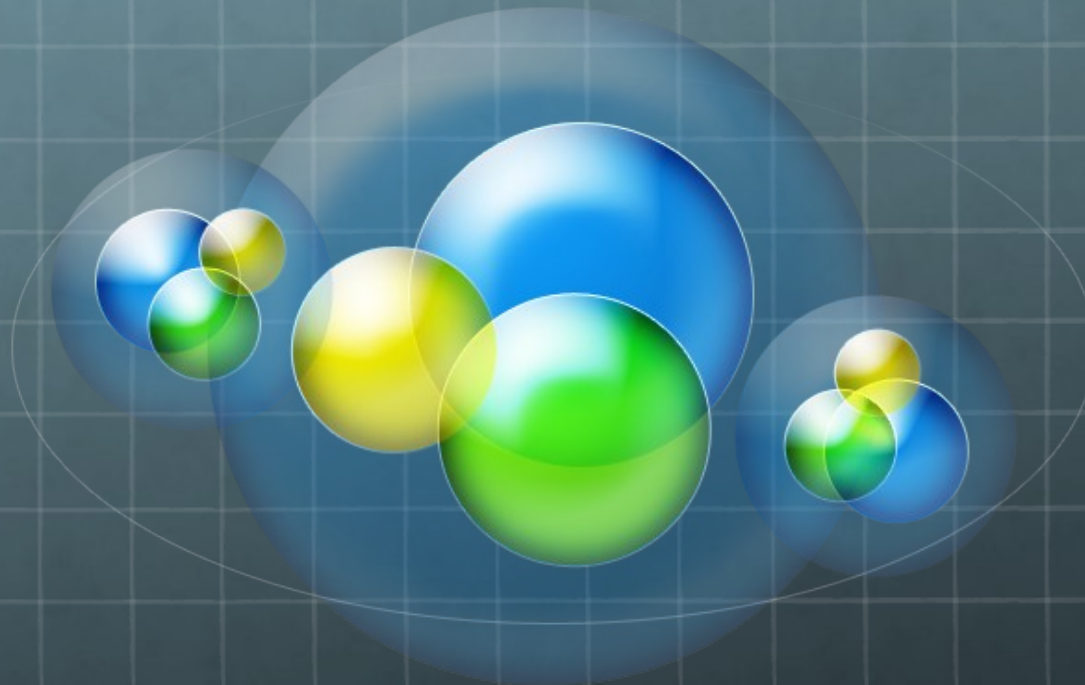


Astroparticules & Neutrinos

Demande de Ressources 2026



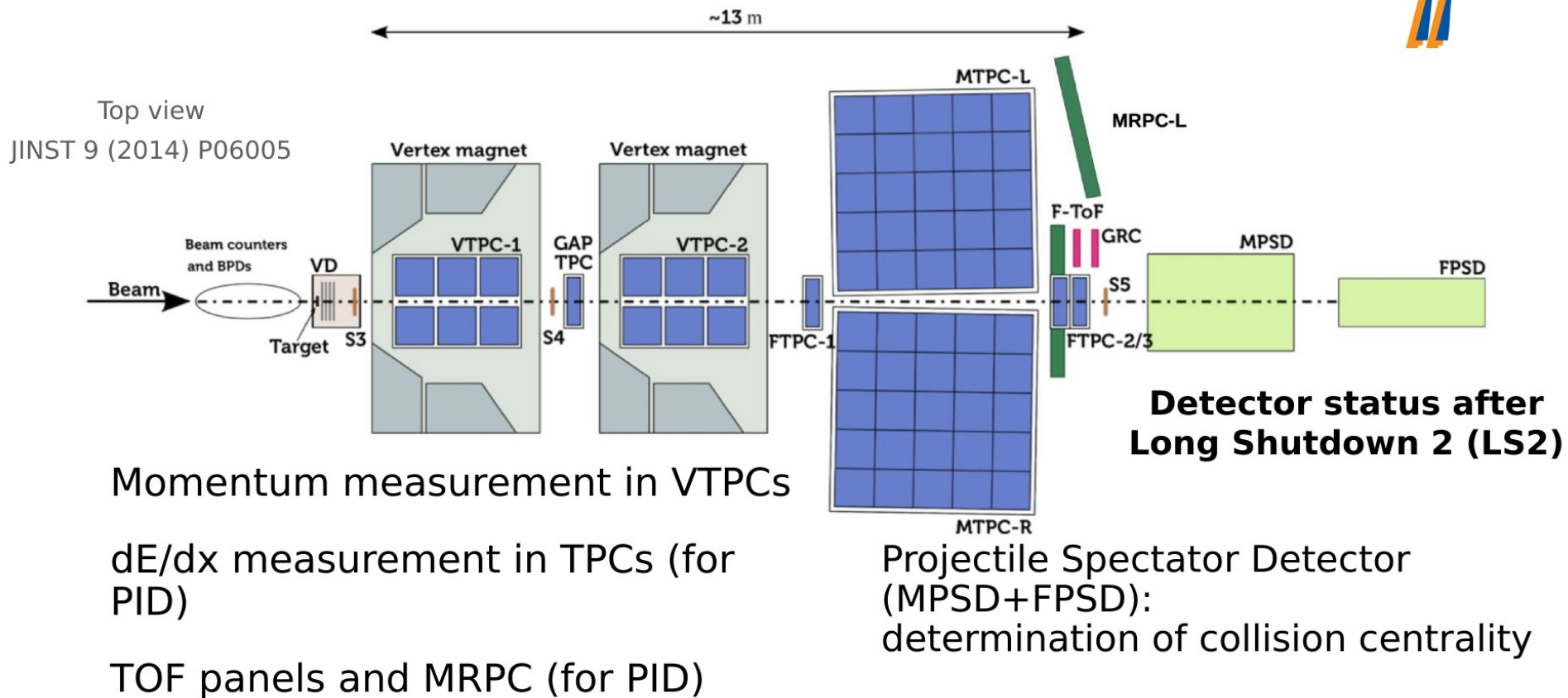
Projet NA61/SHINE

Boris Popov

NA61/SHINE detector




NA61/SHINE spectrometer



Utilisé pour la physique des interactions fortes, la physique des neutrinos d'accélérateur et la physique des rayons cosmiques (galactiques)

Calendrier et faits marquants

 Rappel du calendrier de construction/exploitation
Upgrade majeur et commissioning du détecteur après l'upgrade au cours de l'année 2021-2022. Collecte de données physiques en 2026 avant le LS3 au CERN.

