Overview

- Status @ Dubna
- Progress since Dubna
  - ➔ update of the geometry
  - ➔ reconstruction
    - ➢ muon identification
    - ➢ forward tracking
  - ➔ analysis
    - ➢ kinematic fitter
- Status of some benchmark studies
  - ➔ $\bar{p}\,p \to e^+ e^-$ @ η_C
  - ➔ $\bar{p}\,p \to \Lambda\,\bar{\Lambda}$ close to threshold
- Summary and timeline

Status @ Dubna

- Geometry
  - complete with DCH option in TS
- Digitization/reconstruction
  - full for MVD, central tracker, EMC and DCHs
  - simplified for Cherenkov detectors
- Tracking
  - Kalman filter incl. material budget for TS
  - dipole tracking not available so far
- (global) PID: Cherenkov counters & EMC
- Analysis
  - Simple composition tools
  - vertex tree fitter
  - 4C kinematic fitter not available so far

Status @ Dubna

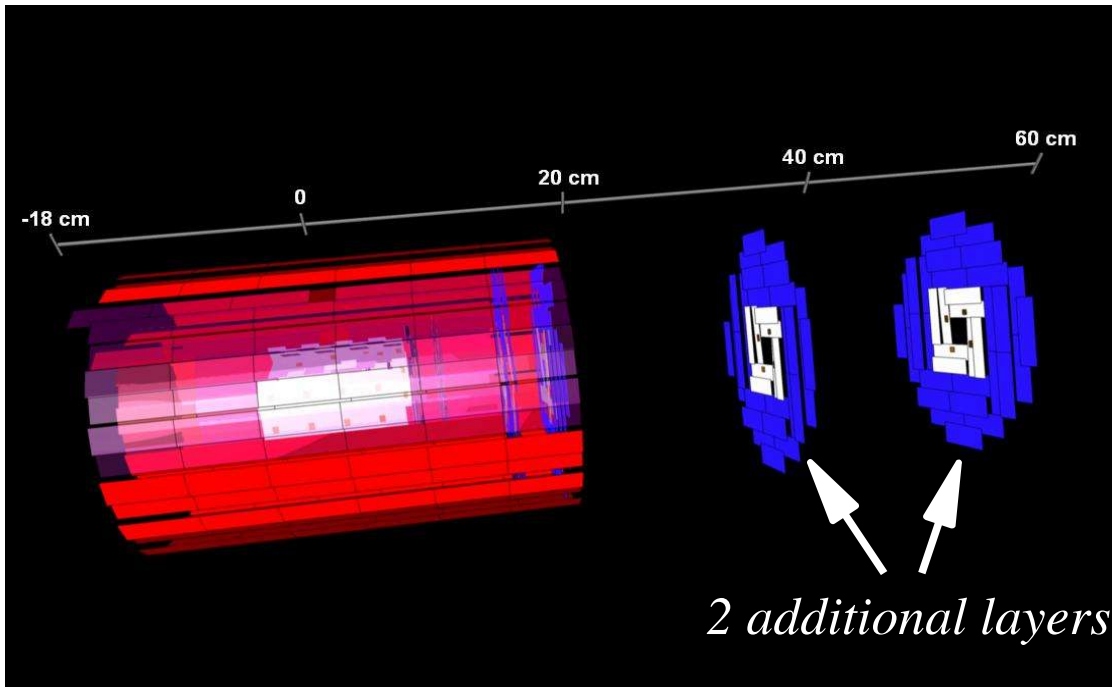
- First preliminary results for physics cases
  - charmonium spectroscopy
  - charmed hybrids
  - open charm production
  - electromagnetic formfactors

- PB convener meeting @ Dubna
  - get rid of 2nd priority channels
    - light mesons, generic channels, tetraquark search
  - new decay chains for
    - $\bar{p}\,p \to \Psi_g\,\eta$ with Ψ_g -> open charm
    - $\bar{p}\,p \to h_C \to \eta_c\,\gamma$ with η_C -> hadrons
  - some channels still open
    - $\bar{p}\,p \to \bar{\Xi}\,\Xi^*$, $\bar{p}\,p \to \gamma\,\gamma$, $\bar{p}\,p \to \pi^0\,\gamma$, $\bar{p}\,p \to l\,\bar{l}\,X$, $\bar{p}\,A \to J/\Psi\,X$

