MINISTERUL EDUCAȚIEI ȘI CERCETĂRII

www.ifin.ro

- Activities and achievements in this year (10.03.2020-30.10.2020)

- Few remarks on additional activities

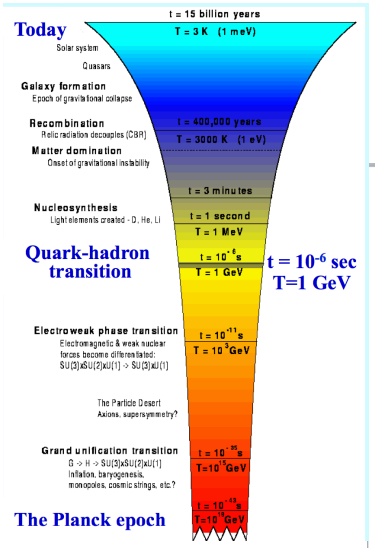
HADRON PHYSICS DEPARTMENT

National Institute for Physics and Nuclear Engineering – IFIN-HH

http://niham.nipne.ro

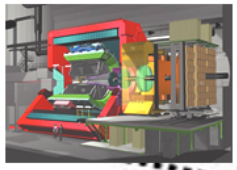
ISAB Meeting, October 30, 2020

Motivation



Expectations based on QCD

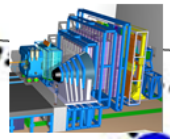
QCD Critical Points



T

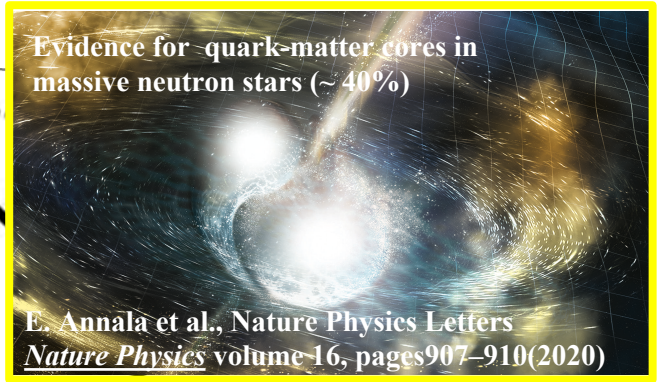
H

μ_H=350 -400 MeV,
T_H = 150-160 MeV

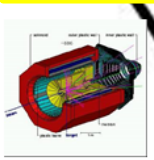


Statistical model:
- *for $\mu_B \ll m_N$ the thermal degrees of freedom dominated by mesons*
- *for higher μ_B more baryons are excited*

E



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



Quark-Hadron continuity:

F

G

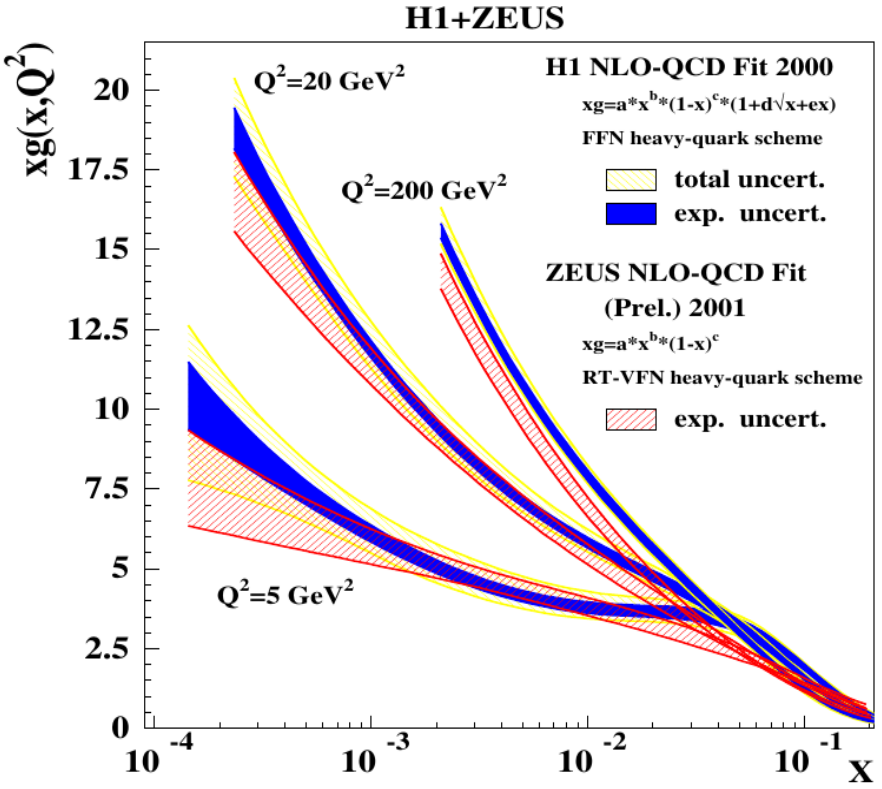
Liquid-gas phase transition:
$\mu_{NM} \cong 924$ *MeV*
$n_0 = 0.17$ *fm*$^{-3}$

Superfluid nuclear matter

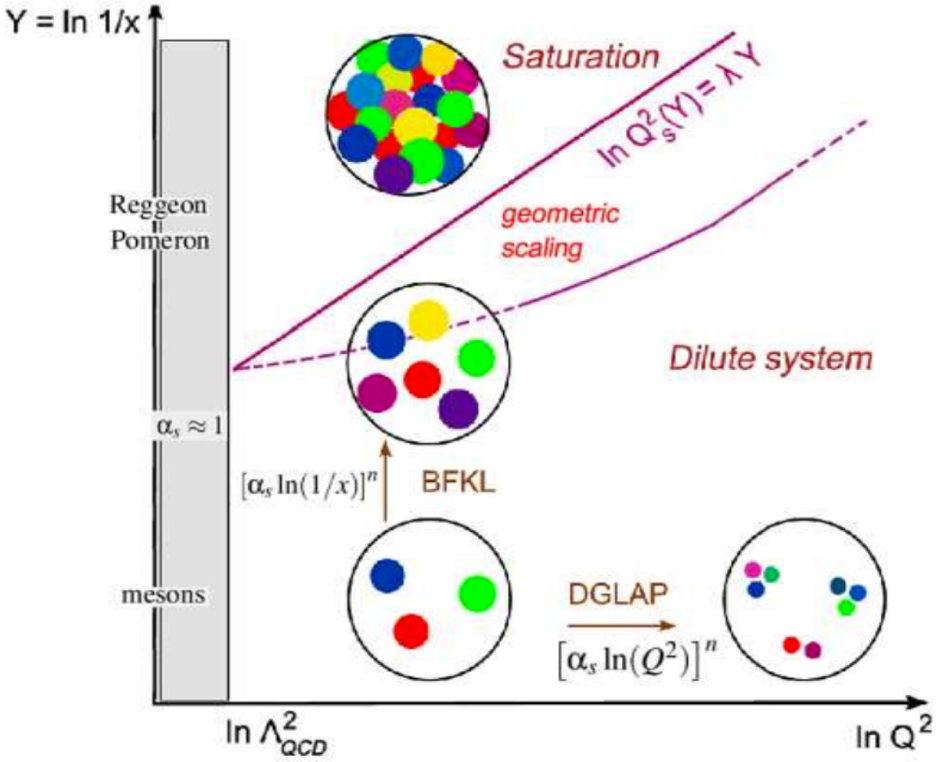
Superconducting quark matter

μ_B

Physics motivation



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

Highlights of accomplishments in the last year

• Physics

- **Charged particles p_T spectra as a function of charged particle multiplicity and sphericity in pp collisions at $\sqrt{s}$ = 7 TeV. Implementation of unfolding based on a multi-dimensional detector response matrix.**

- **Studies of two charged particles correlations as a function of multiplicity and sphericity in pp collisions at $\sqrt{s}$ = 7 TeV.**

- **Considerations on charged particles suppression at RHIC and LHC energies - submitted to Phys.Rev.C**

- **Studies on the core-corona interplay at LHC and RHIC energies based on experimental data and Glauber MC estimates.**

- **1 presentation in ALICE spectra PAG**
- **1 presentation at ICHEP2020**
- **1 paper submitted at Phys.Rev.C**
- **Contribution to 8 conference presentations**
- **Co-authors to 32 ALICE published papers**

- **Contributions to Young Scientists Day - IFIN-HH**
  - **Towards understanding new features of hadron production mechanisms at LHC energies**
    A. Lindner
  - **Simulating the initial stage of hadron-hadron collisions**
    D. Avramescu

- **1 Master thesis**

Highlights of accomplishments in the last year

• Computing

- NIHAM maintained the leading position among Tier2s ALICE GRID centers.
A new data storage capacity of 4.6 PB raw and 3.82 PB effective was installed and is currently in operation.
Another data storage unit of 2.3 PB raw and 1.91 PB effective was purchased and transported from CERN to HPD.
New UPS stations of ~120 KVA - in progress.
NAF is efficiently managed.

• Teaching & Outreach

- **Summer student program cancelled because of COVID pandemic situation**
- **The 2nd and 3rd numbers of the HPD Courier were issued (*https://niham.nipne.ro/HPD_Courier.html)***

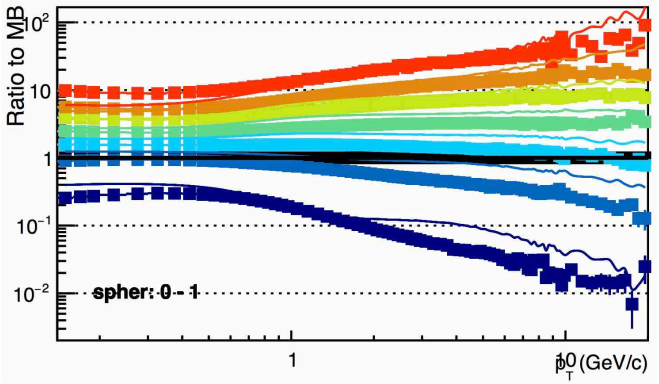
- **visit of the Prime Minister adviser**
- **a movie related to the ALICE-TPC upgrade is closed to be finalized**
- **More details could be seen in:**
  https://niham.nipne.ro
  https://www.youtube.com/watch?v=OJd4fA0xUh0
  https://www.facebook.com/Hadron-Physics-Department-211078852968333/

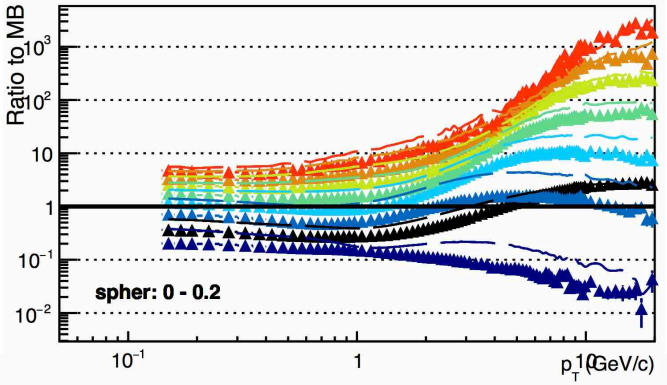
• **ZOOM was implemented on the the versatile audio-video infrastructure of HPD**

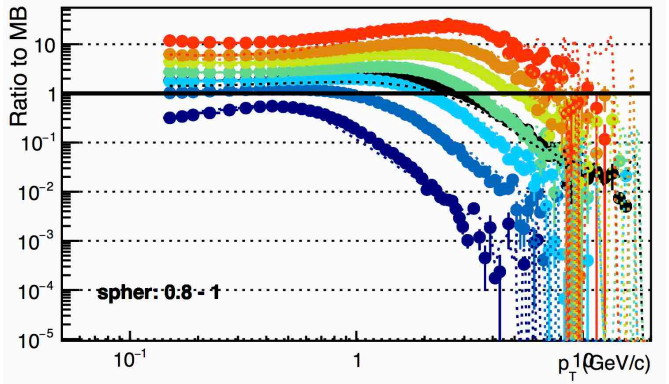
Charged particle p_T distributions - Multi differential analysis in pp collisions at 7 TeV

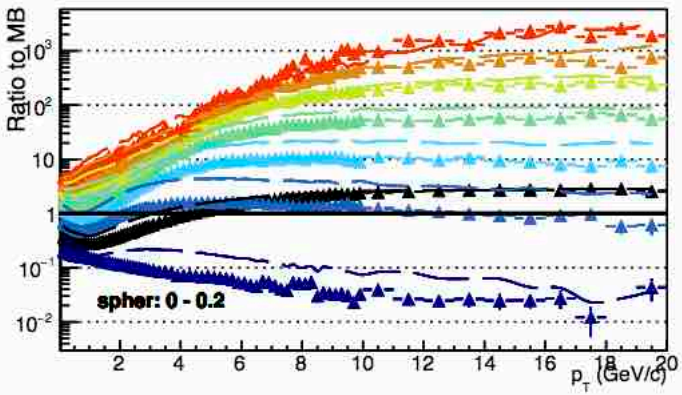
charged particles multiplicity and sphericity dependence

