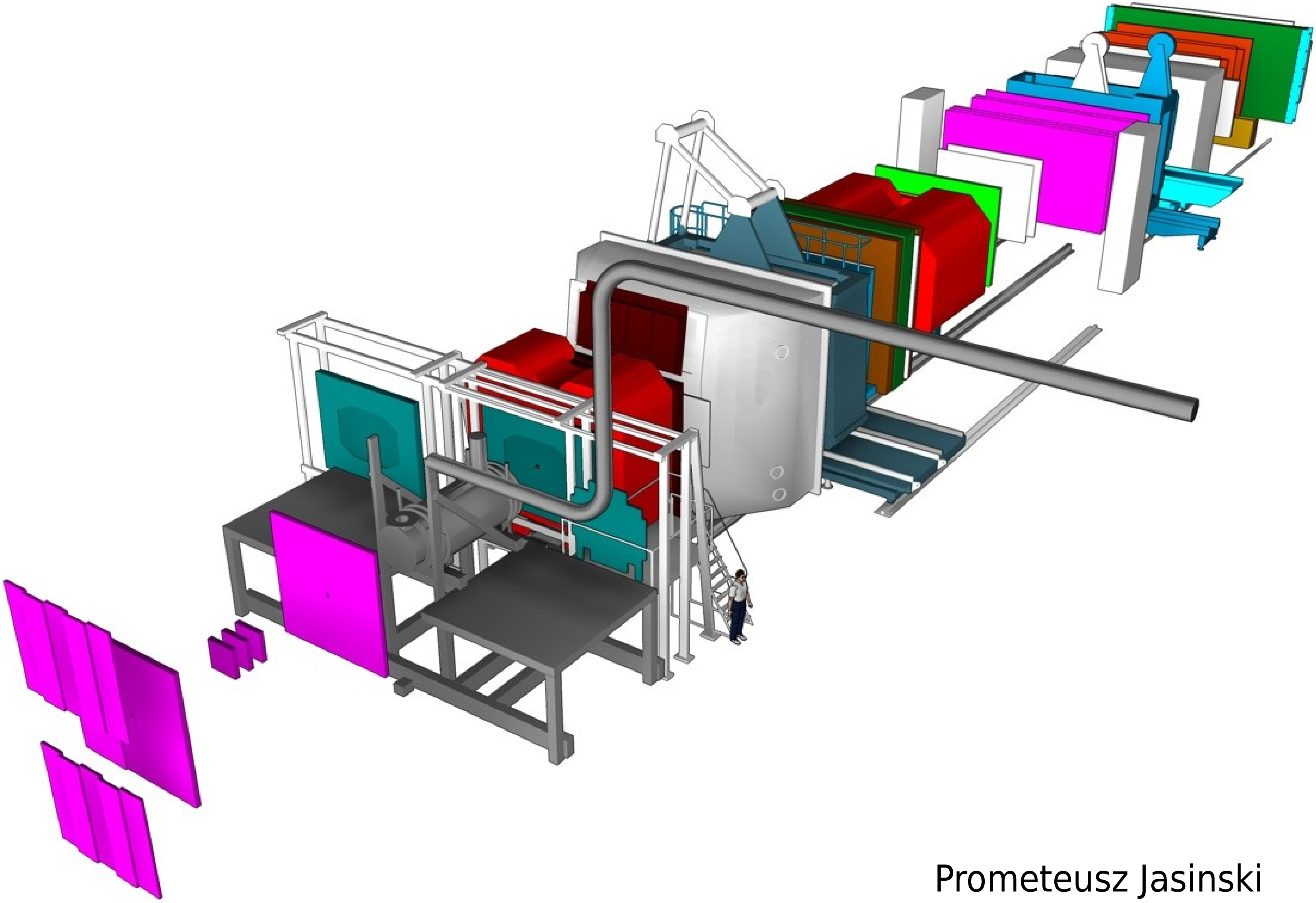
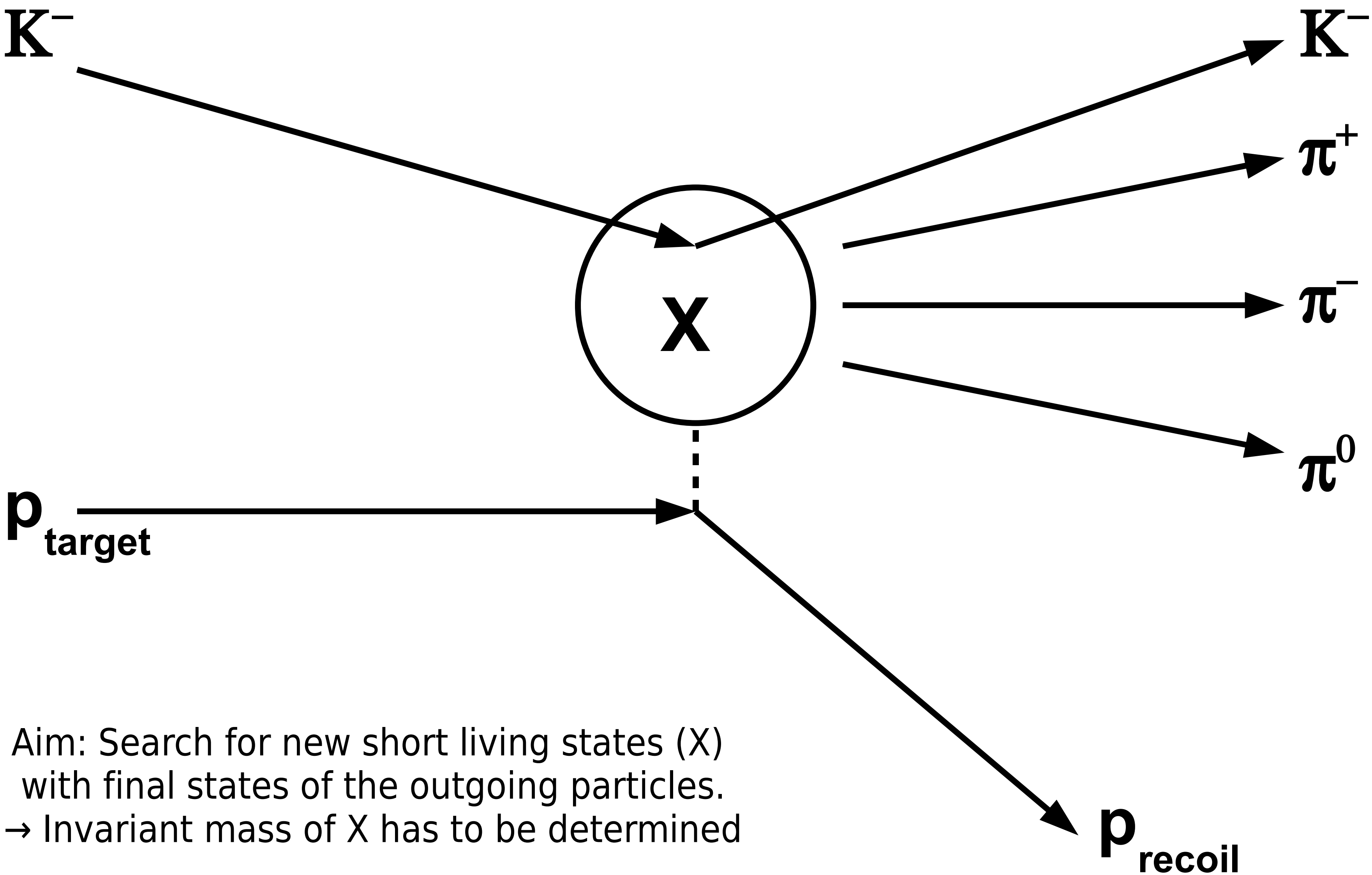
Data reconstruction at Compass for endusers



Prometeusz Jasinski
Compass Seminar 08.05.09

Example for measurement: diffractive dissociation on protons



Aim: Search for new short living states (X)
with final states of the outgoing particles.
→ Invariant mass of X has to be determined

What do we need to measure?

Invariant masses

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Invariant masses

Particles and their kinematical properties in collisions

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Particles and their kinematical properties in collisions

Dynamics best described with Lorentzvectors $(E/p, p)^T$

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momentum – energy – mass - charge

What do we need to measure?

Invariant masses

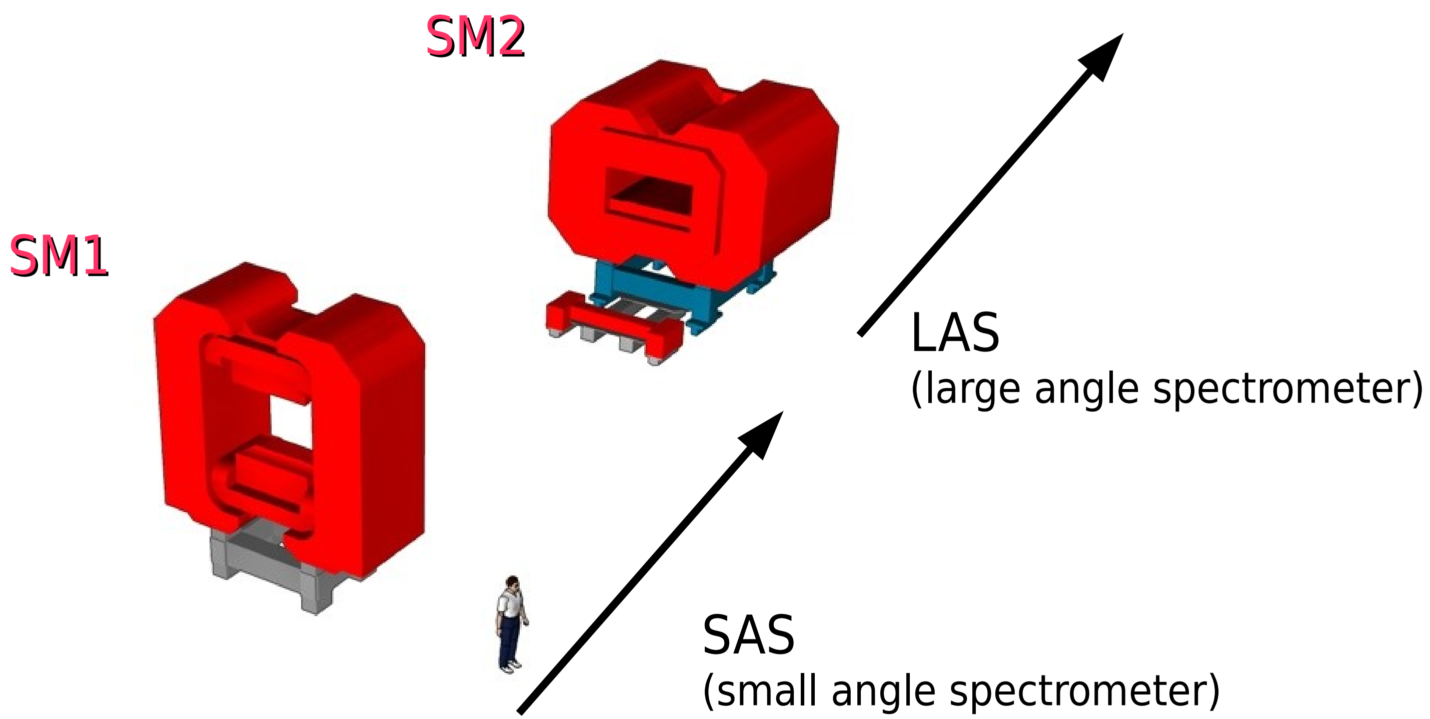
Particles and their kinematical properties in collisions