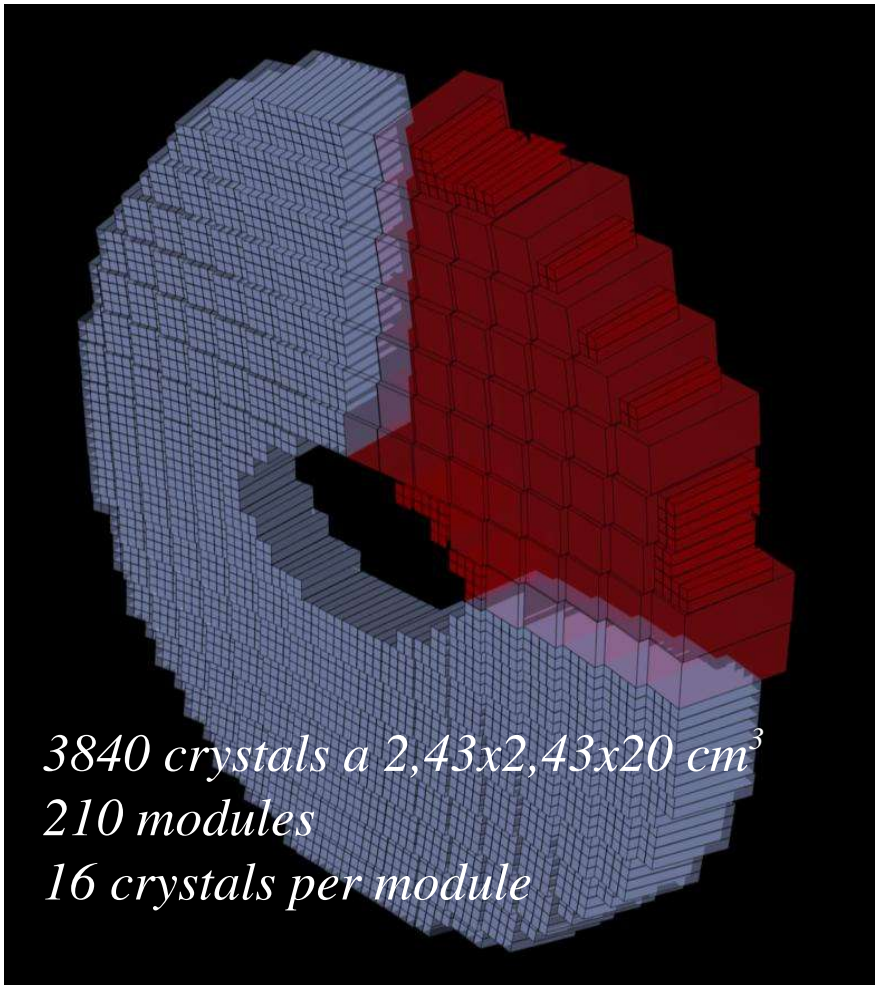
New: Geometry update

- 2 additional discs for MVD
- Latest KVI design of the forward endcap
- GEMs still in progress
  - ➔ will be available soon

MVD

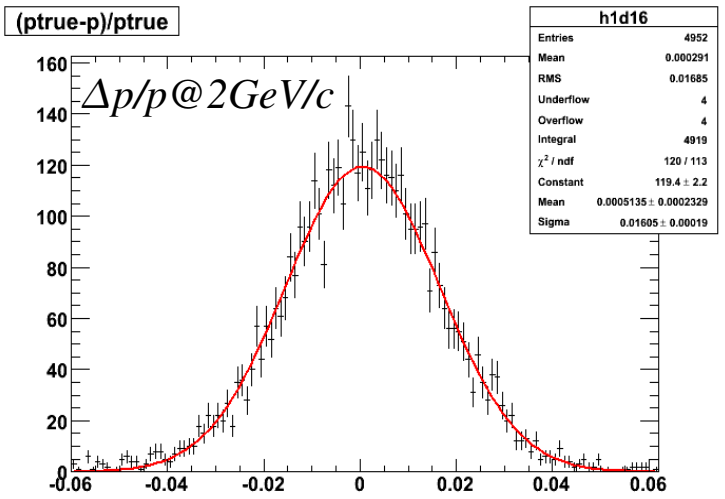


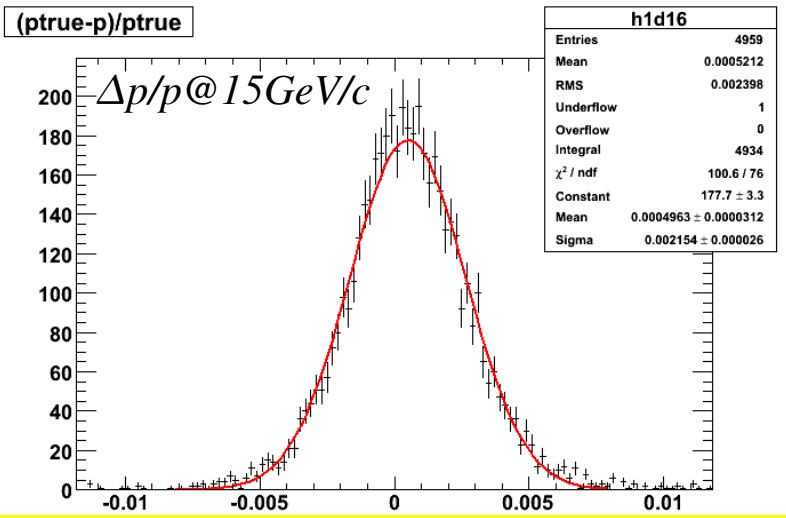
EMC forward endcap



New: Forward tracking

- Strategy
  - seperate fit in dipole region
    - 5^{th} order Runge Kutta method
  - combination with TS fit
    - dipole fit result as input for TS fitter
    - helix parameters for track representation
- Same results even for inhomogeneous dipole fields
- Momentum resolution for μ @ 1GeV/c
  - 1,5% for $p_{\bar{p}}$ @ 2GeV/c ; 0,2% for $p_{\bar{p}}$ @ 15GeV/c