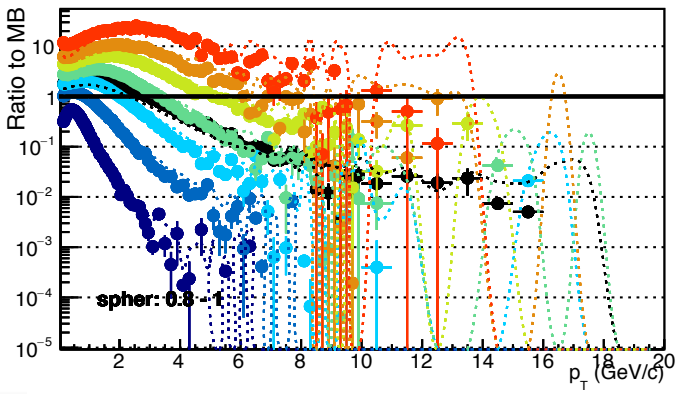
N_{ch}^{mult} for $|\eta|<0.8$; p_T spectra in $|\eta|<0.5$









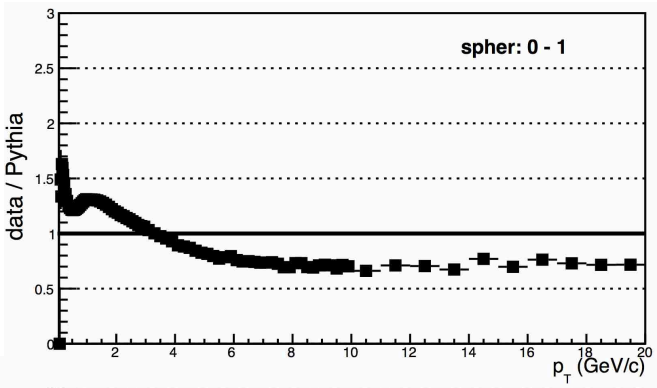


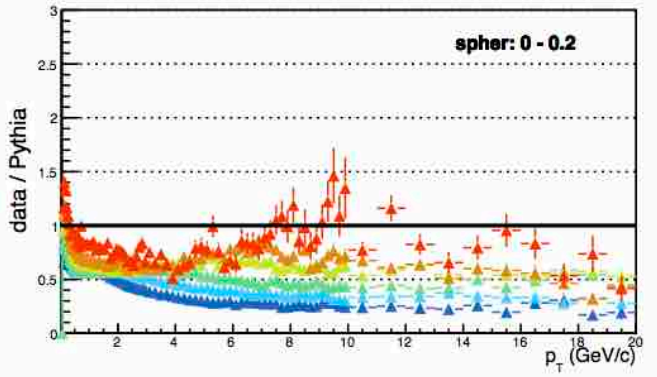
Charged particle p_T distributions - Multi differential analysis in pp collisions at 7 TeV

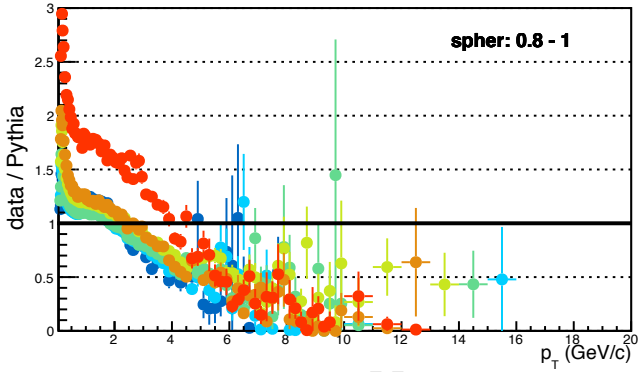
charged particles multiplicity and sphericity dependence

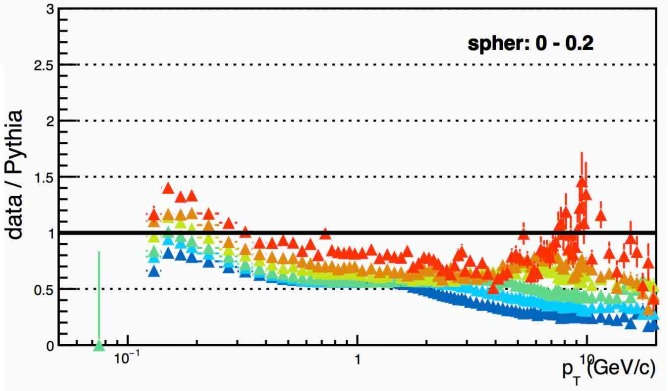
N_{ch}^{mult} for $|\eta|<0.8$; p_T spectra in $|\eta|<0.5$

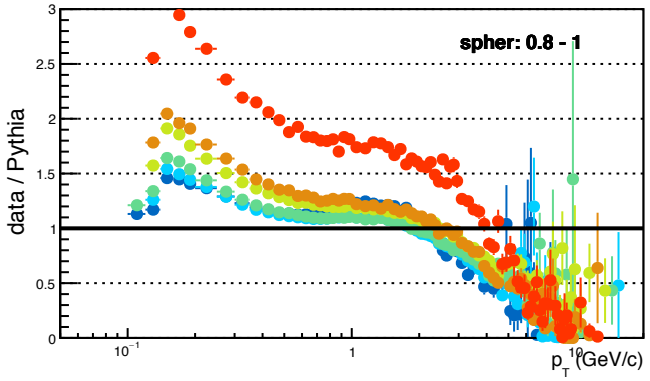
Data/PYTHIA (Perugia0)







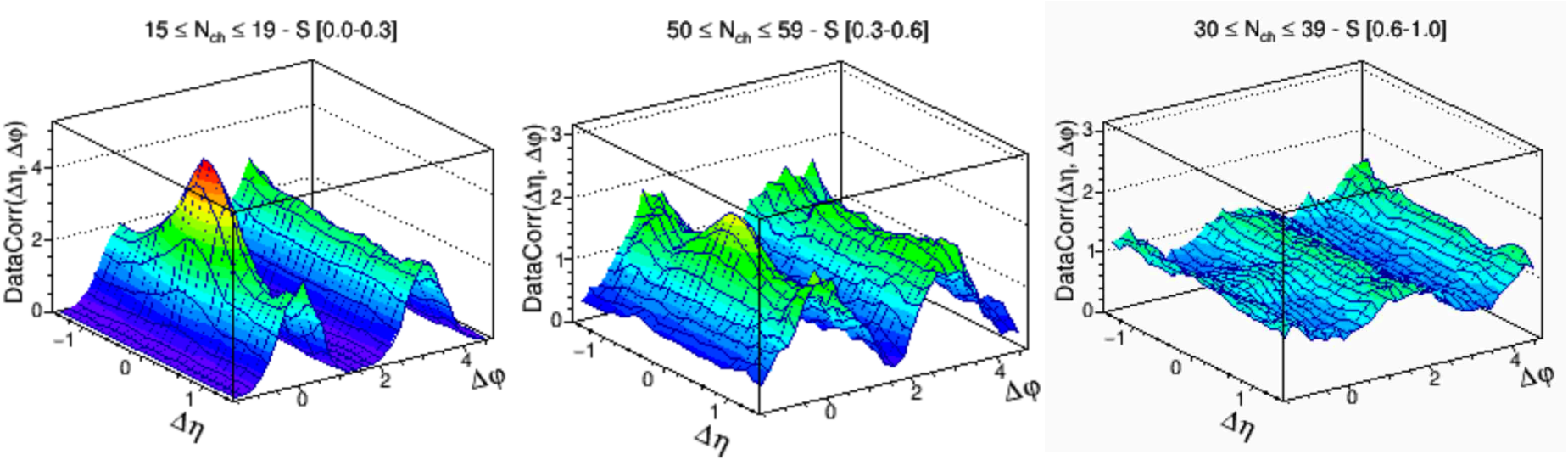




Why extending the Multi-differential analysis ?

Two charged particle correlation

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}

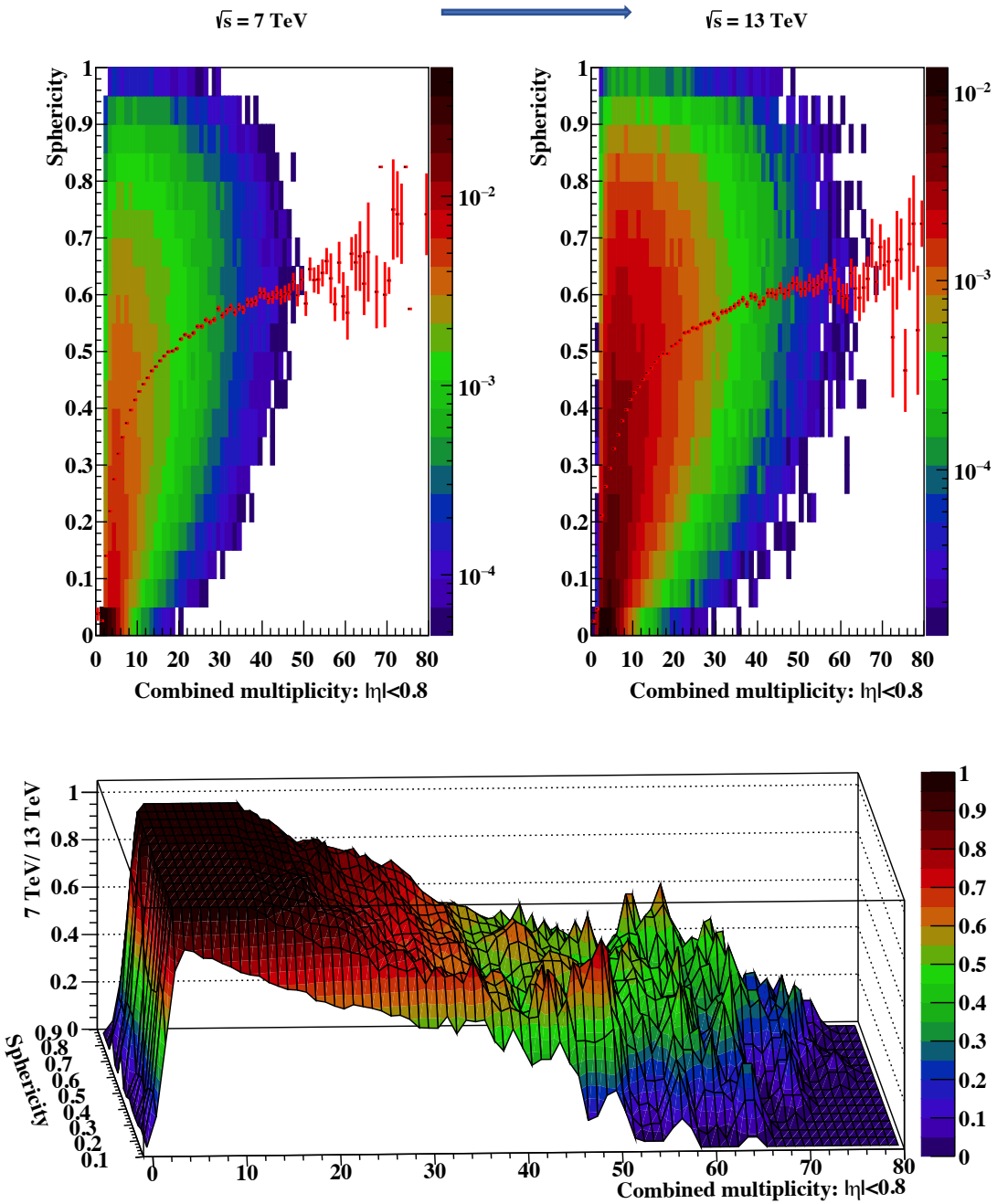


Extending the multi differential analysis:

- $\Delta\eta$ -$\Delta\varphi$

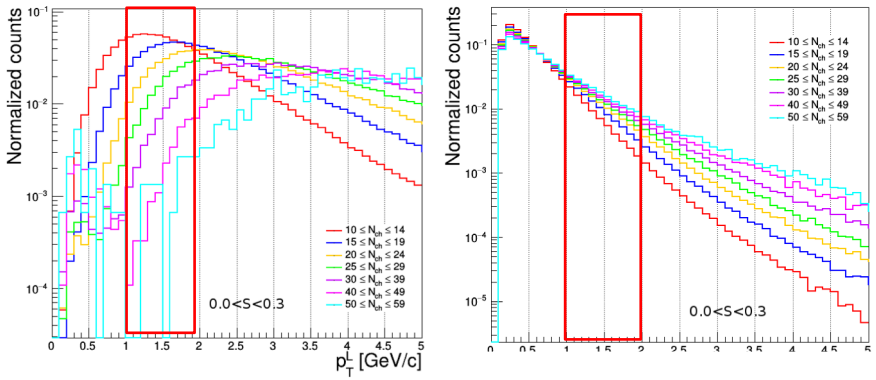
- PID

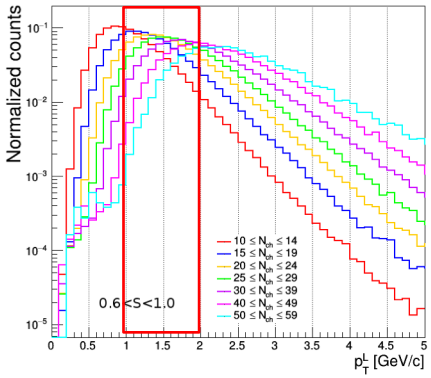
Why extending the Multi-differential analysis ?

