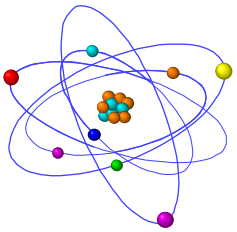
Bologna 2000
Structure of the Nucleus
at the Dawn of the Century

May 29 - June 3, 2000
Bologna, Italy

Anomalous trend of the total $\bar{n}p$ cross section in the low-momentum region

Alessandro Feliciello
I.N.F.N. - Sezione di Torino

for the
OBELIX Collaboration



Outlook

- ★ The $\bar{n}$ physics
- ★ the OBELIX $\bar{n}$ "factory"
- ★ $\bar{n}p$ total cross section
- ☛ hints for the existence of a narrow quasi-nuclear bound state near the threshold
- ★ ideas for a measurement of the $\bar{p}p$ elastic cross section

$\overline{N}N$ interaction at low energy

❶ study of $\overline{N}N$ interaction isospin dependence:

coherence in meson exchange

❷ check of the validity of the potential models:

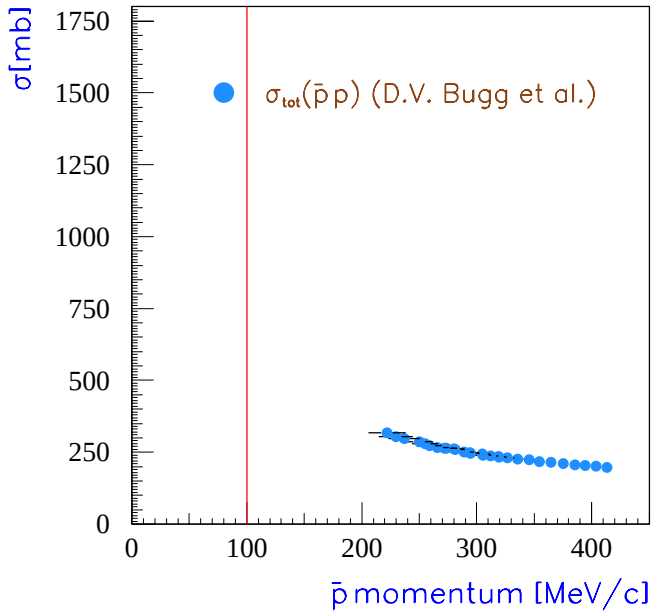
the trend of the $\overline{N}N$ cross sections near the threshold is really smooth?

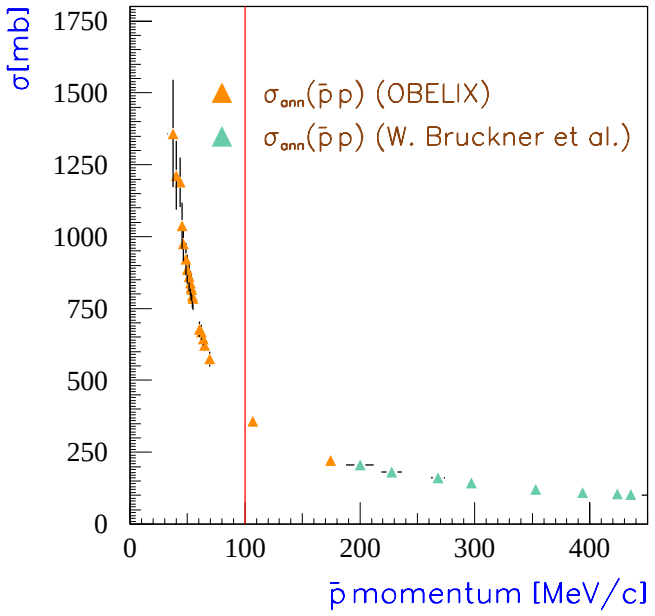
The challenging question

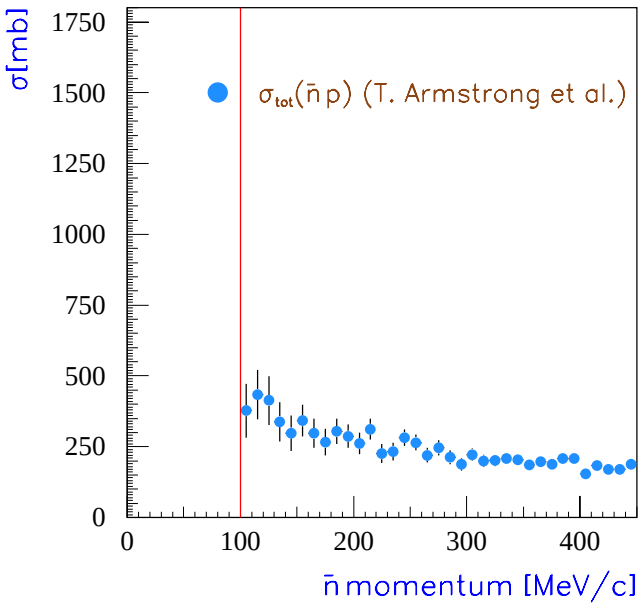
Do the quasi-nuclear bound states exist?

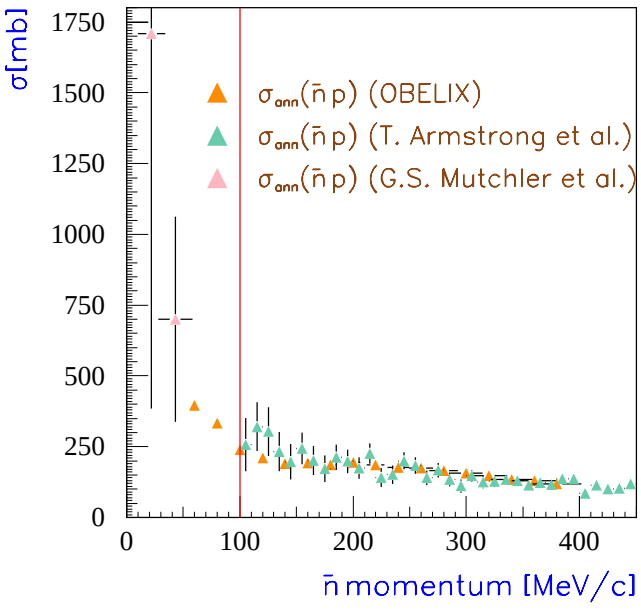
A 20 years old and controversial story!

