*DIS'02*

*Cracow, April 30-May 4, 2002*

# Exclusive diffractive $\rho^0$ Meson Production at hermes

Avetik Airapetian

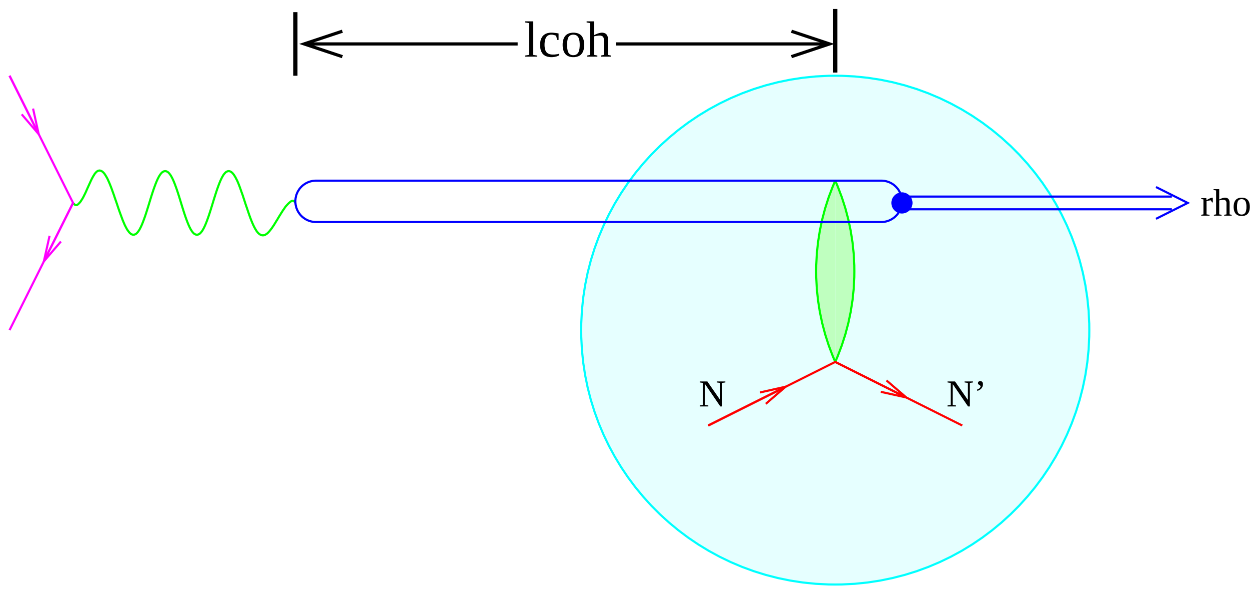
*on behalf of the HERMES Collaboration*

- Physics Motivation
- The Experiment , Data, Event selection
- Definition of cross section ratios and method of extraction
- Results
  cross section ratio: $\sigma^A_{coh}(Q^2)/\sigma^A_{incoh}(Q^2)$
  $l_c$-dependence: $\sigma^N_{(in)coh}(l_c)/A\sigma^p(l_c)$
  $Q^2-$dependence: $\sigma^N_{(in)coh}(Q^2, l_c)/A\sigma^p(Q^2, l_c)$
- Summary

# Physics motivation ,why $\rho^o$'s?

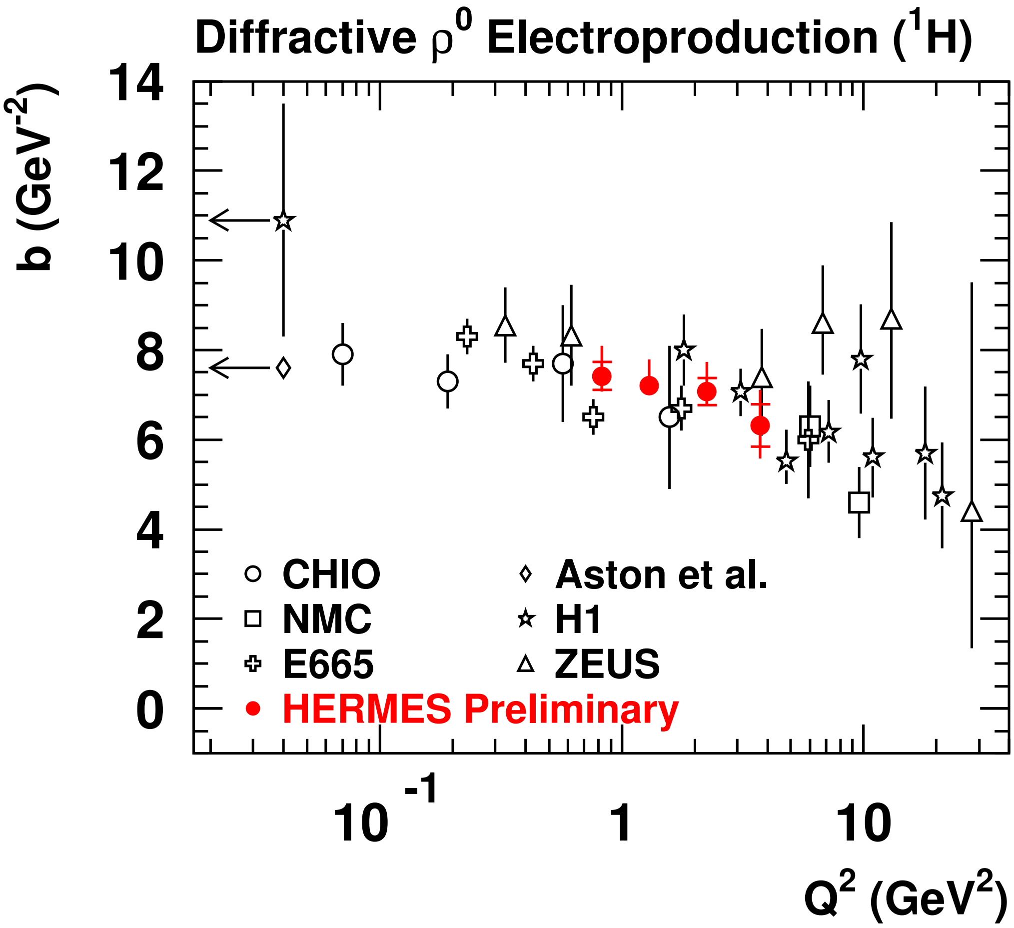
Main motivation:

