NAGI/SHINE: RESULTS AND PLANS

M. GAZDZICKI, FRANKFURT, KIELCE

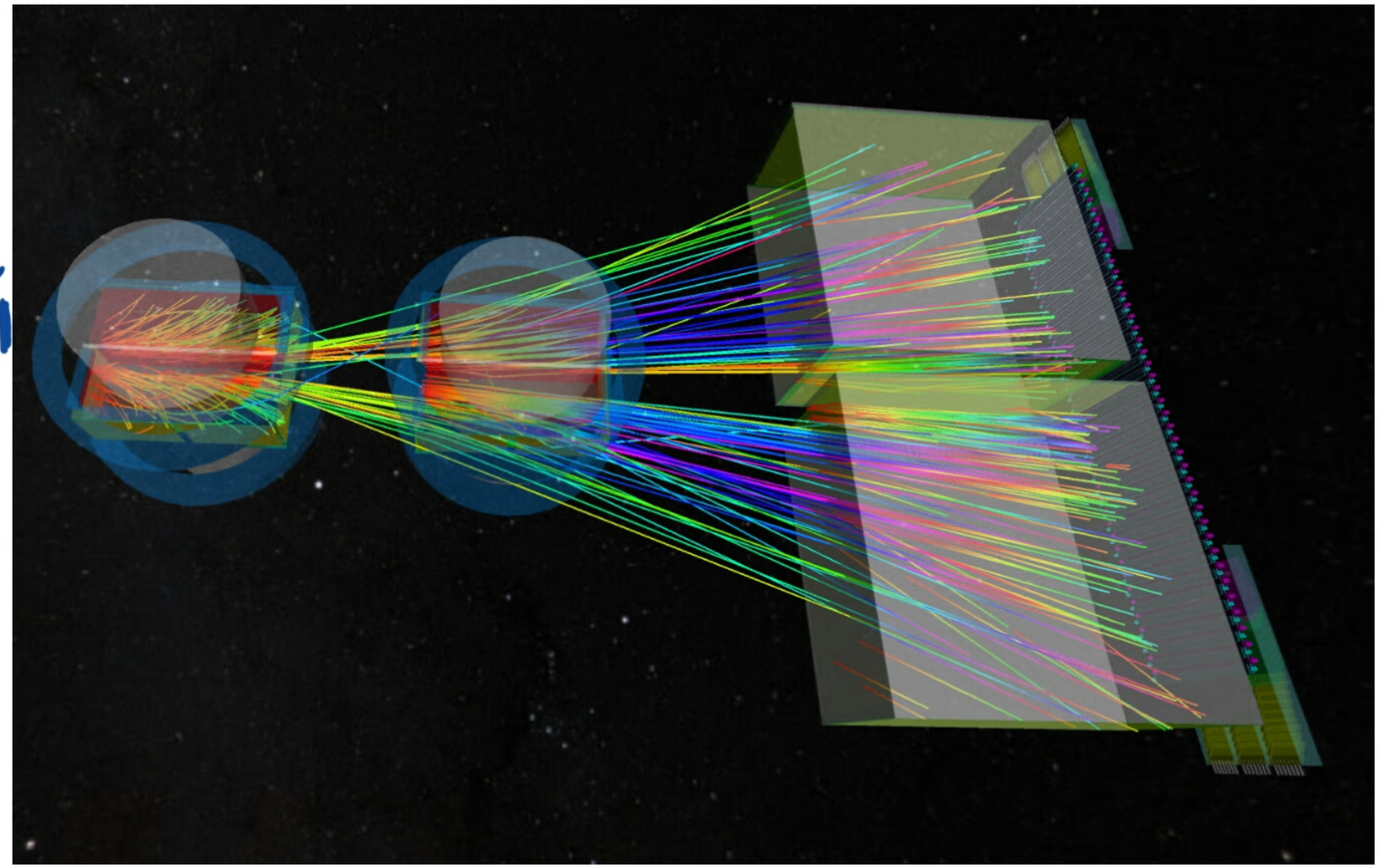
- FACILITY
- RESULTS
- FUTURE

FACILITY


NA61/SHINE - UNIQUE MULTIPURPOSE FACILITY:
HADRON PRODUCTION IN h+p, h+A, A+A
AT 13A - 150A (400) GeV/c
LHCb
ATLAS
CERN Meyrin
PS 628 m
CERN Prévessin
SUISSE
FRANCE
SPS 7 km
S··INE
H2
CMS
ALIC
- ACCELERATION CHAIN
- H2 BEAMLINE
- DETECTOR
LHC 27 km

NAGI / SHINE DETECTOR

Ar + Sc



PRECISE MEASUREMENTS OF PROPERTIES OF PRODUCED PARTICLES: ELECTRIC CHARGE, MASS MOMENTUM VECTOR

RESULTS

NA61 Physics goals

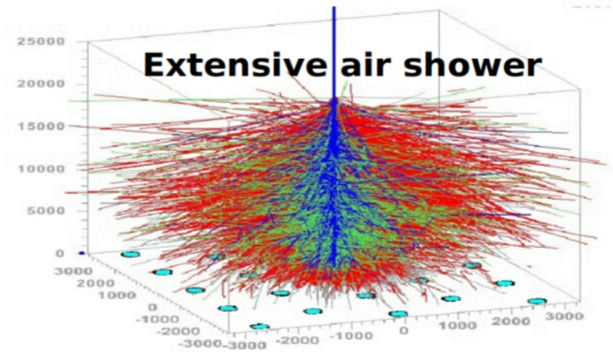
2007:

Data for neutrino and cosmic ray experiments

Precision measurements:

Measure hadron production in the T2K target needed for the T2K (neutrino) physics

Measure hadron production in p+C interactions needed for T2K and cosmic-ray, Pierre Auger Observatory and KASCADE, experiments



2017:

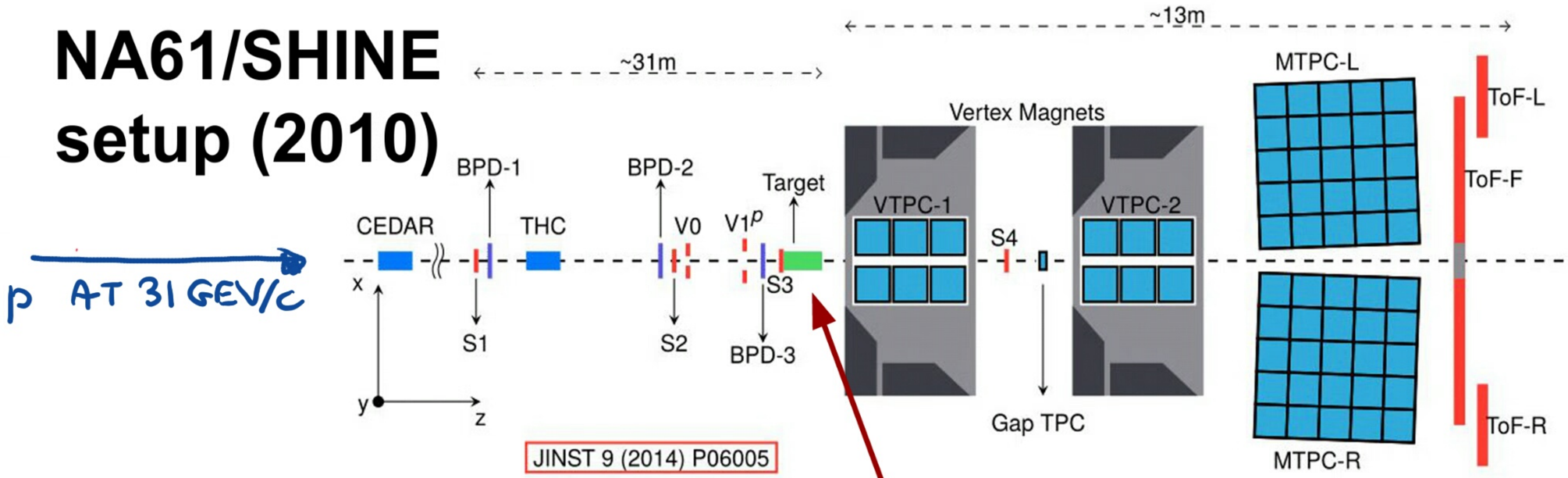
DATA TAKING: COMPLETED
ANALYSIS: WELL ADVANCED