Experimental situation

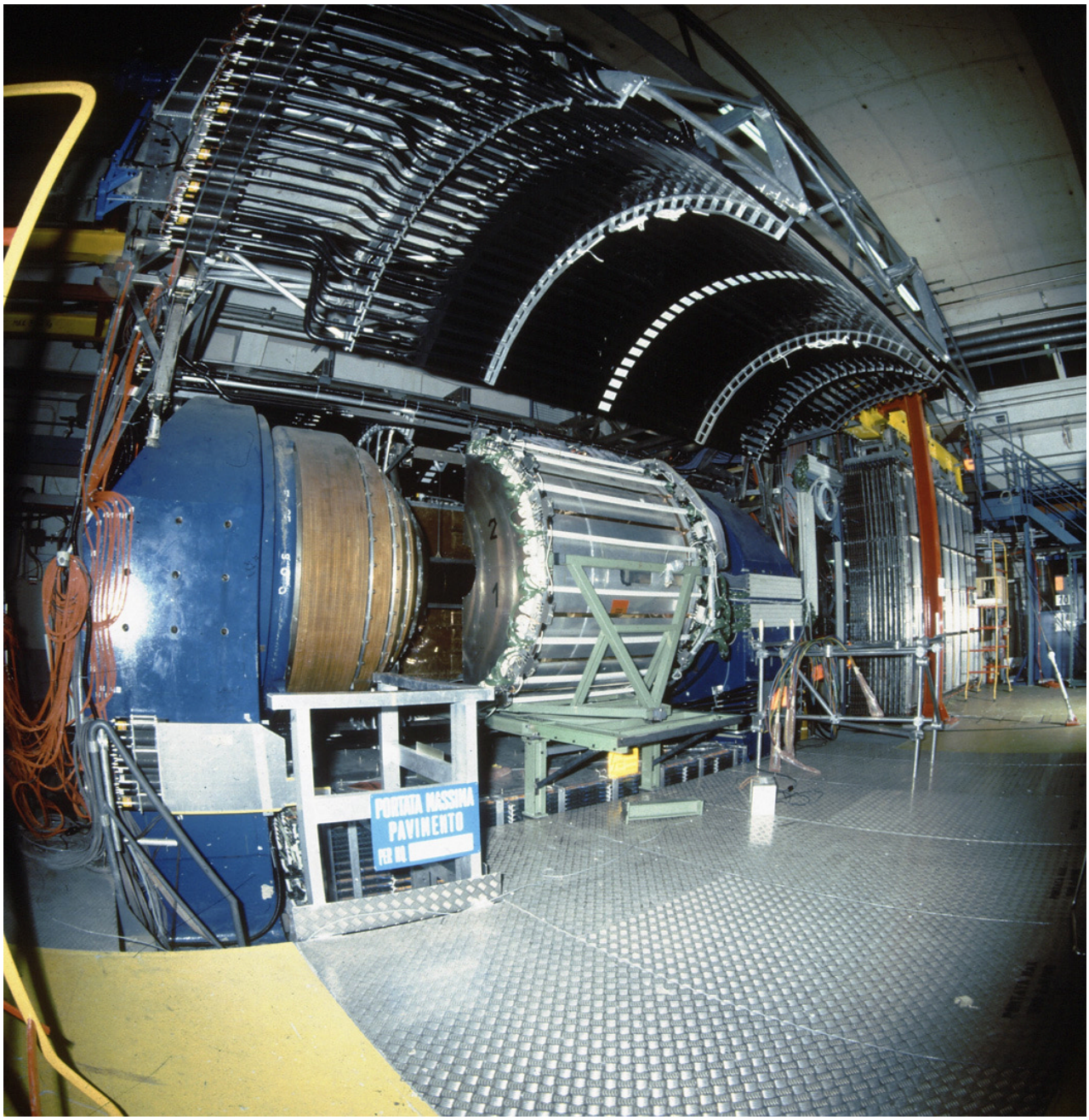








The OBELIX spectrometer



1990 - 1996

The LEAR machine

1983 - 1996

Beam intensity: $10^7\ \bar{p}/s$

$\Delta p/p$: $\sim 10^{-4}$

$\bar{n}$ interaction

Why?

- ▲ scarce data on low energy $\bar{n}p$ interaction
- ▲ complementary/alternative to $\bar{p}p$ interaction
- ▲ the initial $\bar{n}p$ state is a pure I = 1 state
- ▲ better energy and momentum resolution, compared to $\bar{p}d$ reaction, due to the absence of the spectator proton
- ▲ the percentage of *p*-wave in the initial state can be controlled by increasing the $\bar{n}$ momentum
- ▲ at least one prong in the final state (optimal for OBELIX)

but

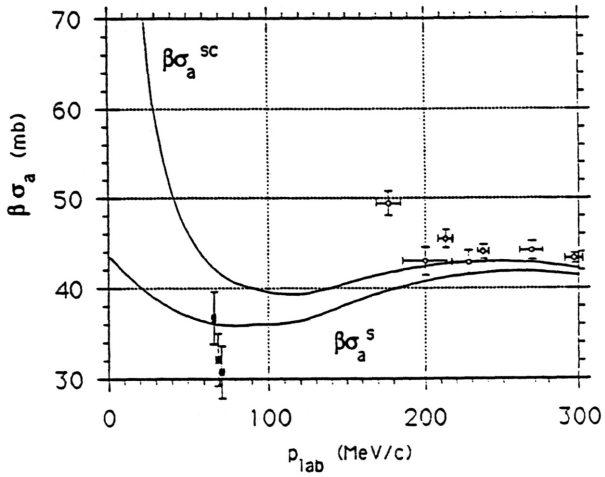
- ▼ technically difficult
- ▼ low $\bar{n}$ production rate ($(36 \pm 1) \times 10^{-6}$ $\bar{n}/\bar{p}$)