- Vector mesons interaction with nuclear medium
- QED Chudakov-Perkins effect analog, Color Transparency(CT)
- Small size configuration(SSC) formation and traverse in medium




"Shrinking photon":
The size of the hadronic components of a virtual photon conjectured to be smaller than the size of a normal hadron. The exclusive production of vector mesons from complex nuclei was suggested as a way of testing this idea.

# "Shrinking photon"




- $\frac{d\sigma}{dt} \sim \exp^{-bt}$
- Yes, Photon shrinks:
- The size of virtual photon is controlled via $Q^2$
- we can control coherence length $l_c$ also
- $l_c = \frac{2 \cdot \nu}{Q^2 + m_V^2}$

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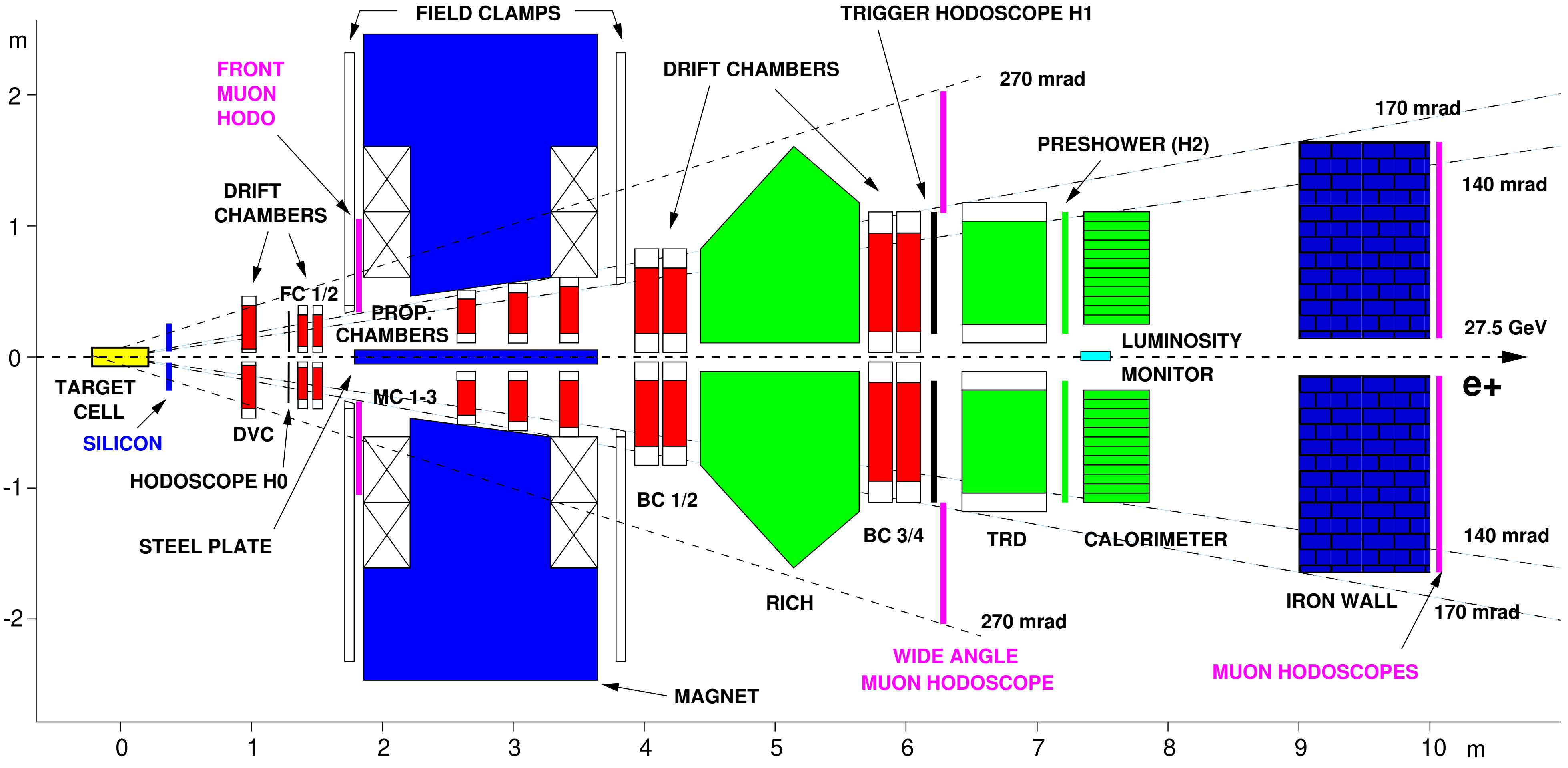
# HERMES Experiment

