

FLAP

Facility for Low-energy Antineutron Physics



**Horizon-INFRA-2025
Hadron Physics in Horizon Europe Town Meeting**



IMT Atlantique, July 1-3, 2025, Nantes, France

Alessandro Feliciello



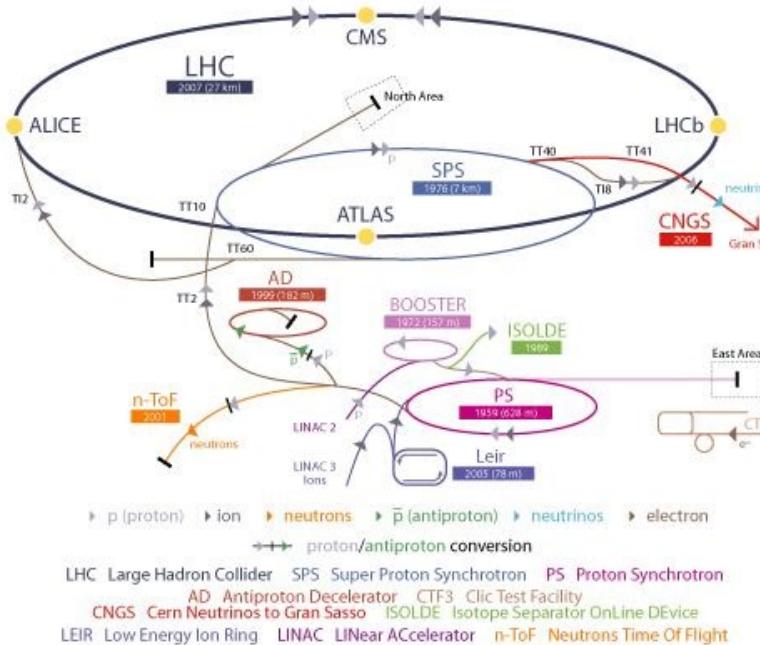
Istituto Nazionale di Fisica Nucleare
SEZIONE DI TORINO

Participating Institutions

- Department of Physics, Institute of Science Tokyo (JP)
H. Fujioka
- Dipartimento di Fisica, Università degli Studi di Torino (IT)
E. Botta
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R. Caravita

The rationale of FLAP

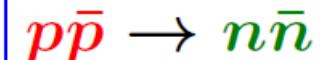
CERN Accelerator Complex



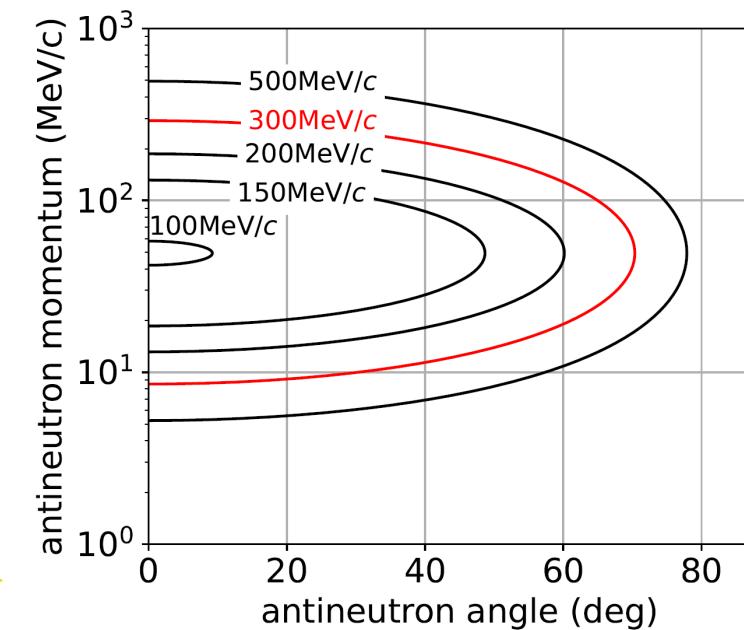
Start from the existing...



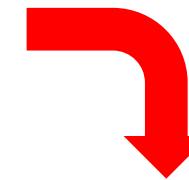
dynamics of



CEX reaction in the lab. frame



... develop and test new ideas...



... implement new tools
to perform
new measurements.