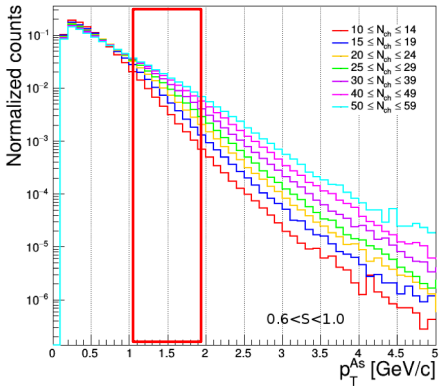


Two charged particles correlation pp collisions at 7 TeV

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







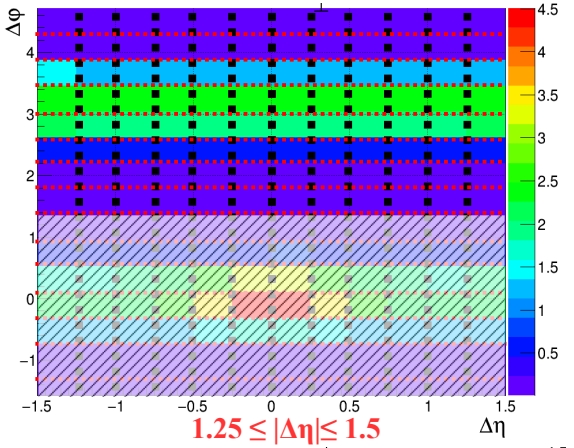
$$C(\Delta\eta,\Delta\varphi) = \frac{N_{pairs}^{mixed}}{N_{pairs}^{signal}} \frac{S(\Delta\eta,\Delta\varphi)}{B(\Delta\eta,\Delta\varphi)}$$

$$S(\Delta\eta,\Delta\varphi) = \frac{d^2 N_{pairs}^{signal}}{d\Delta\eta d\Delta\varphi} \qquad B(\Delta\eta,\Delta\varphi) = \frac{d^2 N_{pairs}^{mixed}}{d\Delta\eta d\Delta\varphi}$$

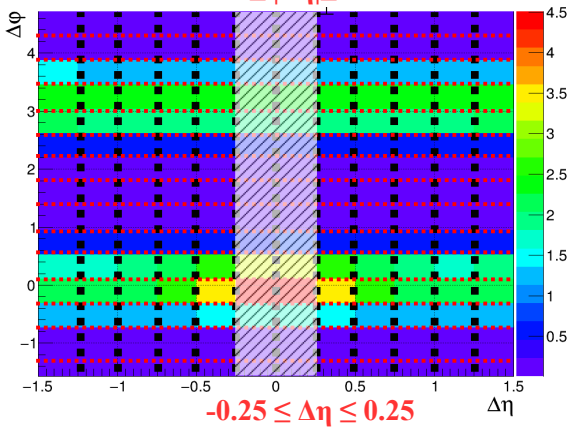
$$C(\Delta\eta,\Delta\varphi)_{Data}^{Corr} = \frac{C(\Delta\eta,\Delta\varphi)_{Gen}^{MC}}{C(\Delta\eta,\Delta\varphi)_{Rec}^{MC}} \cdot C(\Delta\eta,\Delta\varphi)_{Data}^{Raw}$$

$$C(\Delta\eta,\Delta\varphi) = C(\Delta\eta,\Delta\varphi)_{Data}^{Raw} \cdot Corr(\Delta\eta,\Delta\varphi)$$

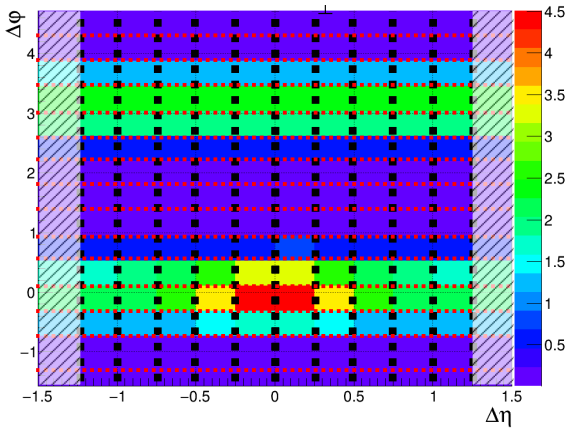
$-\pi/2 \le \Delta\varphi \le \pi/2$



$1.25 \le |\Delta\eta| \le 1.5$

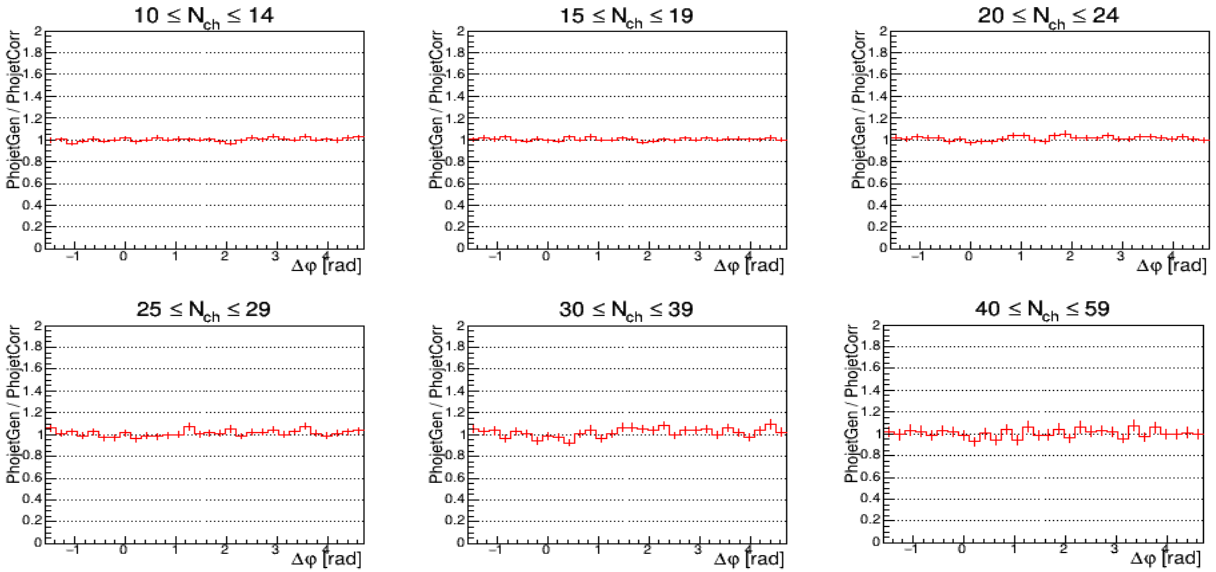


$-0.25 \le \Delta\eta \le 0.25$



Two charged particles correlation

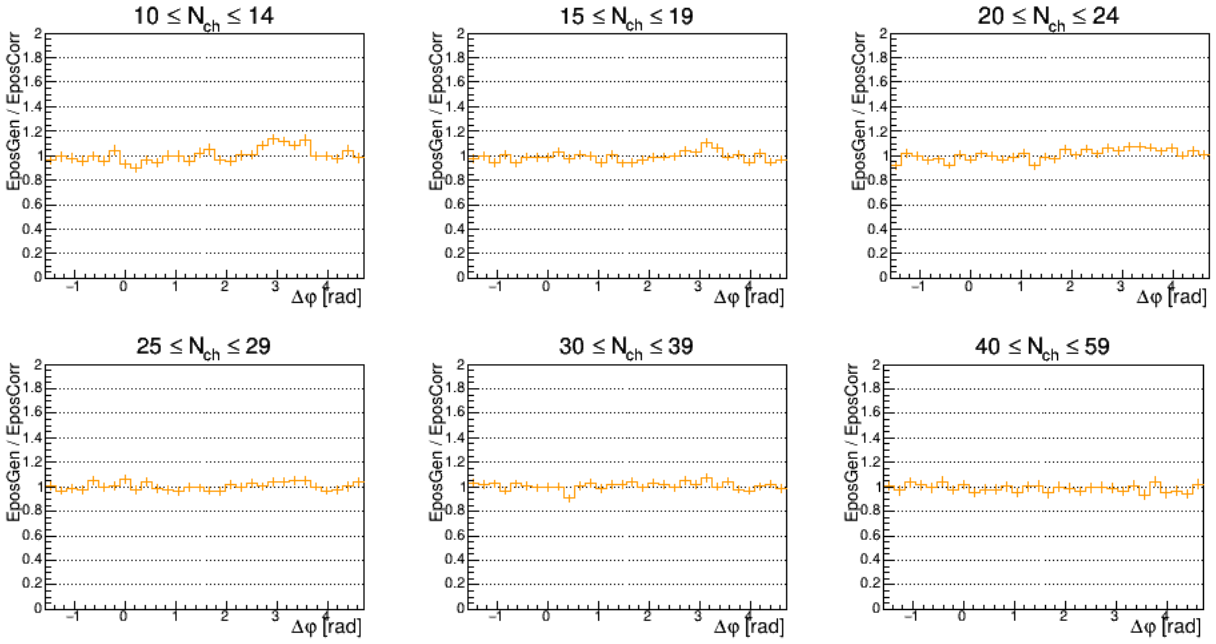
Closure test



PHOJET_Gen/PHOJET_Corr

$$C(\Delta\eta,\Delta\varphi)^{Corr}_{PHOJETrec} = C(\Delta\eta,\Delta\varphi)^{Raw}_{PHOJETrec} \cdot Corr(\Delta\eta,\Delta\varphi)$$

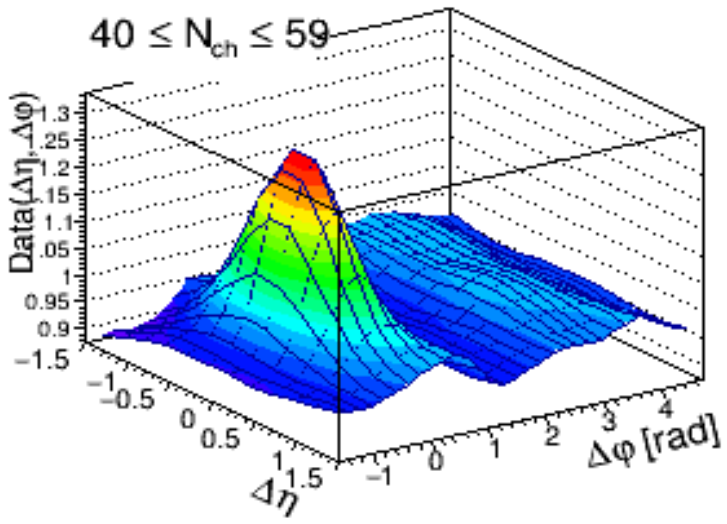
$$\frac{C(\Delta\eta,\Delta\varphi)_{PHOJETgen}}{C(\Delta\eta,\Delta\varphi)^{Corr}_{PHOJETrec}} \approx 1$$