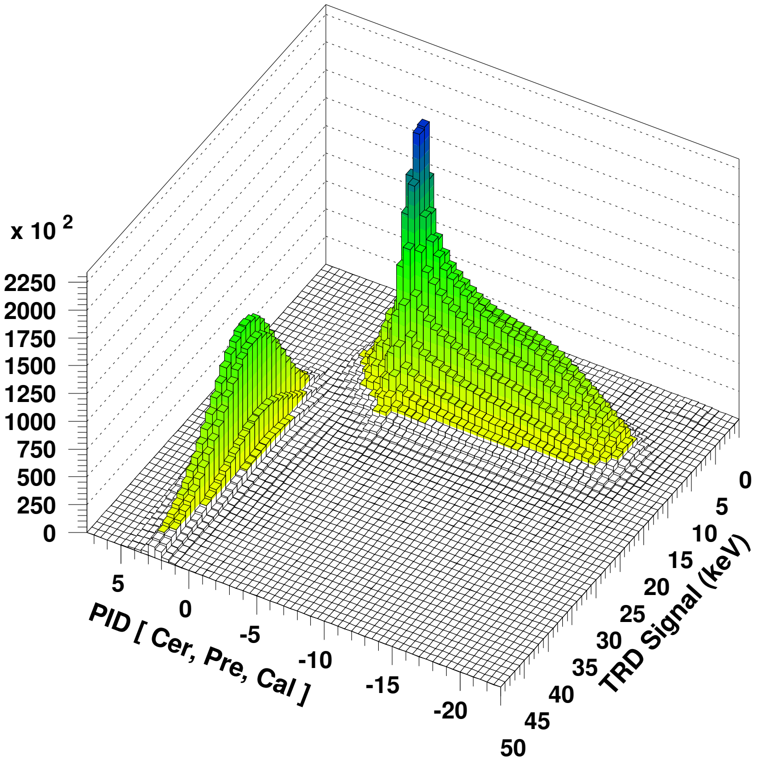


# Data, Event selection

HERMES accumulated 1995-2000 polarized, unpolarized:

| gas | luminosity, pb$^{-1}$ |
|---|---|
| $^{1}H$ | 261.3 |
| $^{2}D$ | 371.3 |
| $^{3}He$ | 109.0 |
| $^{14}N$ | 49.5 |
| $^{20}Ne$ | 88.4 |
| $^{84}Kr$ | 25.0 |

Selection of $eh^{+}h^{-}$ Subsample according PID:




Reconstruct $M_{\pi\pi}$ using kinematics of:

- exclusivity: -2.0 GeV$< \Delta E < 0.6$ GeV
- diffractivity: -$t' < 1.0 GeV^{2}$
- eliminate $\phi$ background: 1.04 GeV $< M_{KK}$
- $\rho^{o}$ mass: 0.6 GeV$< M_{2\pi}$ <1 GeV

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# Ratio's definition and extraction

Nuclear incoherent Transparency:

$Tr^{incoh}=\sigma^A_{incoh}(Q^2)/A\sigma_H(Q^2)$

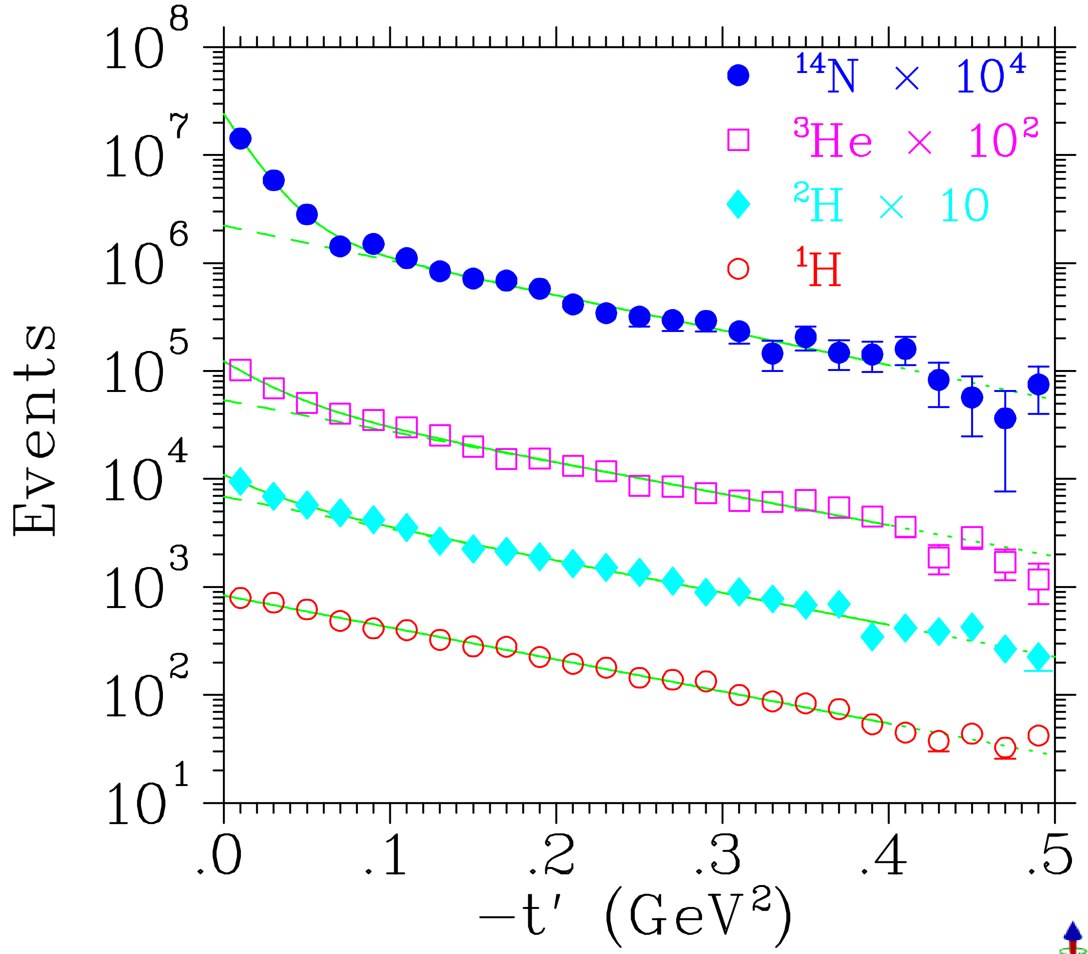
Nuclear coherent Transparency:

$Tr^{coh}=\sigma^A_{coh}(Q^2)/A\sigma_H(Q^2)$

Coherent to incoherent Cross section Ratio:

Ratio=$\sigma^A_{coh}(Q^2)/\sigma^A_{incoh}(Q^2)$,where

$\sigma = \int \frac{d\sigma}{dt}dt$

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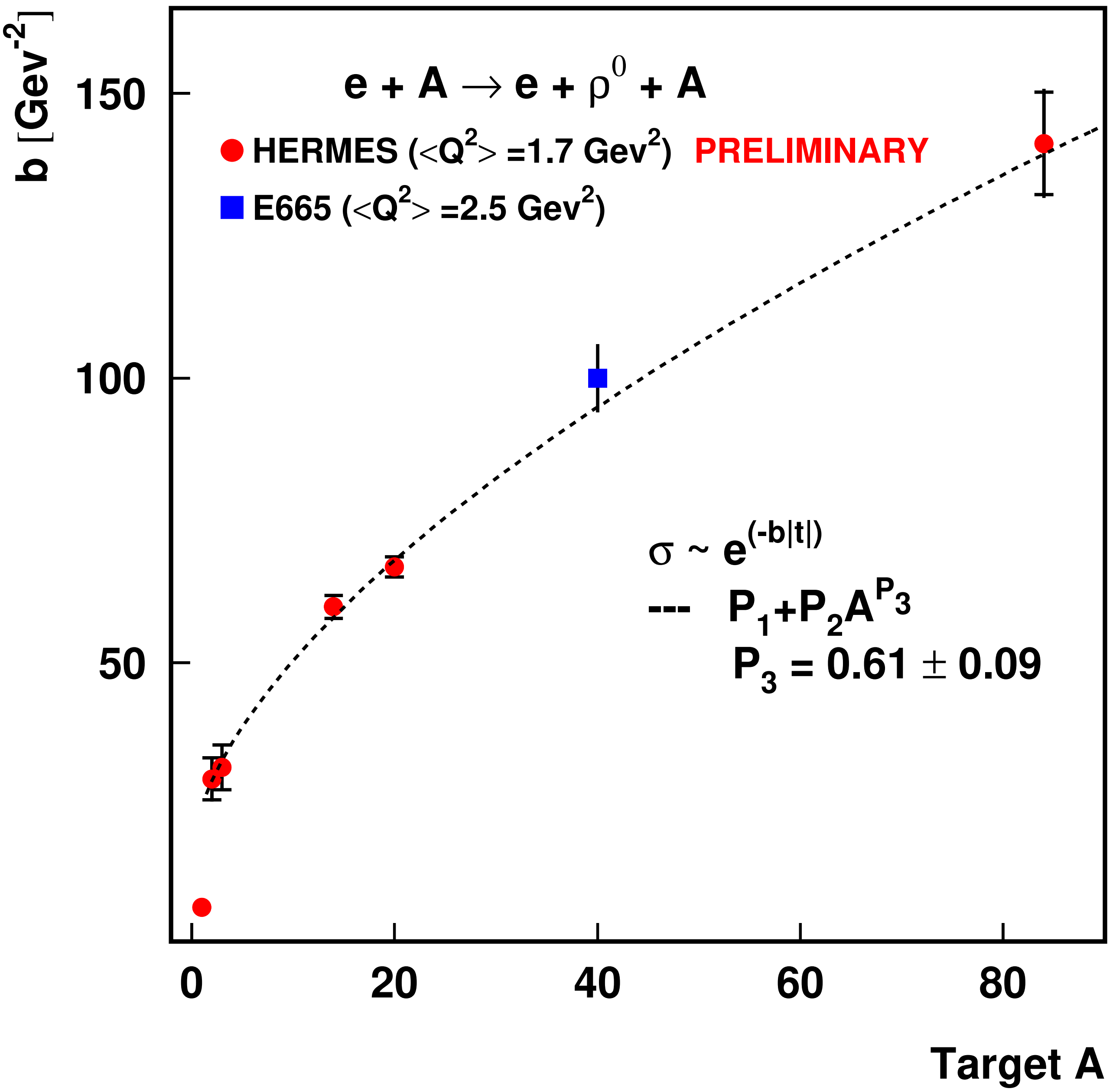
# Nuclear sizes...