EXTENDED BY:
- DATA TAKING FOR FERMILAB NEUTRINO BEAMS
- ANALYSIS FOR AMS

BORIS POPOV (DUBNA, PARIS) – CO-CONVENER OF NEUTRINO/COSMIC-RAY WORKING GROUP

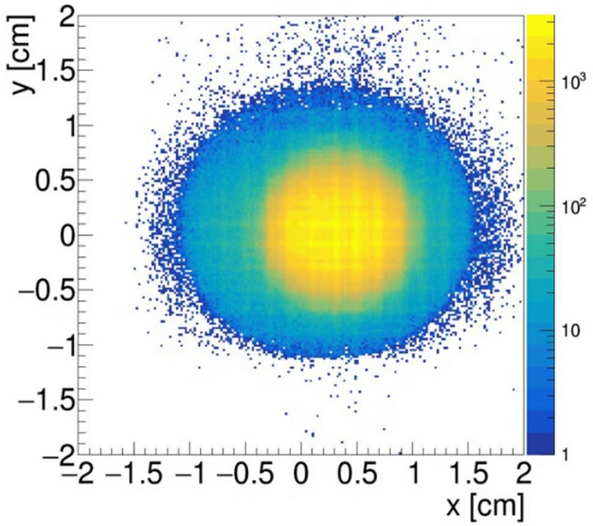
MEASURMENTS OF HADRON FLUX FROM T2K REPLICA TARGET

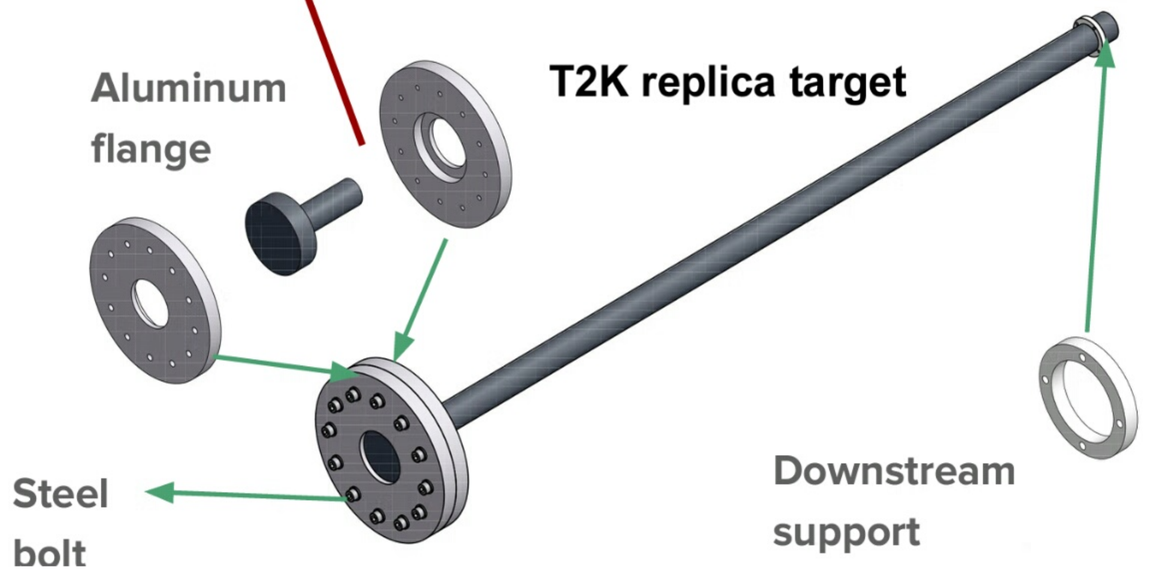
NA61/SHINE setup (2010)