Faits marquants 2025

Utilisation dans l'analyse officielle de T2K des données de la cible réplique et réduction d'un facteur 2 des incertitudes systématiques au niveau de $\sim 5\%$ (**T2K paper in preparation**)

Publication des données pour DUNE/Fermilab: protons sur C à 90 GeV/c (**Phys. Rev. D 112 (2025) 012011**) et à 60 GeV/c (**paper in preparation**)

Mesures de référence pour la production de K_s^0 dans les interactions p+p et observation de la violation de la symétrie d'isospin dans les collisions de noyaux atomiques à haute énergie (**Nature Commun.16(2025)1, 2849**)

Nouvelle prise de données avec la cible anticipée pour DUNE l'été 2024

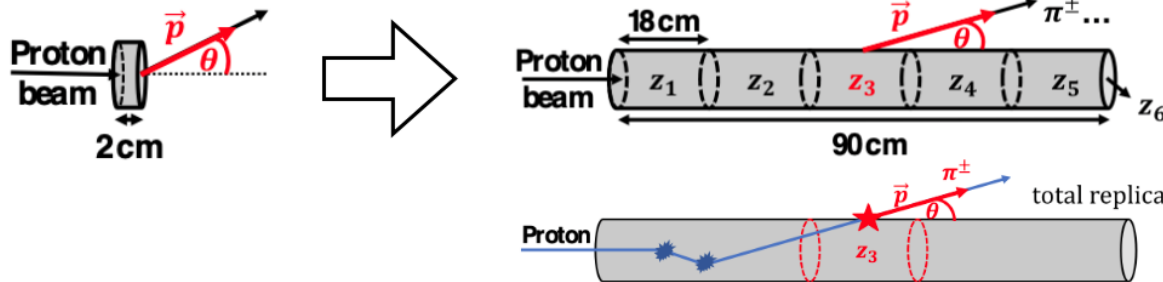
Eventuels faits marquants attendus en 2026

Analyse des données pour T2K (continuation) et premiers résultats

Analyse des données pour Fermilab (continuation)

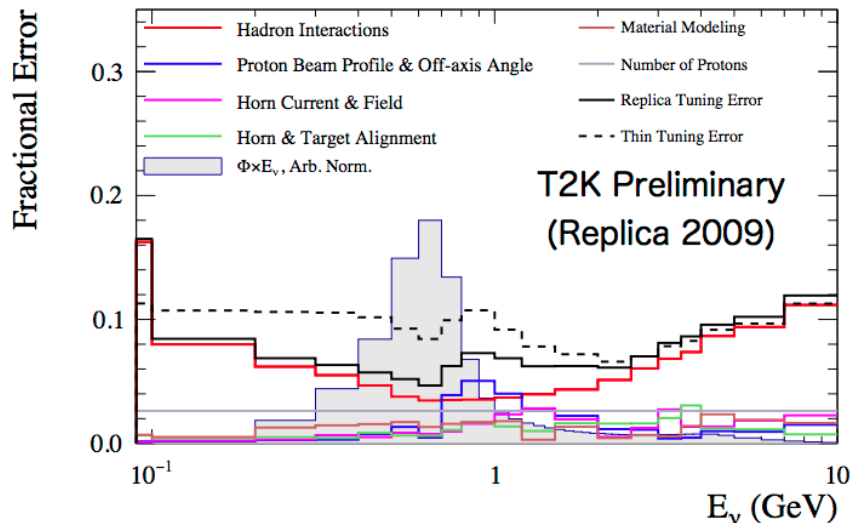
T2K ν_μ flux uncertainties

Move to replica target tuning

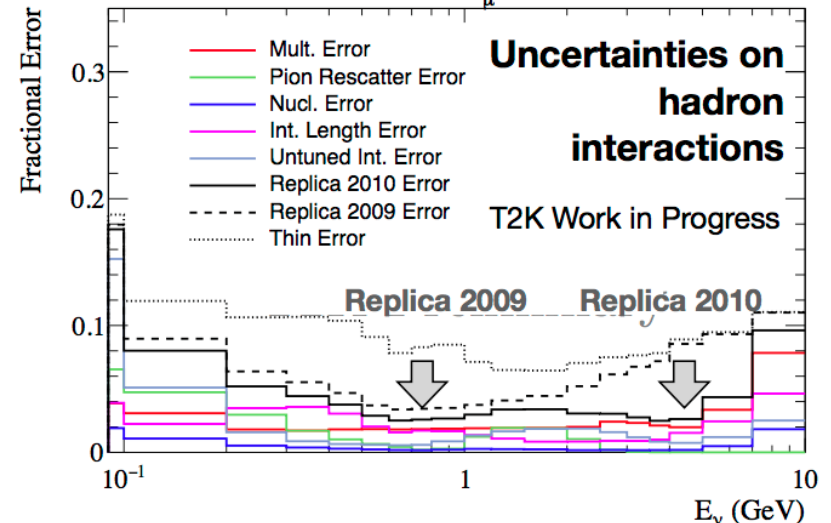


- Strong reduction of interaction length uncertainty
- Single weight per exiting particle