$b \approx 1/3(r_A^2 + r_{q\bar{q}}^2)$
In agreement with old nuclear size measurements , $r_A^2 \sim A^{2/3}$
see "Determination of strong-interaction nuclear radii" H. Alvensleben et al. PRL v24,N14 pp786-796(1970)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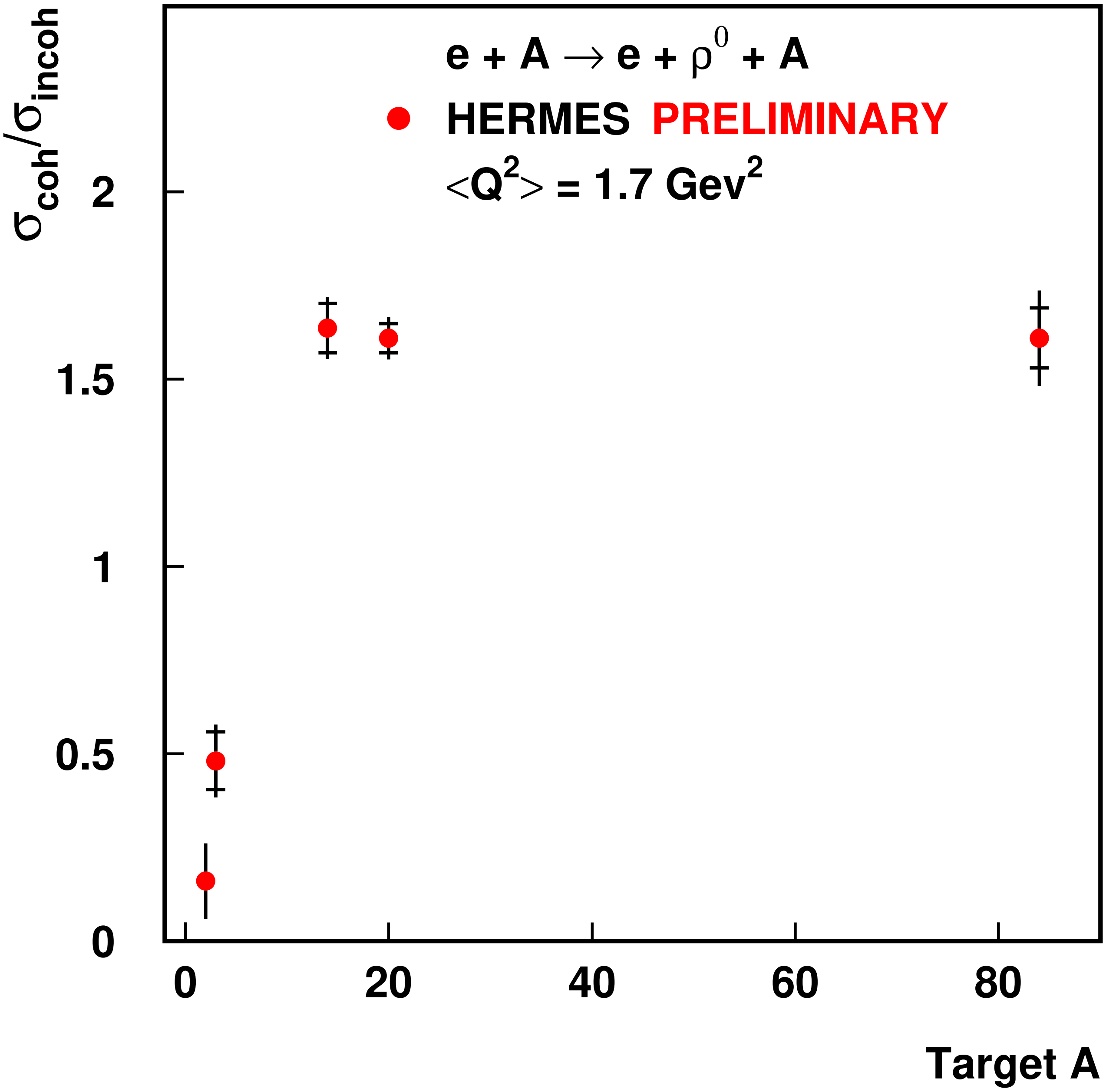
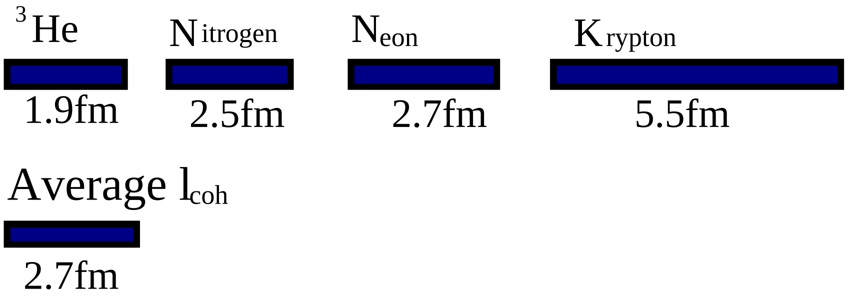
## $\sigma_{coh}(A)/\sigma_{incoh}(A)$