Dynamics best described with Lorentzvectors $(E/p, p)^T$

momentum – energy – mass - charge

Determined by:
particle position – particle time – particle speed

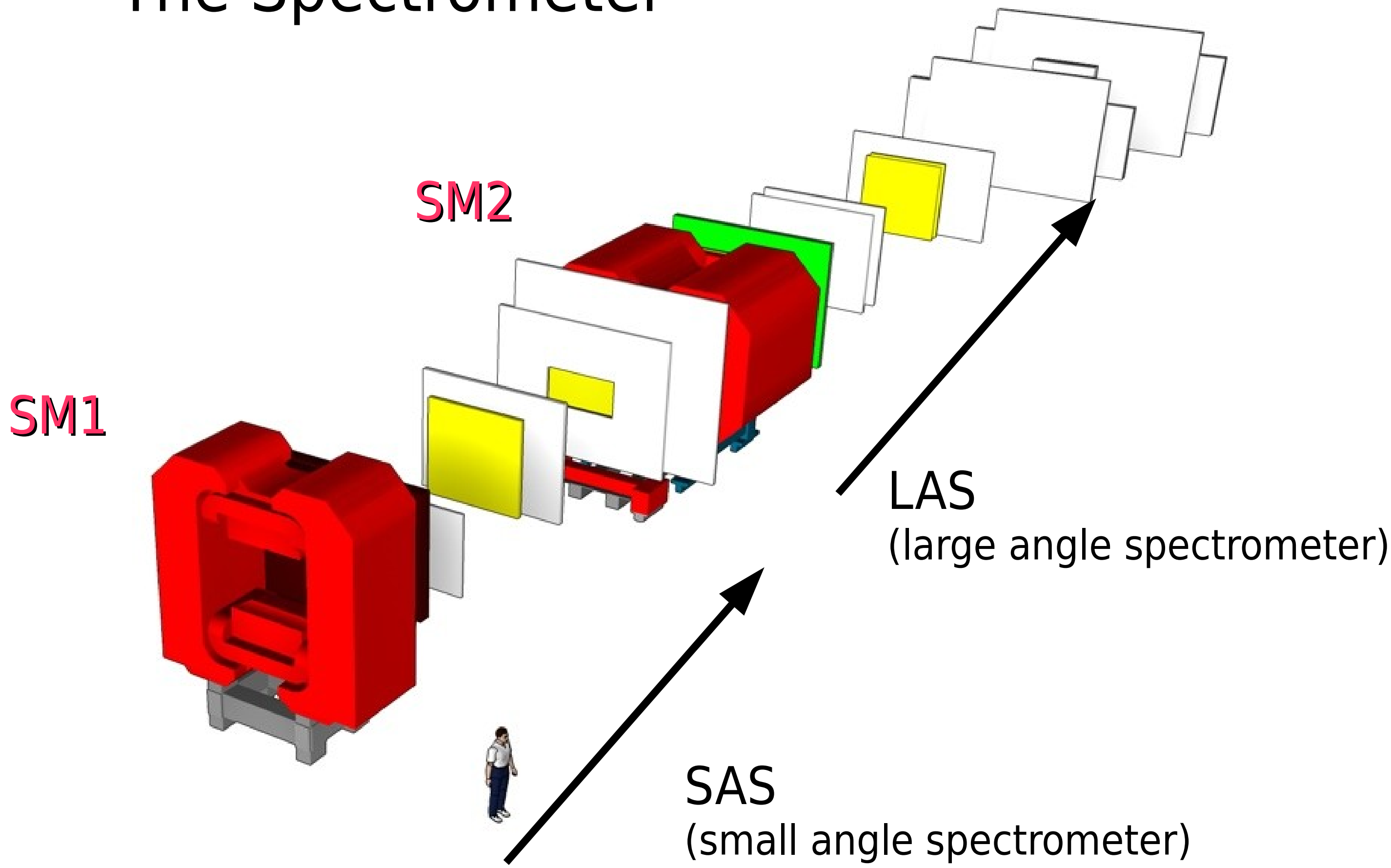
Measure the momentum of outgoing charged particles: The Spectrometer



SM1 bending power = 1 Tm
SM2 bending power = 4 Tm

http://lxfsrb6103.cern.ch/compass/publications/2004_yellow/COMPASS_yellow_report_2004-011.pdf

Measure the momentum of outgoing charged particles: The Spectrometer

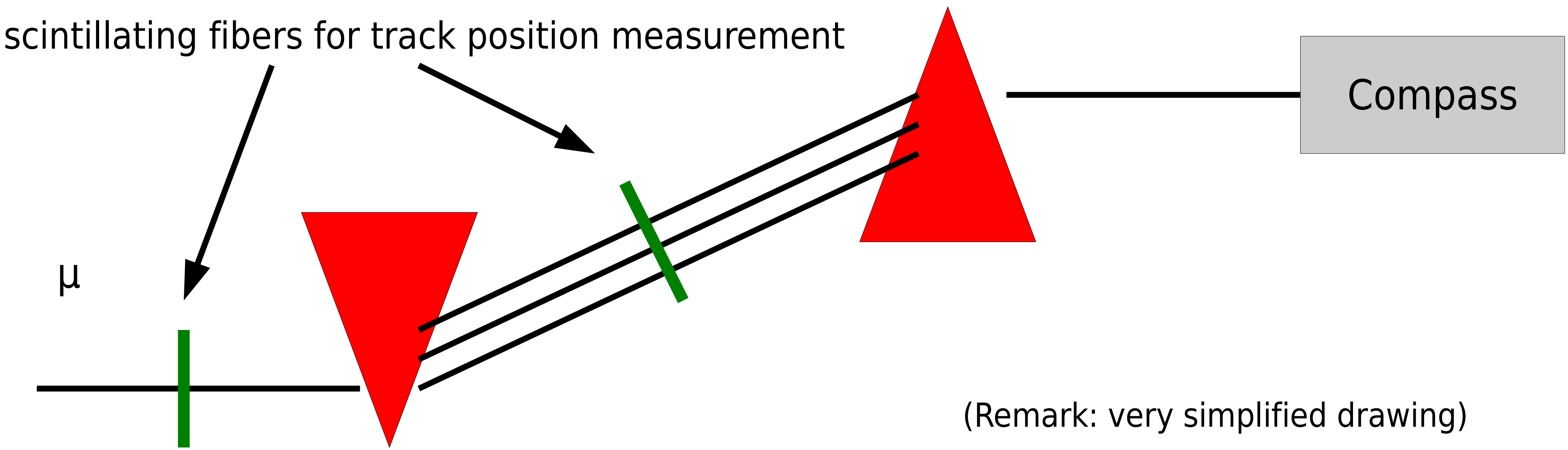


Trackers:
- VSAT (very small area trackers)
- SAT (small area trackers)
- LAT (large area trackers)

http://lxfsrb6103.cern.ch/compass/publications/2004_yellow/COMPASS_yellow_report_2004-011.pdf

Measure the momentum of incoming charged particles: The Beam Momentum Station

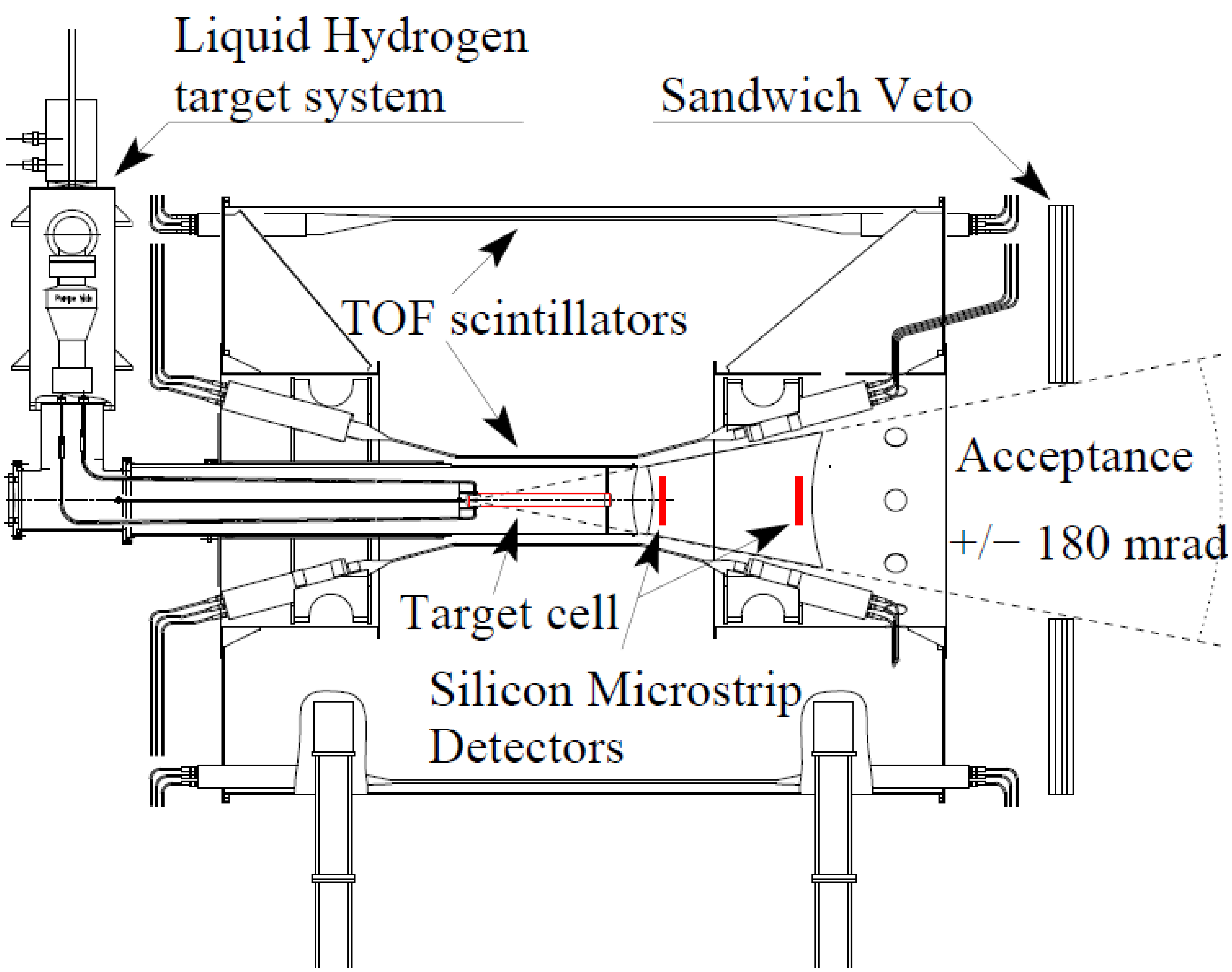
μ beam: BMS (beam momentum station) at the bending magnet station



(Remark: very simplified drawing)

