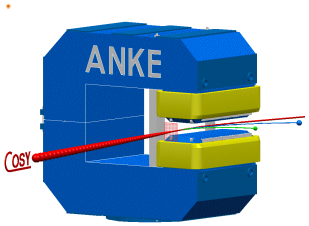

Westfälische
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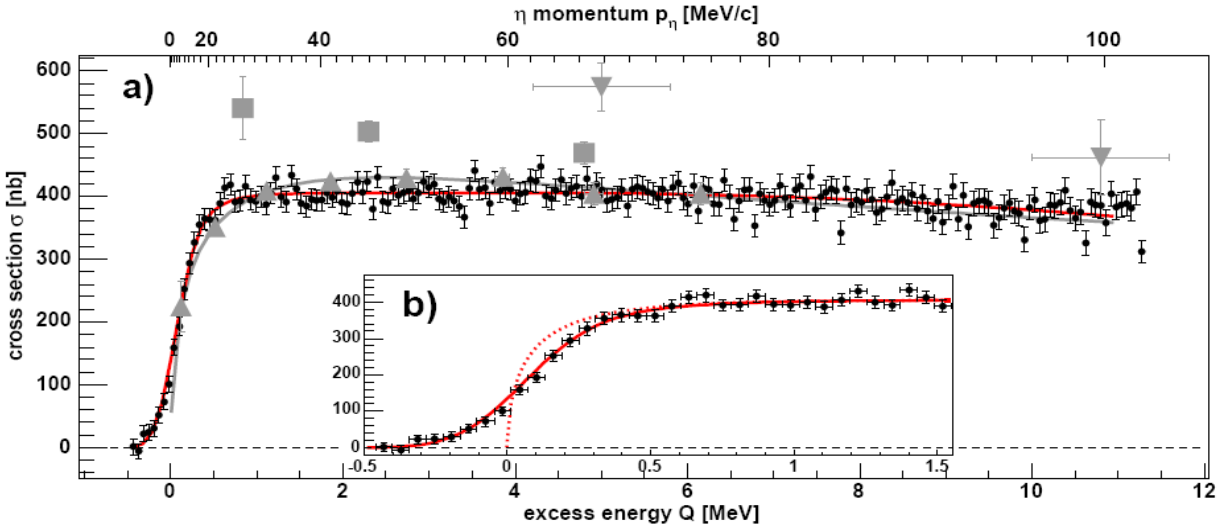
Pion production in dp-collisions at ANKE

Malte Mielke

Institut für Kernphysik
WWU Münster

Status of data analysis from dp → ^{3}Heη beam time at ANKE in January 2005

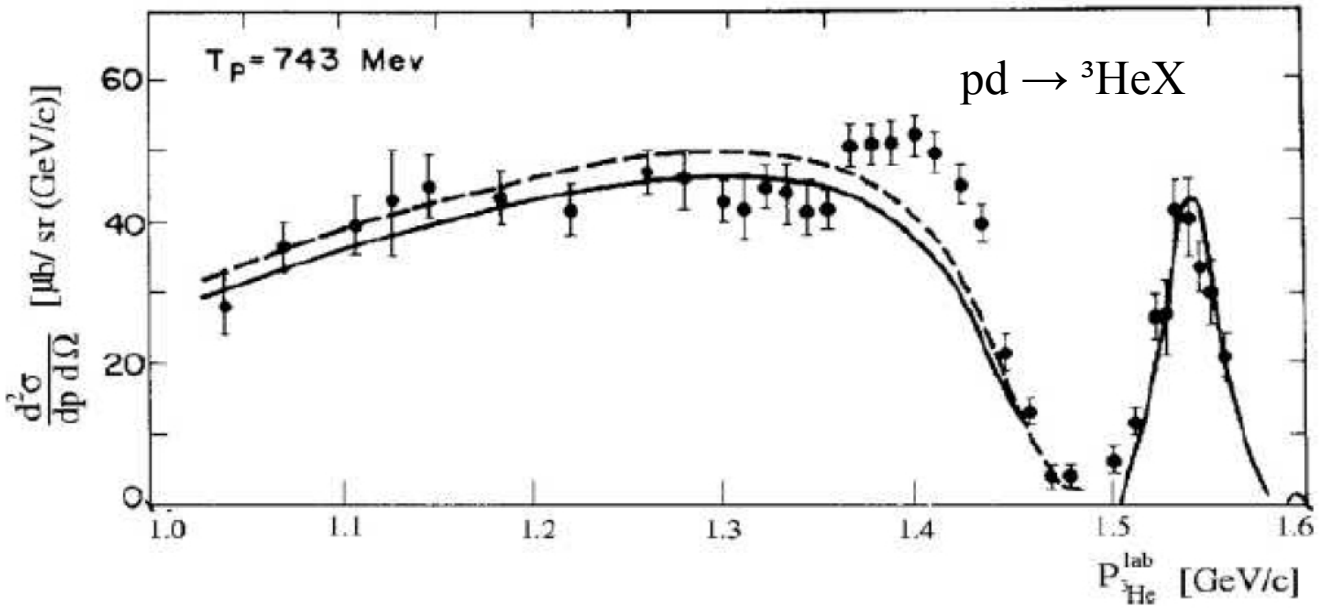
- Precision study of the η ^{3}He system by Timo Mersmann (finished,PRL) and Tobias Rausmann (20, 40 and 60 MeV above η threshold, in progress)