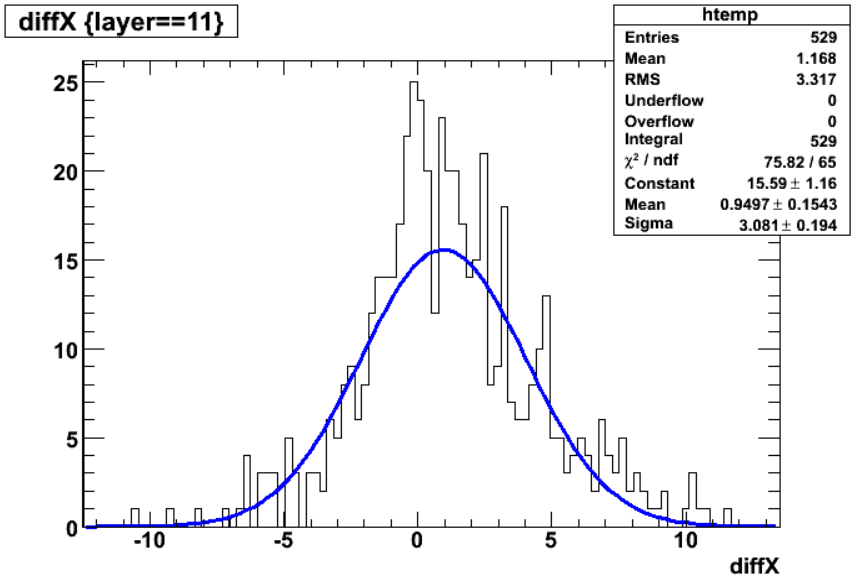


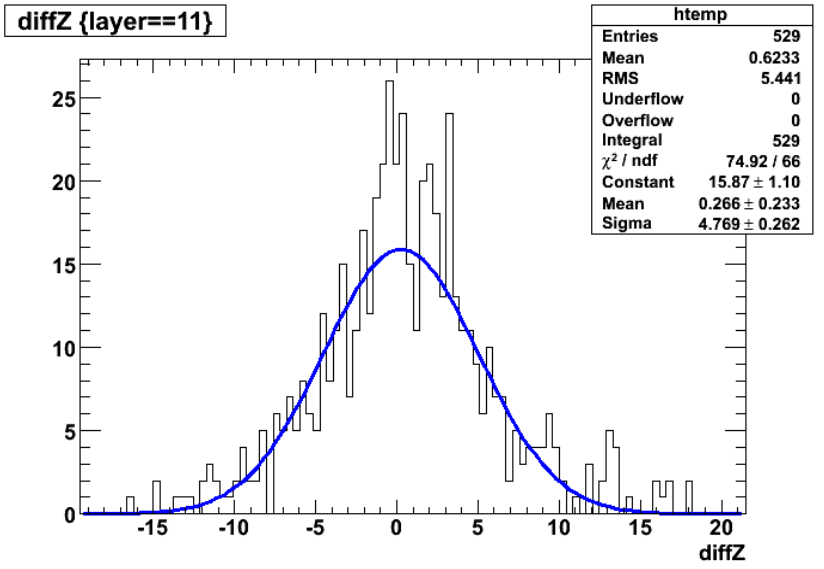


New: Muon identification

- Matching: hits <-> reconstructed tracks
  - expected hits by using swimmer (track follower) with μ hypothesis
    - with material effects and B-field inhomogenities
  - spatial resolution
    - $\sigma_{x,y}$ ~ 3 cm & σ_{z} ~ 5 cm for barrel part

- μ identification
  - probabilities based on number of matched hits and num. of expected hits
  - same behaviour for ~3% of the charged hadrons
  - more absorber material necessary ? -> more investigations needed





