Event Selection in Positron and Pion Data form the October HCAL & TCMT Standalone Runs

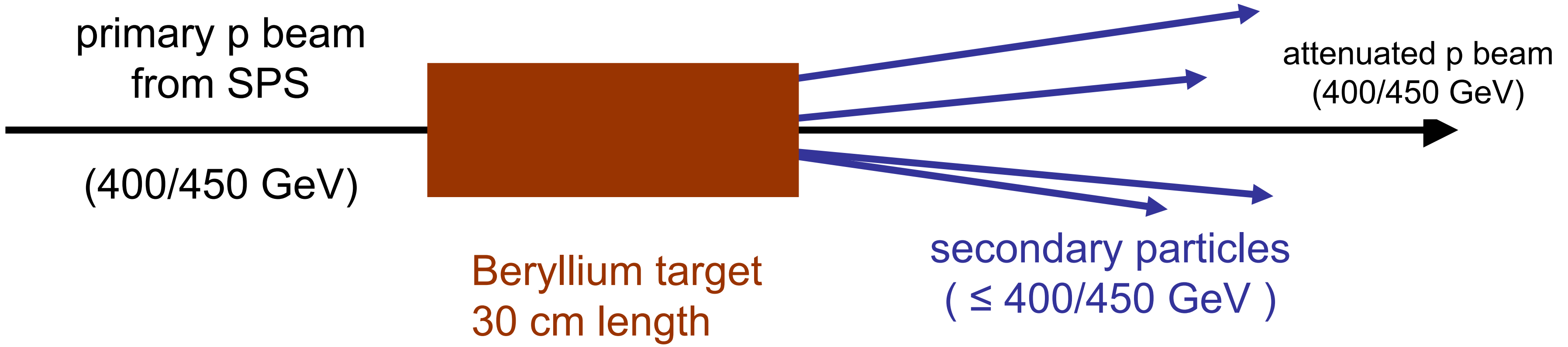
or

getting rid of the give-away particles

in a test-beam environment

Benjamin Lutz

Particle production



Why Beryllium?

→ hadron test-beam wants to have largest X_0/λ_{int} to produce the most hadrons

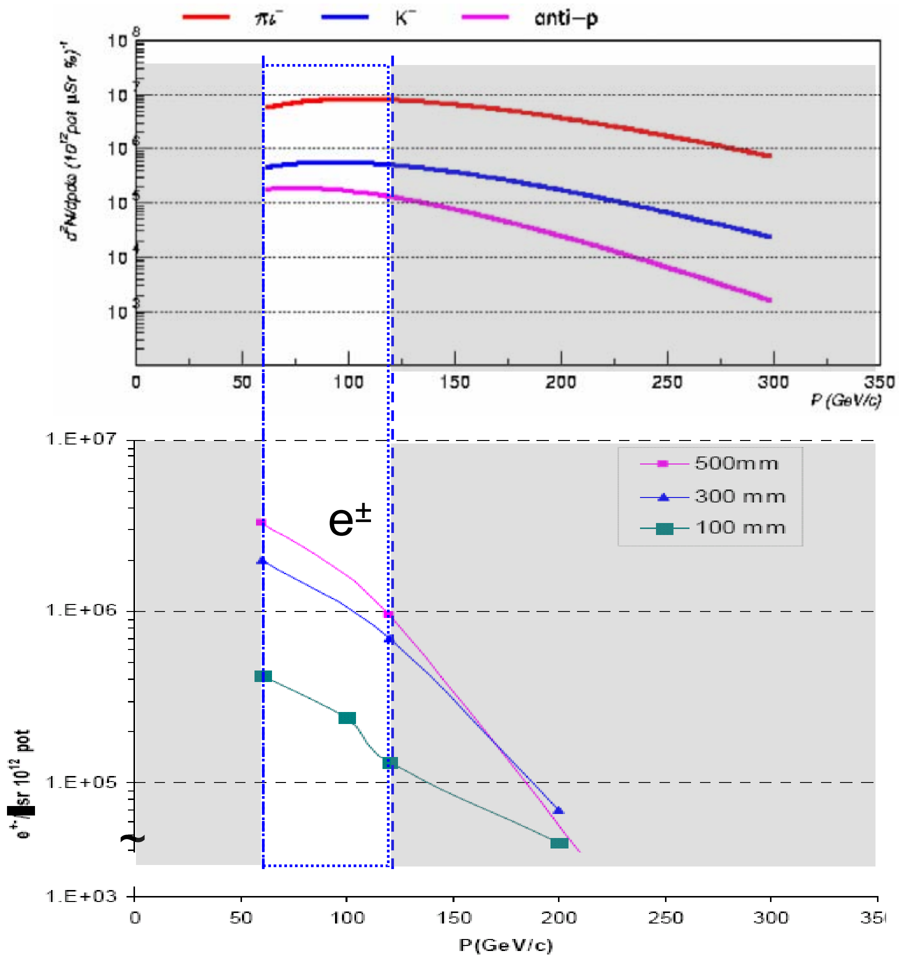
material	X_0	λ_{int}	X_0/λ_{int}
Beryllium	35.3	40.7	0.87
Copper	1.50	15.0	0.10
Lead	0.56	17.1	0.03

