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Hadron Physics Department

End of the year Seminar

2022 achievements

HPD

HPD Conference Hall, 10:00 a.m.

December 20, 2022

Outlook

- ***Introduction***
- ***Physics***
  - ***Nuclear Structure and Dynamics***
  - ***Strongly Interacting Matter***
- ***R&D related to the CBM Experiment at FAIR***
  - ***Multi-strip multi-gap RPCs ⇒ CBM-ToF***
  - ***TRD-2D ⇒ CBM-TRD***
- ***Applied Physics & Technological Transfer***
- ***Training & Teaching***
- ***Final considerations***

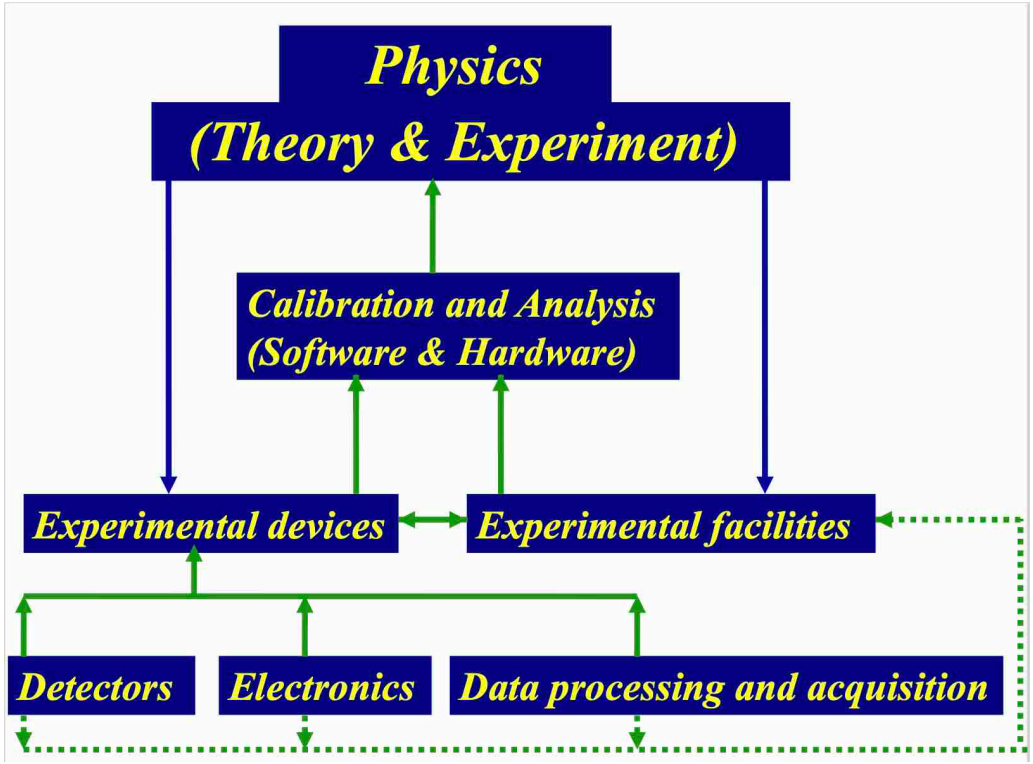
"Our goals can only be reached through a vehicle of a plan,
in which we must fervently believe and upon which we vigorously act.
There is no other rout of success"

Pablo Picasso

"The philosophies and religions of the planet Earth will come and go,
but the ultimate questions will be always alive and relevant"

James Leonard Park

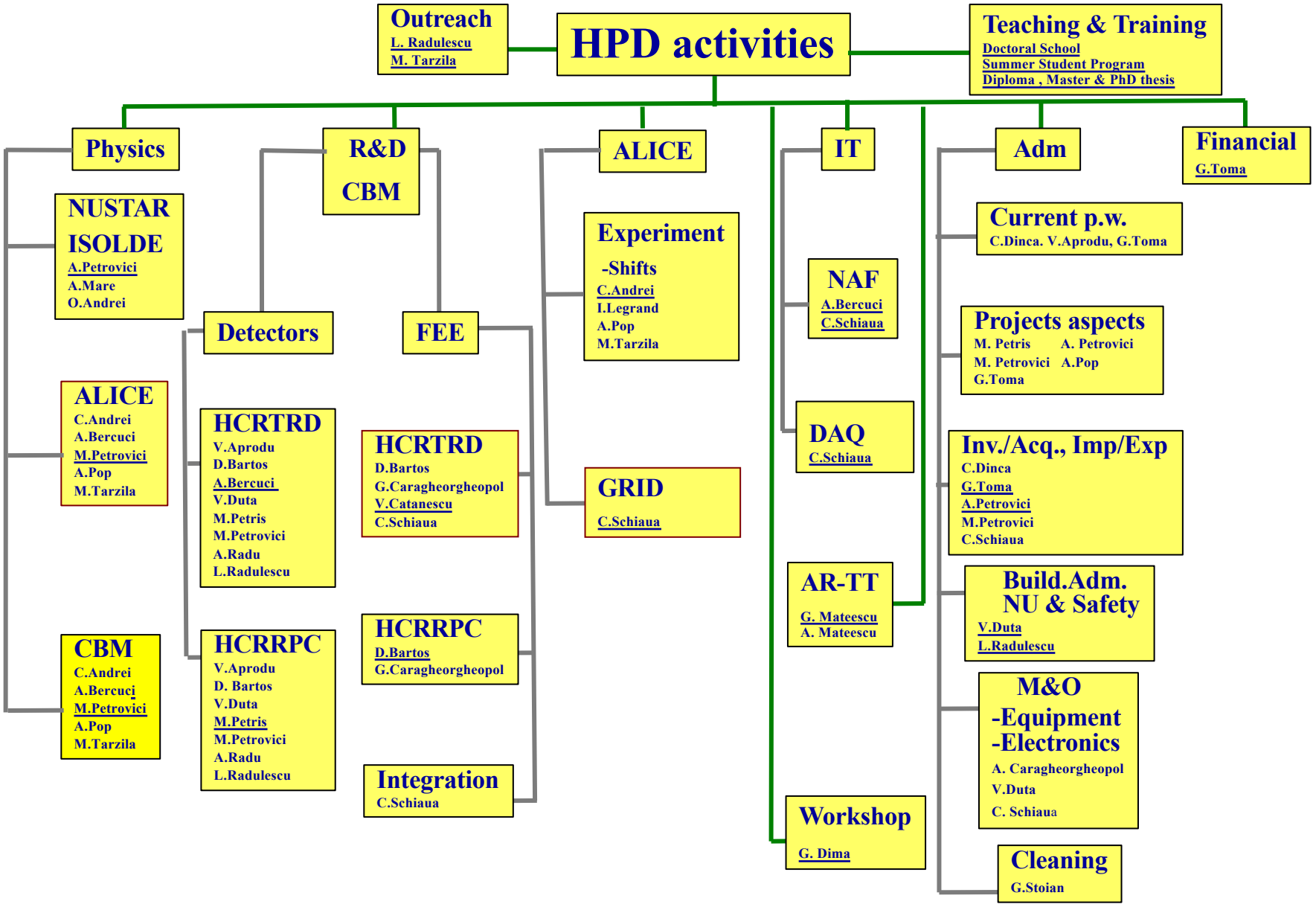
Hadron Physics Department strategy and present manpower



HPD Staff

3 - CS1
4 - CS2
1 - IDT1
2 - IDT2
2 - CS3
1 - CS
1 - Administrator IT
1 - Asistenti cercetare
1 - Fizician
2 - Ingineri
4 - Tehnicieni
1 - Frezor/Strungar
1 - Economist
1 - Ingrijitor

Organizational chart of Hadron Physics Department



2022 achievements

Nuclear Structure and Dynamics

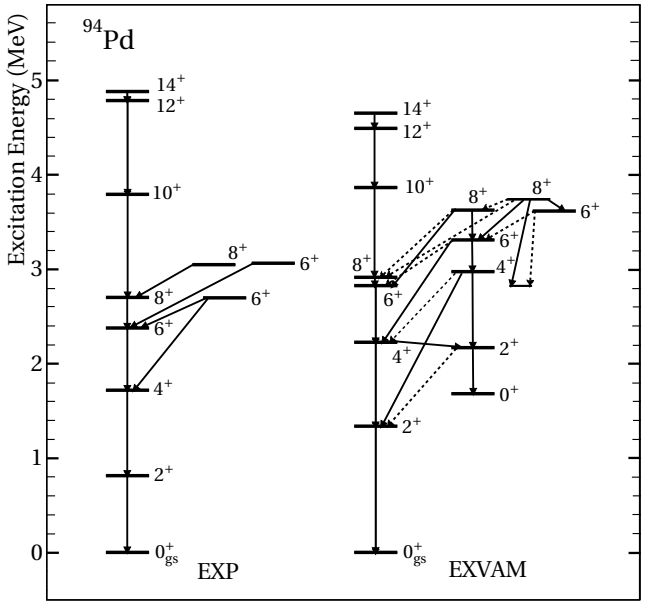
Nuclear Physics **A504** (1989) 277–299
North-Holland, Amsterdam

SHAPE COEXISTENCE AT HIGH SPINS IN THE NUCLEI ^{68}Ge AND ^{72}Se*

A. PETROVICI[1,2], K.W. SCHMID[2], F. GRÜMMER[3] and Amand FAESSLER[2]

[1] *Institute for Physics and Nuclear Engineering, Bucharest, Romania*
[2] *Institut für Theoretische Physik, Universität Tübingen, Fed. Rep. Germany*
[3] *Institut für Kernphysik, Kernforschungsanlage Jülich, Fed. Rep. Germany*

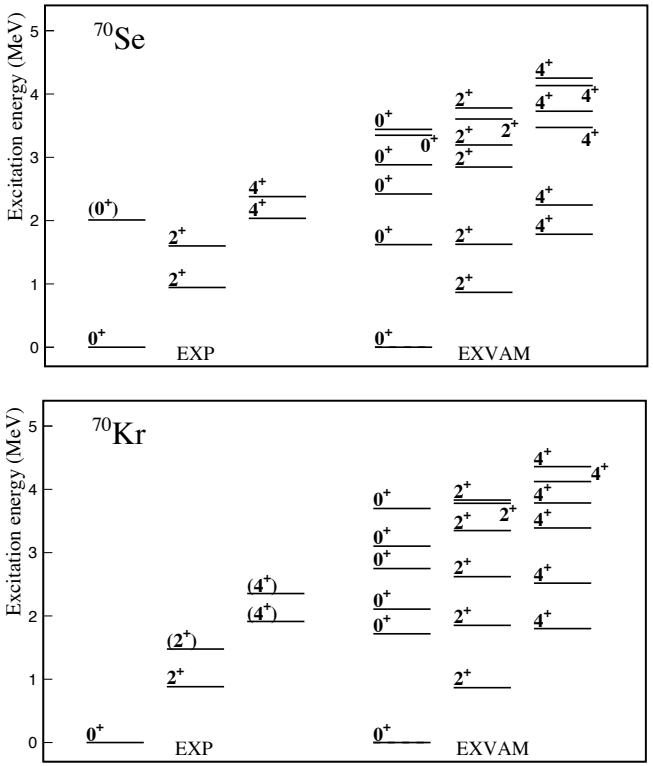
Shape coexistence and isomeric states in ^{94}Pd within a beyond-mean-field approach



Evolution of shape coexistence and mixing in the structure of ^{94}Pd positive parity states and the nature of the isomeric states at spin 8+ and 14$^+$ as well as the feeding of ^{94}Pd by the Gamow-Teller β decay of the 7$^+$ isomer and the super-allowed Fermi β decay of the 0+ ground state of ^{94}Ag

- *S. Mare and A. Petrovici, Phys. Rev. C 106, 054306 (2022)*
- *S. Mare, PhD thesis: Nuclear Structure and Dynamics of Exotic Medium-Mass Nuclei, Doctoral School in Physics, University of Bucharest, 2022 (Coordinator: A. Petrovici)*

E0 transition strengths in ^{70}Se and ^{70}Kr mirror nuclei within a beyond-mean-field model



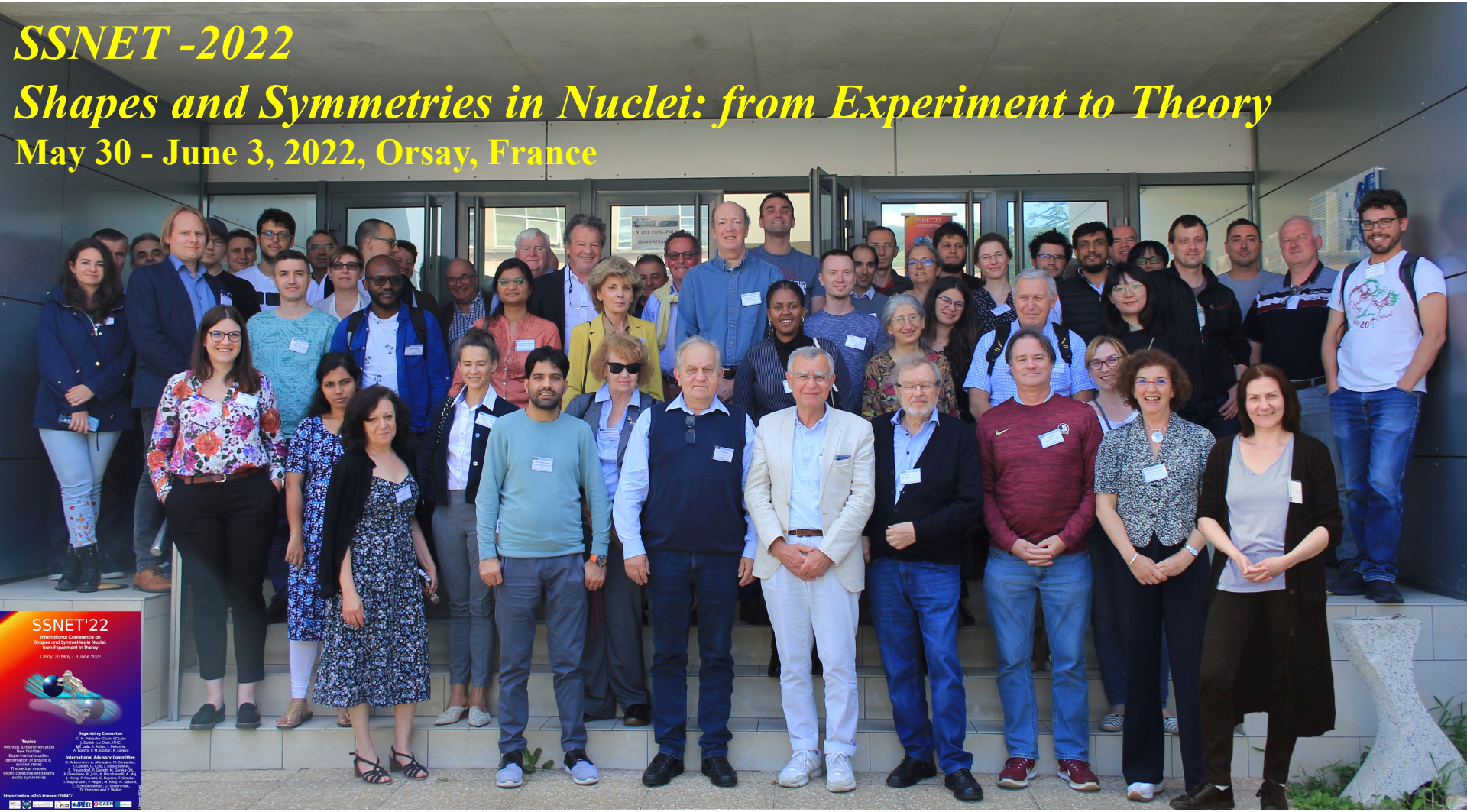
The effects of shape mixing on the E0 transition strengths for the lowest few 0$^+$, 2$^+$, and 4$^+$ states as well as the M1 and E2 strengths for the $2^+_i \rightarrow 2^+_i$ and $4^+_i \rightarrow 4^+_i$ transitions were analysed and discussed.

