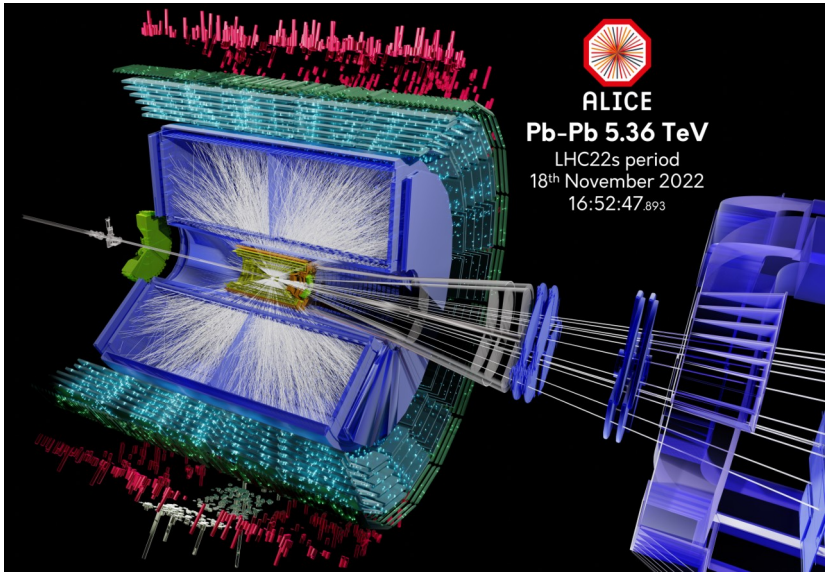
ISS contributions to ALICE physics, computing and hardware (ISSconALICE)

A. Dobrin (Team/Project Leader)

- Accomplishments from last meeting
- Physics highlights
- Summary



Accomplishments from last meeting

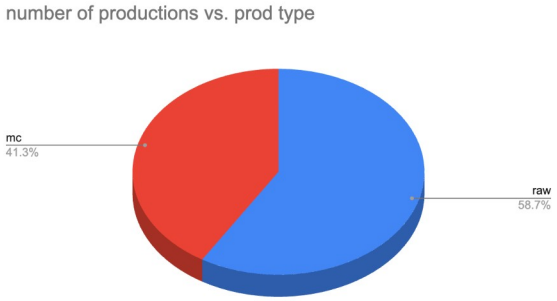
Papers / presentations

- Papers
  - *"Limits on chiral magnetic effect from event shape engineering and participant-spectator correlation techniques in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV"*, in Collaboration Round 2
    - Paper members: *A. Danu, A. Dobrin et al. (6 authors)*

- Presentations
  - 2nd Latin American Workshop on Electromagnetic Effects in QCD, Santiago, Chile
    - *"Searches for effects of the electromagnetic fields with ALICE"*, A. Dobrin – invited talk
  - 6th Workshop on Nonperturbative Aspects of QCD, Valparaiso, Chile
    - *"Searches for effects of the electromagnetic fields with ALICE"*, A. Dobrin – invited talk
  - Quark Matter 2025, Frankfurt, Germany
    - "*Investigating small collision system properties using balance functions*", A. Manea – poster
  - Various presentations in ALICE meetings

PDP, GRID, ALICE roles

- **Physics and Data Processing (PDP)**
  - Institutional responsibility for central processing of RAW data reconstruction and Monte Carlo (MC) simulations → Data Preparation Group (DPG) coordinator



- Productions (383 completed)
  - 60% RAW data
  - 40% MC

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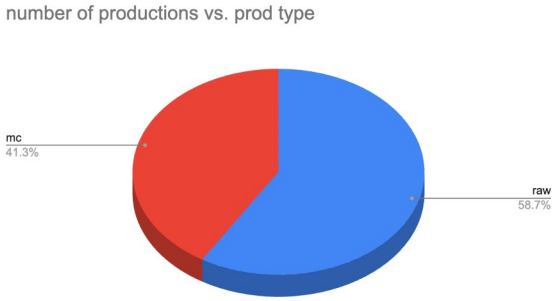

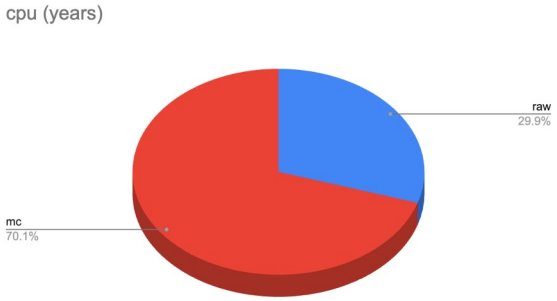

- Productions (383 completed)
  - 60% RAW data
  - 40% MC
- CPU time (50500 years)
  - 30% RAW data
  - 70% MC

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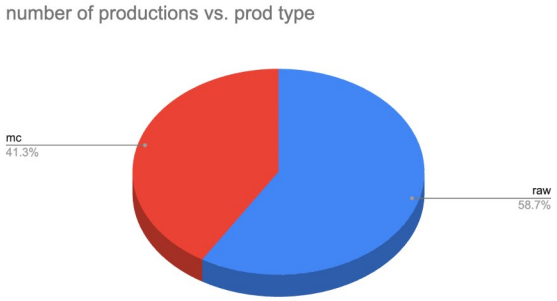

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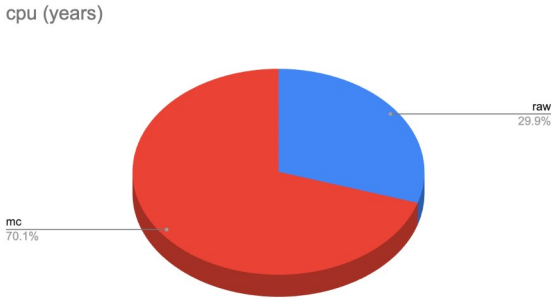

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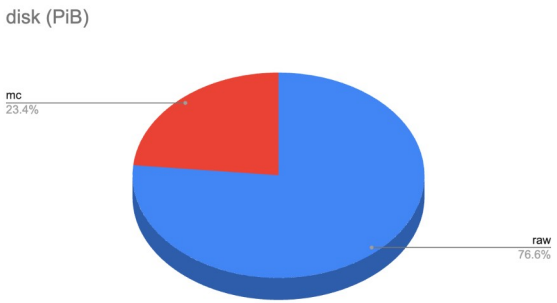
  - 70% MC