- Study of pion production in dp → ^{3}Heπ^0 (Michael Papenbrock) and dp → ^{3}He$\pi^+\pi^-$ (Malte Mielke) (in progress)

Double pionic fusion and the ABC effect

- 1960: A. Abashian, N. E. Booth and K. M. Crowe observe an unexpected enhancement for low $\pi\pi$ invariant masses in pd → ^{3}HeX (later referred to as ABC effect)

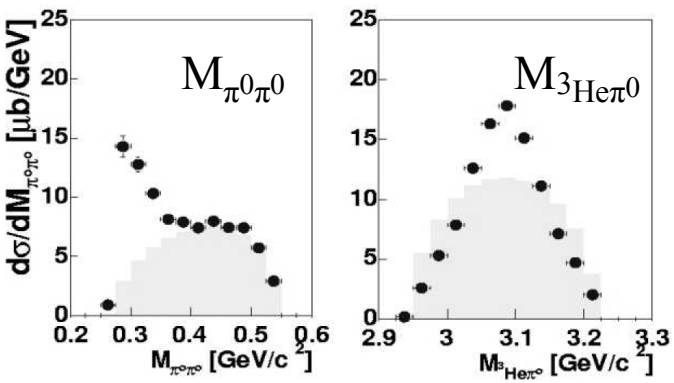


Exclusive measurements of ABC effect at WASA

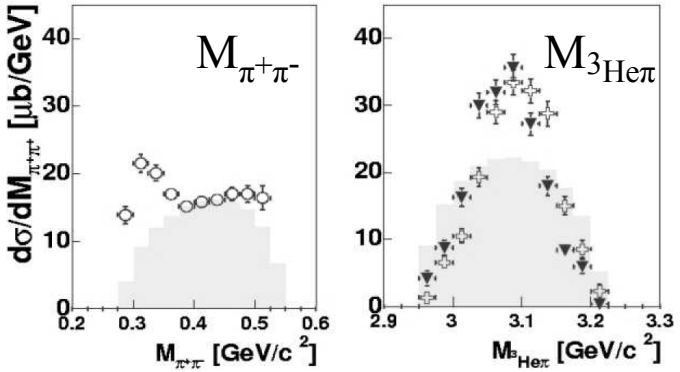
- Investigation of pd → ^{3}Heππ by M. Bashkanov et al. (T_p= 895 MeV)
- Enhancement at low ππ invariant mass spectra always seems to come along with excitation of Δ resonances
- Model of ΔΔ excitation with FSI is a possible solution to describe the existing data