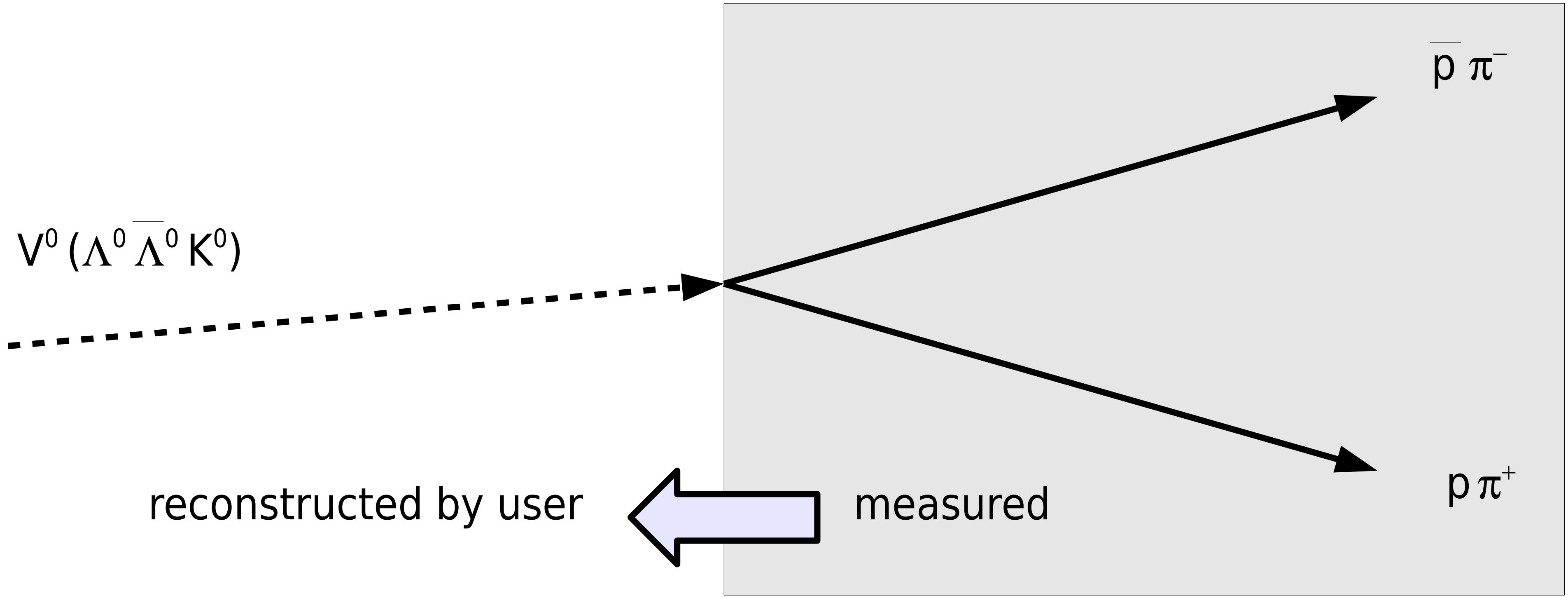
hadron beam: no measurement! Exclusivity is just an approximation.

Measure the momentum of the recoiling particles: The Recoil Particle Detector

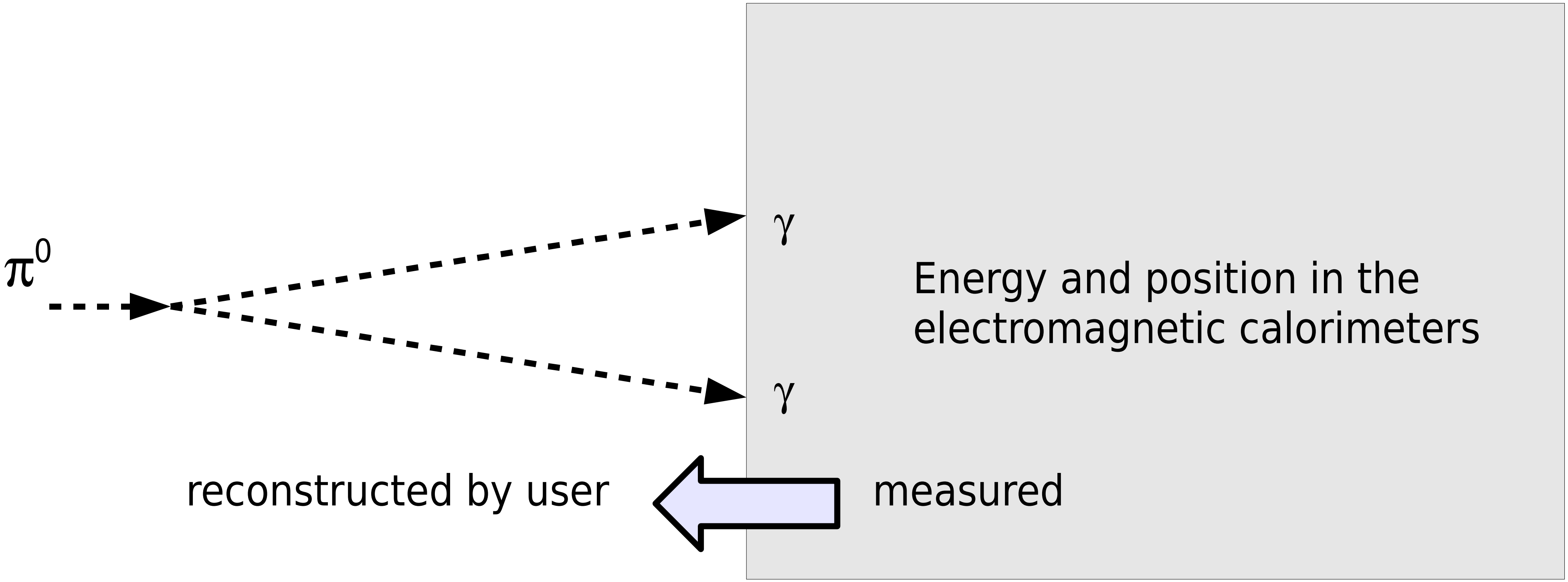


http://wwwcompass.cern.ch/compass/publications/theses/2007_dpl_bernhard.pdf

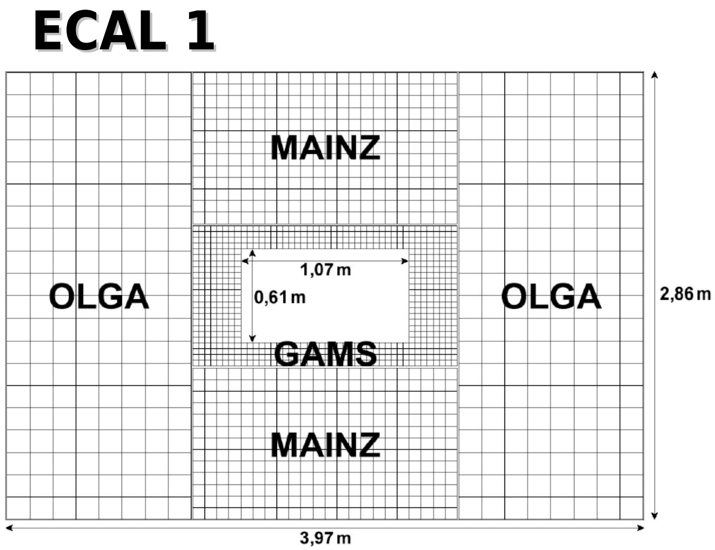
Measure the momentum of neutral particles: Case they decay into charged particles (V^0)

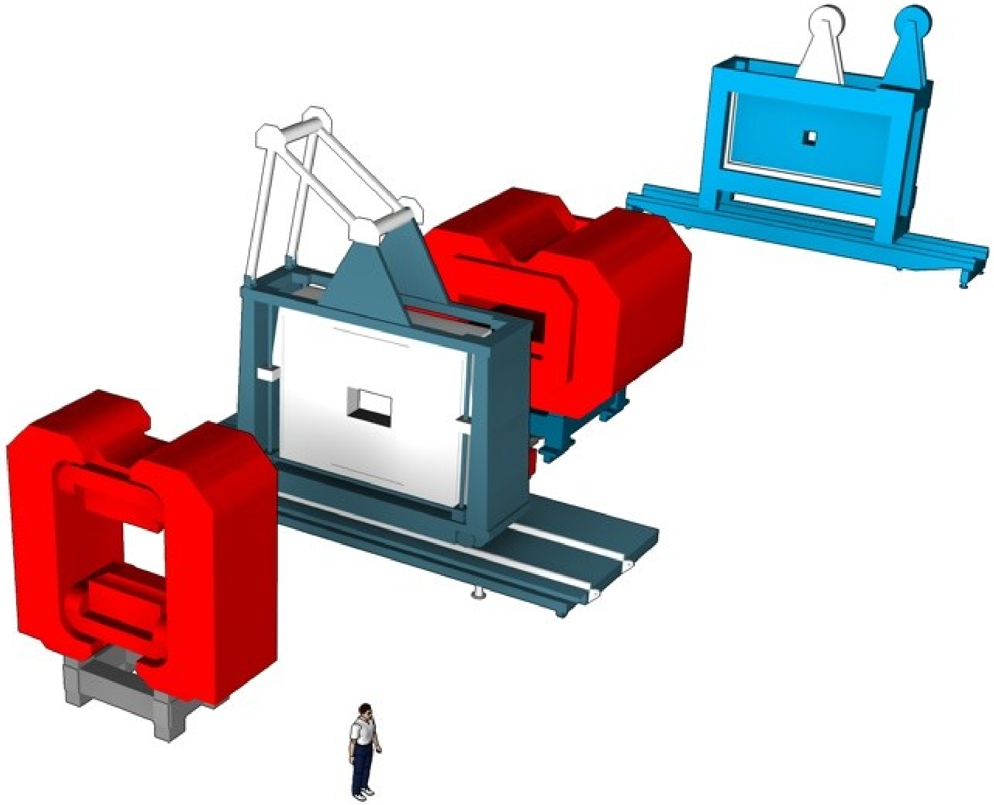


Measure the momentum of neutral particles: Case they decay into γ's (π^0 η)