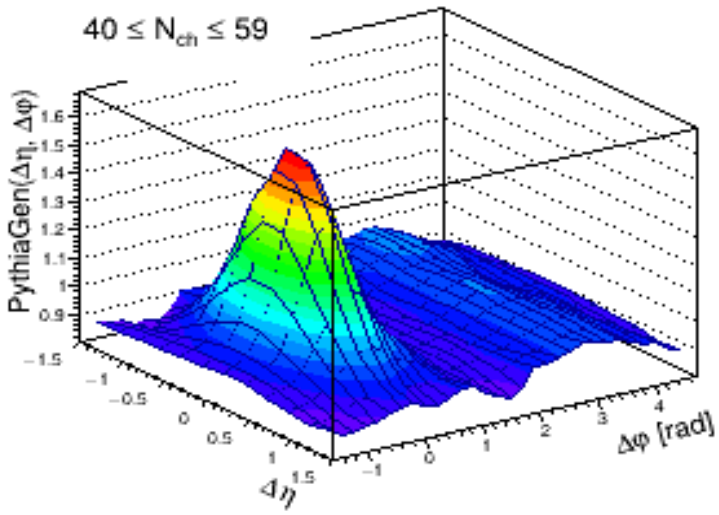
EPOS_Gen/EPOS_Corr

Two charged particles correlation

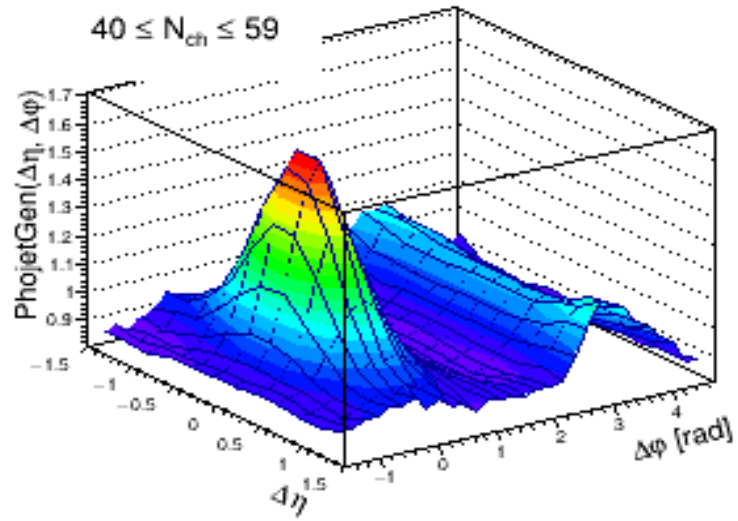
Data



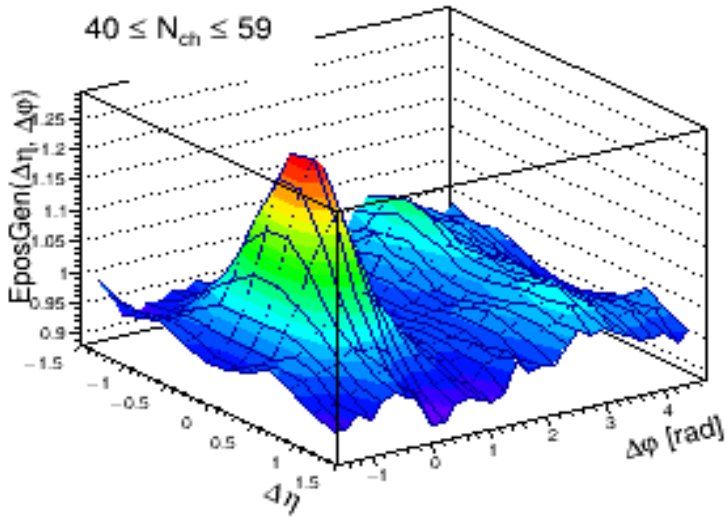
PYTHIA



PHOJET

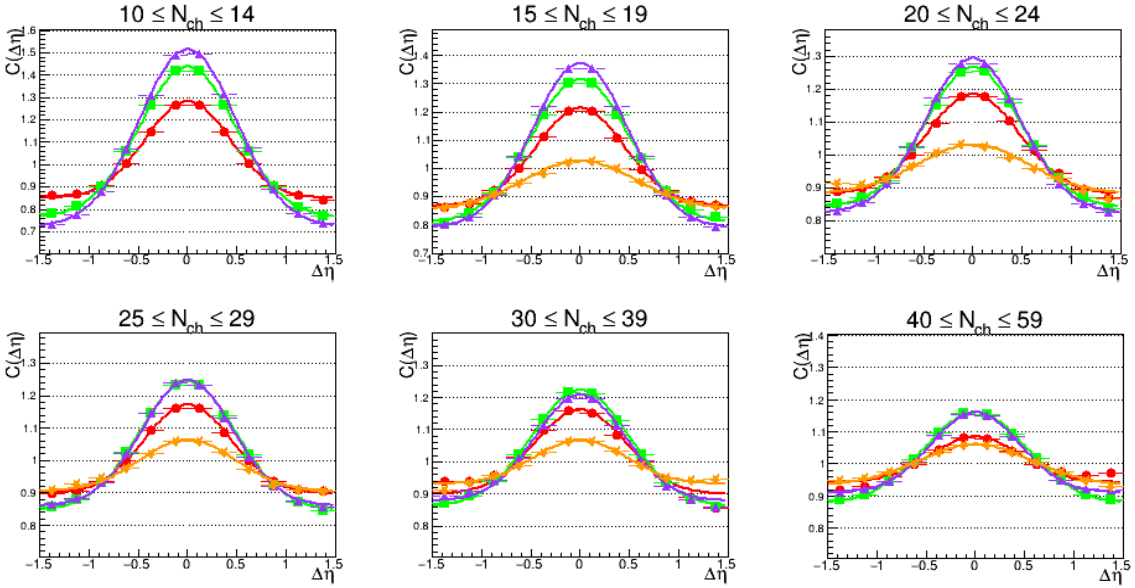


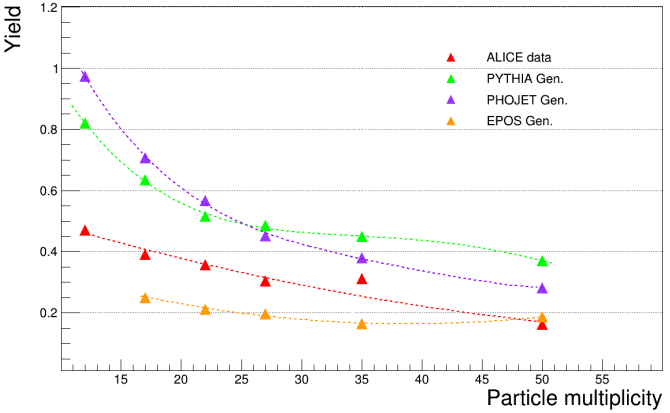
EPOS

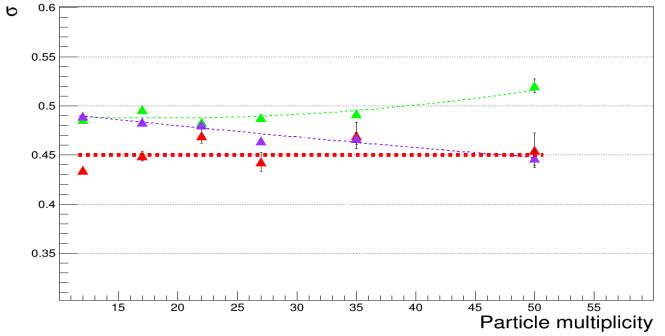


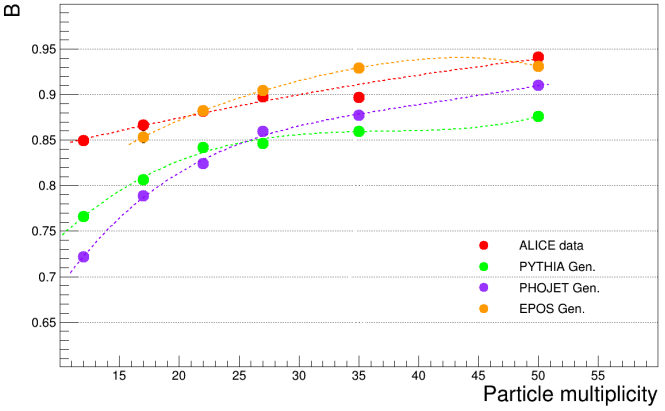
Two charged particles correlation
C(Δη) distributions

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









Corrected Data

PythiaGen

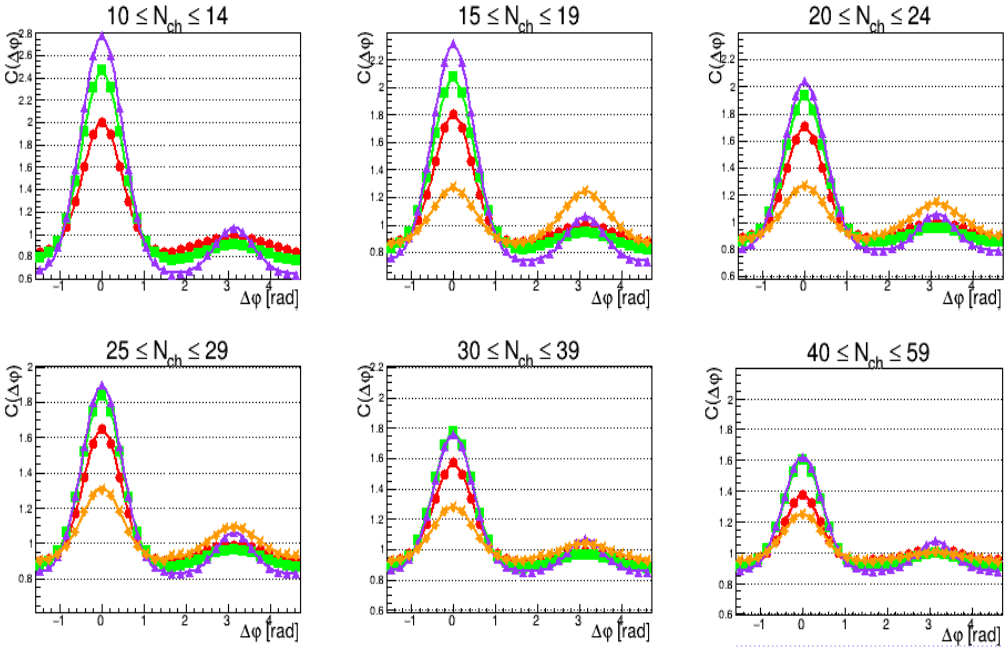
PhojetGen

EposGen

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

Two charged particles correlation
C(Δφ) distributions

$-0.25 \le \Delta\eta \le 0.25$



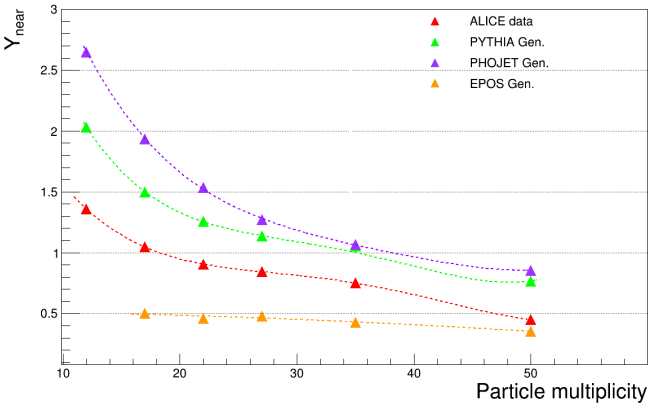
$$G(\Delta\varphi) = \frac{Y_{near}}{\sigma_{near}\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\varphi}{\sigma_{near}}\right)^2} + \frac{Y_{away}}{\sigma_{away}\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\Delta\varphi-\pi}{\sigma_{away}}\right)^2} + B$$