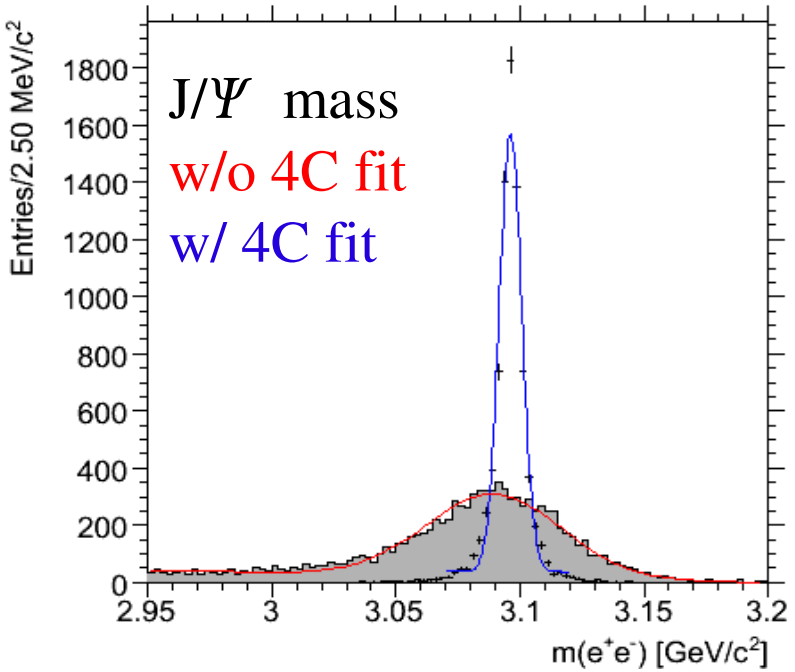
New: Kinematic fitting

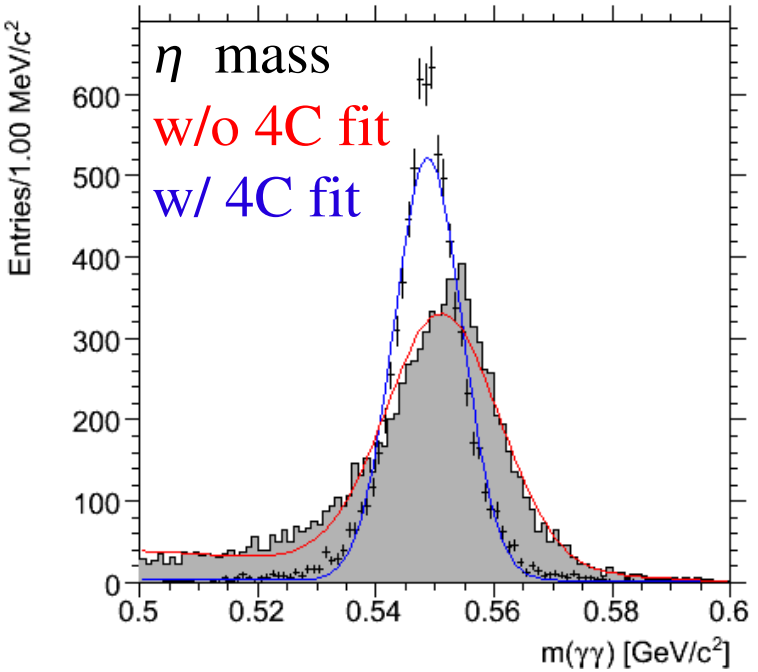
- All final state particles can be measured with PANDA detector
  - ➔ lots of informations available for an event
    - 4 vectors of each final state particle
    - beam properties -> 4-vector
    - (hypothetic) decay chains
    - common vertices
  - ➔ kinematic fit powerful analysis tool
    - strategy
      - variation of measured properties within their errors so that required constraints can be fulfilled
    - significant improvement of resolutions (-> example $\bar{p}\,p \to J/\psi\,\eta$)
    - efficient background suppression (-> example $\bar{p}\,p \to e^+\,e^-$)

New: Kinematic fitting

Example: $\bar{p}\,p \to J/\psi\,\eta \to e^+\,e^-\,\gamma\,\gamma$

- 4C & common vertex fit
  - ➔ constraints: 4-vector of $\bar{p}p$ system and common vertex for J/Ψ
- J/Ψ mass: $\sigma = 27 \pm 1$ MeV/c^2 -> $\sigma = 4{,}52 \pm 0.06$ MeV/c^2
- η mass: $\sigma = 9{,}6 \pm 0.1$ MeV/c^2 -> $\sigma = 5{,}79 \pm 0.07$ MeV/c^2



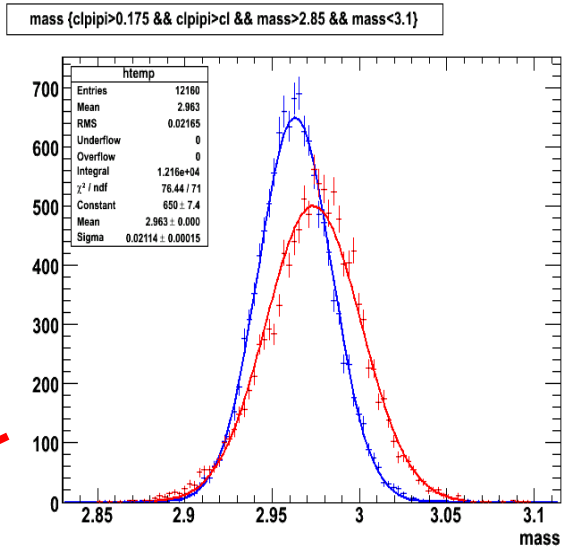


Benchmark channel: $\bar{p}\,p \to e^+\,e^-$

- Physics case
  - measurement of the differential cross section
  - determination of the electromagn. form factor of the proton

- Major background
  - $\bar{p}\,p \to \pi^+\,\pi^-$
  - cross section appr. 10^6 times higher

- Goal
  - $\pi^+\,\pi^-$ background rejection: 10^{-8}
  - cuts on kinematics not efficient
  - big challenge for PID
  - only possible by applying very tight cuts