Particle production rates @ 400 GeV
30 cm Beryllium target

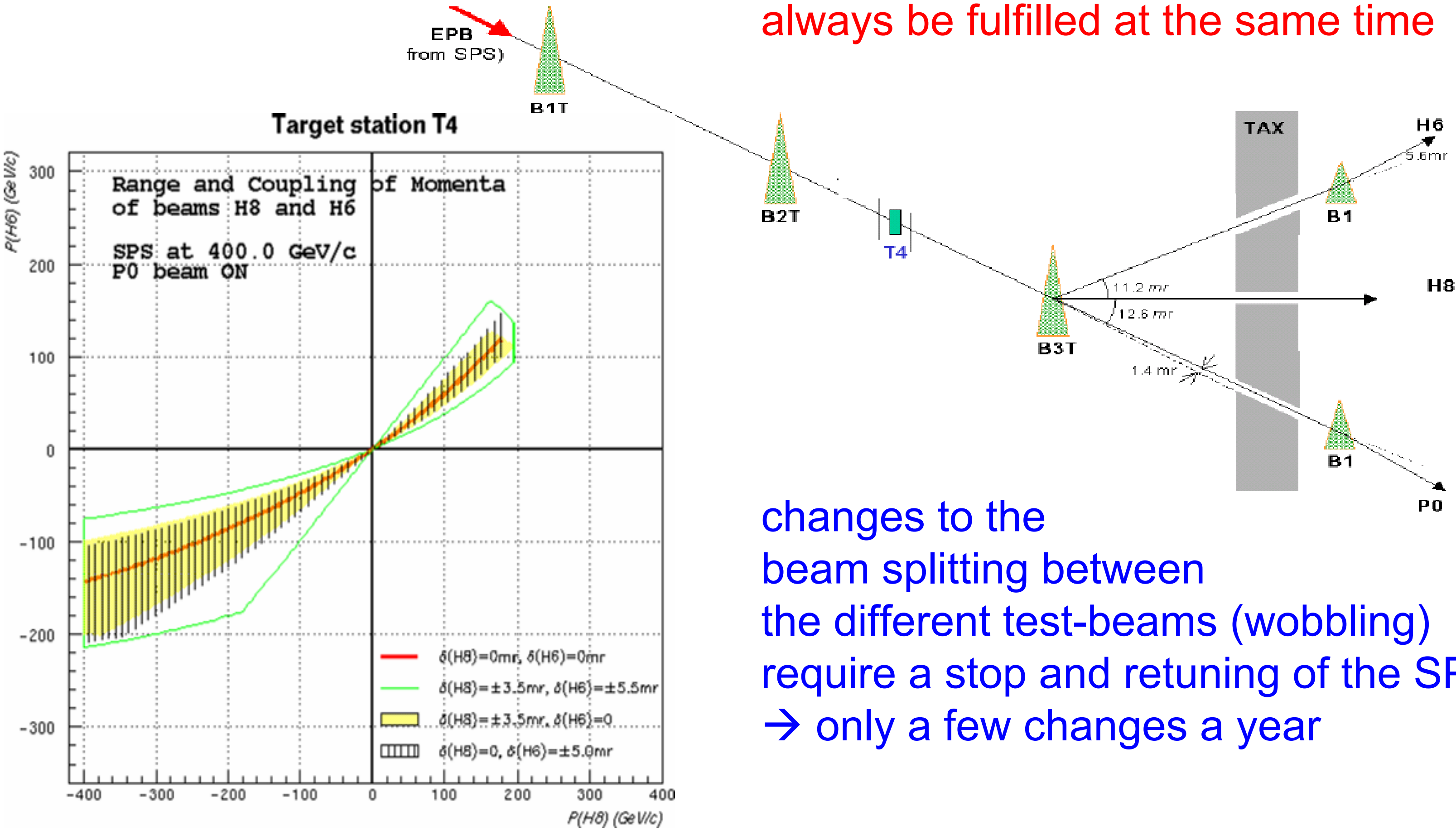
60 GeV π^- contains ≈ 40% e^-

120 GeV π^- contains ≈ 10% e^-

these values are
≈ ¼ smaller for π^+



One target, three beam-lines and a lot of constraints



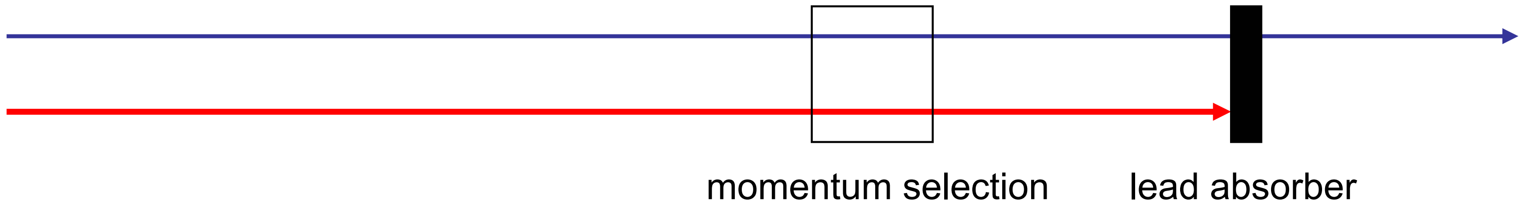
wishes of H6 and H8 users may not always be fulfilled at the same time

changes to the beam splitting between the different test-beams (wobbling) require a stop and retuning of the SPS
→ only a few changes a year

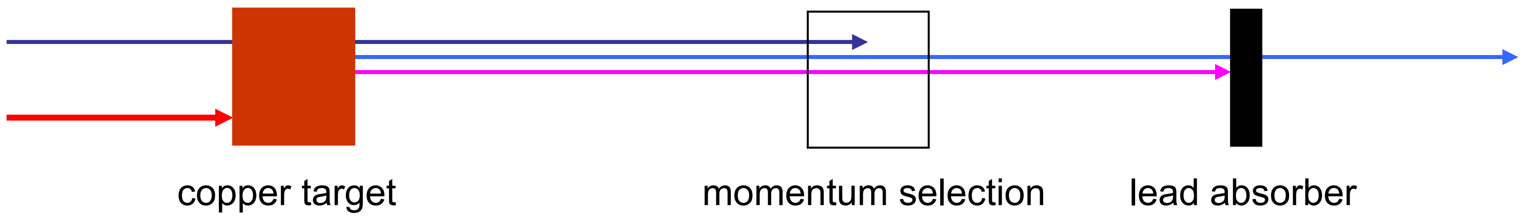
Particle type selection

some examples

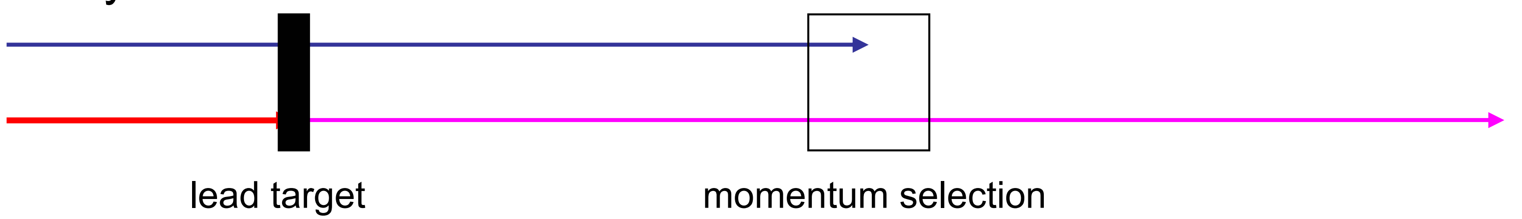
secondary hadrons:



tertiary hadrons:



tertiary electrons:



hadrons

electrons

decaying π generate μ with $0.57 \leq p_{\mu}/p_{\pi} \leq 1$

Why event selection/identification?

beam related

- is particle type selection perfect?
- identify particles in mixed mode beams
- reduce muon contaminations
- remove pre-showering (electron) events
- remove two particle events

detector related

- identify leakage
- test particle identification procedures
- do smart weighting