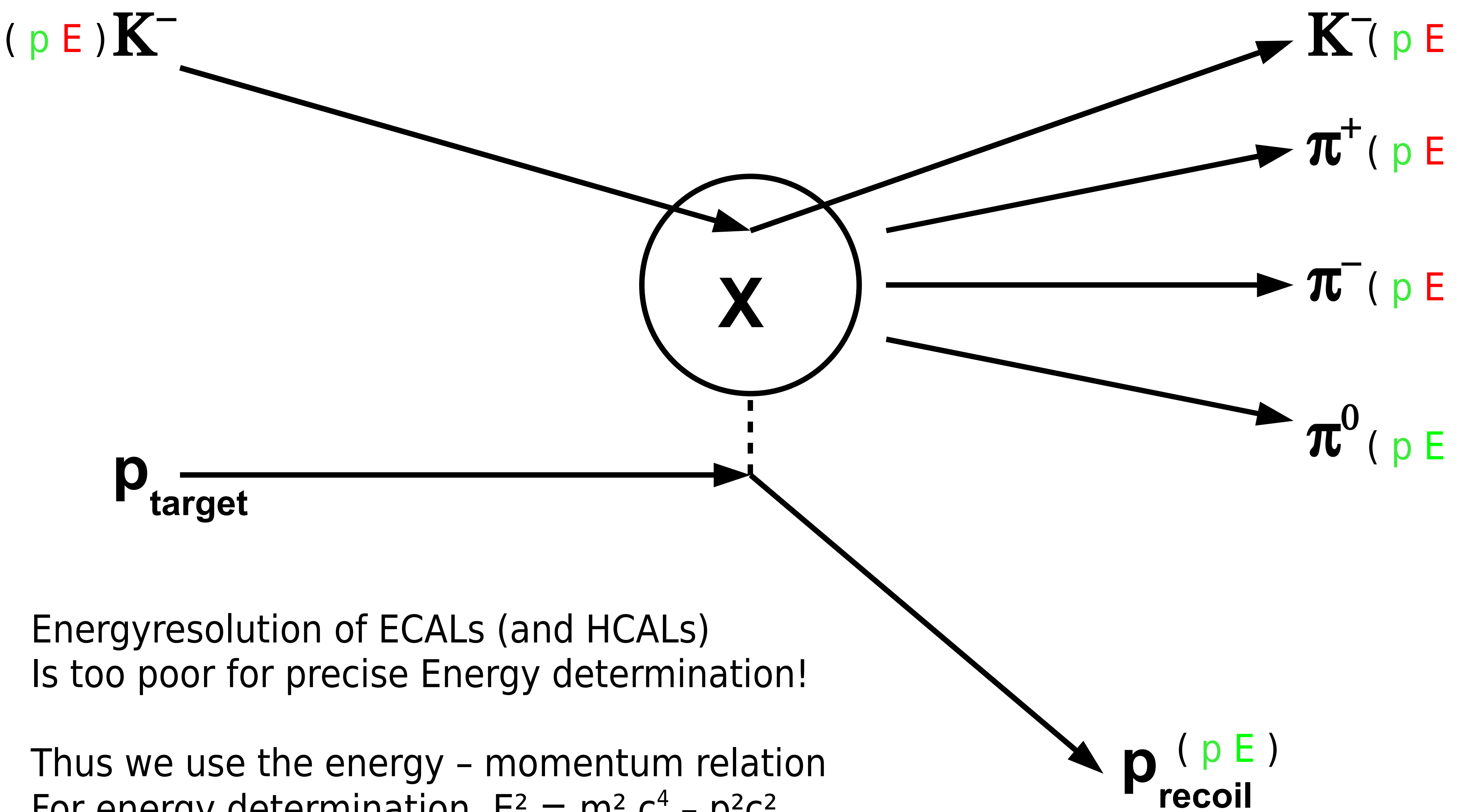
Measure the momentum of neutral particles: Case they decay into γ's ($\pi^0 \eta$)





http://wwwcompass.cern.ch/compass/publications/theses/2007_dpl_kurig.pdf

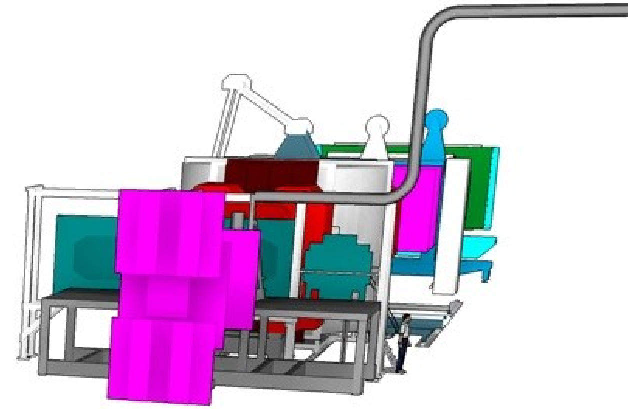
Determination of charged particle energies

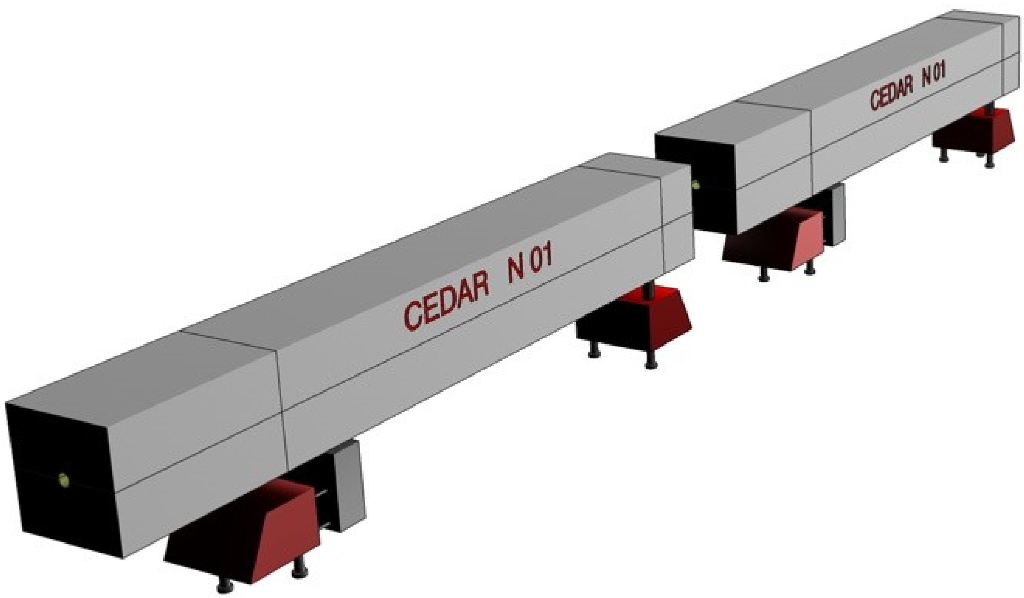


Energyresolution of ECALs (and HCALs)
Is too poor for precise Energy determination!

Thus we use the energy – momentum relation
For energy determination. $E^2 = m^2 c^4 – p^2c^2$
→ Particle identification needed → PDG mass for well known particles is used.

Particle identification for incoming beamparticles: CEDAR





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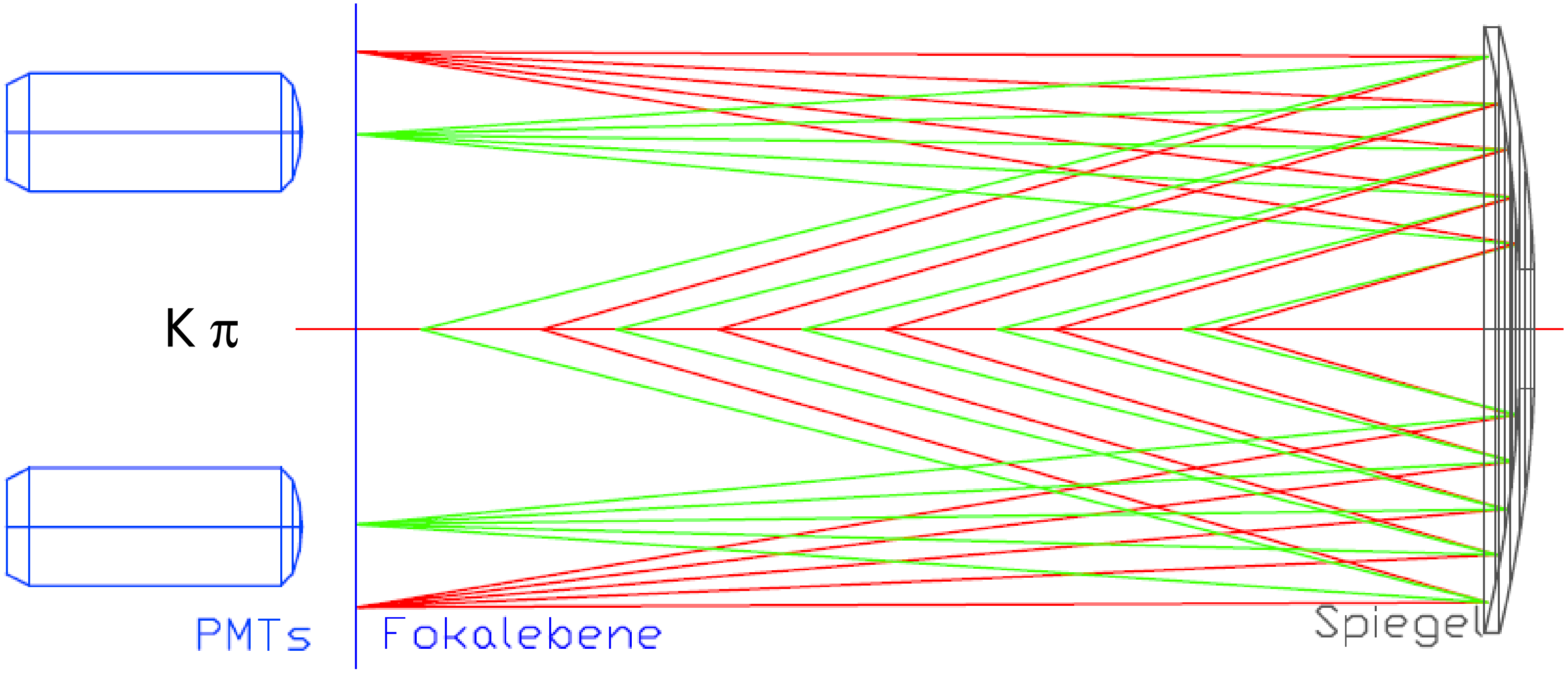
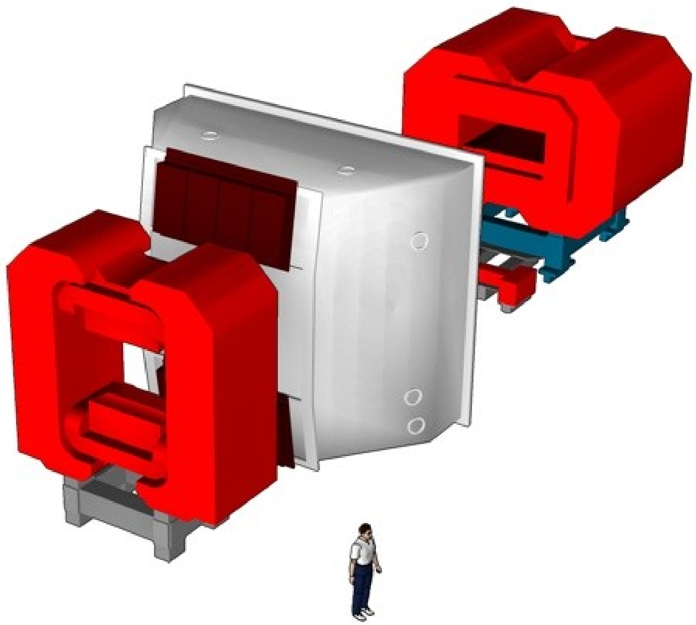


Incoming beam momentum is fixed
→ the velocity for different masses differs.
→ the cherencov angles differ.