$\bar{n}$ interaction

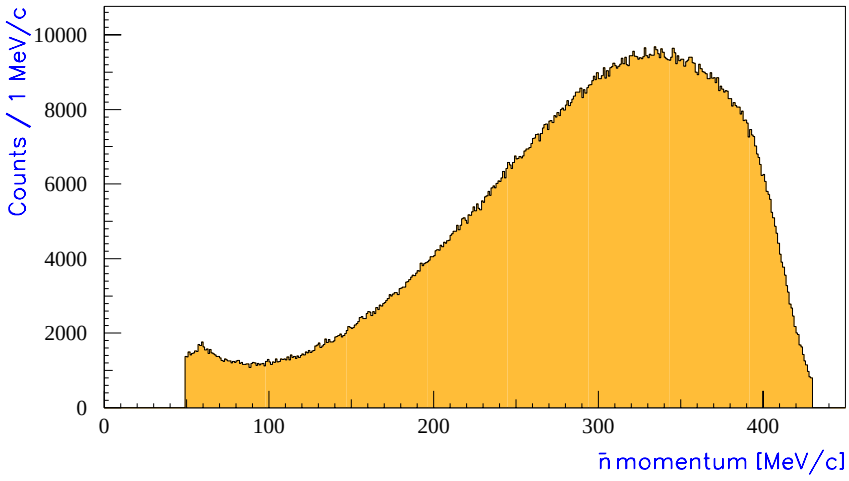
Why?

- absence of Coulomb interaction:
  no distortion on the σ trend
  in the low momentum region

$\beta\sigma_{ann}(\bar{p}p)$



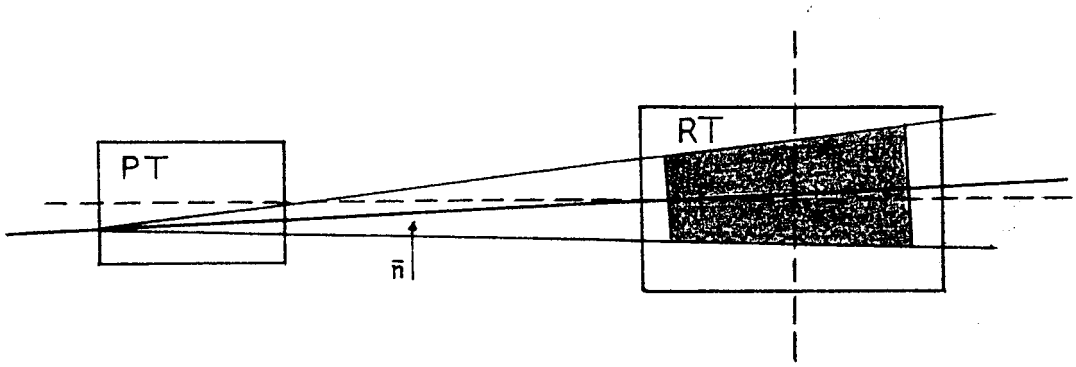
- capability of reconstructing
  the momentum of each interacting $\bar{n}$

