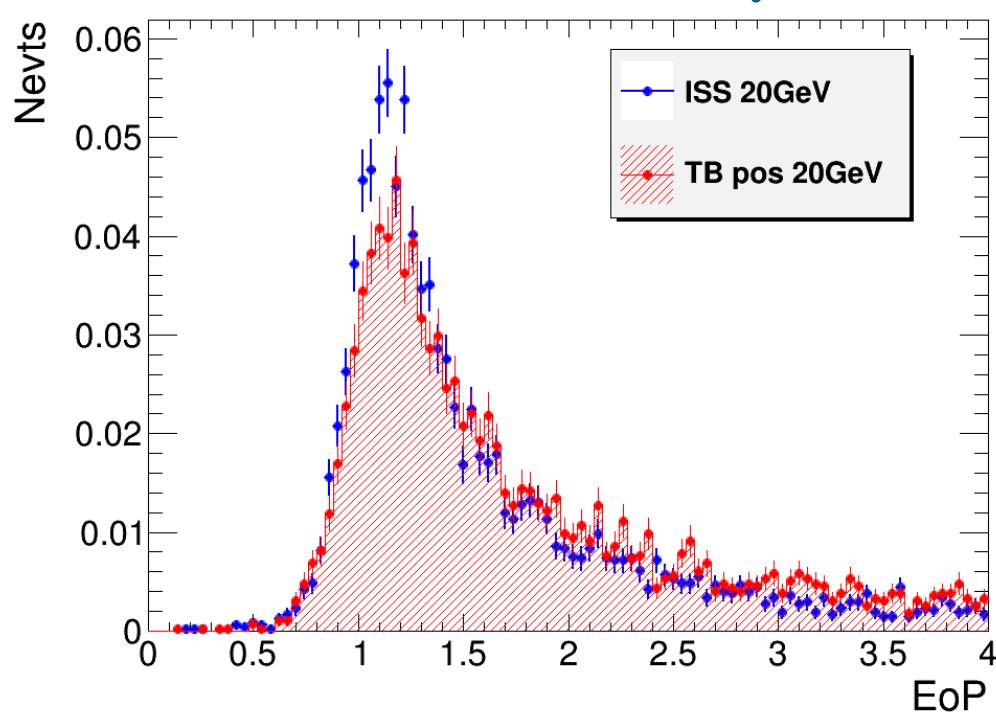
THE AMS DETECTOR



CALIBRATION OF THE ECAL WITH ELECTRONS

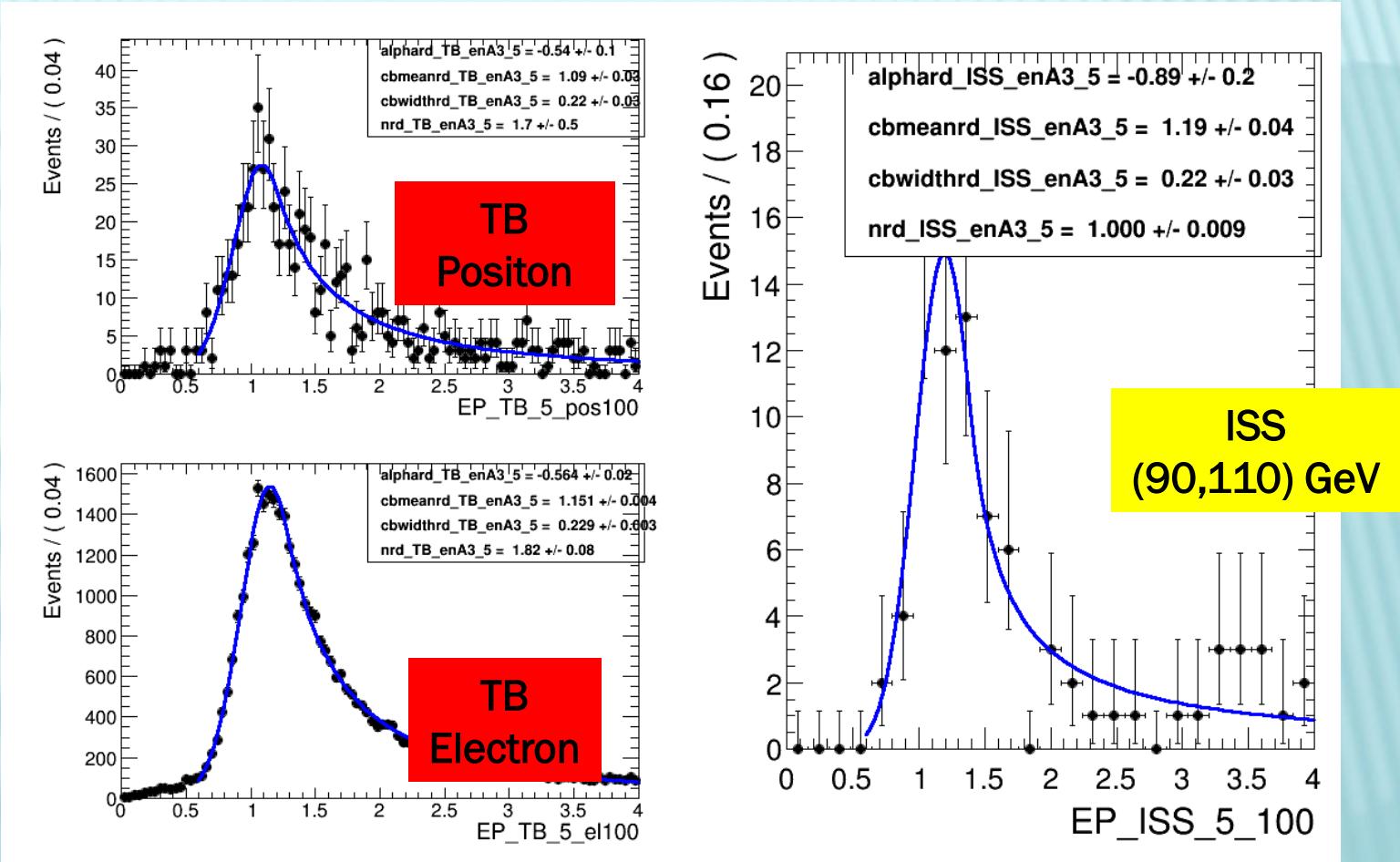
ENERGY SCALE: E/P

- ✖ The absolute calibration of the ECAL is performed by using the Test Beam (TB).
 - ✖ Idea: control the position of the EoP peak between the data and TB
 - + E: deposited energy measured by the ECAL
 - + P: momentum measured by the Tracker