Main goal

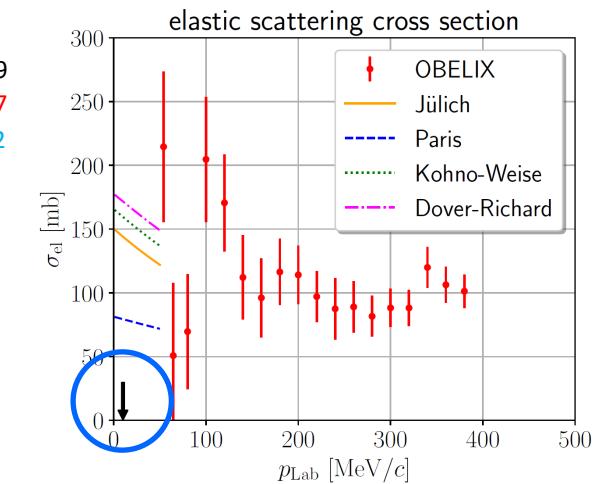
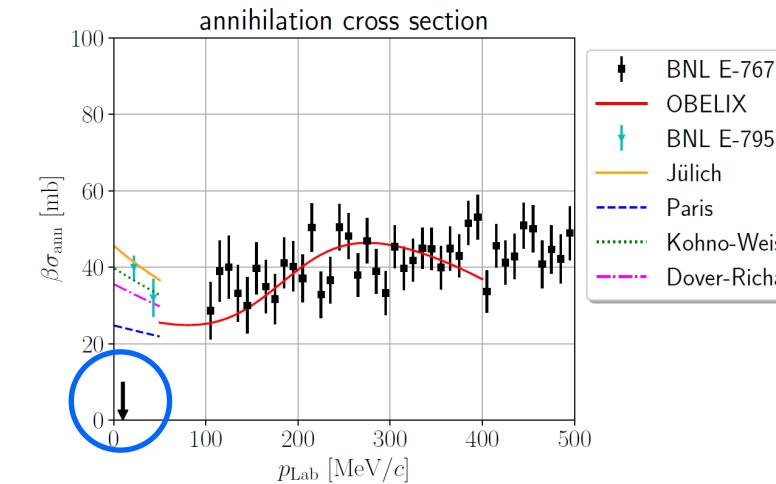
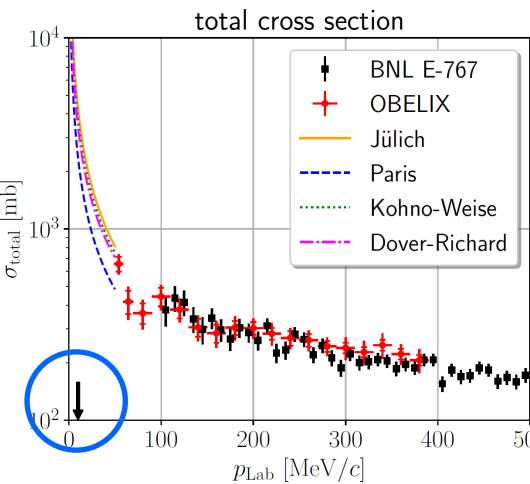
To implement a **novel**, ultra-low-energy antineutron beam line
at the **CERN AD** facility.



To offer the Community an **opportunity**
to pursue **new physics programs**

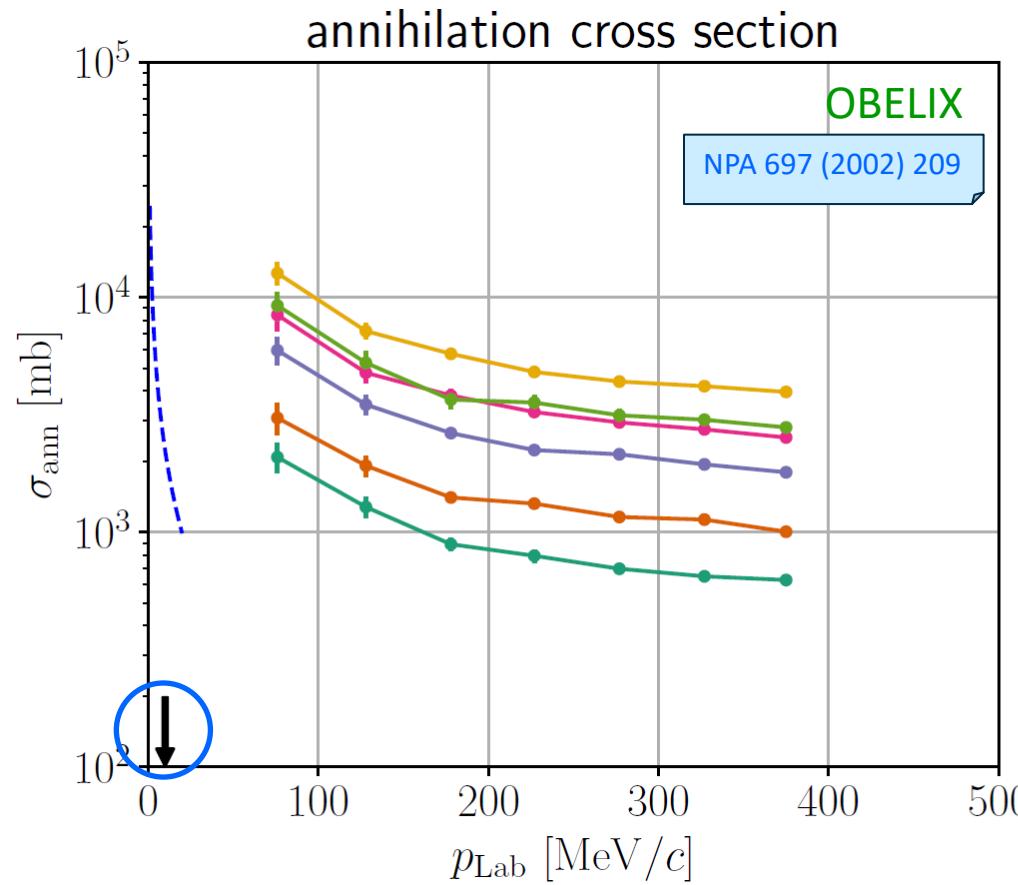
The physics case: low-energy $\bar{n}p$ scattering cross-sections