$$\Delta \rightarrow N + \pi$$

neutral pions



charged pions



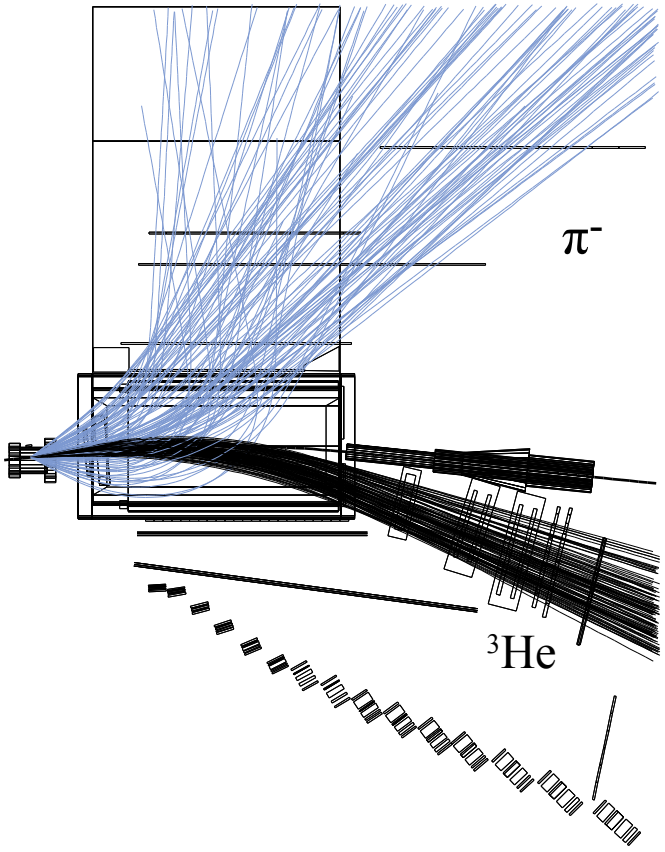
ANKE`s view on the ABC effect

deuteron beam: $T_d = 1.857$ GeV

^{3}He: detected in forward system

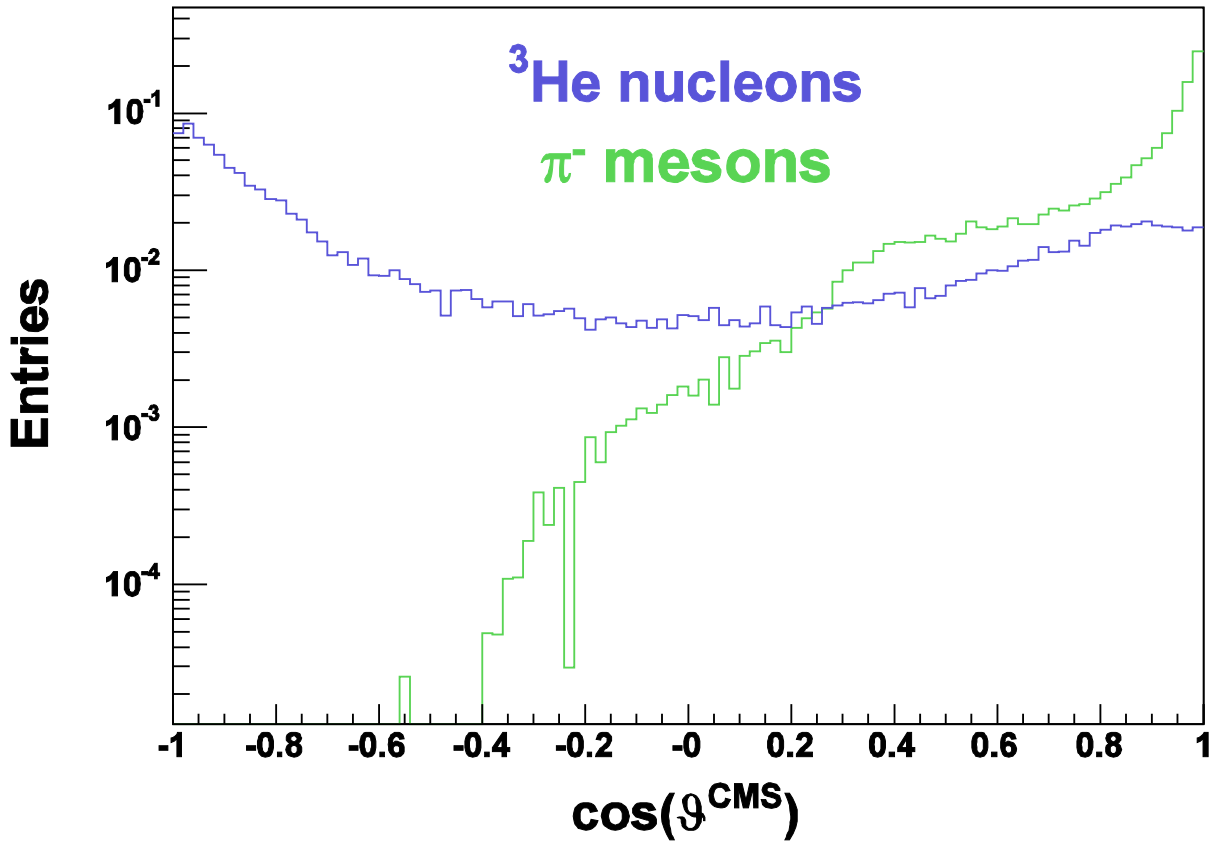
π^-: detected in negative system

π^+: identified and reconstructed via missing mass technique

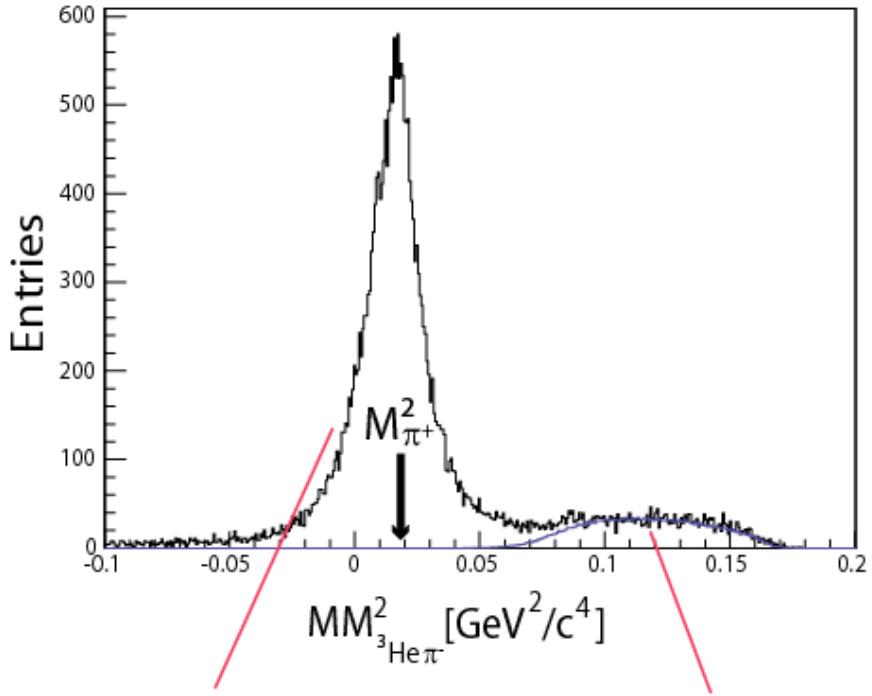


Acceptance for dp → ^{3}He$\pi^+\pi^-$

Request: coincident hits of ^{3}He and π^-