A. Petrovici, Symmetry 14, 2594 (2022)

SSNET -2022

Shapes and Symmetries in Nuclei: from Experiment to Theory

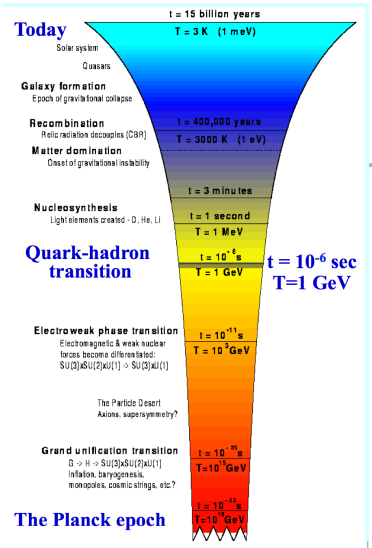
May 30 - June 3, 2022, Orsay, France



Strongly Interacting Matter


ALICE Week, 6-10 June, 2022, CERN

Motivation



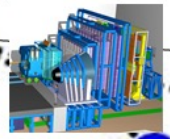
Expectations based on QCD

QCD Critical Points

T

H

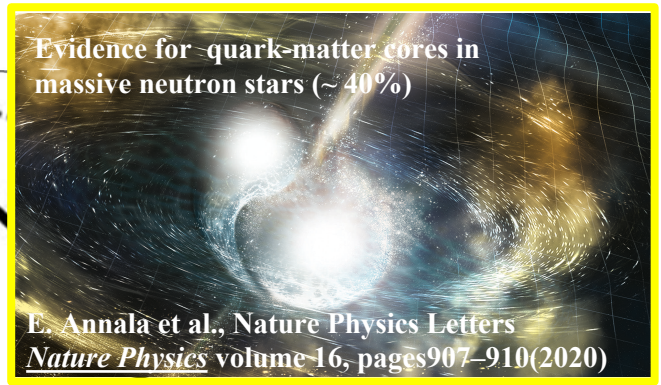
μ_H=350 -400 MeV,
T_H = 150-160 MeV



E

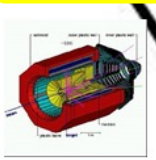
Statistical model:

- for $\mu_B \ll m_N$ the thermal degrees of freedom dominated by mesons
- for higher μ_B more baryons are excited



Chiral transition:

$\mu_B > \mu_E$ - first order
$\mu_B < \mu_E$ - crossover
realistic u,d,s masses



F

Quark-Hadron continuity:

G

Liquid-gas phase transition:

$\mu_{NM} \cong 924$ MeV
$n_0 = 0.17$ fm^{-3}

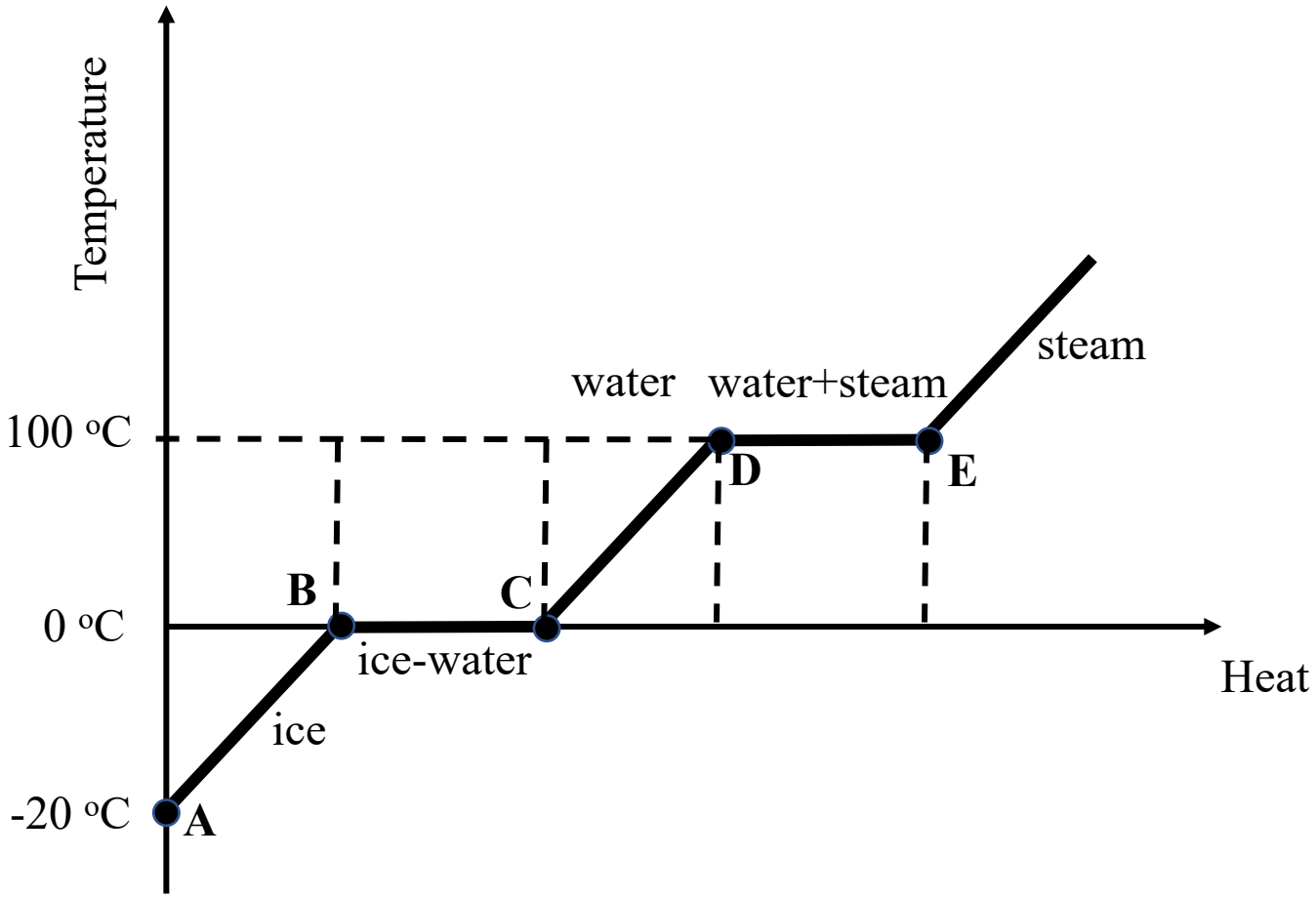
Superfluid nuclear matter

Superconducting quark matter

μ_B

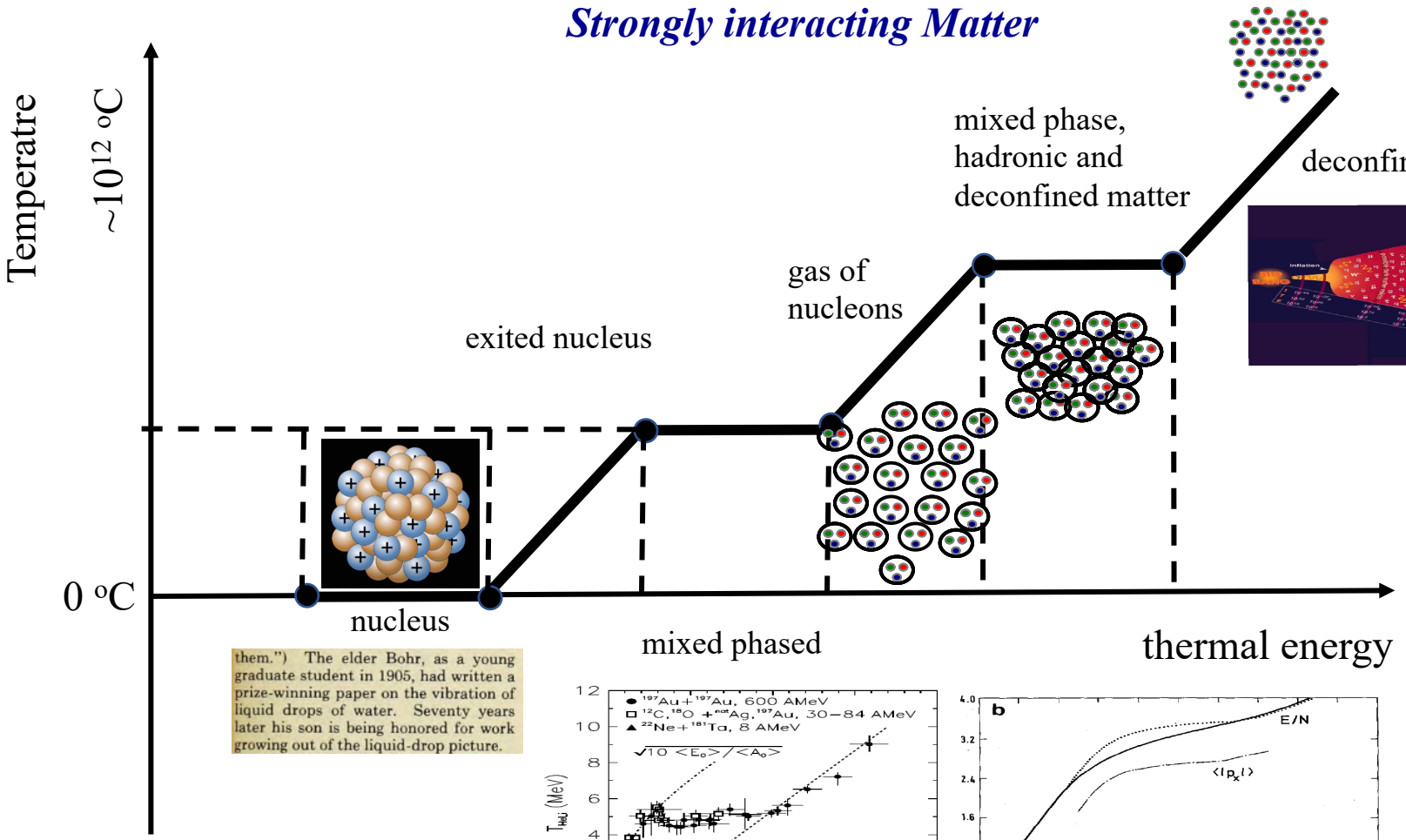
Physics motivation

Phase transitions - Water



Physics motivation

Strongly interacting Matter



them.") The elder Bohr, as a young graduate student in 1905, had written a prize-winning paper on the vibration of liquid drops of water. Seventy years later his son is being honored for work growing out of the liquid-drop picture.

J.Pochodzalla et al., ALADIN Coll., arXiv:[nucl-ex]9607004

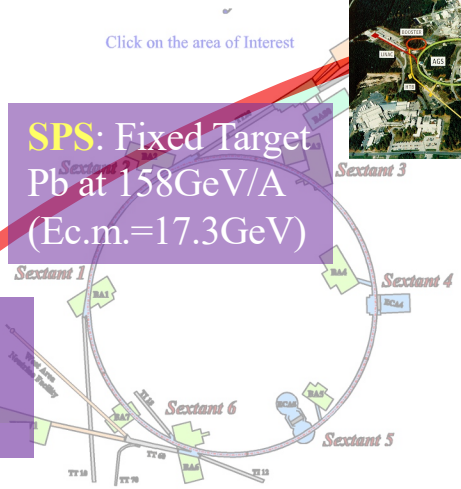
J.-P. Blaizot and J.-Y. Ollitraut, Phys.Lett 191B(1987)21

Physics motivation

Strongly interacting Matter

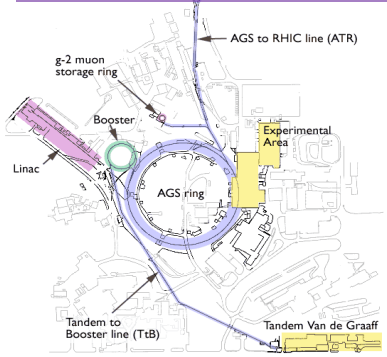
LHC: Collider
Pb+Pb @5020GeV/A

RHIC: Collider
Au+Au @ 200GeV/A



SPS: Fixed Target
Pb at 158GeV/A
(Ec.m.=17.3GeV)

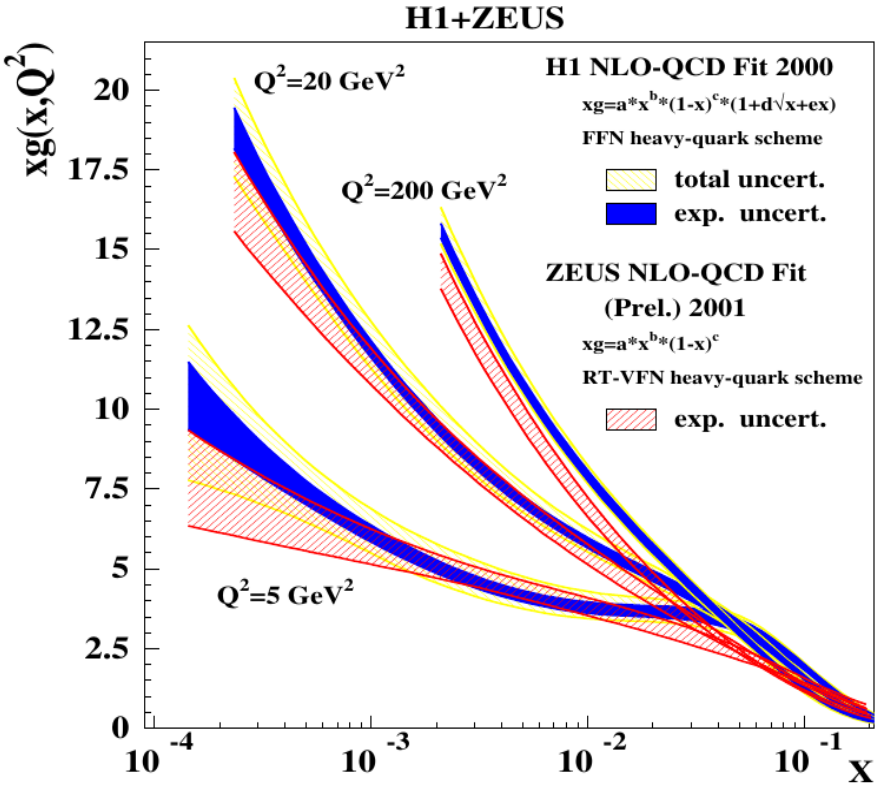
AGS: Fixed Target
Au at 11.7GeV/A
(Ec.m.=4.86GeV)



