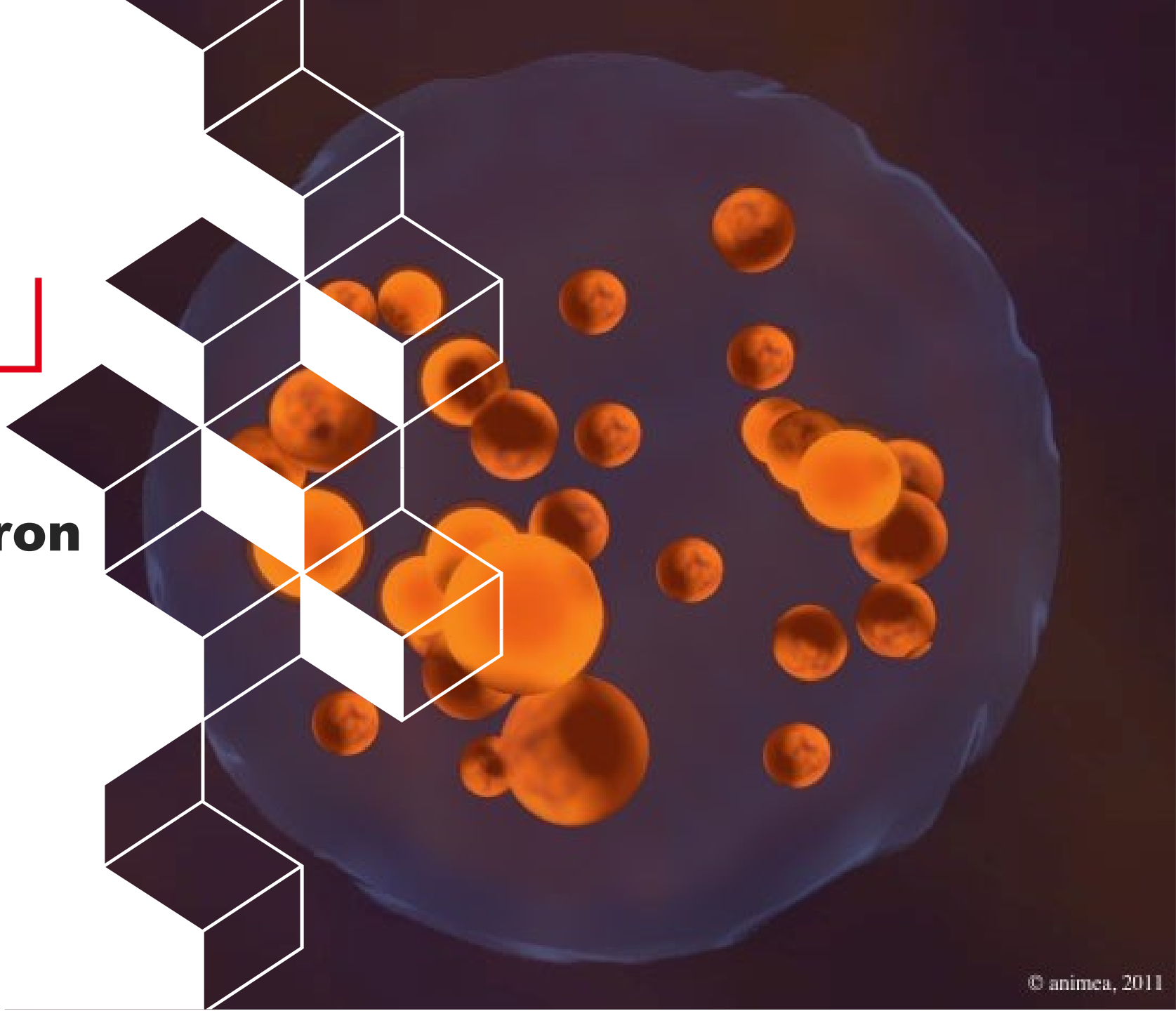
Status and prospects for hadron physics at IRFU