SK: Neutrino Mode, ν_μ



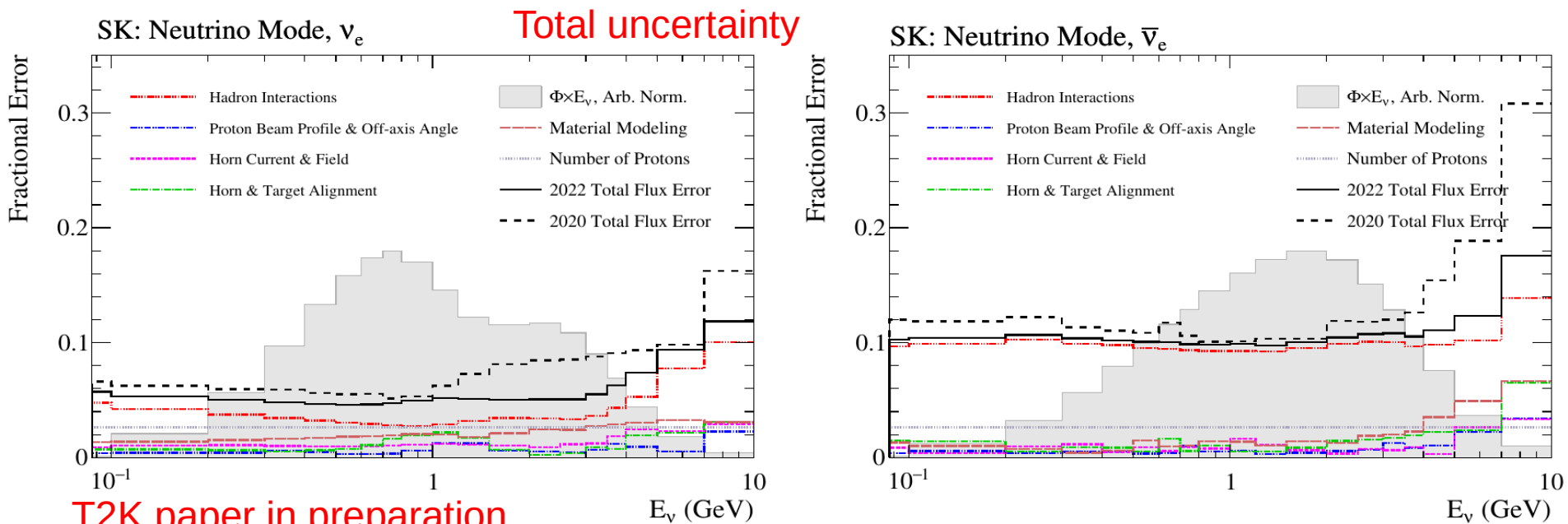
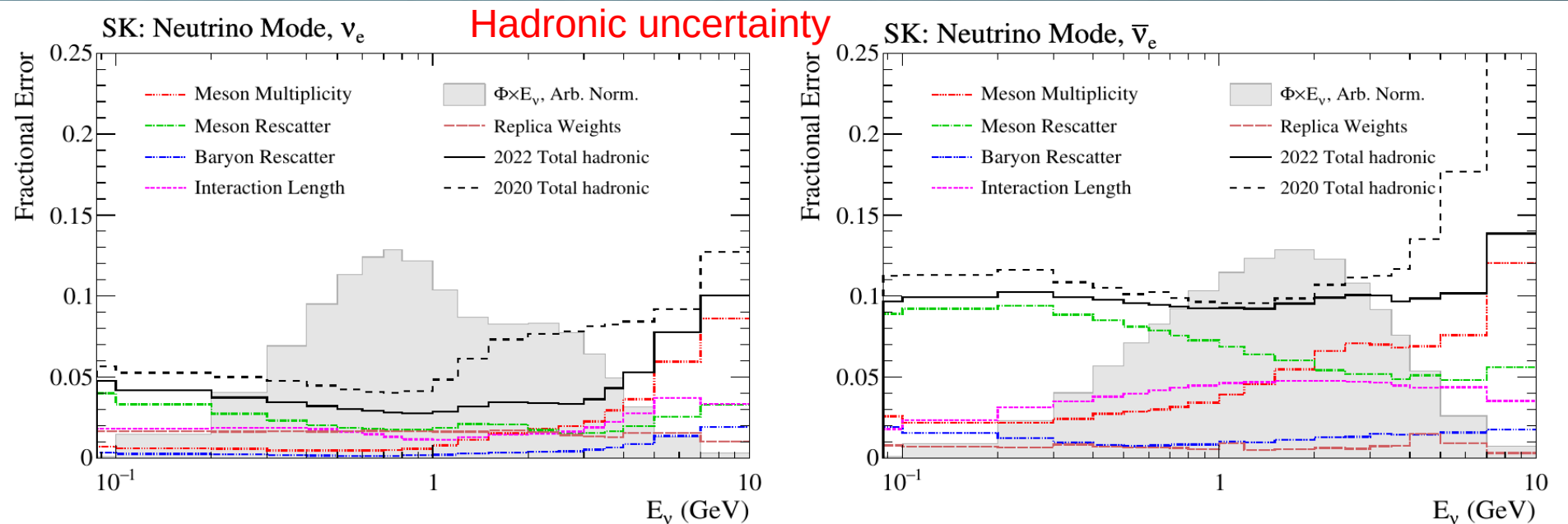
SK: Positive Focussing (ν) Mode, ν_μ



Utilisé pour les résultats officiels présentés à la conférence Neutrino 2022 et toutes les analyses et publications de T2K après cela

