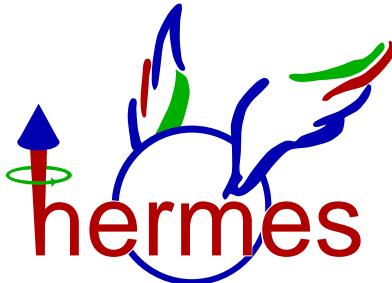


Hard Exclusive Electroproduction of 2 Pions Off Proton and Deuteron at

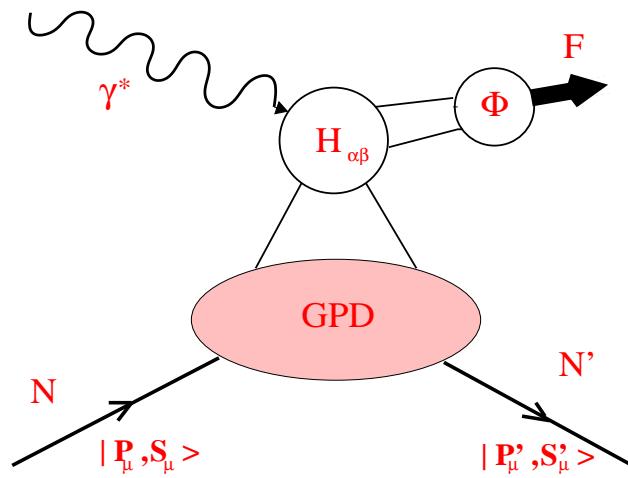


Riccardo Fabbri

on behalf of the *HERMES* Collaboration
Ferrara University - *INFN* Frascati

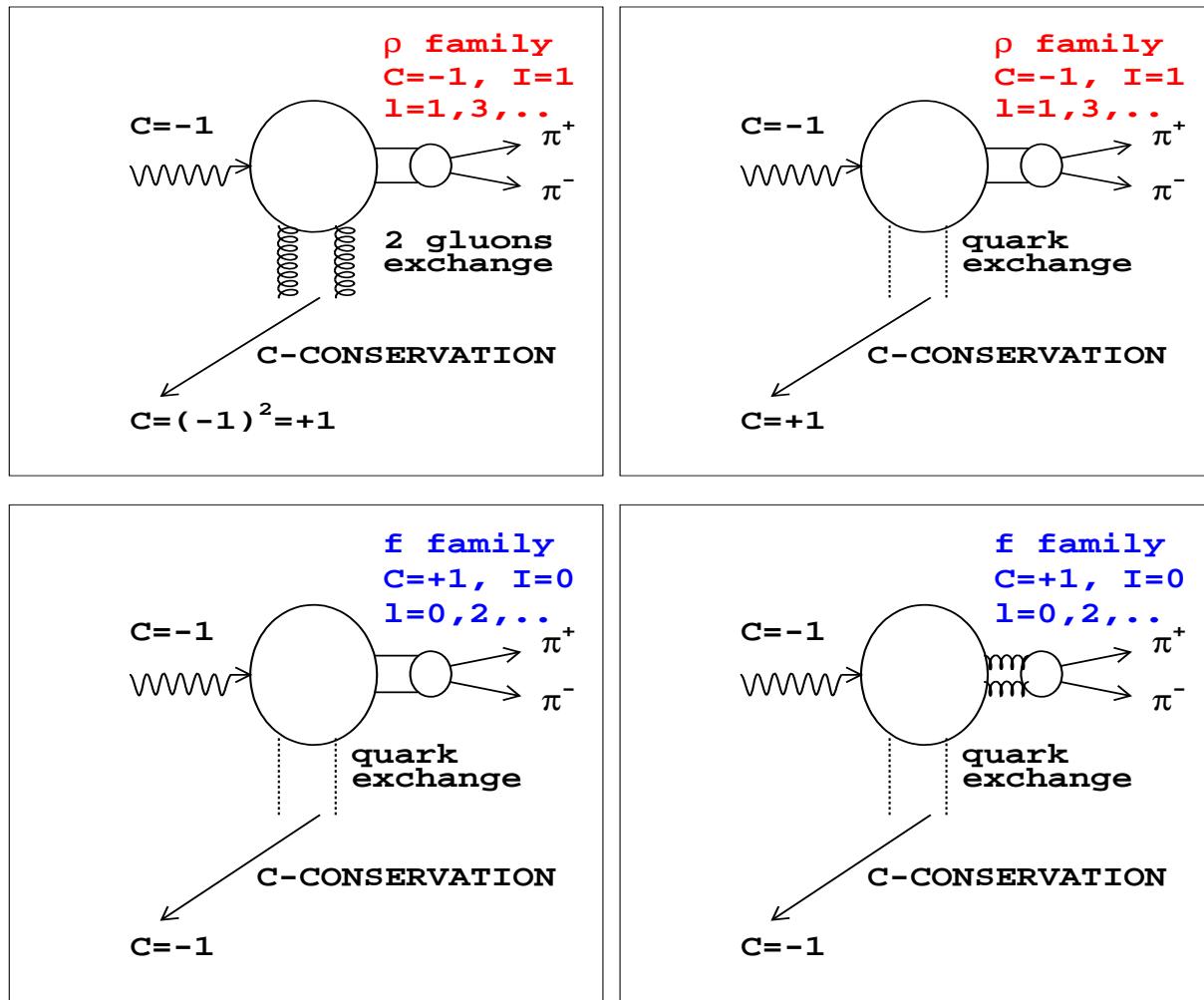
Spin 2002
BNL, September 2002

-
- *GPDs* and Hard Exclusive production of $\pi^+\pi^-$
 - The *HERMES* experiment
 - Results for Proton and Deuteron