Francesco BOSSU

For Hervé MOUTARDE

22 May 2023

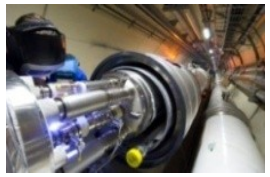


IRFU

Institute of research into the fundamental laws of the Universe

IRFU

Fundamental Research division

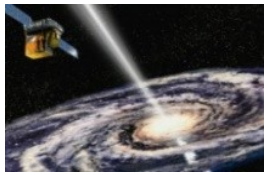


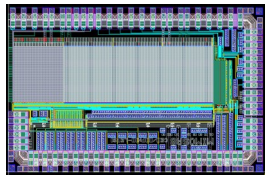
Accelerator, cryogenics and magnetism

DACM

Astrophysics

DAp



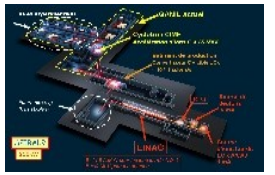


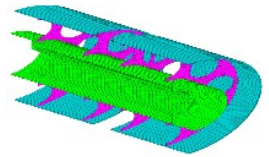
Electronics, detectors and computing

DEDIP

Nuclear physics

DPhN





System engineering

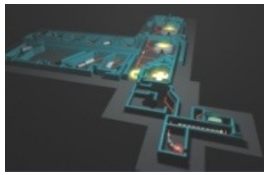
DIS

Particle physics

DPhP

Grand accélérateur national d'ions lourds

GANIL



- 670 permanent staff members
- 94 PhD students
- 44 postdocs

Nuclear physics, from quarks to nuclei

- 44 PhD permanent staff members
- 36 PhD interns, PhD students and postdocs

Cold and hot QCD

Low energy nuclear physics

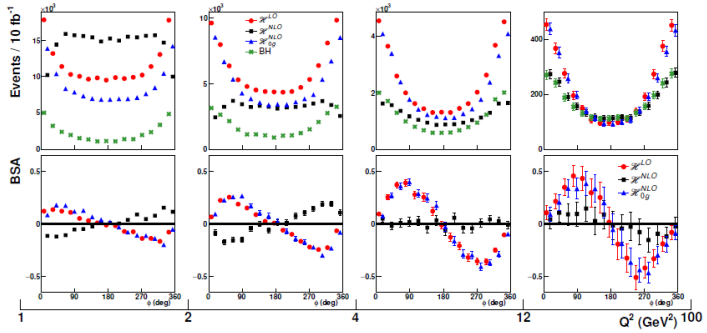
Theory
- Model building
- Phenomenology
- Computing codes

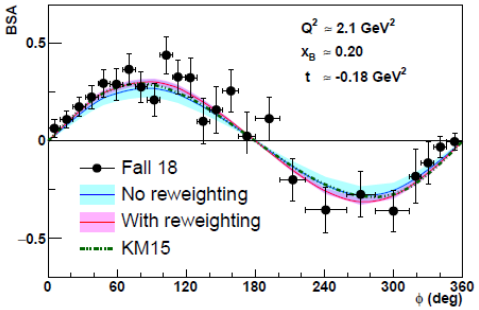
Experiments
- Detector R&D
- Design and data taking
- Data analysis

Applications
- Nuclear data evaluation
- Compact neutron sources
- Beyond nuclear physics: neutrinos and gravitation

