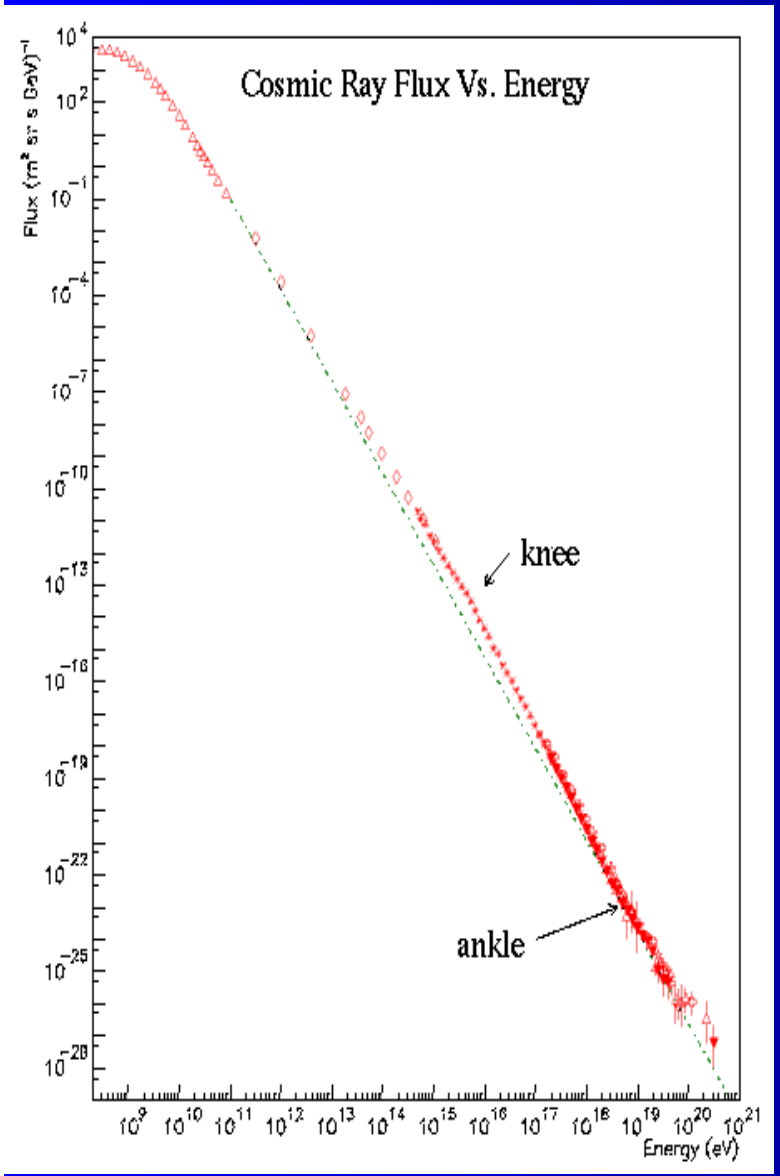
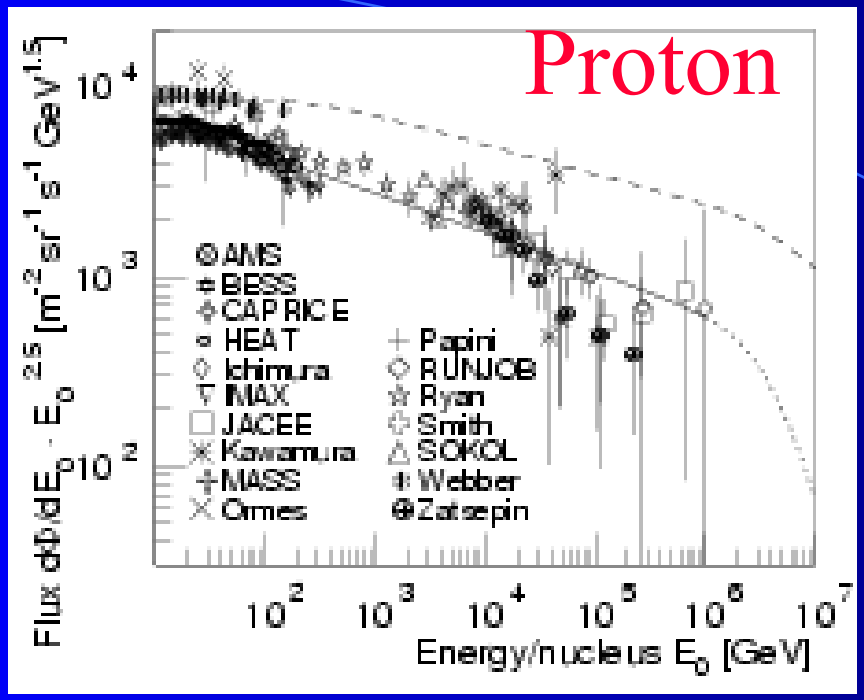
# Can we study the CR composition and spectra by Milagro?