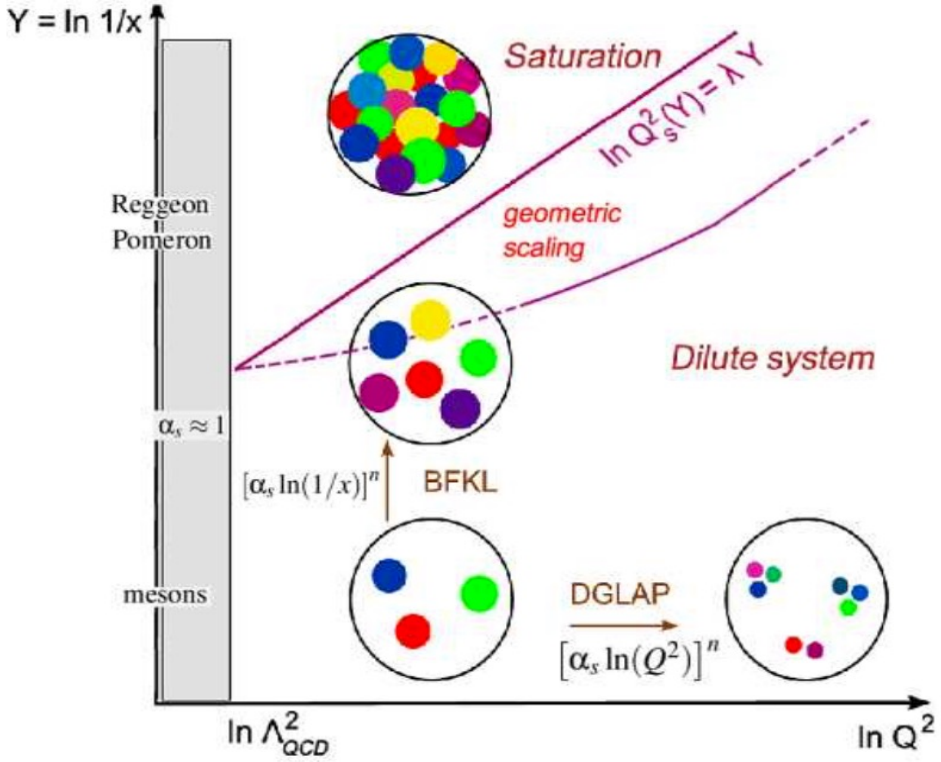
Bevalac
Fixed Target
1-2GeV/A

SIS 18

Physics motivation



M.Dittmar et al., Proceedings HERA-LHC Workshop
arXiv:[hep-ph]0511119



D. d'Enterria, Eur.Phys.J. A31(2007)816

Following A.H. Mueller approximations NP A715(2003)20

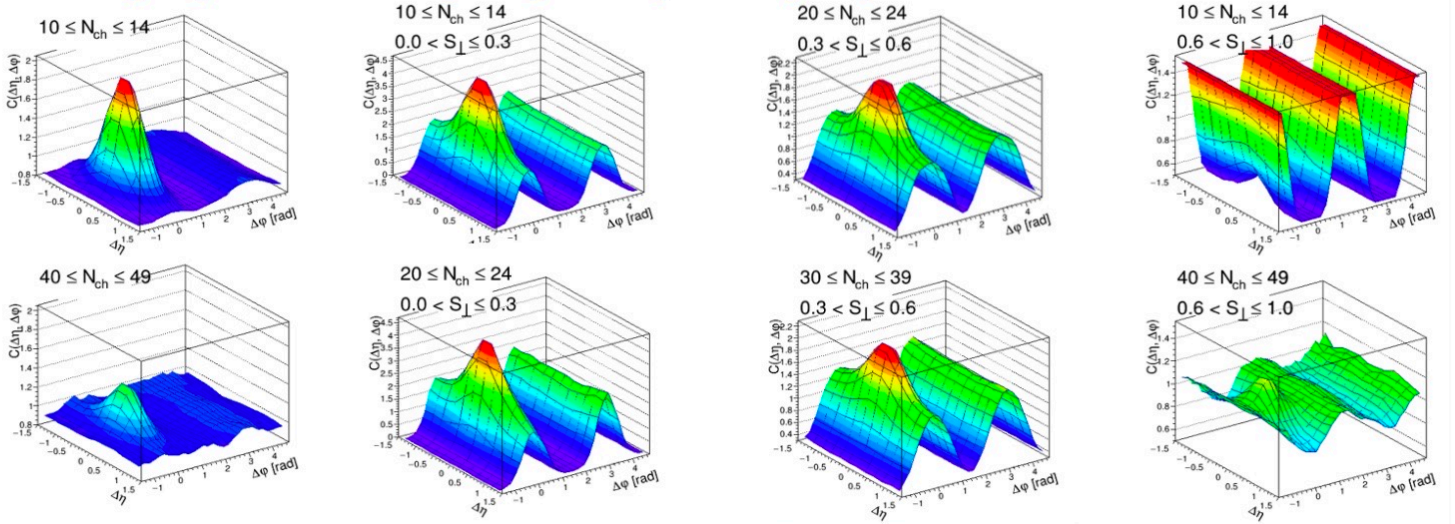
System	*Au-Au*	*Pb-Pb*	*Pb-Pb*	*pp*
$\sqrt{s}(GeV)$	*200*	*2700*	*5020*	*7000*
$\frac{dN_g^{in}}{dyd^2b}(fm^{-2})$	≈4.7	≈11.8	≈15.9	≈18.7
f_{in}^g	≈0.9	≈2.3	≈3.1	≈3.6

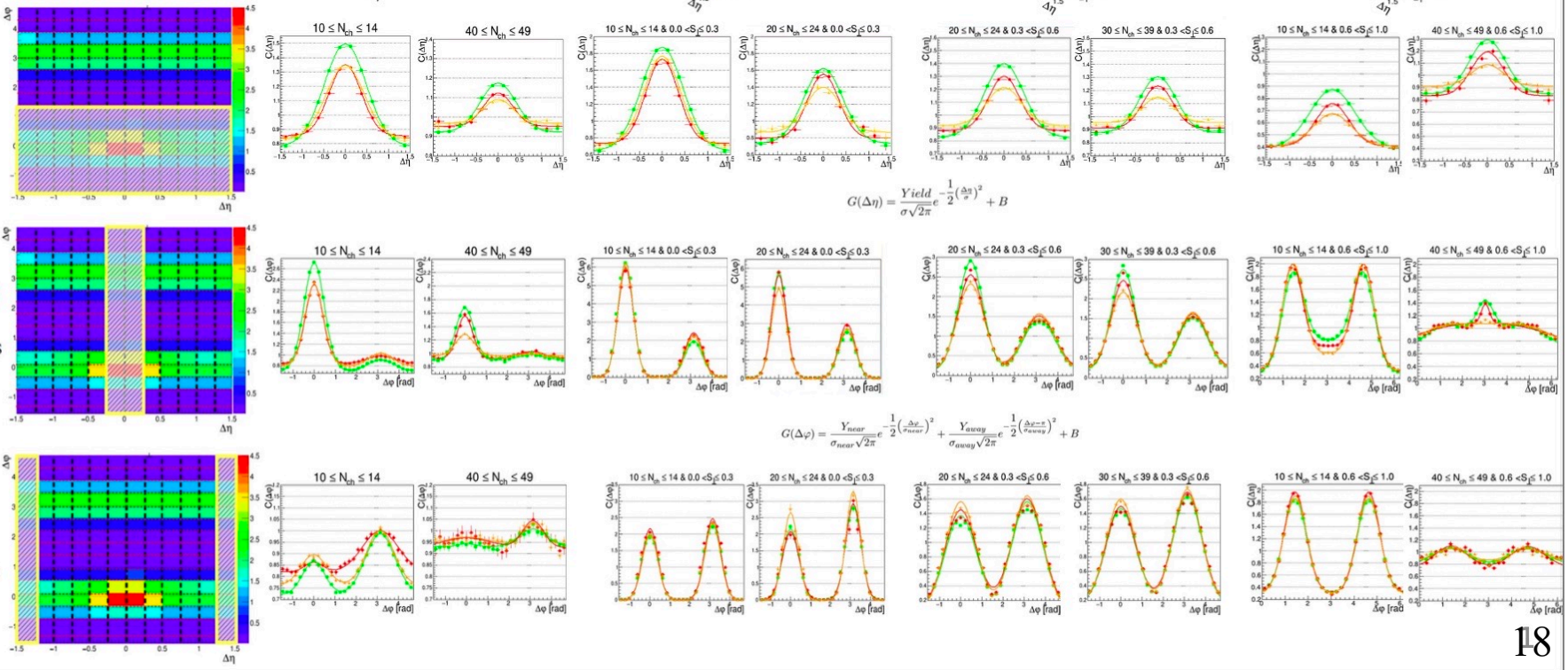
Two charged particle correlations in pp collisions at 13 TeV

charged particles multiplicity and sphericity dependence

1 GeV/c <p_T^{trig}=$p_T^{leading}$<2 GeV/c,
1 GeV/c<p_T^{ass}<2 GeV/c, $p_T^{trig} > p_T^{ass}$

N_{ch}^{mult} for |η|<0.8;
p_T spectra in |η|<0.5





$$G(\Delta\eta) = \frac{Yield}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\eta}{\sigma}\right)^2} + B$$

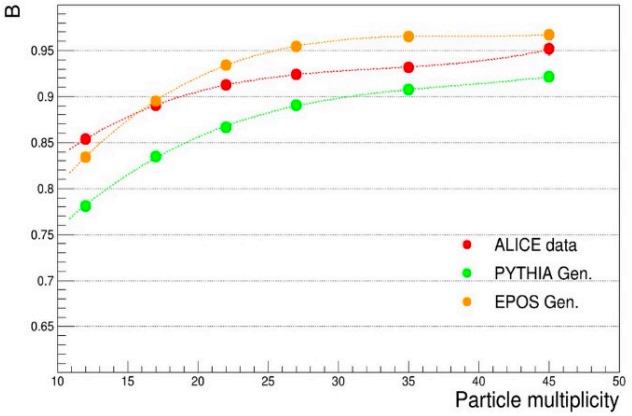
$$G(\Delta\varphi) = \frac{Y_{near}}{\sigma_{near}\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\varphi}{\sigma_{near}}\right)^2} + \frac{Y_{away}}{\sigma_{away}\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\varphi-\pi}{\sigma_{away}}\right)^2} + B$$

Two charged particle correlations

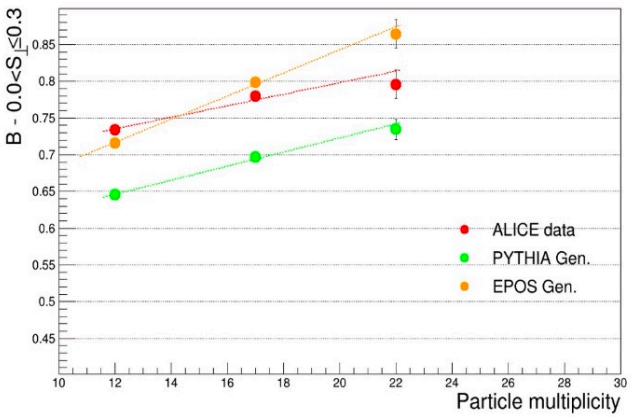
C(Δφ) correlation functions for $|\Delta\varphi| \leq \pi/2$

$|\Delta\varphi| \leq \pi/2$

Multiplicity dependence analysis



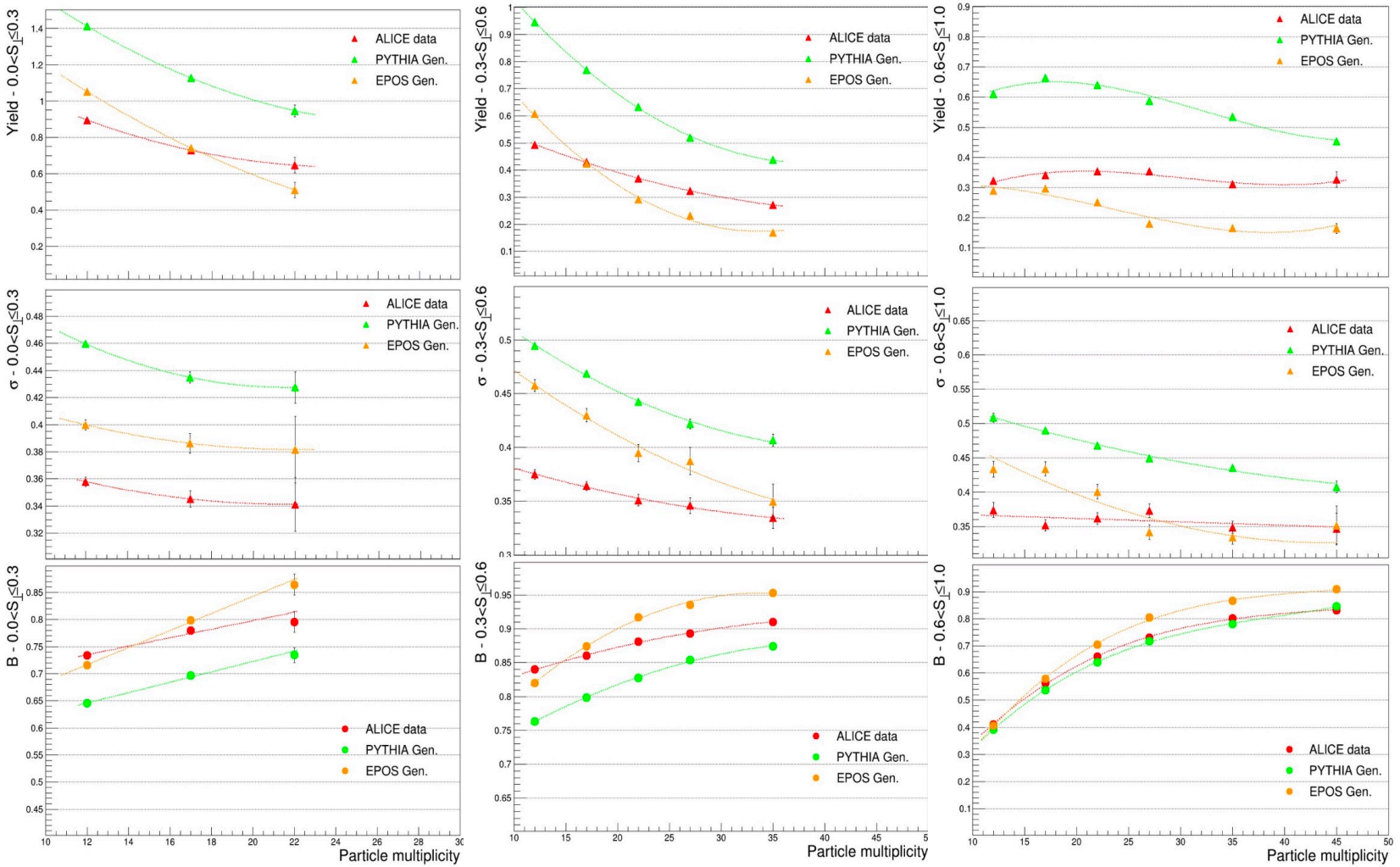
$0.0 \leq S_\perp \leq 0.3$



$$G(\Delta\eta) = \frac{Yield}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\eta}{\sigma}\right)^2} + B$$