- Disk usage (~20 PiB)
  - 75% RAW data
  - 25% MC

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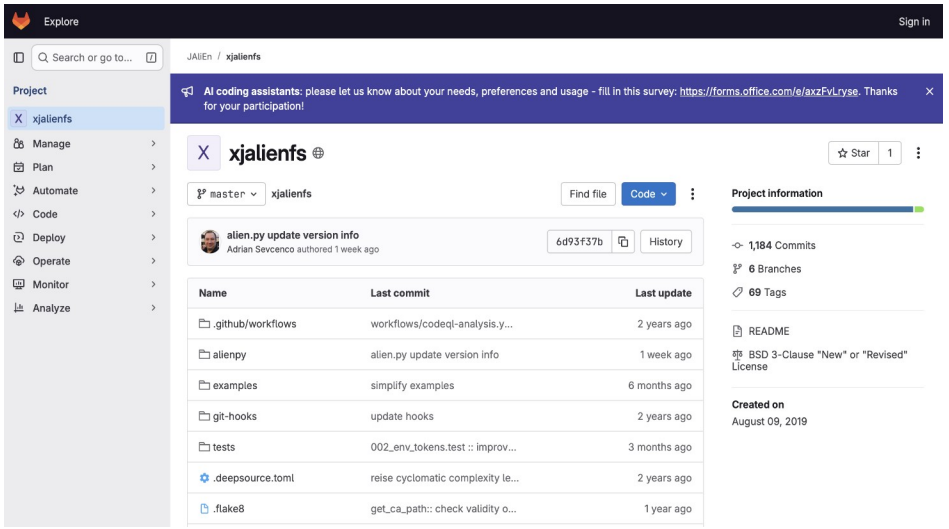
  - Development and support of GRID python client alien.py → default tool to access ALICE GRID

- alien.py (xjalienfs module)
  - Bug fixes and features + library developments
    - 6 releases / 73 commits
  - Tight communication with XRootD developers



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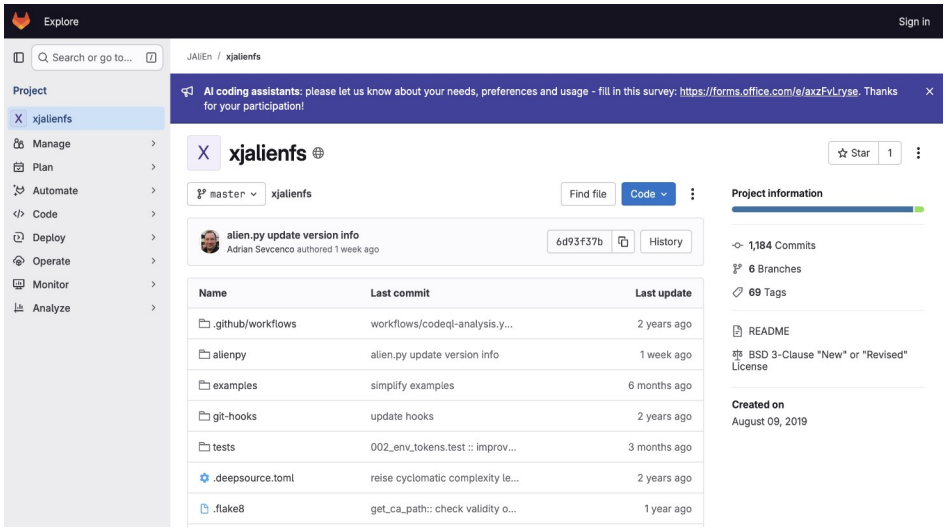
- alien.py (xjalienfs module)
  - Bug fixes and features + library developments
    - 6 releases / 73 commits
  - Tight communication with XRootD developers

- Repackage of ALICE dependencies for XRootD
  - Various ALICE Grid sites migrated to XRootD v5
    - Support for sites upgrading to v5



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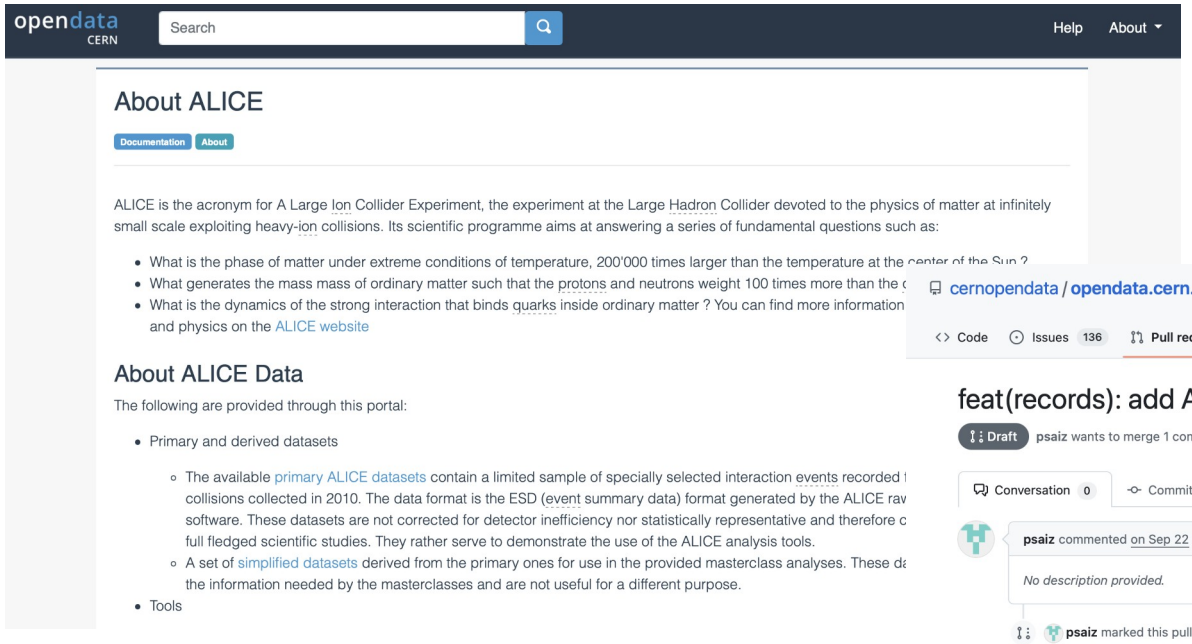