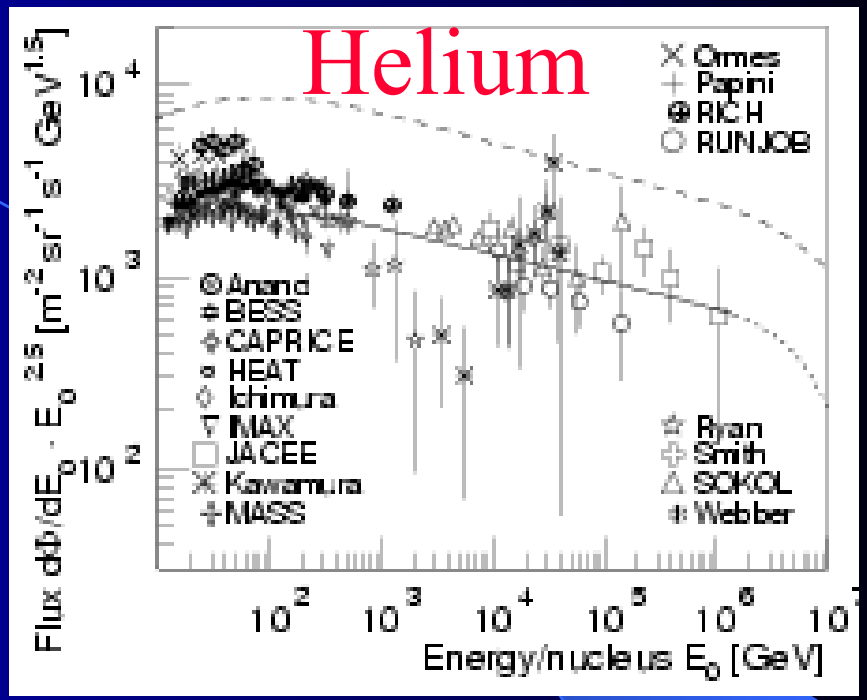
- Motivation
- Estimate the primary energy
- Recognize the compositions
- Problems must be solved

# Motivation




- A few hundred MeV to 300 EeV.
- "Knee" (~3000 TeV), -2.7 → -3.1
- "Ankle" (~5000 PeV), -3.1 → -2.7
- Up to "ankle": Galactic in origin (diffusive shock processes in SNRs).
- Above the "ankle": Extragalactic, GZK cut-off (interact with CMB).
- Mean mass: Light → Heavy → Light


Proton
AMS
BESS
CAPRICE
HEAT
Ichimura
IMAX
JACEE
Kawamura
MASS
Ormes
Papini
RUNJOB
Ryan
Smith
SOKOL
Webber
Zatsepin
Energy/nucleus E0 [GeV]