p AT 31 GEV/c

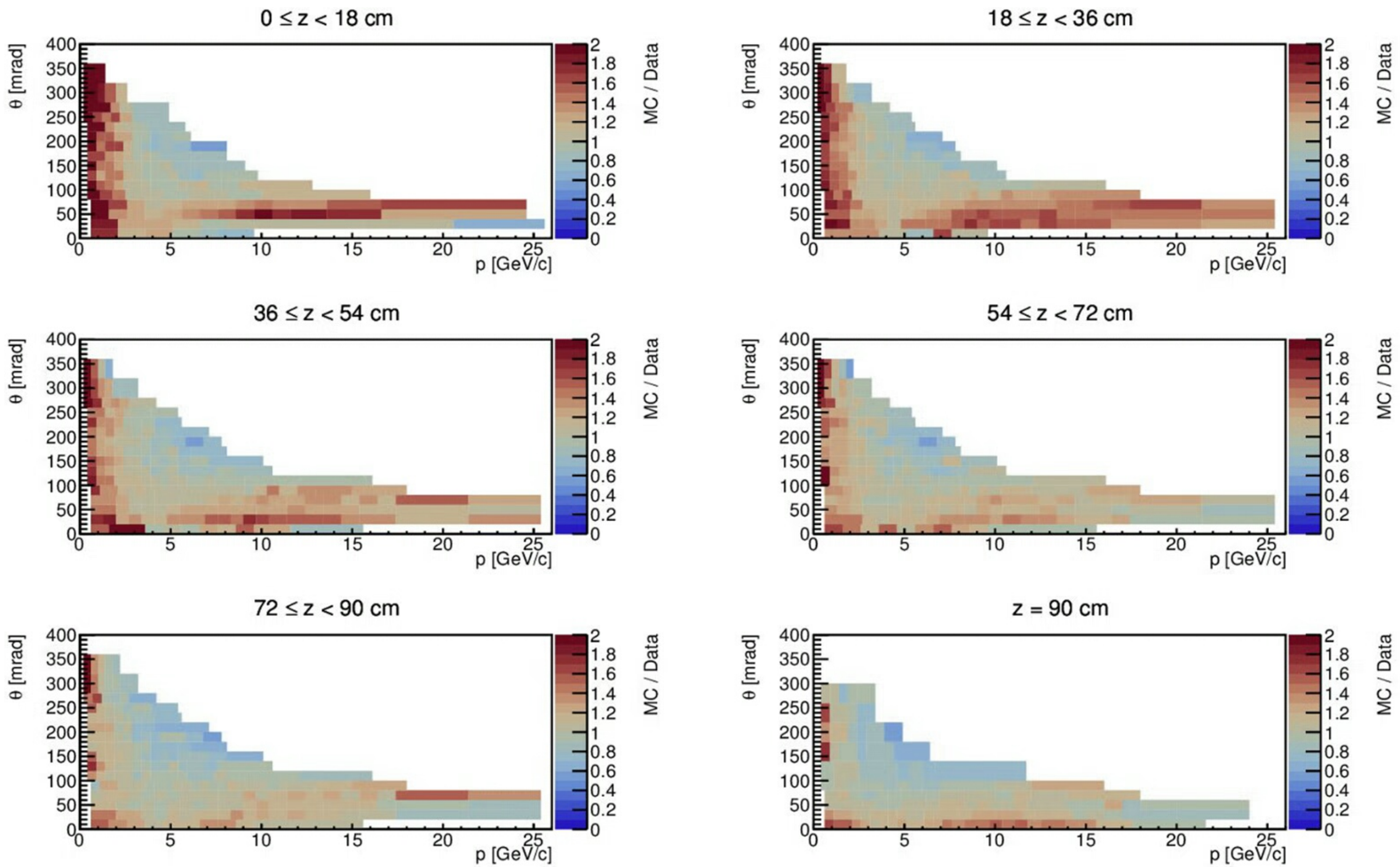
Beam profile





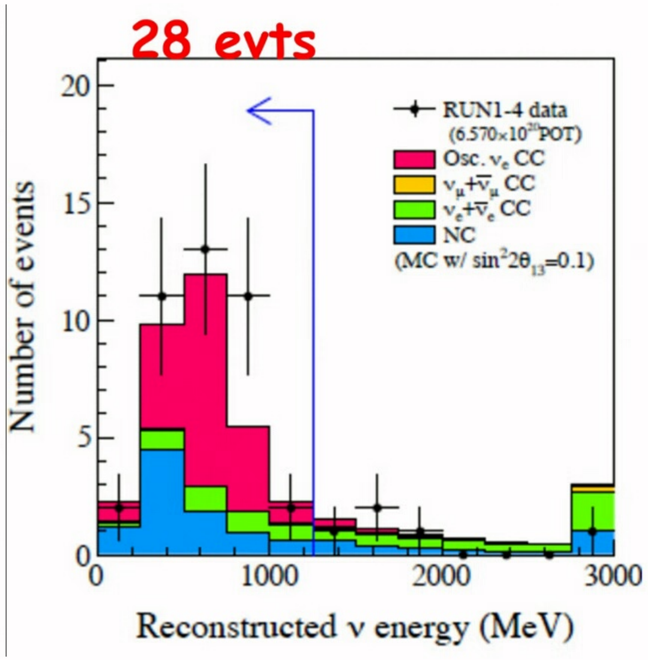
MEASURMENTS OF HADRON FLUX FROM T2K REPLICA TARGET

p yields: FLUKA 2011.2c.5 / data

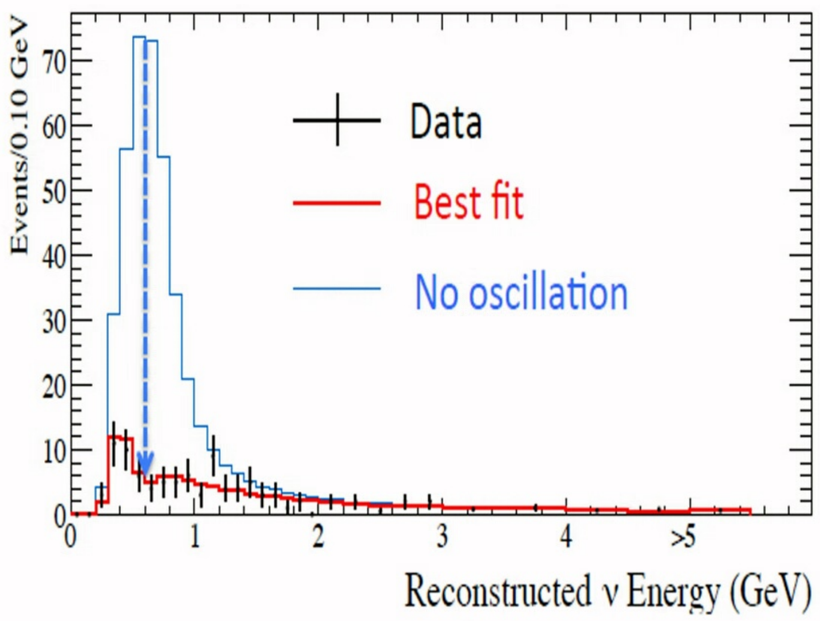


T2K ACHIEVEMENTS AND NA61/SHINE

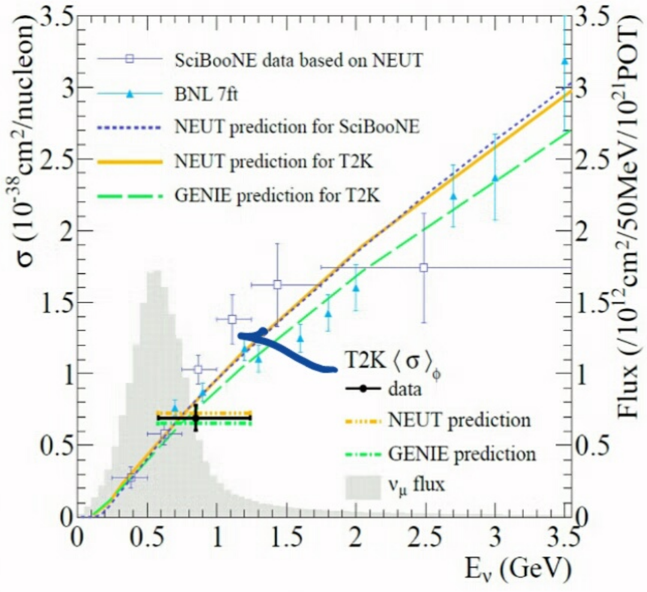
DISCOVERY OF $\nu_\mu \rightarrow \nu_e$ APPEARENCE



ν_μ DISAPPEARENCE



ν_μ CROSS SECTION



INITIAL NEUTRINO FLUX DETERMINATION

NEAR DETECTOR
NA61/SHINE

NEAR DETECTOR
NA61/SHINE

NA61/SHINE

NA61 physics goals

2007

Physics of strongly interacting matter

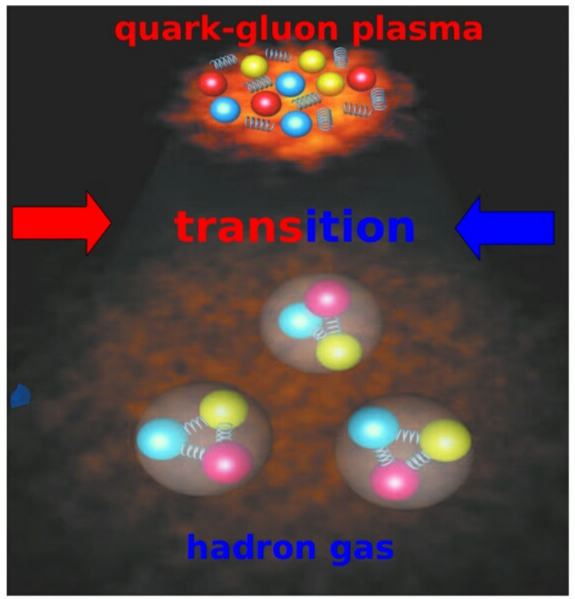
Discovery potential:

Search for the critical point of strongly interacting matter

Precision measurements:

Study the properties of the onset of deconfinement in nucleus-nucleus collisions

Measure hadron production at high transverse momenta in p+p and p+Pb collisions as reference for Pb+Pb results