 - Conclusions and Future Plans
-

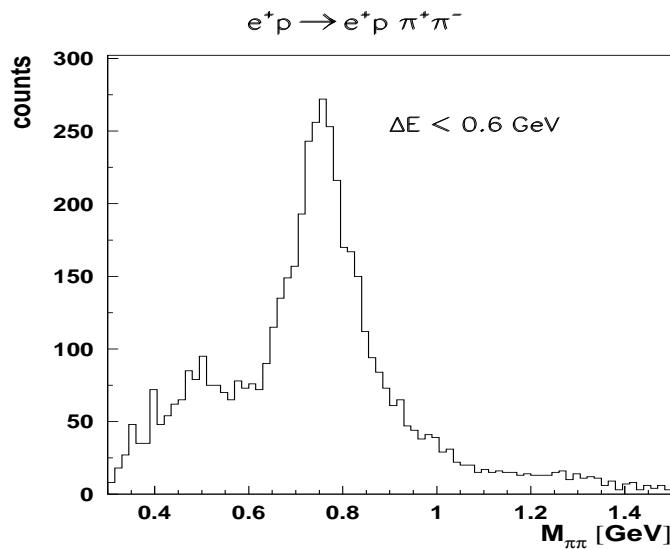


Partial waves and C-Parity of the 2π system

$2\pi DA$ (Distribution Amplitude) Φ describes the transition of partons into 2π .



Hunting the f mesons

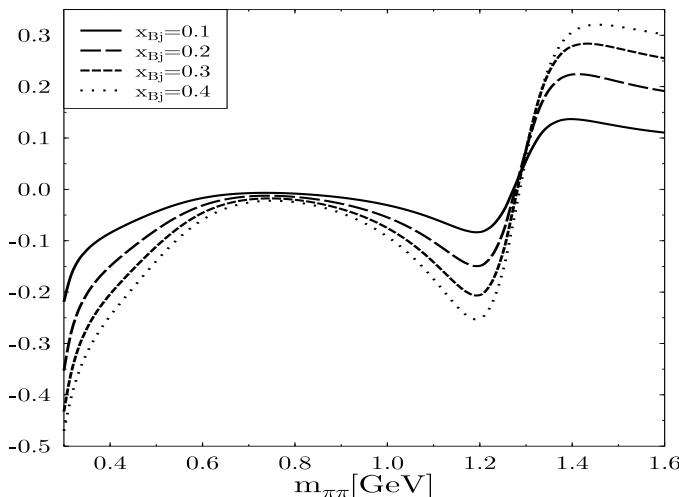
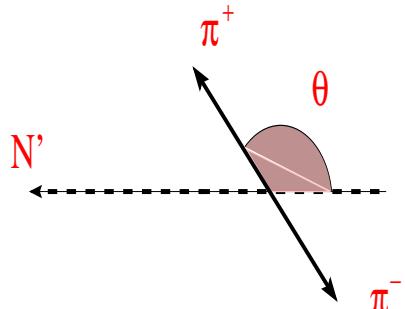


Hard to see exclusive f mesons in the cross-sections

Study their interference with the ρ -family by the so called *intensity density* defined as:

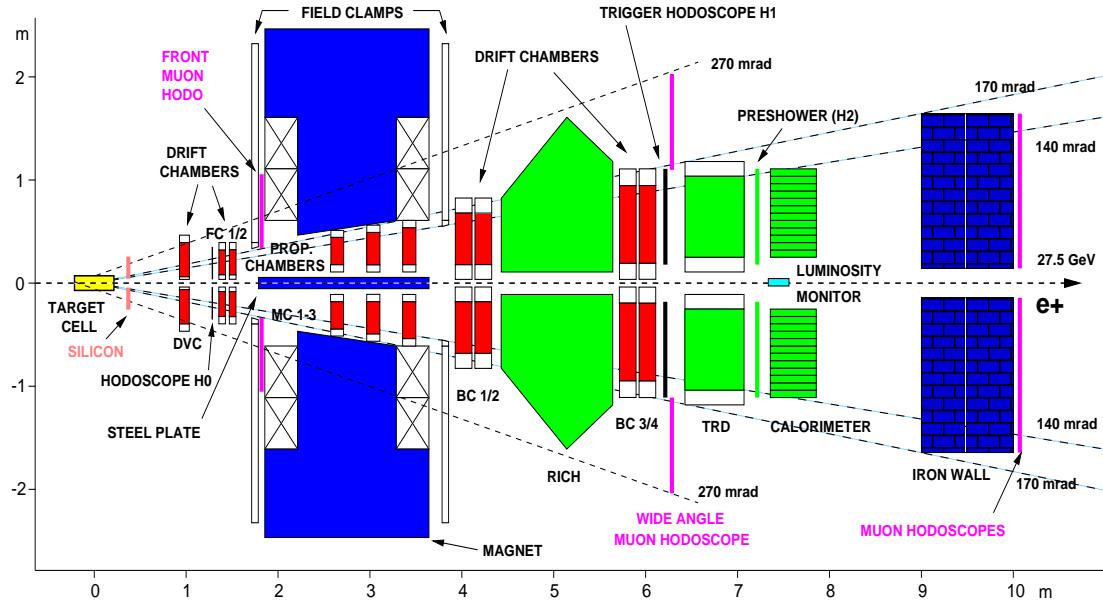
$$\langle P_l(\cos\theta) \rangle^{\pi^+\pi^-} = \frac{\int_{-1}^1 d\cos\theta P_l(\cos\theta) \frac{d\sigma^{\pi^+\pi^-}}{d\cos\theta}}{\int_{-1}^1 d\cos\theta \frac{d\sigma^{\pi^+\pi^-}}{d\cos\theta}}$$

$$\langle P_1(\cos\theta) \rangle^{\pi^+\pi^-}$$

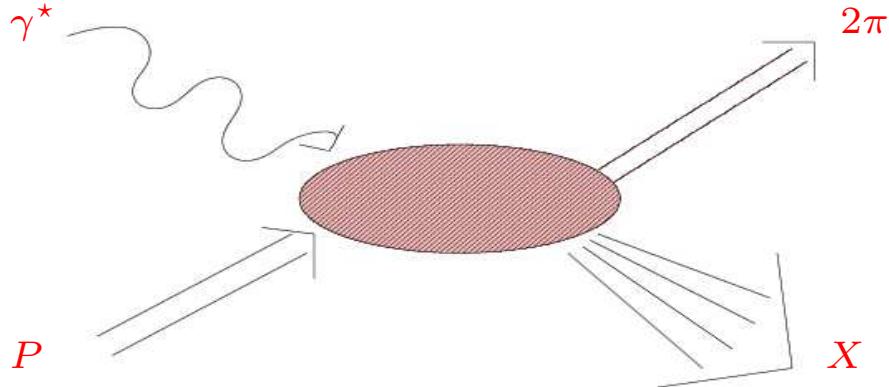


B.Lehmann-Dronke, M.V.Polyakov, A.Schäfer, K.Goeke,
Phys.Rev. D **63**, (2001) 114001

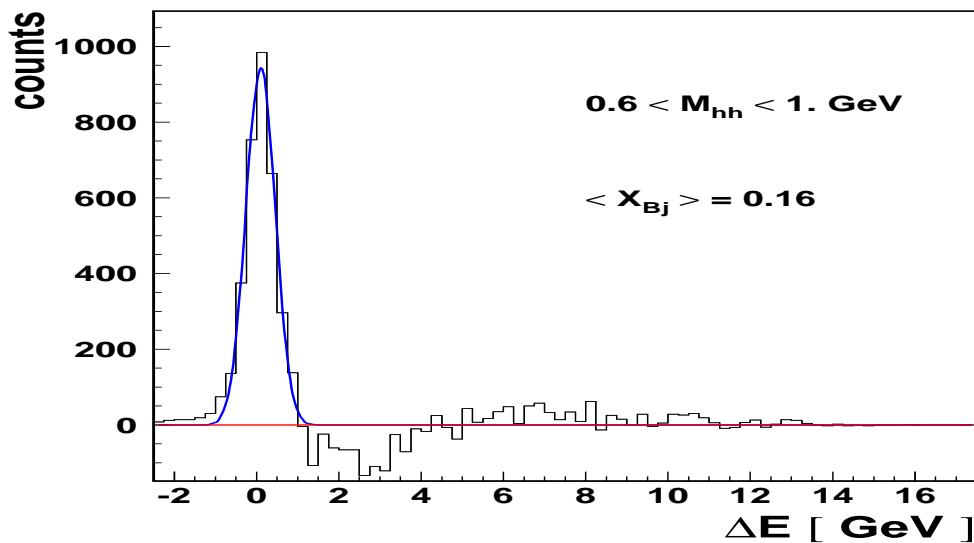
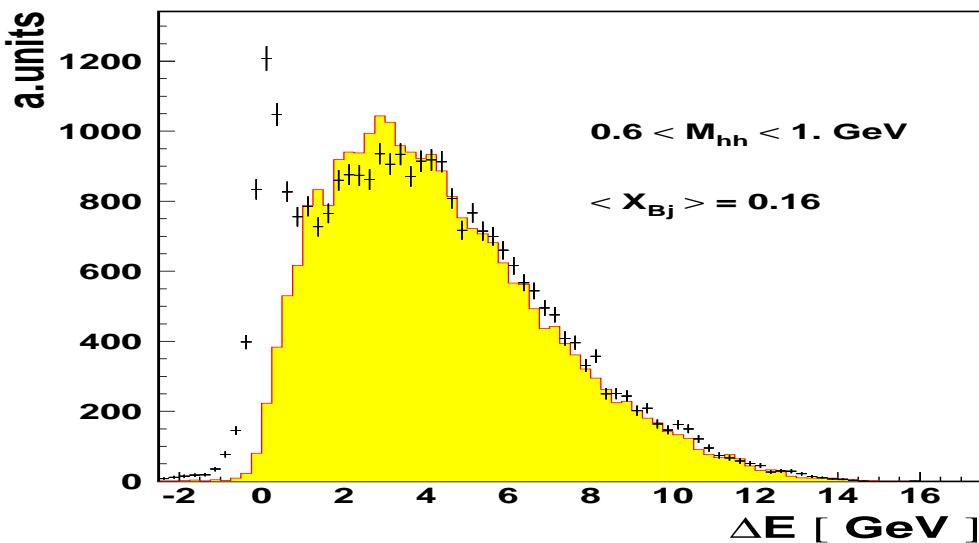
The *HERMES* experiment