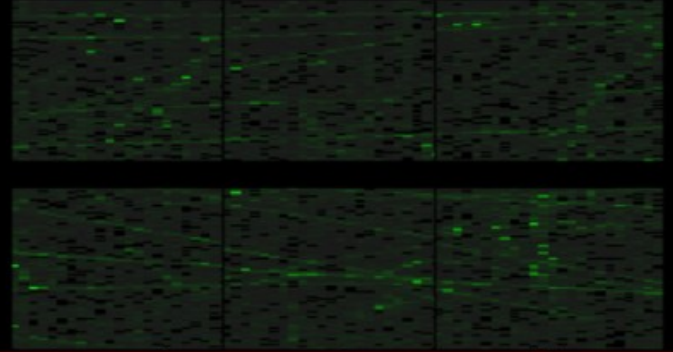
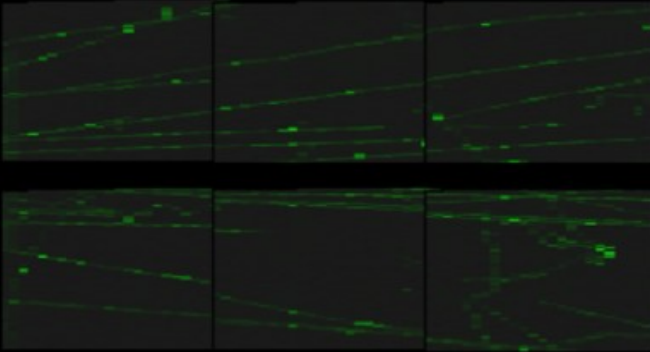
T2K paper in preparation

T2K ν_e flux uncertainties



T2K paper in preparation

Upgraded NA61/SHINE setup



TPC readout rate increased by ~10


Major detector upgrade allowed to collect new high-quality data in 2022 with T2K replica target (180M events to be compared with 10M in 2010)

Recent NA61/SHINE publications

Proposal from the NA61/SHINE Collaboration for update of European Strategy for Particle Physics #1

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Jul 11, 2025)

e-Print: [2507.08602](#) [nucl-ex]

 pdf  links  cite  claim  reference search  2 citations

Multiplicity and net-electric charge fluctuations in central Ar+Sc interactions at 13A, 19A, 30A, 40A, 75A, and 150A GeV/c beam momenta measured by NA61/SHINE at the CERN SPS #2

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Mar 28, 2025)

Published in: *Eur.Phys.J.C* 85 (2025) 8, 918 • e-Print: [2503.22484](#) [nucl-ex]

 pdf  links  DOI  cite  claim  reference search  3 citations

Measurements of hadron production in 90 GeV / c proton-carbon interactions #3

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Oct 30, 2024)

Published in: *Phys.Rev.D* 112 (2025) 1, 012011 • e-Print: [2410.23098](#) [hep-ex]

 pdf  links  DOI  cite  claim  reference search  1 citation

Measurement of the mass-changing, charge-changing, and production cross sections of ^{11}C , ^{11}B , and ^{10}B nuclei in $^{12}\text{C} + \text{p}$ interactions at 13.5 GeV / c per nucleon #4

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Oct 23, 2024)

Published in: *Phys.Rev.C* 111 (2025) 5, 054606 • e-Print: [2410.18273](#) [nucl-ex]

 pdf  links  DOI  cite  claim  reference search  7 citations

Recent NA61/SHINE publications

K_S^0 meson production in inelastic p+p interactions at 31, 40 and 80 GeV/c beam momentum measured by NA61/SHINE at the CERN SPS #5

NA61/SHINE Collaboration • N. Abgrall (Geneva U.) et al. (Feb 26, 2024)

Published in: *Eur.Phys.J.C* 84 (2024) 8, 820 • e-Print: [2402.17025](#) [hep-ex]

 pdf  links  DOI  cite  claim  reference search  7 citations

Search for a critical point of strongly-interacting matter in central $^{40}\text{Ar} + ^{45}\text{Sc}$ collisions at 13 A–75 A GeV/c beam momentum #6

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Jan 7, 2024)

Published in: *Eur.Phys.J.C* 84 (2024) 7, 741 • e-Print: [2401.03445](#) [nucl-ex]

 pdf  links  DOI  cite  claim  reference search  9 citations

Measurements of higher-order cumulants of multiplicity and net-electric charge distributions in inelastic proton-proton interactions by NA61/SHINE #7

NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U. and Cracow, INP) et al. (Dec 21, 2023)

Published in: *Eur.Phys.J.C* 85 (2025) 3, 341 (erratum), *Eur.Phys.J.C* 84 (2024) 921 • e-Print: [2312.13706](#) [hep-ex]

 pdf  links  DOI  cite  claim  reference search  5 citations

Evidence of isospin-symmetry violation in high-energy collisions of atomic nuclei #8