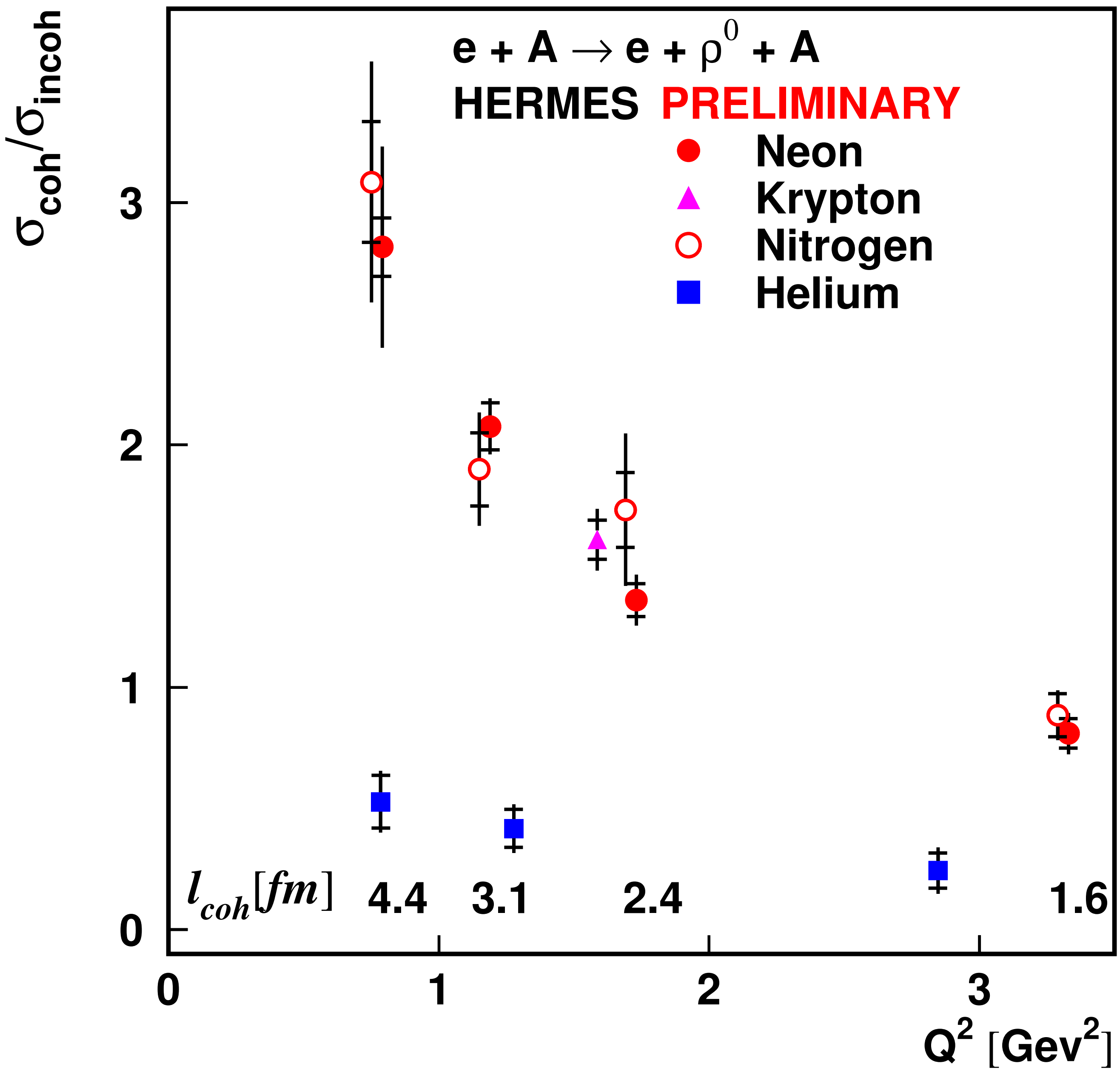

Plateau at heavy targets as $< l_{coh} >= 2.7$ fm $\leq r_A$.