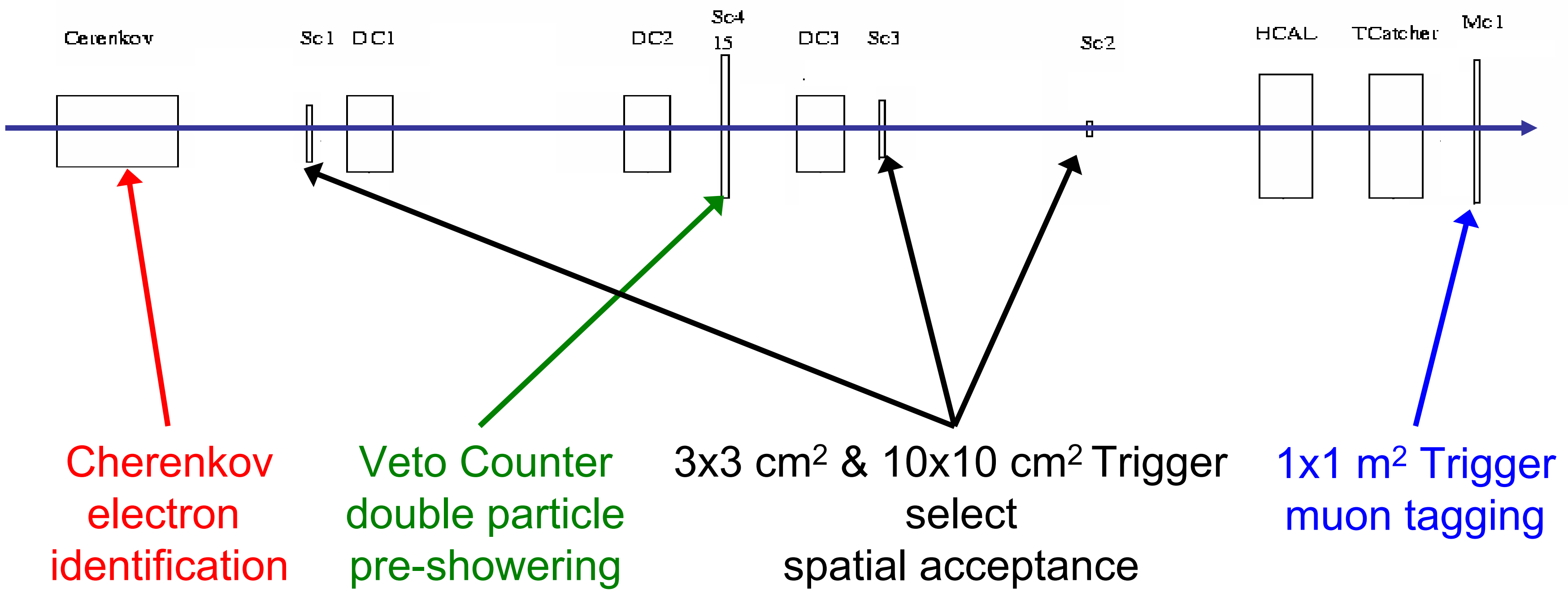
1st step

now

2nd step

soon

CALICE CERN test-beam setup

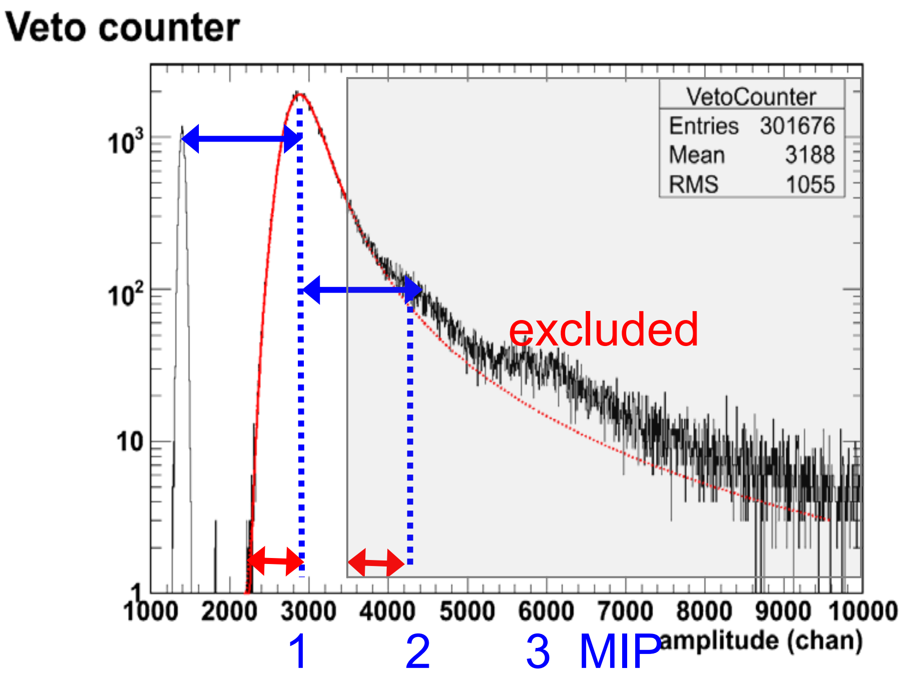


drift chambers were read out as well,
but reconstruction is not yet established

Amplitude in VetoCounter

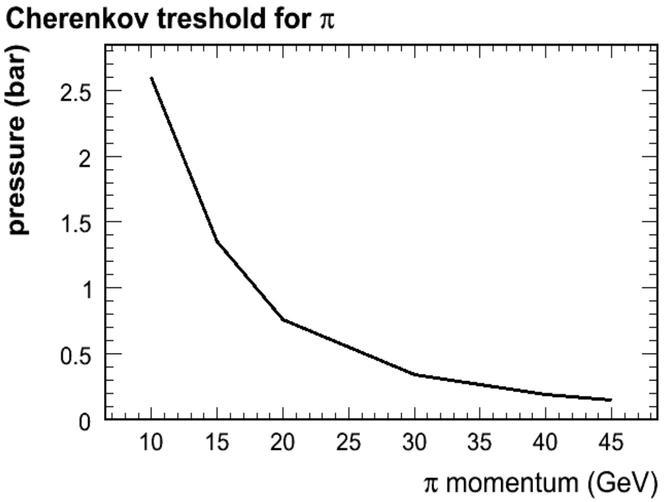
- MIP signal in Veto-Counter is well described by convolution of Landau and Gauss
- starting point of second MIP can be calculated from fit

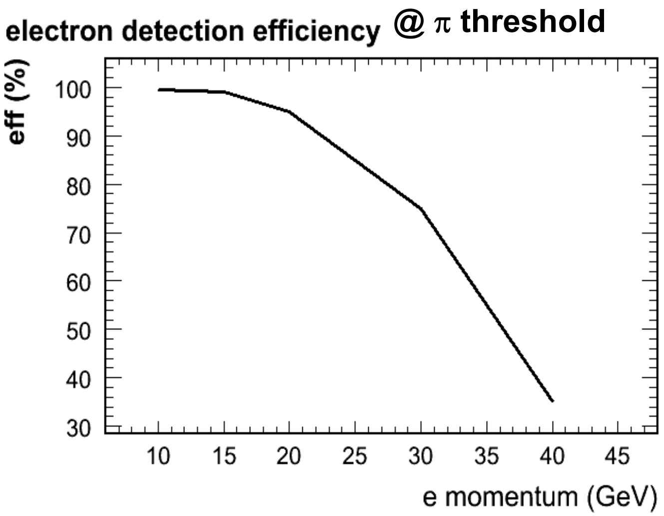
  → threshold
- events with two particles are excluded
- events already showering before the Veto Counter are excluded