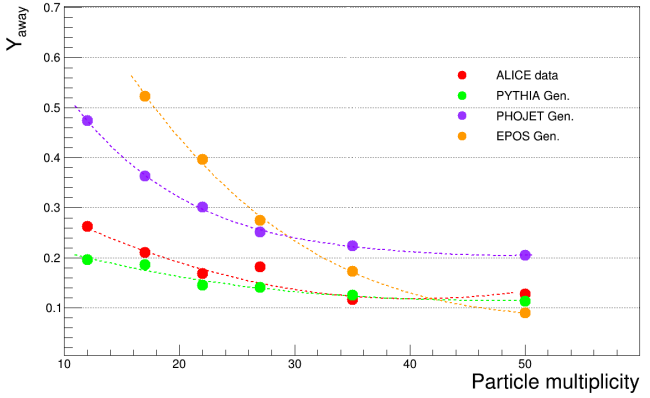
Corrected Data

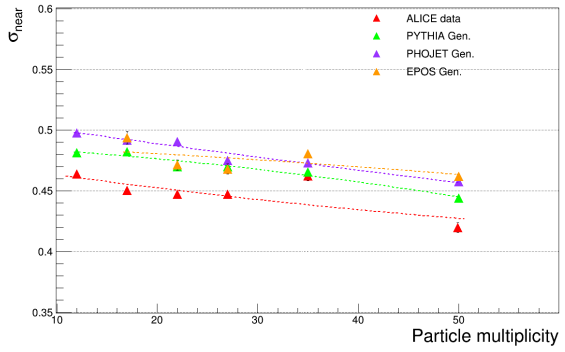
PythiaGen

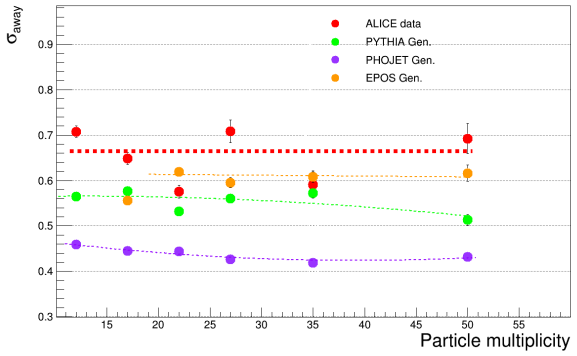
PhojetGen

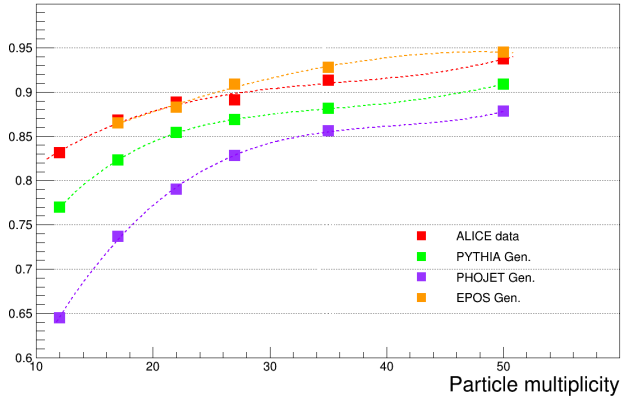
EposGen





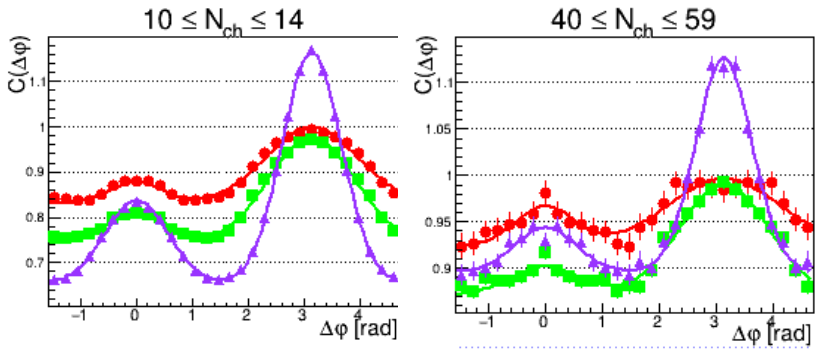


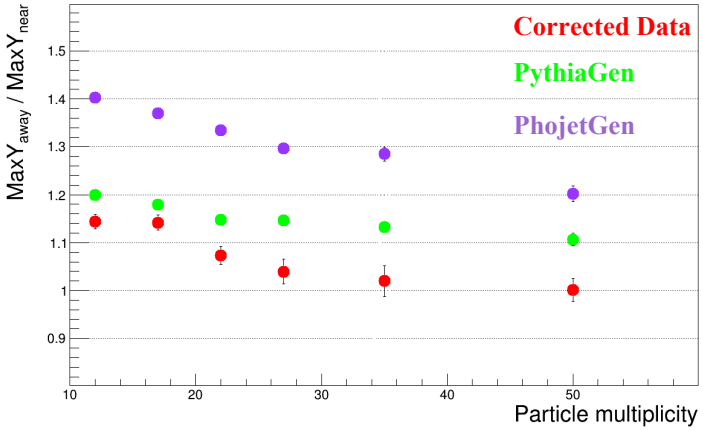


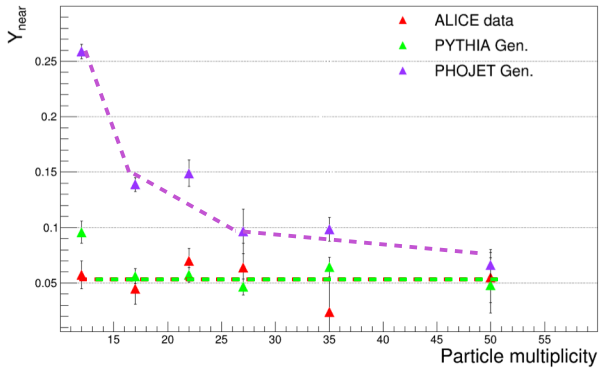


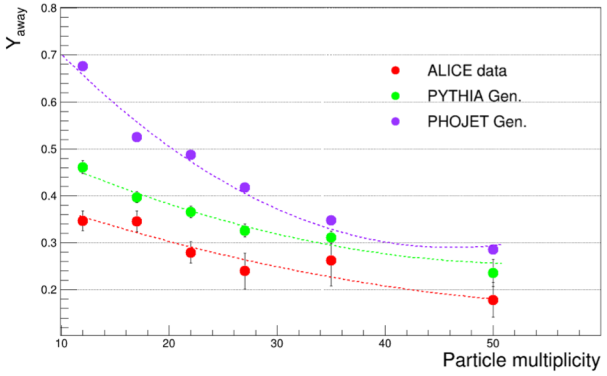
Two charged particles correlation
C(Δφ) distributions

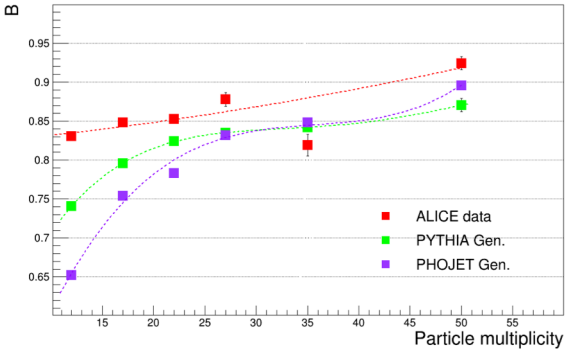
$1.25 \leq |\Delta\eta| \leq 1.5$

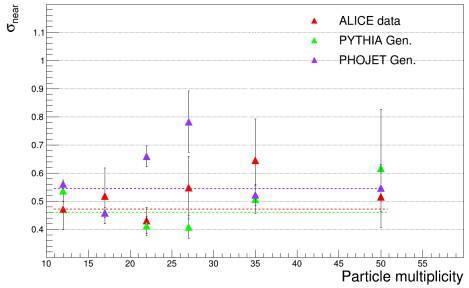


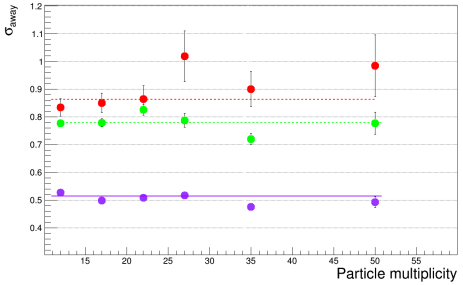






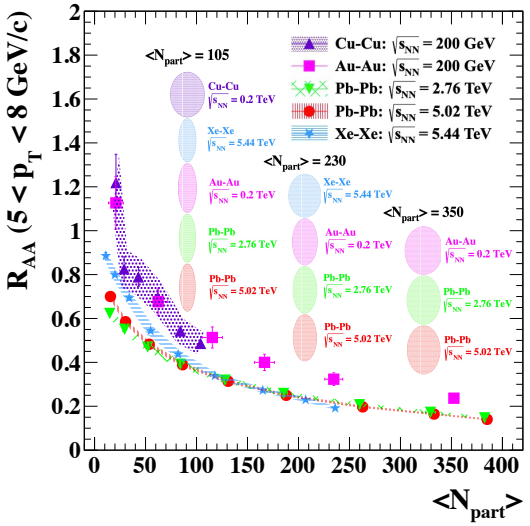


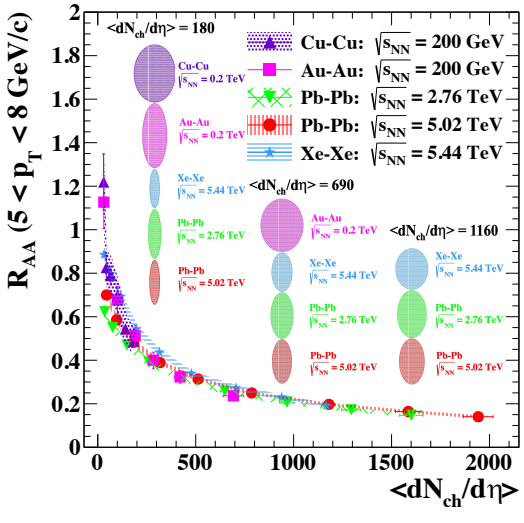




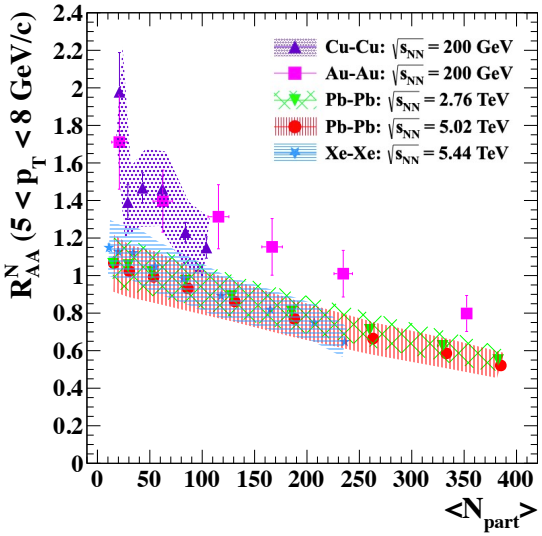
Considerations on charged particles suppression at RHIC and LHC energies

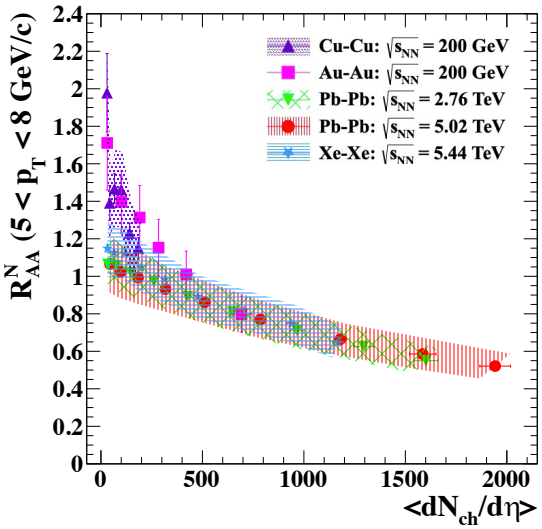
$$R_{AA} = \frac{\left(\frac{d^2N}{dp_t d\eta}\right)^{A-A}}{\left(\frac{d^2N}{dp_t d\eta}\right)^{pp}} \cdot \frac{1}{\langle N_{bin}\rangle^{A-A}}$$