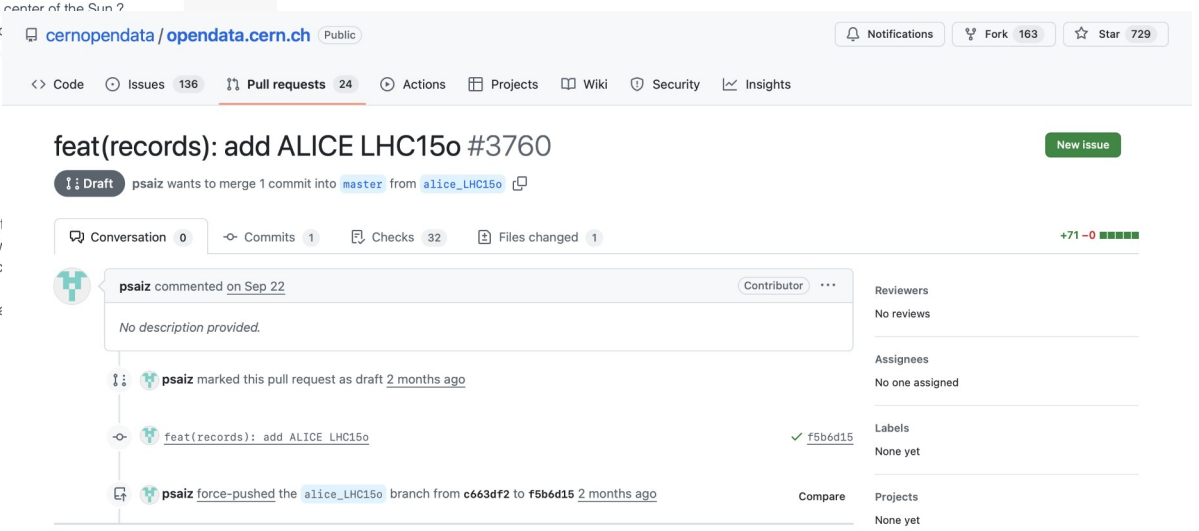

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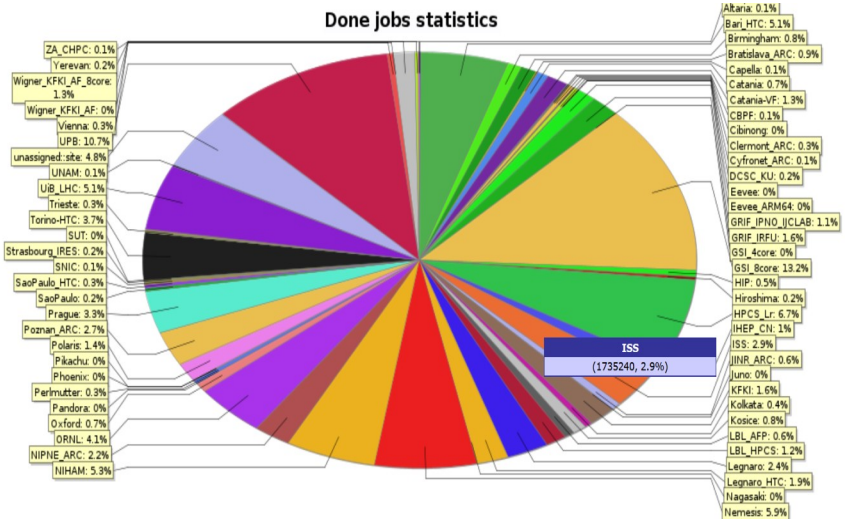
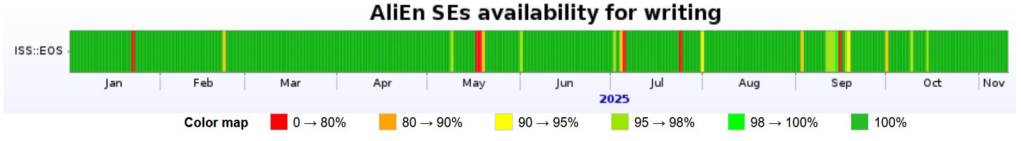
- **GRID**
  - High computing contribution/cost ratio
  - ~1.73M DONE jobs, >98% availability, ~60 PB data transfer
    - 18.1% of CPU time and 13.8% DONE jobs from Romanian contribution



Disk storage elements

ISS

	AliEn SE		Catalogue statistics (1024-base units)						Storage-provided information (1024-base units)					
SE Name	AliEn name	Tier	Size	Used	Free	Usage	No. of files	Type	Size	Used	Free	Usage	Version	EOS Version
1. ISS - EOS	ALICE::ISS::EOS	2	6.028 PB	5.526 PB	514.3 TB	91.67%	83,447,760	EOS	5.92 PB	5.474 PB	456.4 TB	92.47%	Xrootd 5.8.4	5.3.2
Total			**6.028 PB**	**5.526 PB**	**514.3 TB**	**91.67%**	**83,447,760**		**5.92 PB**	**5.474 PB**	**456.4 TB**	**92.47%**		



Statistics

Link name	Data		Individual results of writing tests			Overall
	Starts	Ends	Successful	Failed	Success ratio	Availability
ISS::EOS	01 Jan 2025 15:21	10 Nov 2025 15:42	7438	105	98.61%	98.65%

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- **ALICE roles**
  - Member of Editorial Board
  - Coordinator of DPG; coordinator of the ALICE Open Data group
  - Members in 2 Internal Paper Review Committees
  - Institutional review of 2 ALICE papers

Outreach, Education, Collaboration

- **Outreach**
  - “ALICE MasterClass” – DUROCERN, Magurele
  - “Different School: Know more, be better!”, middle/high school students – ISS, Magurele
  - European Researchers’ Night – Bucharest & Magurele
  - AstroFest – Bucharest
  - O-O/Ne-Ne collisions – ALICE ACR, CERN


DESCOPERIRI CARE SCHIMBĂ VIITORUL

„Să fiu în sala de control ALICE chiar în timpul achizițiilor de date de la ciocnirile oxigen-oxigen e o experiență unică – simți că ești martor direct la cum se scrie o nouă pagină în domeniul fizicii energiilor înalte

Dr. Andreea Danu, cercetătoare la Institutul de Științe Spațiale

https://home.cern/

ACCELERATORUL LHC

În tunelul de 27 de km al acceleratorului LHC (Large Hadron Collider) de la CERN s-au ciocnit pentru prima dată protoni și ioni de oxigen, oferind posibilitatea unei game largi de cercetări, de la studiul razelor cosmice până la cel al ciocnirii primordiale Big Bang, ce a dus la nașterea Universului nostru.

EXPERIMENTUL ALICE

Cercetători români, din camera de control a experimentului ALICE, au contribuit la acest moment important, afirmând contribuția semnificativă a României pentru cercetare și dezvoltare.

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DESCOPERIRI CARE SCHIMBĂ VIITORUL

România la granițele Universului: Ciocniri de oxigen la CERN

Experimentul ALICE recreează *mici Big-Bang-uri*, la care iau parte cercetători români

În perioada 29 iunie–9 iulie 2025, la Large Hadron Collider (LHC) de la CERN are loc o noutate experimentală, constând în primele ciocniri proton–Oxigen (p–O) și Oxigen–Oxigen (O–O), urmate de o zi de ciocniri Neon–Neon (Ne–Ne). Aceste ciocniri au recreat condițiile extreme ale materiei de la câteva microsecunde după Big Bang, în special plasma de quarci și gluoni (QGP) – o stare a materiei în care quarcii și gluonii, particulele fundamentale, existau libere, neconstrânse de forța tare. Pentru domeniul fizicii ionilor grei, acest eveniment a reprezentat un moment de referință. Pentru România, a fost o confirmare a contribuției sale la unul dintre cele mai impresionante experimente științifice ale epocii noastre.