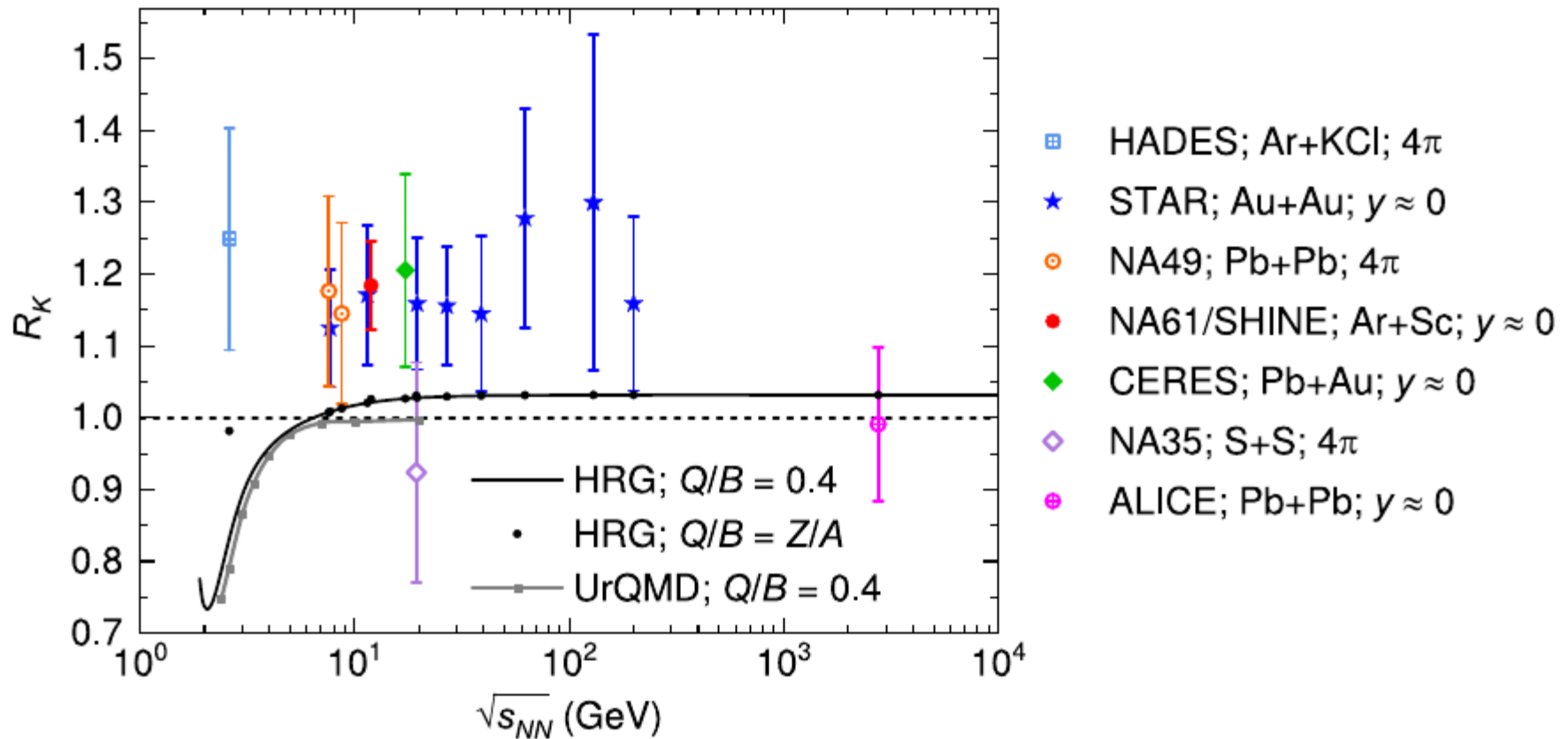
NA61/SHINE Collaboration • H. Adhikary (Jan Kochanowski U.) et al. (Dec 11, 2023)

Published in: *Nature Commun.* 16 (2025) 1, 2849 • e-Print: [2312.06572](#) [nucl-ex]