Helium
Ormes
Papini
RICH
RUNJOB
Anand
BESS
CAPRICE
HEAT
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IMAX
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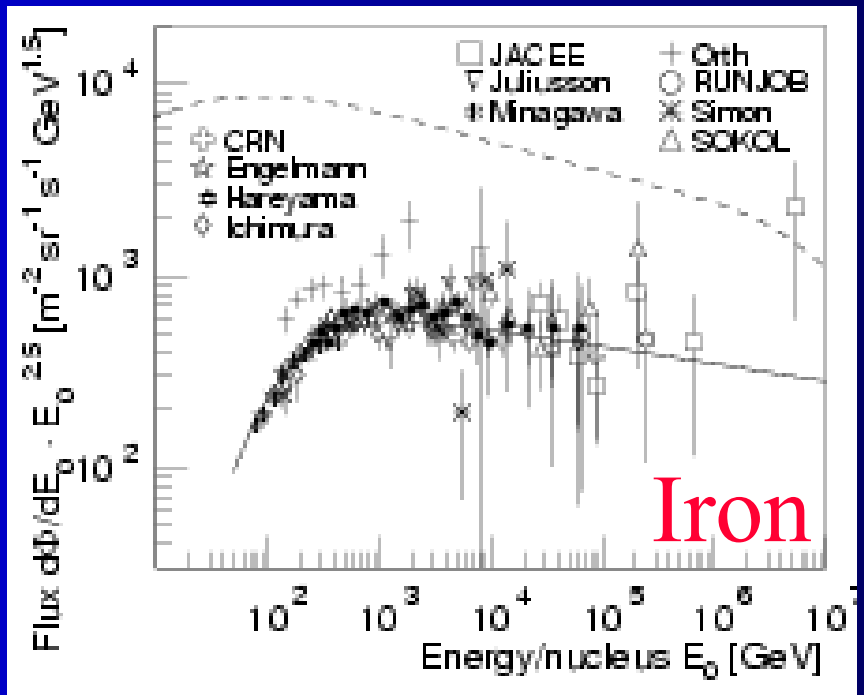

Iron
JACEE
Juliusson
Minagawa
Orth
RUNJOB
Simon
SOKOL
CRN
Engelmann
Hareyama
Ichimura
Energy/nucleus E0 [GeV]

# Milagro pond is a

- Large calorimeter:

  Bottom: 35m×60m

  Top: 50m ×80m
- Atmosphere depth: 750 g/cm^2, a little lower but not too bad for the study in “knee” energy region.
- AS layer: 1.50m → 4.2 r.l.
- Muon layer: 7.00m → 19.5 r.l.
- Muon multiplicity.
- Is it suitable to measure high energy AS core? AS core is usually sensitive to the compositions.

**Outrigger:** Help to determine the core position

# Estimate the primary energy:

- Ne → E0

  Fitting the lateral distribution by NKG function.

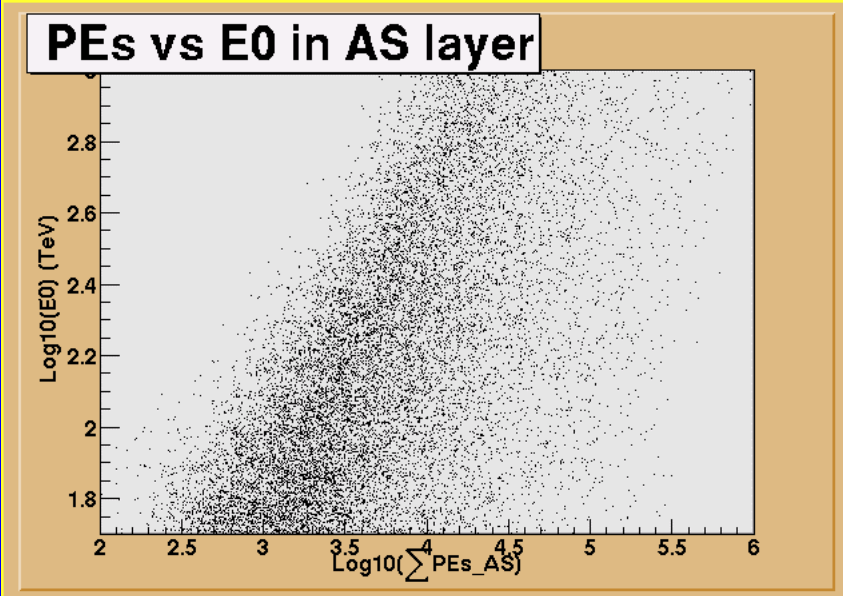
  How to determine the particle density by each fired tube of the pond?