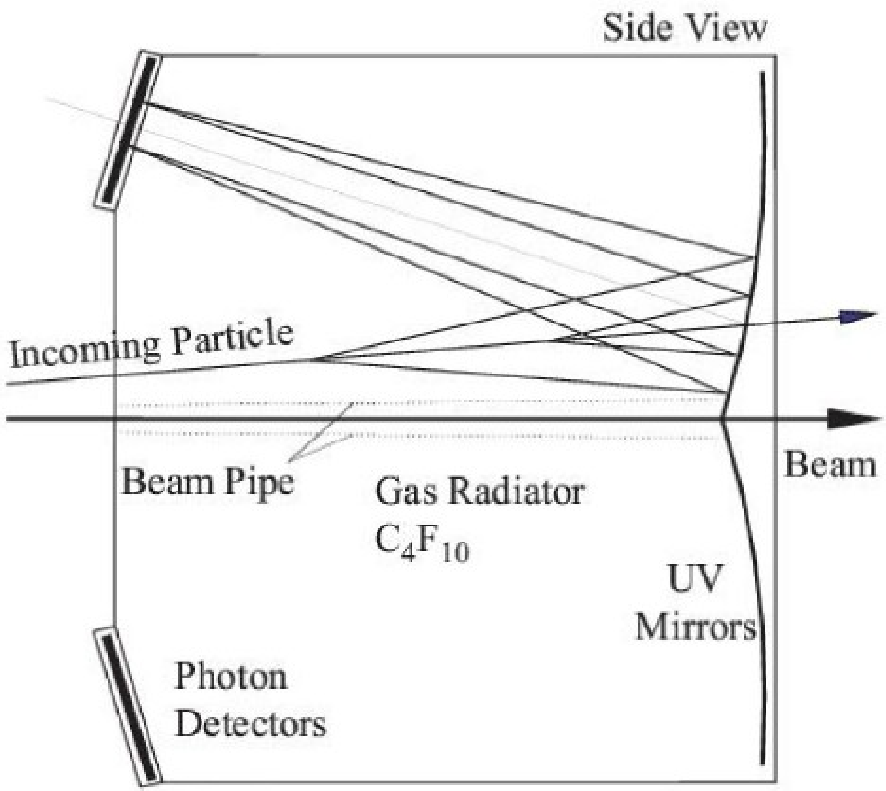
http://wwwcompass.cern.ch/compass/publications/theses/2007_dpl_jasinski.pdf

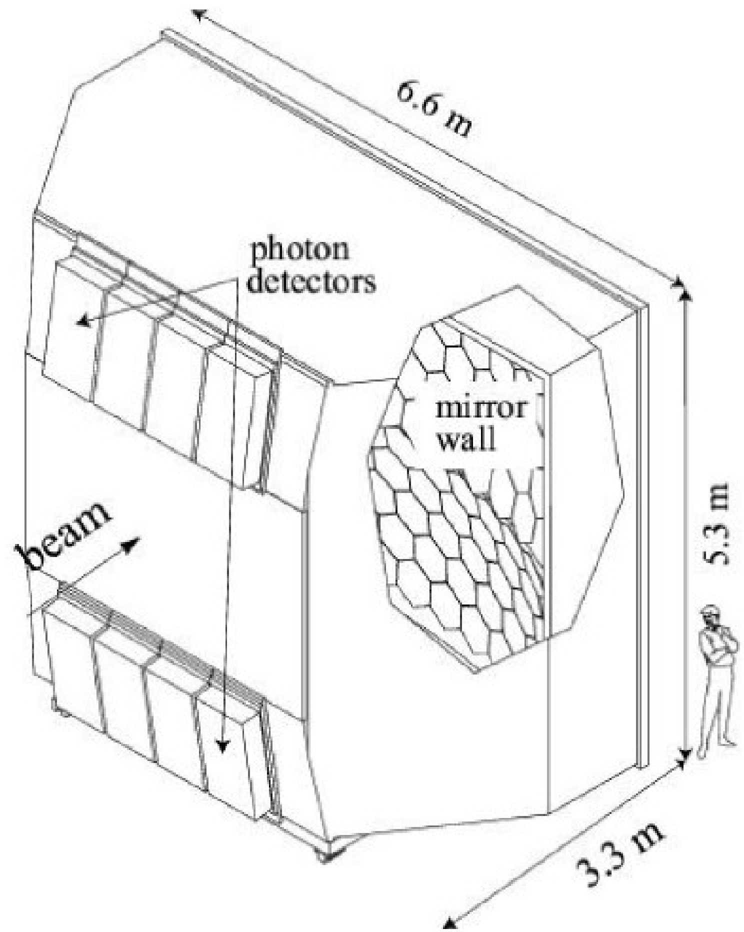
Particle identification for outgoing charged beamparticles: The RICH Detector



Realized only for the first stage of spectrometer
Mainly for separation of pions, Kaons and protons

Particle identification for outgoing charged beamparticles: The RICH Detector





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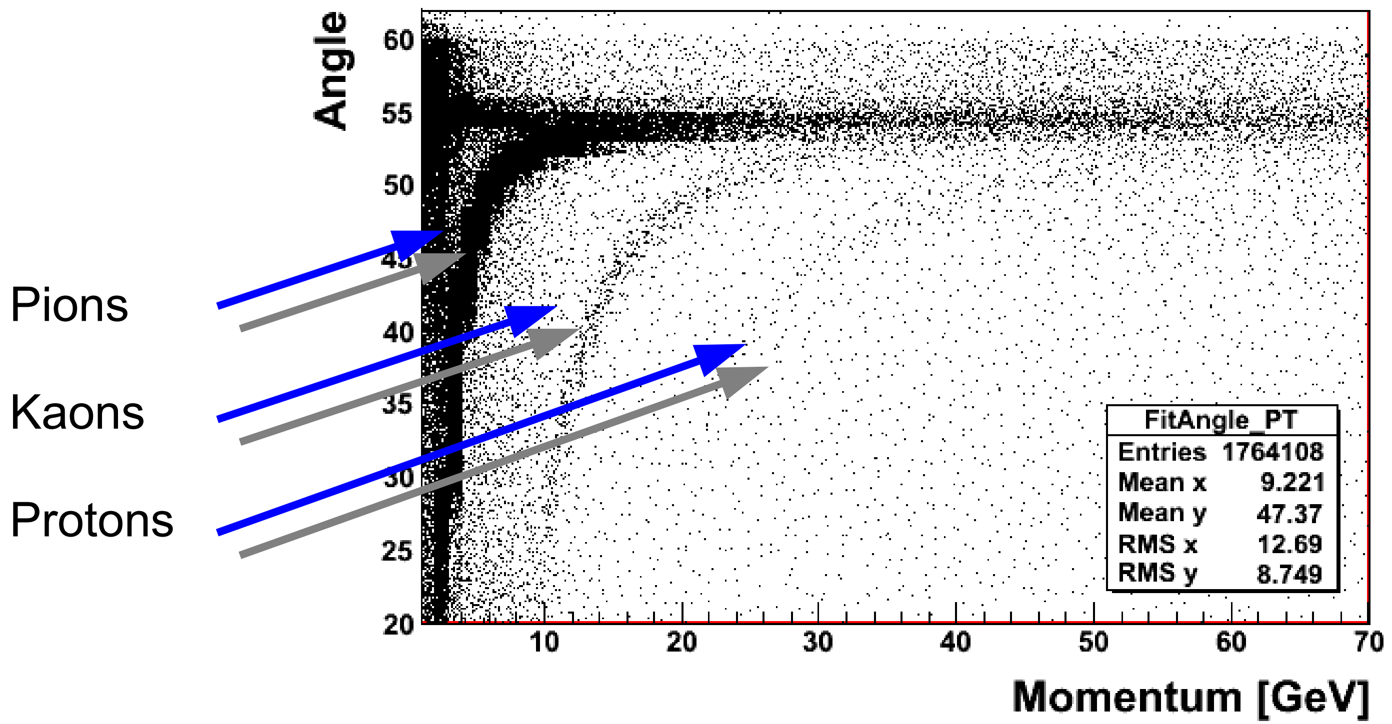
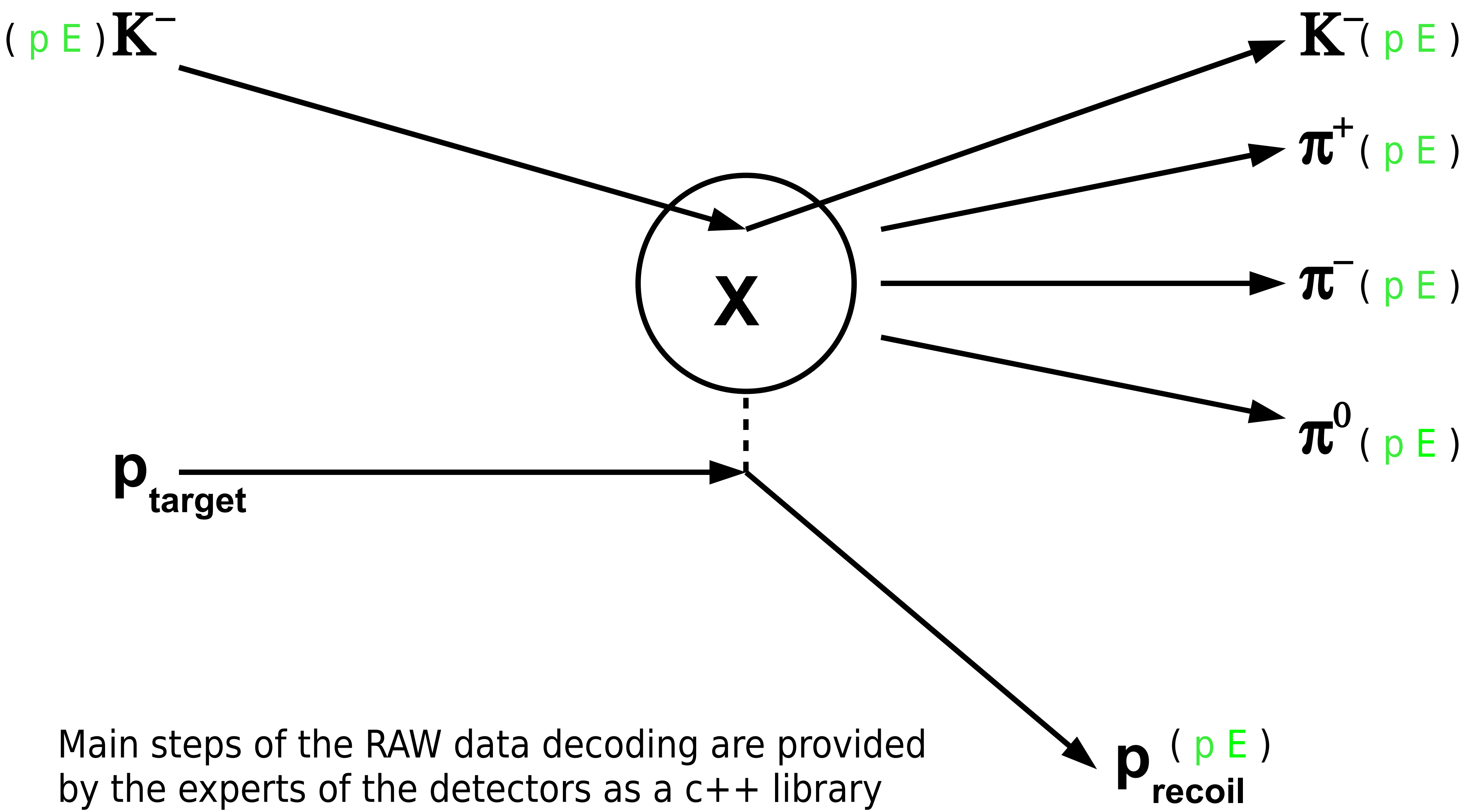


By knowing the beam momentum and the Cherencov cone angle we know the mass
But Identification of Kaons only possible up to 50 – 60 GeV.