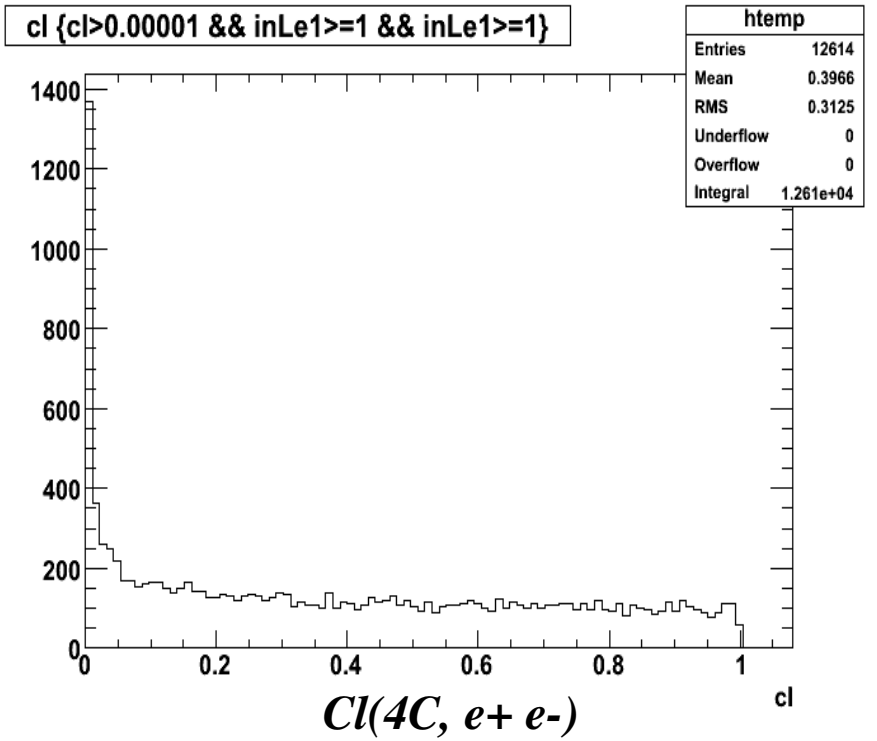


seems to be not right if using 4C fit

Benchmark channel: $\bar{p}\,p \to e^+\,e^-$

Physics Book simulations

- Generated events (phase space)
  - 20k e+ e- @ η_C *(with QED corrections)*
  - 10^7 π+ π- @ η_C *(with QED corrections)*
- 1st step
  - common vertex fit combined with
  - 4C fit for e+ e- hypothesis
    - p_x, p_y, p_z, e beam constraint
    - CL distribution flat
      - correct errors for measured particles
    - 1st cut: CL(4C,e+e-) > 0.1%



Cl(4C, e+ e-)

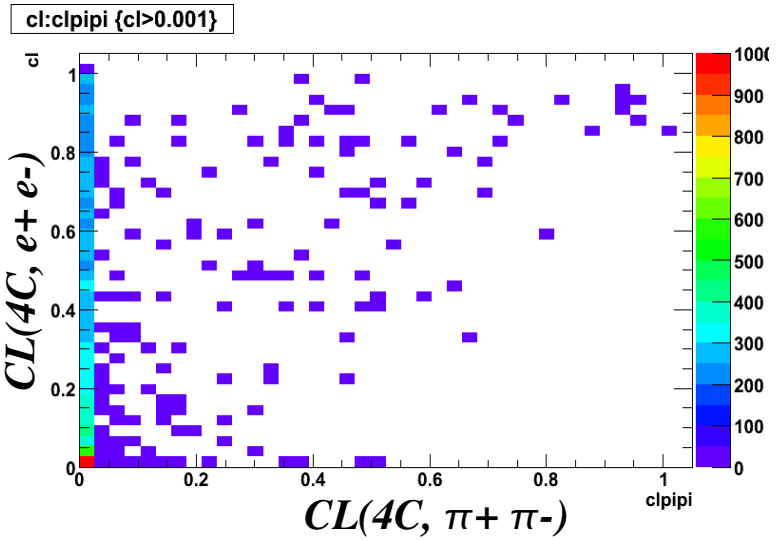
	$e^+ e^-$	$\pi^+ \pi^-$
charged list	61,18%	3,45%
very loose	58,09%	$3{,}23 * 10^{-5}$
loose	56,17%	$3{,}50 * 10^{-6}$
tight	46,41%	$3 * 10^{-7}$
very tight	38,43%	$1 * 10^{-7}$

Benchmark channel: $\bar{p}\,p \to e^+\,e^-$

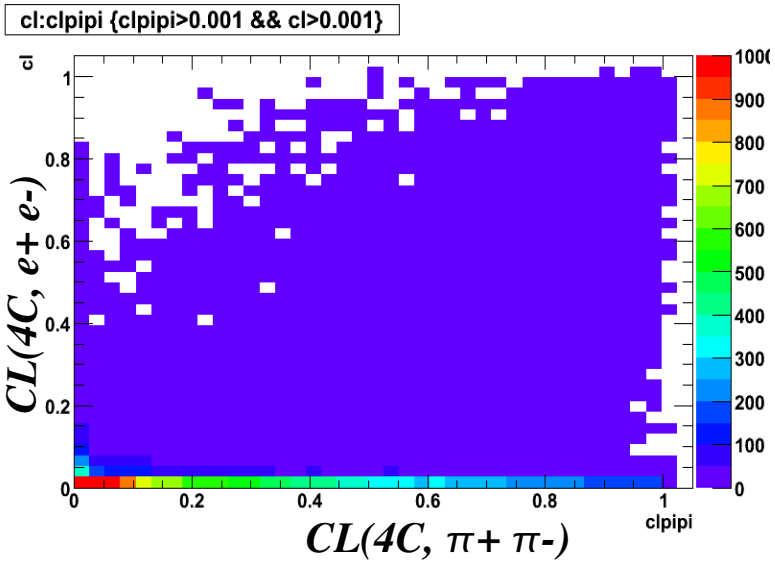
Physics Book simulations

- 2nd step
  - ➔ vertex&4C fit for π+ π- hypothesis
    - ➢ most of select. signal evts:
      CL(e+e-) > CL(π+ π-)
    - ➢ most of select. background evts
      CL(e+e-) < CL(π+ π-)
  - ➔ 2nd cut:
    CL(e+e-) > CL(π+ π-)

signal: charged tracks



background: charged tracks



1st cut

	$e^+ e^-$	$\pi^+ \pi^-$
charged list	61,18%	3,45%
very loose	58,09%	$3{,}23 * 10^{-5}$
loose	56,17%	$3{,}50 * 10^{-6}$
tight	46,41%	$3 * 10^{-7}$
very tight	38,43%	$1 * 10^{-7}$