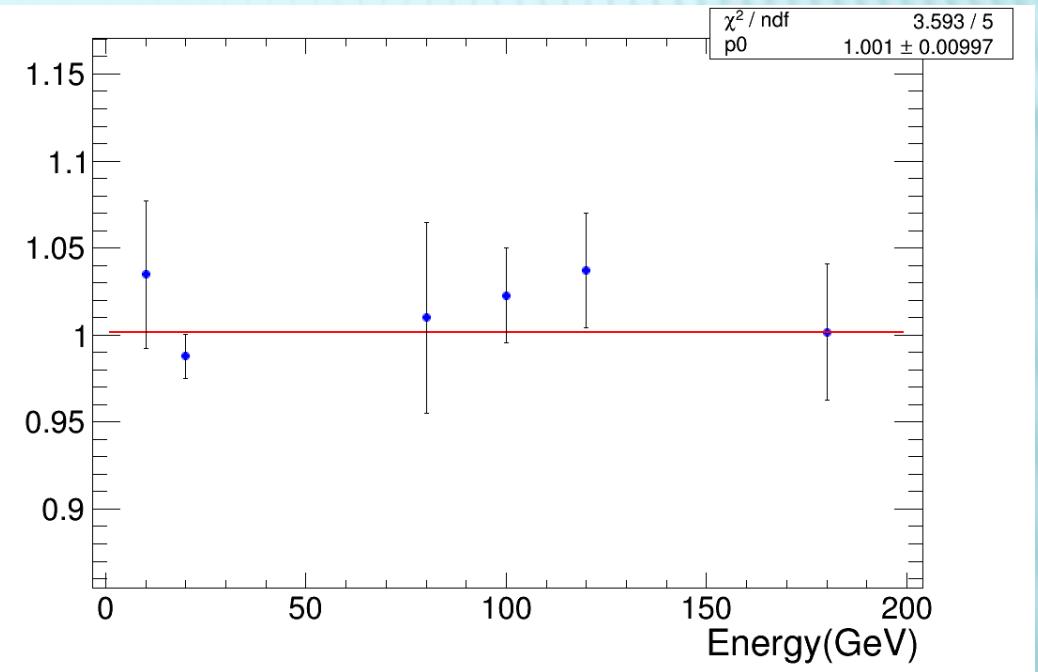
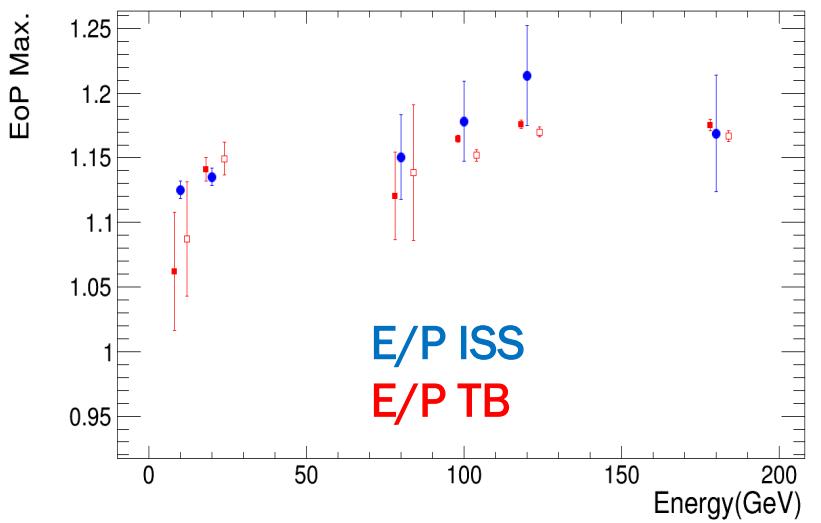


- Fit with Crystal Ball function
 - 4 parameters
- Find the mean of the CB
 - The maximum of E/P
- Compare the mean of the CB
 - TB and ISS

EXAMPLE AT 100 GEV



RESULTS OF THE CONTROL



- Good agreement (0,1 %)
- Dependence on the tracker (alignment, resolution)

CALIBRATION OF THE ECAL CONCLUSIONS

- ✖ Calibration by Test Beam
 - + Check on the data with E/P: very good agreement
 - ✖ The calibration is well maintained after the launch
- ✖ The other methods of calibration
 - + Different systematics and different energy ranges
 - ✖ Minimum ionizing nuclei
 - ✖ Rigidity (P/Z) of the cutoff (geomagnetic field)

ELECTRON FLUX

ELECTRON FLUX

- I. Number of electrons
- II. acceptance of selection
- III. Trigger efficiency
- IV. Exposure time

$$\Phi = \frac{N_{signal(e^-)}}{A_{geo} * \varepsilon_{sel.} * \varepsilon_{trig.e^-} * T_{expo}(R) * \Delta E}$$

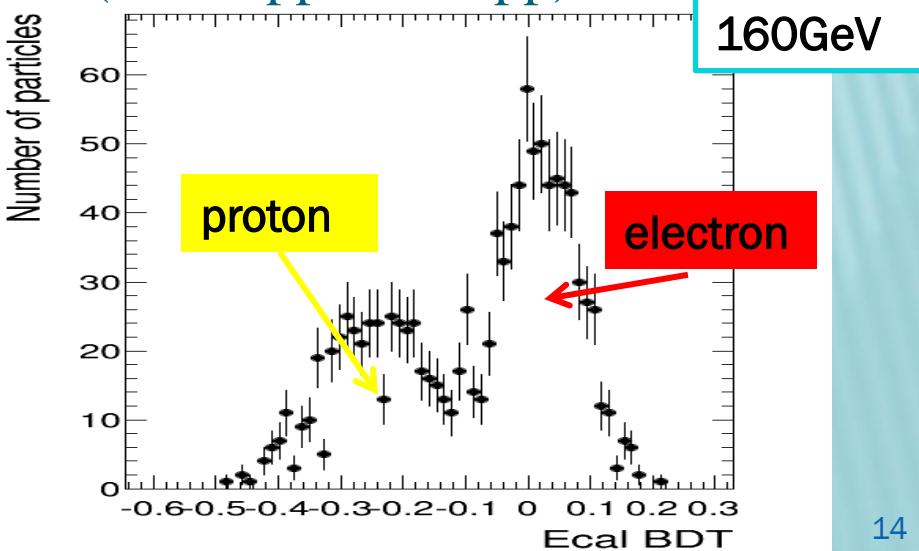
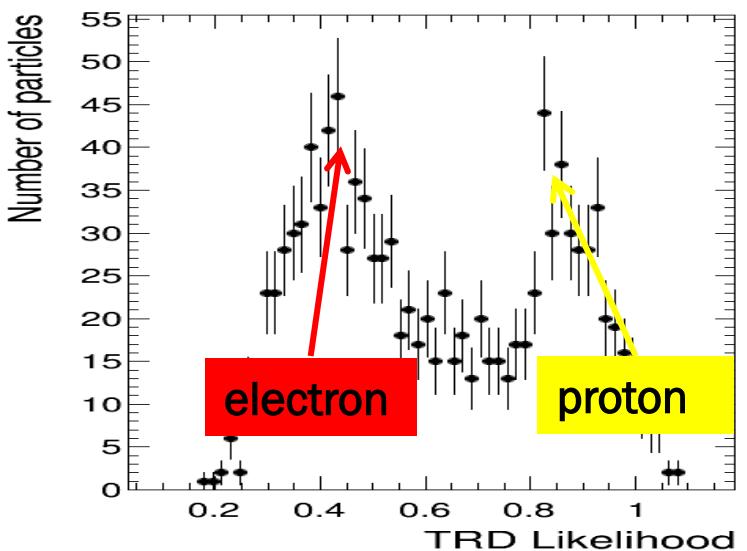
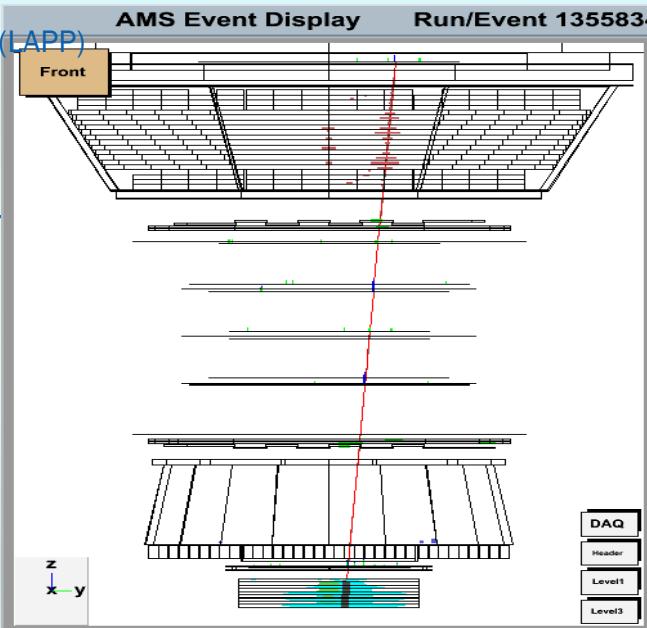
MC

63 energy bins from 1 to 500 GeV

The diagram illustrates the formula for electron flux. It shows the formula $\Phi = \frac{N_{signal(e^-)}}{A_{geo} * \varepsilon_{sel.} * \varepsilon_{trig.e^-} * T_{expo}(R) * \Delta E}$. A yellow bracket labeled "MC" groups the terms $A_{geo} * \varepsilon_{sel.} * \varepsilon_{trig.e^-} * T_{expo}(R)$. Another yellow arrow points to the term ΔE .