How do we obtain the physical values out of the RAW data (TDC, ADC, position)?

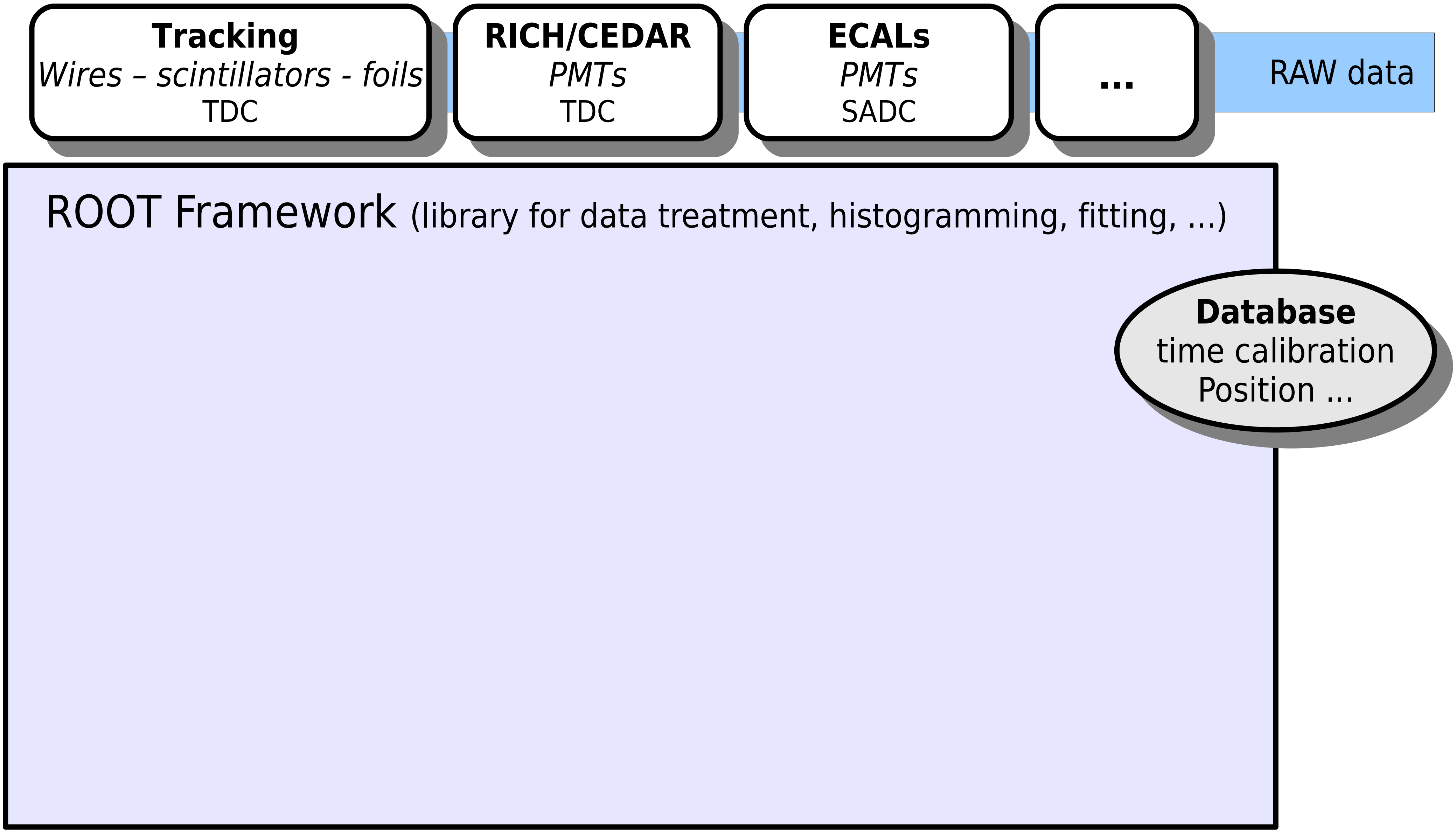


Main steps of the RAW data decoding are provided by the experts of the detectors as a c++ library

From the RAW data stored on CASTOR tapes to Enduser data stored as mini DSTs

ROOT Framework (library for data treatment, histogramming, fitting, ...)

From the RAW data stored on CASTOR tapes to Enduser data stored as mini DSTs



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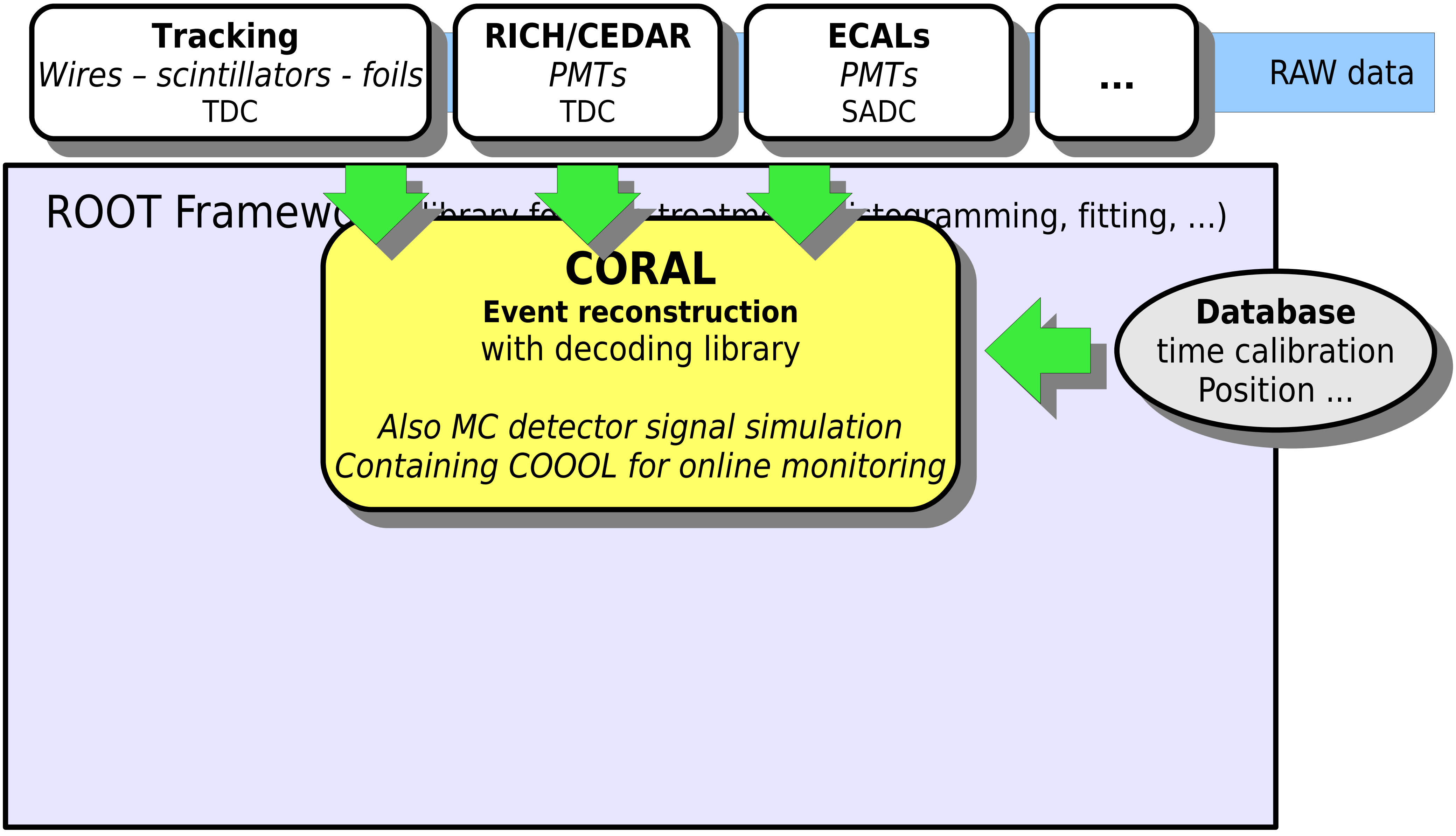