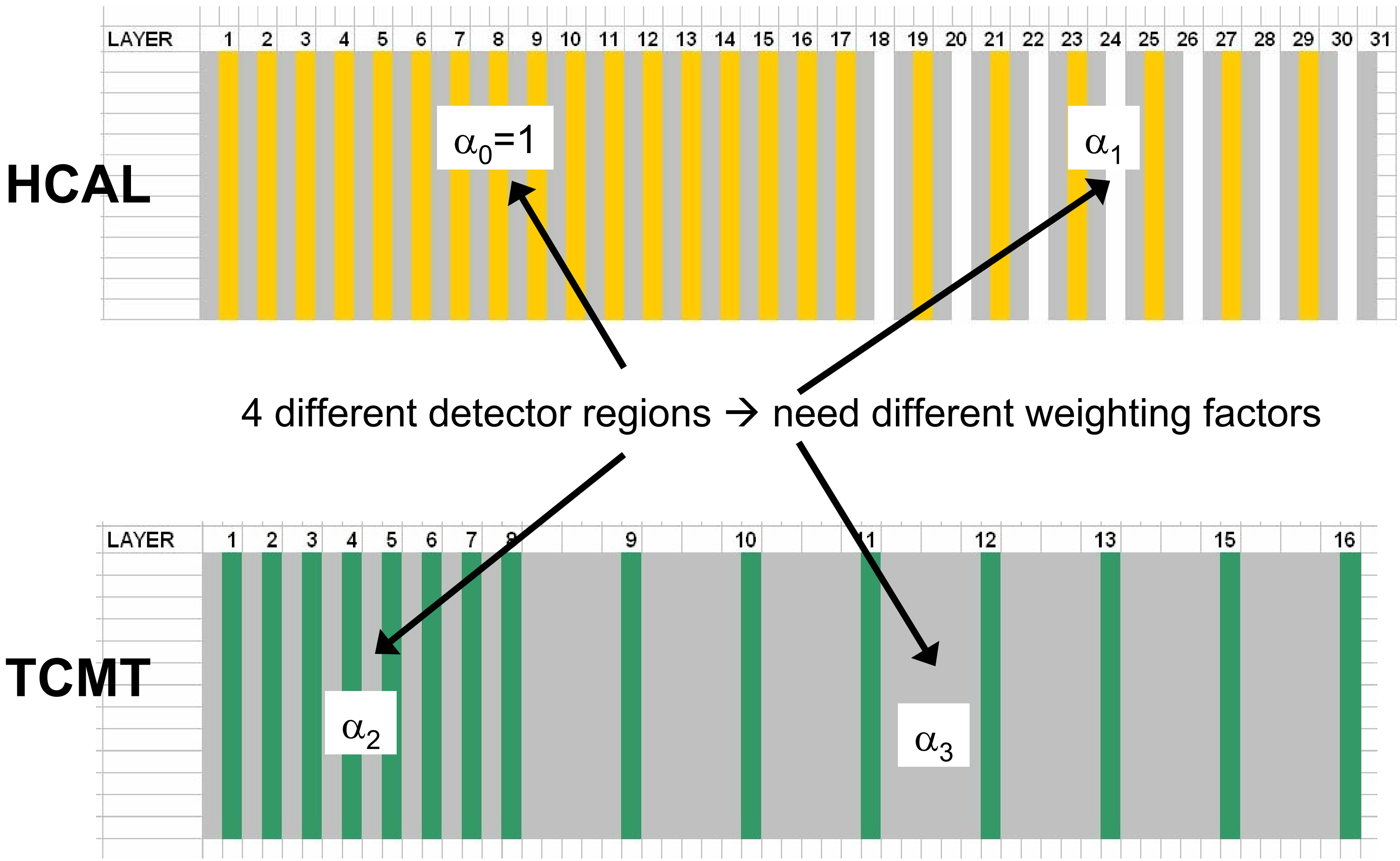
Cherenkov

- charged particles moving faster than speed of light in a medium generate Cherenkov radiation
- refraction index of gases can be steered by pressure
- to separate e from π select pressure just before π of beam momentum starts to generate Cherenkov radiation
- limited by electron detection efficiency at π threshold



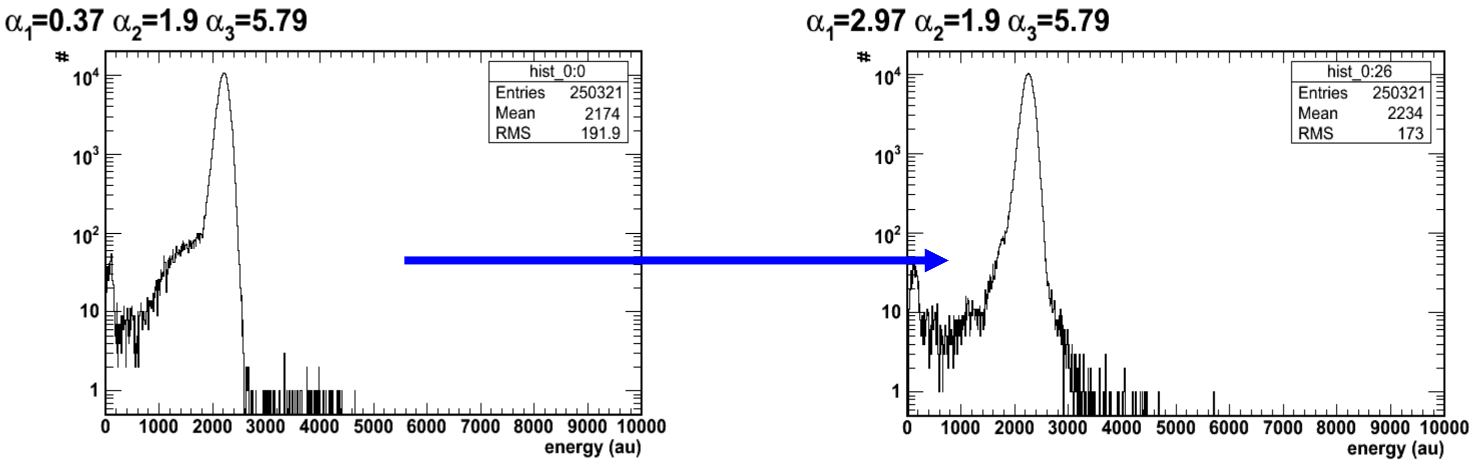


The October detectors



Method to retrieve the factors

assumption: wrong weighting factors lead to bigger signal width
→ minimize $\sigma/\langle mean \rangle$

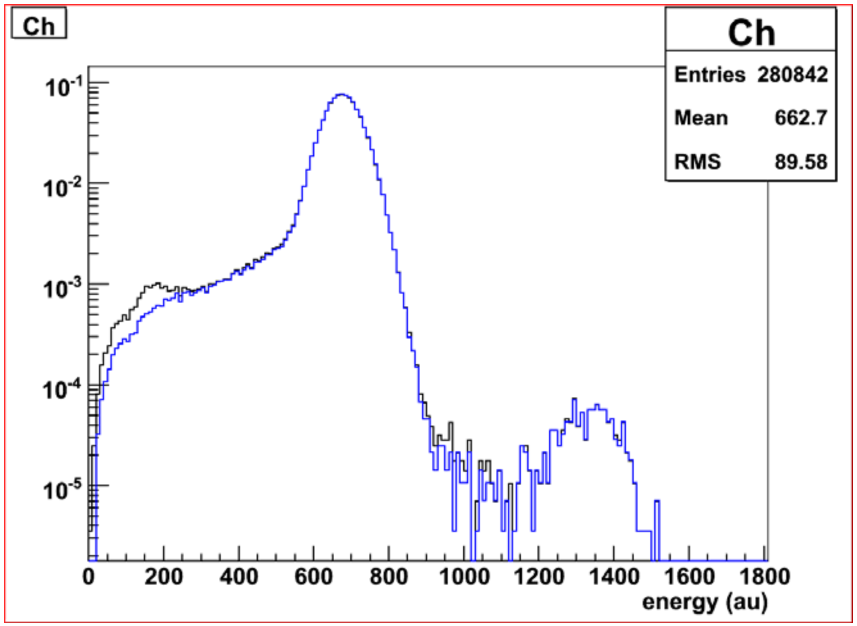


Comparison with Monte Carlo shows that this method delivers a good first order approximation, but reality is more complex (as always ☺)