ELECTRON SELECTION

- ✖ Preselection
 - + Reconstruction quality
 - + β_{mes} and charge close to 1
 - + Negative rigidity
- ✖ $E/|P| > 0.6$
- ✖ Variables used to discriminate protons and electrons
 - + TRD Likelihood
 - + EcalStandaloneEstimator ‘ESEv3’ (developped at lapp)

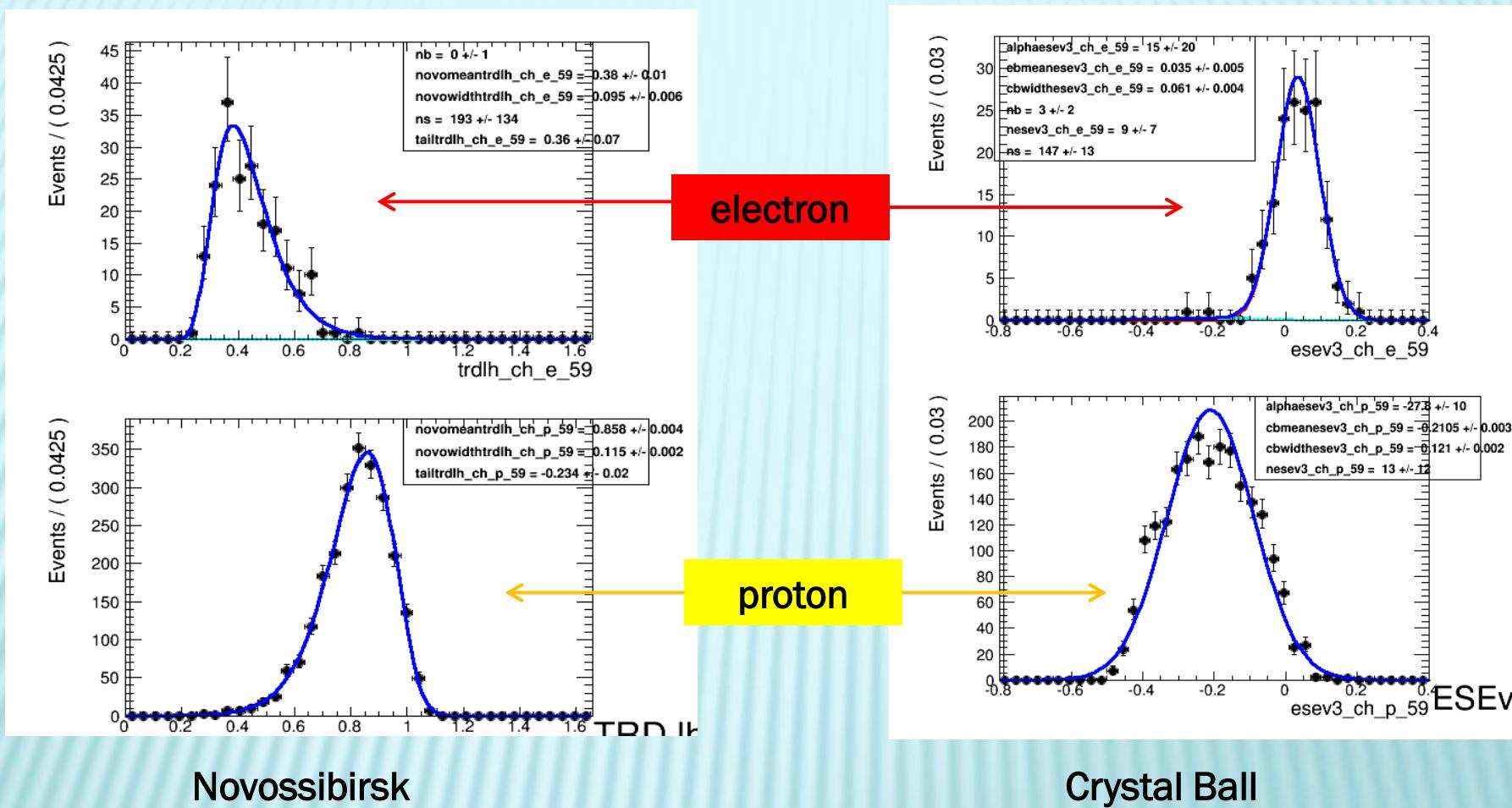


NUMBER OF ELECTRONS

- ✖ Fit on the data with the templates of signal and background (RooFit)
- ✖ To get the templates from data:
 - + Best track pattern in the Tracker: inner layers + layer 1 + layer 9
 - + Electrons:
 - ✖ Negative rigidity
 - ✖ $E/P > 0.6$
 - ❖ TRD LL $< 0.4 \rightarrow$ Template for ESE
 - ❖ $ESEv3 > 0.02 \rightarrow$ Template for TRD LL
 - + Protons:
 - ✖ Positive rigidity
 - ✖ $E/P < 0.4$
 - ❖ TRD LL $> 0.8 \rightarrow$ Template for ESE
 - ❖ $ESEv3 < -0.15 \rightarrow$ Template for TRD LL