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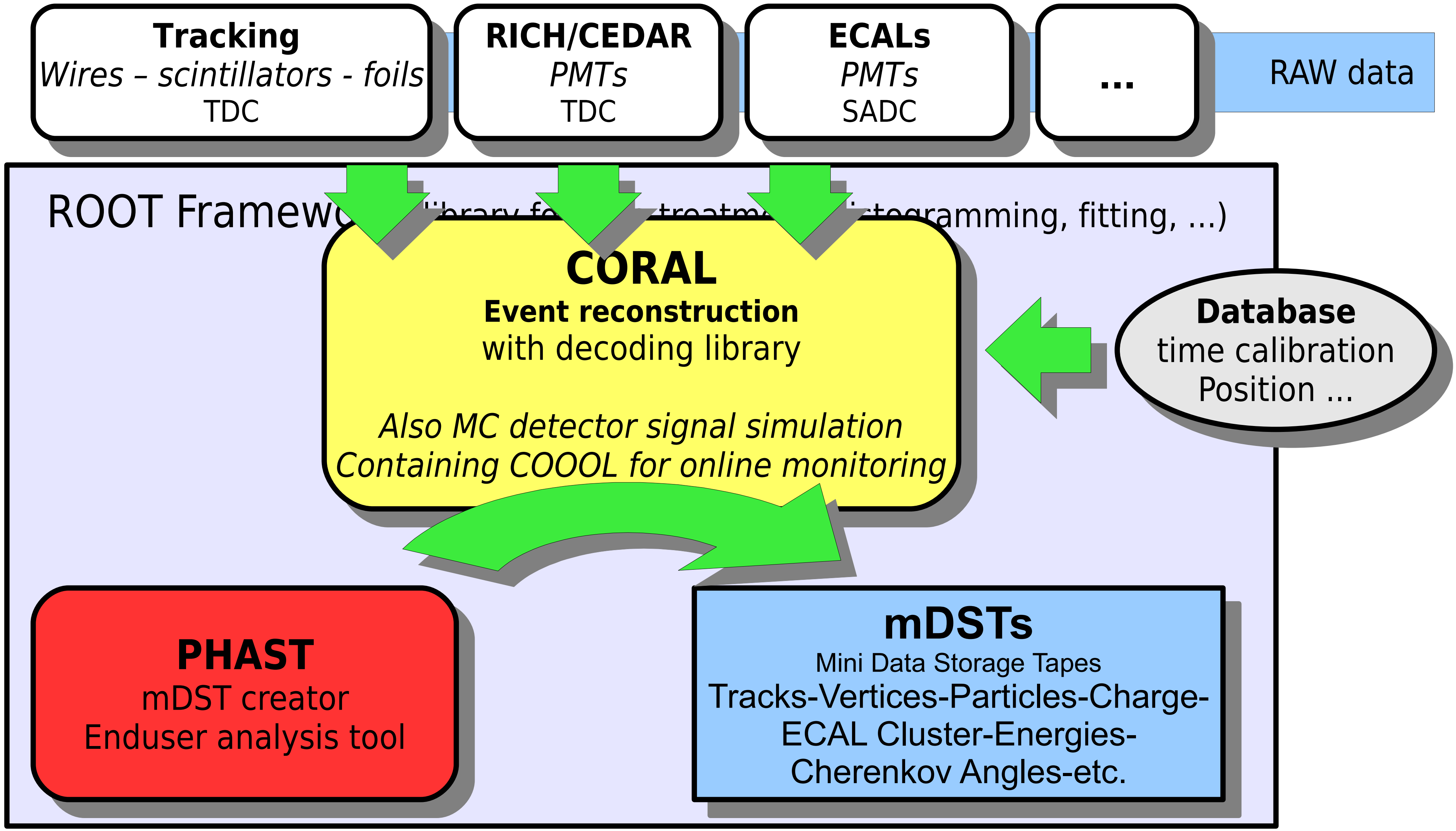
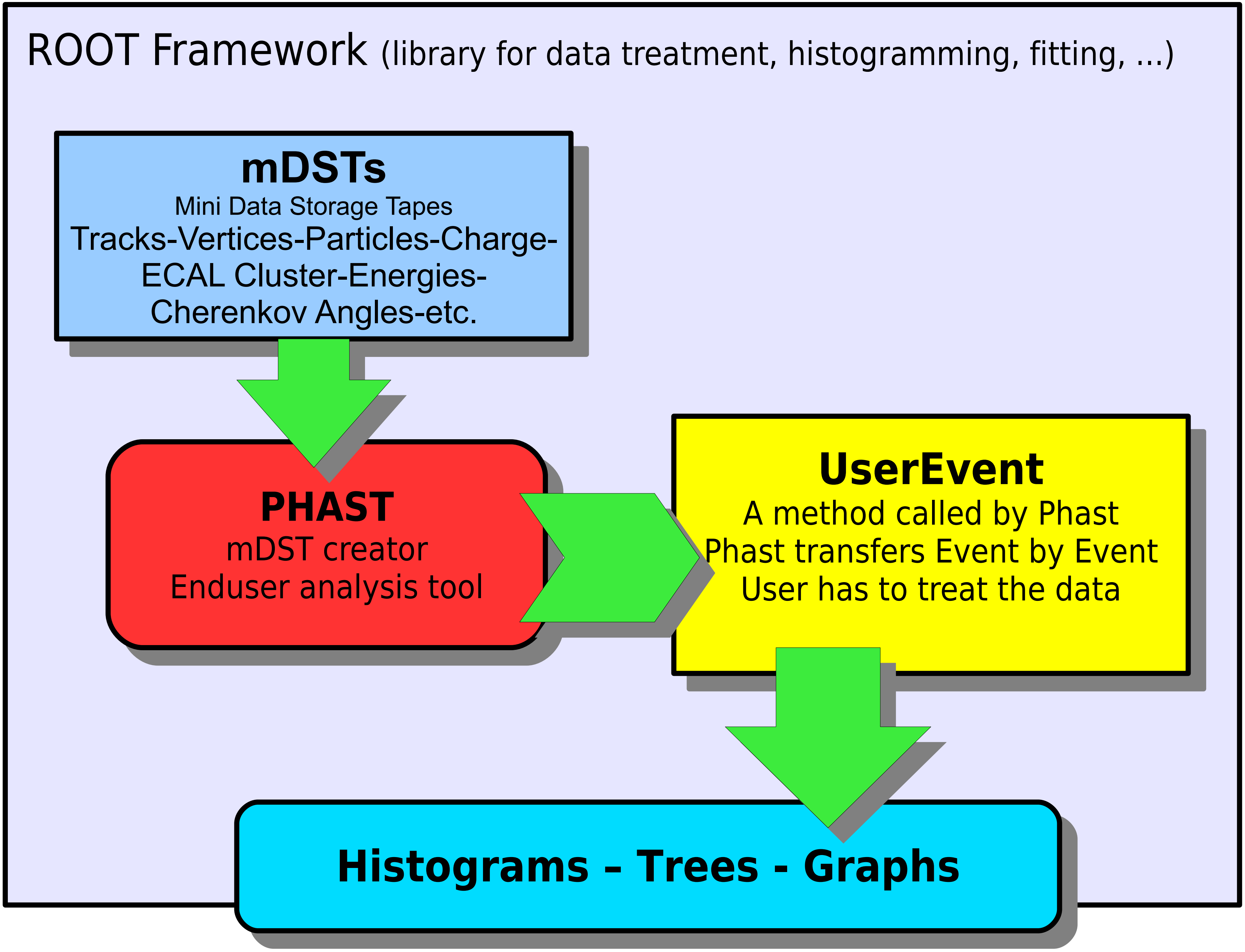


The Configuration for the Enduser



Typical work of an Enduser

- **Eventselection:**
  mDST-run-spill selection, Triggerselection

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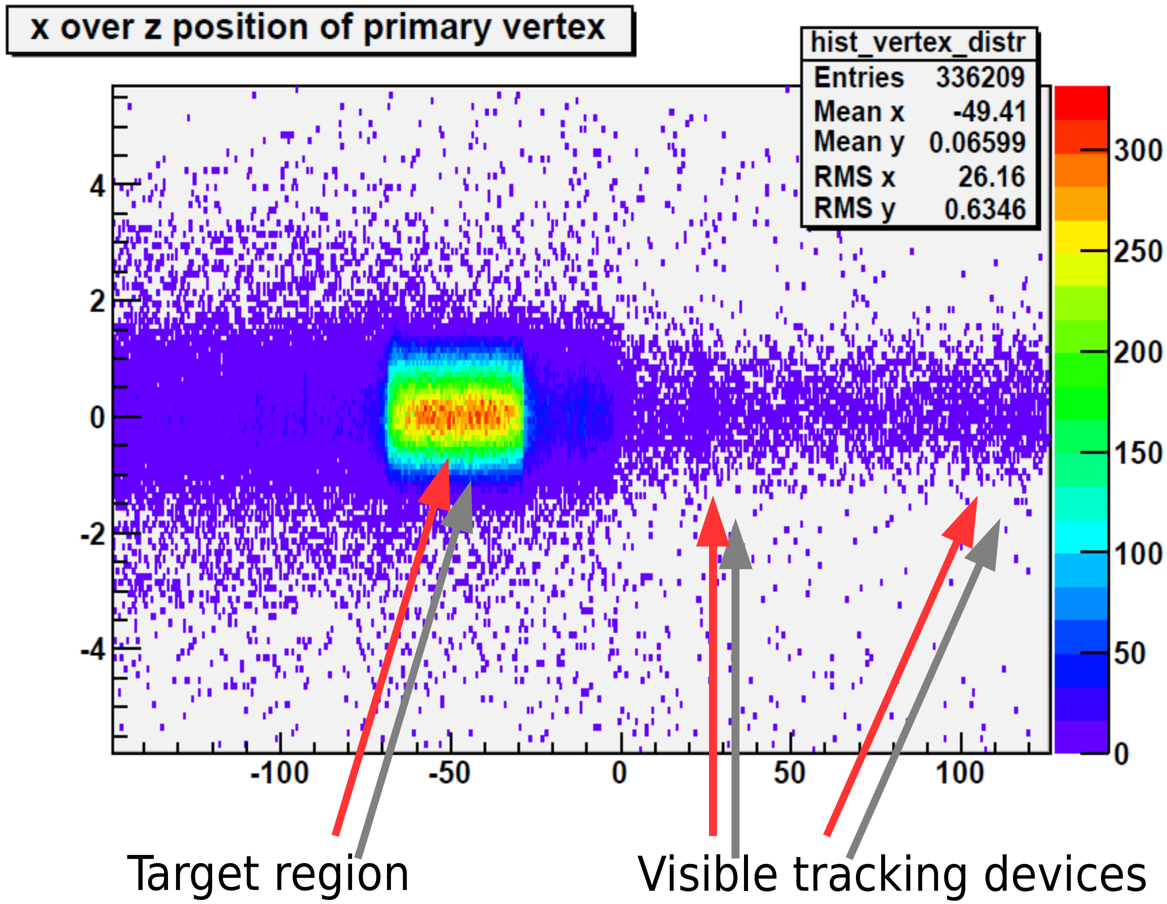

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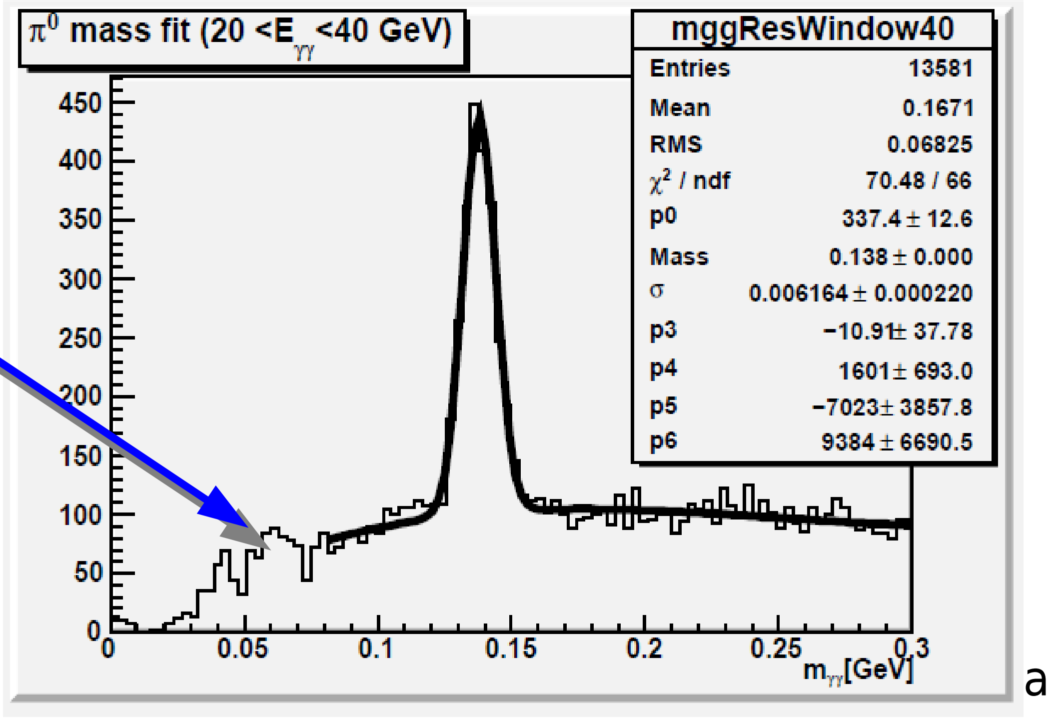
Lot of background
due to noisy channels



analysis by uman

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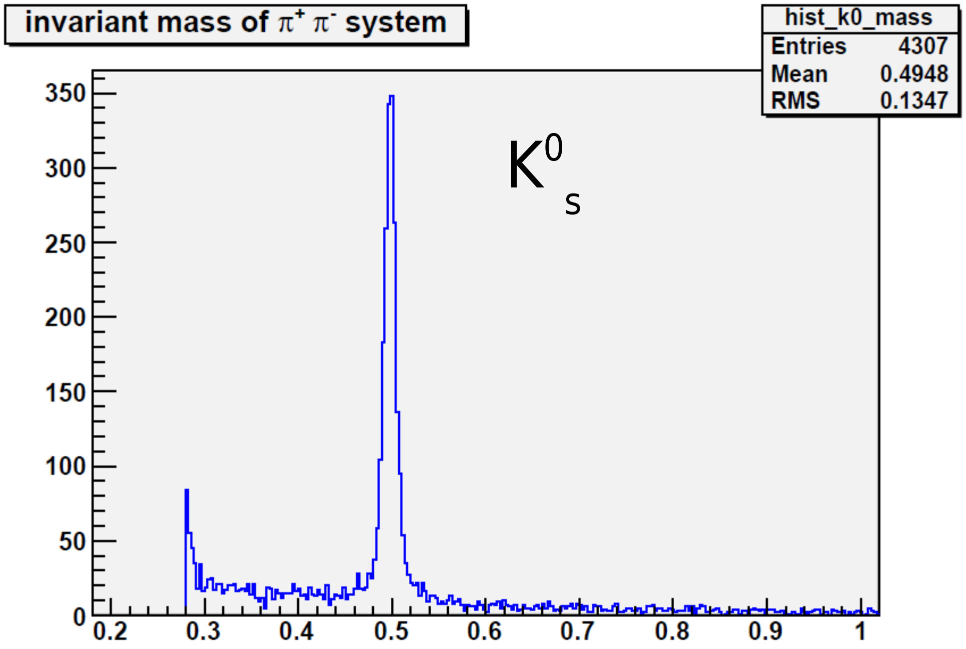