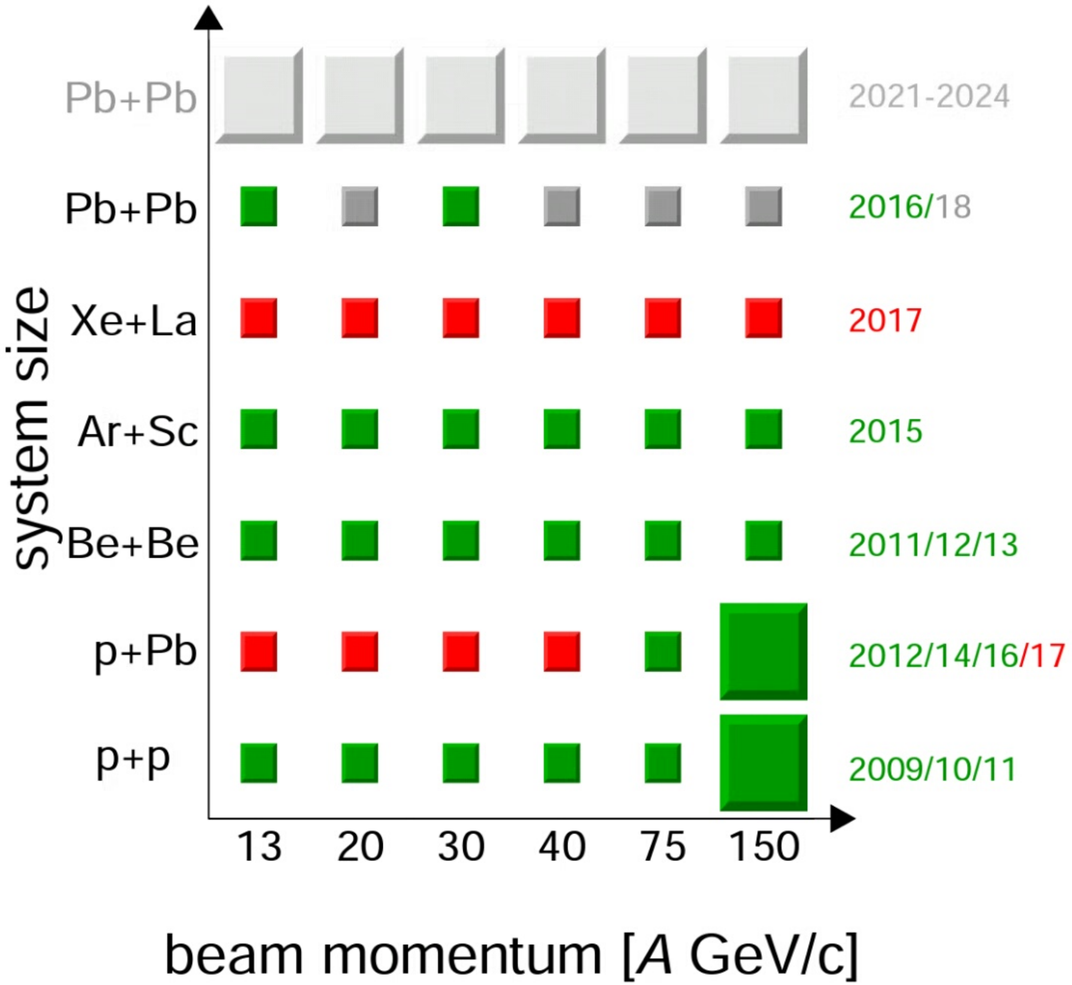
2017

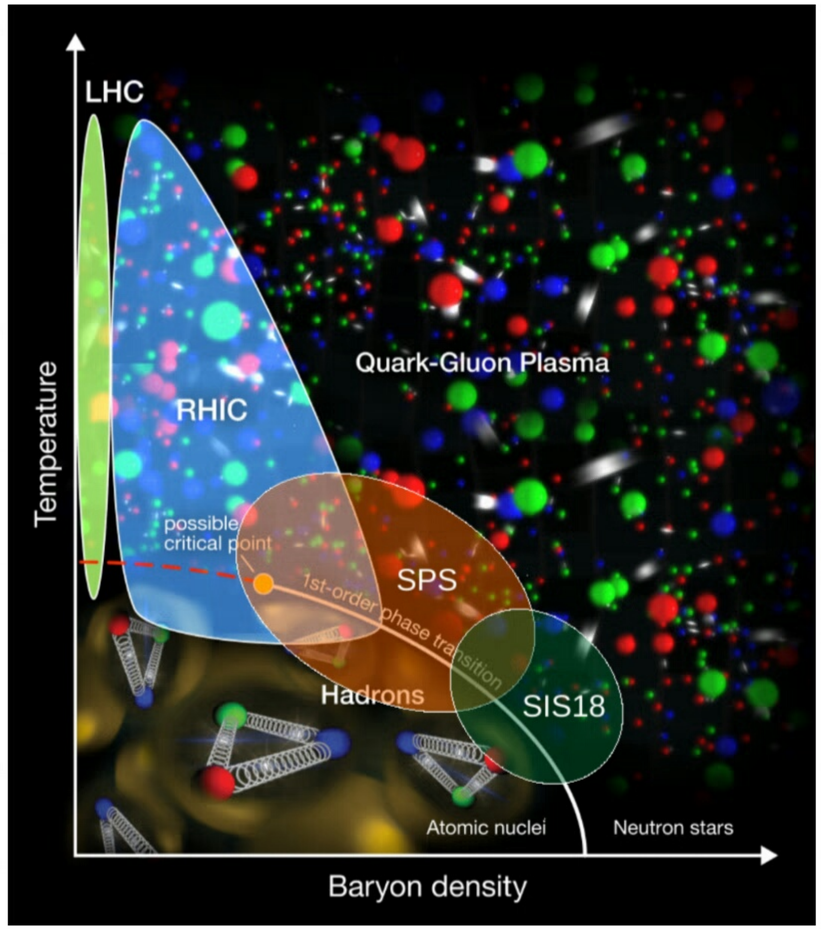
DATA TAKING: IN PROGRESS
ANALYSIS: IN PROGRESS

EXTENDED BY P6+P6 SCAN:
- OPEN CHARM
- COLLECTIVE EFFECTS
- FLUCTUATIONS

"ONSET OF DECONFINEMENT" ≡ BEGINING OF QGP (DECONFINEMENT AND CHIRAL SYMMETRY RESTORATION) CREATION IN A+A COLLISIONS WITH INCREASING COLLISION ENERGY