TRD LIKELIHOOD

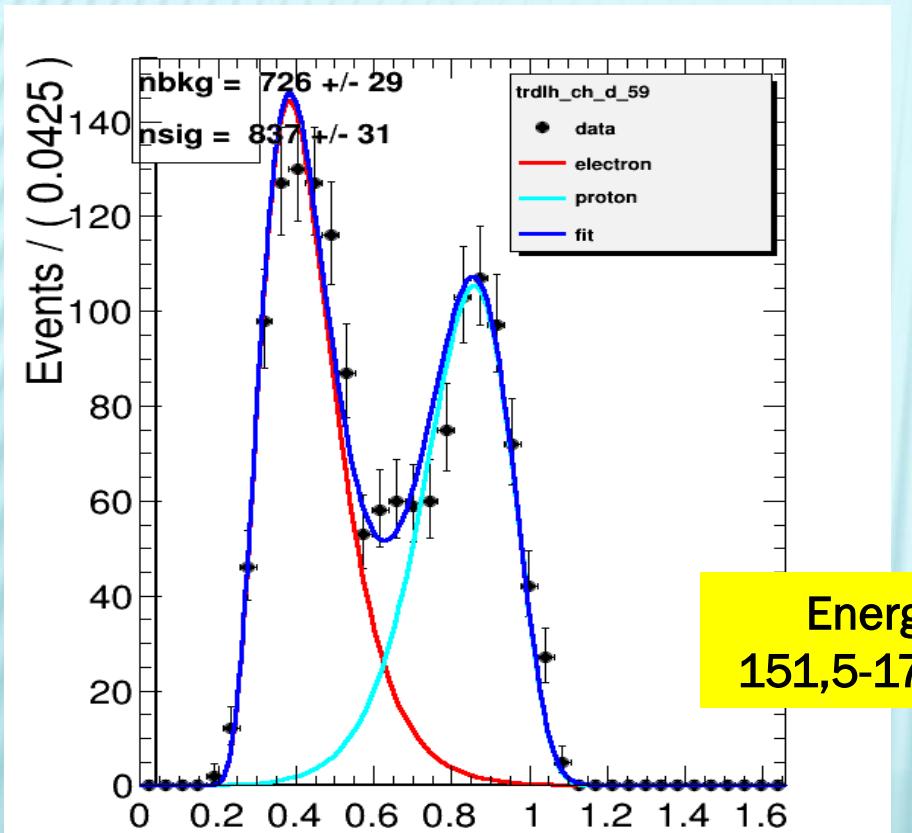
ECAL ESEV3



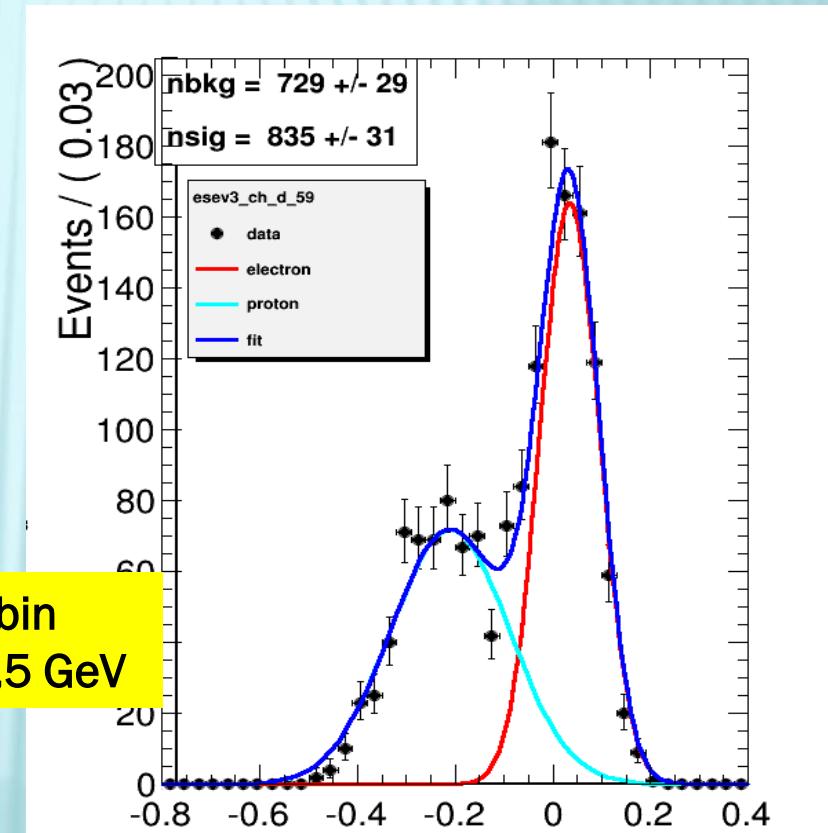
TEMPLATES AT 160 GEV

FIT RESULTS – EXAMPLE

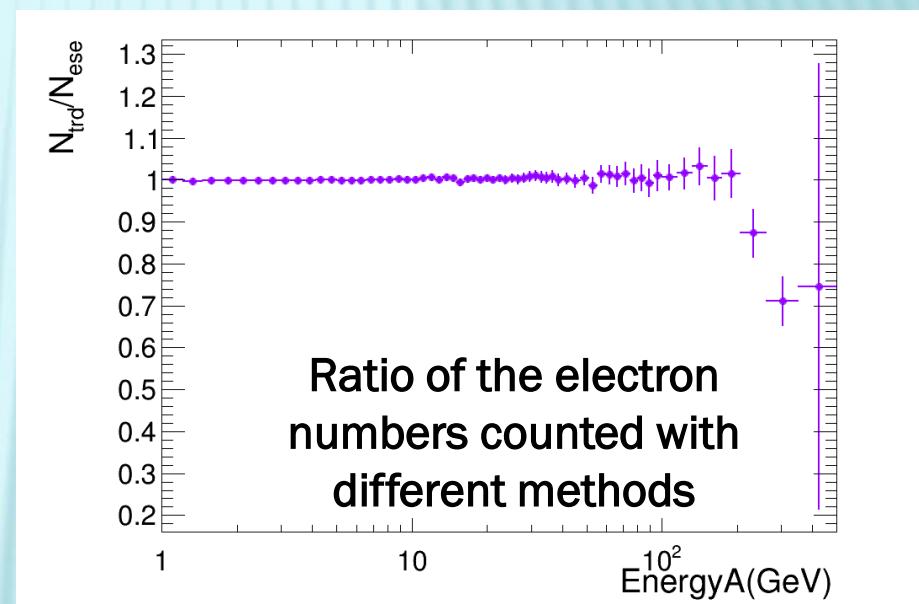
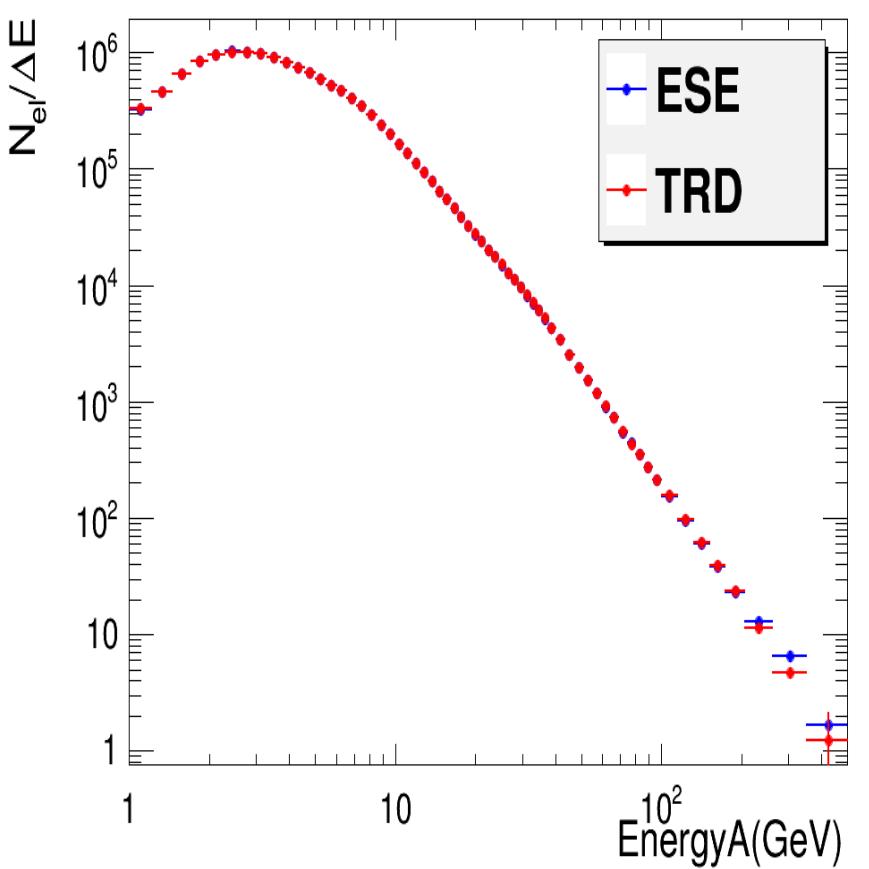
METHOD 1: TRD LIKELIHOOD