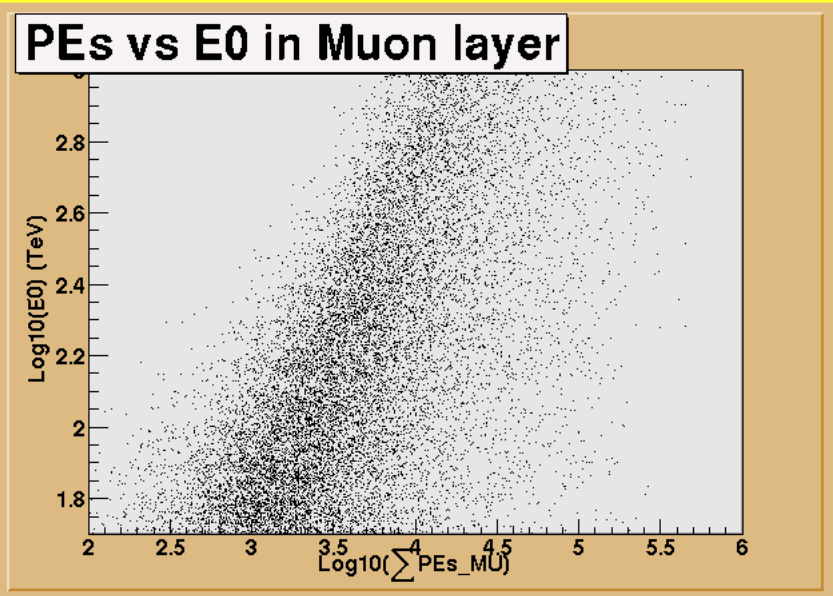
- ∑PEs → E0

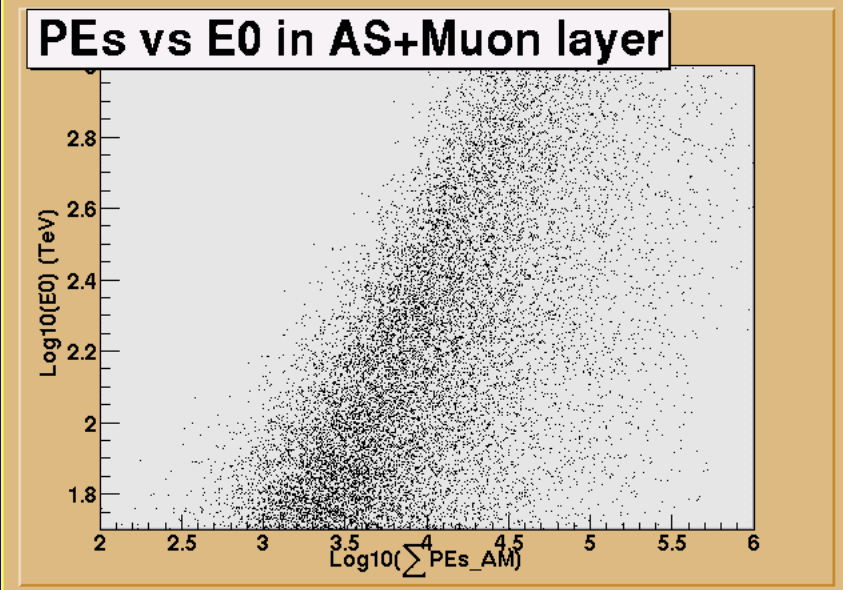
  AS core must be in the pond.

How about the energy resolution?