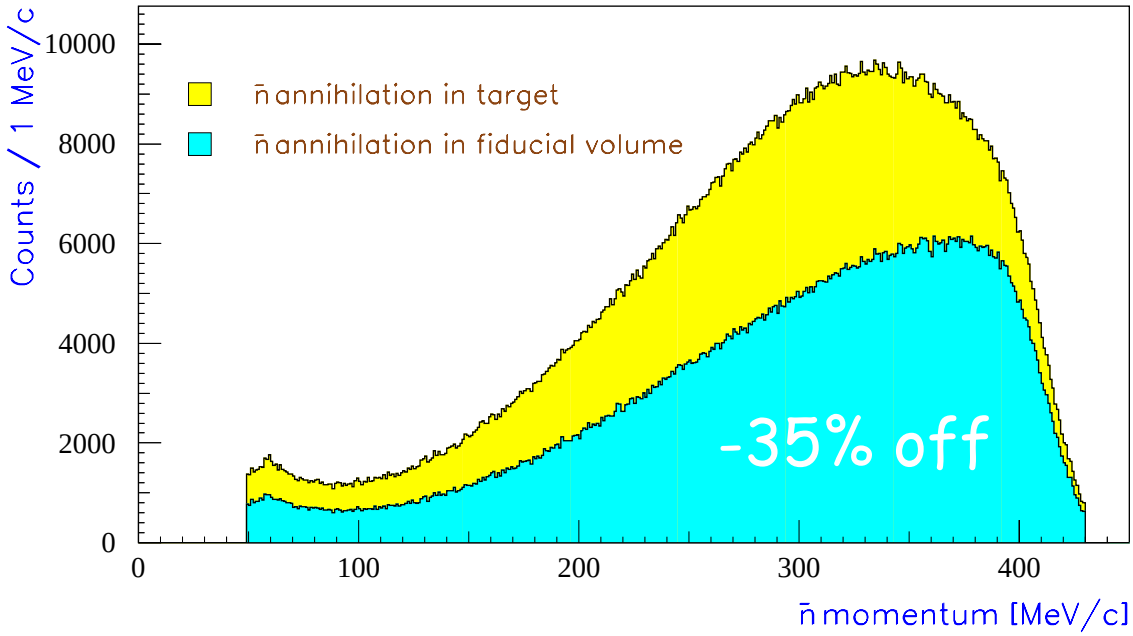


- data at different momenta
  are collected in the same run

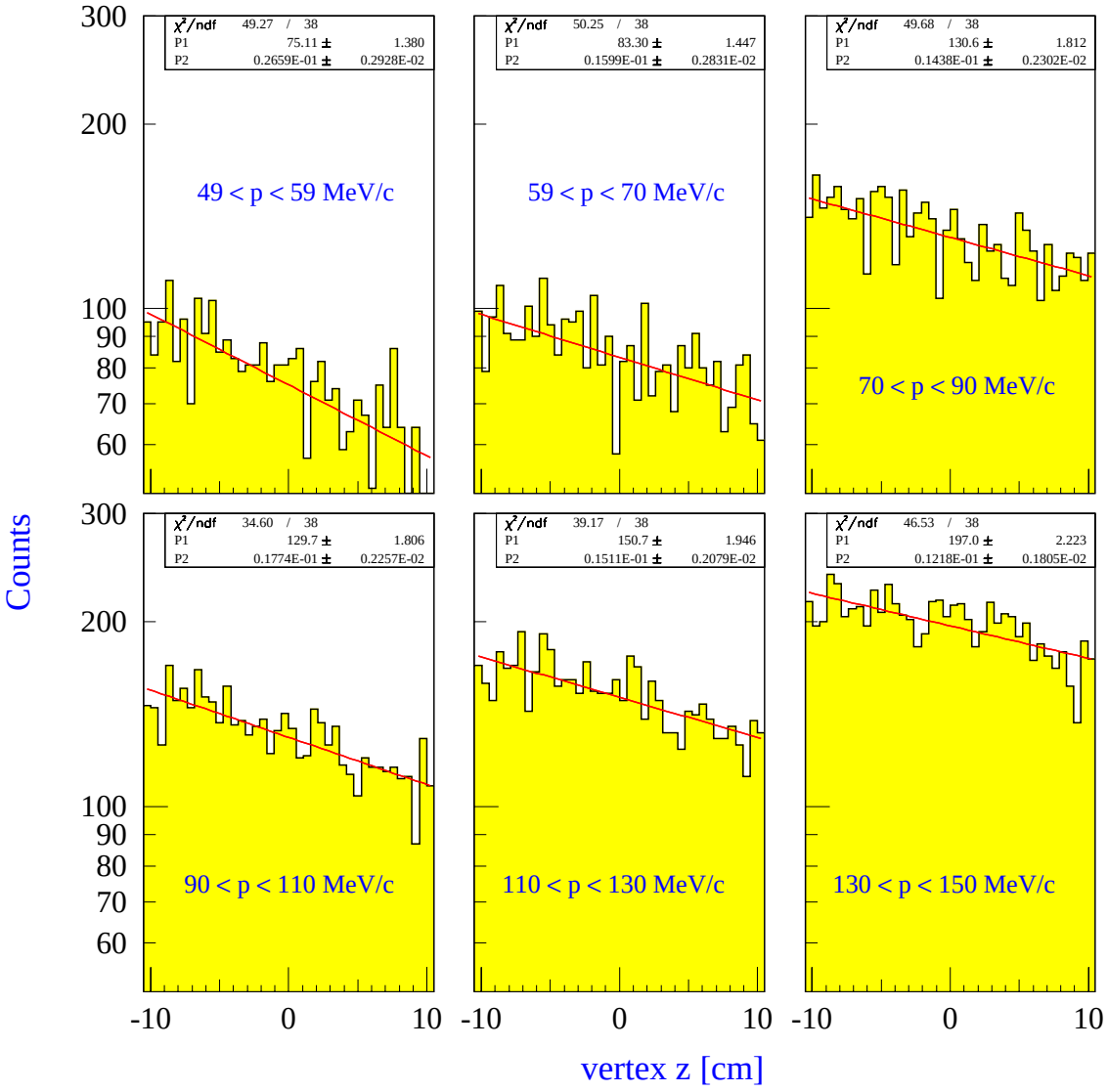
The transmission technique

The transmission technique

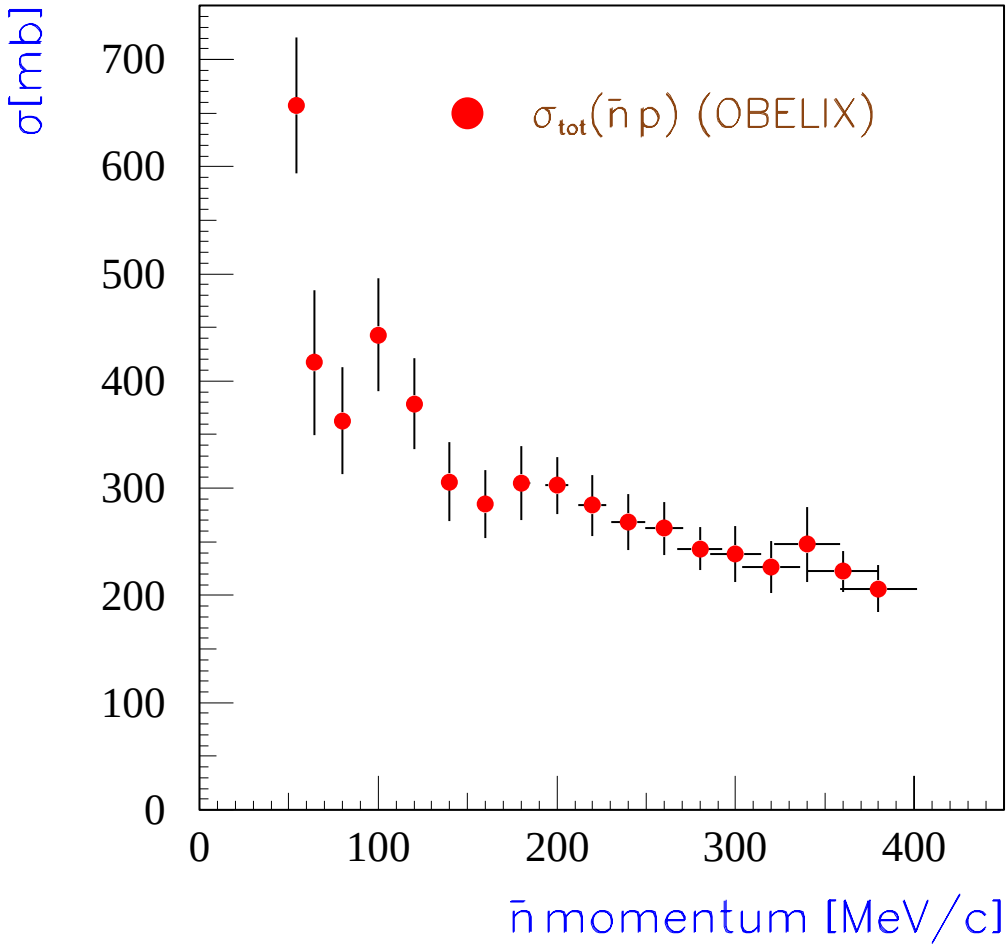