 pdf  links  DOI  cite  datasets  claim

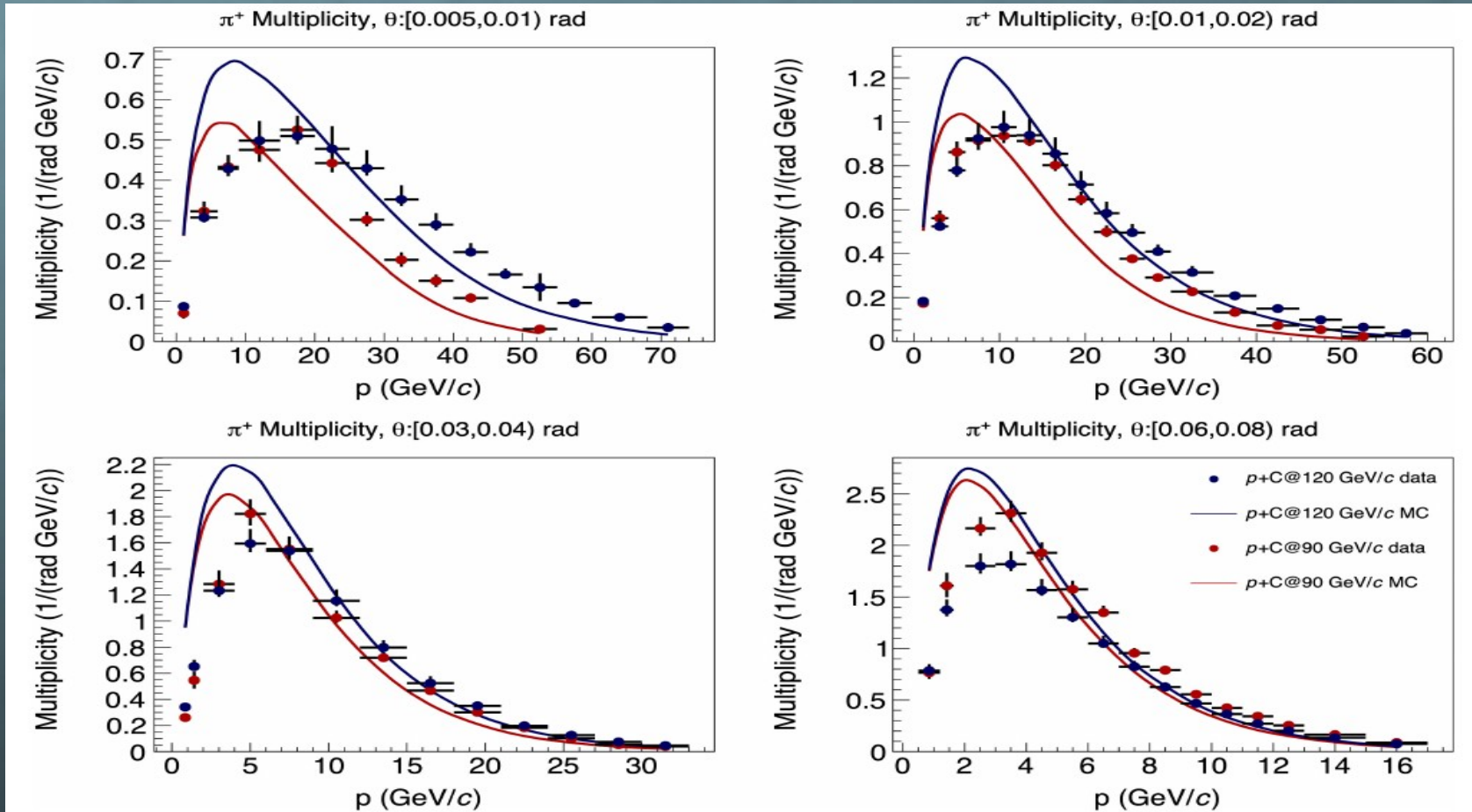
 reference search  26 citations

New results published in 2025



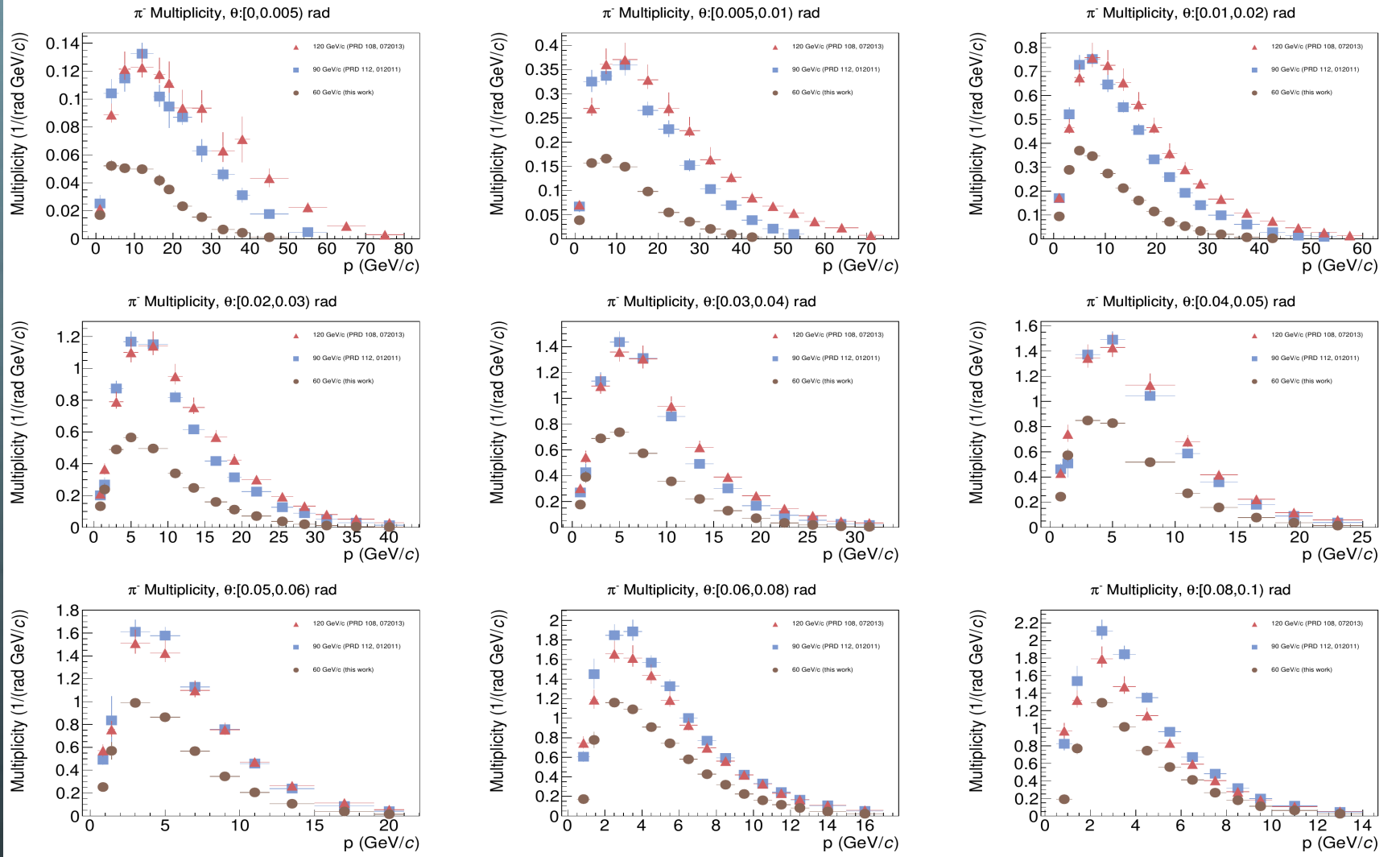
World data on measurements of *charged-to-neutral kaon* ratio indicating isospin-symmetry violation (*Nature Commun.* 16 (2025) 1, 2849)

New results in 2025



Measurements of π^+ , π^- , K^+ , K^- and (anti)protons, K_S^0 and (anti) Λ production in $p+C@90 \text{ GeV}/c$ published (Phys. Rev. D 112 (2025) 012011) and compared with $p+C@120 \text{ GeV}/c$ measurements