We need \bar{n} cross-section data at the **lowest** possible energies
to **improve** and **deepen** our current understanding
of low-energy antinucleon interactions



New measurements are **essential** to determine the **S-wave scattering length**
in a **model-independent** way

\bar{n} - nucleus cross-section

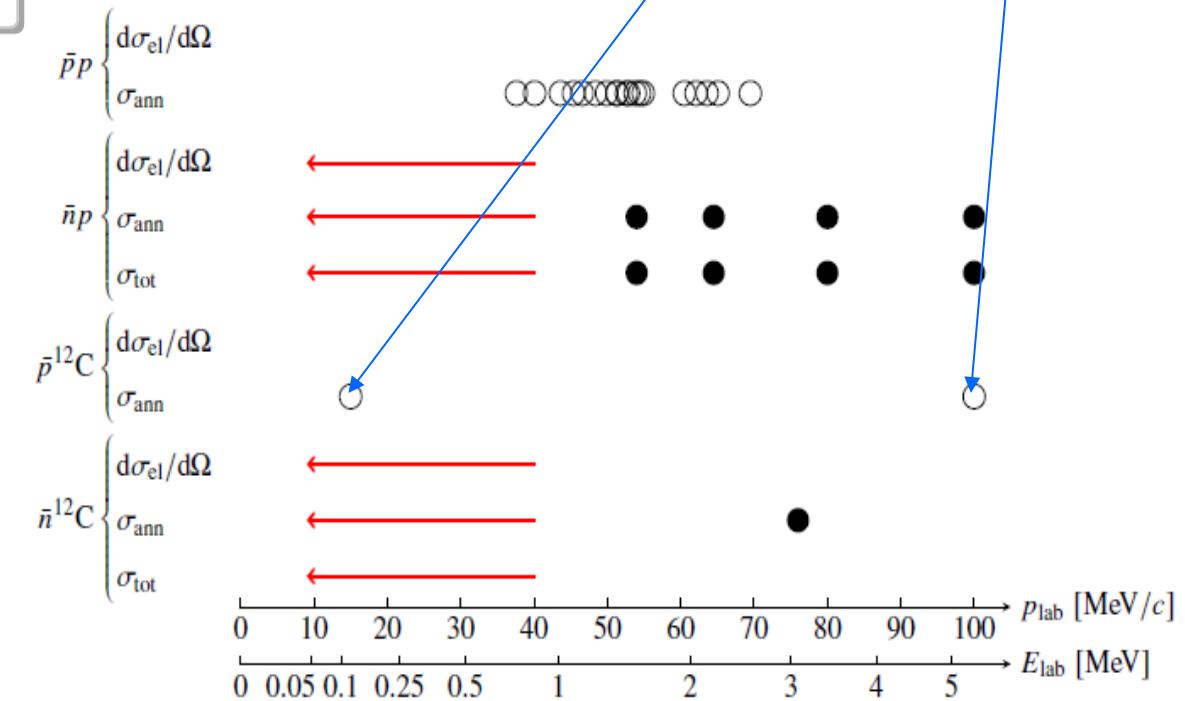


OBELIX
NPA 697 (2002) 209

C
Al
Cu
Ag
Sn
Pb
Batty

ASACUSA

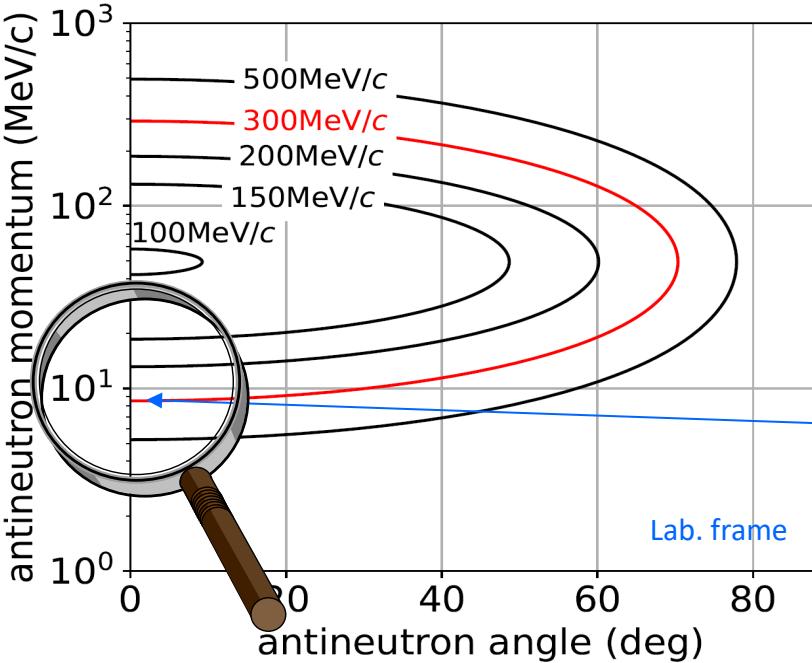
NPA 1009 (2021) 122170



- medium effect
• $n\bar{n}$ oscillation?