2nd cut

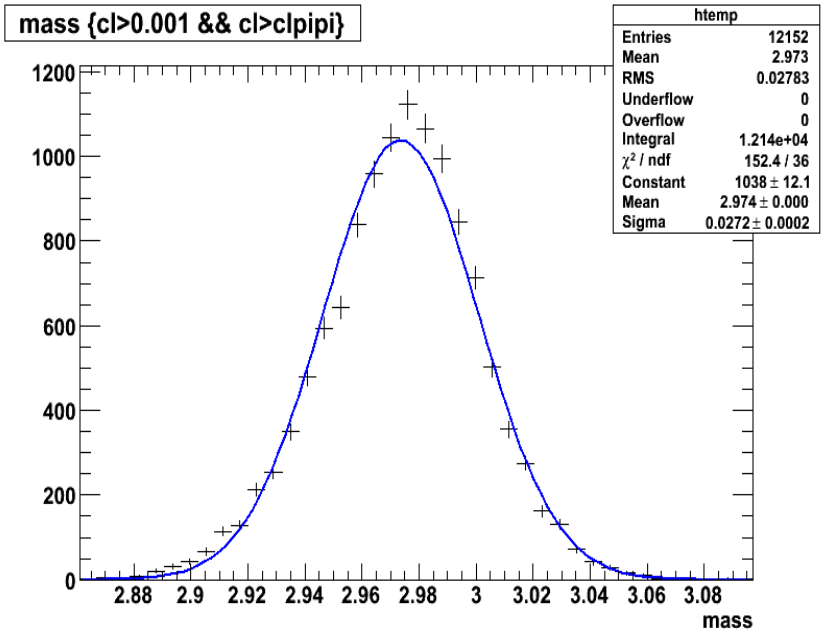
	$e^+ e^-$	$\pi^+ \pi^-$
charged list	60,76%	$8{,}49 * 10^{-3}$
very loose	57,69%	$5{,}00 * 10^{-6}$
loose	55,81%	$6 * 10^{-7}$
tight	46,15%	$1 * 10^{-7}$
very tight	38,21%	$< 10^{-7}$

Benchmark channel: $\bar{p}\,p \rightarrow e^+\,e^-$

Physics Book simulations

- Selection via 4C fit seems to help
  - → $8{,}5 * 10^{-3}$ background rejection without any PID
  - → more than 1 order of magnitude less background for electron lists
  - → gaussian mass distr. for signal evts (not fitted cands after cut):
    $\sigma\,(M_{e+e-}) = 27{,}2\ \mathrm{MeV}/c^2$

e+e- mass for signal events



Dubna

	$e^+\,e^-$ no QED corr.	$\pi^+\,\pi^-$
very loose	75,10%	$5{,}4 * 10^{-5}$
loose	69,10%	$4{,}5 * 10^{-6}$
tight	53,30%	$1{,}0 * 10^{-6}$
very tight	37,40%	$1{,}0 * 10^{-7}$

now

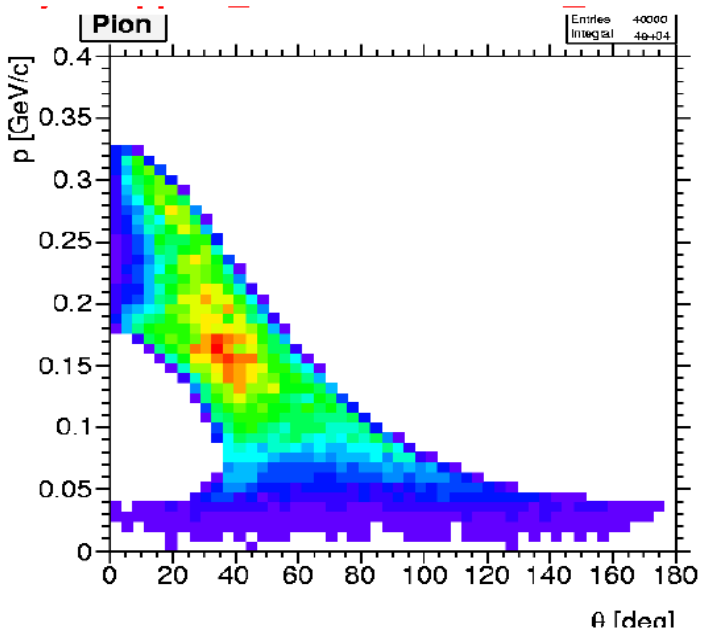
	$e^+\,e^-$ no QED corr.	$e^+\,e^-$ w/ QED corr.	$\pi^+\,\pi^-$
charged	-	60,76%	$8{,}49 * 10^{-3}$
very loose	73,10%	57,69%	$5{,}0 * 10^{-6}$
loose	70,60%	55,81%	$6 * 10^{-7}$
tight	58,37%	46,15%	$1 * 10^{-7}$
very tight	48,91%	38,21%	$< 10^{-7}$

Benchmark channel: $\bar{p}\,p \rightarrow \Lambda\,\bar{\Lambda} \rightarrow p\,\pi^-\,\bar{p}\,\pi^+$