Examples of the cuts for 15 GeV positron data

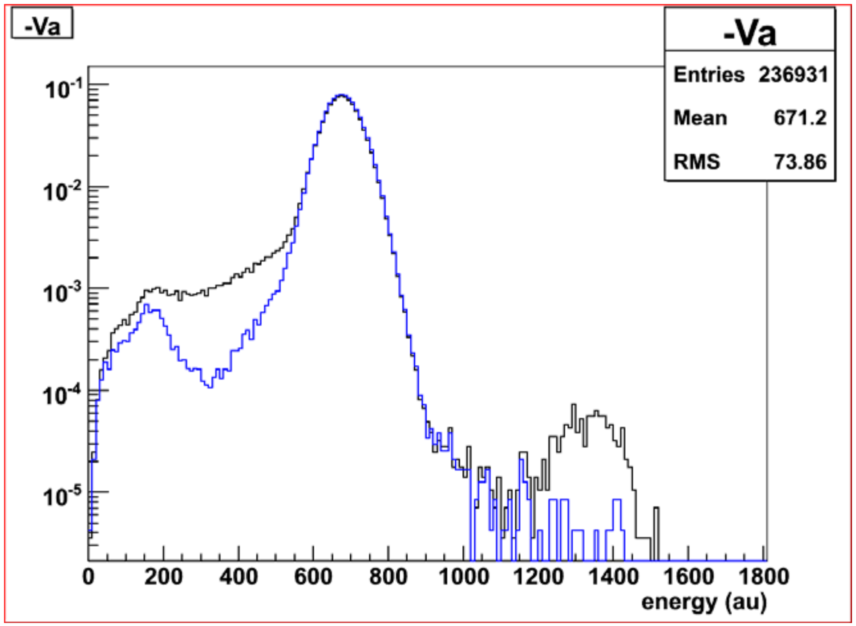
events before cut: 383958

-1% statistics



Cherenkov

-16% statistics

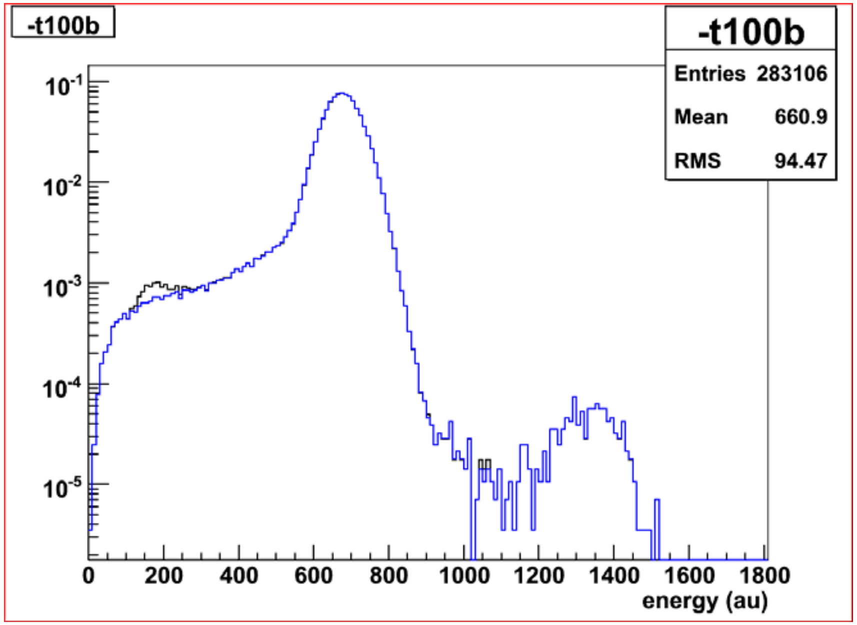


amplitude cut in VetoCounter

Examples of the cuts for 15 GeV positron data

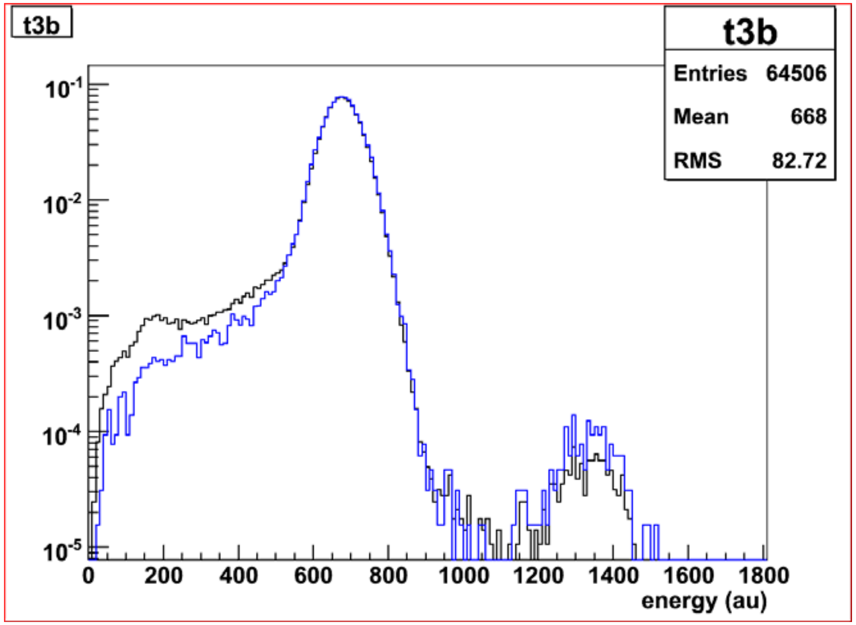
events before cut: 383958

-0.3% statistics



1x1m² muon veto trigger

-77% statistics



3x3cm² trigger

Which one do we buy?