Campania din 2025 reprezintă o etapă unică în programul de la LHC. Spre deosebire de ciocnirile proton–proton sau Plumb-Plumb (Pb-Pb), ciocniri ce fac parte din programul de baza al CERN, ciocnirile p-O, O-O si Ne-Ne vor completa lipsa de informație despre nucleele intermediare si comportarea lor in ciocnirile relativiste.

„Prin activitățile noastre ne propunem să transformăm cercetarea într-un demers deschis, colaborativ și relevant pentru societate.

O campanie istorică pentru fizica ionilor grei

Între 29 iunie și 1 iulie, timp de două zile, ciocnirile p–O au reprezentat o provocare tehnică majoră datorită diferențelor în raportul de sarcină–masă dintre protoni și ioni de oxigen, necesitând ajustări precise ale frecvenței și impulsului fasciculelor pentru a asigura ciocniri exacte în centrul experimentelor ALICE, ATLAS, CMS și LHCb.

Între 2 și 4 iulie, ciocnirile O–O, o premieră pentru datele experimentale, vor permite studierea plasmei de quarci și gluoni în sisteme mai compacte decât cele create prin ciocniri Pb–Pb. Spre finalul campaniei, o zi dedicată ciocnirilor Ne–Ne va completa date noi despre interacțiunile nucleare la energii extreme.

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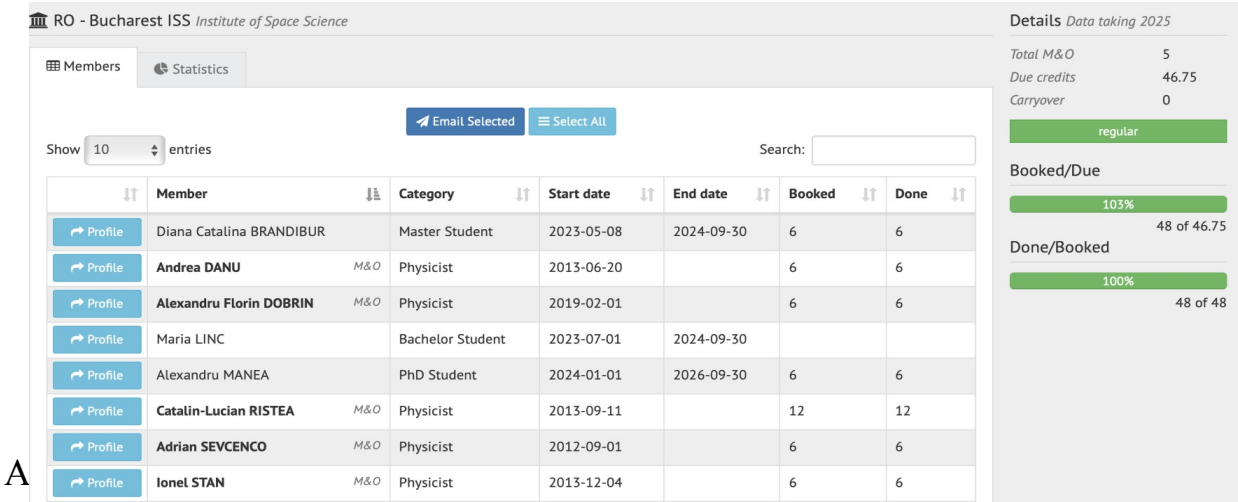
  - O-O/Ne-Ne collisions – ALICE ACR, CERN

- **Collaboration**
  - Shifts: 48 (done) / 46.75 (due)


RO - Bucharest ISS *Institute of Space Science*

Members | Statistics

Email Selected | Select All

Show 10 entries | Search:

	Member		Category	Start date	End date	Booked	Done
Profile	Diana Catalina BRANDIBUR		Master Student	2023-05-08	2024-09-30	6	6
Profile	**Andrea DANU**	M&O	Physicist	2013-06-20		6	6
Profile	**Alexandru Florin DOBRIN**	M&O	Physicist	2019-02-01		6	6
Profile	Maria LINC		Bachelor Student	2023-07-01	2024-09-30		
Profile	Alexandru MANEA		PhD Student	2024-01-01	2026-09-30	6	6
Profile	**Catalin-Lucian RISTEA**	M&O	Physicist	2013-09-11		12	12
Profile	**Adrian SEVCENCO**	M&O	Physicist	2012-09-01		6	6
Profile	**Ionel STAN**	M&O	Physicist	2013-12-04		6	6

Details *Data taking 2025*

Total M&O 5
Due credits 46.75
Carryover 0

regular

Booked/Due

103%

48 of 46.75

Done/Booked

100%

48 of 48

Outreach, Education, Collaboration

- **Outreach**
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  - Shifts: 48 (done) / 46.75 (due)
  - Service work: 2.325 FTE (assigned) / 1.25 FTE (due)

RO - Bucharest ISS

2025

Member	M&O	Category	Start date	End date	Institute	Assigned FTE
Adrian Sevcenco	M&O	Physicist	2012-09-01	2099-12-31	RO - Bucharest ISS	1
Alexandru Florin Dobrin	M&O	Physicist	2019-02-01	2099-12-31	RO - Bucharest ISS	0.025
Alexandru Manea		PhD Student	2024-01-01	2026-09-30	RO - Bucharest ISS	0.25
Andrea Danu	M&O	Physicist	2013-06-20		RO - Bucharest ISS	0
Catalin-Lucian Ristea	M&O	Physicist	2013-09-11	2099-12-31	RO - Bucharest ISS	0.8
Diana Catalina Brandibur		Master Student	2023-05-08	2024-09-30	RO - Bucharest ISS	0.25
Ionel Stan	M&O	Physicist	2013-12-04		RO - Bucharest ISS	0
Maria Linc		Bachelor Student	2023-07-01	2024-09-30	RO - Bucharest ISS	0

Accounting

Total M&O-A 5

Due FTE 1.25

Assigned FTE 2.325

Final FTE 2.325

Provisional FTE 0

186%

2.325/1.25

of Space Science

Email Selected | Select All

Search:

	Category	Start date	End date	Booked	Done
BRANDIBUR	Master Student	2023-05-08	2024-09-30	6	6
M&O	Physicist	2013-06-20		6	6
in DOBRIN M&O	Physicist	2019-02-01		6	6
	Bachelor Student	2023-07-01	2024-09-30		
NEA	PhD Student	2024-01-01	2026-09-30	6	6
RIST A M&O	Physicist	2013-09-11		12	12
CO M&O	Physicist	2012-09-01		6	6
M&O	Physicist	2013-12-04		6	6

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  - Service work: 2.325 FTE (assigned) / 1.25 FTE (due)