DPhN, from hardware to theory

Morgado Chavez *et al.*
PRL**128** (2022) 202501





Christiaens *et al.*
arXiv:2211.11274
to appear in PRL

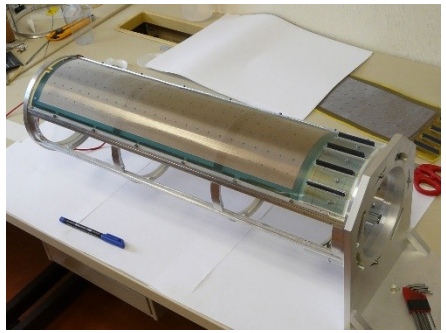
1 Detector R&D

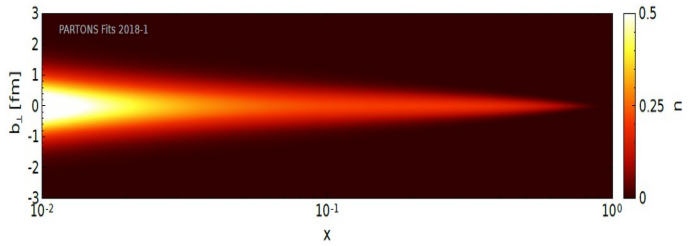
2 Feasibility studies

3 Experiment and data analysis

4 Data release

5 Phenomenology





Moutarde *et al.*
arXiv:1807.07620

Experimental programs – Today

COMPASS (CERN)

- Many R&Ds and detector contributions
- Leadership in many areas:
  - DVCS, Drell-Yan, SIDIS...
- DPhN is now phasing out

At JLab

- Involvement in Hall A and B
- Leading the DVCS program with CLAS12
- First curved resistive Micromegas detectors

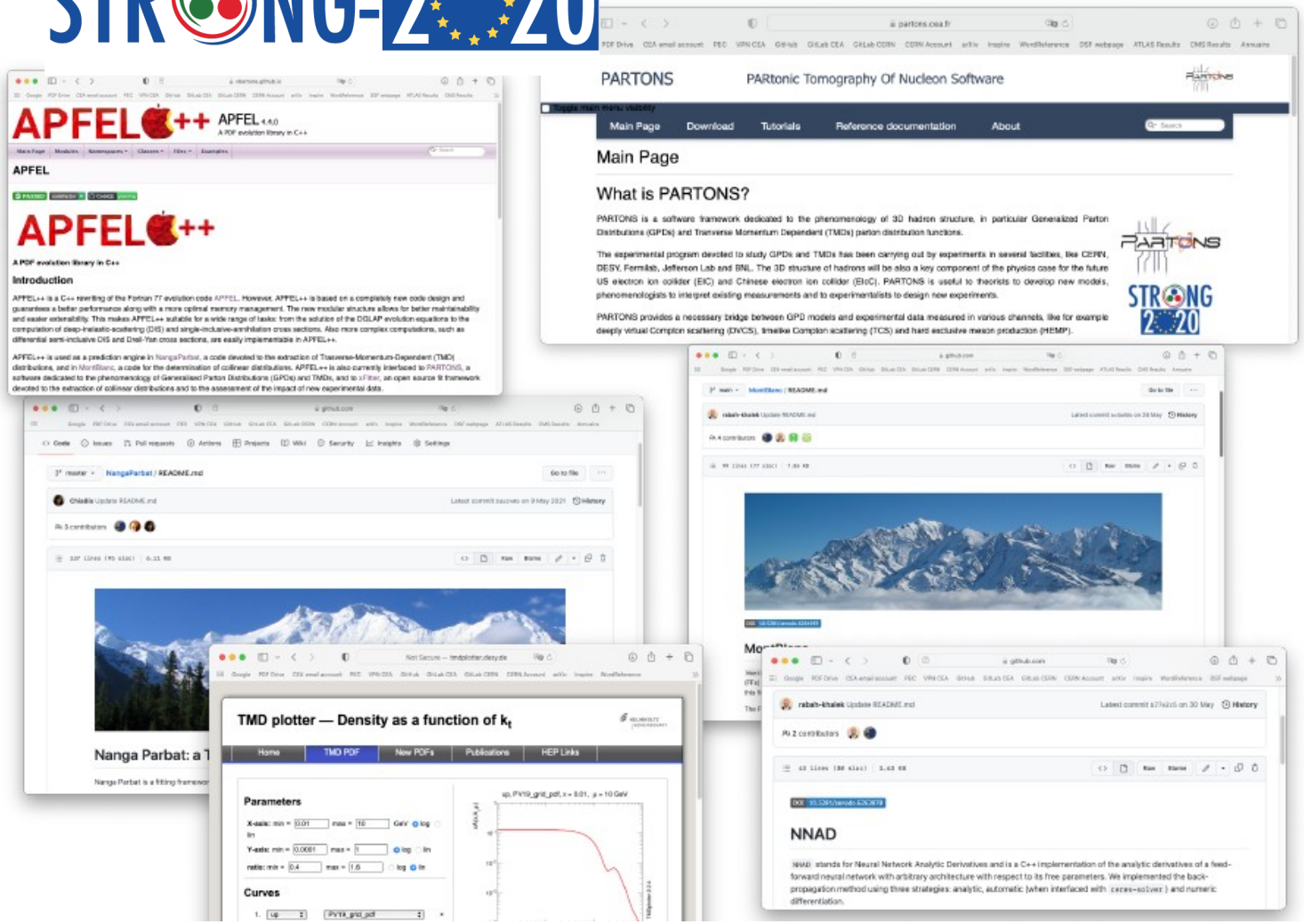
ALICE (CERN)