New (preliminary) results in 2025

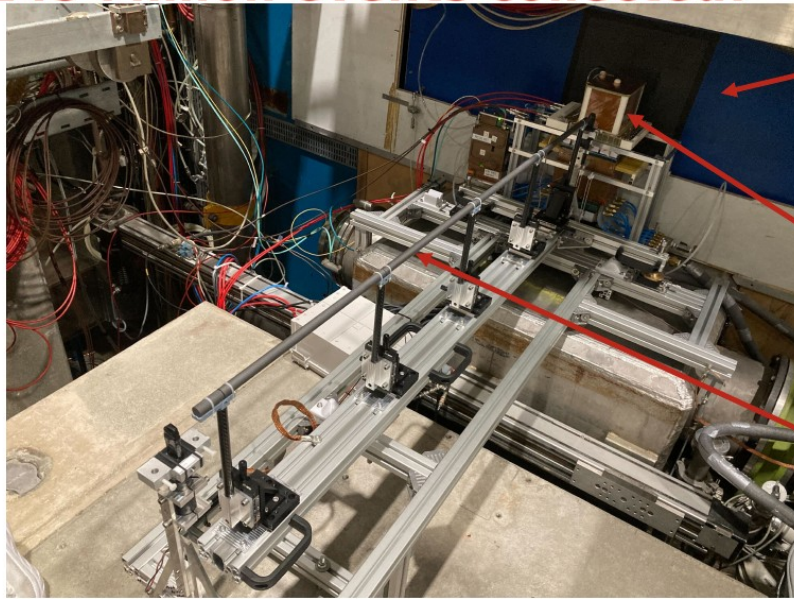


Example of comparison of π^- yields in $p+C@60$ GeV/c with $p+C@90$ GeV/c and $p+C@120$ GeV/c measurements

Summer 2024 data taking

2024: **LBNF/DUNE prototype target** newly taken data

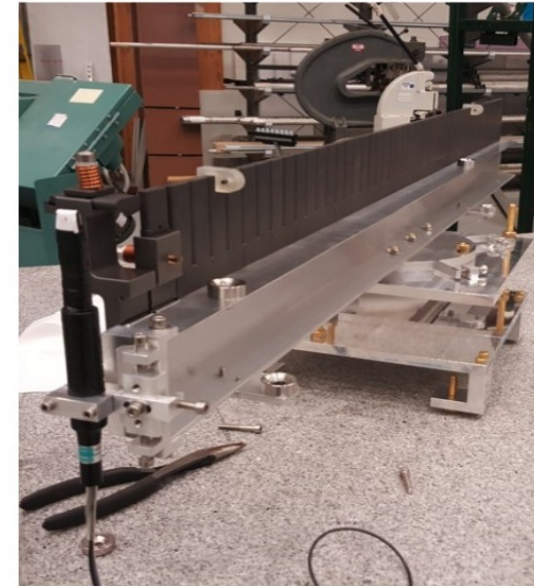
245 Million events collected!



VTPC1

Long Target
Tracker
chamber

150 cm long
graphite
target



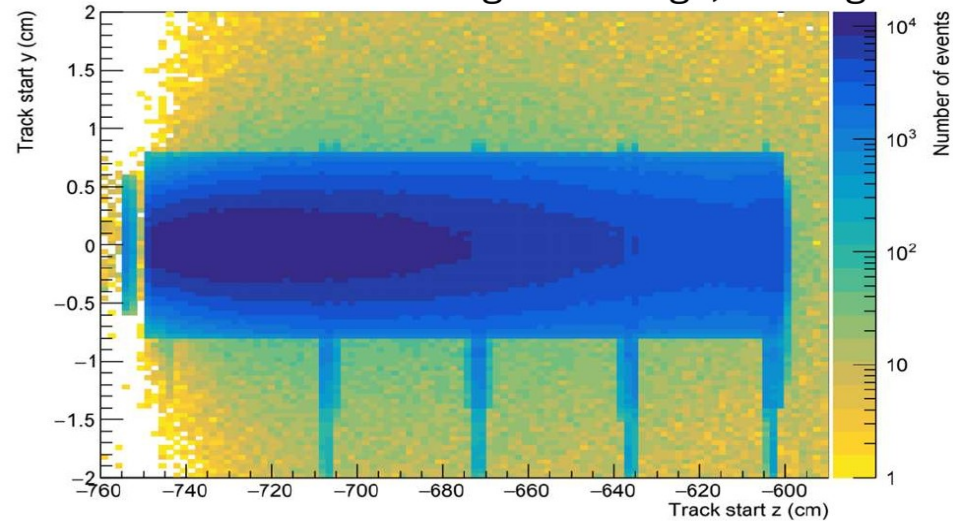
NuMI replica target

Major detector upgrade allowed to collect new high-quality data for Fermilab neutrino beams (245M events with a prototype of the LBNF/DUNE target collected during the 2024 run)