# The correlation between ∑PEs and E0



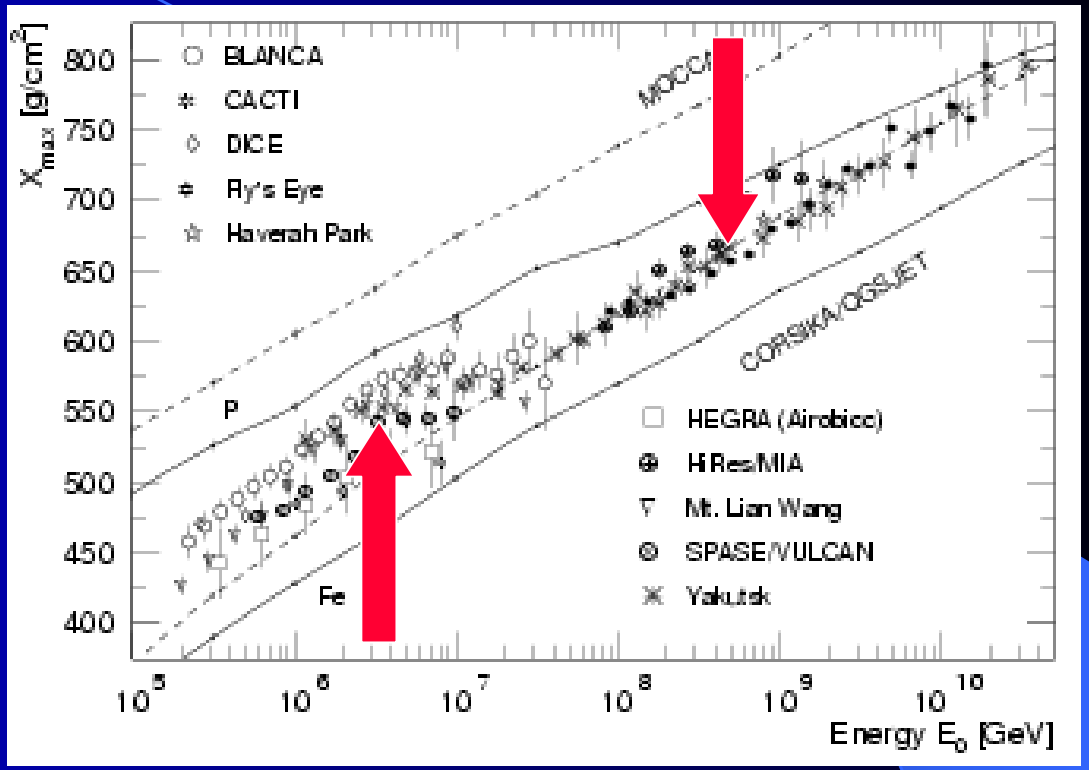



# Recognize the compositions:

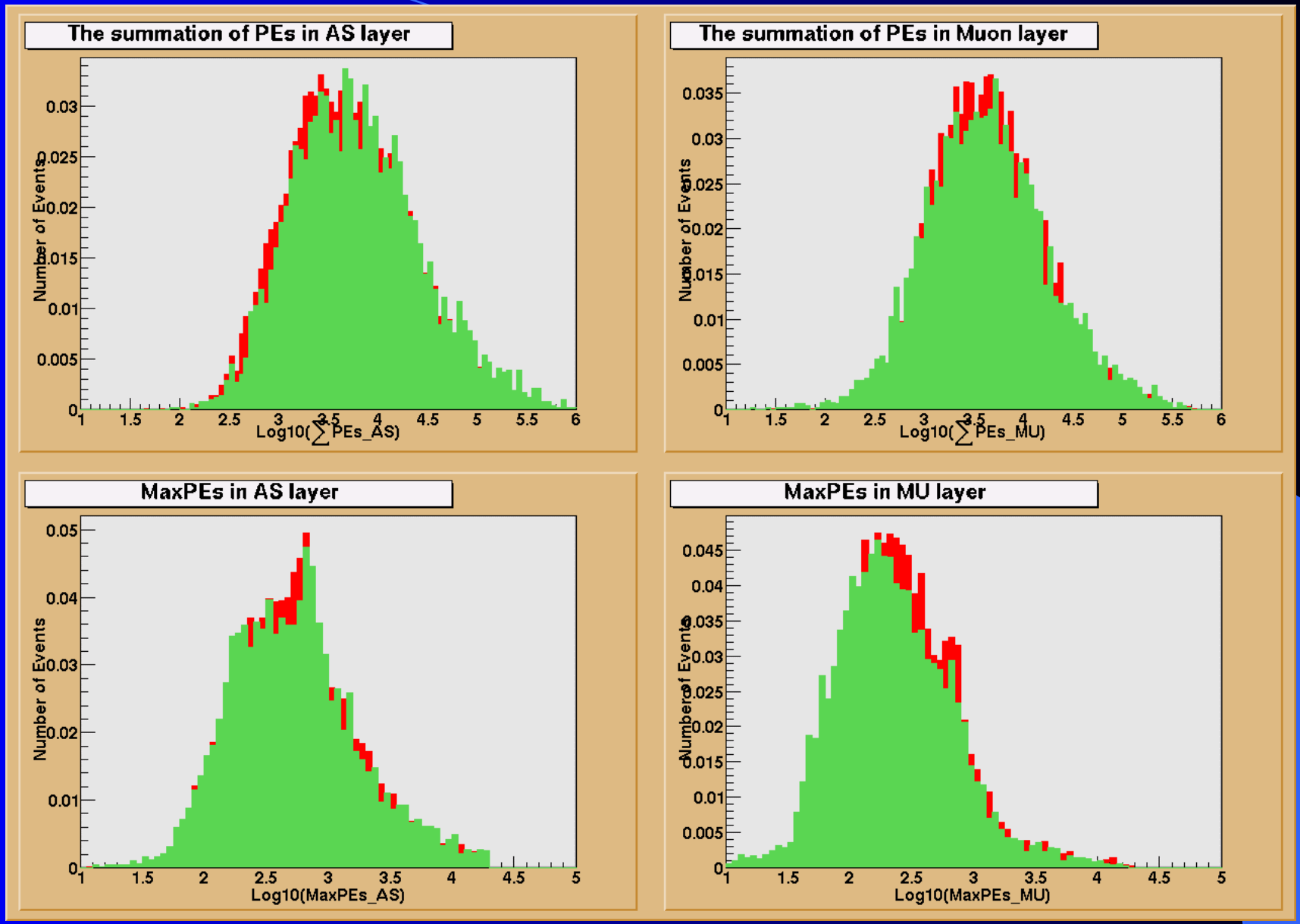
- <Xmax>

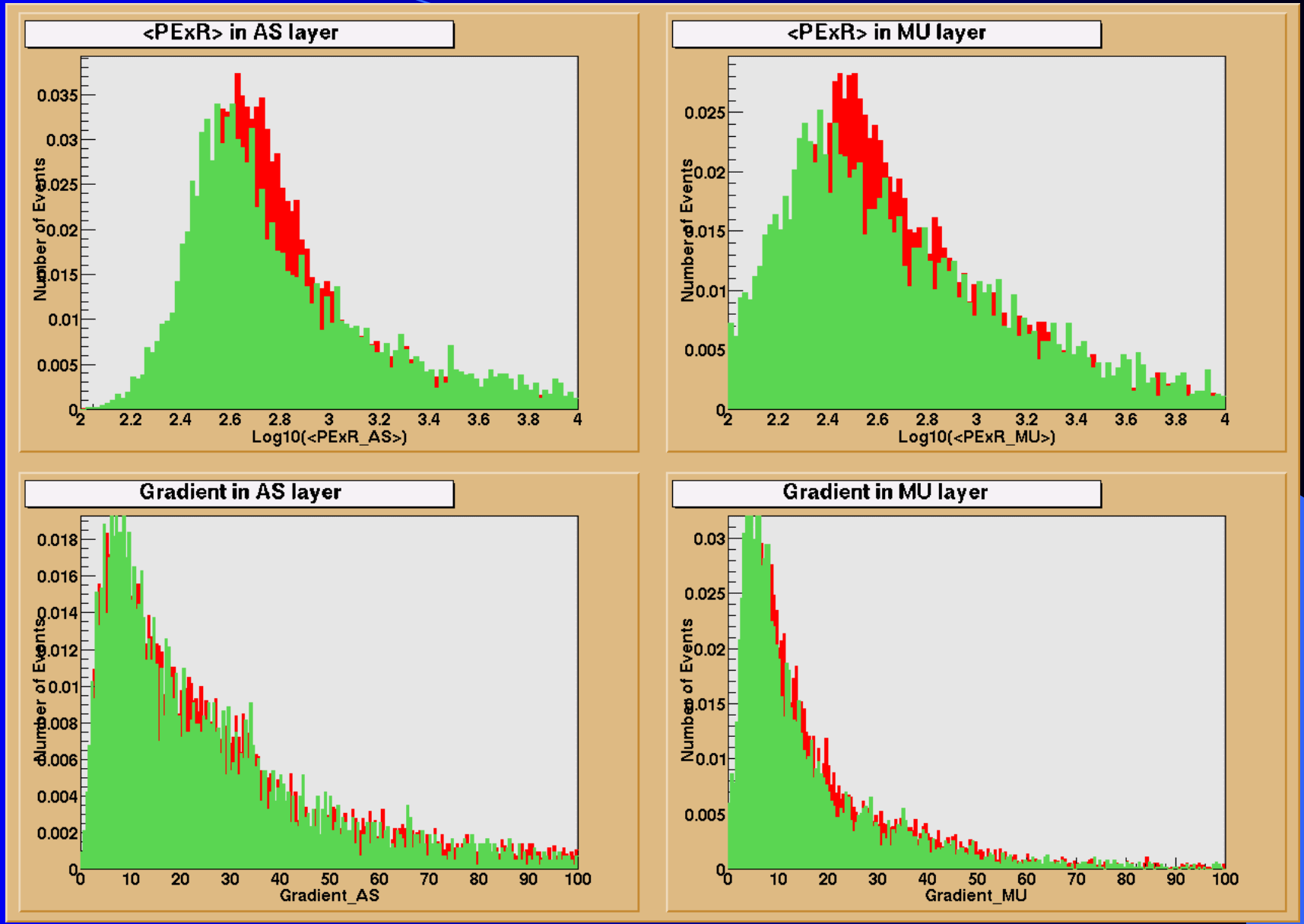
  WACT

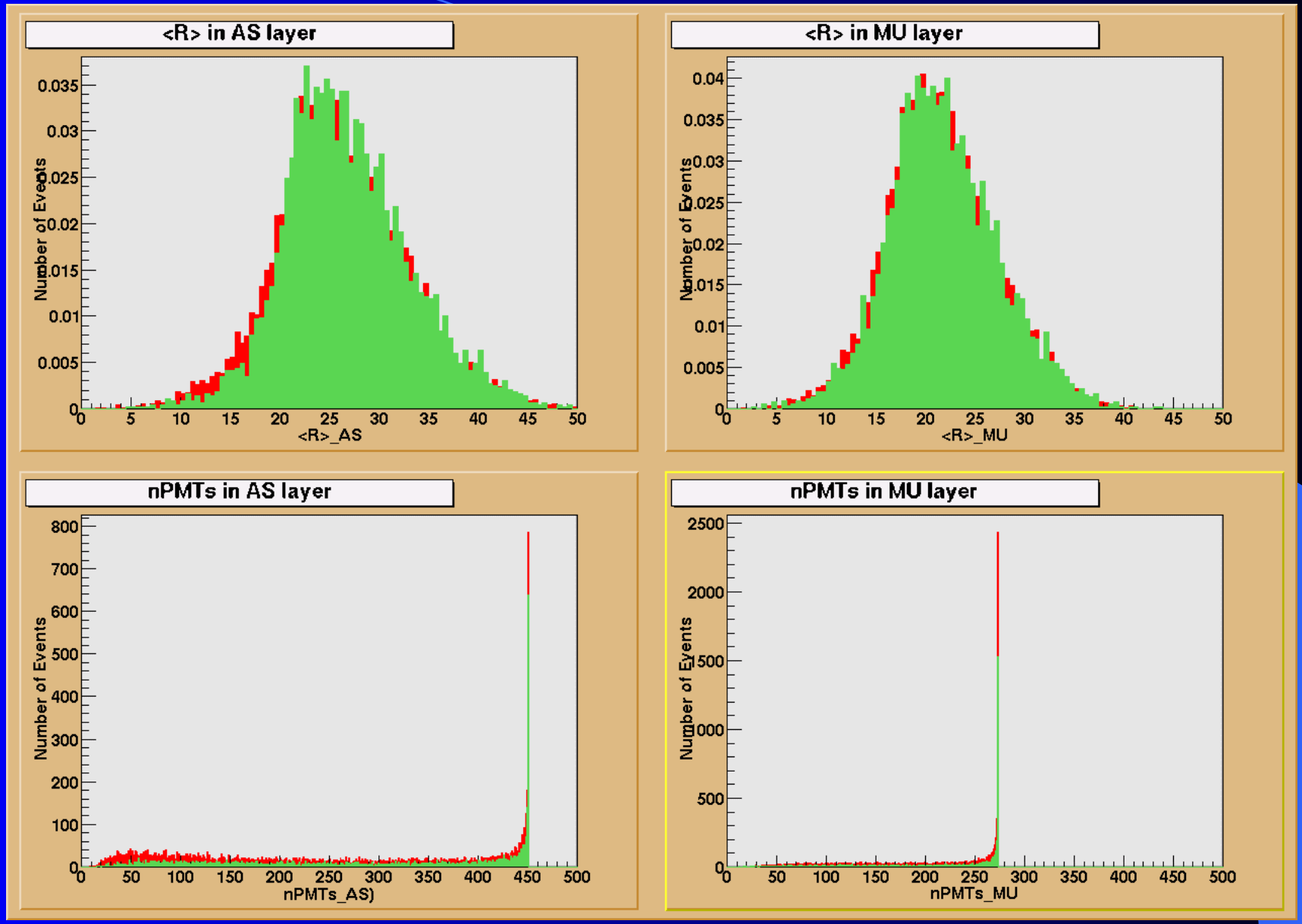



- Shower lateral distribution

  Milagro pond + Outrigger


The summation of PEs in AS layer
Number of Events
Log10(∑PEs_AS)
The summation of PEs in Muon layer
Number of Events
Log10(∑PEs_MU)
MaxPEs in AS layer
Number of Events
Log10(MaxPEs_AS)
MaxPEs in MU layer
Number of Events
Log10(MaxPEs_MU)


<PExR> in AS layer
Number of Events
Log10(<PExR_AS>)
<PExR> in MU layer
Number of Events
Log10(<PExR_MU>)
Gradient in AS layer
Number of Events
Gradient_AS
Gradient in MU layer
Number of Events
Gradient_MU


<R> in AS layer
Number of Events
<R>_AS
<R> in MU layer
Number of Events
<R>_MU
nPMTs in AS layer
Number of Events
nPMTs_AS)
nPMTs in MU layer
Number of Events
nPMTs_MU

# Problems must be solved:

1. Can Milagro measure HE AS core? What is the sensitive energy region? what is local shower size? Will tube be saturated? Can multi-muons be recognized from single muon?
2. Extensive simulations of EAS and detector response. It will take very long time and use much CPUs. Can we tolerate it?
3. Particle density calibration. How to do it in the pond?
4. Improve the core position resolution by Outrigger.
5. Others ????