The leading idea

$p\bar{p} \rightarrow n\bar{n}$ @ $p_{\bar{p}} = 300$ MeV/c



to take into account the 2nd solution for the \bar{n} momemtum
i.e.

to select backward emitted \bar{n} in the C.M. frame



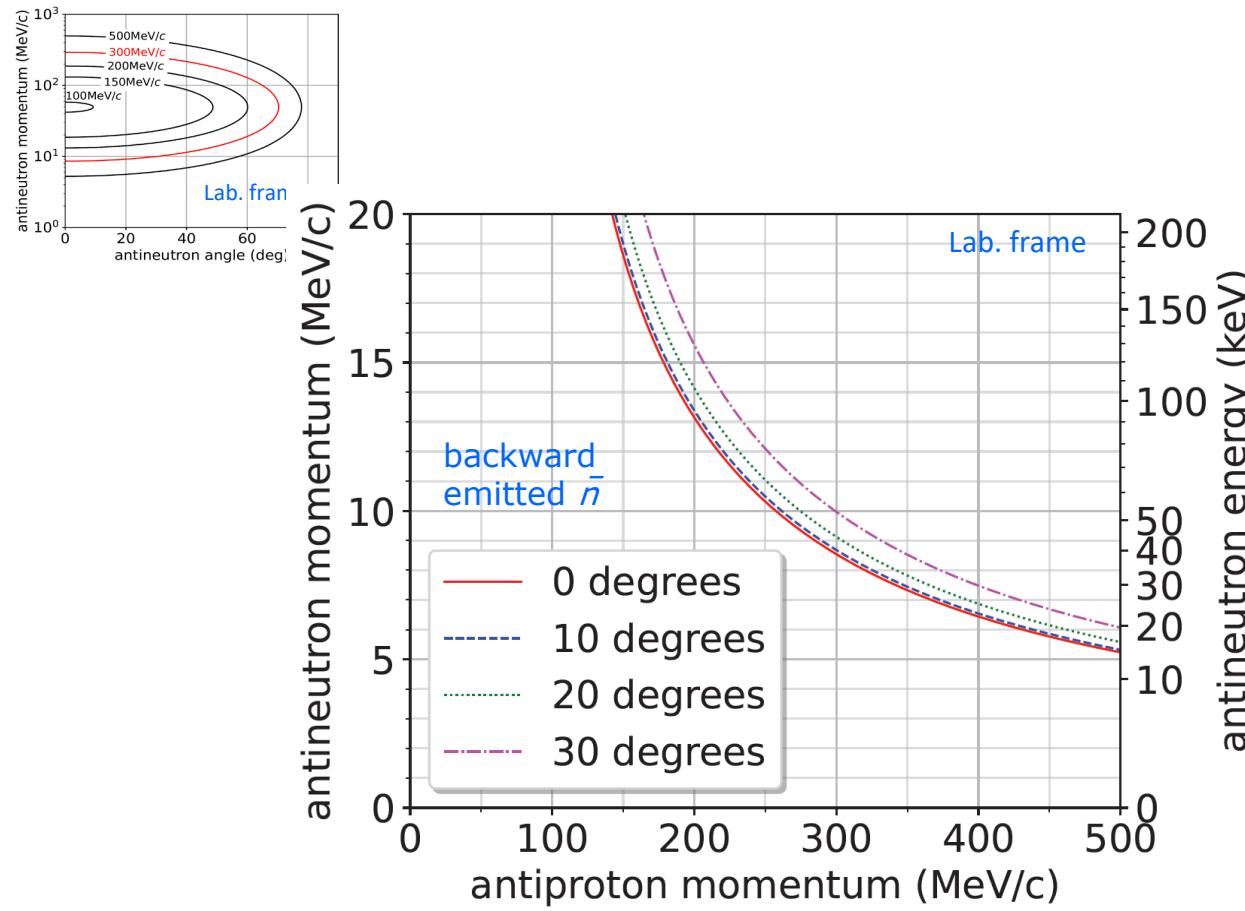
$$p_{\bar{n}} \approx 9 \text{ MeV/c !!!}$$

$$\left(\frac{d\sigma}{d\Omega}\right)_{\theta_{lab}=0^\circ} (\theta_{CM} = 180^\circ) = 4.7 \pm 1.9 \text{ } \mu\text{b/sr}$$

estimated @ $p_{\bar{p}} = 300$ MeV/c on the basis of previous measurements at LEAR [PLB 169 (1986) 302]