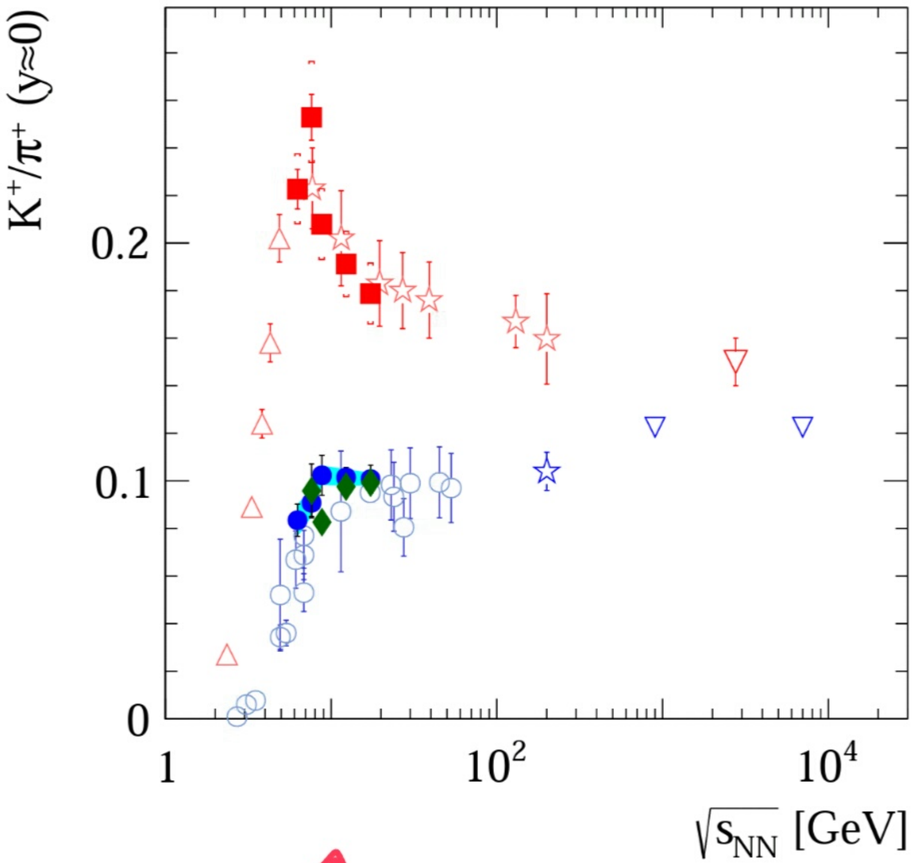
DATA FOR STRONG INTERACTIONS



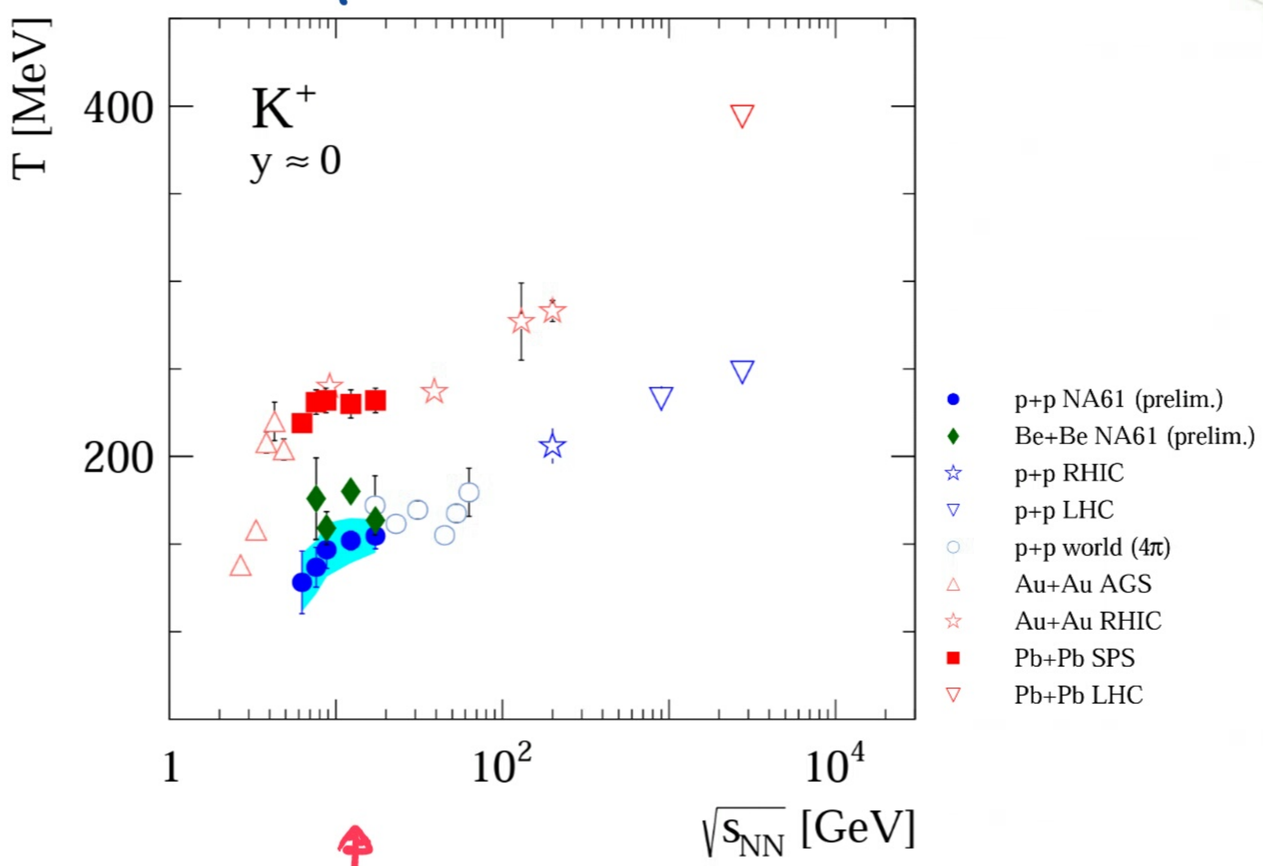


EVIDENCE FOR RAPID CHANGES IN COLLISION ENERGY DEPENDENCE

MEAN MULTIPLICITY RATIO



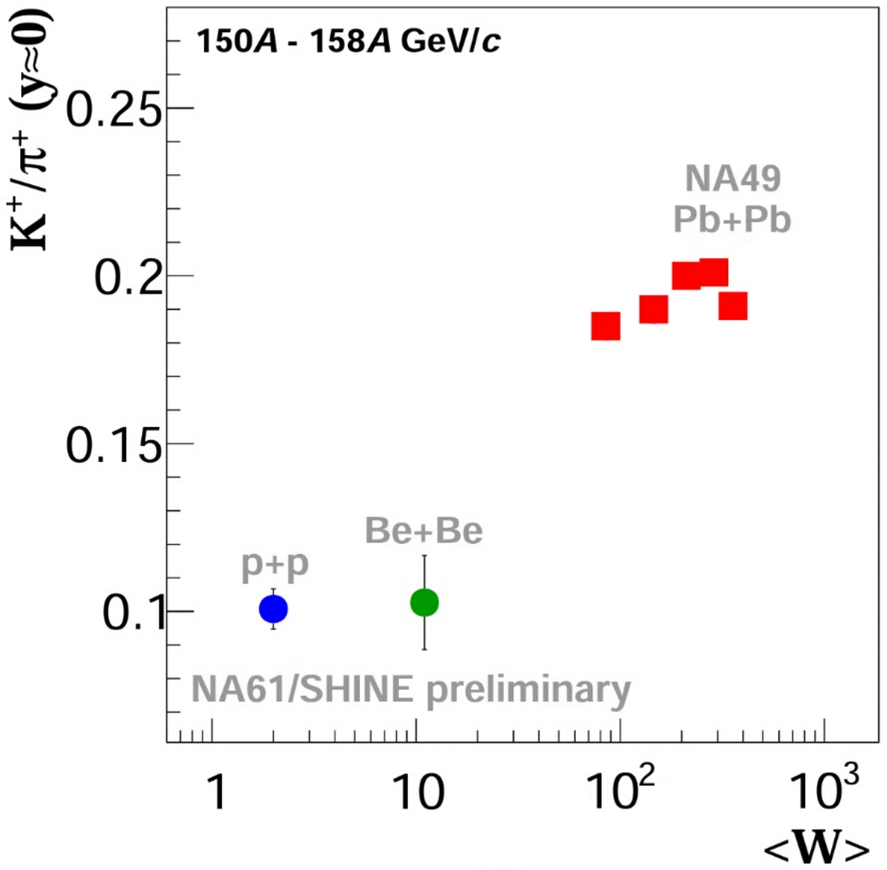
m_T-SPECTRA SHAPE



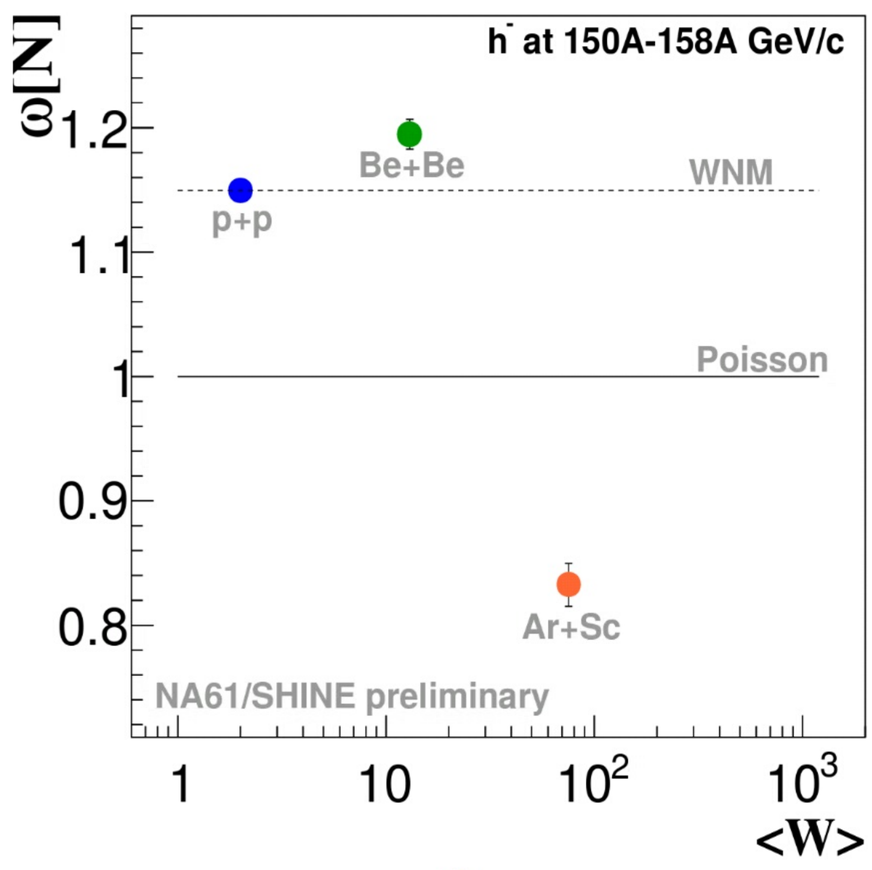
ONSET OF DECONFINEMENT

EVIDENCE FOR RAPID CHANGES IN SYSTEM-SIZE DEPENDENCE

MEAN MULTIPLICITY RATIO



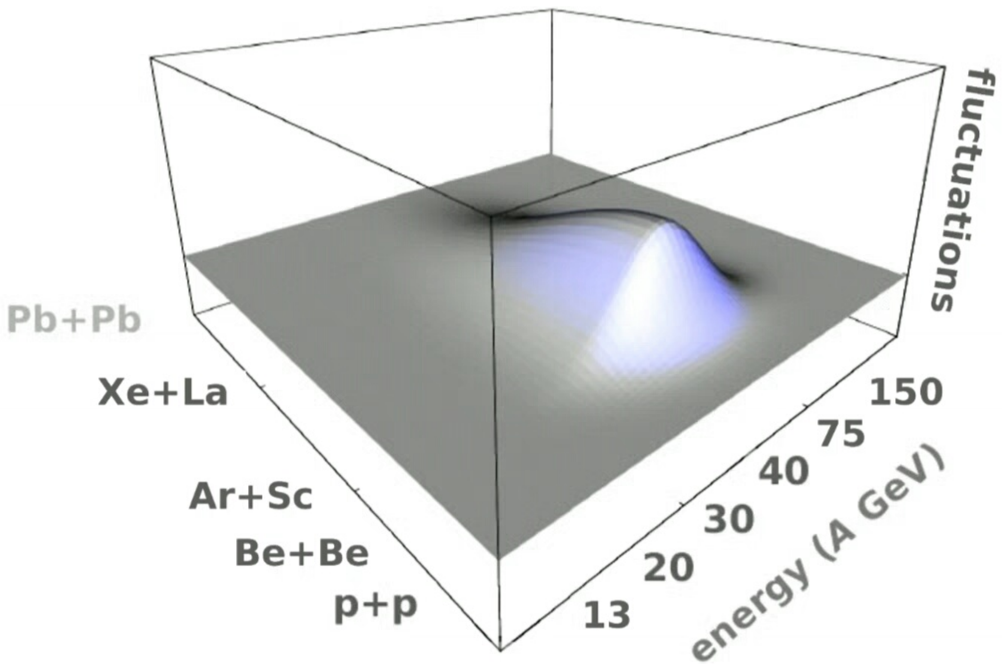
MULTIPLICITY FLUCTUATIONS

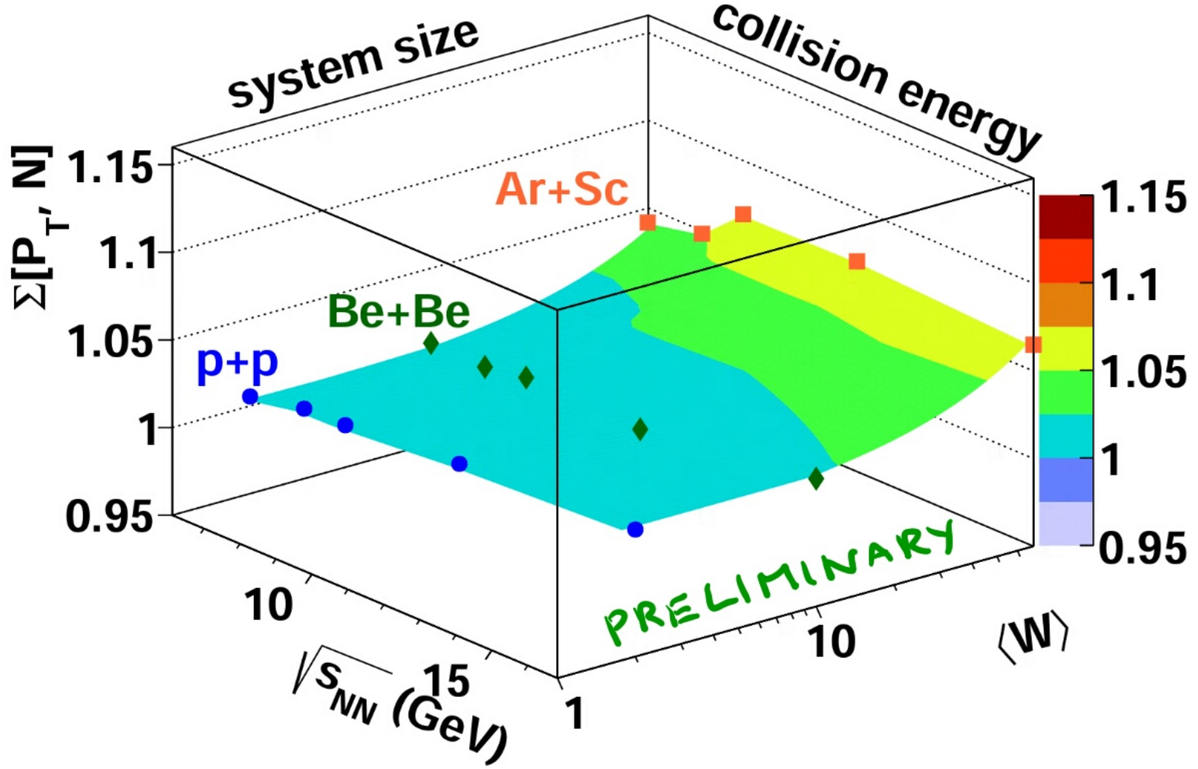


PERCOLATION THRESHOLD ?