- event selection: $e^+ h^+ h^-$ only & no neutral cluster
- kinematical cuts:
 - $Q^2 > 1 \text{ GeV}^2$, $W > 2 \text{ GeV}$
 - $x_{Bj} > 0.1$ → to enhance the isoscalar production
- All hadrons have been considered as pions.
- Exclusivity cut:
$$\Delta E = \frac{M_X^2 - M_P^2}{2M_P}$$



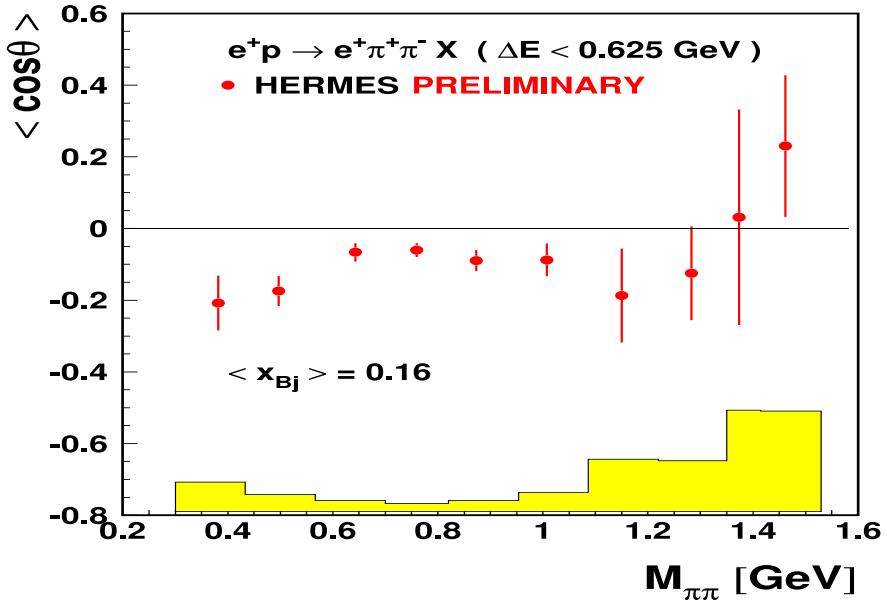
Exclusive event selection



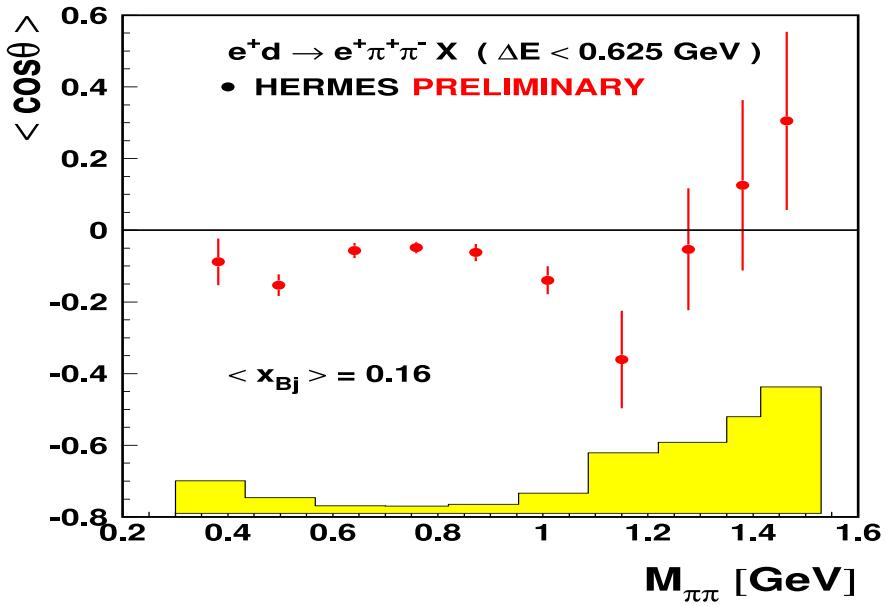
- Bg normalized at $\Delta E > 2 \text{ GeV}$
- Exclusive sample chosen with $\Delta E < 0.625 \text{ GeV}$
- $\langle \cos\theta \rangle_{Bg}$ measured for $\Delta E > 2 \text{ GeV}$
- $\langle \cos\theta \rangle = \alpha \cdot \langle \cos\theta \rangle_{Sg} + \beta \cdot \langle \cos\theta \rangle_{Bg}$