The transmission technique

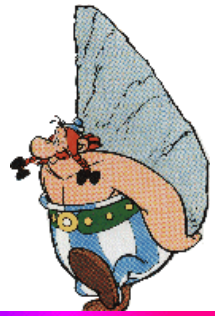


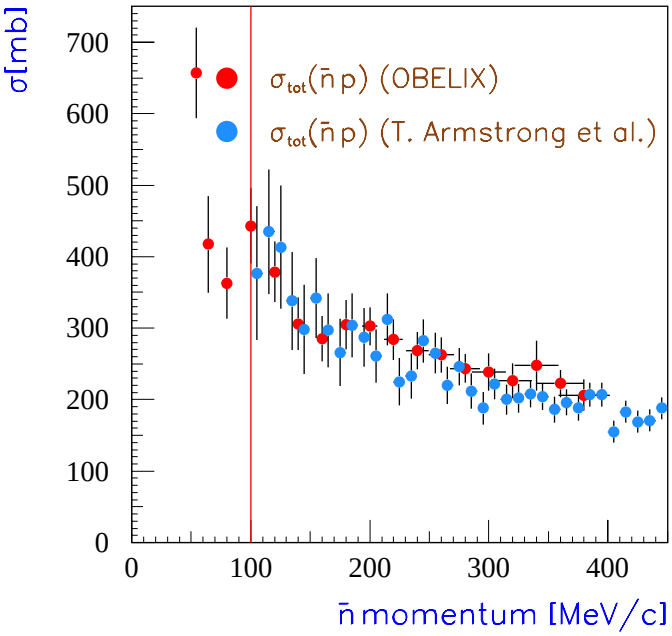
$\bar{n}p$ total cross section

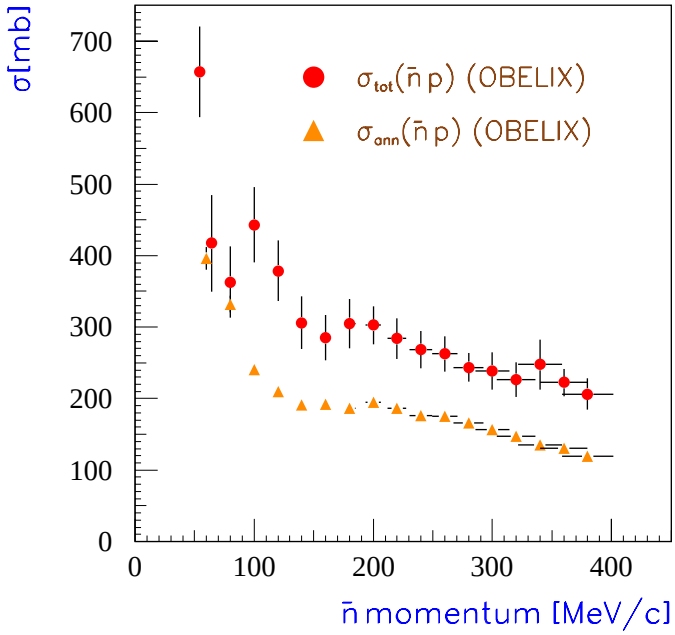


[*Phys. Lett.* **B** 475 (2000) 378]