SEARCH FOR CRITICAL POINT

CP ⇒ "FLUCTUATION HILL"





NO INDICATION FOR CRITICAL POINT SO FAR

NA61/SHINE FUTURE

2017 - 2018:

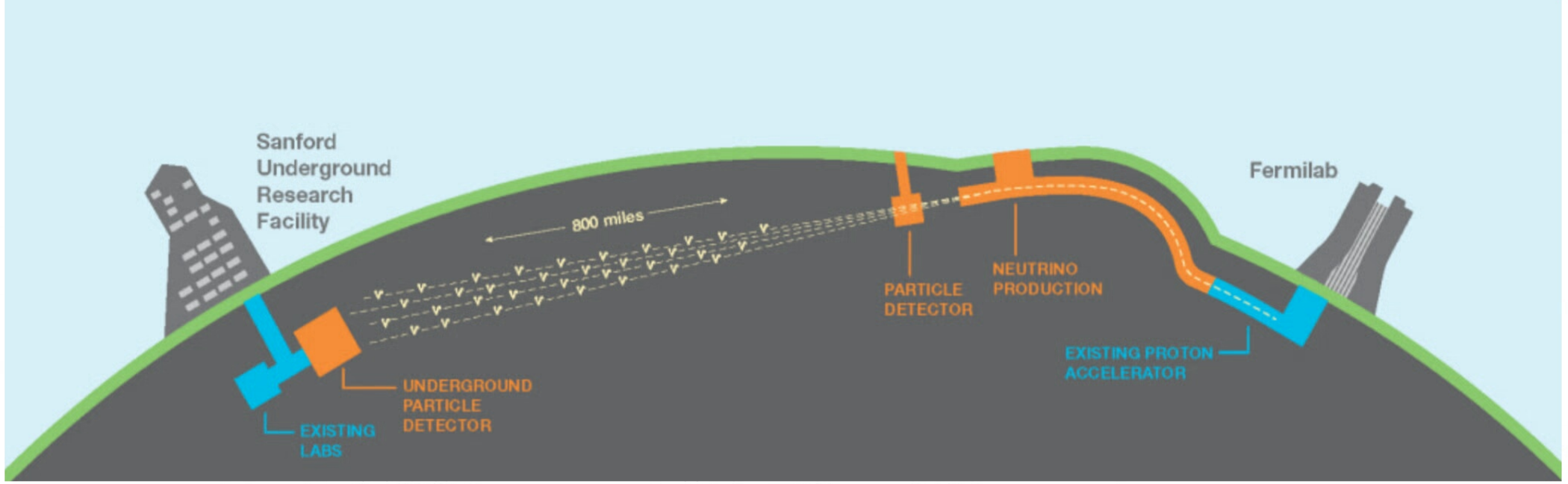
- TWO-DIMENSIONAL SYSTEM-SIZE AND BEAM-MOMENTUM SCAN WILL BE COMPLETED WITH p+Pb, Xe+La AND Pb+Pb COLLISIONS:
  - NEW VERTEX DETECTOR SHOULD RESULT IN FIRST MEASURMENTS OF OPEN CHARM IN Pb+Pb AT SPS
  - MEASURMENTS OF COLLECTIVE EFFECTS DUE TO ELECTROMAGNETIC AND STRONG INTERACTIONS
  - PRECISE MEASURMENTS OF FLUCTUATIONS
- MEASURMENTS OF h+A INTERACTIONS FOR FERMILAB NEUTRINO BEAMS