METHOD 2: ECAL ESEV3

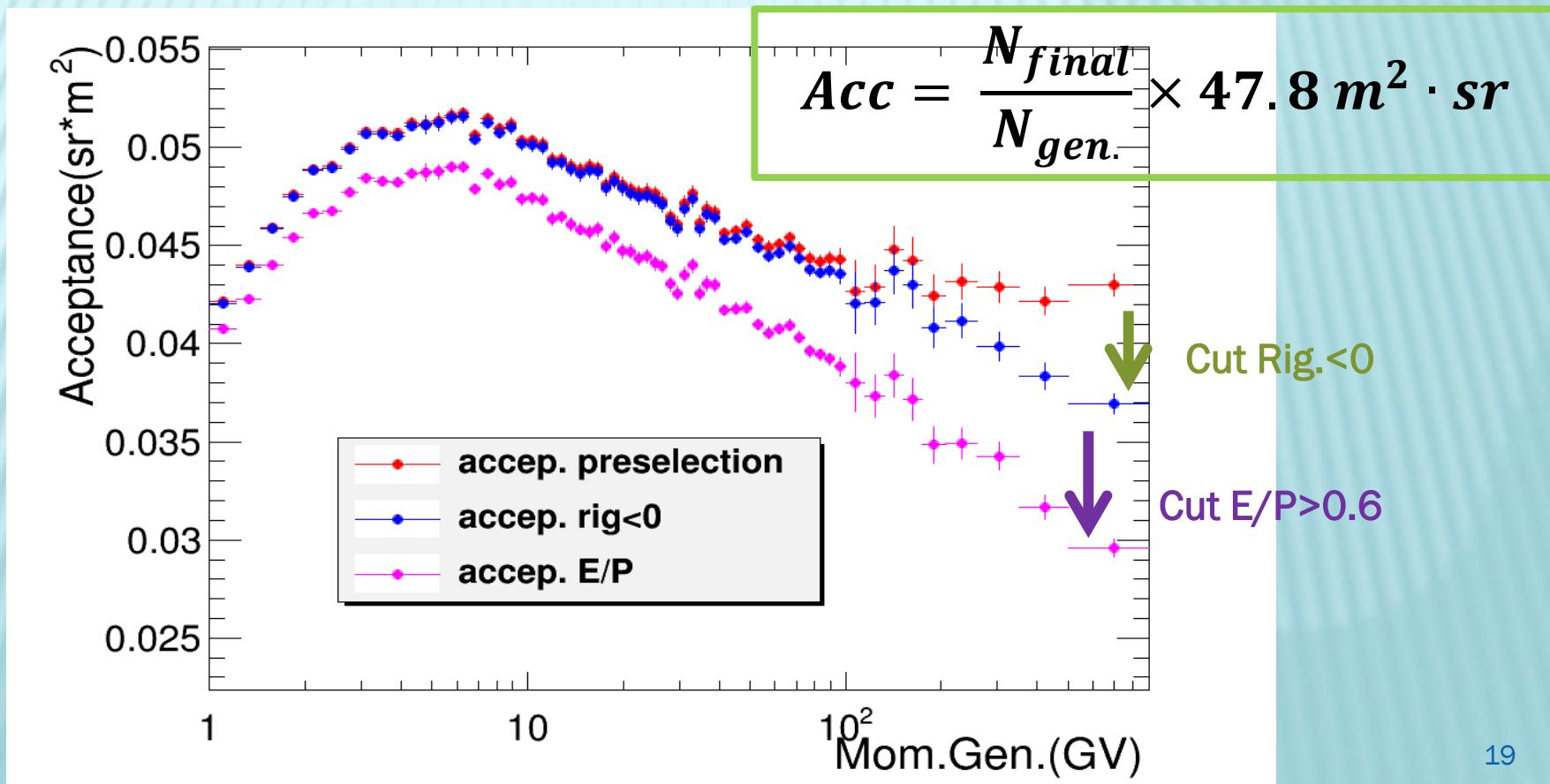


NUMBER OF ELECTRONS (17 MONTHS' DATA)

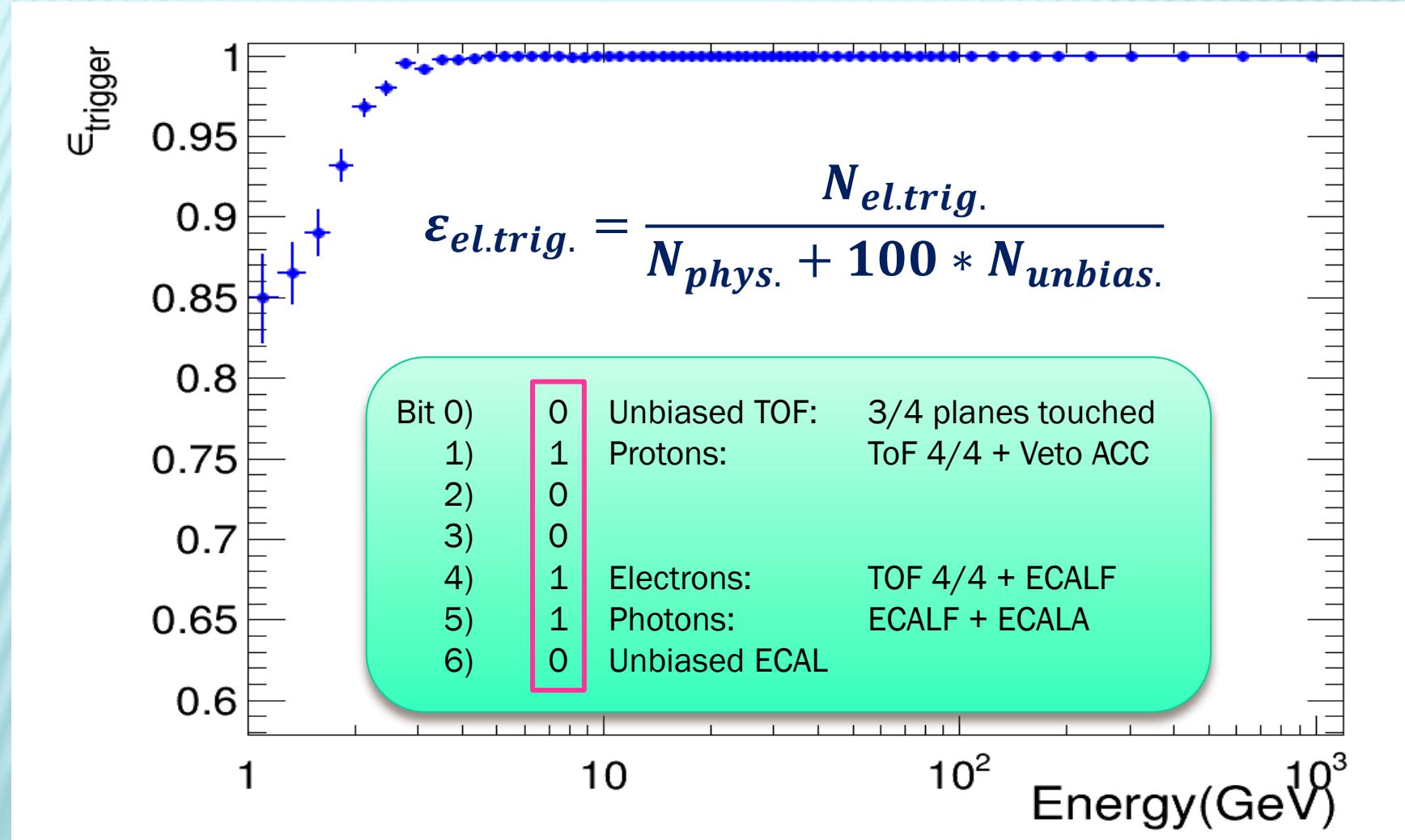


ACCEPTANCE (MC)

- The acceptance of the detector is calculated by using Monte Carlo. (MC)
- The MC data is generated isotropically on a squared plane 1.95 m above the detector center. The generation acceptance is $47.8 \text{ m}^2 \cdot \text{sr}$

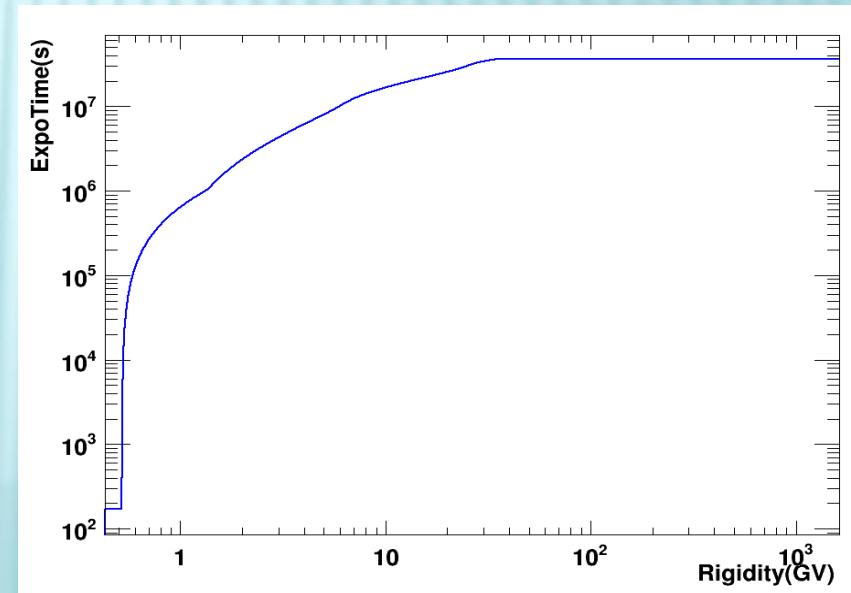
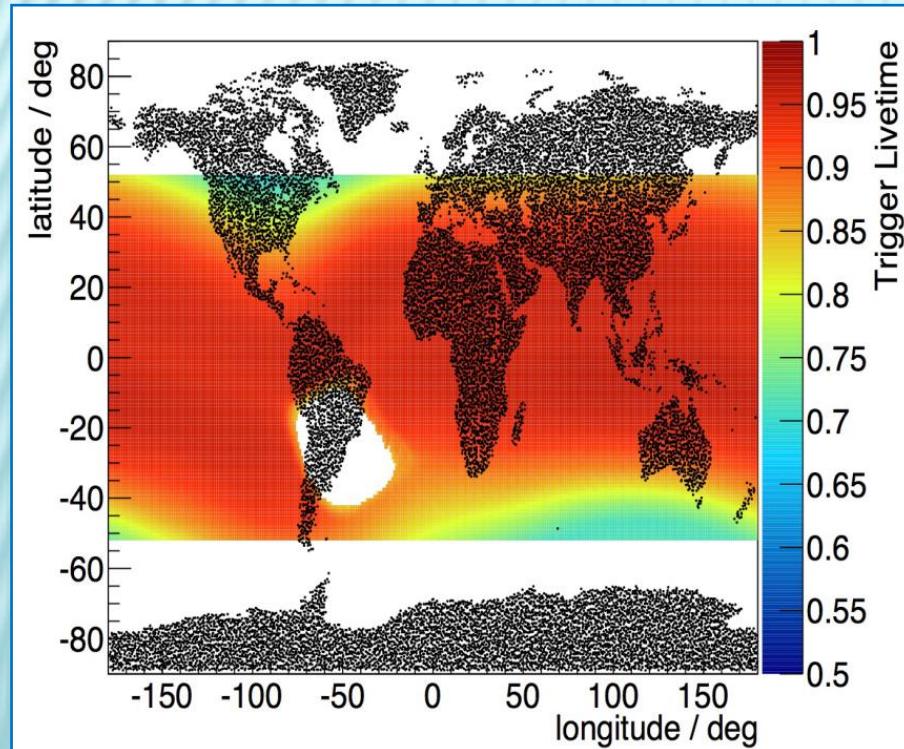