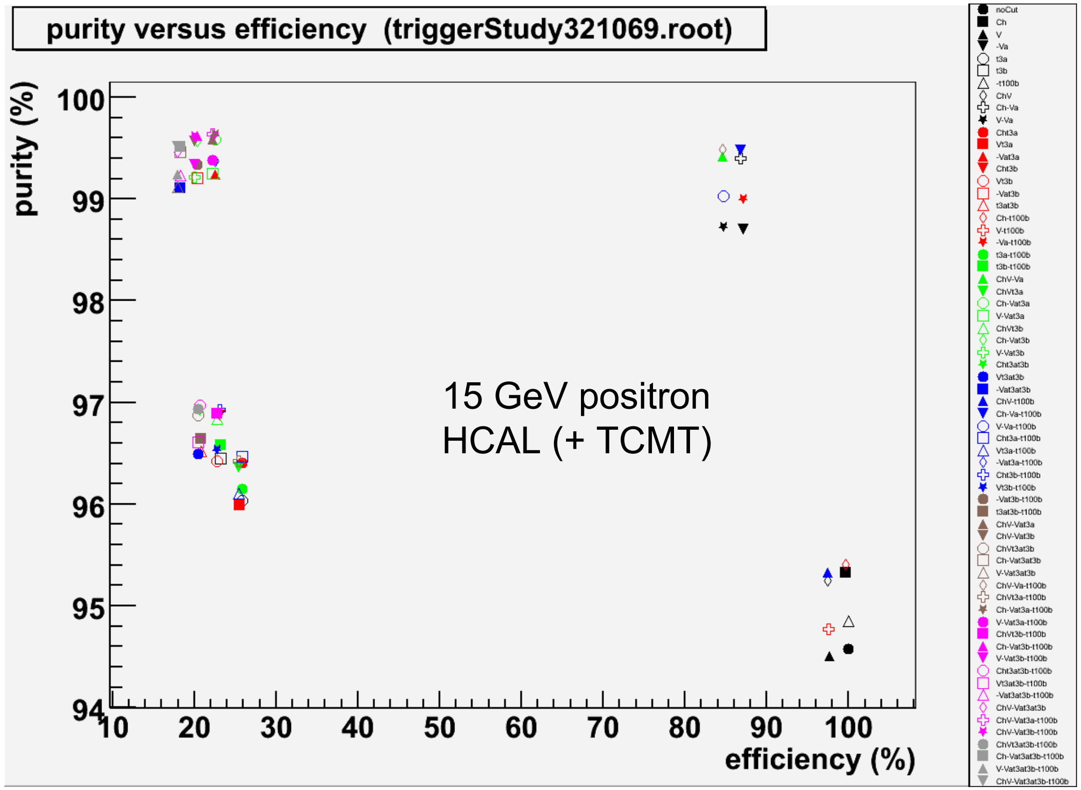
So far single cuts were discussed!

But this is not enough to judge which trigger/ trigger combination is the best for general sample improvement
or the best choice for your special analysis

→ systematic studies of the possible trigger combinations necessary

→ study of the energy and particle dependence of the different selections

An approach to study the combinations



purity

$$p = \frac{\int_{-2\sigma}^{2\sigma} g}{0.9545 \cdot \int_{-\infty}^{\infty} g}$$