ANALYSIS OF THE DATA WILL CONTINUE OVER MANY YEARS

2021 - 2024: (UNDER DISCUSSION)

- HIGH STATISTICS BEAM MOMENTUM SCAN WITH Pb+Pb FOR PRECISE MEASURMENTS OF OPEN CHARM AND MULTISTRANGE HYPERONS

- PRECISION MEASUREMENTS OF HADRON FLUX FROM REPLICA DUNE AND HYPERK TARGETS



CHARMING FUTURE OF NA61/SHINE

NA49, NA61/SHINE:

PRODUCTION OF LIGHT AND MEDIUM MASS QUARKS/HADRONS:

$m_q \lesssim T_c \approx 150$ MEV

⇓

STATISTICAL:

ONSET OF DECONFINEMENT

PERCOLATION THRESHOLD ?

NA61/SHINE 2020+:

PRODUCTION OF HEAVY CHARM QUARKS/HADRONS:

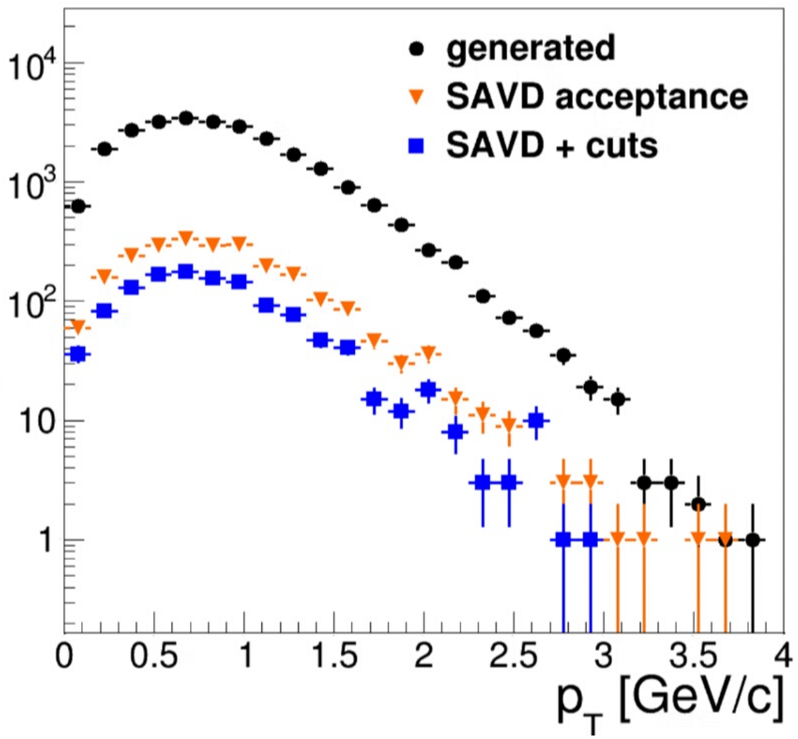
$m_c = 1300$ MEV $\gg T_c$

?

STATISTICAL OR DYNAMICAL

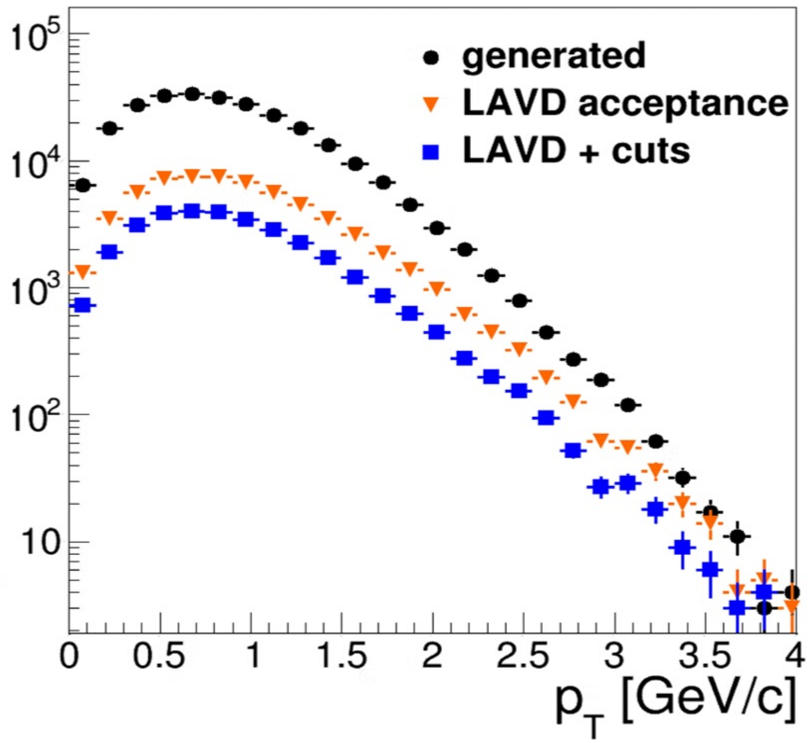
2020+ : $D^0+\bar{D}^0$ IN CENTRAL Pb+Pb AT 150A GEV/c