Two charged particle correlations

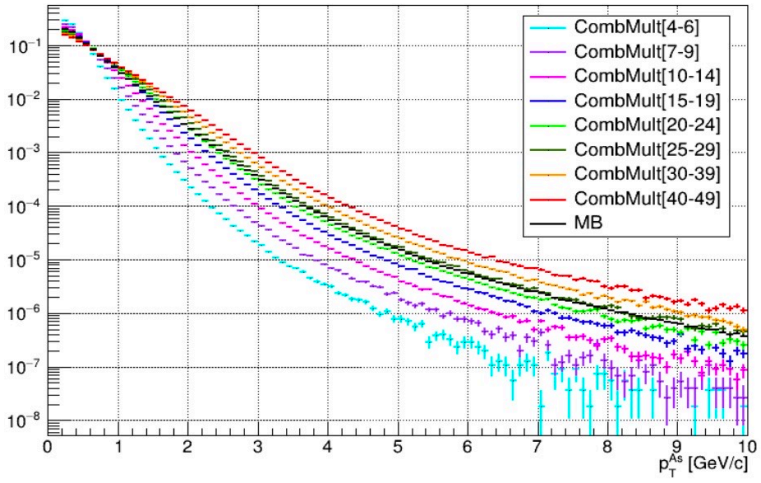
C(Δφ) correlation functions for $|\Delta\varphi| \leq \pi/2$



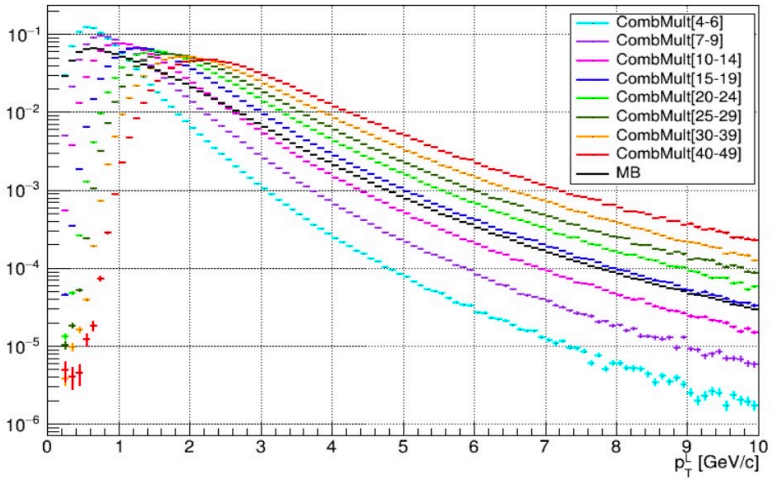
$$G(\Delta\eta) = \frac{Yield}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\eta}{\sigma}\right)^2} + B$$

Two charged particle correlations

p-p 13 GeV



p_T leading distribution - multiplicity dependence



p_T assopciated distribution - multiplicity dependence

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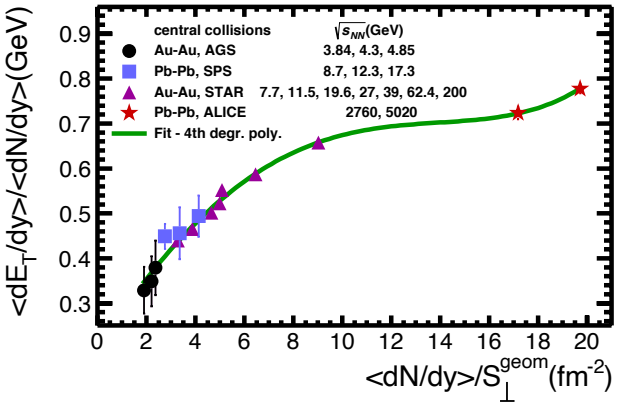
Features of hadronic and deconfined matter from AGS to LHC energies

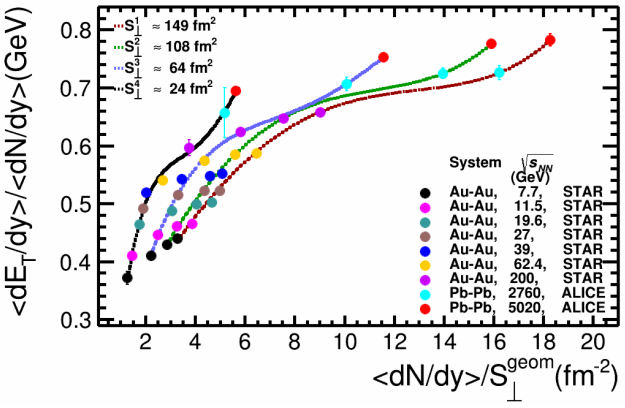
Mihai Petrovici and Amalia Pop

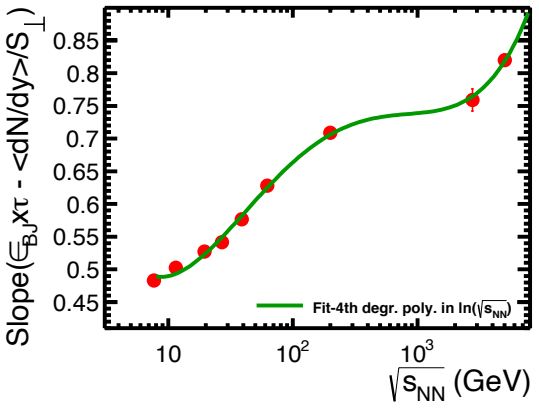
Hadron Physics Department
National Institute for Physics and Nuclear Engineering, Bucharest

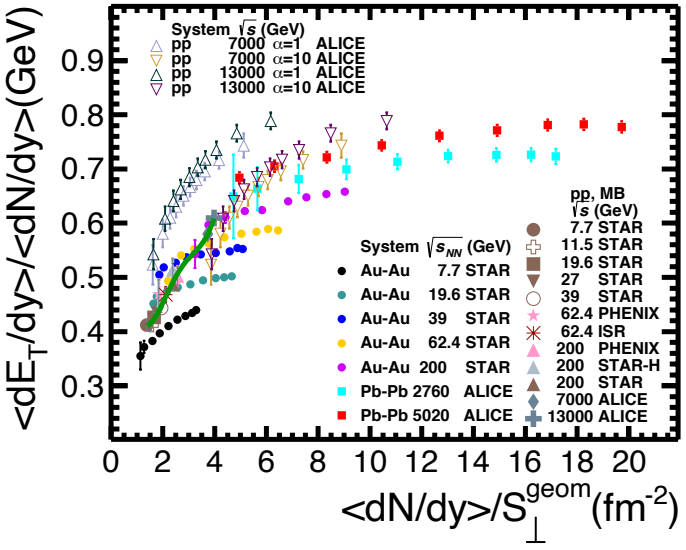
cancelled in the last minute because of the closure of the South African embassy in Romania, the only possibility to obtain a visa being traveling to Budapest, Hungary

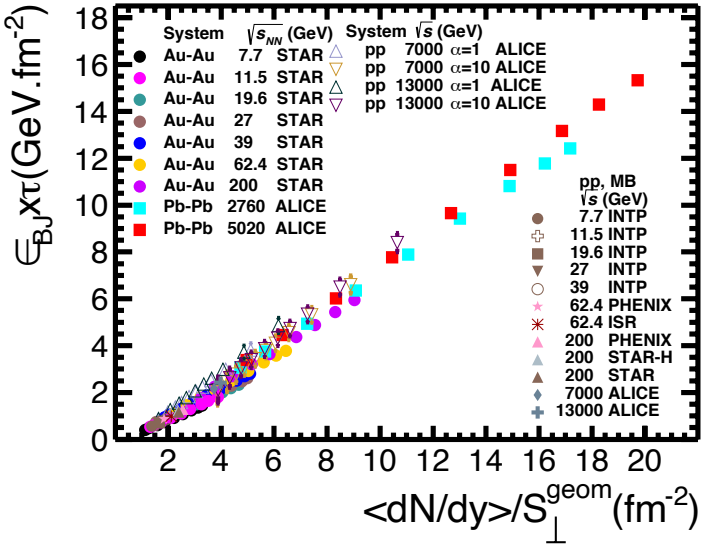
Features of hadronic and deconfined matter from AGS to LHC energies











Features of hadronic and deconfined matter from AGS to LHC energies
M.Petrovici and A.Pop, arXiv:2209.08828[hep-ph], will be published in Phys.Rev.C

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Features of strangeness production in pp and heavy ion collisions

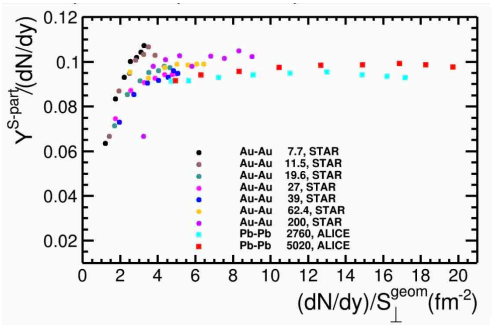
***Mihai Petrovici* and Amalia Pop**

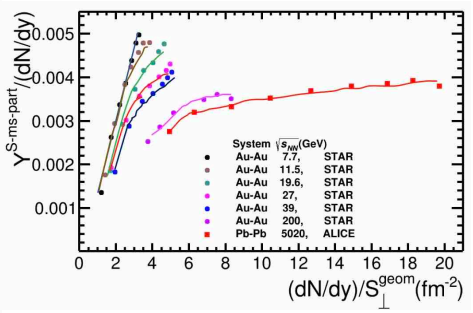
Hadron Physics Department
National Institute for Physics and Nuclear Engineering, Bucharest

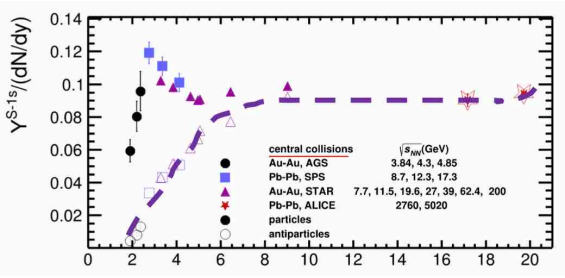
European Nuclear Physics Conference 2022

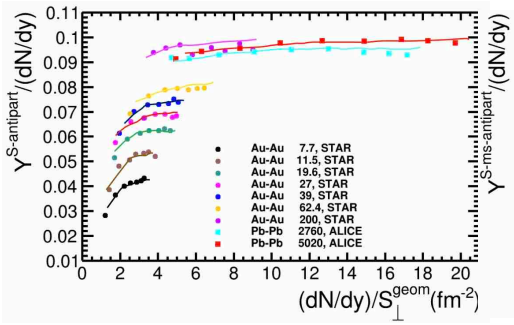
24–28 Oct 2022
University of Santiago de Compostela

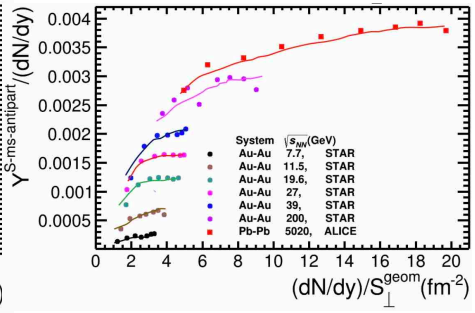
Features of strangeness production in pp and heavy ion collisions

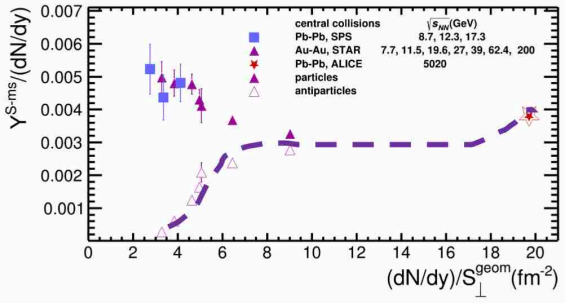


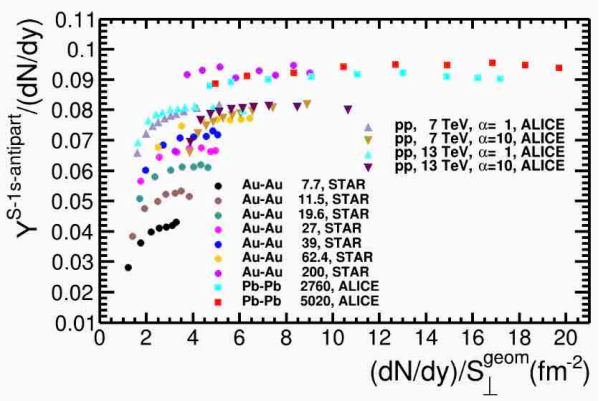


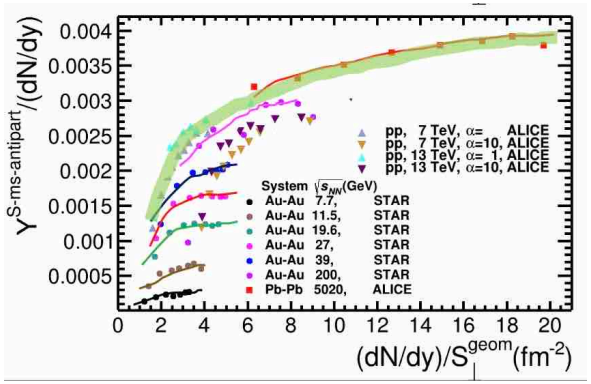






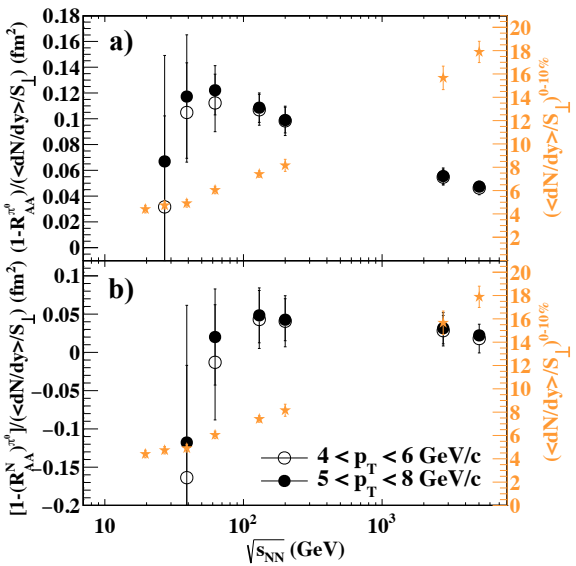




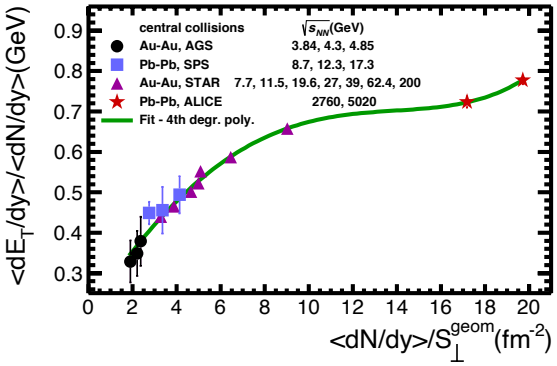


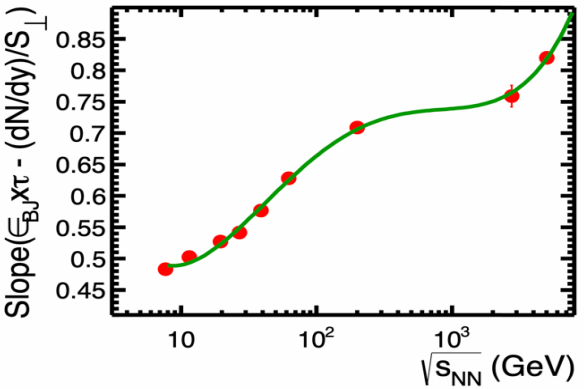
Features of strangeness production in pp and heavy ion collisions
M. Petrovici and A. Pop
oral presentation at EuNPC 2022, October 24-28, 2022, University of Santiago de Compostela, Spain
https://indico.cern.ch/event/1104299/contributions/5055299/attachments/2536779/4366087/EuNPC_talk_mp.pdf

Do we see a new state of deconfined matter at LHC energies?