Expected \bar{n} yield

$p\bar{p} \rightarrow n\bar{n}$ @ $p_{\bar{p}} = 300$ MeV/c



* cfr. OBELIX: $13-56 \bar{n} / 10^6 \bar{p}$

a little help from the kinematics of the reaction:
by slightly increasing the angular acceptance
for backward produced \bar{n} (5°),
it will be possible to partially compensate
the low cross-section value



reasonable production target lenght:
 $0.44 \text{ g/cm}^2 \equiv 6.2 \text{ cm (LH}_2)$



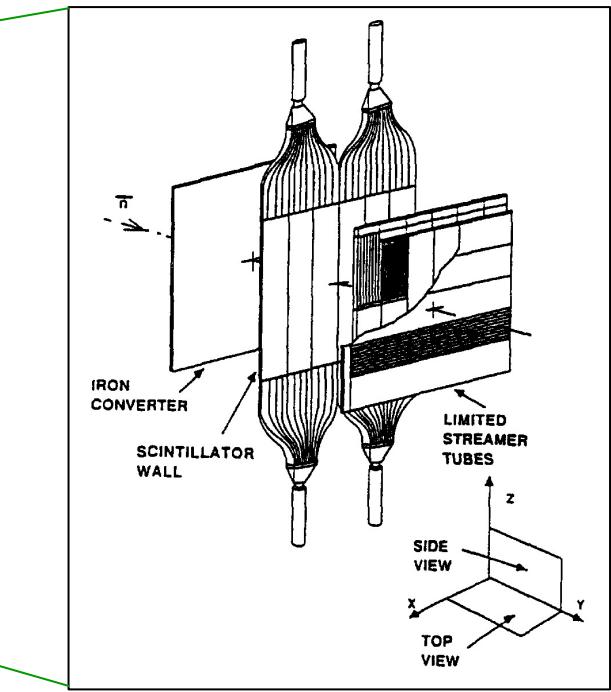
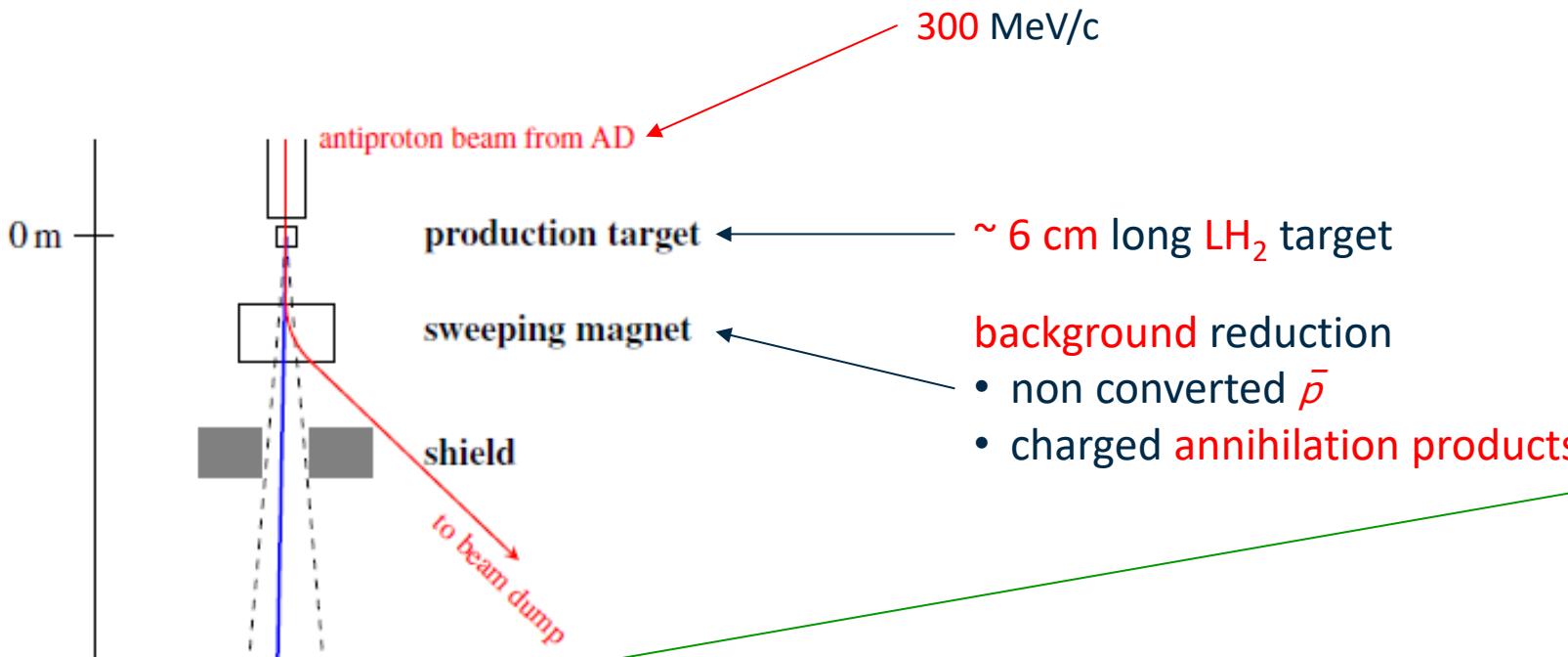
- \bar{p} momentum range: 250 – 300 MeV/c
- \bar{n} momentum range: 8.5 – 10.4 MeV/c
- \bar{n} transmission 62%