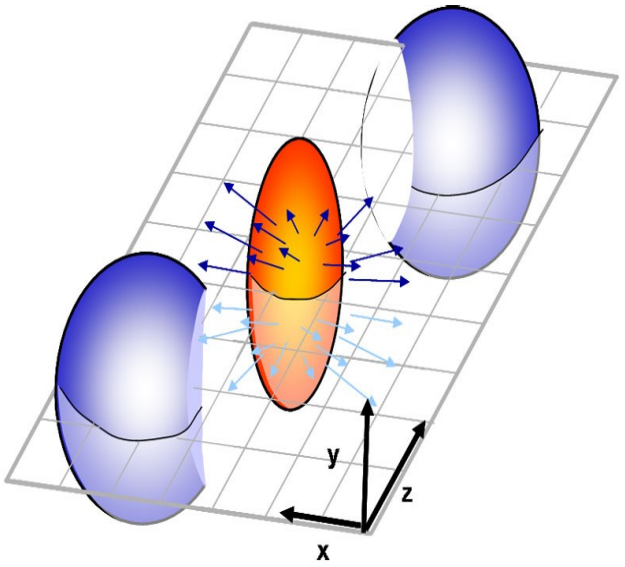
- **Education**
  - 2 projects: 1 master and 1 PhD students
  - Participation at different schools
    - International school of nuclear physics – Erice, Italy
    - 1st PhyStat School of Statistics – Nooitgedacht, Netherlands

Physics highlights

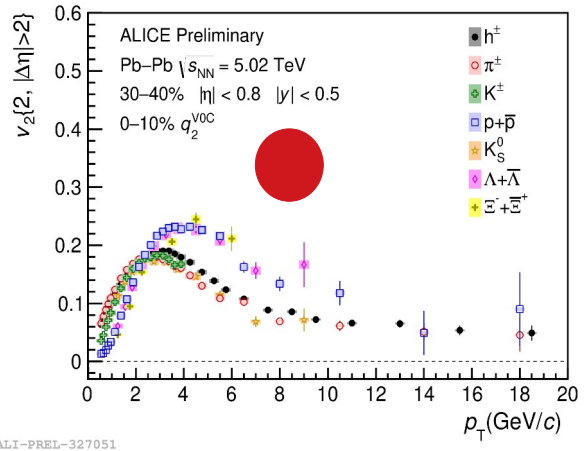
Anisotropic flow

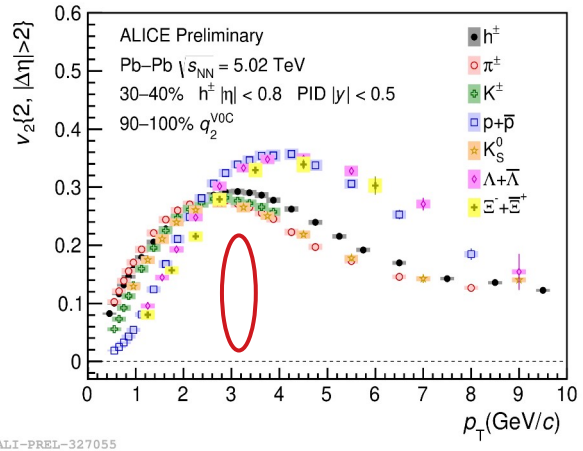
$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}\left(1+\sum_{n=1}^{\infty} 2v_n\cos\left(n\left(\varphi-\Psi_n\right)\right)\right)$$

$$v_n = \left\langle \cos\left(n\left(\varphi-\Psi_n\right)\right)\right\rangle$$



- Anisotropic flow: initial spatial anisotropy → final momentum anisotropy via collective interactions
  - v_n quantify the event anisotropy
- Characterize key QGP properties





Flow vector → q-distributions

$$Q_{n,x} = \sum_i \cos(n\varphi_i) \qquad Q_{n,y} = \sum_i \sin(n\varphi_i)$$

$$\rightarrow \quad Q_n = \{Q_{n,x}, iQ_{n,y}\} \qquad q_n = |Q_n|/\sqrt{M}$$

Large-q_2: 10% high

Small-q_2: 10% low

- More differential measurements using event shape engineering (ESE)
- Rerun analysis on the latest reconstruction passes

Anisotropic flow

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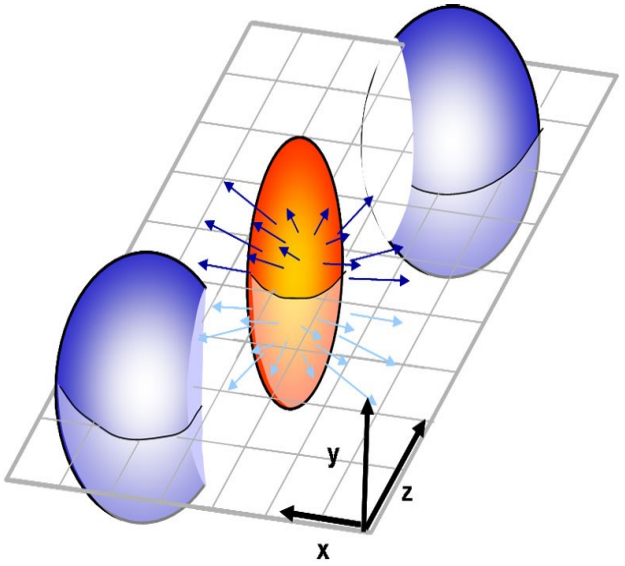

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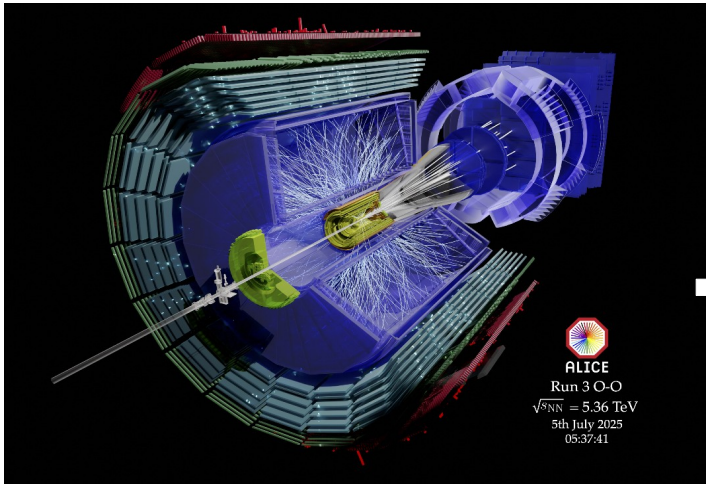
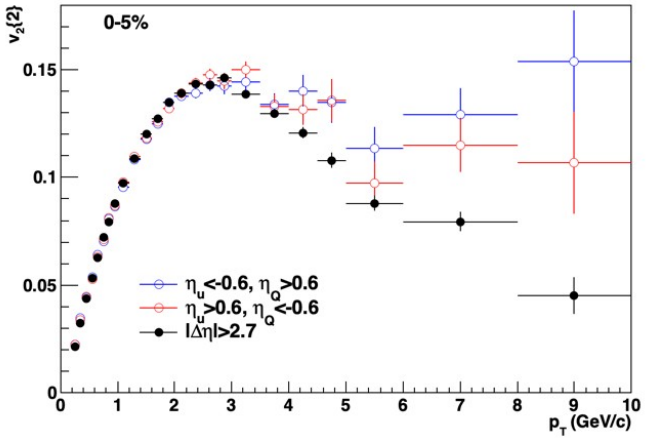
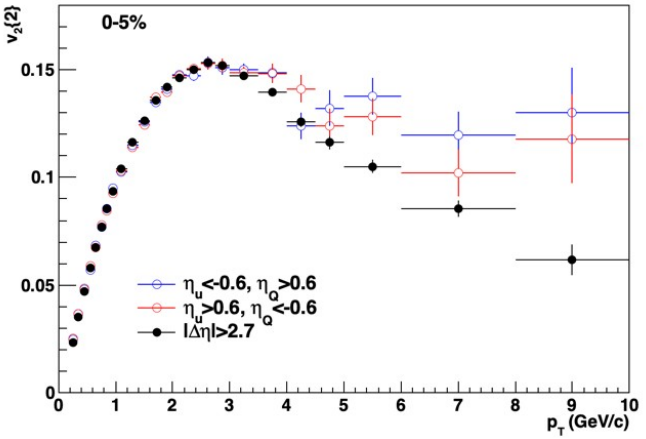