10 DAYS IN 2018



≈ 4000 D^0 IN 4M EVENTS

10 DAYS IN 2020+
(100 kHz + LAVD)

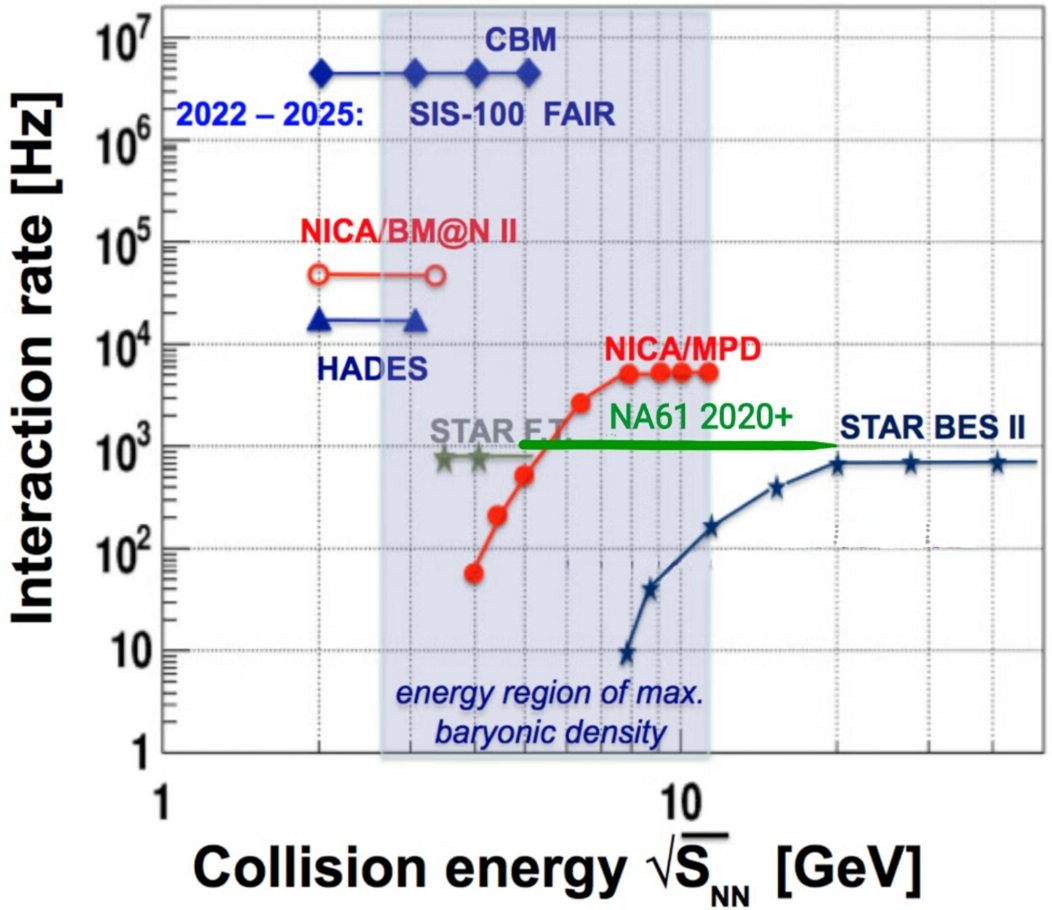


≈ 40000 D^0 IN 40M EVENTS

... AND ABOUT 1000 D^0+D^0 IN Pb+Pb AT 40A GEV/c

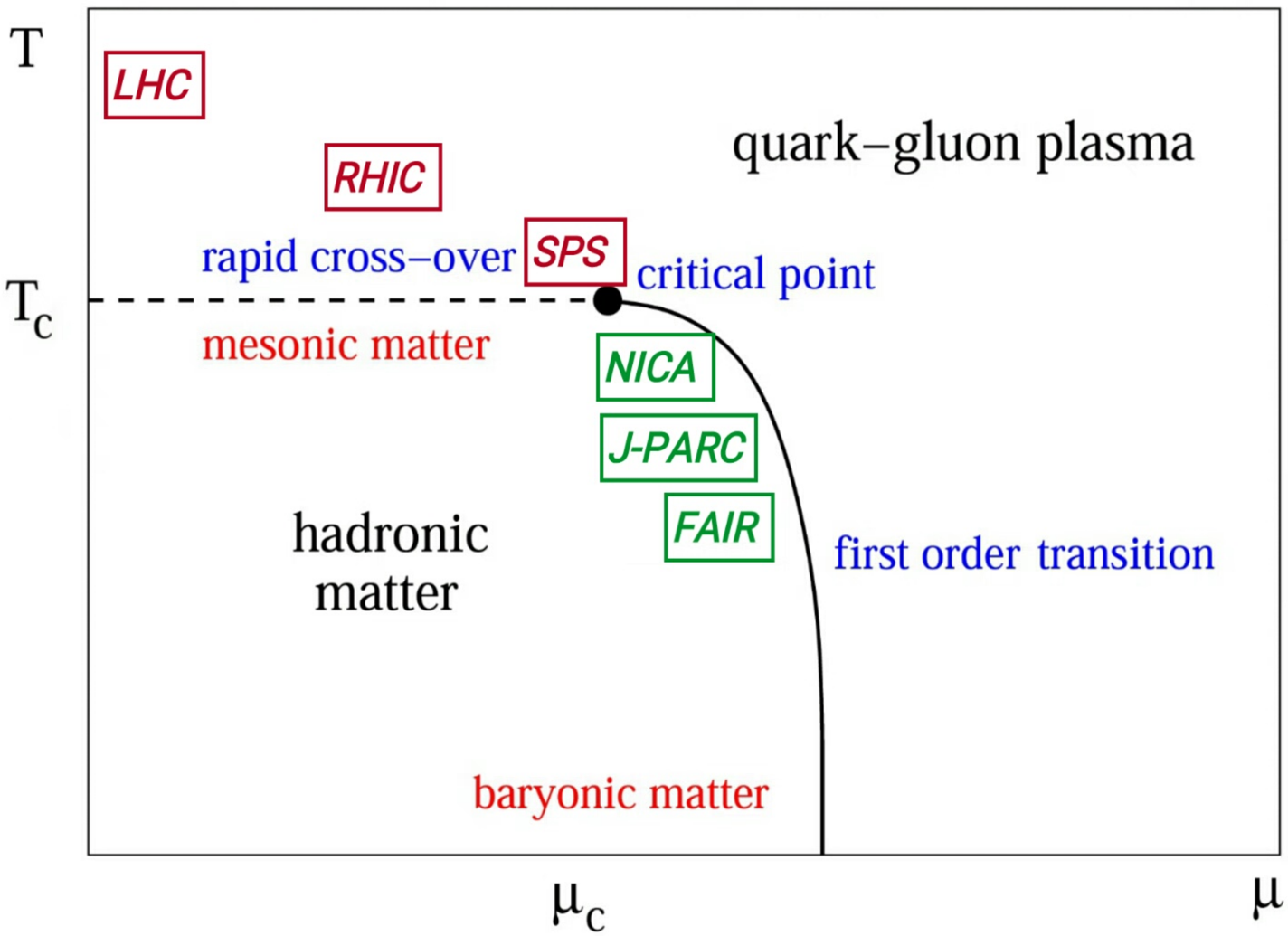
2019-2020: (R&D STARTED)

- UPGRADE OF THE DETECTOR DURING THE CERN LONG SHUTDOWN 2: (SYNERGY WITH OTHER PROJECTS)
  - EVENT RATE ≈ 1000 Hz (ALICE)
  - VERTEX DETECTOR (ALICE)
  - ToF DETECTORS (mRPC FROM DUBNA?)
  - PROJECTILE SPECTATOR DETECTOR (CBM, MPD)



EXPERIMENTAL PROGRAMMES ON HEAVY ION COLLISIONS AT HIGH ENERGIES

CURRENT AND FUTURE



NA61/SHINE Collaboration

- Azerbaijan
  - National Nuclear Research Center, Baku
- Bulgaria
  - University of Sofia, Sofia
- Croatia
  - IRB, Zagreb
- France
  - LPNHE, Paris
- Germany
  - KIT, Karlsruhe
  - Fachhochschule Frankfurt, Frankfurt
  - University of Frankfurt, Frankfurt
- Greece
  - University of Athens, Athens
- Hungary
  - Wigner RCP, Budapest
- Japan
  - KEK Tsukuba, Tsukuba
- Norway
  - University of Bergen, Bergen
- Poland
  - UJK, Kielce
  - NCBJ, Warsaw
  - University of Warsaw, Warsaw
  - WUT, Warsaw
  - Jagiellonian University, Kraków
  - IFJ PAN, Kraków
  - AGH, Kraków
  - University of Silesia, Katowice
  - University of Wrocław, Wrocław
- Russia
  - INR Moscow, Moscow
  - JINR Dubna, Dubna
  - SPBU, St.Petersburg
  - MEPhI, Moscow
- Serbia
  - University of Belgrade, Belgrade
- Switzerland
  - ETH Zürich, Zürich
  - University of Bern, Bern
  - University of Geneva, Geneva
- USA
  - University of Colorado Boulder, Boulder
  - LANL, Los Alamos
  - University of Pittsburgh, Pittsburgh
  - FNAL, Batavia
  - University of Hawaii, Manoa

∼150 physicists from ∼30 institutes