Size of Nuclei

Radii in fm

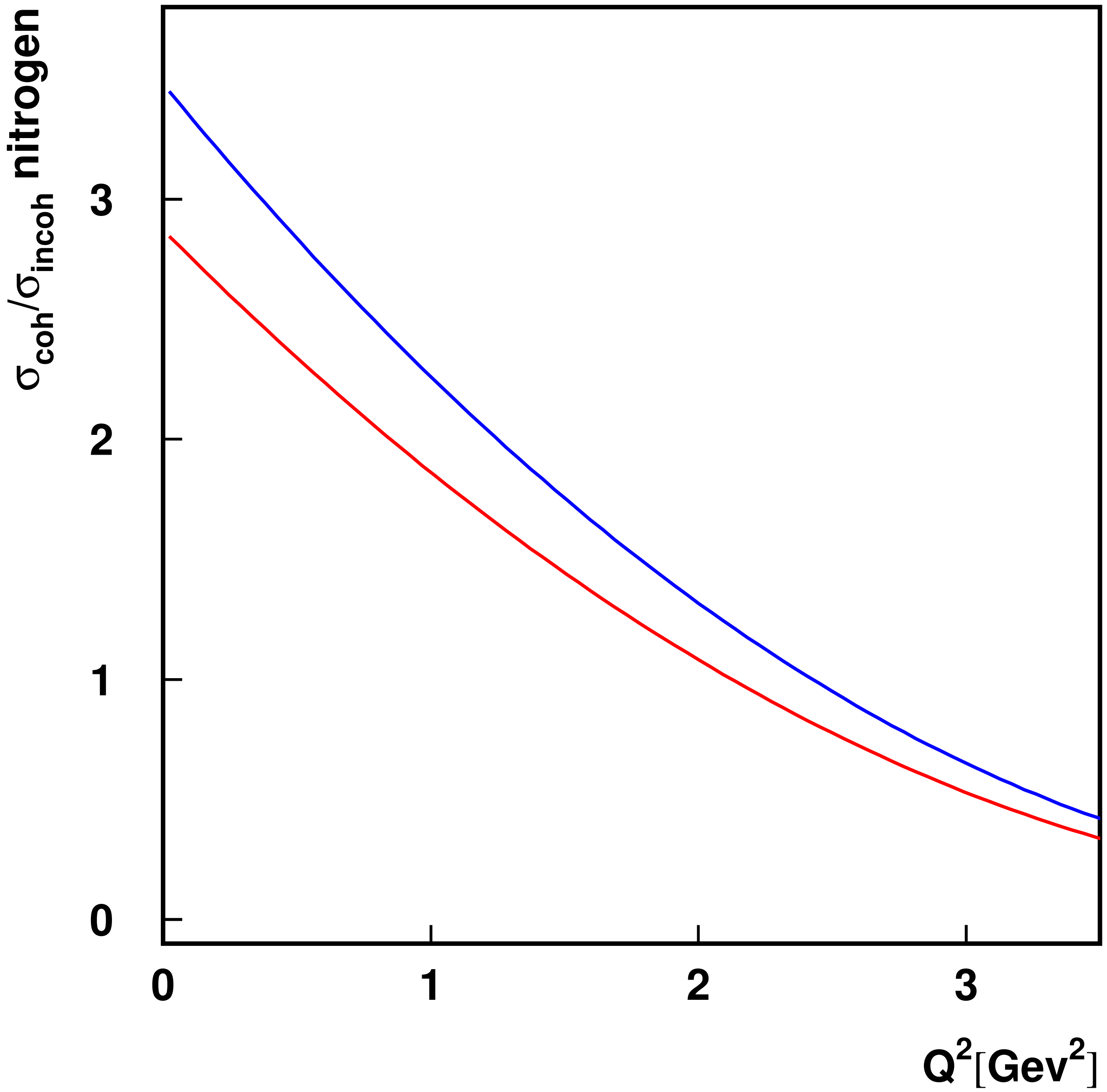


$$\sigma^A_{coh}(Q^2)/\sigma^A_{incoh}(Q^2)$$




→ strong $Q^2$-dependence of ratio

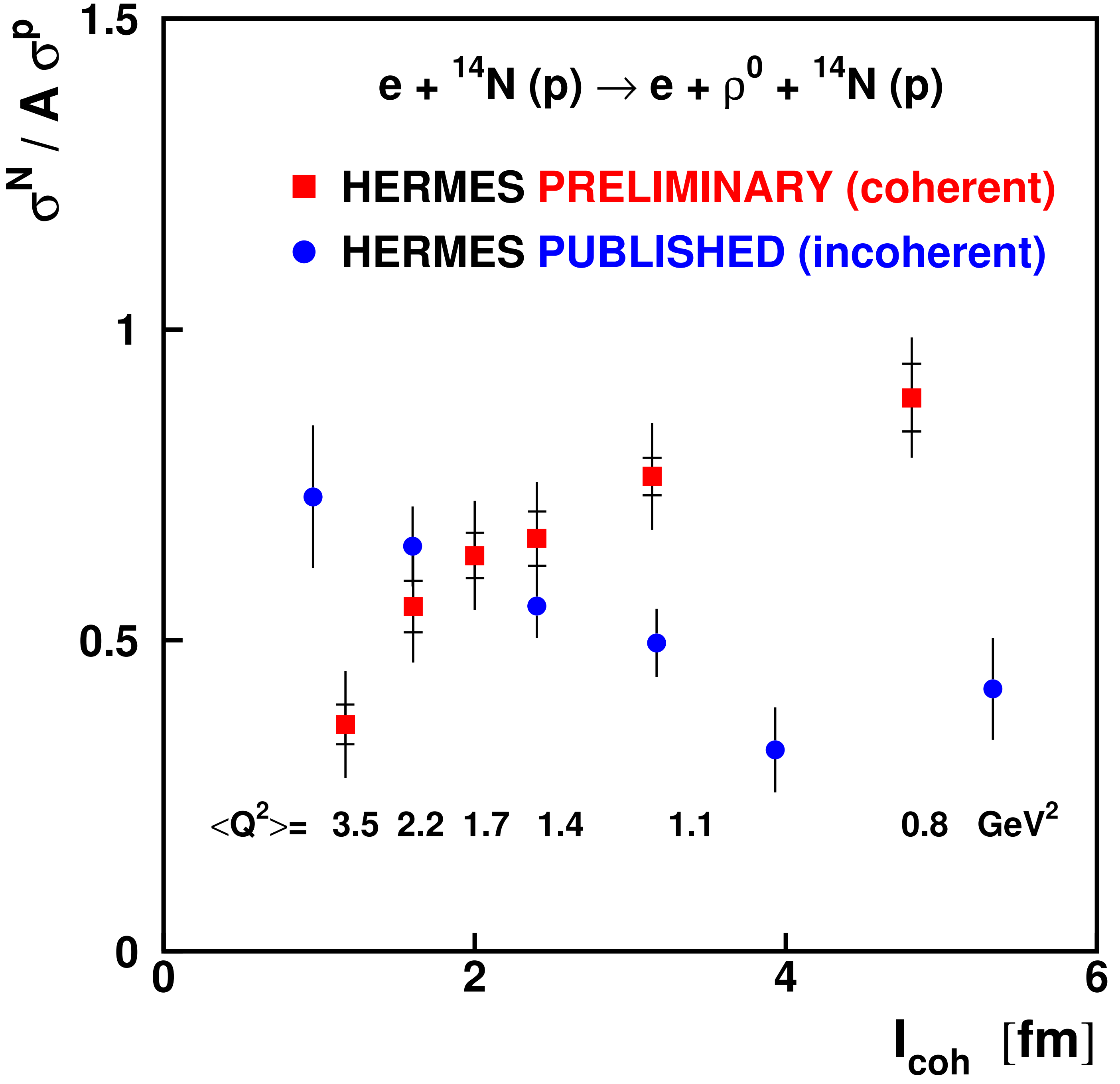
# Theory Prediction Nitrogen




→ Red curve is calculated with single scattering amplitude, blue one multiple scattering contribution with up to n=2 are included, see for details:

T. Renk, G. Piller, W. Weise ”coherence Effects in Diffractive electroproduction of $\rho$ mesonsfrom Nuclei”
hep-ph/0008109

## Coherence Length Effects....




In all cases:

- $Tr^{incoh}$
- Ratio=$\sigma_{coh}/\sigma_{incoh}$
- $Tr^{coh}$

  We see strong dependence from $l_{coh}$ coming from variation of $l_{coh}$ and possible signal from CT

