MANTRA

Measuring Anti-neutron: Tagging and Reconstruction Algorithm for frontier experiments

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I. Garzia, on behalf of the MANTRA group

The MANTRA group

Name	Qualification	University/Research Institution	Months/person
I. Garzia	RTDb	UNIFE	5
S. Spataro	PA	UNITO	5
S. Marcello	PO	UNITO	1
F. De Mori	PA	UNITO	1
U. Tamponi	Ricercatore	INFN	5
A. Filippi	Primo Ric.	INFN	1

- PI: I.Garzia; Vice PI: U. Tamponi (under 40)
- Collaborations: BESIII and Belle II
- Experts on anti-neutron physics: S. Marcello and A. Filippi

The MANTRA project

We propose a method to measure the energy of anti-neutrons (n-bar's) produced in high-energy physics (HEP) experiments with an energy up to few GeV. At present, large amounts of data are being collected by several high energy physics experiments, and the possibility of studying a wealth of new reactions and still unexplored reaction mechanisms could open an effective method to reliably measure their energy and kinematics be devised, exploiting at no additional cost the current experimental set-ups. The so developed method will be released as a tool exploitable for HEP community which could be used in data analysis for several kinds of measurements in which n-bar's play a fundamental role, such as nucleon and hyperon form factors, charmed mesons decays and anti-deuteron production.

IDEA:

- fully reconstruction of n-bar's at the modern collider experiments
  - not dedicated experimental setup for n-bar reconstruction

How to:

- Electromagnetic calorimeter
  - n-bar annihilates in the EMC crystals: characteristic signature
- TOF/TOP for time measurement (also muon detectors?)

The MANTRA project: Working Packages

MANTRA

1 year

WP1 (UNITO)
Calorimeter signature: clustering algorithm

WP2 (INFN)
Time-of-Flight signature in Cherenkov detector (TOP/Belle II)

WP3 (UNIFE)
Time-of-Flight signature in scintillators detector (TOF/BESIII)

1 year

WP4 (INFN)
Development of a global reconstruction algorithm

WP5 (UNIFE)
Dissemination

BESIII and Belle II data

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Project Title	MANTRA - Measuring Anti-Neutron: Tagging and Reconstruction Algorithm for frontier experiments	DATA	30/03/2022

WP	WP title	Deteails	Year 1 (months 1–12)	Year 2 (months 1–12)	Year 3 (months 1–2)
WP1	Calorimetric signature	- Implementation of GEANT4 calorimeter model - Study of the shower shapes and identification of variables - Comparison of the simulation results with real data			END OF THE PROJECT
WP2	Time-of flight signature in cherenkov detectors	- Study the timing signature of n-bar annihilation and backsplash events in the TOP - Develop a reconstruction algorithm to measure the timing - Study the timing signature of n-bar interactions in the inner layers of the muon identification system - Comparison of the simulation results with real data from Belle II			
WP3	Time-of-flight signature in scintillators	- Study the timing signature of n-bar annihilation and backsplash events in the ToF - Develop a reconstruction algorithm to measure the timing - Study the timing signature of n-bar interactions in the inner layers of the BESIII muon identification system - Comparison of the simulation results with real data from BESIII			
WP4	Development of the global reconstruction algorithm	- Determination of the NN design for the IDENTIFICATION of the n-bar interaction and training on MC simulation - Determination of the NN design for the MEASUREMENT OF THE ENERGY on the n-bar and training on a MC simulation - Application of the method to a simplified detector geometry modeled with GEANT4 - Application on the existing dataset by BES III and Belle II			
WP5	Dissemination	- Preparation of a stand at the event "Notte dei Ricercatori - Torino" - Preparation of a stand at the event "Notte dei Ricercatori - Ferrara" - Preparation of talks for conferences - Submission of publication about the method we developed to an international, peer-reviewed journal			

Project impact

MANTRA is a fundamental research project. By its nature it is not expected to produce an immediate economic or industrial impact

- 3 Research grants, each of 18 months
  - form highly-trained, young researches and professionals
  - WP4: study of NN-based algorithms
    - impact also in industry and business
- The developed tool could be used for n-bar identification and energy reconstruction in all particle detector in which an electromagnetic calorimeter and detectors for the measurement of the time-of-flight are available
- Large data set still available (BESIII, Belle II): no additional cost and investment in new experiments are required
- Open the door to a large number of measurements in which n-bar's play a fundamental role (nucleon and hyperon form factors, charmed mesons decays, anti-deuteron production, …)

Conclusions

Thanks to all the people involved in the MANTRA project