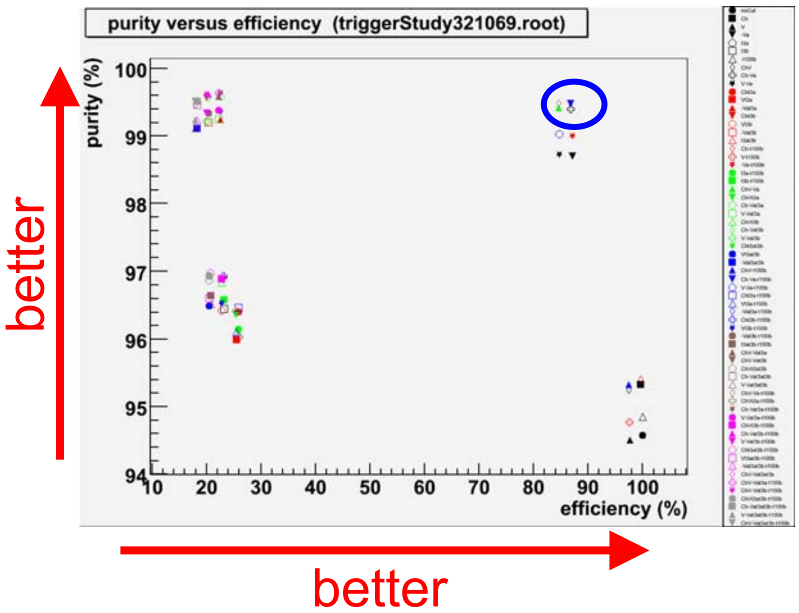
f: without cut
g: with cut

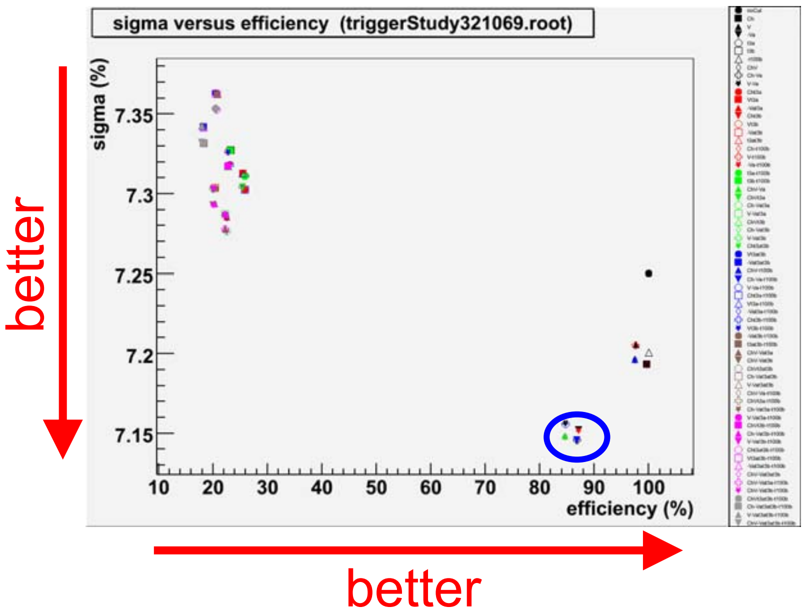
efficiency

$$\eta = \frac{\int_{-2\sigma}^{2\sigma} g}{\int_{-2\sigma}^{2\sigma} f}$$

assumption: signal behaves Gaussian

Another benchmark





15 GeV positron
HCAL (+ TCMT)

purity vs. efficiency

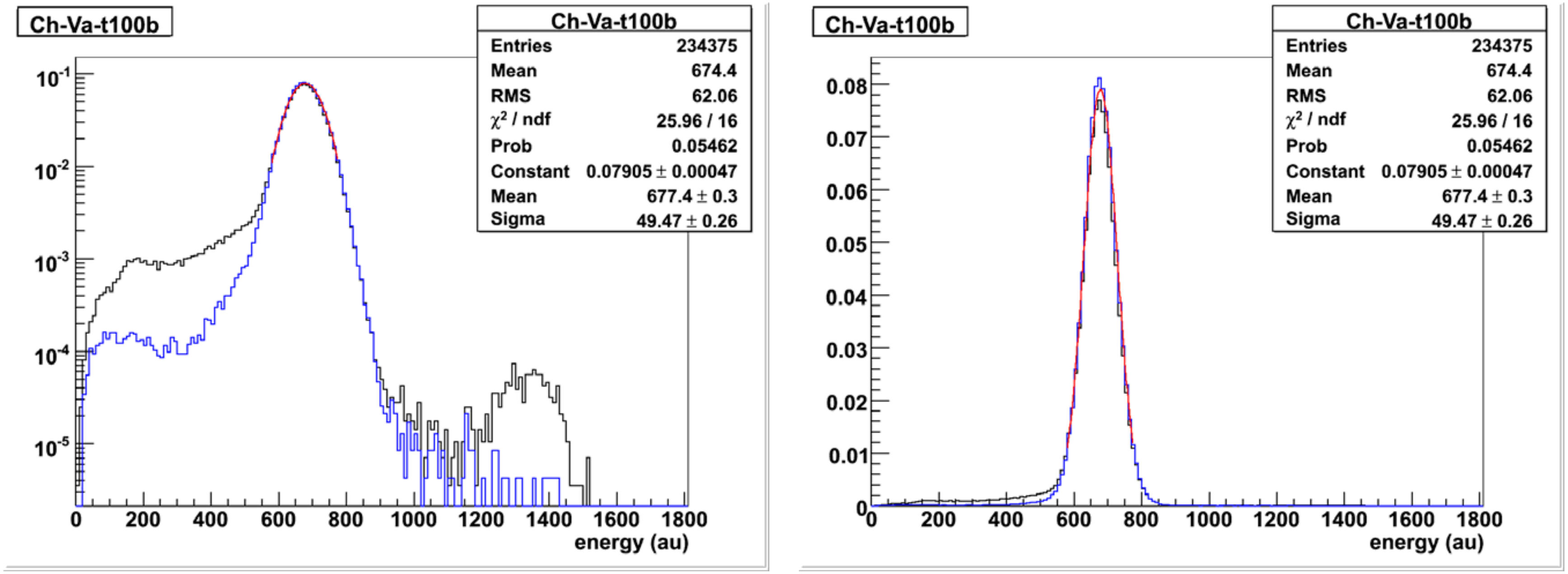
σ/E vs. efficiency

◯ = Cherenkov + Veto amplitude + muon trigger

Energy spectrum

15 GeV positron HCAL (+TCMT)

-17% statistics



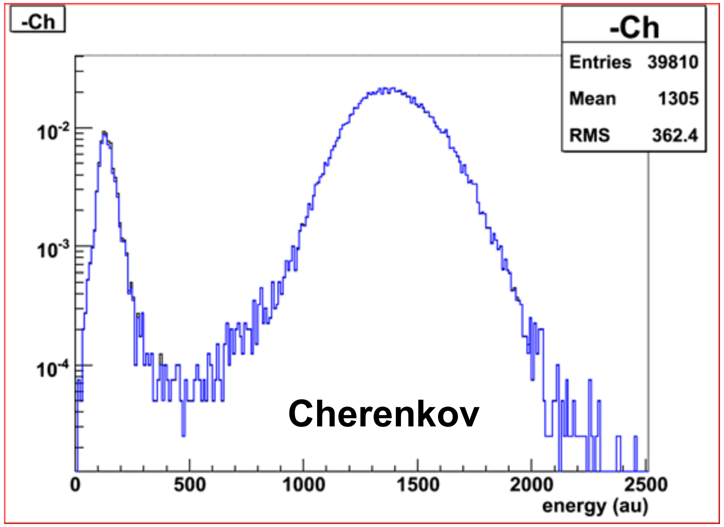
Cherenkov + Veto amplitude + muon trigger

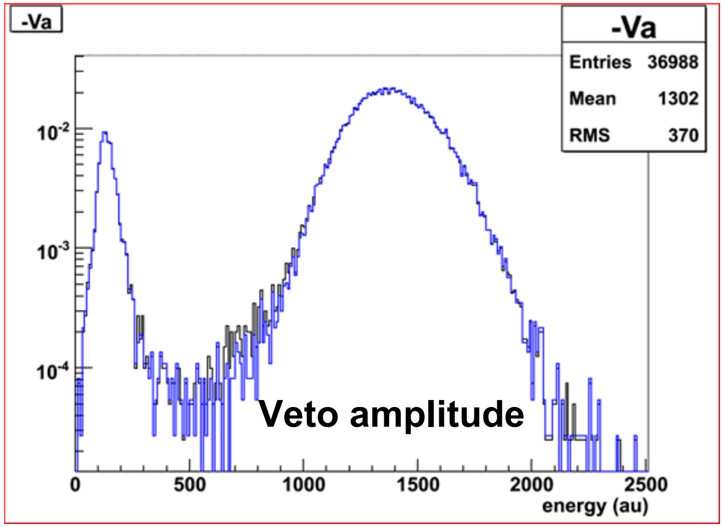
my favorite trigger combination

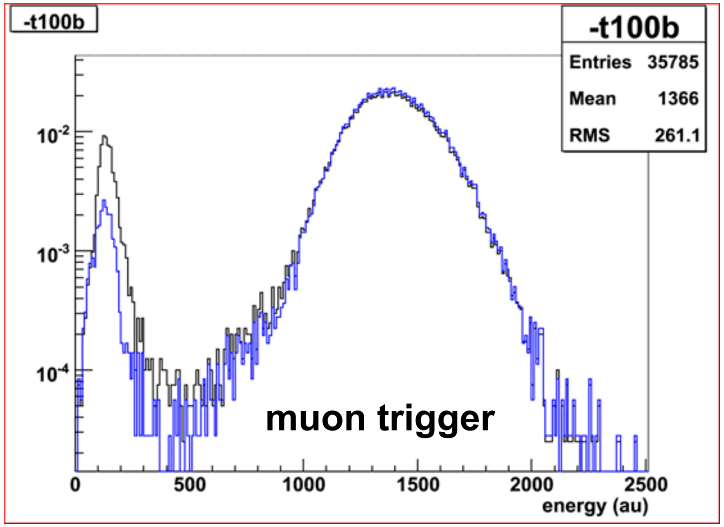
Summary of systematic studies with positrons

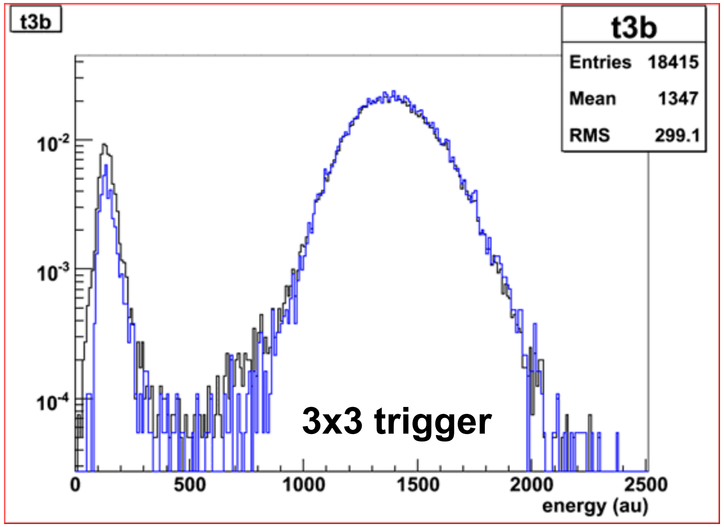
- Veto amplitude & muon trigger are always a good choice
- Cherenkov is a good choice for low energies
  - fine up to 20 GeV
  - costs a lot of statistics without improvement at 50 GeV
  - unfortunately no data points in-between
- Smaller acceptance (3x3 trigger) can do some good, but costs quite some statistics
  → may be the right choice for special studies