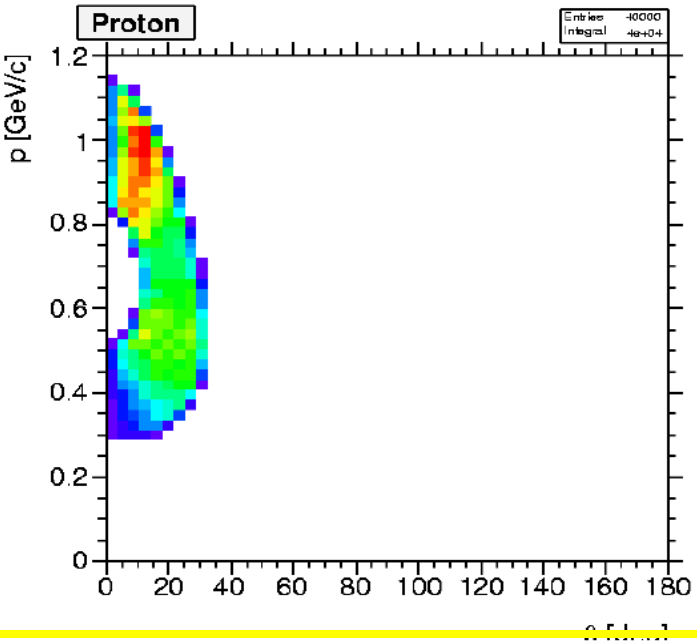
Sophie Grape, Eric Thome (Uppsala)

- Analysis close to threshold (1,64 GeV/c) started
  - ➔ assumption: 100% polarization
  - ➔ unisotropic production in CMS (->peak in forward direction for $\bar{\Lambda}$)
  - ➔ challenge for reconstruction
    - ➢ very low momentum pions (<350 MeV/c)
- Investigations also @3 GeV/c started and @ 15 GeV/c planned

Pions close to threshold



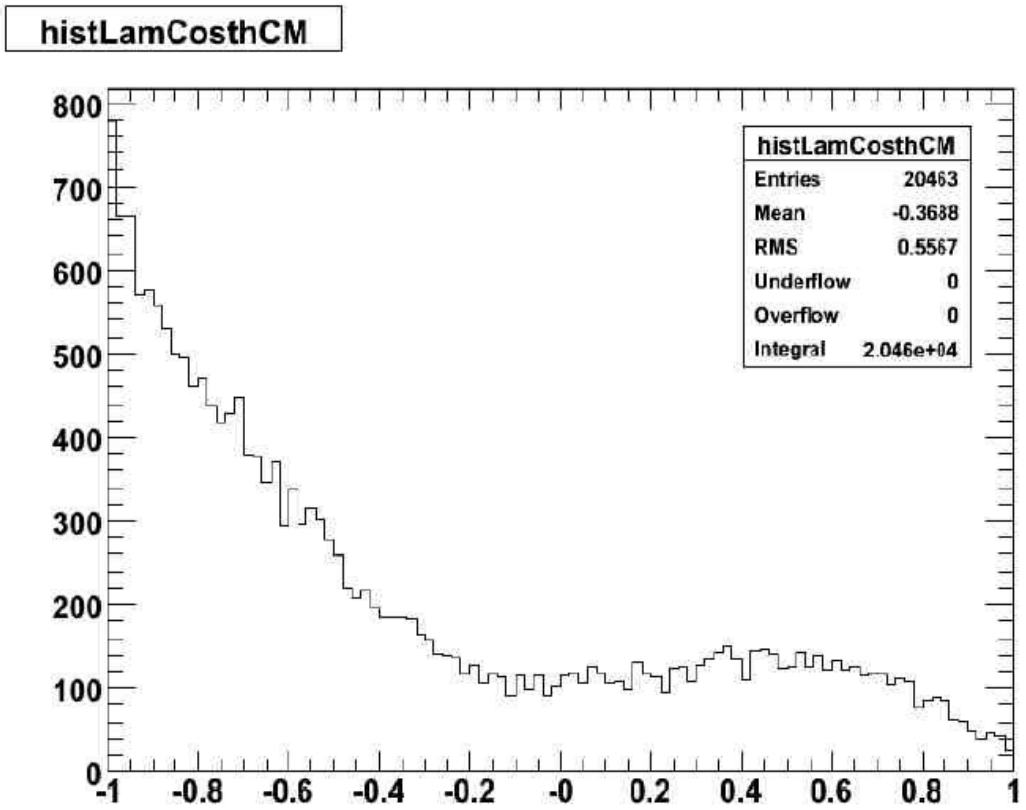
Protons close to threshold



Analysis @ Threshold

Sophie Grape, Eric Thome (Uppsala)

- Reconstruction efficiency: 20,5%
- Angular distribution of Λ production looks fine



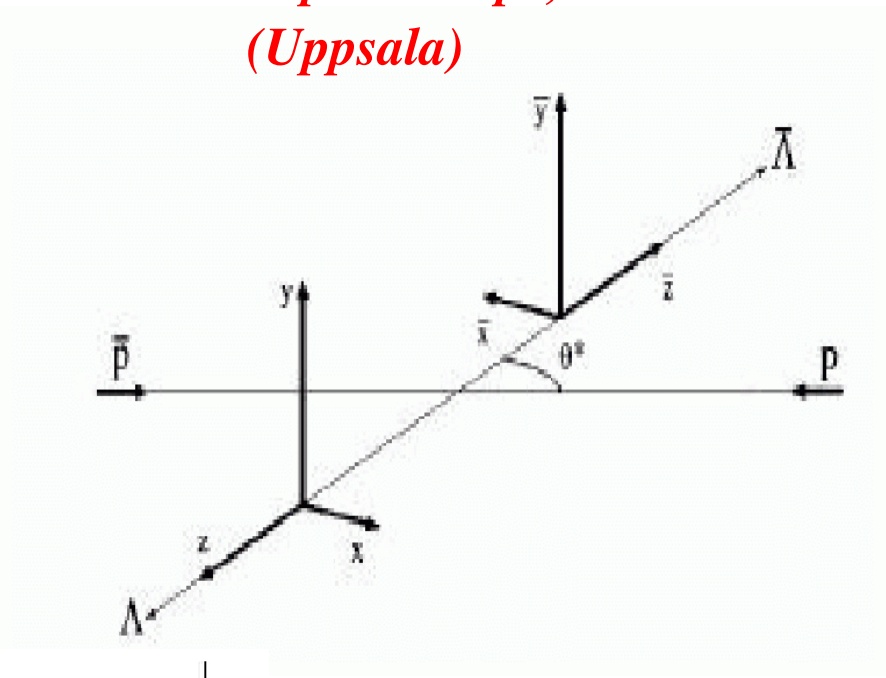
Benchmark channel: $\bar{p}\,p \to \Lambda\,\bar{\Lambda} \to p\,\pi^-\,\bar{p}\,\pi^+$