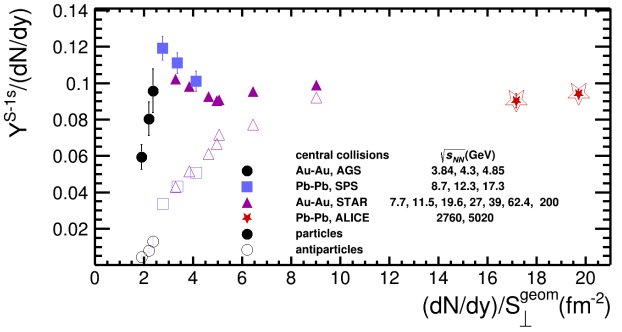


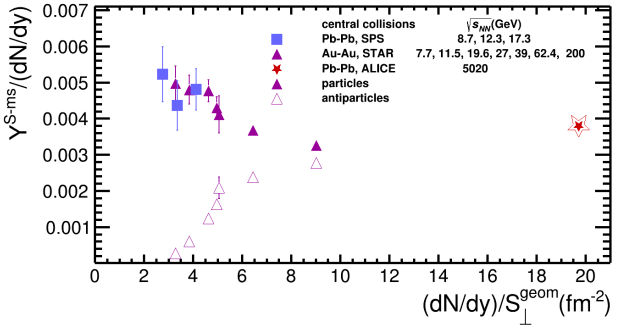
M.Petrovici et al., Phys. Rev. C103(2021)034903



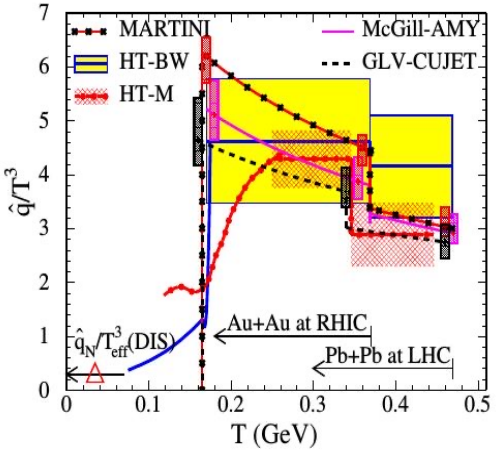


M.Petrovici, A.Pop, arXiv:2209.08828[hep-ph]

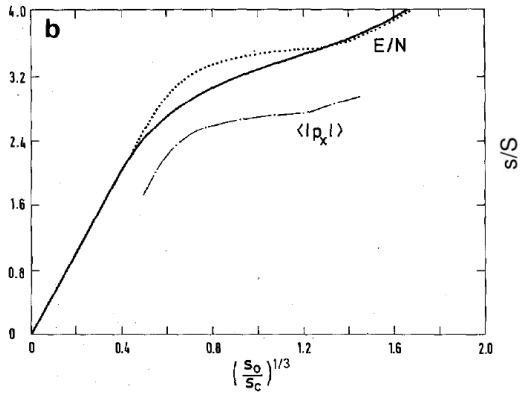




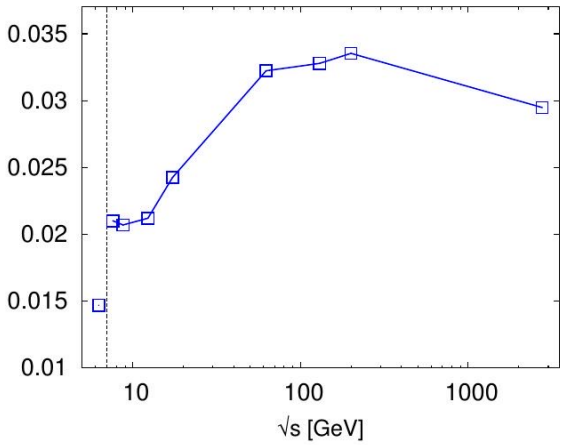
M. Petrovici and A. Pop , EuNPC 2022



K.M. Burke et al., JET Collaboration, Phys. Rev. C90(2014)014909

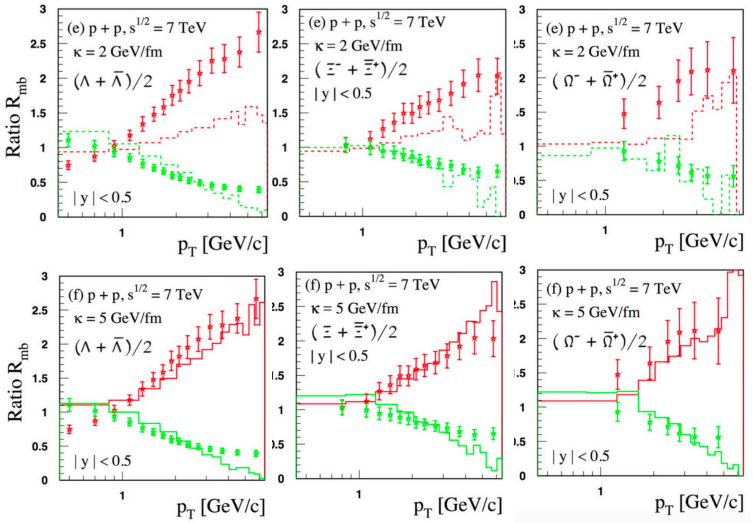


J.-P. Blaizot and J.-Y. Ollitraut, Phys.Lett 191B(1987)21

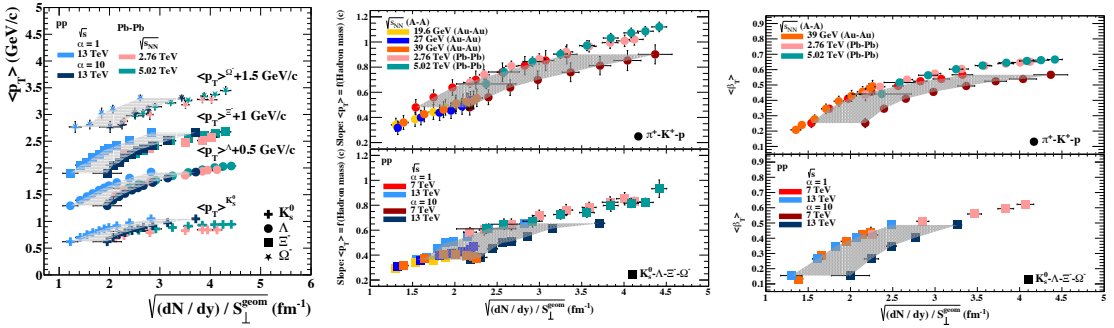


J. Rafelski and M. Petran, Acta Phys.Polon.Supp. 7 (2014) 35, arXiv[nucl-th]1403.4036

A-A vs pp @ LHC

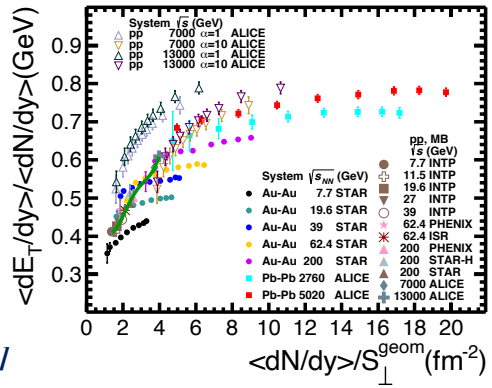


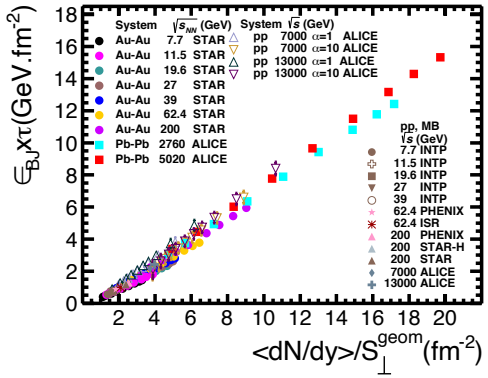
V. Topor Pop and M. Petrovici, Phys. Rev. C 98, 064903 (2018)

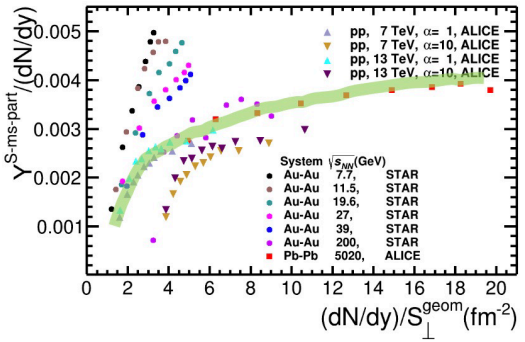


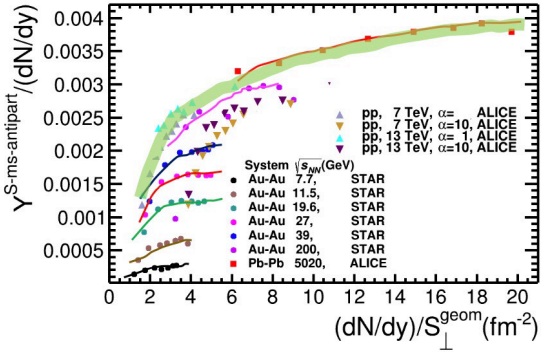
M.Petrovici et al., Phys. Rev. C 98, 024904 (2018)024904
A. Lindner et al., Proceedings of Science (PoS) 380(2021)197 (PANIC2021), https://pos.sissa.it/380/197/.

M.Petrovici and A.Pop, arXiv:2209.08828 [hep-ph]





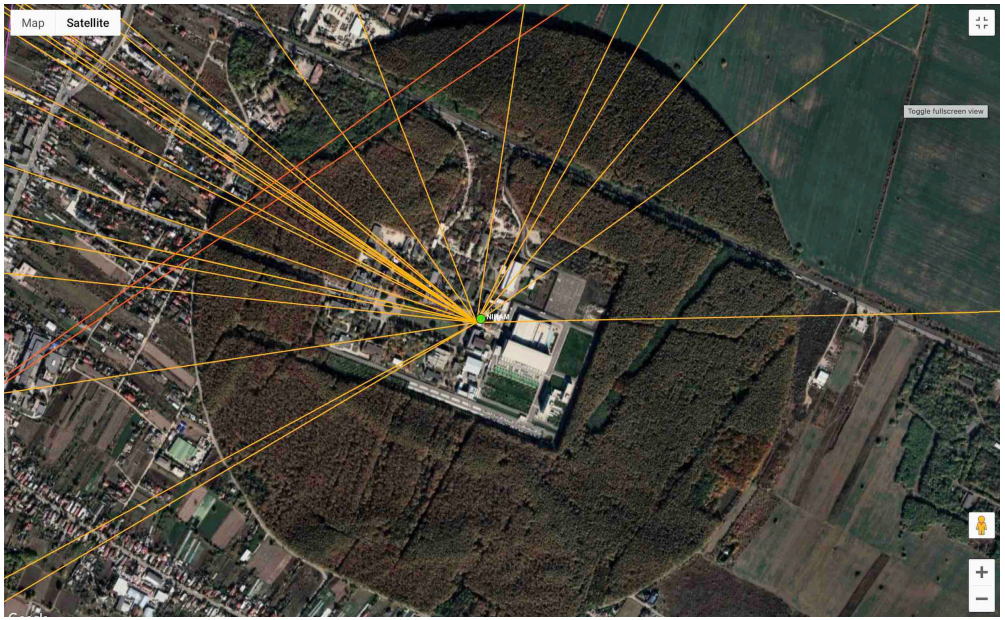




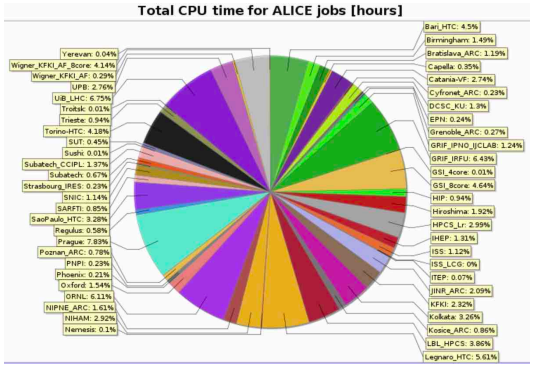
M. Petrovici and A. Pop , EuNPC 2022

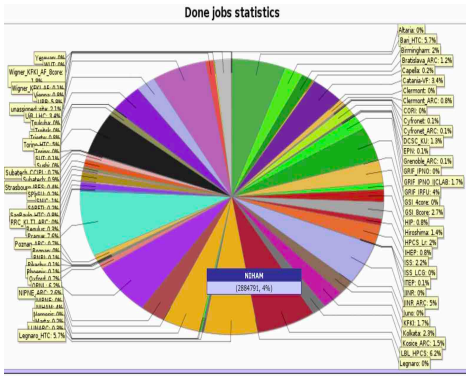
NIHAM Data Centre

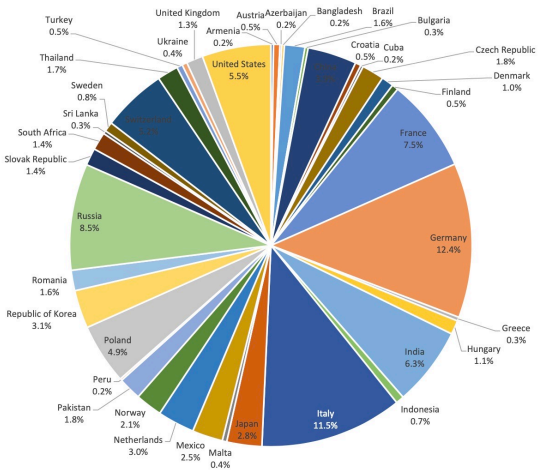
Contribution to ALICE GRID



- *A new cooling unit was purchased and deployed.*
- *5 new computing servers (240 CPU cores) were purchased.*
- *The deployment of the new servers and of the extension of the storage capacity are in progress.*
- *NAF is efficiently managed and running.*







CPU:
- *9.5 Mhours*
- *2.9 % of total Tier2 ALICE contribution*

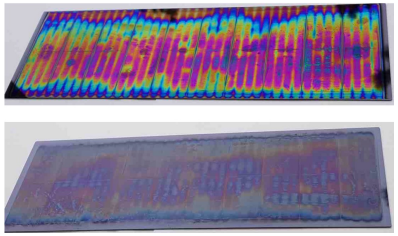
Done jobs:
- *2.9 Mjobs done*
- *4 % of total Tier2 ALICE contribution*