40 GeV pions in HCAL & TCMT

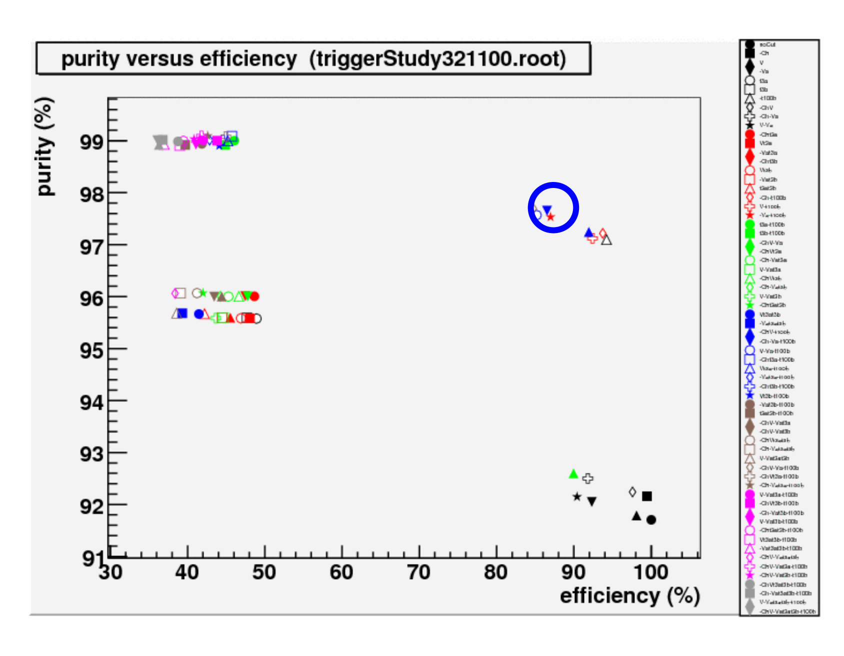


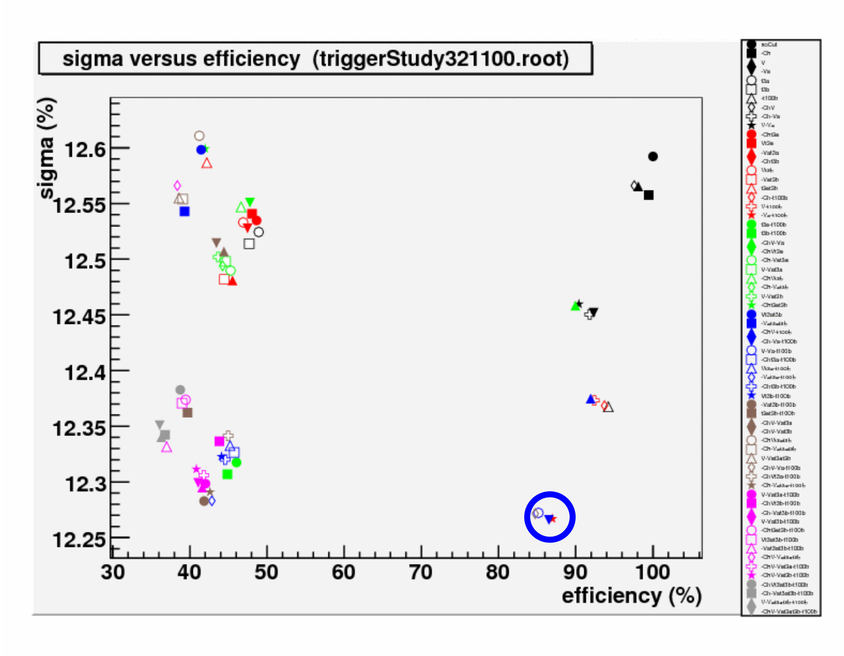






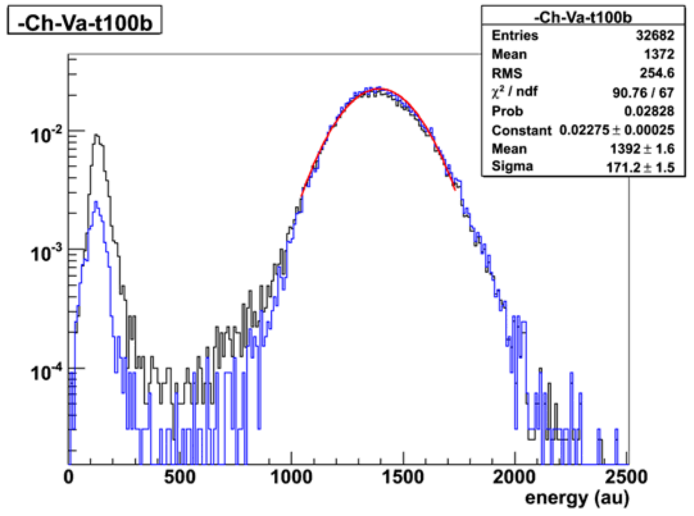
40 GeV pions HCAL + TCMT

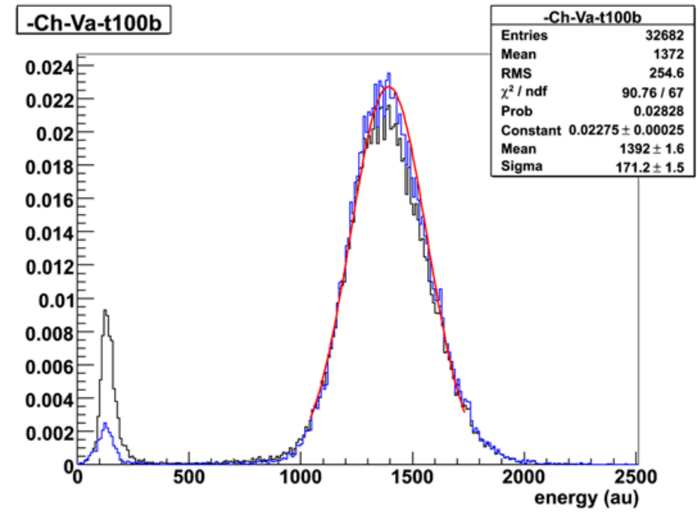




○ = Cherenkov + Veto amplitude + muon trigger

Result for pions





- only two energy points available → no systematic study possible
- But: Cherenkov, Veto amplitude and muon trigger are at least not the worst choice

Outlook

- Extend the cuts to detector-based triggers
  - muon detection with TCMT
  - pion/electron separation from depth of shower
  - tag halo muons
  - hadron leakage detection with TCMT
- Include ECAL into the pion trigger studies

Backup

shortcut	trigger	remarks
P	pedestal	excluded for this study
Co	cosmic	
Ca	calibration	excluded for this study
B	beam	
Ch	Cherenkov	
V	veto trigger	
Va	veto amplitude cut	values above 3850 ADC without pedestal substraction
t3a	3cmx3cm trigger A	
t3b	3cmx3cm trigger B	
t10a	10cmx10cm trigger A	coincidence used as beam trigger
t10b	10cmx10cm trigger B	
t100a	1mx1m trigger A	
t100b	1mx1m trigger B	muon trigger
S	spill	
G	generic	
O	oscillator	

triggers in grey fields were evaluated in this study