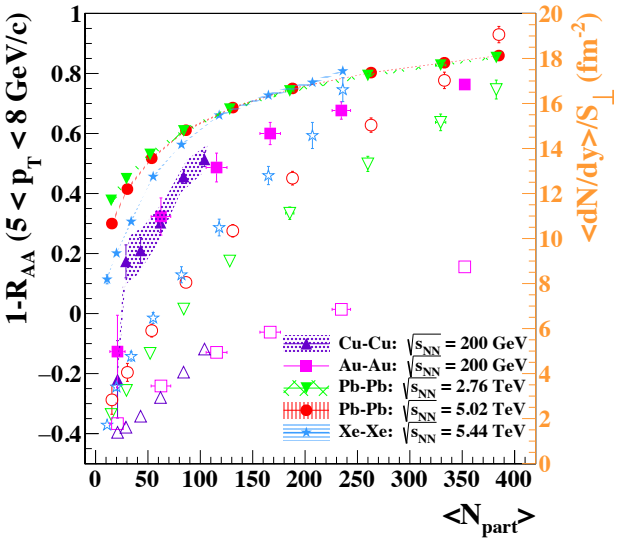




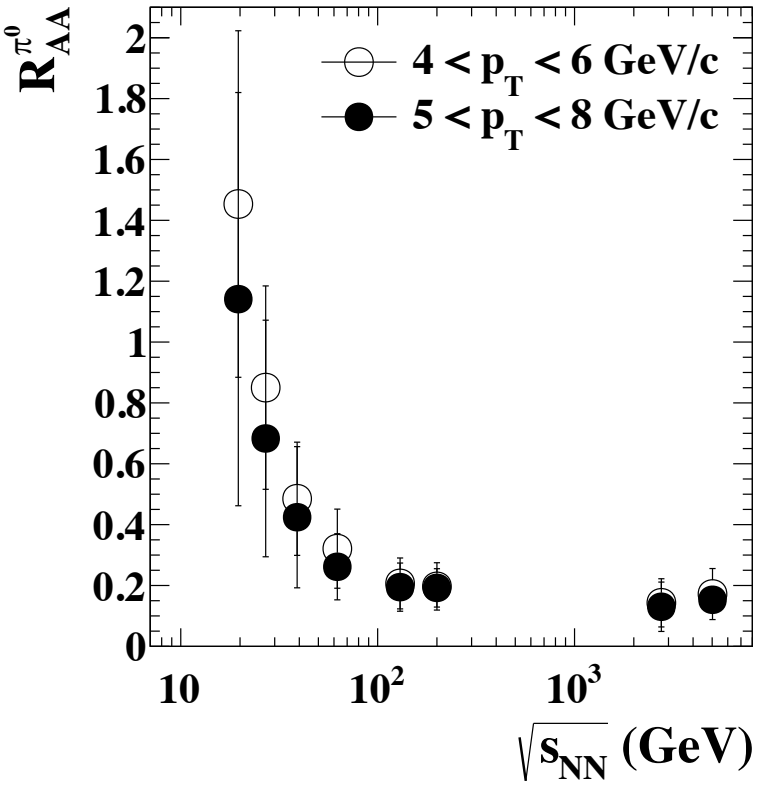
$$R^N_{AA} = \frac{\left(\frac{d^2N}{dp_T d\eta} / \frac{dN_{ch}}{d\eta}\right)^{A-A}}{\left(\frac{d^2N}{dp_T d\eta} / \frac{dN_{ch}}{d\eta}\right)^{pp}}$$

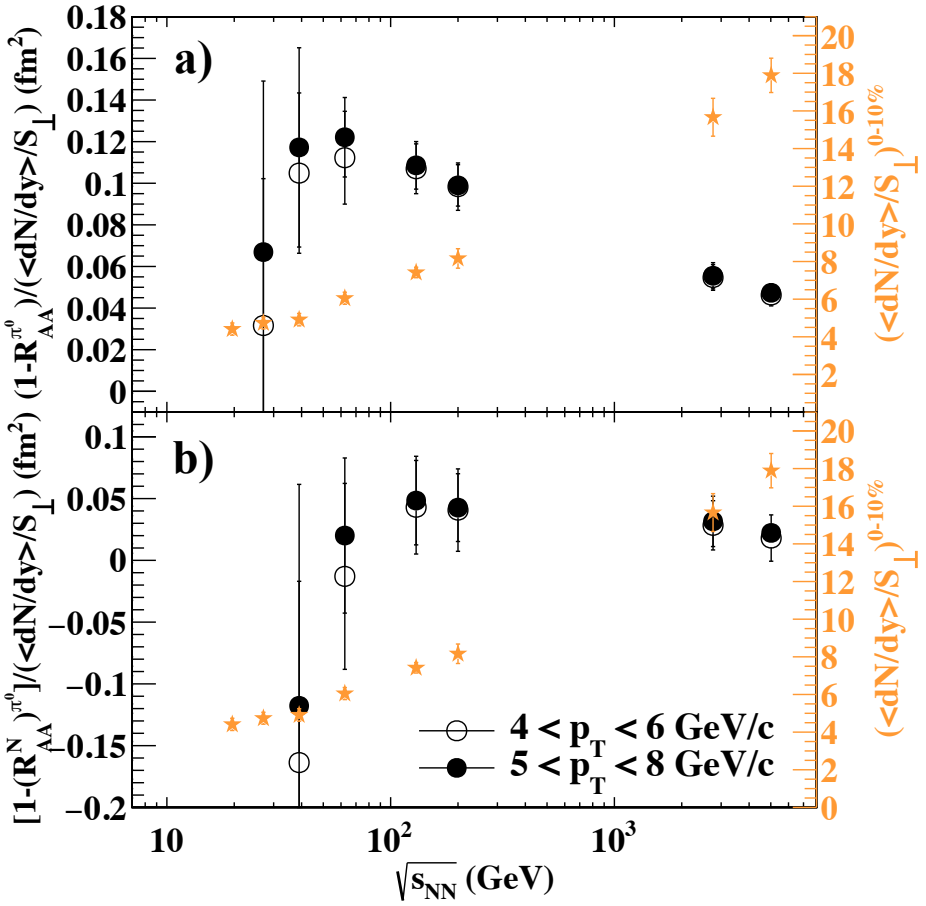




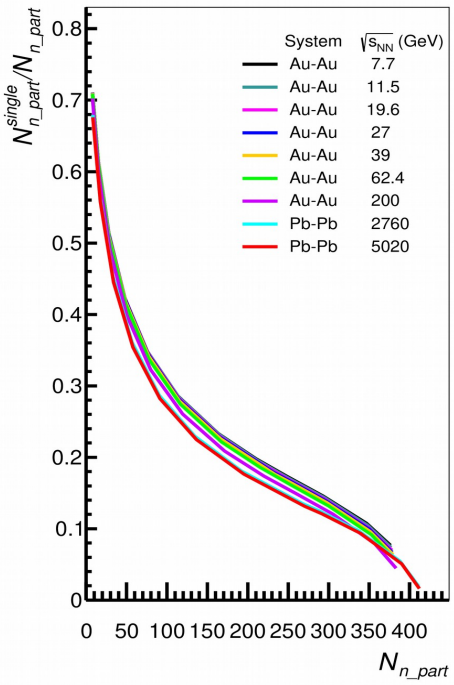


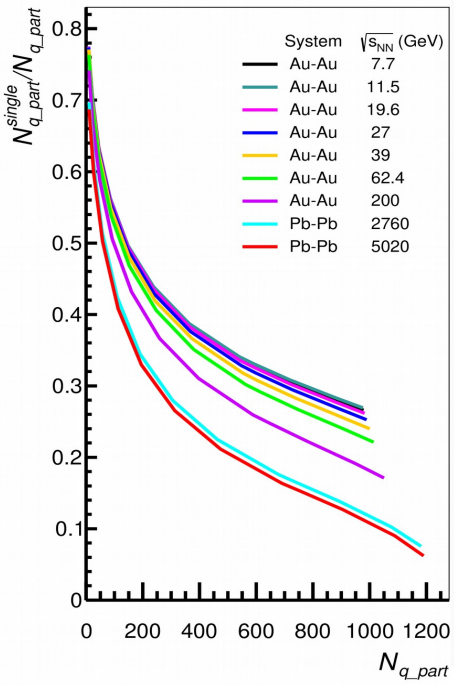
Considerations on charged particles suppression at RHIC and LHC energies

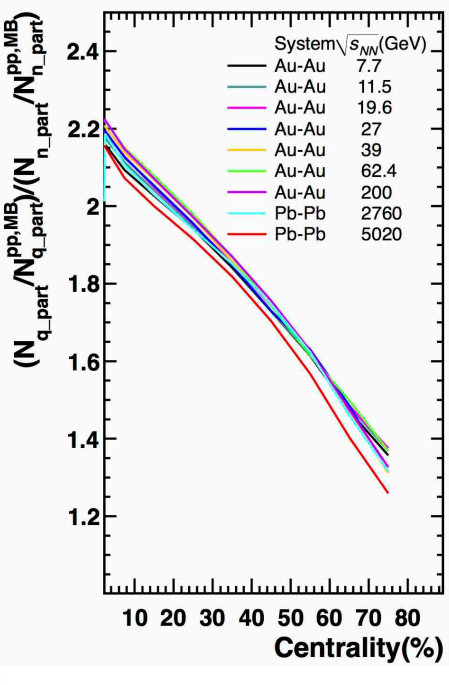


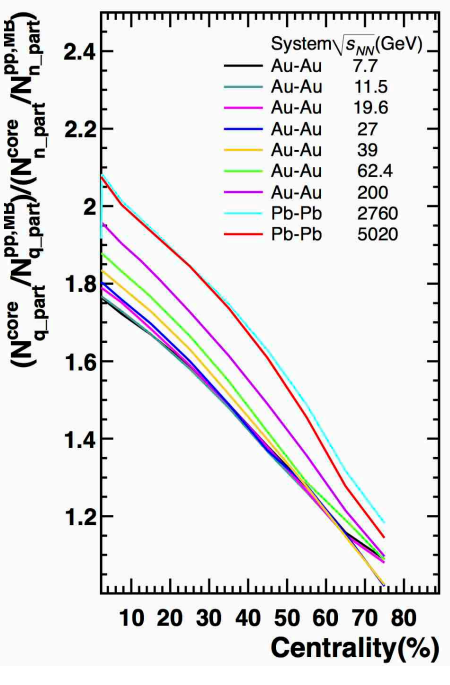


Core-Corona
Glauber-MC - wounded nucleon vs. wounded parton approach





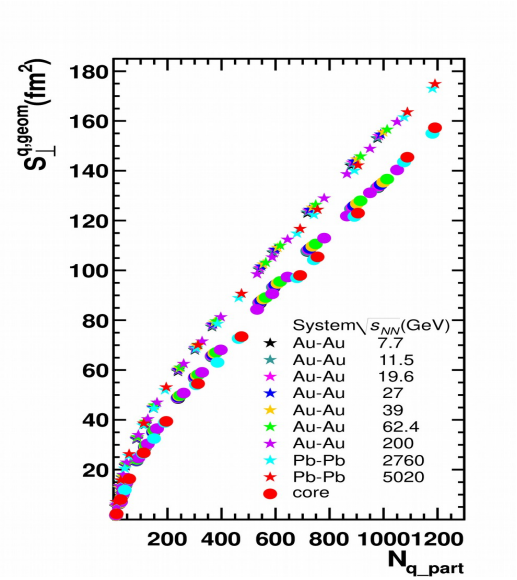


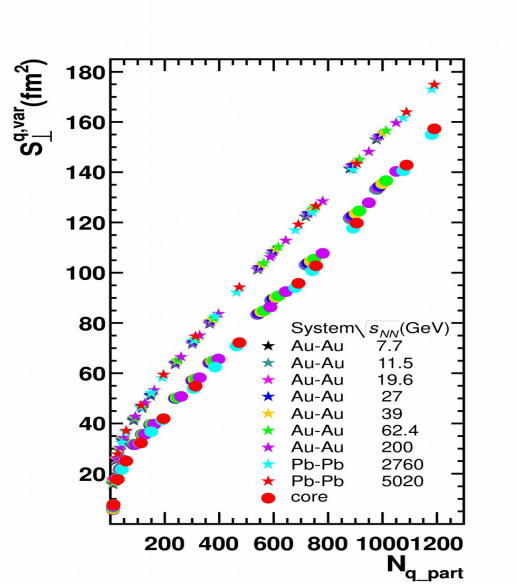


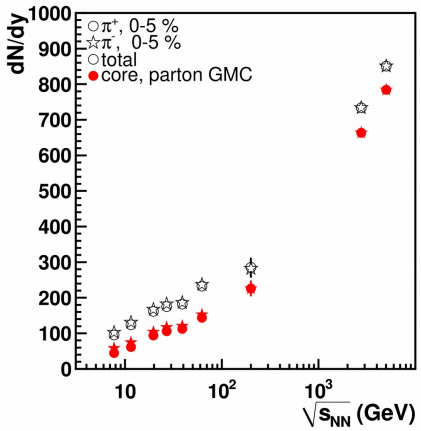
GLISSANDO 3
P.Bozek, W.Broniowski, M.Rybczynski, G.Stefanek, Comp.Phys.Comm. 245(2019)106850

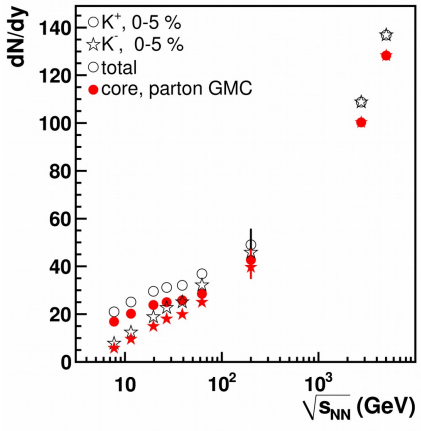
Core-Corona

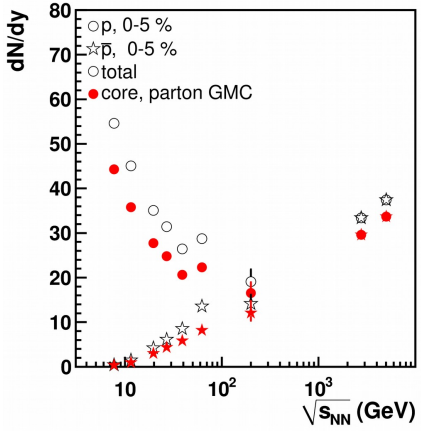
Glauber-MC - wounded nucleon vs. wounded parton approach