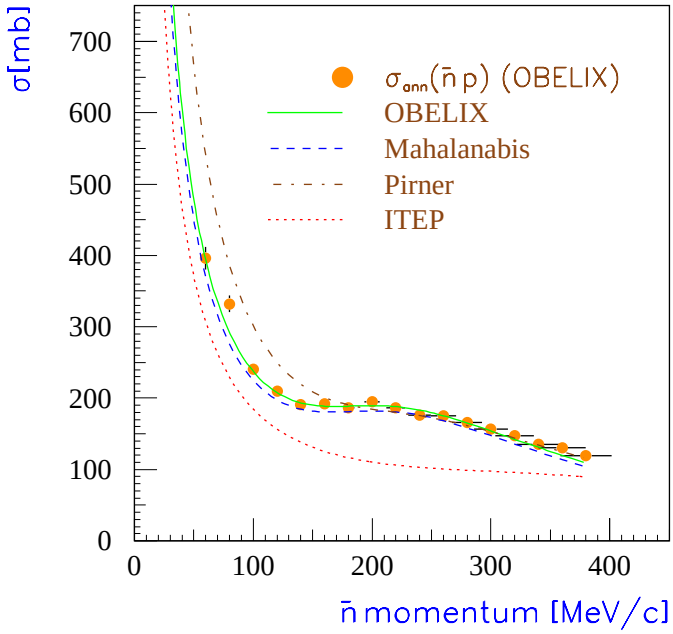
Comparisons





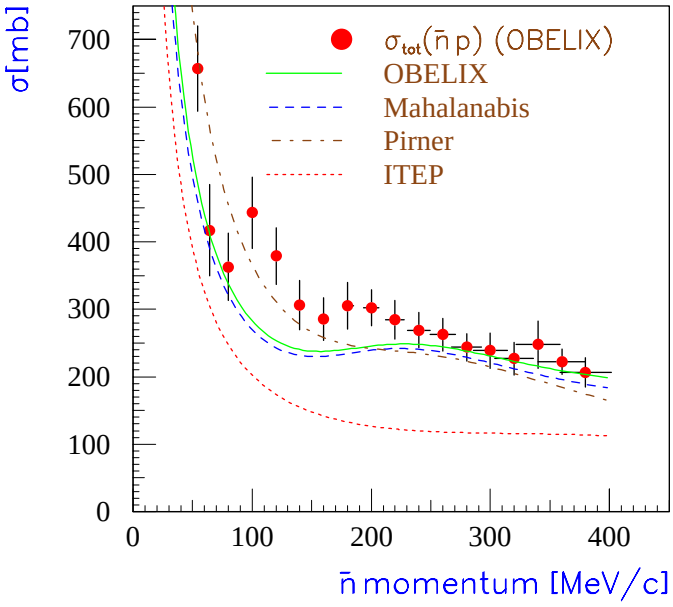


Effective range expansion



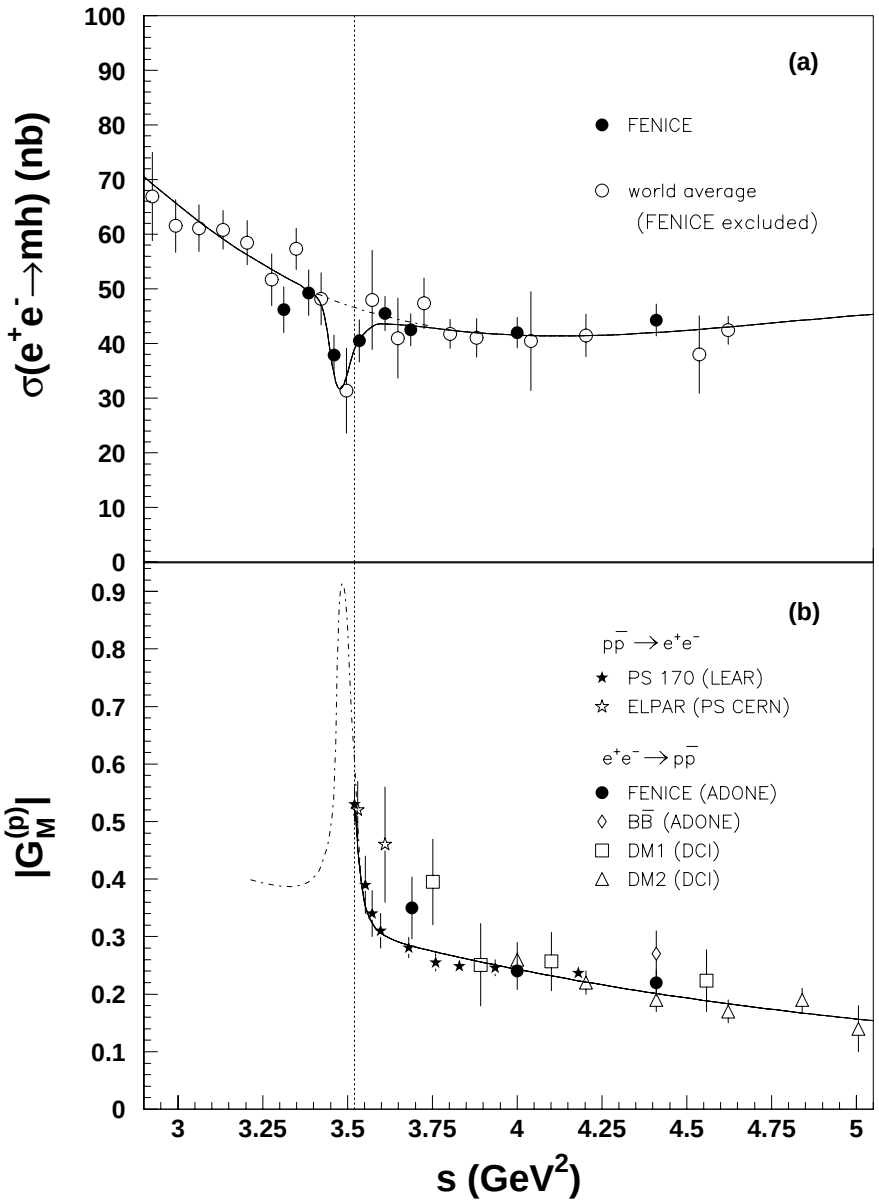
annihilation

total



FENICE experiment

$\sigma(e^+e^-) \rightarrow hadrons$

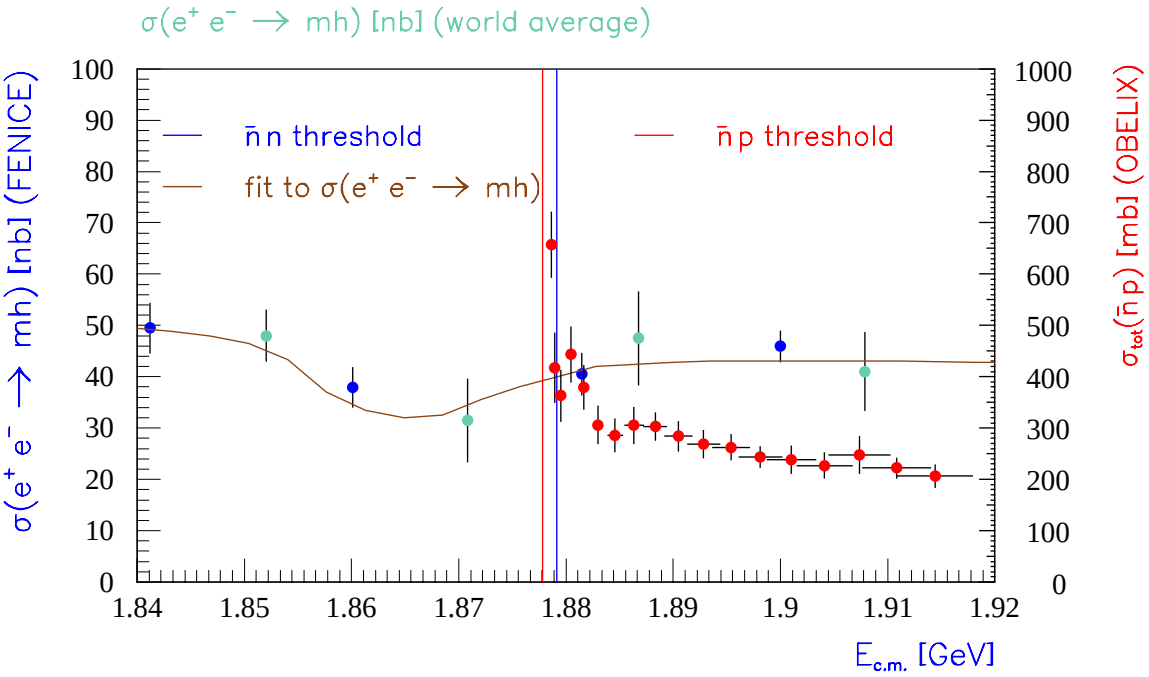


[*Nucl. Phys.* **B** 517 (1998) 3]