1 backward \bar{n} per AD cycle ($5 \times 10^7 \bar{p} / 120 \text{ s}$)*

percent level precision
scattering cross section measurement
within 1 week

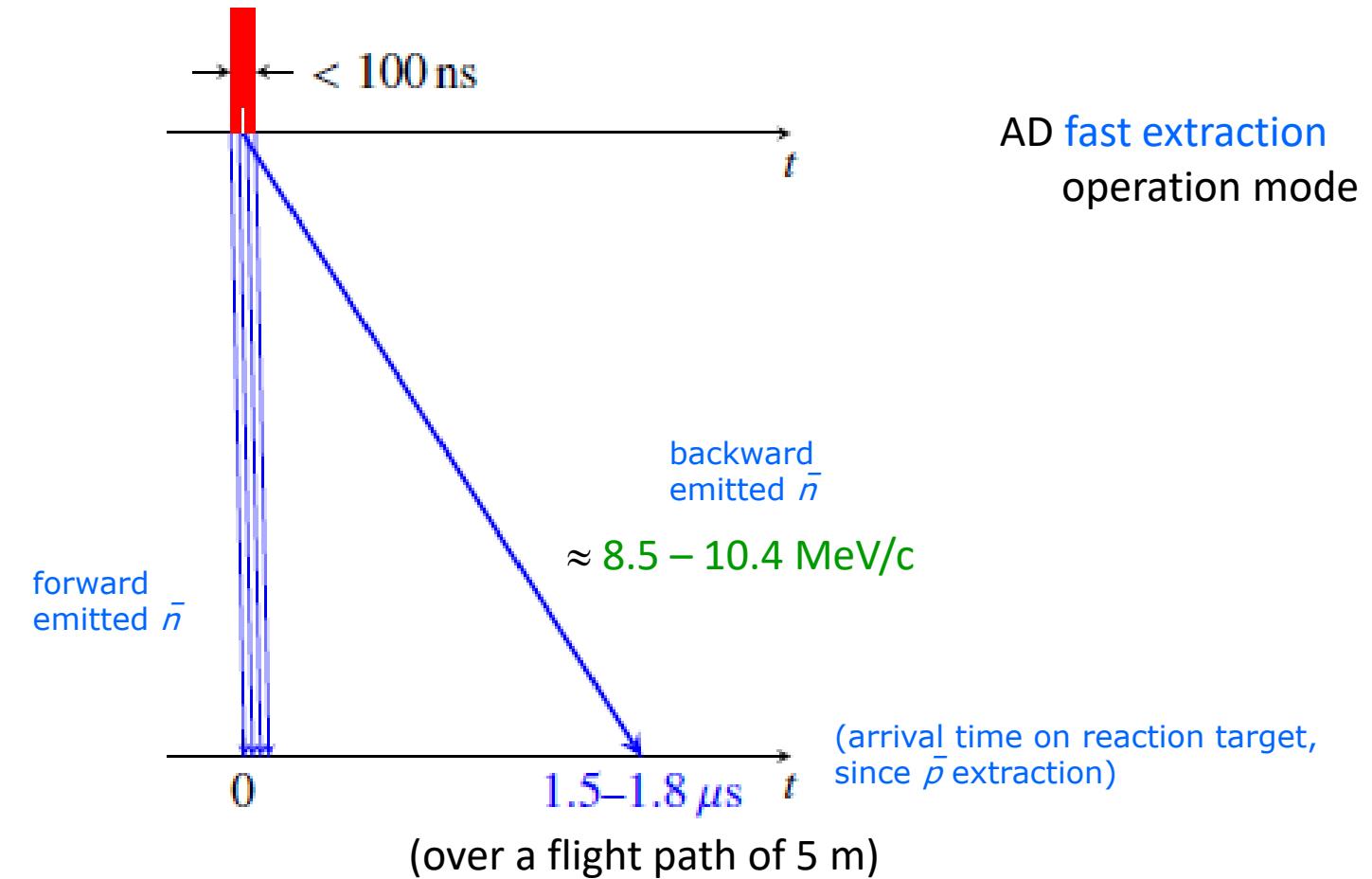
Schematic layout of the FLAP beamline



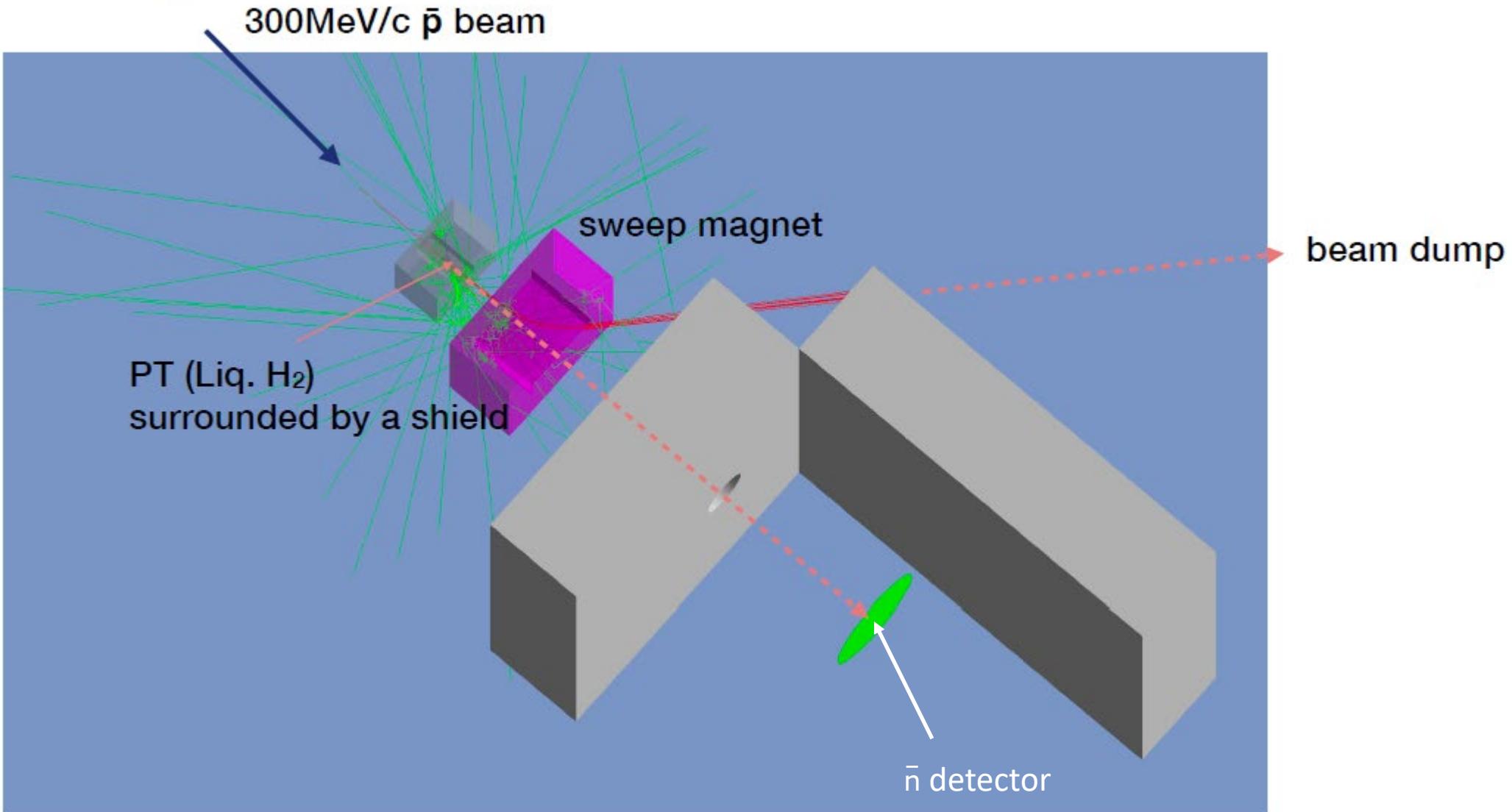
AD \bar{p} bunch time structure

(background reduction)