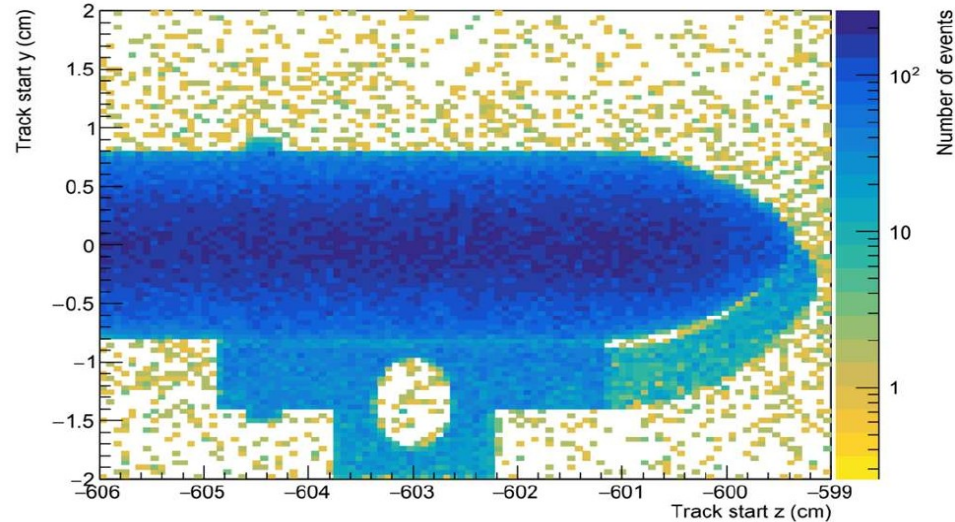
DUNE/LBNF target in MC

startY vs. startZ

DUNE target with legs, 1.898 g/cc

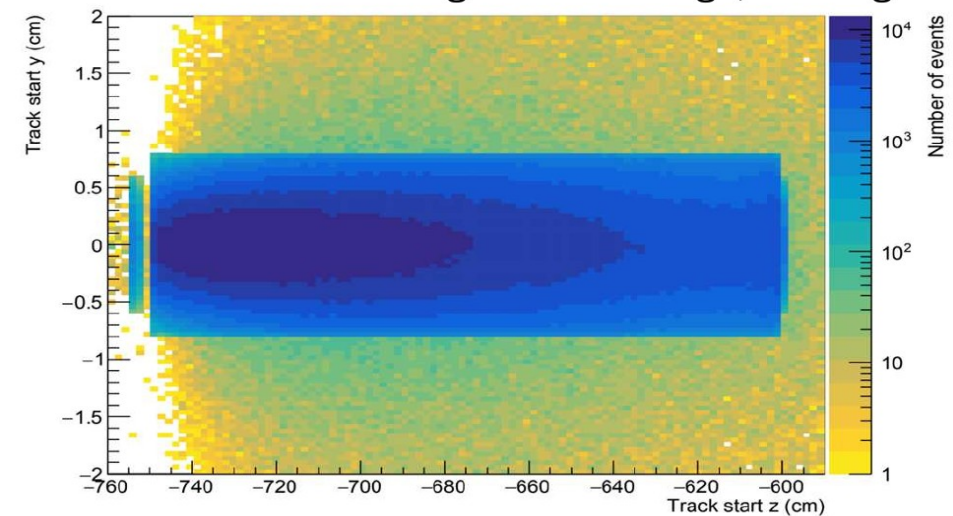


startY vs. startZ

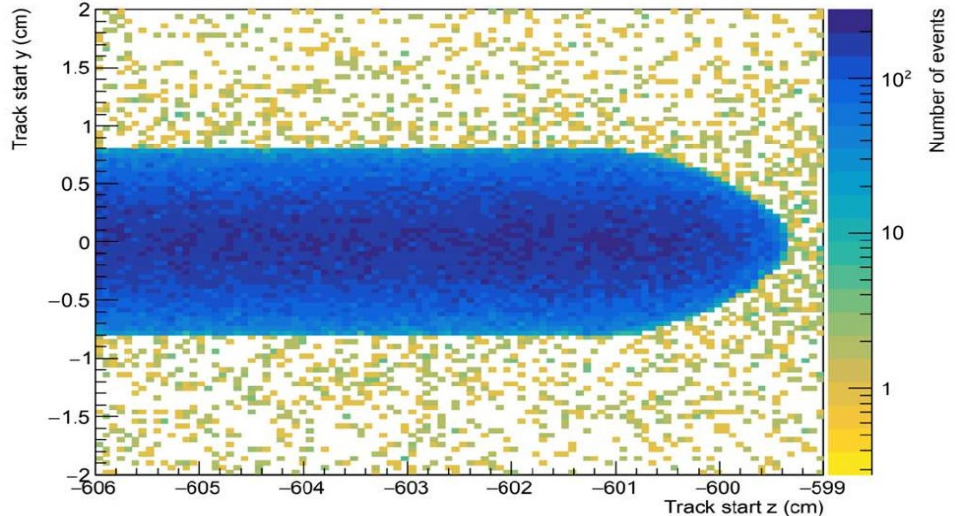


startY vs. startZ

DUNE target without legs, 1.898 g/cc



startY vs. startZ



Detailed simulation of the DUNE/LBNF prototype target in NA61/SHINE

Ressources Humaines (1/2)

- 🌐 Responsable Technique IN2P3 :
- 🌐 Ressources humaines IN2P3 engagées en 2025* :

Laboratoire	Responsable Scientifique	Chercheurs (Nb/ETP)	ITA (Nb/ETP)	Postdocs	Doctorants
LPNHE	B. Popov	3 / 1	0/0	0	1 / 0.5
Total		3 / 1	0/0	0	1 / 0.5

Responsibilities:

- Analysis coordinator for neutrino physics (BP)
- Resources coordinator (BP) [till summer 2025]
- BPD calibration and TPC alignment for 2022 T2K data (CD)
- analysis of K0S yields from T2K replica target (CD)

Ressources Humaines (2/2)

 Ressources humaines IN2P3 en 2026 (projection):

Laboratoire	Responsable Scientifique	Chercheurs (Nb/ETP)	ITA (Nb/ETP)	Postdocs	Doctorants
LPNHE	B. Popov	3 / 1	0/0	0	1 / 0.5
Total		3 / 1	0/0	0	1 / 0.5

Ressources Financières (2/2)

 Demande Ressources Financières IN2P3 pour 2026

Laboratoire	Fond Commun	Equipement Scientifique	Missions Scientifiques	Missions Techniques *	Total (k€)
LPNHE	15	0	2		17
Total	15	0	2		17

Demandes:

1 bourse de thèse (qui pourrait être une co-tutelle dans le cadre de l'IRL ILANCE avec l'Université de Tokyo ou avec KEK) pour les mesures de hadroproduction nécessaires à la réduction des incertitudes sur le flux de neutrinos dans les expériences T2K-II et HK.

Liste nominale des signataires des publications et statut (permanent, postdoc, thèsard, etc)

LPNHE

A.Blondel (DR), C.Dalmazzone (PhD), J.Dumarchez (DR), B.Popov (DR)

Commentaires :

C.Dalmazzone was the NA61/SHINE speaker at the 4th J-PARC symposium in Mito (October,2024)

M. Pavin, L.Zambelli (anciens doctorants: LZ postdoc JSPS puis LAPP et maintenant CR@CNRS, MP postdoc TRIUMF/Fermilab): tous deux ont donné des talks de revue aux conférences Neutrino de 2016 et 2020.

C.Dalmazzone started her postdoc at APC at the beginning of November,2025, but she is still interested in the analysis of NA61/SHINE data.