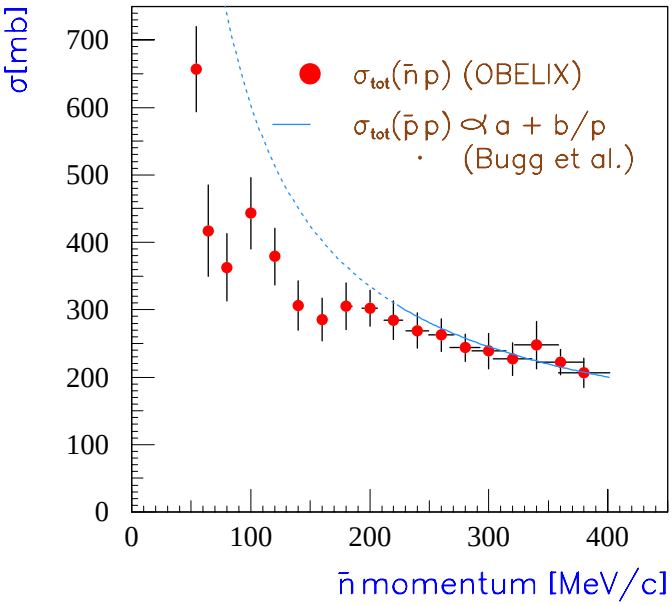
$M_x = (1.87 \pm 0.01)$ GeV

$\Gamma_x = (10 \pm 5)$ MeV

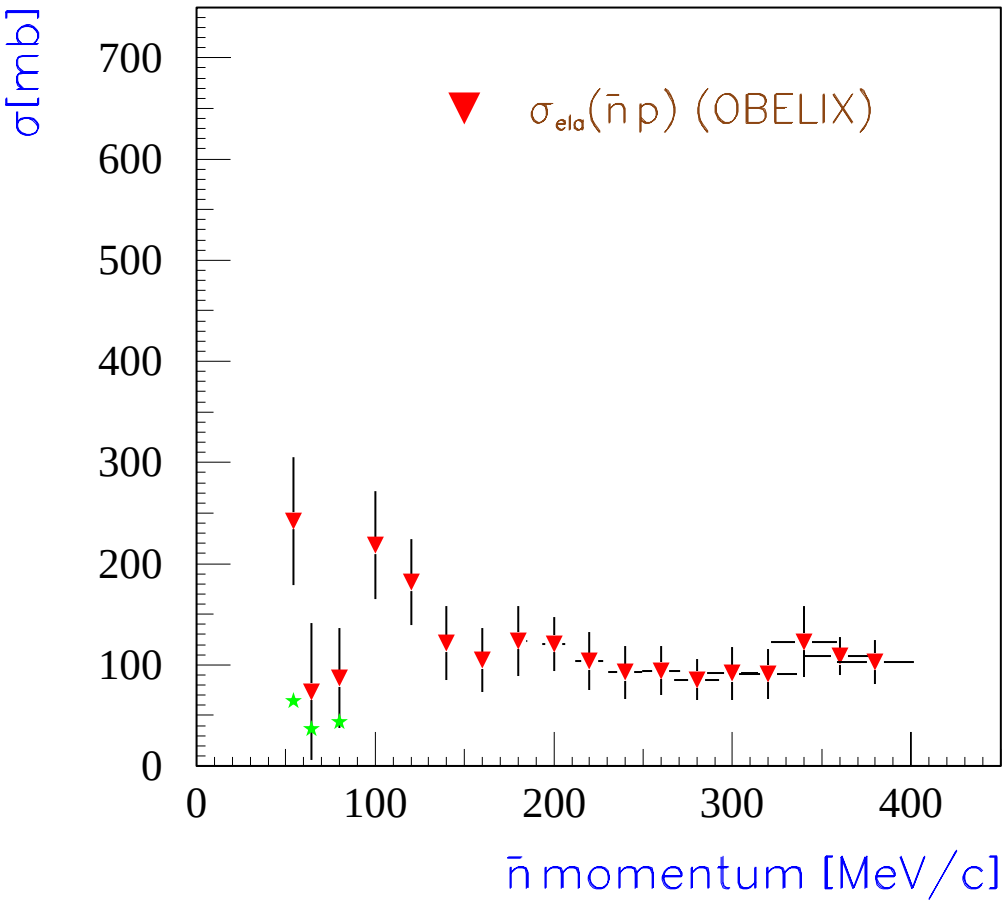
The threshold region



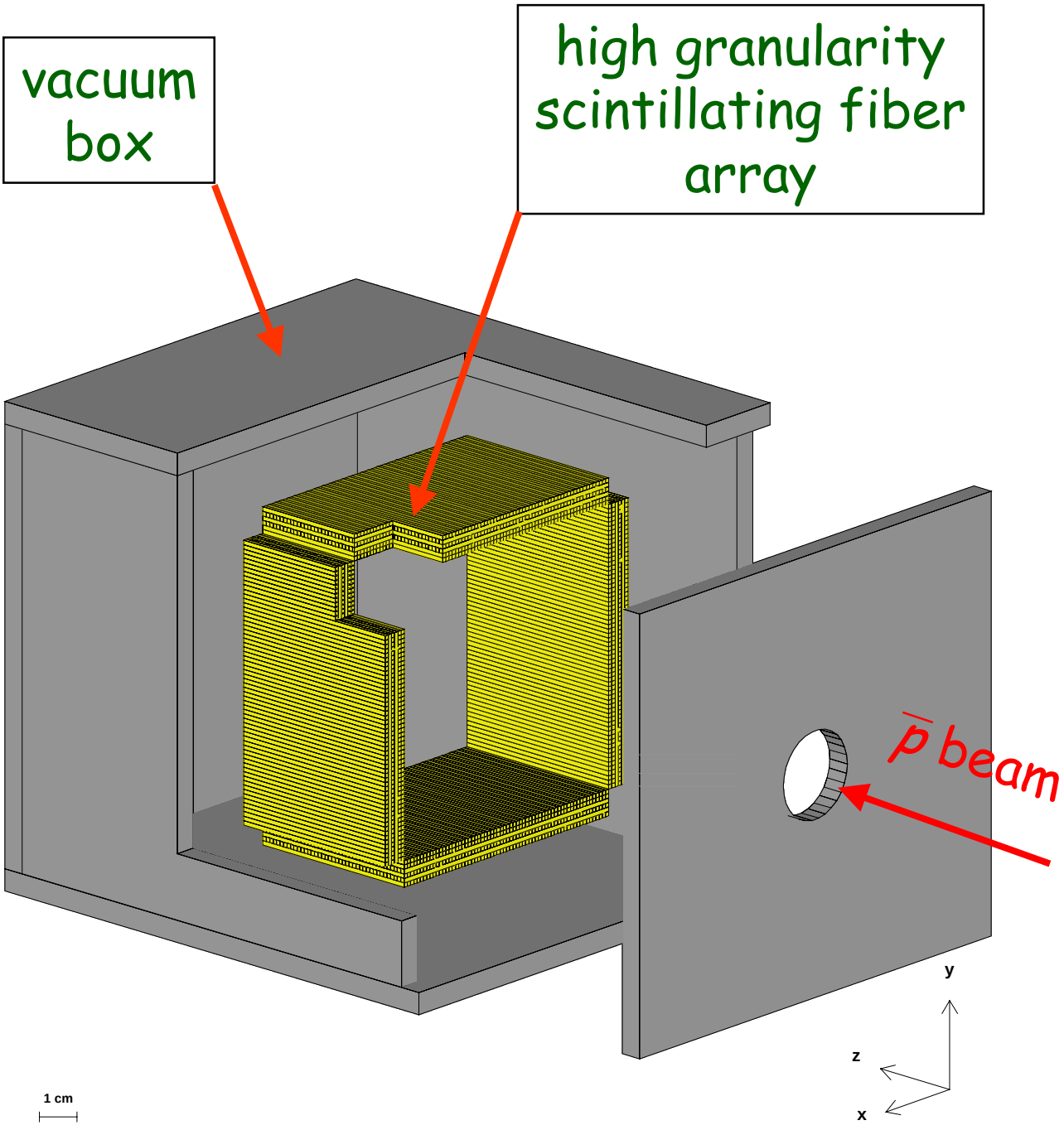
Isospin dependence

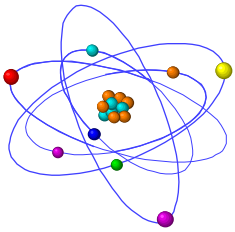


$\bar{n}p$ elastic cross section



The ELAPP project





Conclusions

✔ $\bar{n}p$ σ_{tot} measured for the first time:

1. down to 50 MeV/c
2. with high statistics

✔ evident anomalous behaviour of σ_{tot} ($\rightarrow \sigma_{el}$) near threshold

$\Downarrow$

indication for a narrow (quasi-nuclear bound?) state

✔ new proposal for a $\bar{p}p$ σ_{el} measurement

- test of the detector prototypes
- completion of the simulation code
- development of "clever" pattern recognition algorithms