Identification of two pion production via missing mass



Explicit separation of two and three pion production

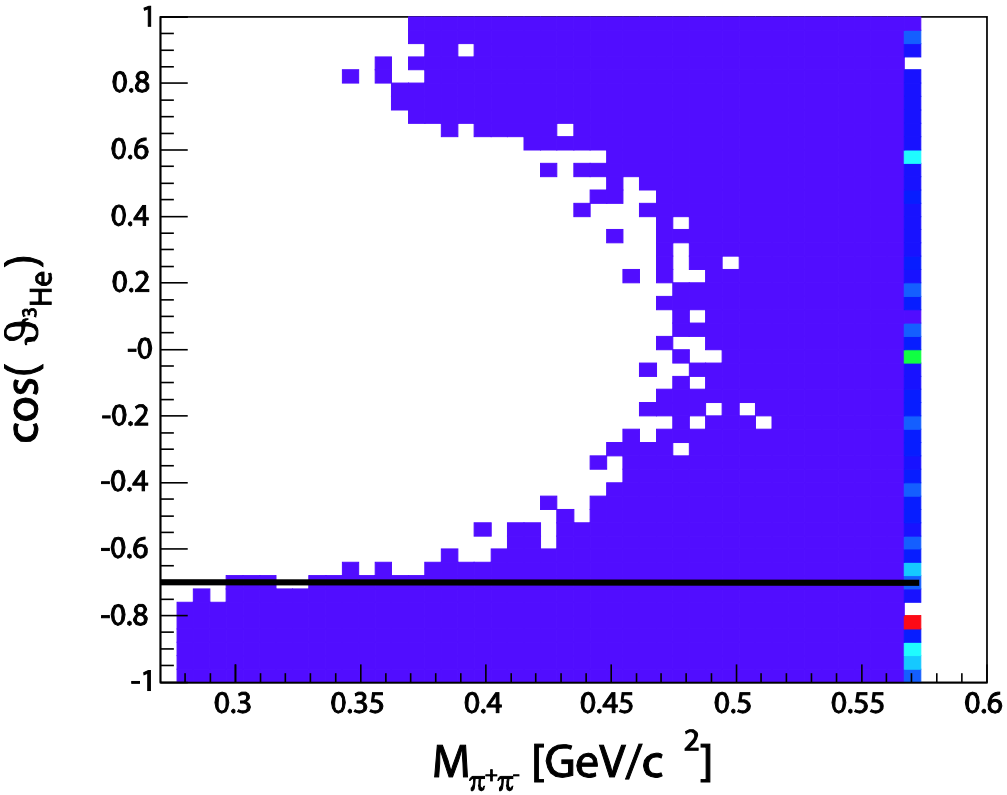
Clear selection of

dp → ^{3}He π^+ π^- with almost no background

two pion production
dp → ^{3}He π^+ π^-

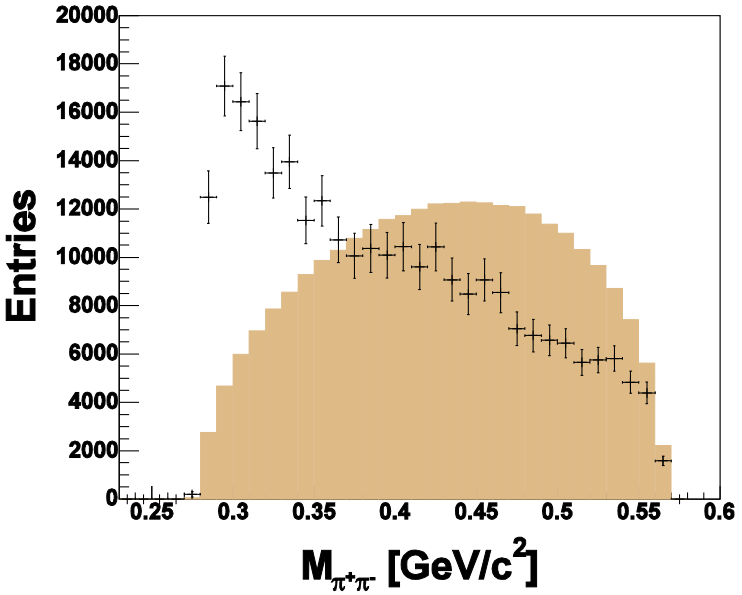
three pion production
dp → ^{3}He π^0 π^+ π^-
dp → ^{3}Heη [η → π^0 π^+ π^-]

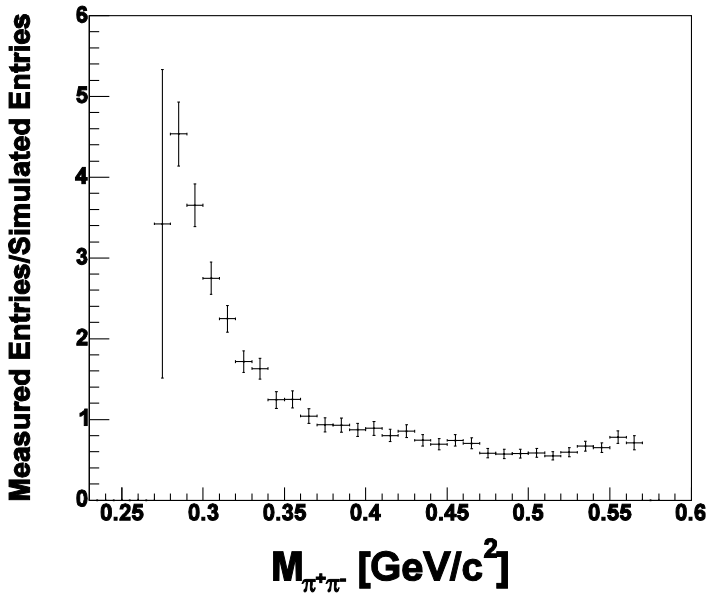
Acceptance of ππ invariant mass spectrum