  Need to fix $l_{coh}$

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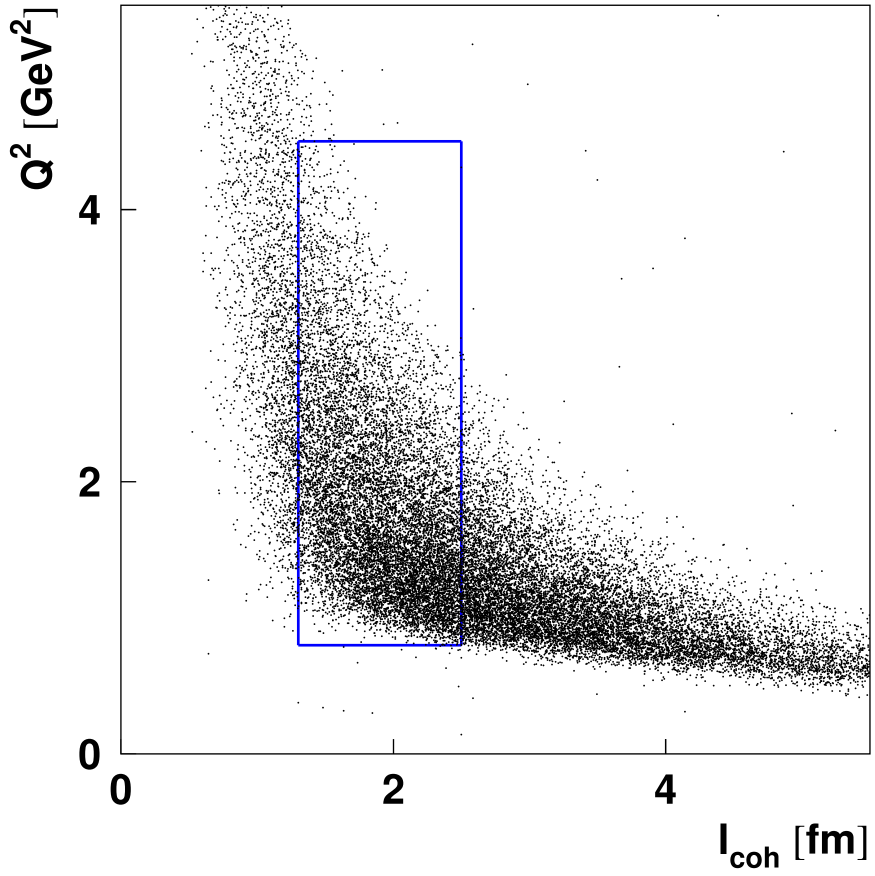
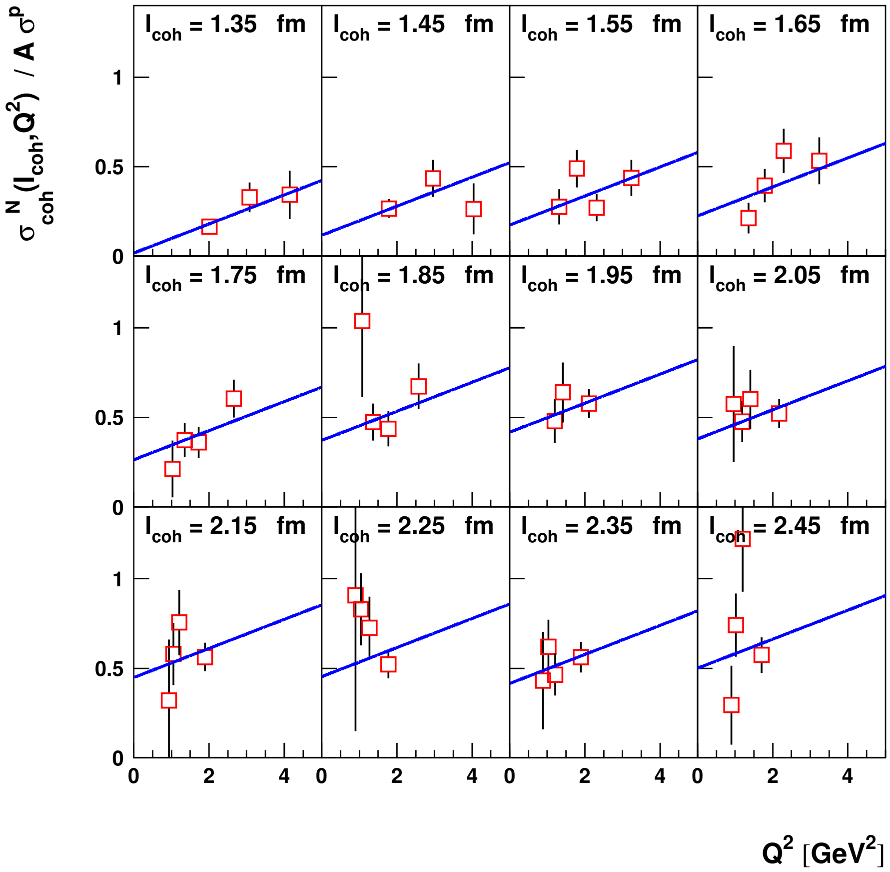
# $Tr^{coh}, Tr^{incoh}(Q^2)$ at fixed $l_{coh}$

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# Fit Results and Theory Comparision

| data | Slope of $Q^2$-dependence, GeV$^{-2}$ |
|---|---|
| N-97 incoh. total err. | $0.097 \pm 0.050(\pm 0.048_{st} \pm 0.008_{syst})$ |
| N-97 coh. total err. | $0.081 \pm 0.030(\pm 0.027_{st} \pm 0.011_{syst})$ |
| N-97 combined | $0.085 \pm 0.025$ |

HERMES data are in agreement with theoretical calculations , where positive slope of $Q^2$-dependence of nuclear transparency ( $\simeq 0.07$ ) has been derived from the onset of CT effect.

see

B.Z. Kopeliovich, J. Nemchik, A.Schaefer, A.V. Tarasov *Color transparency versus quantum coherence in electroproduction of vector mesons off nuclei*, Phys. Rev. C, **65**, 035201, 2002..

# SUMMARY,OUTLOOK

- HERMES allows us to make different types of analysis in search of CT signal in optimal kinematic region.

- We have extracted $Tr^{incoh}$, Ratio=$\sigma_{coh}/\sigma_{incoh}$, $Tr^{coh}$ (the last two for the first time) to investigate formation and propagation of $q\bar{q}$=$V_{meson}$ in the nuclear medium.

- Positive slope of $Q^2-$dependence of nuclear transparency observed on nitrogen at $l_{coh} = 1.3 \div 2.5$ fm and $Q^2 = 0.9 \div 4$ GeV$^2$ for the coherent and incoherent contributions of exclusive $\rho^o$ production.

- Analyse of full statistics on different targets, Neon, Krypton in addition of 12 GeV data on Nuclear targets will allow us to solidify our conclusions on this subject.

- HERMES Plans......RUN II more data will come especially from unpolarised running.