TRIGGER EFFICIENCY

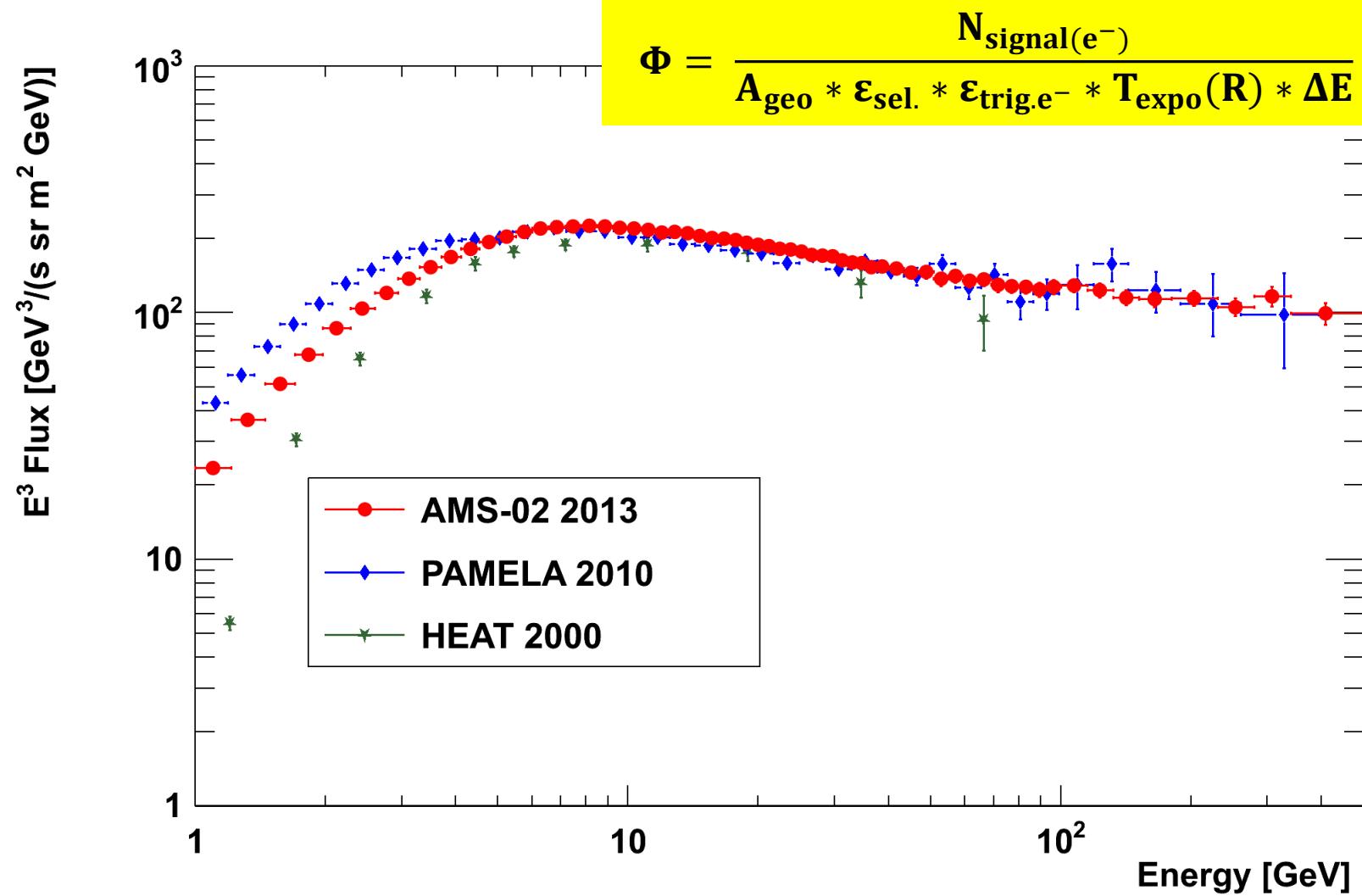


EXPOSURE TIME

- The exposure time for a certain rigidity R is the integral of all the seconds for which a particle with a rigidity R can be detected.



ELECTRON FLUX (ICRC)