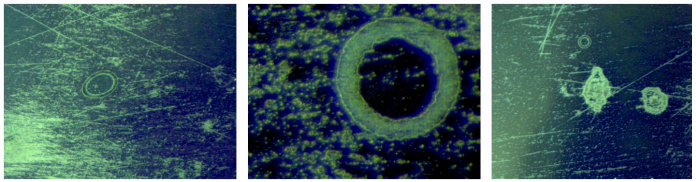
R&D Activities
&
Steps towards construction & tests
of
CBM ToF & TRD subdetectors
for
CBM Experiment @ FAIR

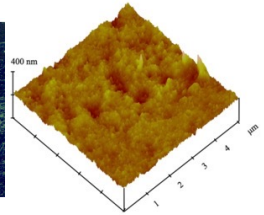

CBM Collaboration Meeting,
10-14 October, 2022, Warsaw

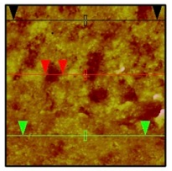
MSMGRPC - ageing tests

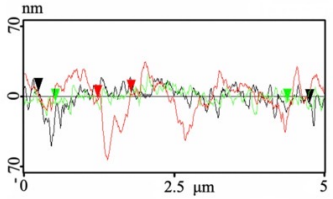
Studies of the irradiation hardness of
Multi Strip Multi Gap Resistive plate Counters
using Multipurpose Irradiation Facility of IFIN-HH

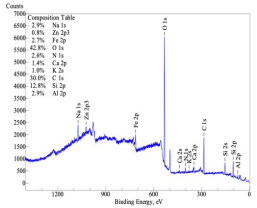


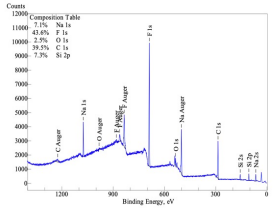


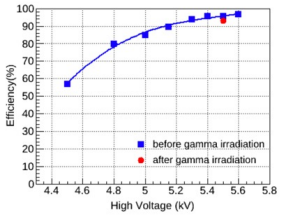


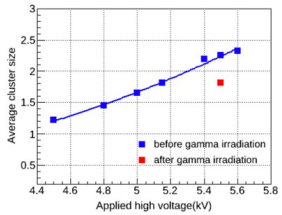












Probe	R_V (GΩ·cm)	R_S (GΩ/□)
irradiated cathode surface	67.4	20.0
irradiated anode surface	61.5	21.1
non-irradiated glass	65.2	20.2

Nuclear Inst. and Methods in Physics Research, A 1024 (2022) 166122

Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

Ageing studies of Multi-Strip Multi-Gap Resistive Plate Counters based on low resistivity glass electrodes in high irradiation dose

D. Bartos [a], C. Burducea [c], I. Burducea [c], G. Caragheorgheopol [a], F. Constantin [c], L. Craciun [c], D. Dorobantu [a], M. Ghena [e], D. Iancu [c], A. Marcu [e], G. Mateescu [a], P. Mereuta [c], V. Moise [b], C. Negrila [d], D. Negut [b], M. Petris [a], M. Petrovici [a,*], L. Radulescu [a], V. Aprodu [a], L. Prodan [a], A. Radu [a], G. Stoian [a]

[a] Hadron Physics Department, National Institute for Physics and Nuclear Engineering - IFIN-HH, P.O. Box MG-6, Bucharest-Magurele, Romania
[b] Multipurpose IrradiationCentre, National Institute for Physics and Nuclear Engineering - IFIN-HH, P.O. Box MG-6, Bucharest-Magurele, Romania
[c] Applied Nuclear Physics Department, National Institute for Physics and Nuclear Engineering - IFIN-HH, P.O. Box MG-6, Bucharest-Magurele, Romania
[d] National Institute of Materials Physics, INCDFM, P.O. Box MG-7, Bucharest-Magurele, Romania
[e] Institute for Laser, Plasma and Radiation Physics - INFLPR, P.O. Box MG-36, Bucharest-Magurele, Romania

Diploma Work

UNIVERSITATEA DIN BUCUREŞTI
FACULTATEA DE FIZICĂ

TITLUL TEZEI

LUCRARE DE LICENŢĂ

Absolvent
Daniel-Ion DOROBANŢU

Conducător ştiinţific
Prof. dr. Mihai PETROVICI
CS II dr. Mariana PETRIŞ
Prof. dr. Alexandru JIPA

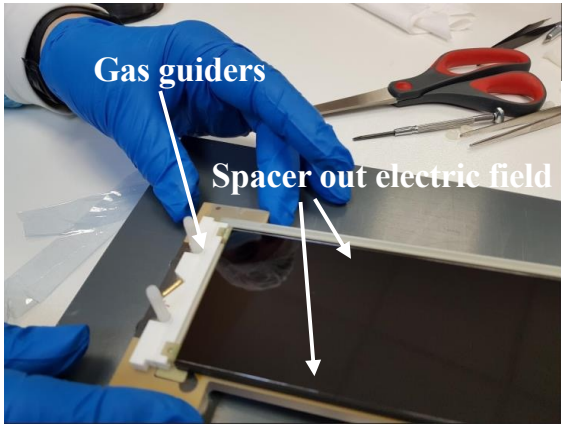
Bucureşti, 2021

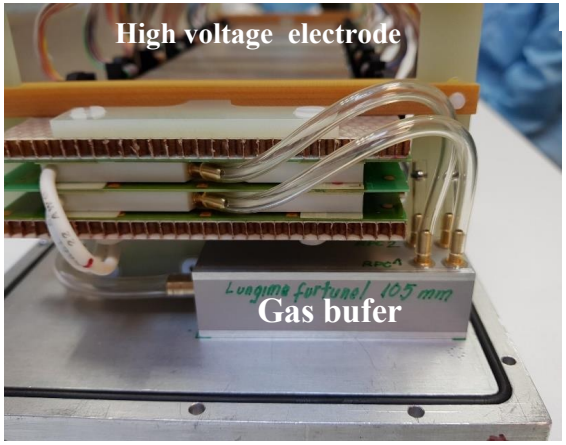
M. Petris et al., 15th Pisa Meeting on Advanced Detectors, La Biodola, Isola d'Elba, May 22-28, 2022

M. Petris et al., Nucl. Instr. Meth. A, 1045(2023)167621

First prototype with a direct flow – 70% gas transmission

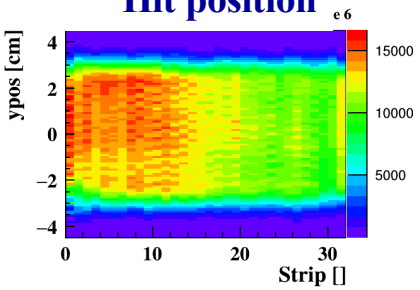
- Direct gas flow through the gas gaps.
- Spacers run across the strips
- Spacers outside electric field area.
- 5.6 cm strip length



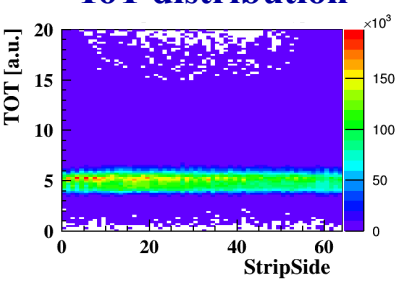


mCBM@SIS18 July 2021 in-beam test results

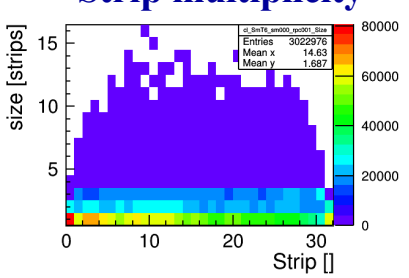
Hit position



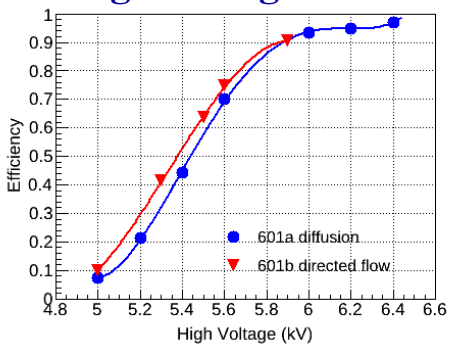
ToT distribution



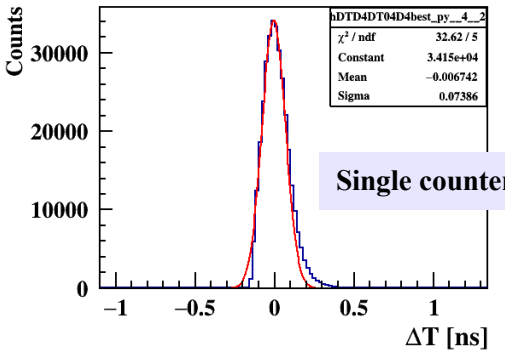
Strip multiplicity



High voltage scan

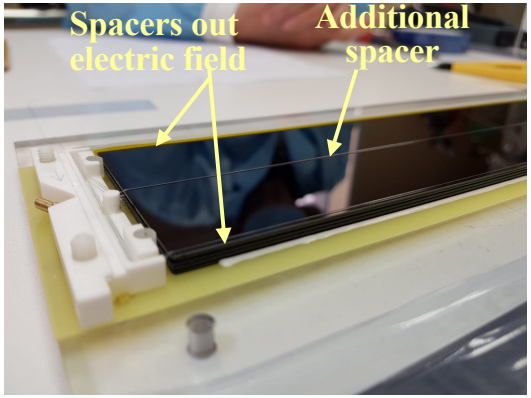


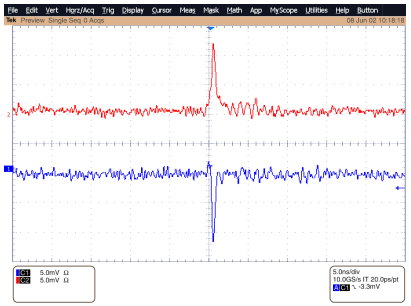
Time resolution @±5.9 kV



Single counter = 51 ps

Second prototype with a directed flow – 100% gas transmission

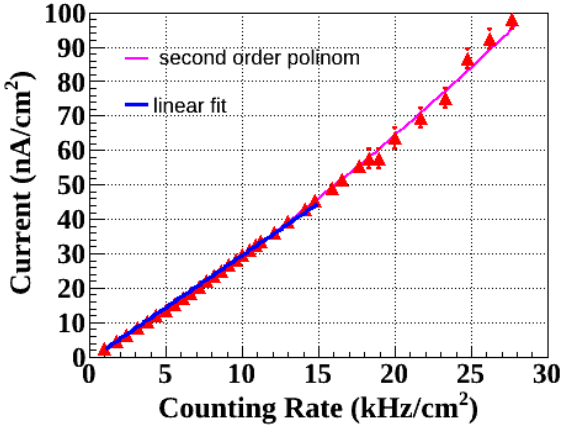




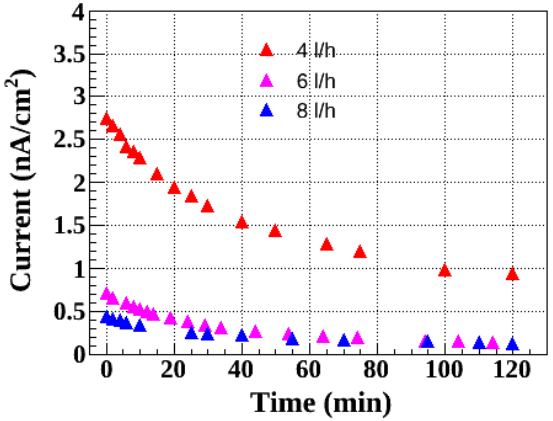
Tested in mCBM (June 2022) up to 2 x 6.4 kV & in high counting rate up to 4x10^8 part/spill

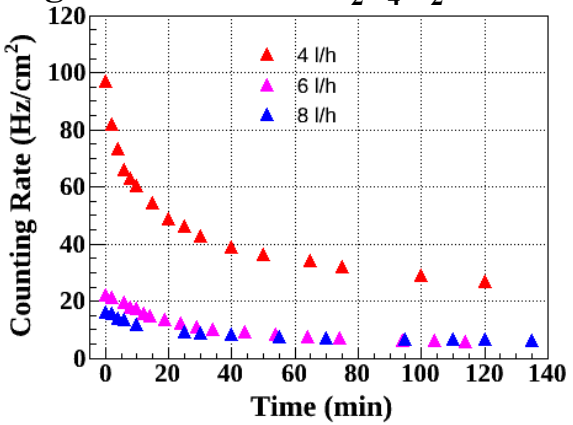
High intensity X-ray irradiation of MSMGRPC with direct flow and spacer on the middle

Calibration current vs. rate

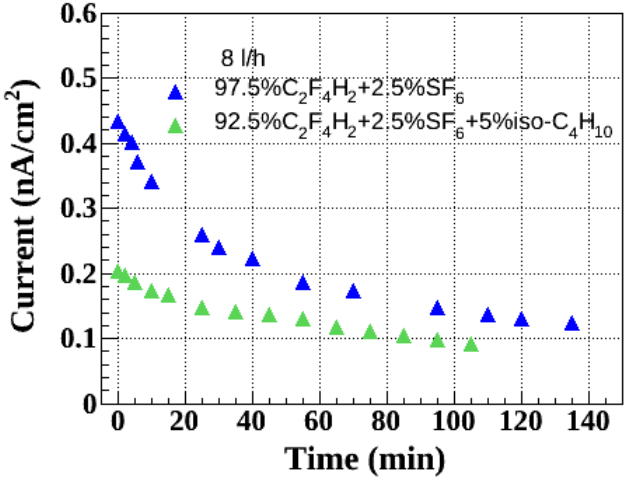


Detector recovery at different gas flows: 97.5%$C_2F_4H_2$ + 2.5%SF_6

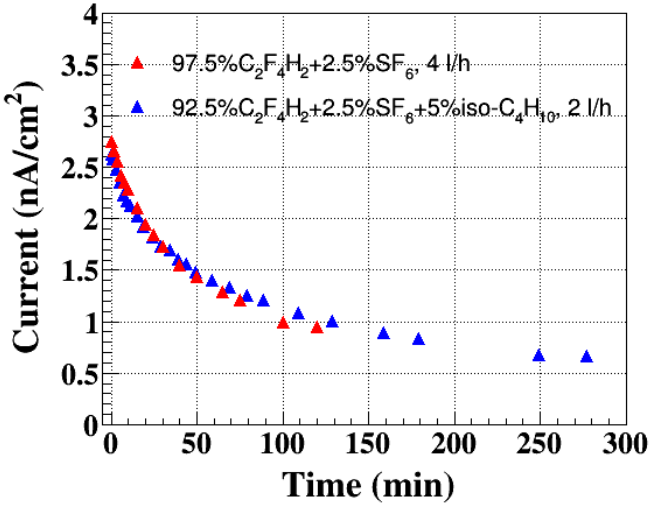




Detector recovery - flushed with a gas mixture w/o isobutane



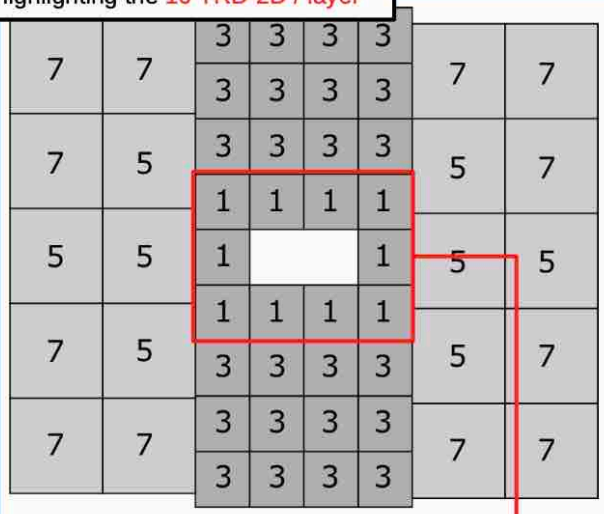
Detector recovery - flushed w/o isobutane 2 and 4 l/h gas flows