- Main focus:
  - physics of QGP
  - Quarkonia and HFs
- Forward muon spectrometer
  - Tracking chambers
  - New silicon forward tracker

sPhenix (BNL)

- Main focus: cold QCD physics
- TPOT
  - Micromegas tracker outside the TPC
  - Challenging project: 6 months from the contract signed to the delivery of the detectors

The PARTONS ecosystem



- Computing framework for 3D hadron structure
  - Open-source codes.
  - Modular and open architecture.
  - GPDs, TMDs, PDFs, QCD evolution, etc.
  - Generic exclusive event generator EpIC.
- From Jefferson Lab to EIC physics.

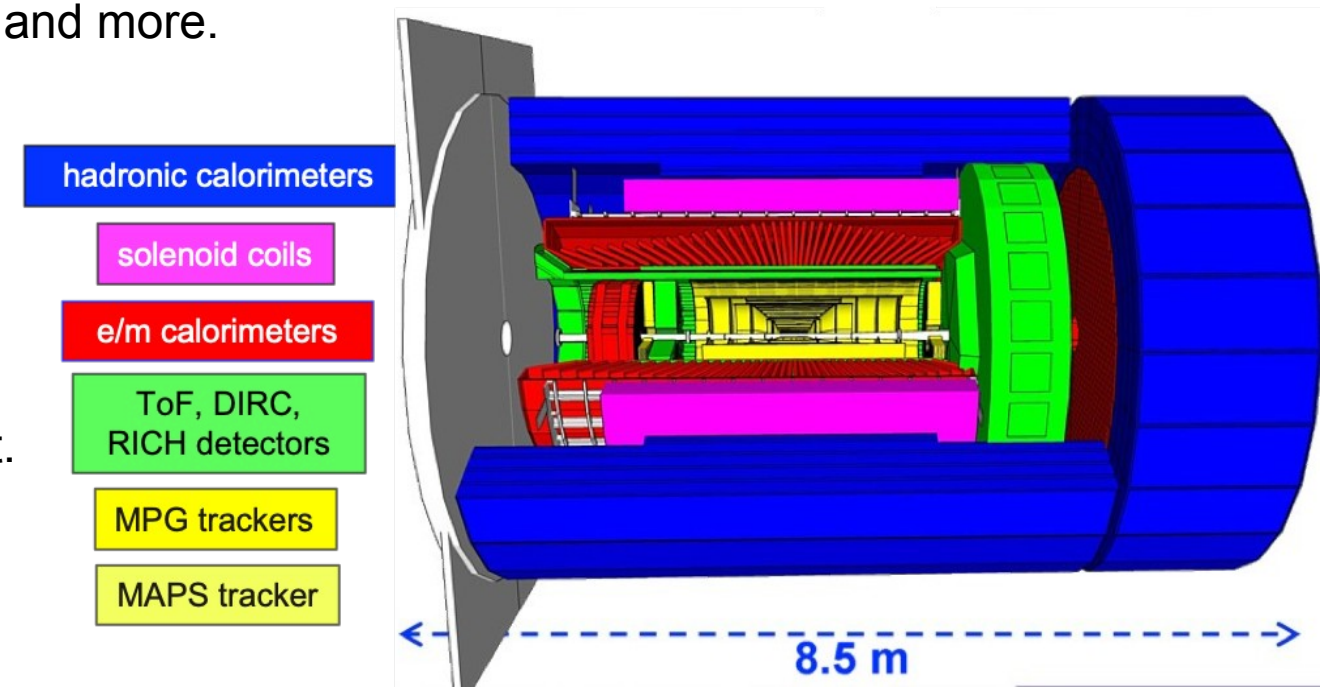
EIC, the future of hadron physics at DPhN