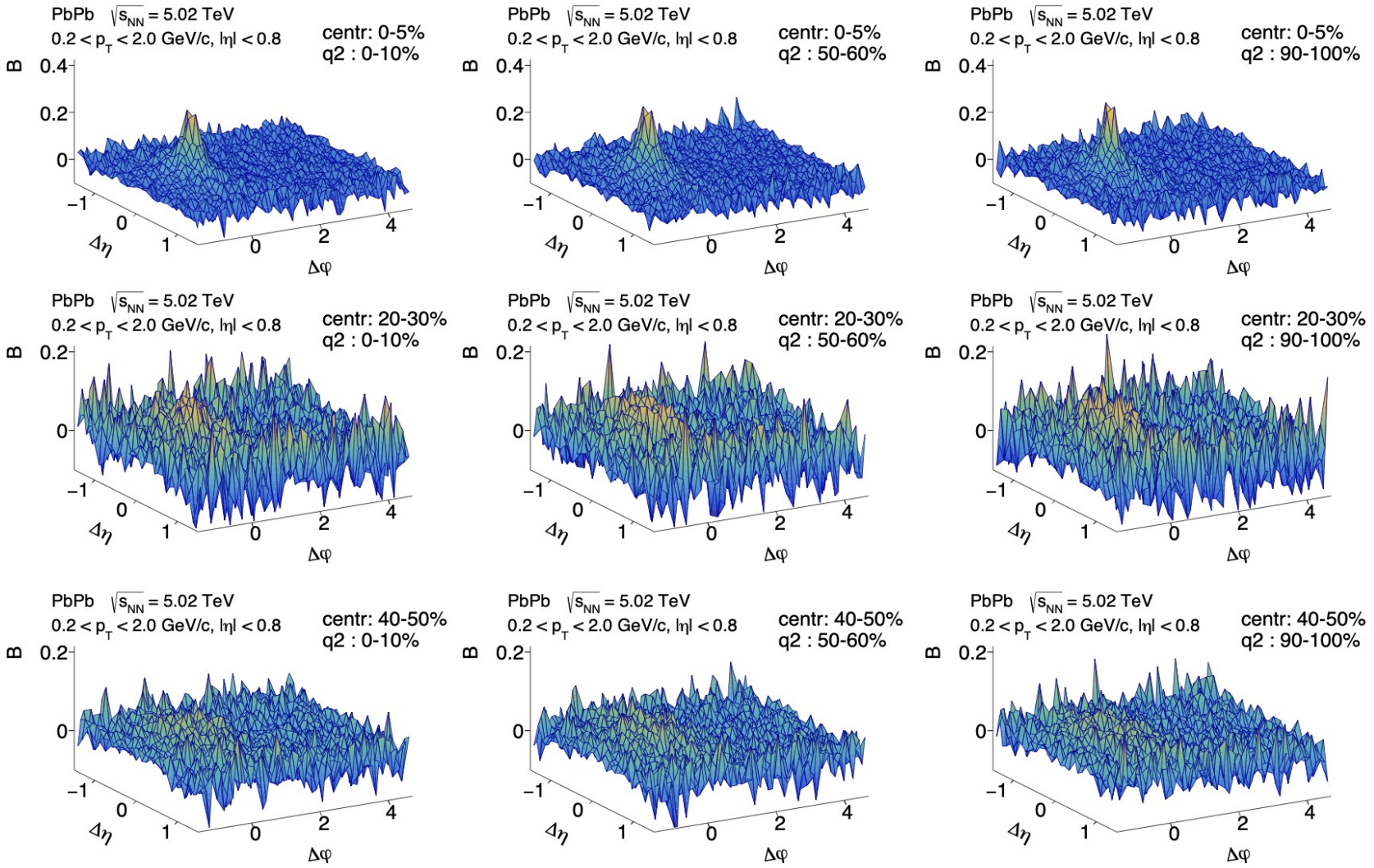




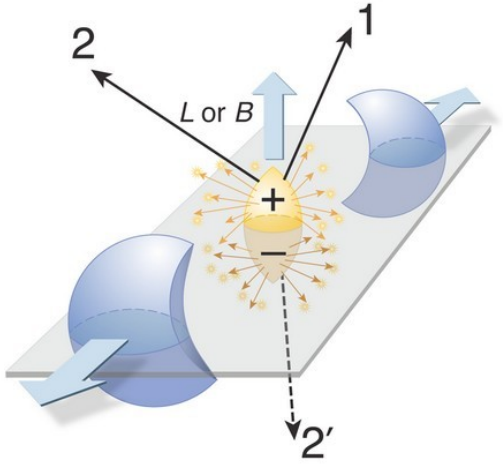
First look at v_2 vs p_T from the O-O and Ne-Ne collisions at $\sqrt{s_{NN}}$ = 5.36 TeV

Balance Function

$$B^{\alpha\bar{\beta}}(\Delta\eta,\Delta\varphi) = \bar{\rho}_1^{\bar{\beta}}\left[R_2^{\alpha\bar{\beta}}(\Delta\eta,\Delta\varphi) - R_2^{\bar{\alpha}\bar{\beta}}(\Delta\eta,\Delta\varphi)\right] \qquad R_2^{\alpha\beta}(\Delta\eta,\Delta\varphi) = \frac{\rho_2^{\alpha\beta}(\Delta\eta,\Delta\varphi)}{\rho_1^{\alpha}\otimes\rho_1^{\beta}(\Delta\eta,\Delta\varphi)} - 1$$



Chiral Magnetic Effect (CME)