Full ππ invariant mass spectrum for $\cos(\theta) < -0.7$

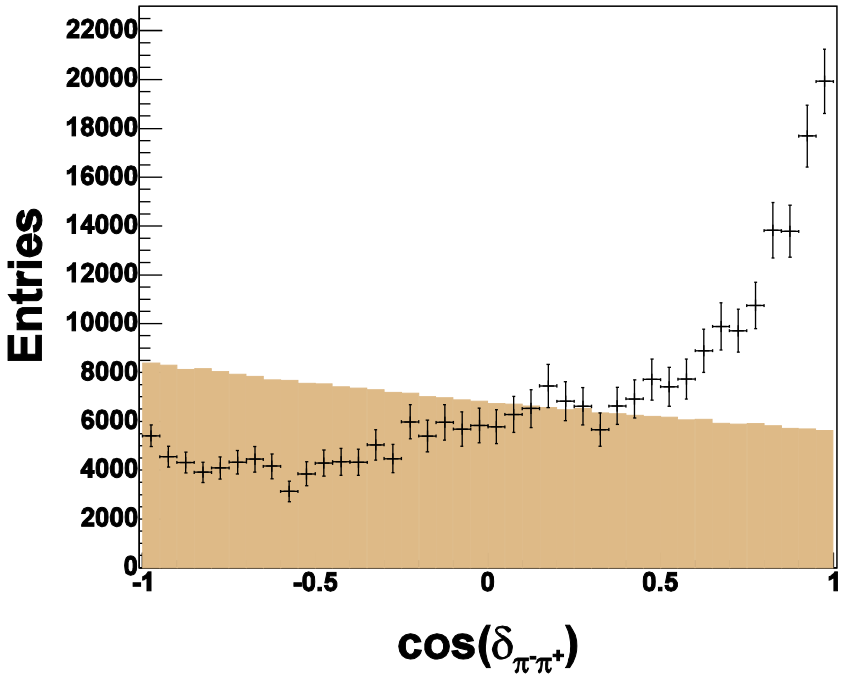
ABC effect in ππ invariant mass spectrum





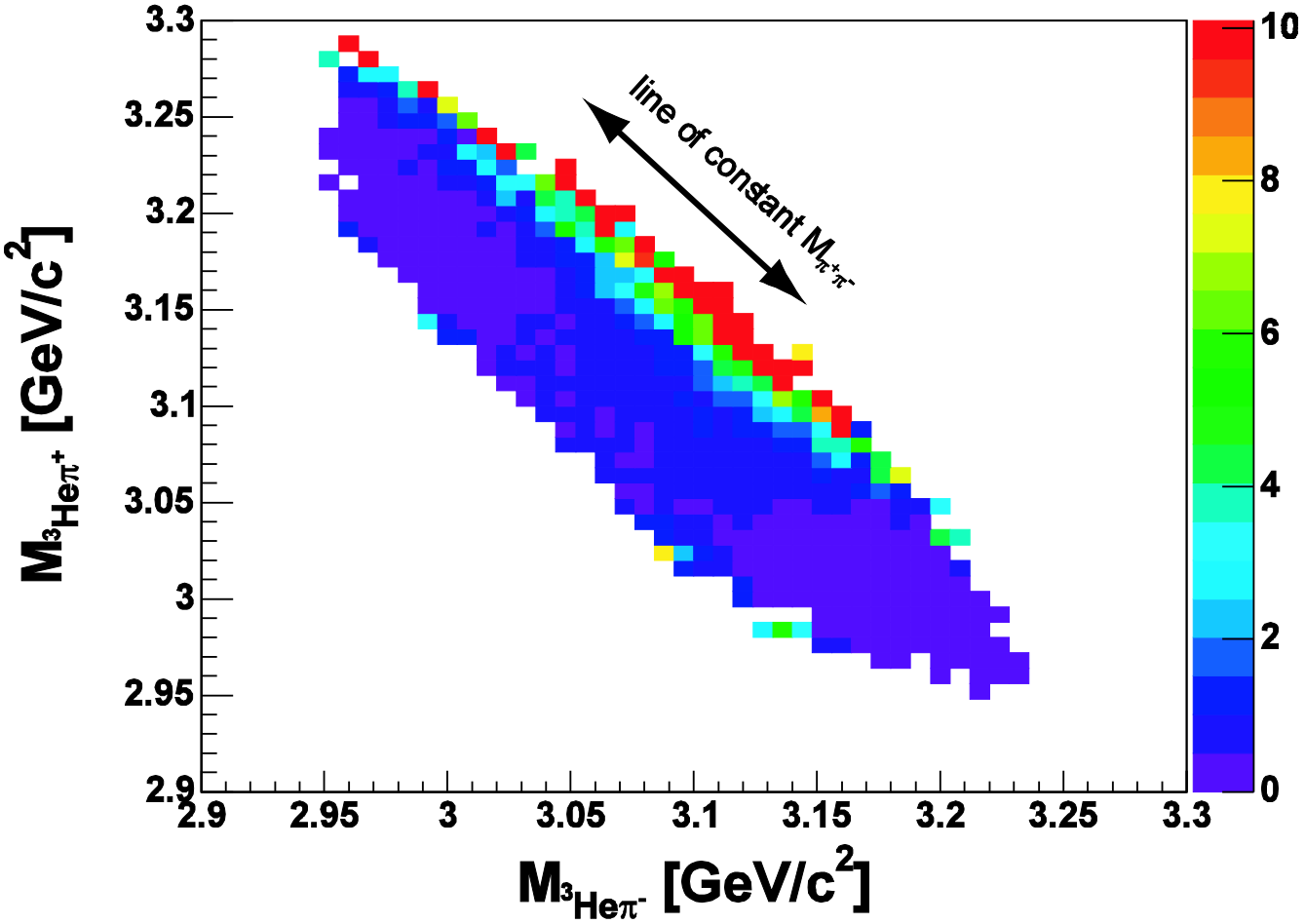
Ratio of measured data and phase space simulations allows for quantification of the ABC effect