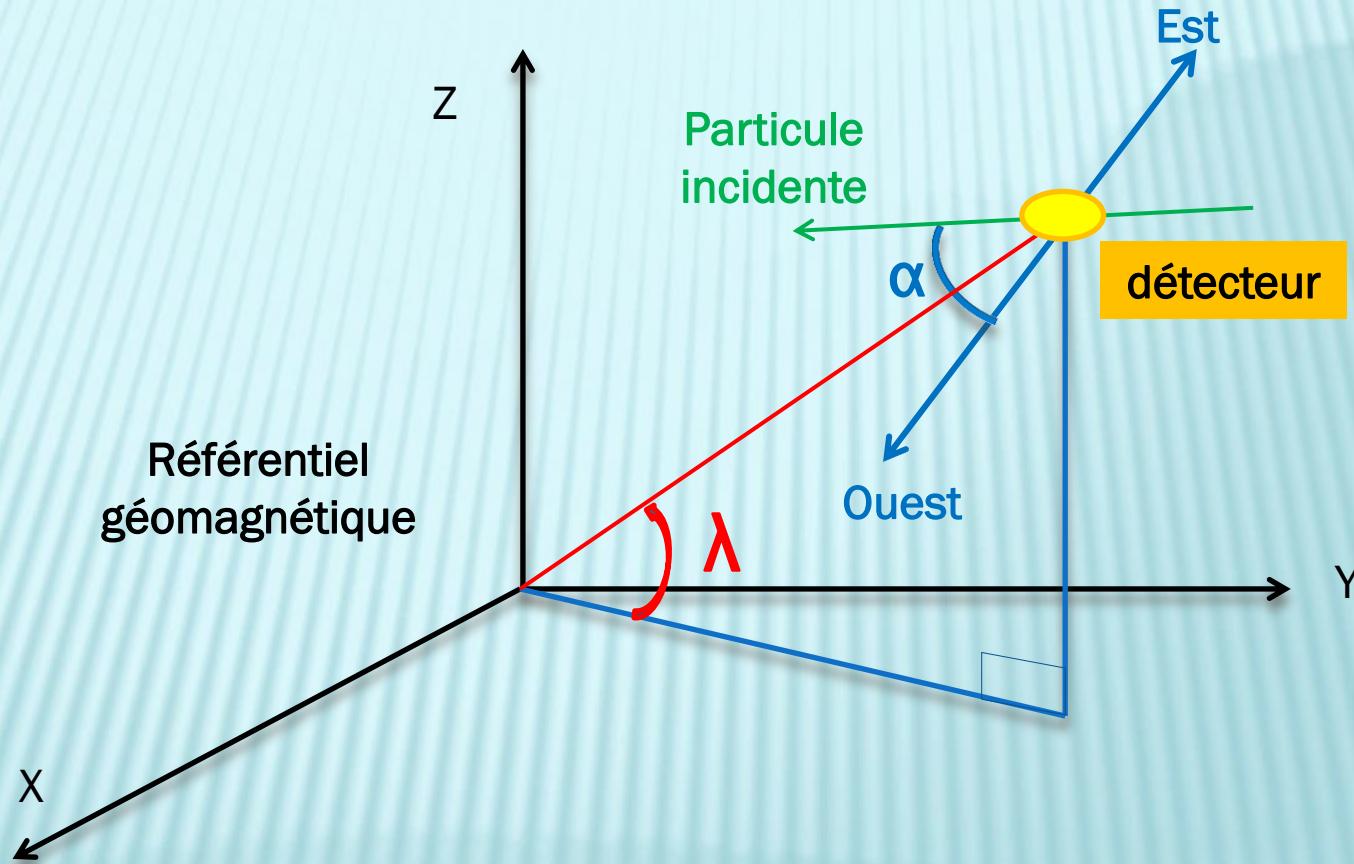


ELECTRON FLUX CONCLUSIONS

- ✖ The electron flux is measured independently with TRD likelihood and ECAL estimator.
 - + Acceptance from MC
 - + Trigger efficiency from data
- ✖ Ongoing studies:
 - + Optimisation of the energy bins
 - ✖ In 4 years, 70M events
 - ✖ ~160 electrons expected above 500 GeV
 - + Estimation of the systematic errors
- ✖ Flux of $e^- + e^+$ to compare with the other experiments, such as Fermi and HESS

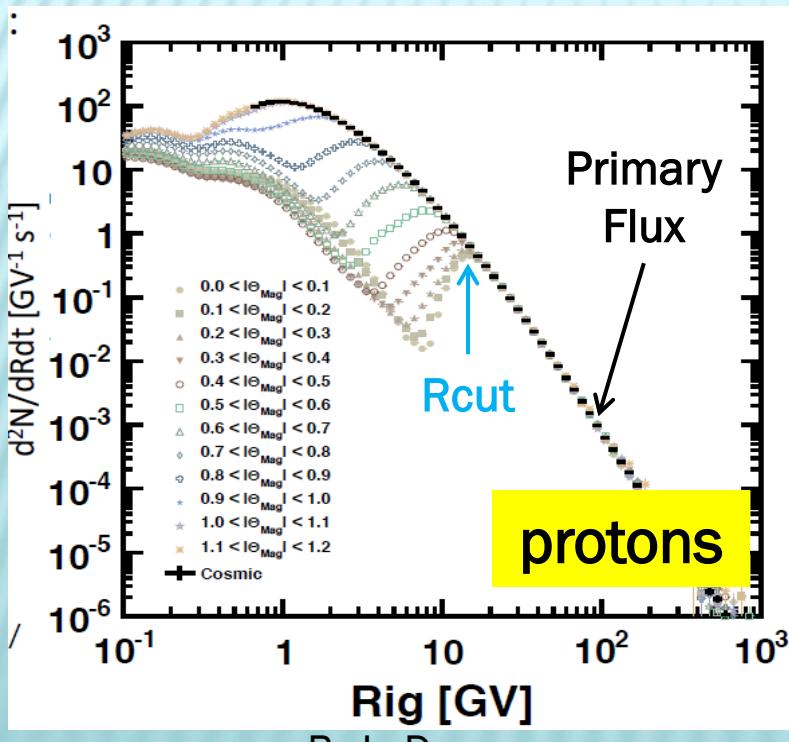
THANK YOU

ANGLE EST-OUEST

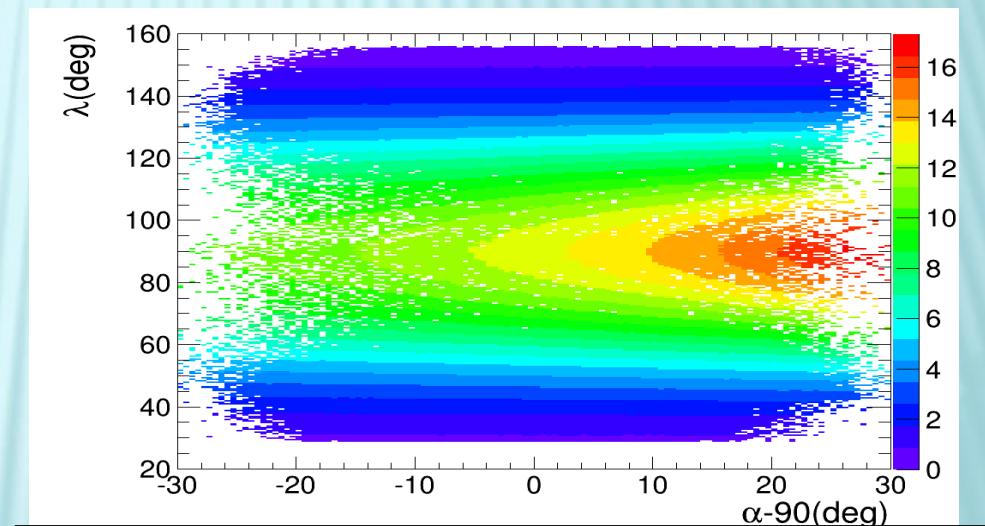


RIGIDITY OF CUTOFF

- ✖ Because of the geomagnetic field, the low energy electrons cannot reach the earth. The minimum rigidity required for a charged particle to enter the magnetosphere is called the rigidity of cutoff. (**Rcut**).
- ✖ Rcut depends on two parameters: the magnetic latitude and east-west angle.