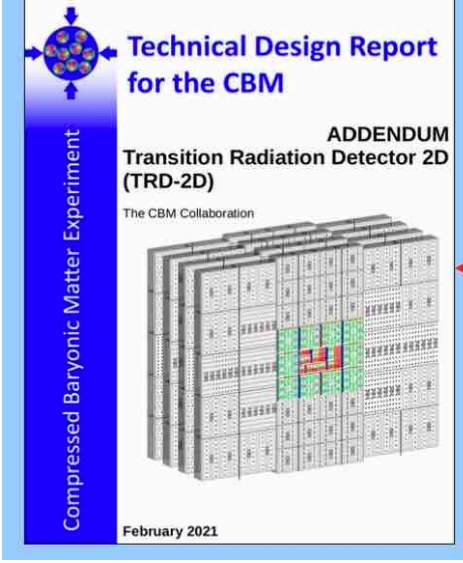


M. Petris et al., Nucl. Instr. Meth. A, 1045(2023)167621

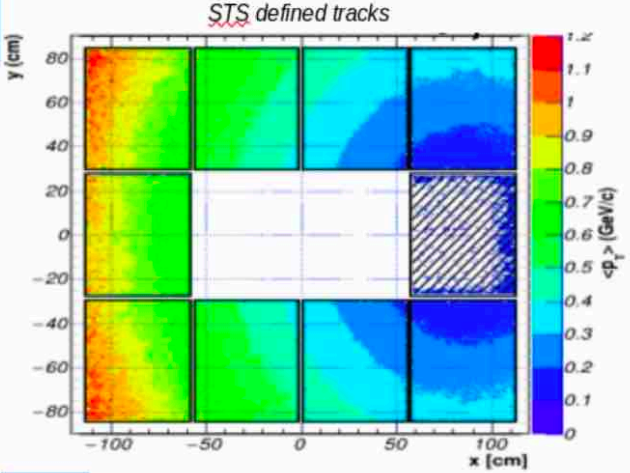
TRD-2D in CBM
from physics to a TDR Addendum

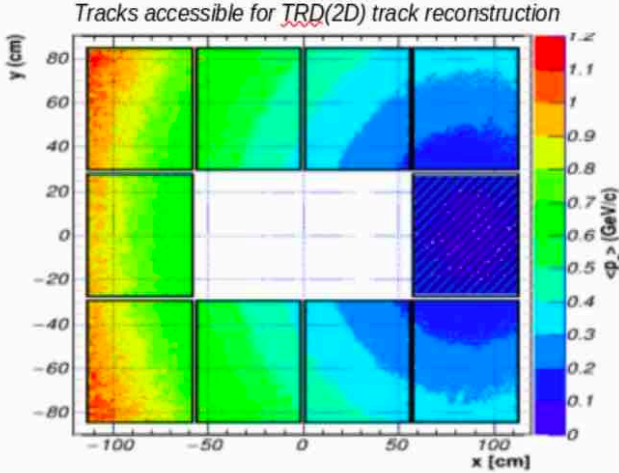
TRD wall
Module types distribution
Highlighting the 10 TRD-2D / layer





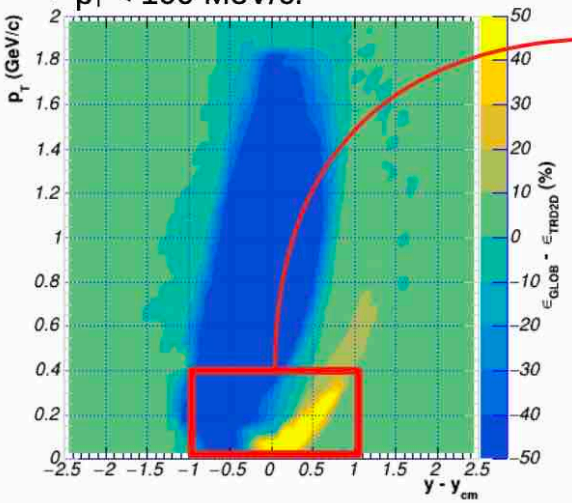
Projection of proton tracks to the first TRD(2D) layer for mid rapidity in the CM.

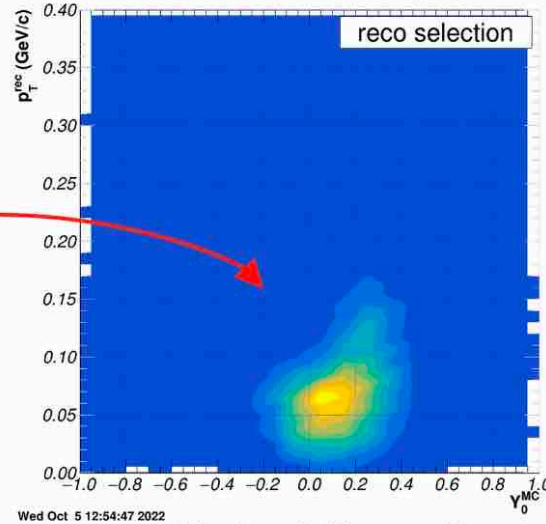




MC feasibility studies

→ extend kinematic space of CBM
→ protons @ mid-rapidity
→ p_T < 100 MeV/c.

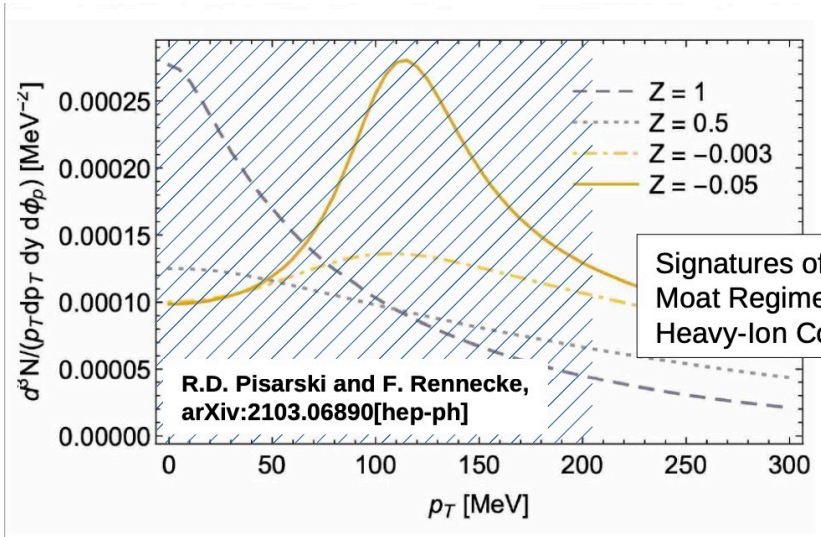




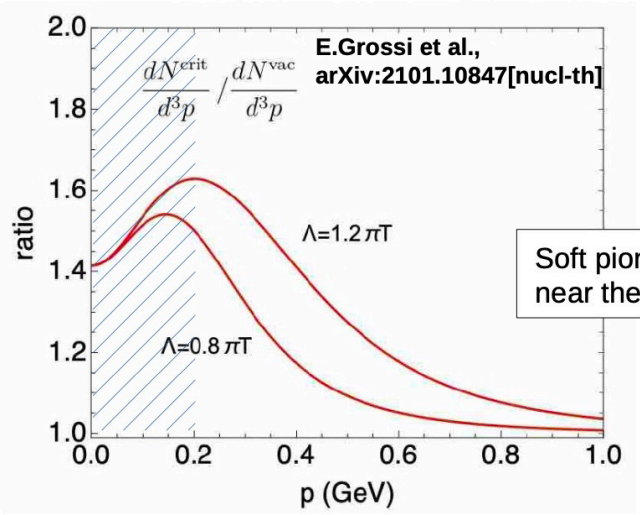
Reconstructable feasibility studies

→ extend CA tracking to TRD-2D reco
→ use only vertex for Δp < 10%
→ use ToF for proton PID.

Physics Motivation

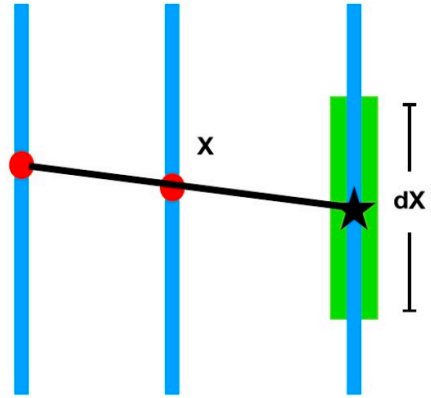


Signatures of Moat Regimes in Heavy-Ion Collisions

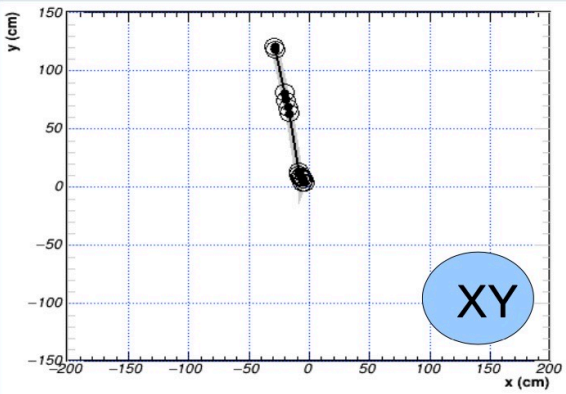


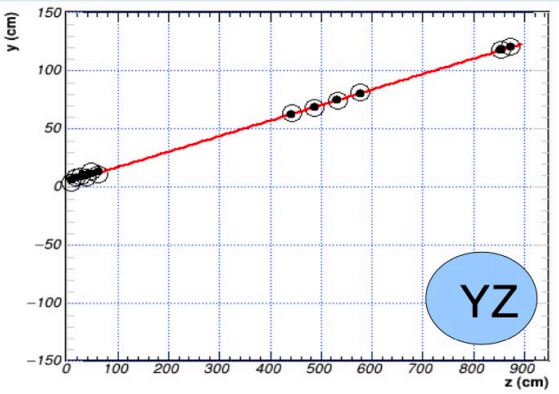
Soft pions and transport near the chiral critical point

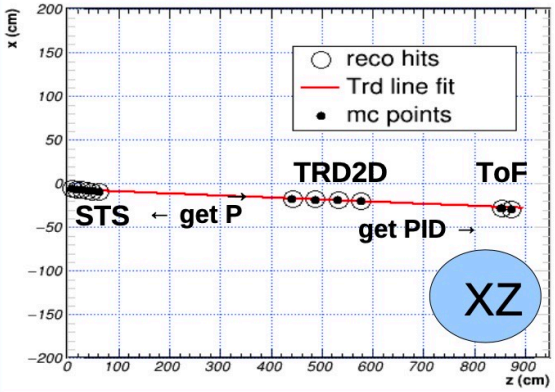
TRD-2D performance within CBM



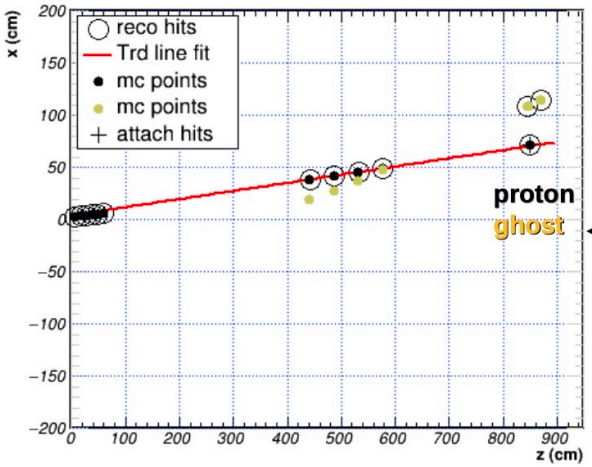
- **A new application of L1 tracking, started for the mCBM data to become the main tracking algorithm for CBM was developed on the TRD2D reconstructed hits.**







Eff. All tracks, Pt > 0 GeV	*93.9 %*
Eff. Primaries, Pt > 0.1 GeV	*100.0 %*
Eff. Primaries, Pt < 0.1 GeV	*98.3%*
Eff. Secondaries, Pt > 0.1 GeV	*84.6%*
Eff. Secondaries, Pt < 0.1 GeV	*84.6%*
Clone rate	*0 %*
Ghost rate	*25.7%*