ππ opening angle



- Small invariant masses → small relative momenta → small opening angles
- Confirmes invariant mass spectrum

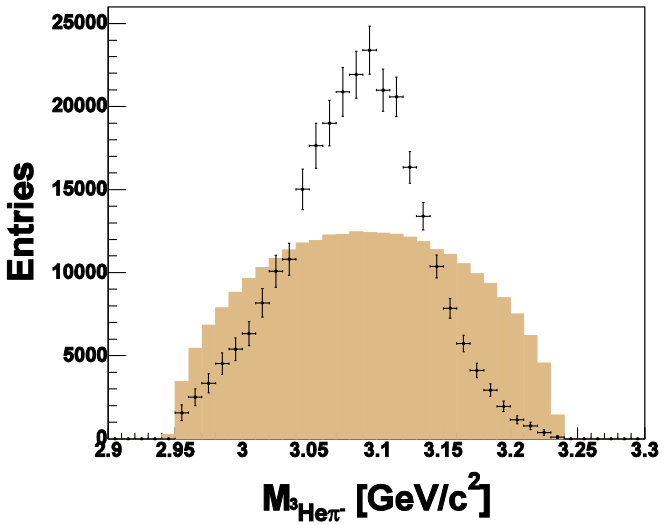
Dalitz Plot

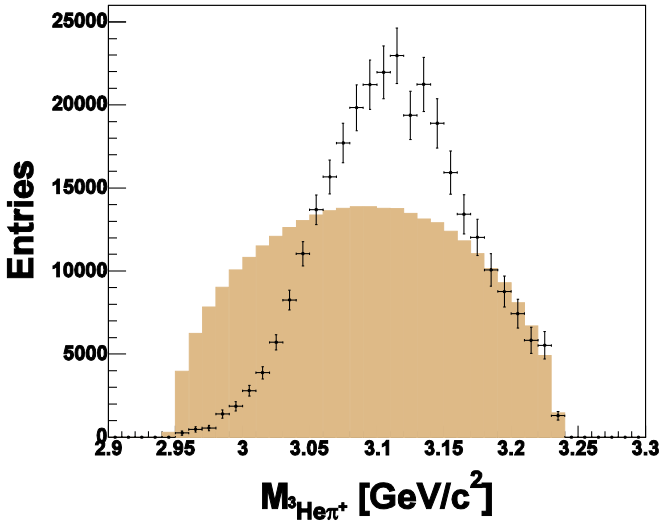

line of constant $M_{\pi^+\pi^-}$
$M_{^3He\pi^+}$ [GeV/c^2]
$M_{^3He\pi^-}$ [GeV/c^2]
3.3
3.25
3.2
3.15
3.1
3.05
3
2.95
2.9
10
8
6
4
2
0