$m_{\pi\pi}$ dependence of $\langle \cos\theta \rangle$

Hydrogen:



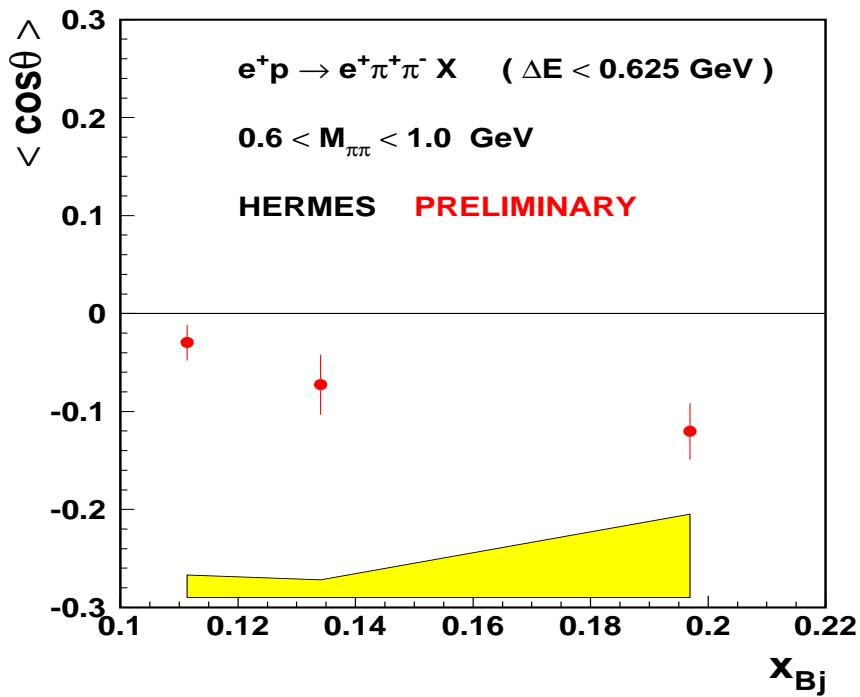
Deuteron:



- $\langle \cos\theta \rangle$ shows a minimum in size at $m_{\pi^+\pi^-} = m_\rho$
- a larger asymmetry is seen, at lower and at larger $m_{\pi\pi}$
- the change of sign of $\langle \cos\theta \rangle$ at $m_{\pi\pi} \approx 1.3 \text{ GeV}$ may be interpreted as due to the interference between f_2 and ρ^0 tail

x_{Bj} dependence of $\langle \cos\theta \rangle$

Hydrogen:



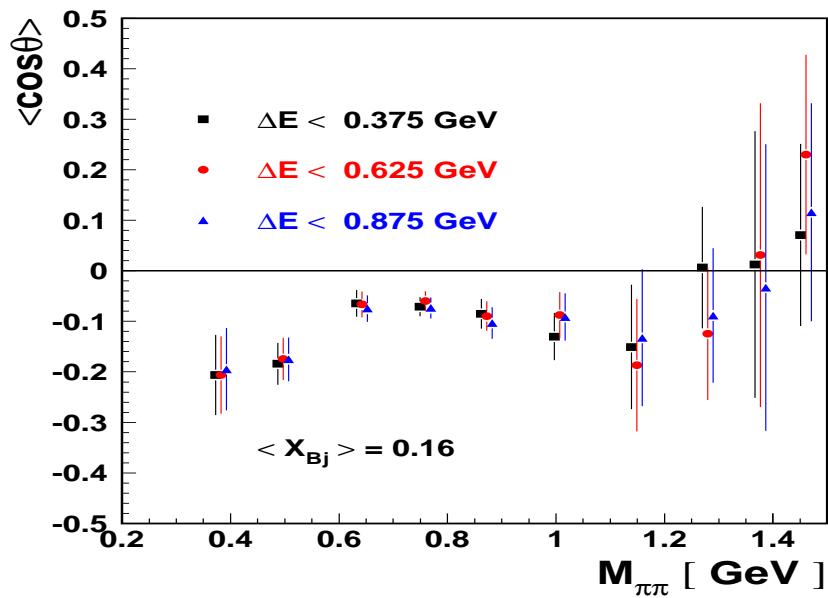
The size of $\langle \cos\theta \rangle$ asymmetry increases with x_{Bj} :