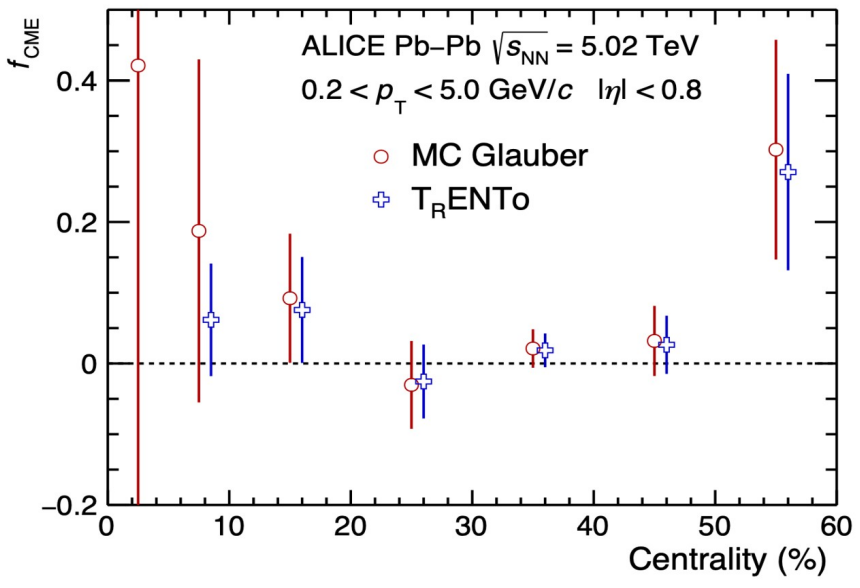


D. Kharzeev, PLB 633, 260 (2006)
D. Kharzeev et al., NPA 803 227 (2008)
S. Voloshin, PRC 70, 057901 (2004)

- Investigate parity violation (*P*) in the strong interaction (fundamental property)
  - Allowed by theory but never observed (strong-CP problem)
- Heavy-ion collisions: strong magnetic field ($B \sim 10^{19}$ Gauss)
- Theory: domains with P and CP symmetries locally broken
- Interaction of quarks with these domains and *B* → *charge separation along B (CME)*

3-particle correlator

$$\gamma_{ab} = \langle \cos(\varphi_a + \varphi_b - 2\Psi_2) \rangle \approx -\langle a_{1,a} a_{1,b} \rangle + B_{\text{in-plane}} - B_{\text{out-plane}}$$



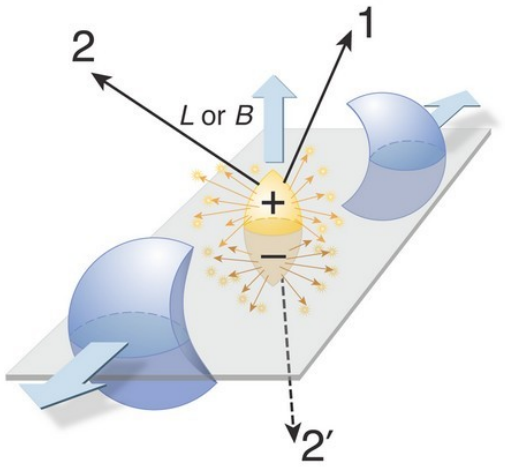
$$f_{\text{CME}} * p_{1,MC} + (1 - f_{\text{CME}}) * 1 = p_{1,data}$$

- CME fraction in 0-5% is currently statistically limited
- Combining the points from 5-60% gives

  f_{CME} (Glauber) = 0.028 ± 0.021 → 7% at 95% C.L.

  f_{CME} (T_RENTo) = 0.025 ± 0.018 → 6% at 95% C.L.
- Draft in Collaboration Round 2

Chiral Magnetic Effect (CME)



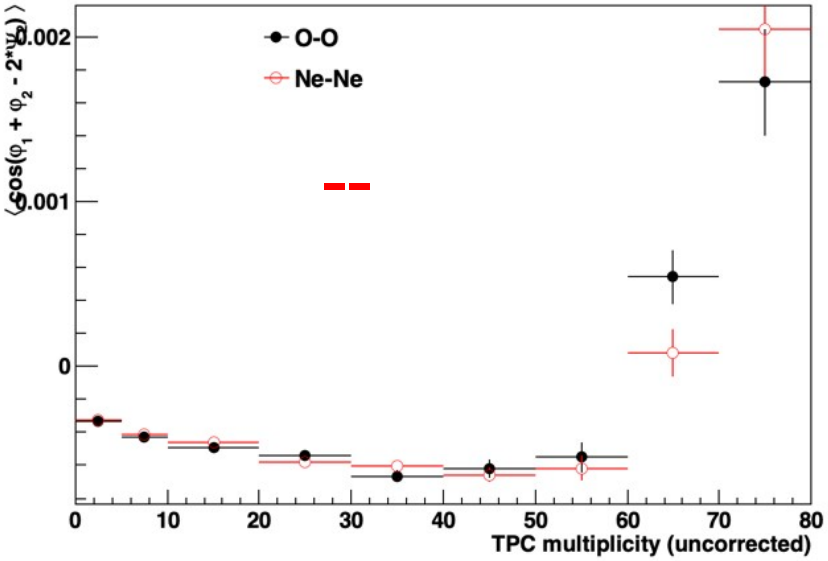
- Investigate parity violation (*P*) in the strong interaction (fundamental property)
  - Allowed by theory but never observed (strong-CP problem)
- Heavy-ion collisions: strong magnetic field ($B \sim 10^{19}$ Gauss)
- Theory: domains with P and CP symmetries locally broken
- Interaction of quarks with these domains and *B* → *charge separation along B (CME)*

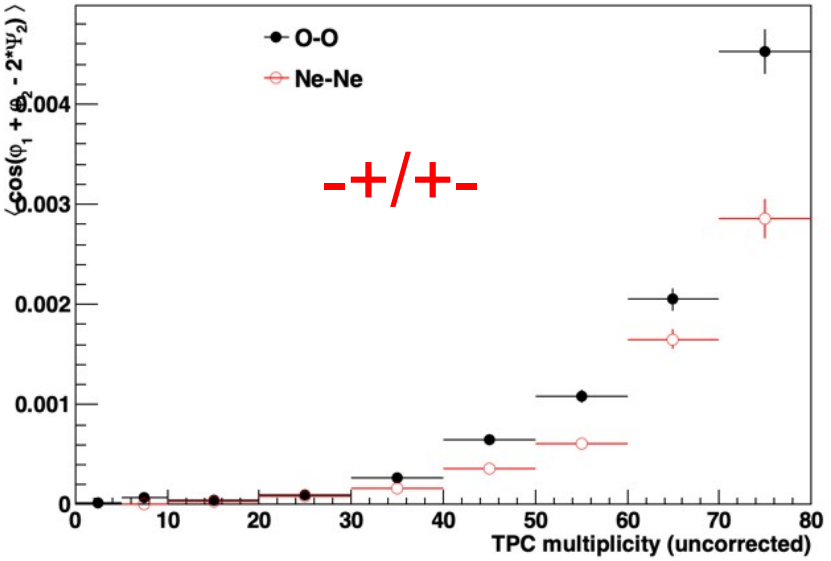
3-particle correlator

$$\gamma_{ab} = \langle \cos(\varphi_a + \varphi_b - 2\Psi_2) \rangle \approx -\langle a_{1,a} a_{1,b} \rangle + B_{\text{in-plane}} - B_{\text{out-plane}}$$