Gaseous tracking detectors

- Low material budget Micromegas 2D detectors.
- Based on the technology developed for the CLAS12 experiment at Jlab and taking data since 2017.
- Capacity to design and produce the whole system: experience from CLAS12, ATLAS NSW, T2K and more.

ASIC for MPGDs

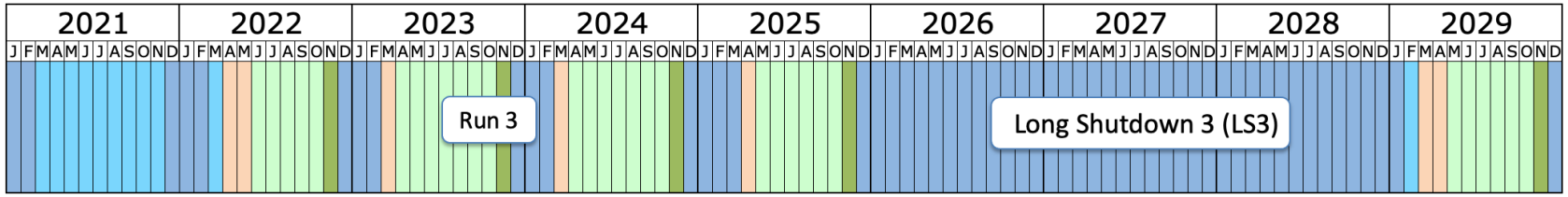
- Development of a new versatile ASIC for Micromegas and µRWELL readout.
- Partnership with Sao Paolo University.
- Close synergy with the detector development.
- Integration with the DAQ system.