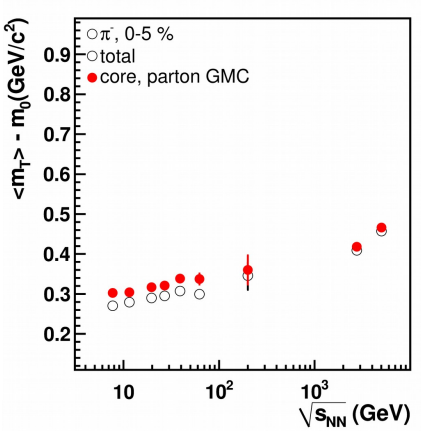


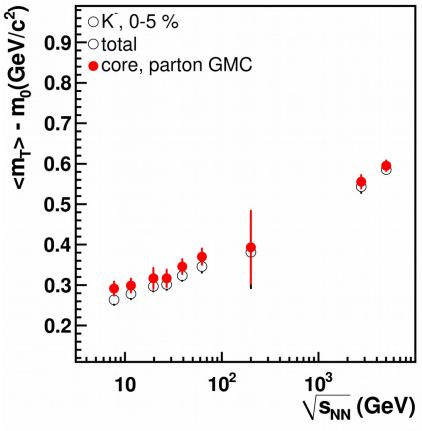


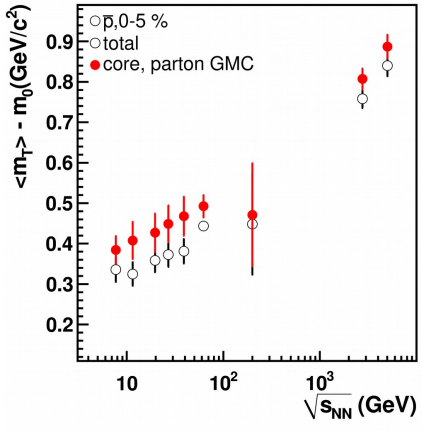






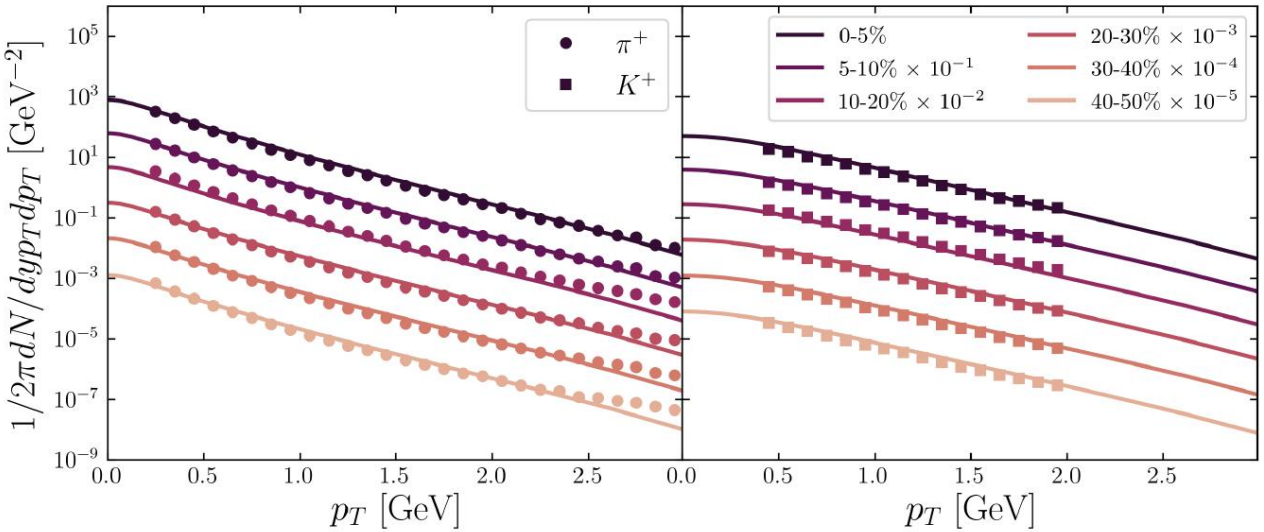




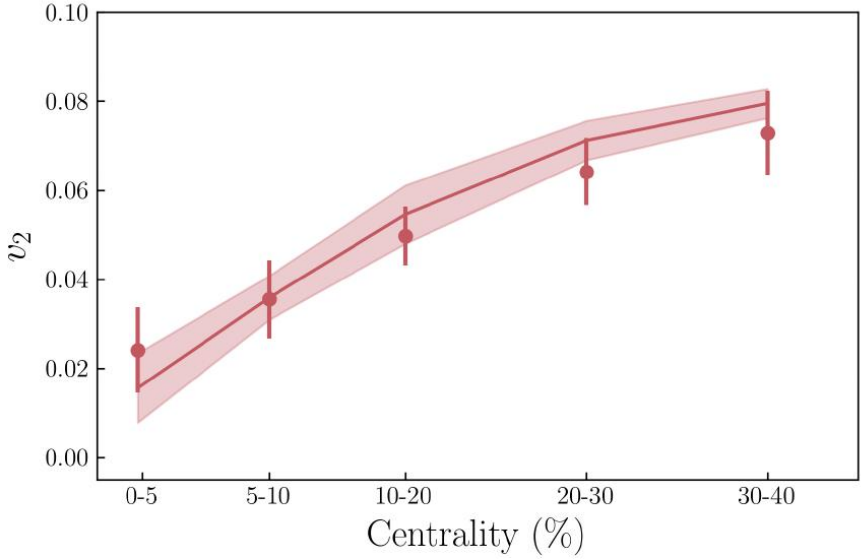


Hybrid simulations of relativistic heavy ion collisions
Au-Au 200 GeV

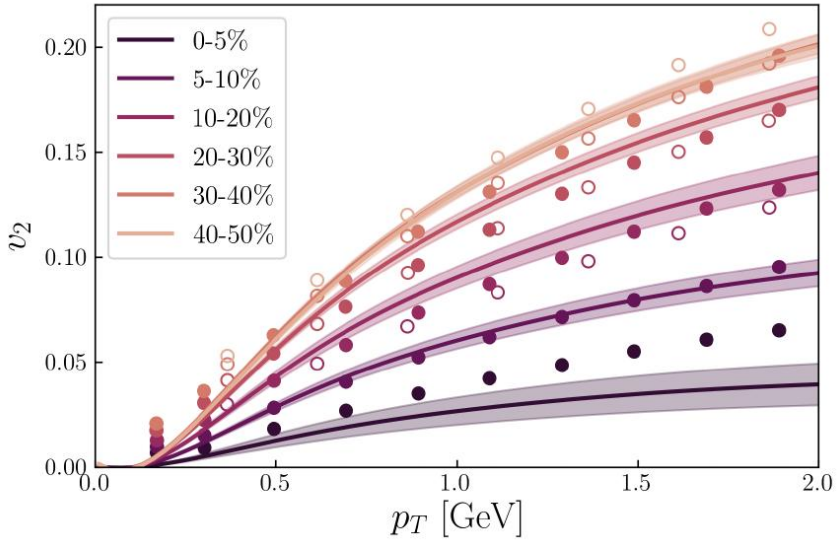
- *Curraun - a Python based code for computing Glasma field*
- *coupled to MUSIC - C++*



S.Adler et al., Phys.Rev. C69(2004)034909



B.Abelev et al., Phys.Rev. C77(2008)054901



A.Adare et al., Phys.Rev.Lett. 107(2011)252301
J.Adams et al., Phys.Rev. C72(2005)014904

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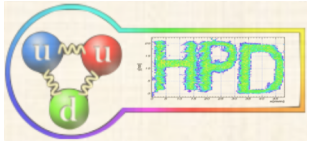
What's really new at LHC energies ?

C. Andrei, D. Avramescu, I. Berceanu, A. Bercuci, A. Herghelegiu, A. Lindner, A. Pop, C. Schiaua, M. Tarzila

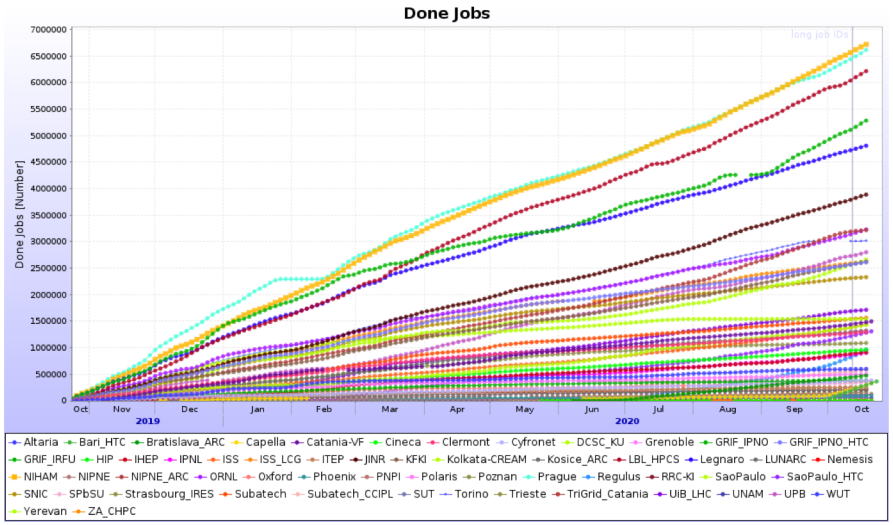
Continuation of the presentation made in Spectra PAG , September 16, 2019 (attached as backup slides)

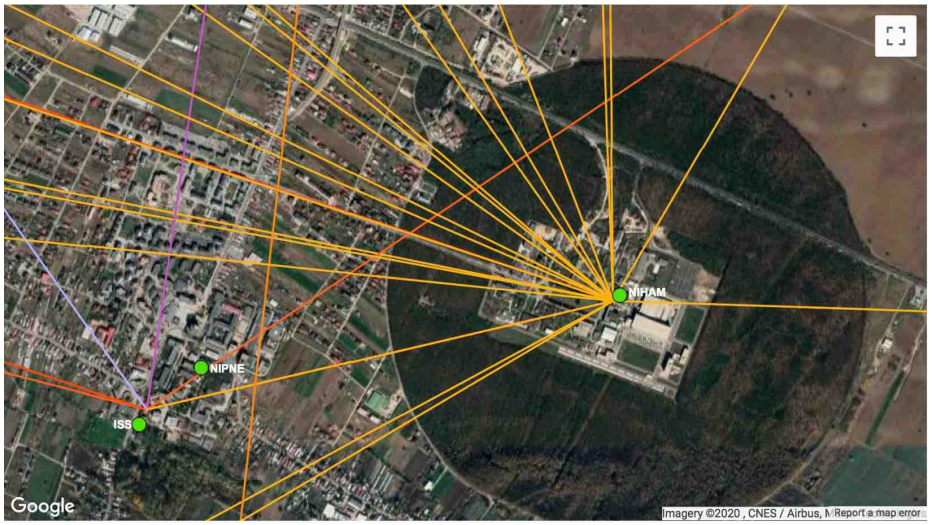
https://twiki.cern.ch/twiki/pub/ALICE/PWGLFPAGSPECTRA/InternalNote_pp_14TeV_220819.pdf

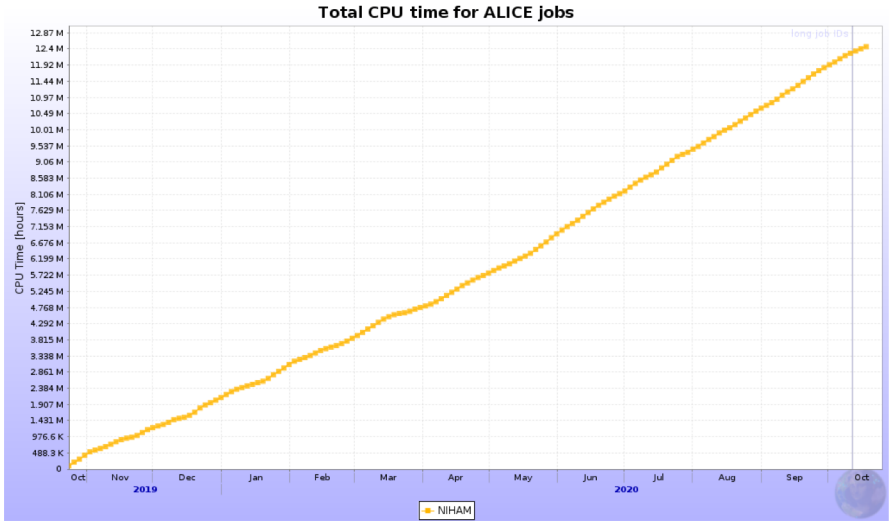
HADRON PHYSICS DEPARTMENT



NIHAM Data Centre







Contribution to ALICE GRID

Done jobs - NIHAM:

- $6.7 \cdot 10^6$
- *4.7 % of total Tier2 ALICE contribution*

CPU:

- *6.6 Mhours 12.46 Mhours*
- *4.2 % of total Tier2 ALICE contribution*

New UPS stations - in progress

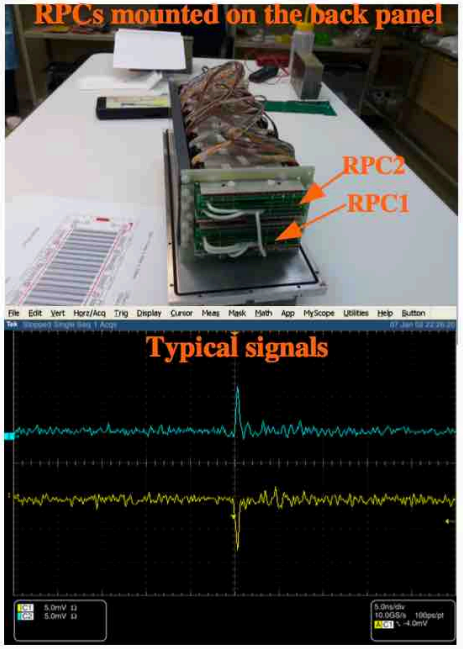
Remarks on additional activities

Assembling and tests of 2x2 new RPC prototypes

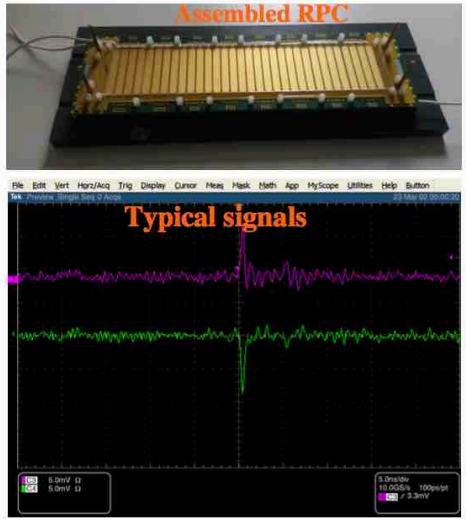
In mCBM

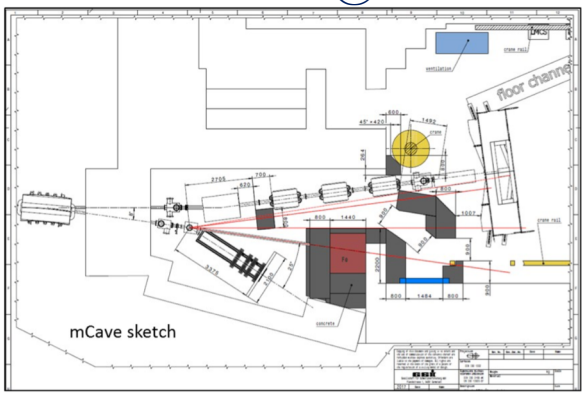
FAIR Phase0 @ SIS18

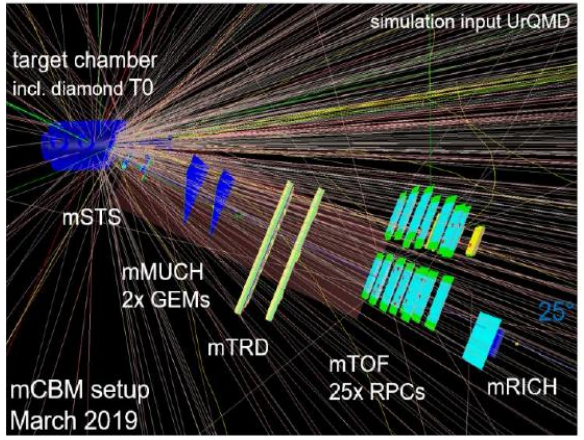
low resistivity Chinese glass – RPC2019



low resistivity CERN float glass – RPC2020







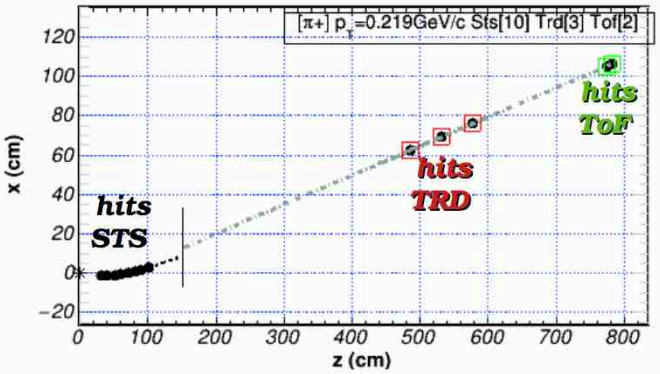
Efficiency Bucharest counter

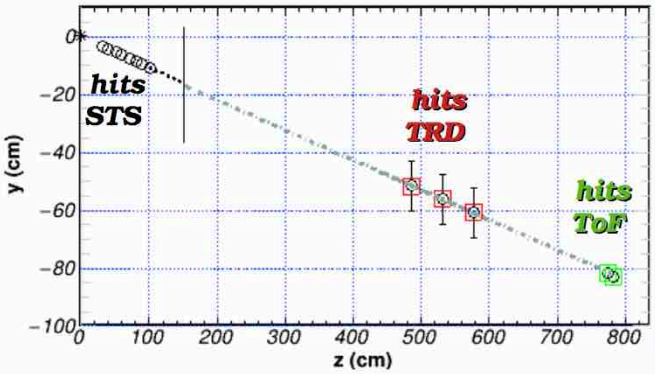
Efficiency	Gap 140 µm	Gap 200 µm
PADI X	81 %	93 %
PAD XI	92 %	98 %

TRD - tracking performance

TRD-2D seeding:

- can be done with at least 2 hits
- x-y resolution independent of missing station !



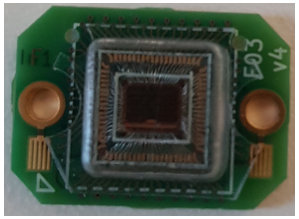


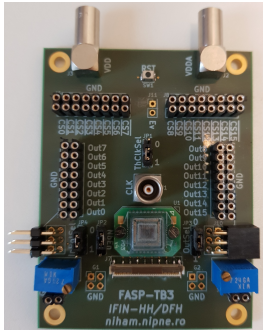
TRD-2D seeding:

- can seed STS residual hits
- can extend/complement STS seeding for ToF hit attachment (see next slide)

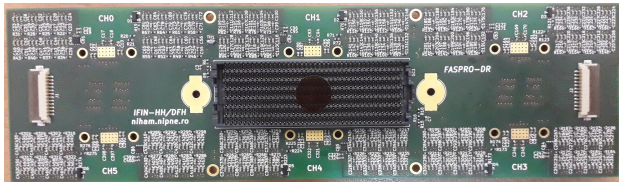
Readout chain, Hardware status

FASP:
- ~40 already bonded, need individual testing.
- 190 dies available, need bonding
- bonding board and testing boards are designed and tested

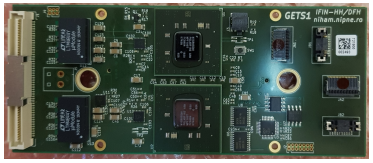




FASPRO:
- 9 boards available, need individual testing.
- components available for another ~20 boards.

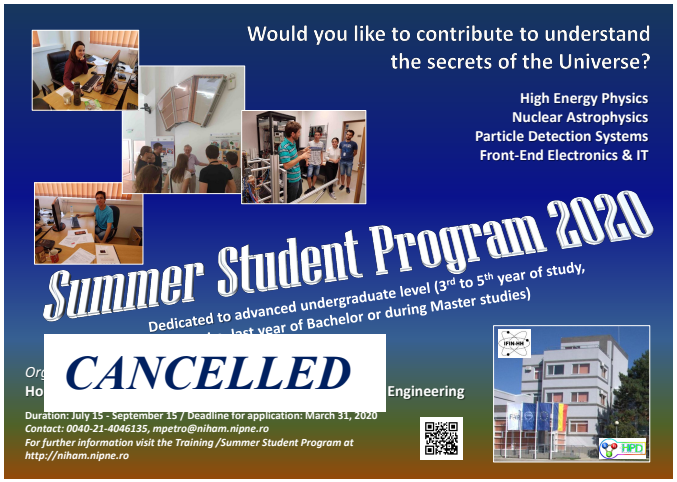


GETS:
- 10 boards available, need individual testing.
- components available for another ~20 boards

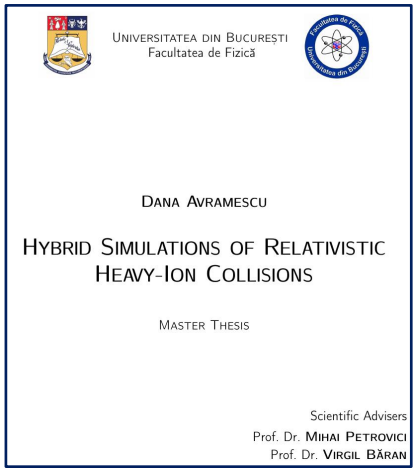


Adapter boards (GETS→SATA, SATA→ CROB):
passive boards, available for connecting 30 GETS.

Training & teaching

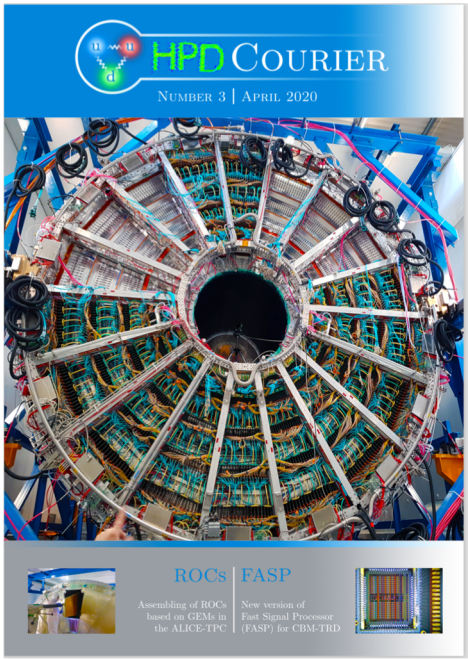


Master Thesis



Outreach

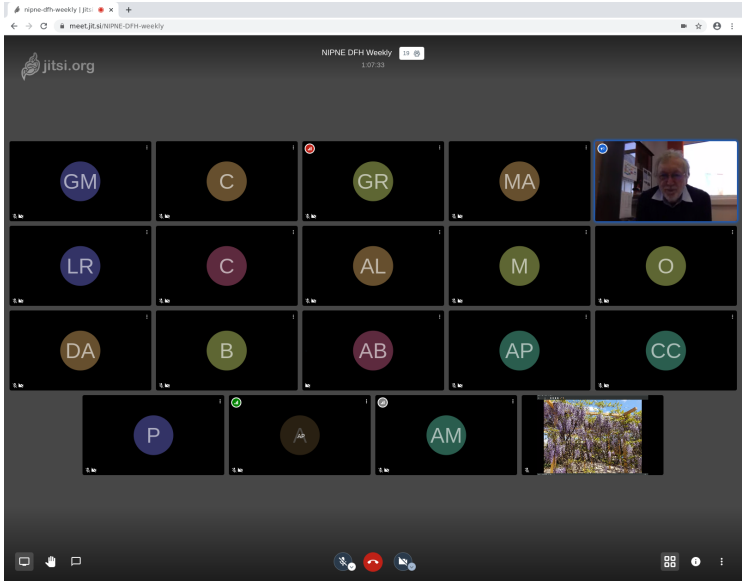
https://niham.nipne.ro/HPD_Courier.html



Last Party before Covid

Meetings and visits in these special pandemic circumstances

March-April 2020



"The only way to make progress
is to defy one of those prohibitions that are
uncritically accepted without good reasons"
(M. Gell-Mann)

Thank you !

https://niham.nipne.ro
https://www.youtube.com/watch?v=OJd4fA0xUh0
https://www.facebook.com/Hadron-Physics-Department-211078852968333/