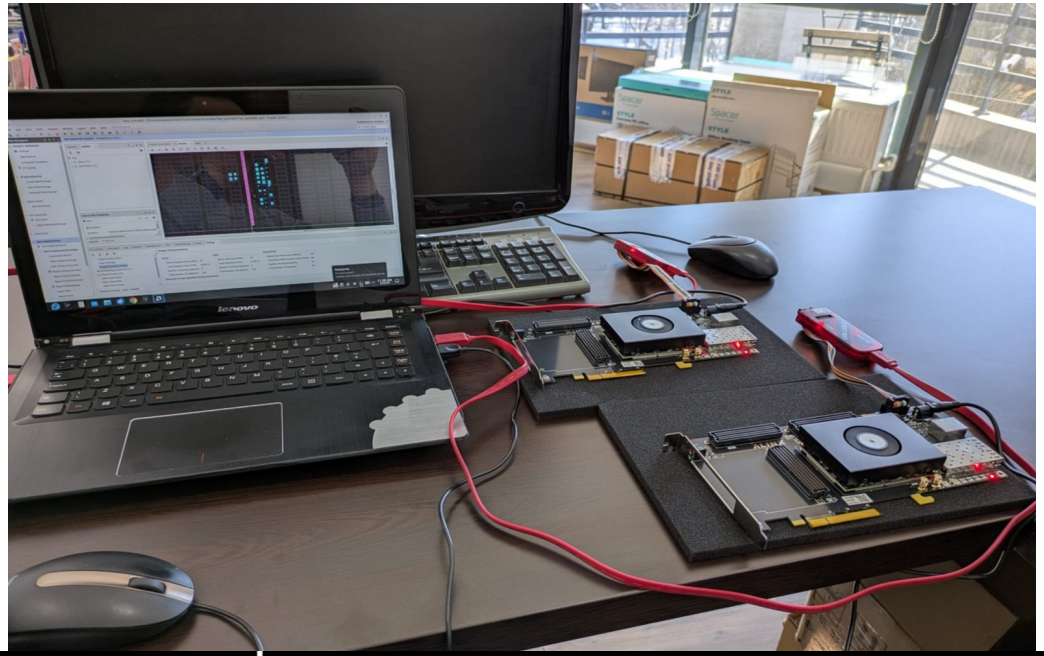
D. Kharzeev, PLB 633, 260 (2006)
D. Kharzeev et al., NPA 803 227 (2008)
S. Voloshin, PRC 70, 057901 (2004)

First look for CME in O-O and Ne-Ne collisions at $\sqrt{s_{NN}}$ = 5.36 TeV

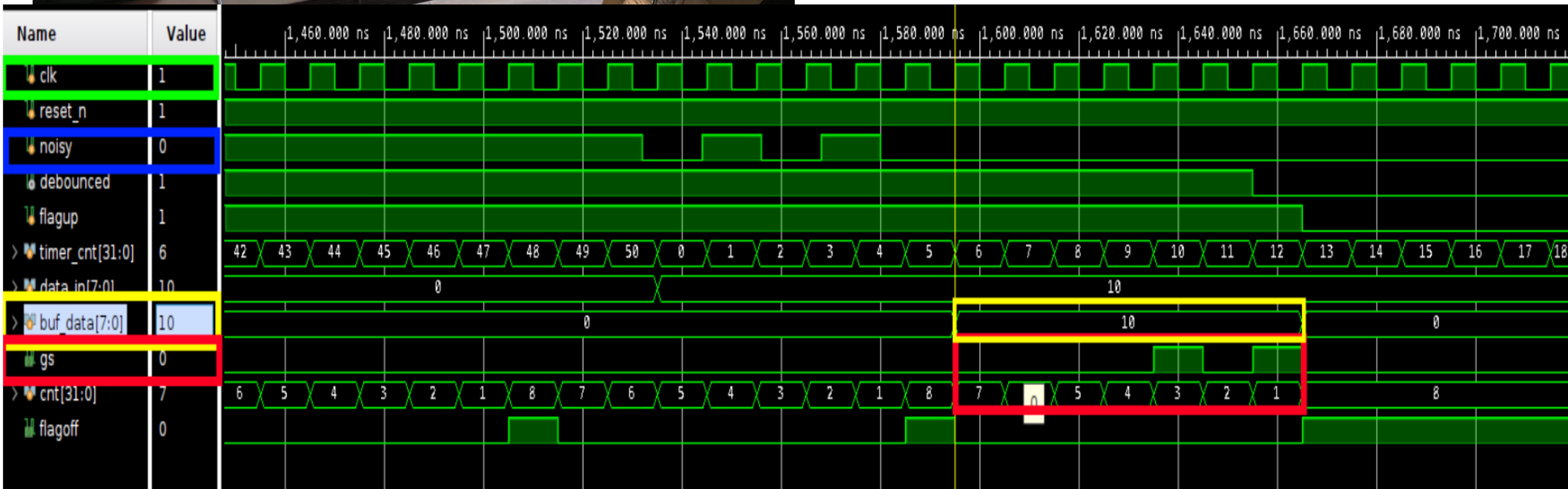




FoCal activities



- Acquired several FPGA boards
  - Test benches for the RU framework at ISS and INFLPR
- Developed and tested several modules
  - Bouncing / debouncing
  - Data serialization / deserialization



Project Team

- Group members
  - ISS
    - BRANDIBUR Catalina Diana (until 15.10.2025)
    - CHERCIU Madalin
    - DANU Andrea
    - DOBRIN Alexandru Florin
    - LINC Maria
    - MANEA Alexandru
    - NEDELCU Liliana
    - RISTEA Catalin Lucian
    - SEVCENCO Adrian
    - STAN Ionel
  - INFLPR
    - DINCA Ana
    - MIHAILESCU Cristian Nicolae
    - MIHALCEA Alexandru
    - SIMION Sandel
    - VESTEA Darius Adrian
    - ZAMFIR Mihai Robert

Summary

- Rich physics output → help constraining the properties of the QGP
  - 1 ALICE paper in Collaboration Round 2
  - New analyses started from light-ion and Pb-Pb collisions (e.g., Balance Function)
  - ALICE presentations+poster at 3 conferences/workshops
  - Several presentations at various ALICE meetings
- ALICE data reconstruction and Monte Carlo simulations up-to-date
  - Fulfill the Institutional Responsibility
  - Coordinator of the DPG
- GRID python client default tool when accessing ALICE GRID
  - Independent module in the ALICE software framework
- Coordination of the ALICE Open Data activities
- Support ALICE GRID via ISS-ALICE Tier-2 site
- Develop several FPGA modules for FoCal RU