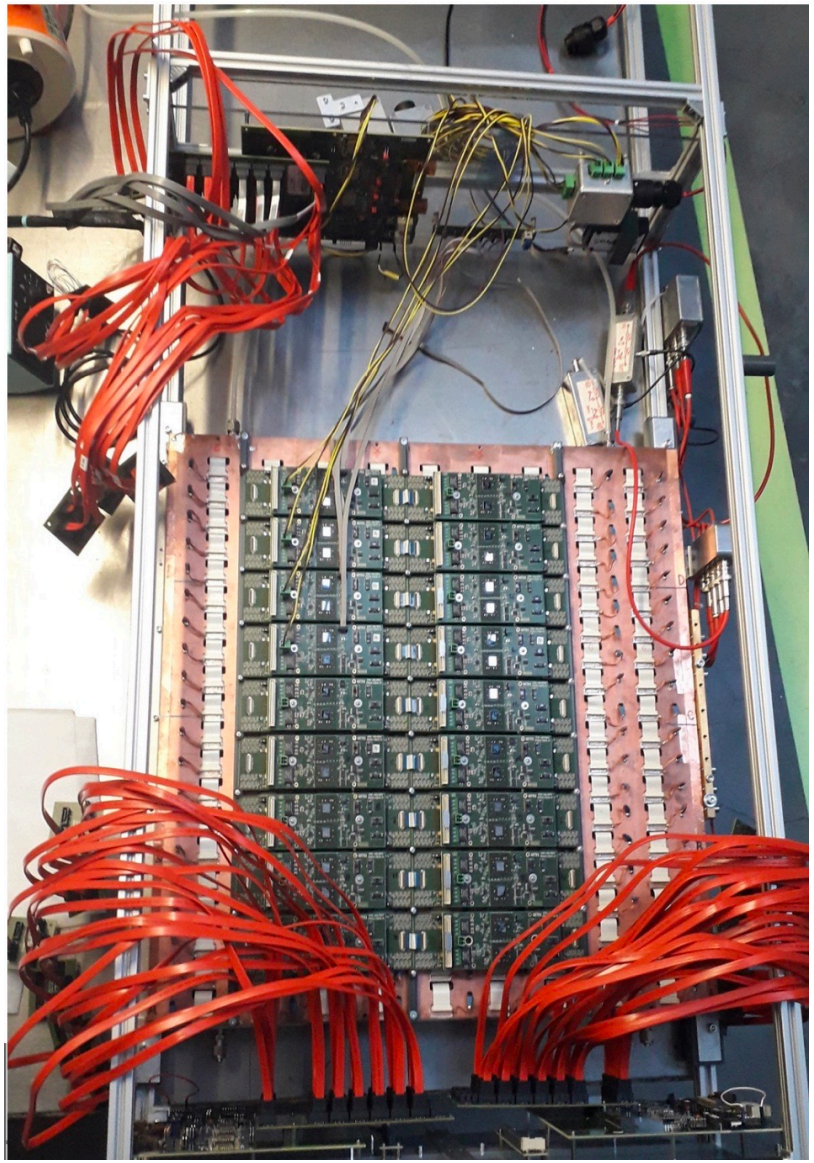


example of ghost track

L1 tracking

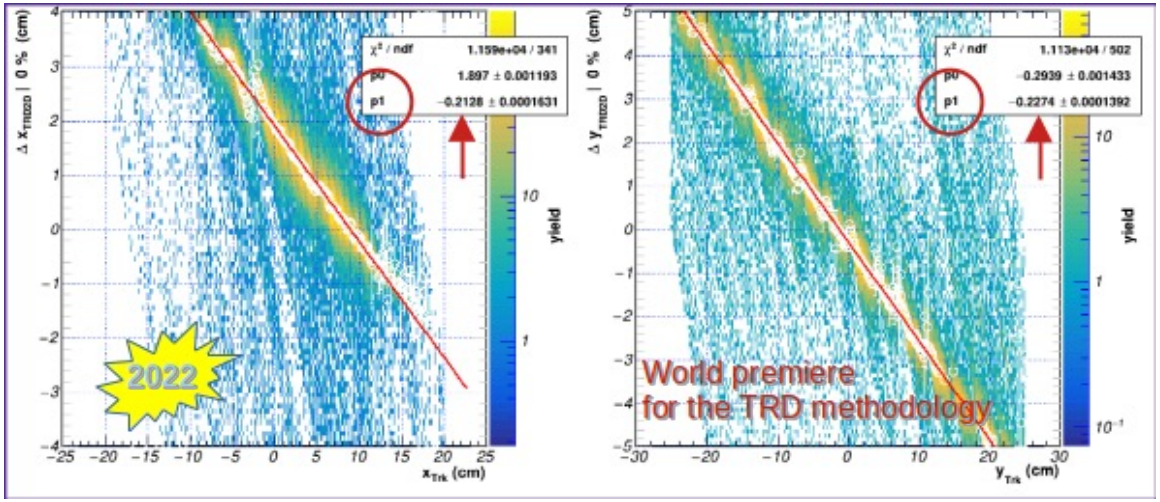
- *QA – reconstructed hit attachment against MC info*
- *Ghost = track with less than 75% (3 TRD2D hits) correct MC.*
- *Actual PID is based on ToF hit info not (yet) TRD dEdx. See slide 14.*

Participation in mCBM

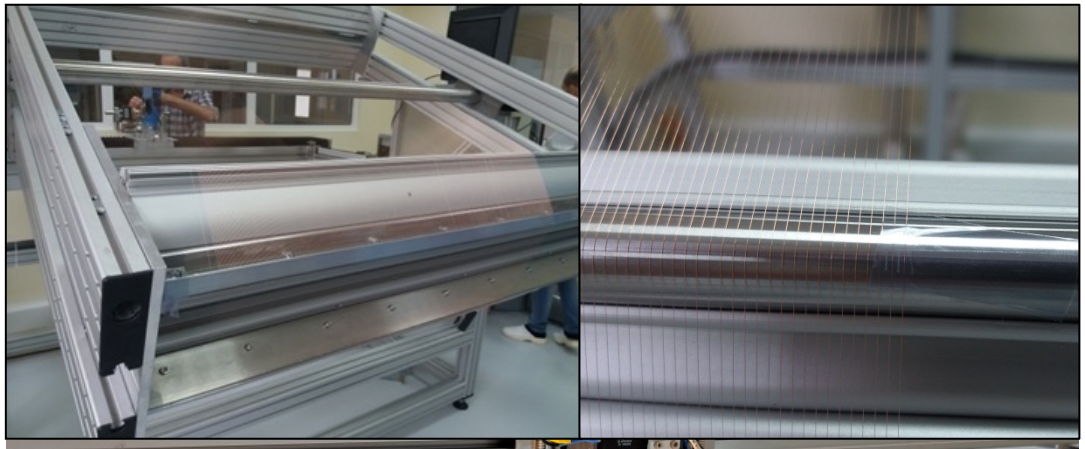


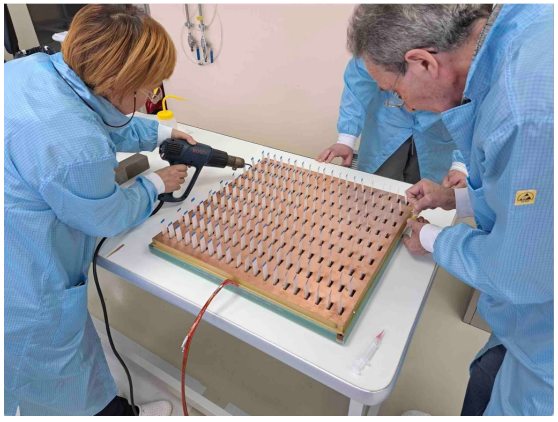
- *Participated in all mCBM data taking campaigns using the new (CRI1) DAQ chain (since July 2021)*
- *Fully integrated in mCBM DAQ chain and development platform*
- *Stable operation, no HW errors (eg. SEU) observed*

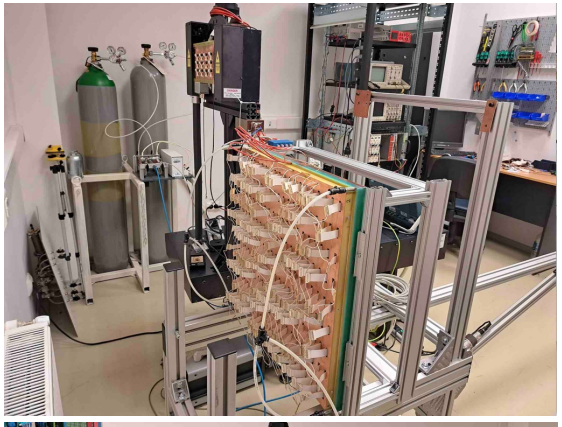
TRD-2D performance within mCBM

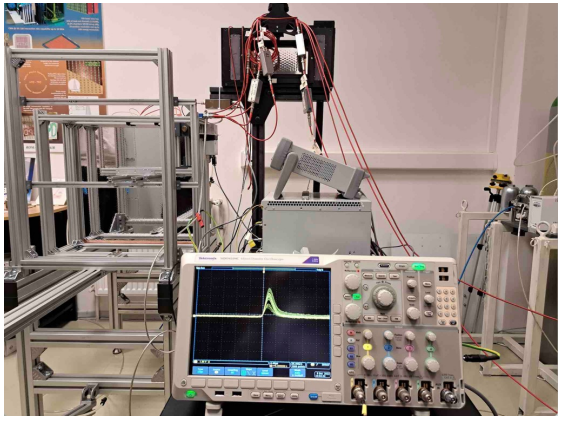


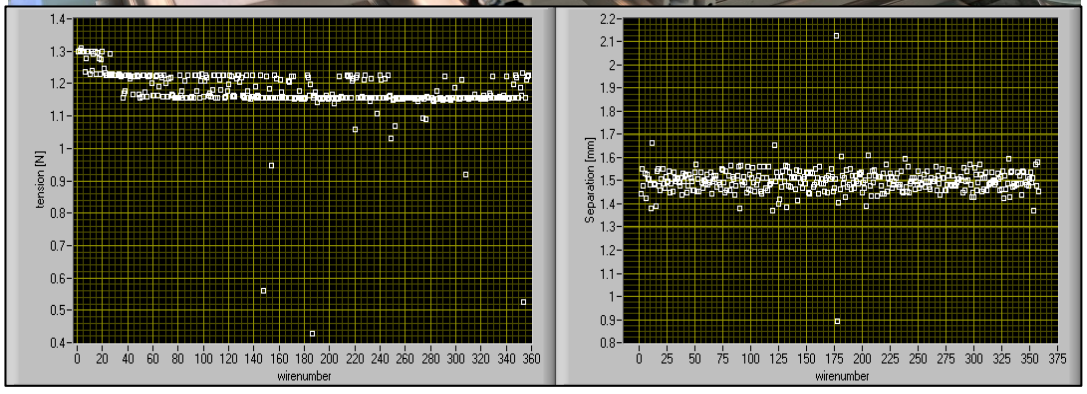
TRD-2D Production Readiness Prototype





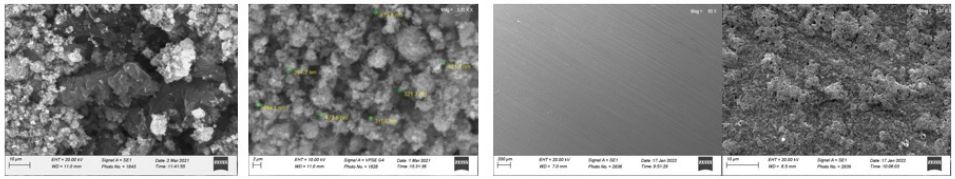


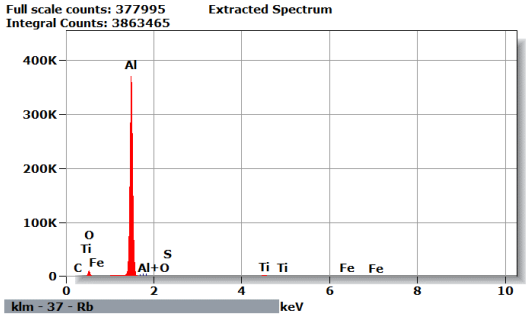


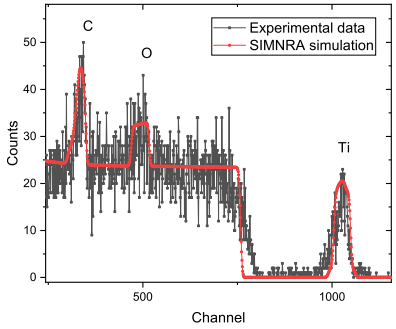


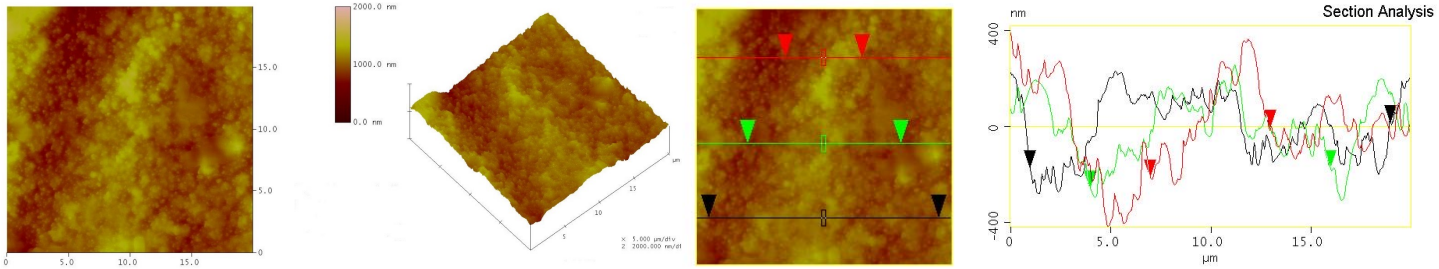
Applied Research
&
Technological Transfer

Electrophoretic Deposition of TiO_2+graphene nanoparticles from colloidal dispersion on aluminum substrate









Training & teaching

PhD Thesis

University of Bucharest
Faculty of Physics
Doctoral School of Physics

Adrian Sorin MARE

NUCLEAR STRUCTURE AND DYNAMICS OF EXOTIC MEDIUM-MASS NUCLEI

A thesis submitted for the degree of Doctor of Philosophy

Supervisor,
Prof. dr. Petrovici Alexandrina

Bucharest, 2022

Master Thesis

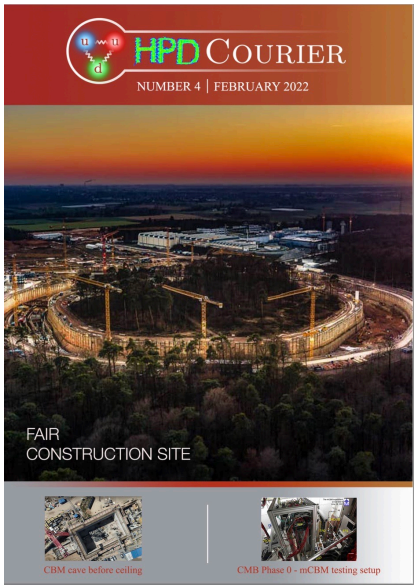
Universitatea Transilvania din Brașov
FACULTATEA DE INGINERIE ELECTRICĂ ȘI ȘTIINȚA CALCULATOARELOR

Departamentul Electronică și calculatoare
Programul de studii Sisteme electronice și de comunicații integrate - RCD

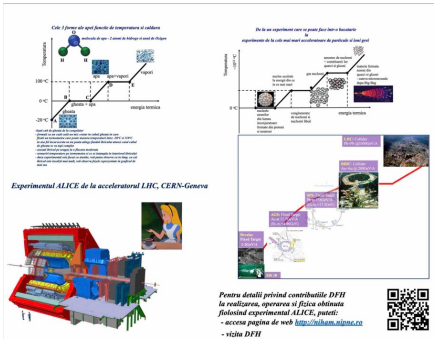
NAN Adriana-Georgiana

VISUALISATION OF DATA AND VALIDATION OF RECONSTRUCTION ALGORITHMS USED IN HADRONIC PHYSICS EXPERIMENTS

VIZUALIZAREA DATELOR ȘI VALIDAREA ALGORITMILOR DE RECONSTRUCȚIE FOLOSIȚI ÎN CADRUL EXPERIMENTELOR DE FIZICĂ HADRONICĂ



Poster Researchers Night



Outreach

Visit of the Minister of Research, Innovation and digitization

Students from Technical University, Bucharest

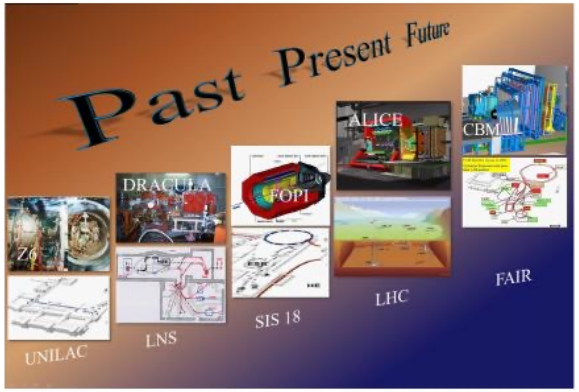
Doctor Honoris Causa of UPB Dr. Iosif Legrand

HPD 2023 Calendar

HADRON PHYSICS DEPARTMENT

wishes you a succesful and happy 2023 year!

Hadron Physics Department
Horia Hulubei National Institute of Physics and Nuclear Engineering



Hadron Physics Department
Horia Hulubei National Institute of Physics and Nuclear Engineering


Merry Christmas, Season's greetings
and
A happy, healthy and successful
2023 !