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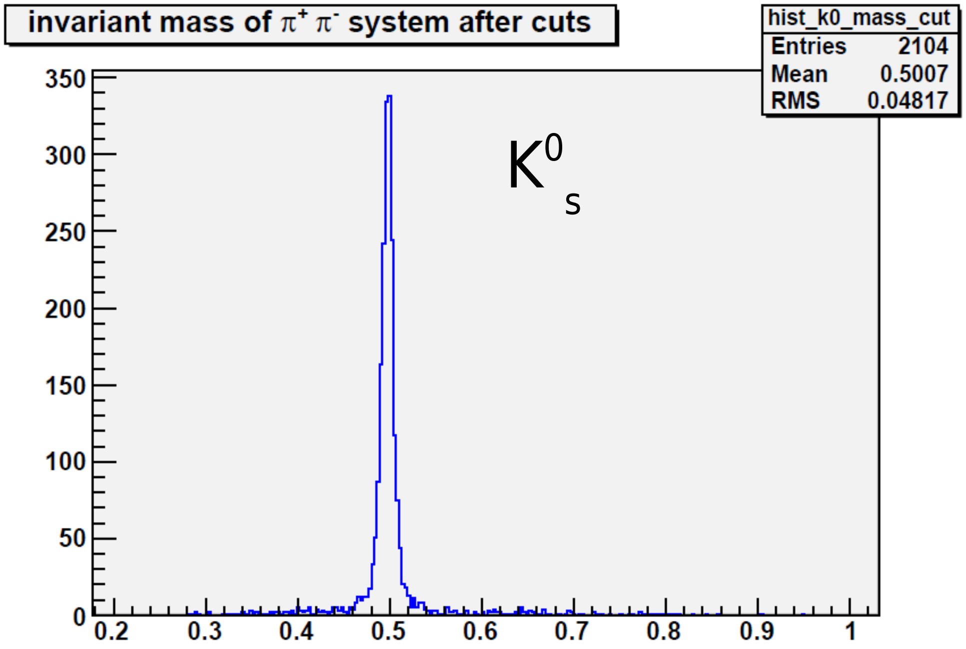

Reduced background due to
PID of protons and antiprotons

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  Find the short living particles in the mass spectra (Example on the next page)

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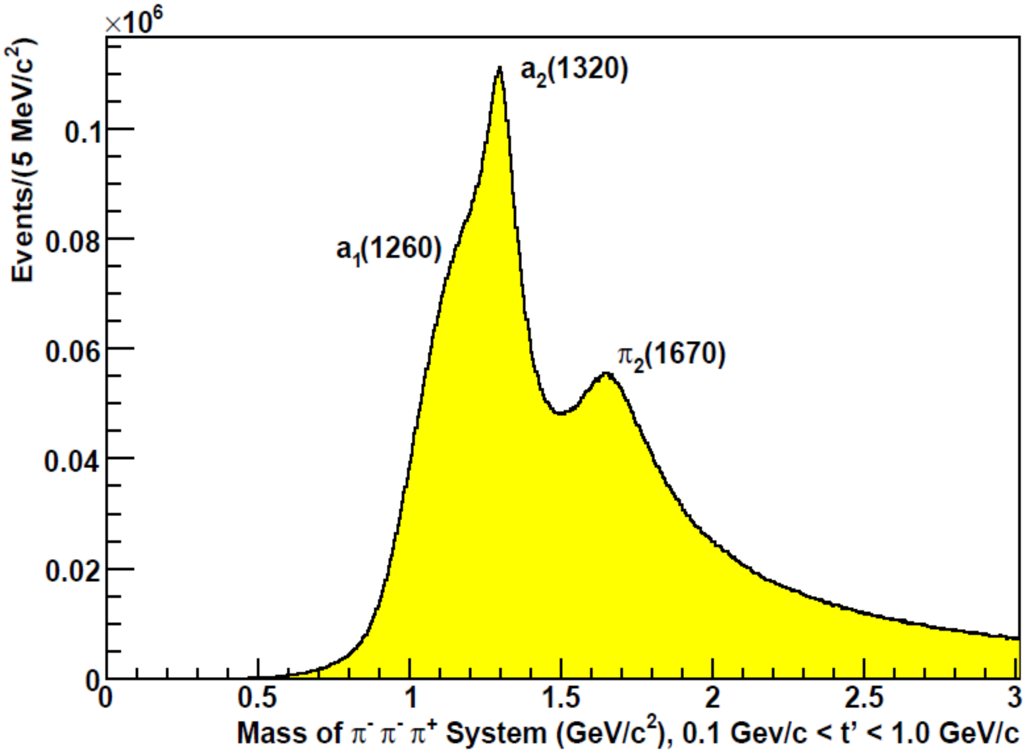
- **Computation of invariant masses:**
  Find the short living particles in the mass spectra
- **Comparison with Monte Carlo:**
  Test the code on Monte Carlo data.
  Determine systematic errors and background.

Simplyfied codesample of an UserEvent

```
void UserEvent1(PaEvent& e){
    // create a histogram to fill only when this
    // method is called the first time
    static TH1F* mass_hist;
    bool first(true);
    if (first){
        mass_hist = new TH1F("mass_hist", "invariant mass distr", 1000, 0, 5);
        first = false;
    }
    // go though all vertices in this event
    for(int ivertex = 0; ivertex < e.NVertex(); ivertex++){
        const PaVertex& vertex = e.vVertex(ivertex); // copy vertex
        if (!vertex.IsPrimary()) continue; // take only primaries
        if ((-65 < vertex.Z()) && (vertex.Z() < -30)) continue; // only target region
        if (vertex.NOutParticles() != 3) continue; // number of outgoing particles must fit
        // get the indexes of the particles in the vector
        int index_pi1 = vertex.iOutParticle(0);
        int index_pi2 = vertex.iOutParticle(1);
        int index_pi3 = vertex.iOutParticle(2);
        // retrieve the particle themselves
        const PaParticle& particle_pi1 = e.vParticle(index_pi1);
        const PaParticle& particle_pi2 = e.vParticle(index_pi2);
        const PaParticle& particle_pi3 = e.vParticle(index_pi3);
        // calculate the Lorentz vectors in the specific position of the vertex
        TLorentzVector LzVec_pi1 = particle_pi1.ParInVtx(ivertex).LzVec(0.139);
        TLorentzVector LzVec_pi2 = particle_pi2.ParInVtx(ivertex).LzVec(0.139);
        TLorentzVector LzVec_pi3 = particle_pi3.ParInVtx(ivertex).LzVec(0.139);
        mass_hist->Fill((LzVec_pi1+LzVec_pi2+LzVec_pi3).M());
    }
}
```

Output of UserEvent Analysis

3 outgoing particles assigned with masses of pions



from analysis by haas

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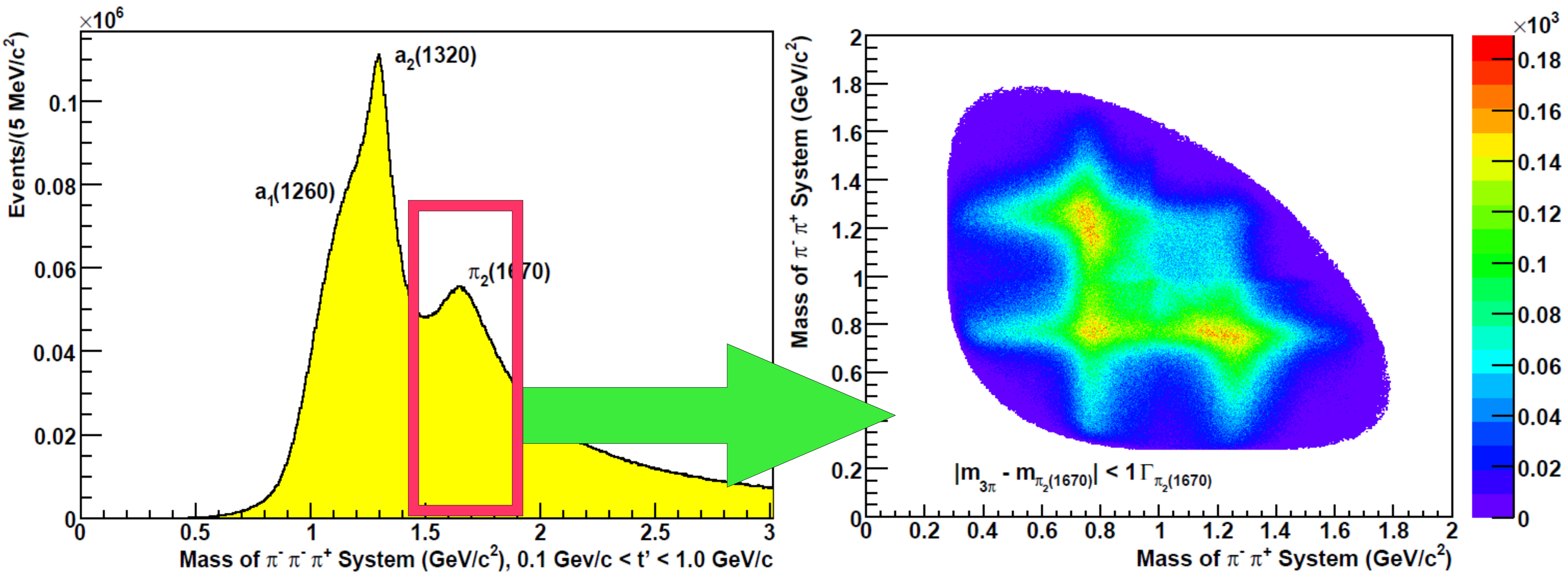

from analysis by haas

Thank you