Invariant masses of the $^3He\pi$ systems

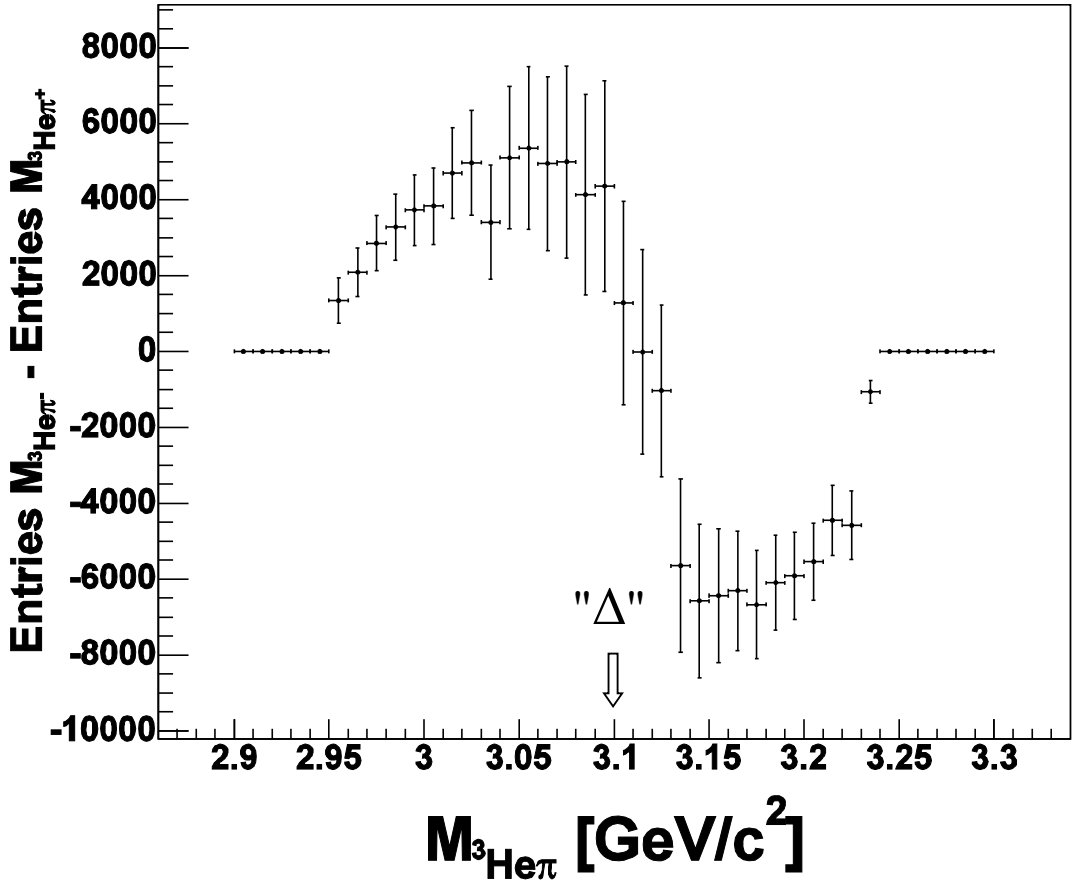
- Clear signs of Δ resonance in both invariant mass spectra ($^3He\pi^-$ and $^3He\pi^+$)
- In case of pure $\Delta\Delta$ excitation the shape of both distributions should be equal
- Indication of N* contribution

$$N^* \rightarrow \Delta\pi \rightarrow N\pi\pi$$





Difference between both $M_{^3He\pi}$ spectra

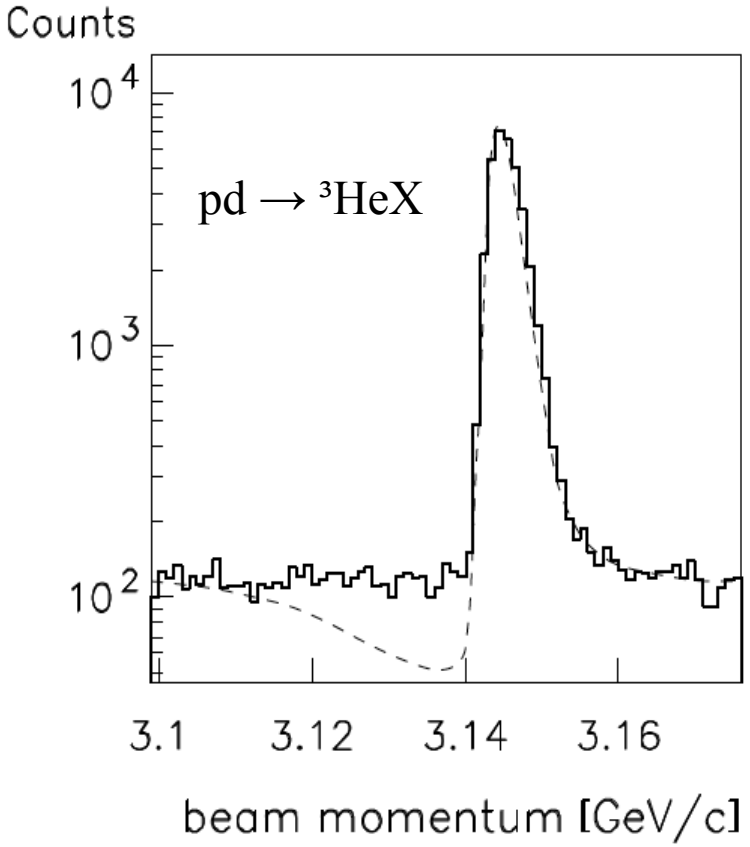


$N^* \rightarrow \boxed{\begin{array}{l}\Delta^{++} \rightarrow p\,\pi^+ \\ \Delta^0 \rightarrow p\,\pi^-\end{array}}$

$N^* \rightarrow \pi^-\Delta^{++}$
strongly preferred to
$N^* \rightarrow \pi^+\Delta^0$