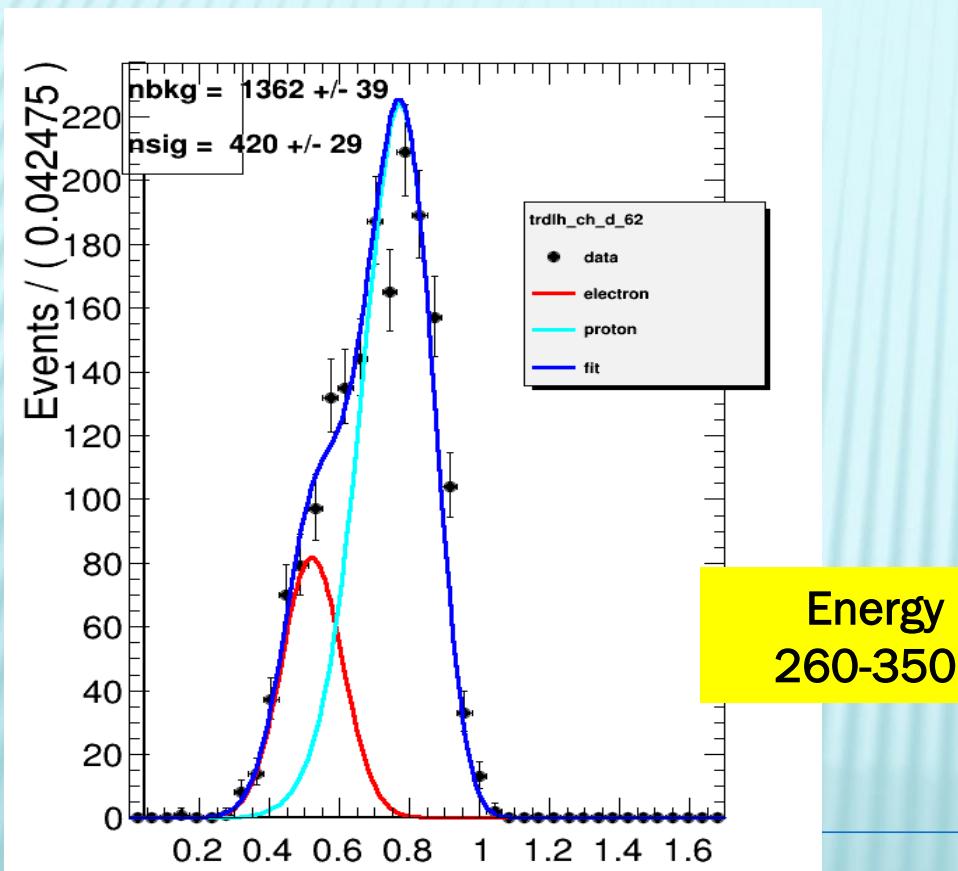
By L. Derome



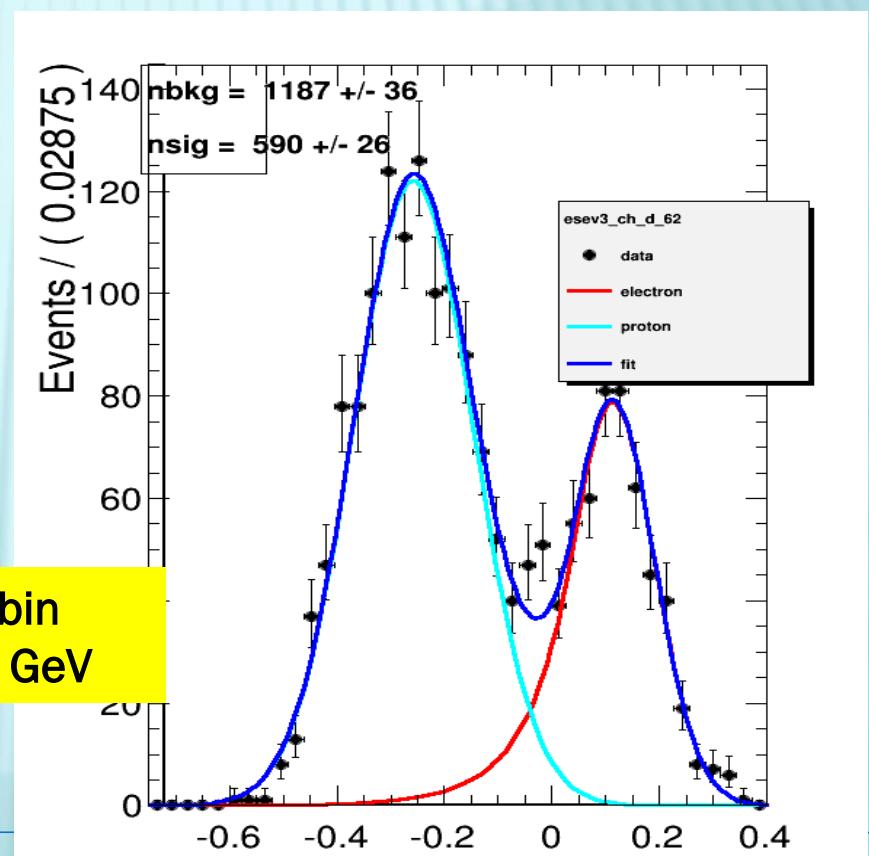
$$R_{cut} = P_E \left(\frac{R_E}{r} \right)^2 \frac{\cos^4 \lambda}{\left[1 + \left(1 - \frac{z}{|z|} \cos \alpha \cos^3 \lambda \right)^{1/2} \right]^2}$$

RESULTS OF THE FIT – EXAMPLE 2

METHOD 1: TRD LIKELIHOOD



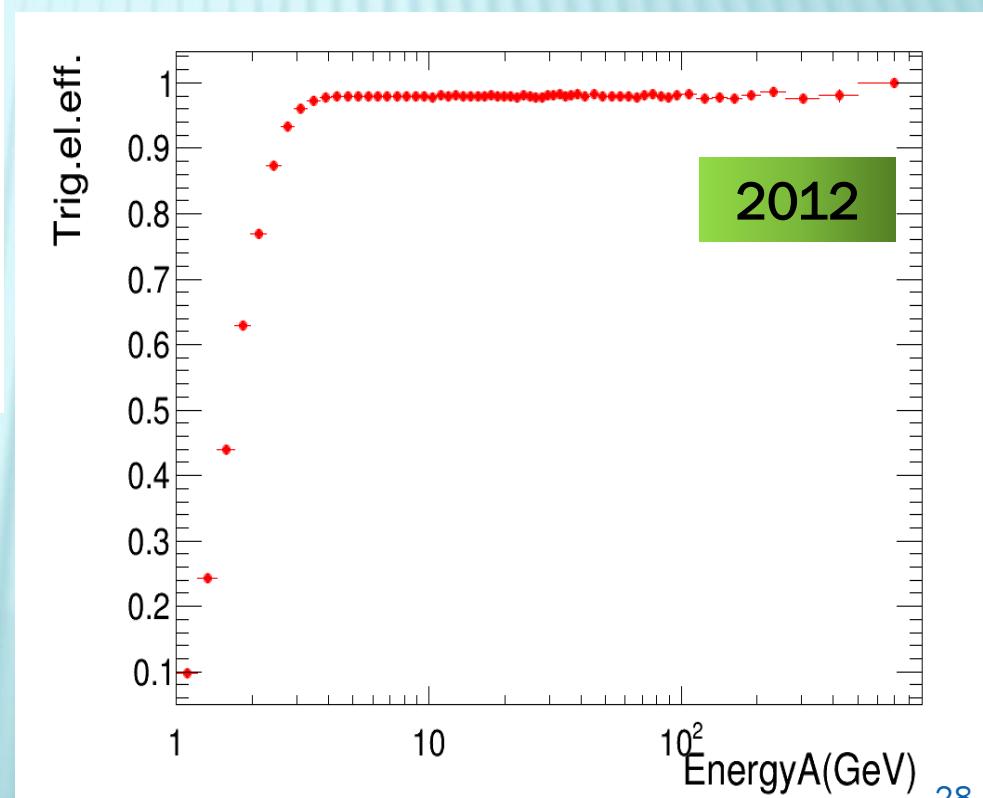
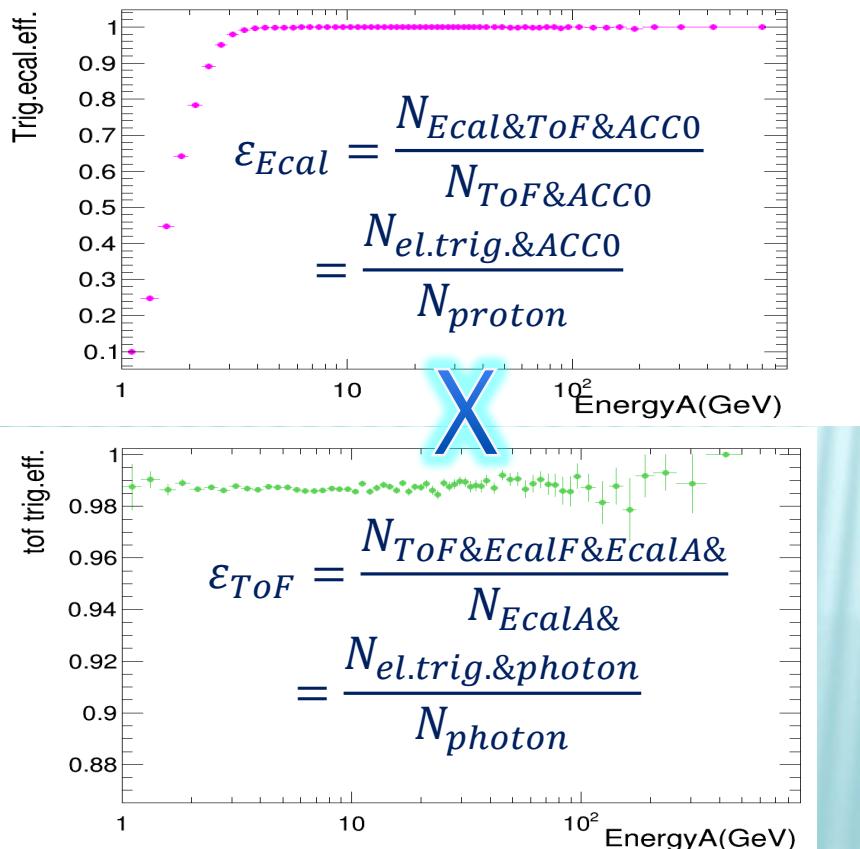
METHOD 2: ECAL ESEV3



ELECTRON TRIGGER EFFICIENCY

ELECTRON TRIGGER EFFICIENCY

- ❖ Méthode 2: estimation indépendante du ToF et l'ECAL
- Le déclenchement d'un électron dépend des deux sous-détecteurs: ToF et ECAL $\varepsilon_{el.trig.} = \varepsilon_{Ecal\&ToF} = \varepsilon_{Ecal} * \varepsilon_{ToF}$



EFFICIENCY OF TOF TRIGGER