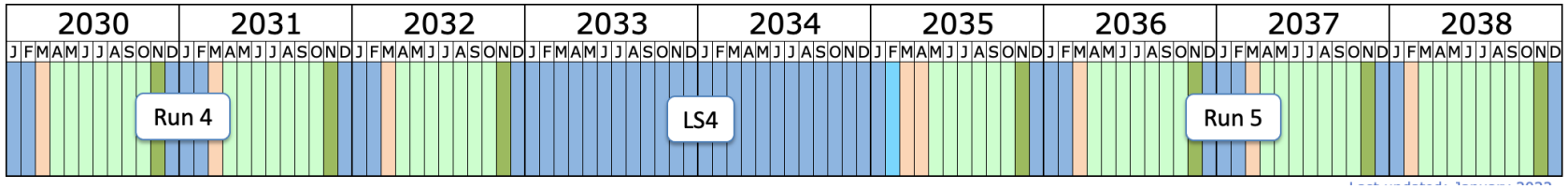


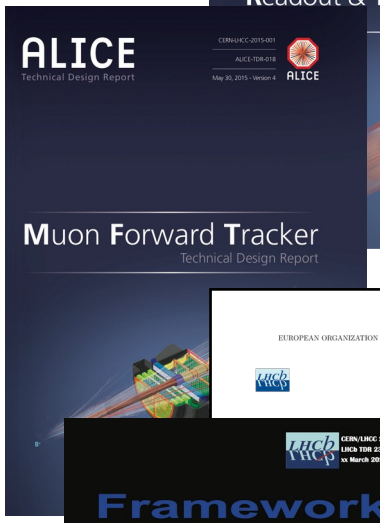
Magnet

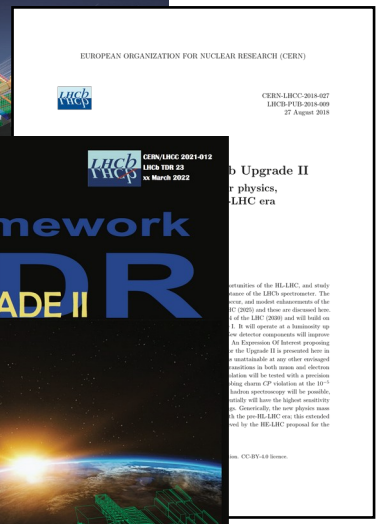
- Design of the solenoid for the ePIC detector in collaboration with Jefferson Lab magnet engineers.

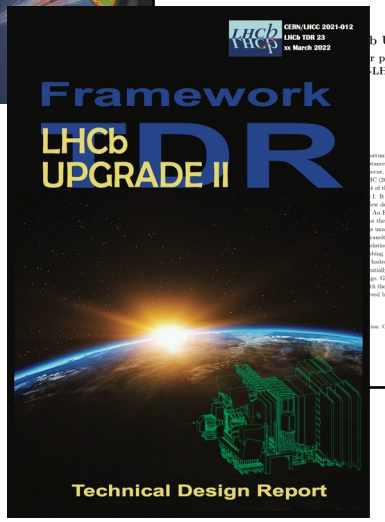
DPhN's Timeline for QGP studies







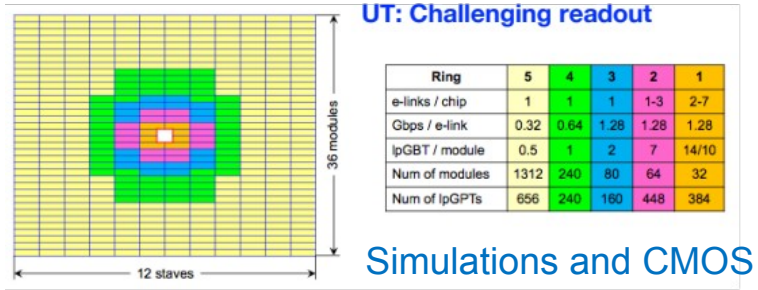




- Upgraded ALICE muon spectrometer (with MFT) for Run 3 and after.
  - **Much higher statistics** (~10 nb-1 in Pb-Pb): rare signals: Psi (2S), Upsilon,…
  - **J/Psi separation** between prompt and non-prompt (B -> J/Psi + X).
  - **Improved Psi(2S)** due to the increase of S/B ratio (thanks to the MFT).
  - **B measurements** using non-prompt J/Psi.
- LHCb for Run 5: installation in LS4
  - High precision **heavy flavors** and **quarkonia** measurements (including χ_c family).
  - Complete study of **small systems** (including high multiplicity pp).
  - **Upgraded apparatus** for heavy-ion collisions (collider & fixed target).

LHCb and the upstream tracker (UT) upgrade

- From a versatile flavor physics experiment to a general purpose detector.
- Planned and discussed upgrades:
  - Full software trigger.
  - Improvement of **heavy-flavor reconstruction**.
  - Development of a **small-system** program.
  - Development of a fixed-target program.
  - Extension to heavy-ion running conditions: **UT critical**.
- Increasingly important actor for QGP physics:
  - From Run 3: **small systems** and fixed target (SMOG2).
  - From Run 4: central and semi-central Pb-Pb.
  - From Run 5: full light- and **heavy-ion program**.
- Key expected physics achievements
  - Precise experimental assessment of **in-medium QCD** features and **hadronization** mechanism.
  - Precise measurement of the **temperature** and **time evolution** of the system.



Simulations and CMOS solutions

Thank you!

Francesco BOSSU

Head of the Nucleon Structure Laboratory

for

Hervé MOUTARDE

Head of Nuclear Physics Department
Fundamental Research Division
CEA Paris-Saclay center
France

herve.moutarde@cea.fr
Standard. (+ 33) 1 69 08 32 06