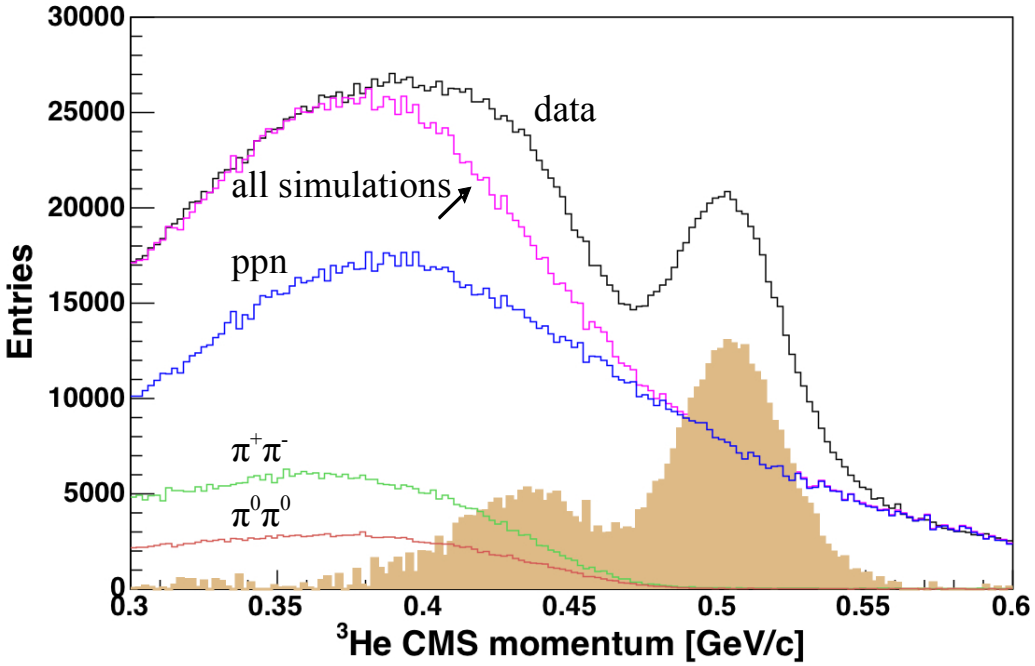
tail of the Δ to higher masses leads to an enhancement of $M_{^3He\pi^+}$ above the Δ position

Possible cusp effect in $dp \rightarrow {}^3He\pi^0$



- Investigations on a „cusp“ in the excitation function of pd → ³HeX close to η threshold
- Observed at SATURNE (dashed line,³He in forward direction), but not at COSY-11 (solid line, ³He in backward direction)
- Further investigations on the π^0 production necessary

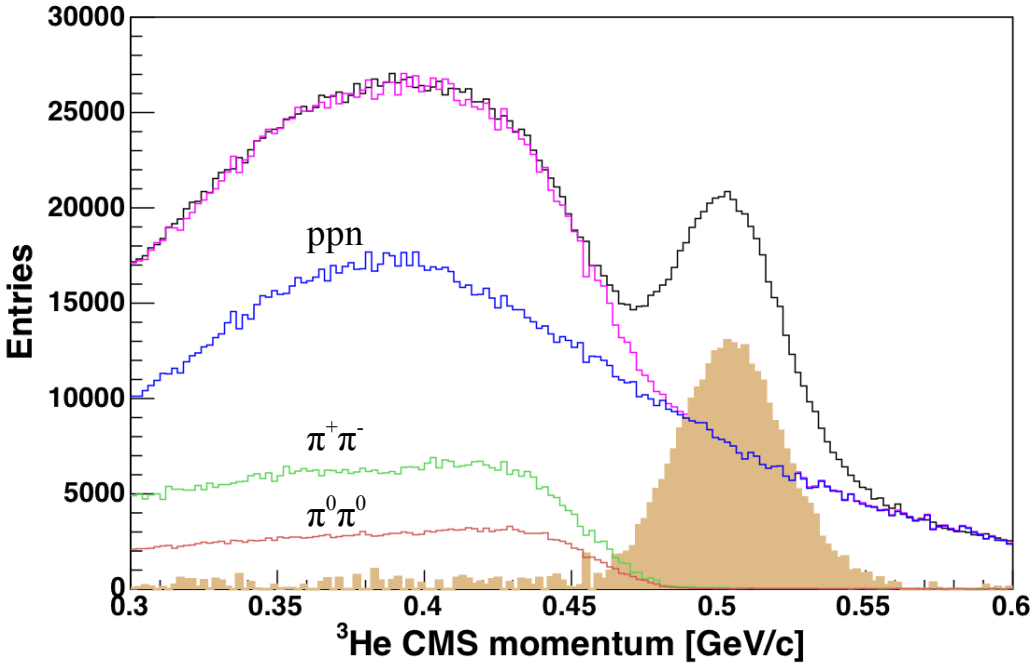
Extraction of π^0 signal



- Backgound analysis at 20 MeV above η threshold (high statistics, constant beam momentum)
- $+0.80 < \cos(\theta) < +1.00$ due to geometrical acceptance
- Monte Carlo simulations for description of the background

Discrepancy between experimental data and phase space simulations!

ABC effect revisited



- Discrepancy assumed to be completely caused by the ABC effect

⇩

Introduction of an „artificial“ ABC effect

⇩

Simulation of double pion production can be fitted to experimental data

- Corrected data permit a clear extraction of the π^0 signal

Next steps

- Apply obtained description of the ABC effect on data close to the η threshold

- Determine differential cross sections for the reaction $d+p \rightarrow {}^3He+\pi^0$ with respect to a possible cusp effect.

Summary

- ABC effect in double pionic fusion is still an open issue of research
- Two pion production can be investigated well with ANKE
- Results are comparable with those of WASA and provide important information to study the relevant processes of the ABC effect
- Possible explanations for the ABC effect are (among others) $\Delta\Delta$ and N* excitation
- Investigation of single pion production delivers differential cross sections and possibly allows for investigation of a cusp effect