- different mechanisms take place at different x_{Bj}
- at large x_{Bj} the pion pairs production is dominated by $q\bar{q}$ exchange, which leads to a sizeable admixture of isoscalar pion pairs (f -family)

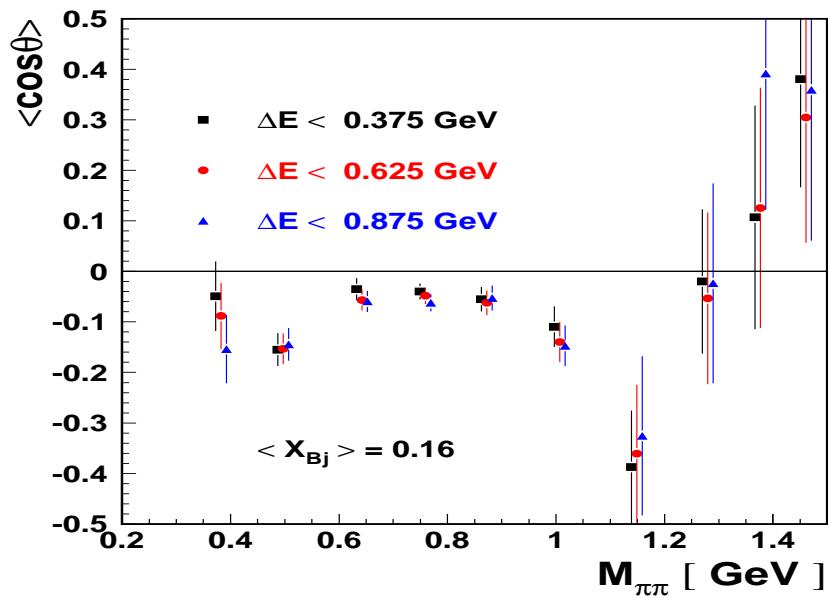
Stability of results

The stability of $\langle \cos\theta \rangle$ at has been tested at different exclusive cuts:

Hydrogen:



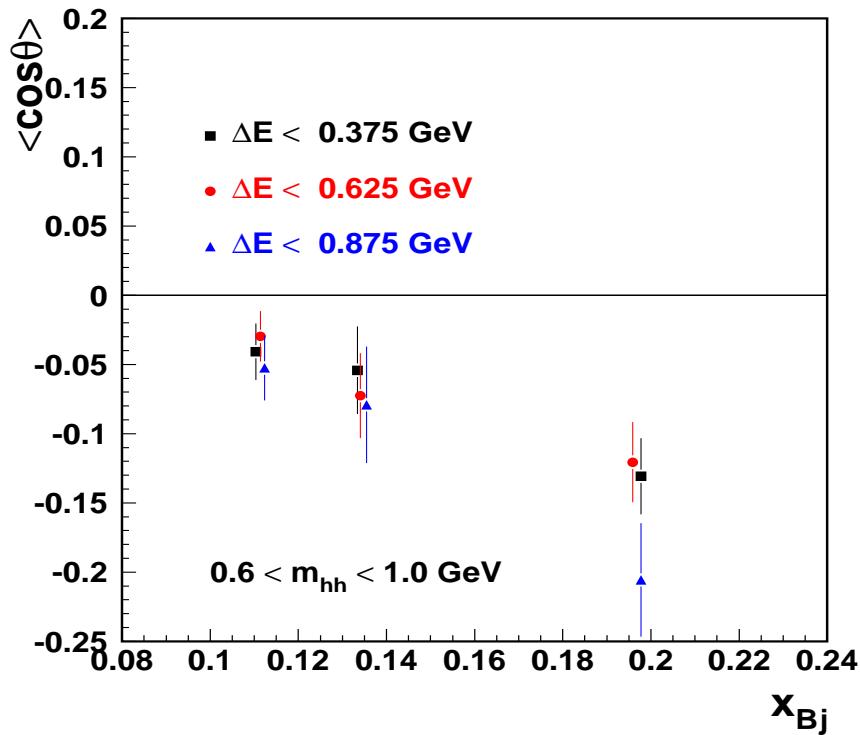
Deuterium:



Stability of results

The stability of $\langle \cos\theta \rangle$ has been tested at different exclusive cuts:

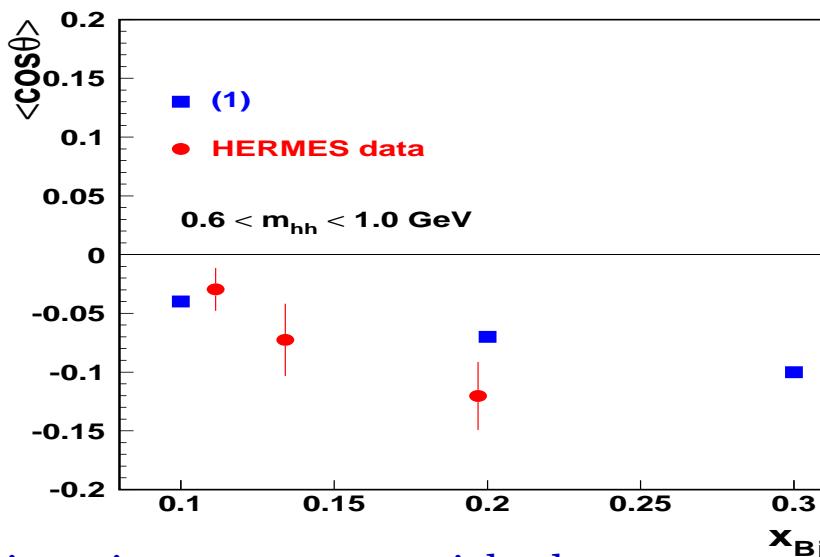
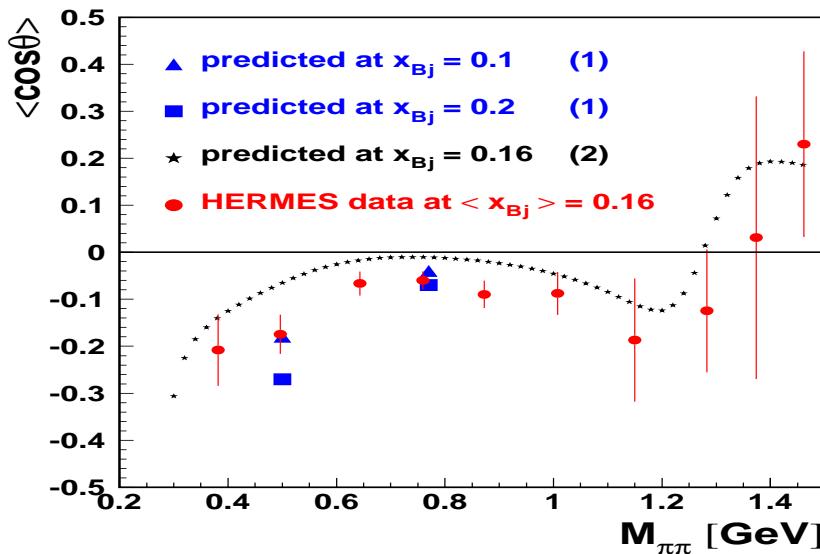
Hydrogen:



- Using *DIPSI* MC-generator, effects due to the acceptance have been found negligible.
- *RCs* predicted to be negligible

Comparison with theory

1. B.Lehmann-Dronke, P.V.Pobylitsa, M.V.Polyakov, A.Schäfer, K.Goeke, Phys. Lett. B **475**, (2000) 147
⇒ without gluon *GPD*
2. B.Lehmann-Dronke, M.V.Polyakov, A.Schäfer, K.Goeke, Phys. Rev. D **63**, (2001) 114001
⇒ with gluon *GPD*



- Behaviour in agreement with theory
- Stronger size of the asymmetry may be due either to higher twist effects or to gluon *GPD* overestimation.

Disentangle the f -family

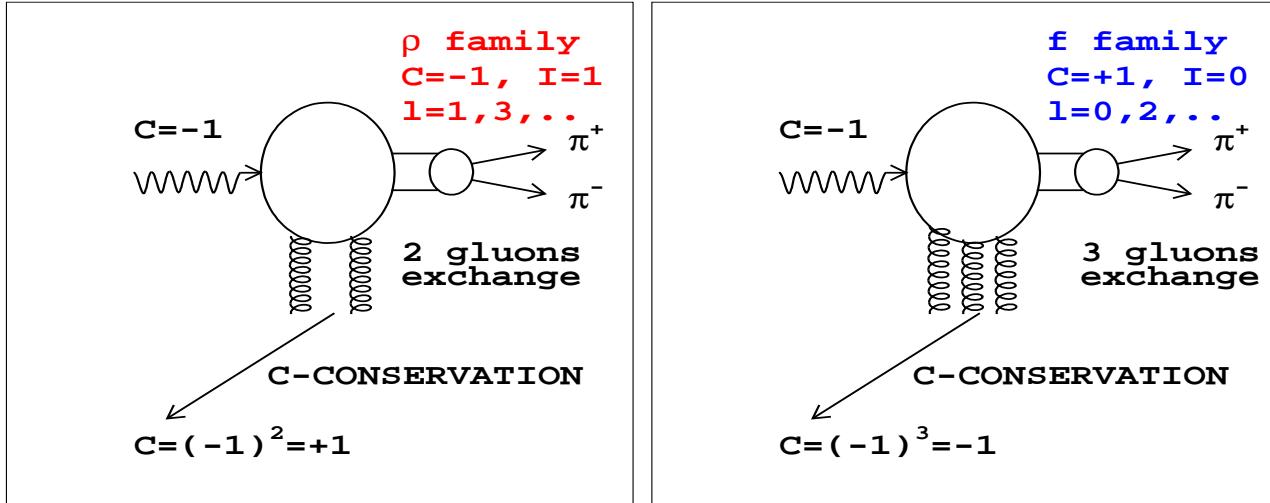
Suitable $\langle P_l(\cos\theta) \rangle$ can be used to disentangle different contributions from the f -family:

- $\langle P_1(\cos\theta) \rangle \Rightarrow P\text{-}S/D$ wave ($\rho^0\text{-}f_0$ and $\rho^0\text{-}f_2$)
- $\langle P_3(\cos\theta) \rangle \Rightarrow P\text{-}D$ wave only ($\rho^0\text{-}f_2$) interference
- a better binning of $m_{\pi\pi}$ in the $\langle P_1(\cos\theta) \rangle$ asymmetry may highlight a signature of the f_0 narrow resonance

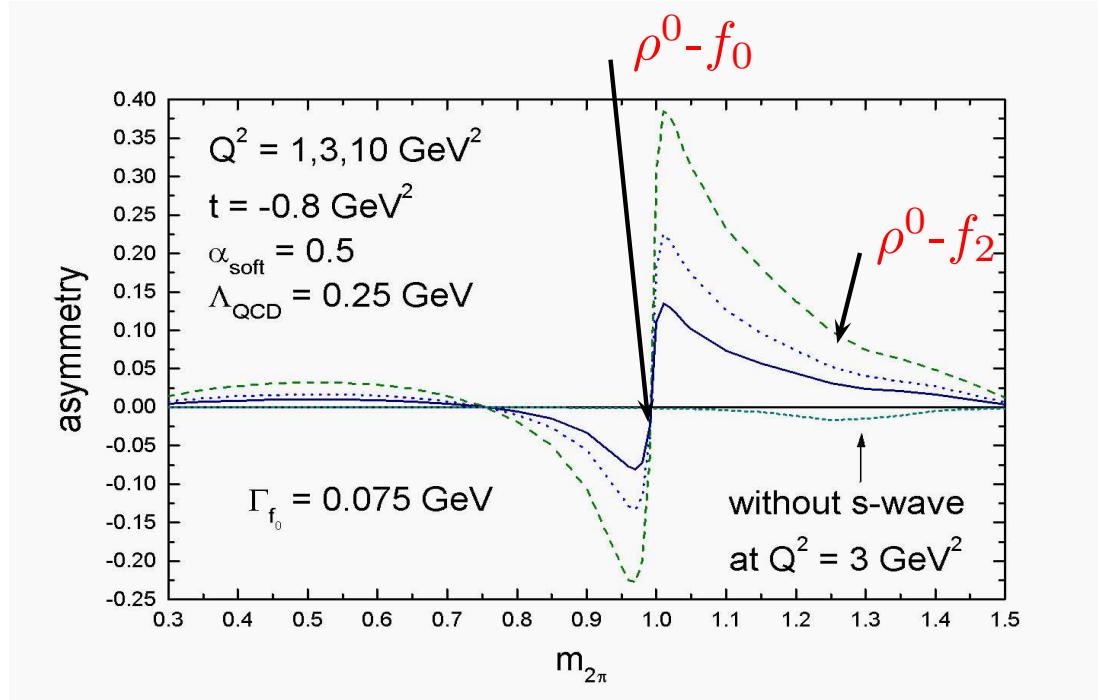
The analysis to disentangle f_0 from f_2 contribution is in progress.....

Low x_{Bj} and Odderon

At very low x_{Bj} (mainly gluon exchange) the asymmetry may give a signature of the *C-odd* gluon exchange (*Odderon*).



- Pire et al.: hep-ph/0202231



- Analysis in progress....

Conclusions and Future Plans

- the first measurement of angular asymmetry in $\pi^+\pi^-$ hard exclusive electroproduction has been performed
- $\langle \cos\theta \rangle$ asymmetry does highlight the presence of the weak f -family channel
- agreement between the behaviour of data and theory. Possible constrain to the *GPDs*

In progress:

- analysis to disentangle the different contributions from the f -family ($f_0(980)$, $f_2(1270)$) to the angular asymmetries
- the study of angular asymmetries at low invariant masses, low x_{Bj} (2 and 3 gluons exchange) and their t -dependence