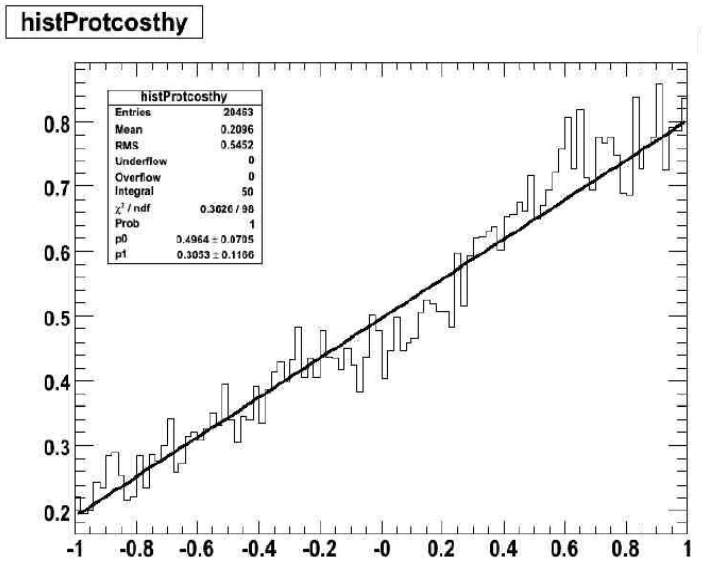
Physics Book simulations

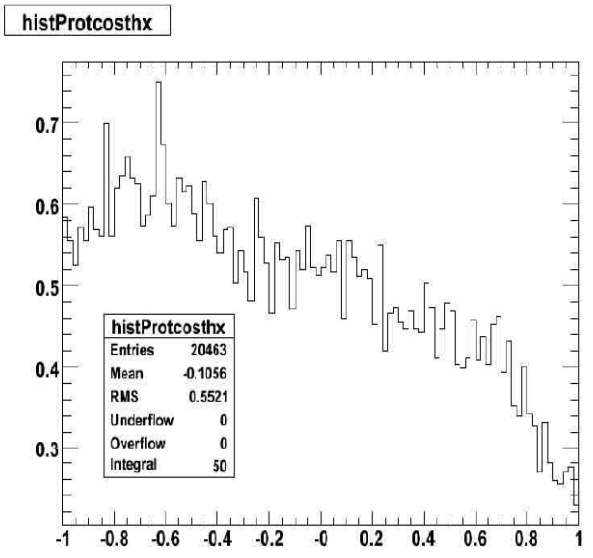
Analysis close to threshold

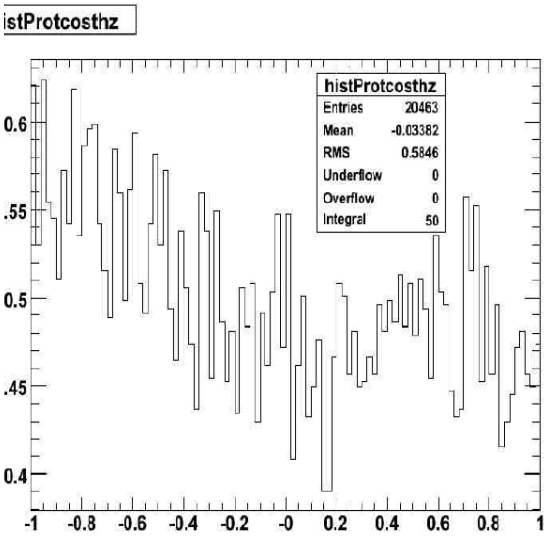
Sophie Grape, Eric Thome (Uppsala)

- Polarisation
  - ➔ perpendicular to the production plane
  - ➔ result
    - ➢ y direction o.k.: 0,979 ± 0,019
    - ➢ x & z direction not flat
      - · loss of acceptance
  - ➔ problems with low momentum pions ?
    - ➢ pions are curling below 150MeV/c
    - ➢ more investigations needed









Summary

- All detector components available in simulation, digitization & reconstruction
  - only simplified for Cherenkov & Muon detectors
- Analysis
  - high level analysis tools available
    - Simple Composition Tools
    - kinematic fitter
      - combination constraints for decay vertiezes, 4C & masses possible
  - good progress for each benchmark study
- Mass production
  - automated tools for job distributions ready
  - storage via database
- Still to be done
  - implementation of GEM detectors
  - general improvements
- Start of event mass prodcution: End of November 2007