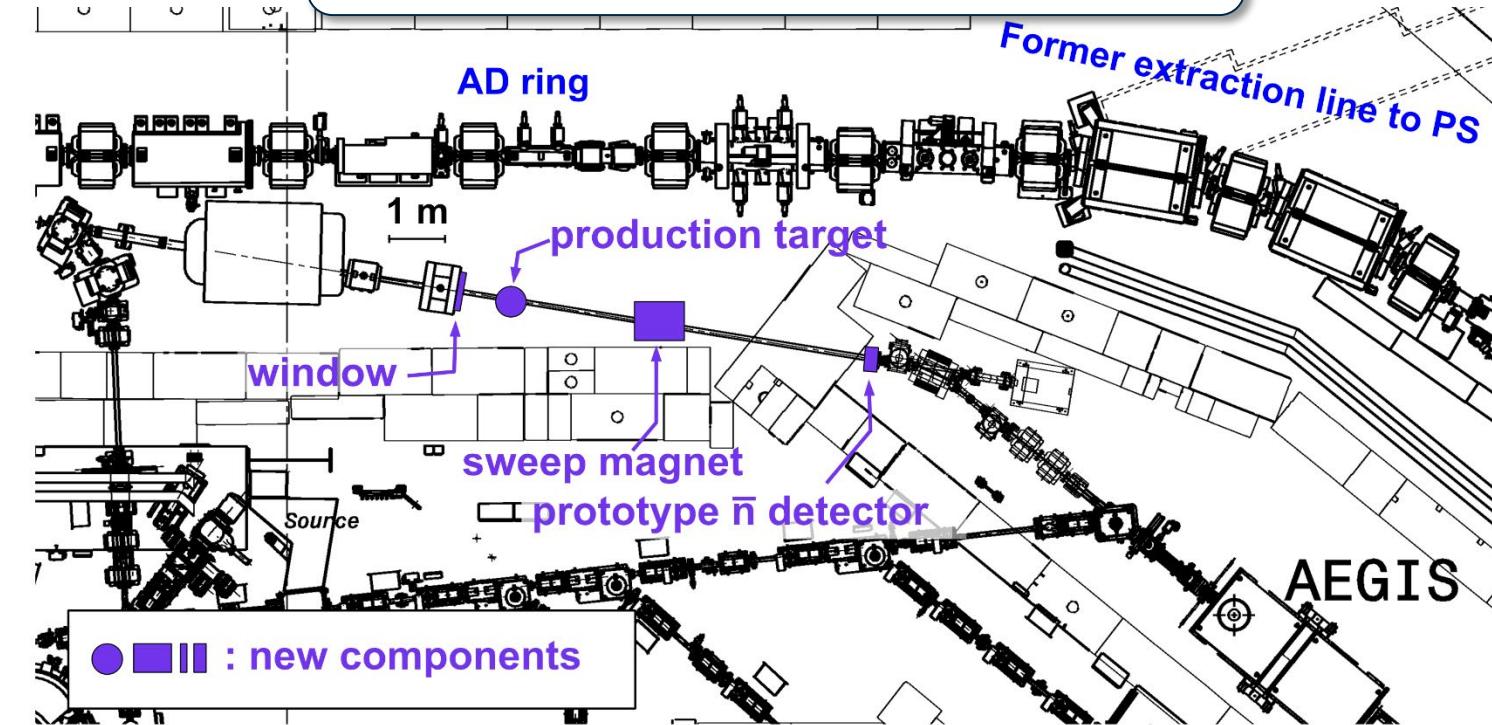
$$\frac{\text{backward } \bar{n}}{\text{forward } \bar{n}} = \mathcal{O}(10^{-3}) !$$



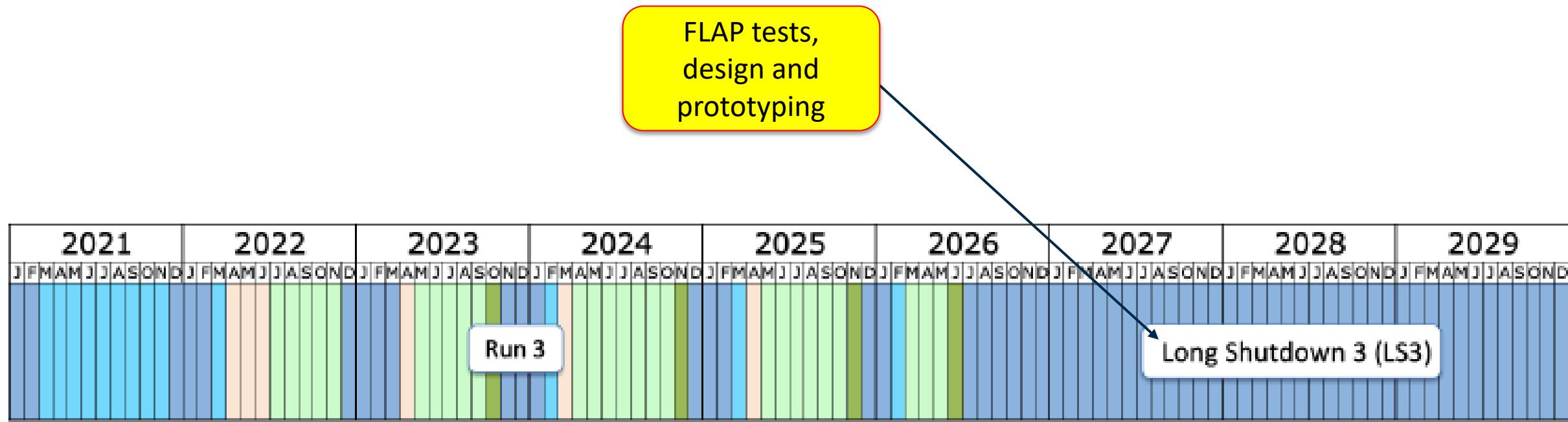
Experimental design concept



Short term tests



Timeline



Deliverables

- test results
- full Proposal to CERN
- groundwork for a complete Technical Design Report

Budget requests

- one **2-year contract** for a Post-Doc, working on the tests of:
 - slow antineutron production feasibility with fast extracted beam
- **travels to CERN** for tests and collaboration:
(5 k€/yr/PAX for 5 people) 100 k€
- administrative activities: 10 k€/yr 40 k€
- **total:** 290 k€

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