

COLLABORATION AGREEMENT

IN2P3 - COPIN

I. Identification of the laboratories

Partner	COPIN
IN2P3 laboratories	IJCLab
Partner laboratories	Warsaw (Warsaw University of Technology), Warsaw (NCNR), Wroclaw (IFT)

II. Identification of the collaboration

Title of the collaboration	Fixed target at LHC and ALICE-FT system
Number of the collaboration	22-153
IN2P3 spokesperson	Cynthia Hadjidakis
COPIN spokesperson	Daniel Kikola
Scientific Domain	Hadronic and Particle Physics

Status of the collaboration

Status	The renewal of the collaboration is requested for the period January 1st - December 31st, 2023
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III. Status report for the period January 1st to December 31st, 2022

III.1 IN2P3 scientists in COPIN

Total time approved for 2022	30
Total time used for 2022	0
List of scientists	

III.2 COPIN scientists in France

Total time approved for 2022	30
Total time used for 2022	30
List of scientists	1. Aleksander Kusina (10 days) 2. Daniel Kikola (20 days)

III.3 Scientific results of the above-mentioned collaboration

Description	
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By extracting the beam with a bent crystal or by using an internal gas target, the multi-TeV proton and lead LHC beams allow one to perform the most energetic fixed-target experiments ever and to study pp and pA collisions at a center of mass energy of 115 GeV and Pbp and PbA collisions at a center of mass energy per nucleon pair of 72 GeV with high precision and modern detection techniques. Such studies address open questions in the

domain of the nucleon and nucleus partonic structure at high-x and its connection to astroparticles and the quark-gluon plasma in heavy-ion collisions between SPS and RHIC energies.

We have proposed a fixed target programme at the LHC within ALICE and LHCb and several studies on the experimental and phenomenological sides have been funded thanks to the work package FTE@LHC (Fixed Target Experiments at the LHC) of the STRONG-2020 European project, that will end in November 2023.

In ALICE, we are investigating the use of a bent crystal prior to the LHC interaction point 2 that deviates the beam halo on a solid target internal to the beam pipe. The crystal layout for ALICE is one of the task of the fixed target programme in ALICE. Another task is the target system development. Both IJCLab and WUT laboratories are involved in this programme.

The crystal layout with the proton beam was developed by M. Patecki (WUT) in collaboration with CERN collimation experts and the results of this study were published in a proceedings in 2022. A minimal value for the channeled proton flux on target was estimated with the configuration of parallel running with the ALICE fixed target configuration mode and the other LHC experiments. A study on the number of absorbers needed after the experimental cavern has also started.

A first target conceptual design was achieved in 2021 with several subtasks defined on target material and motorization, vacuum, impedance and integration. In 2022, we have chosen the motorization hardware from UHVDesign and improved the target design according to geometrical and vacuum constraints. We plan now to study the vacuum profile in the beam pipe and the constraints from the LHC beam impedance in order to improve the target system design and build an evolutive model of the target system. This will allow us to study and validate its design for its installation at the LHC during the Long Shutdown 3.

In addition, the FT@LHC physics programme were reinforced thanks to the implication of C. Flore (IJCLab), M. Nefedov (NCBJ), M.R. Hacque (WUT) and C. Van Hulse (IJCLab) on projected performances for different topics such as D meson, antiproton and quarkonium production. M.R. Hacque worked on performance studies in ALICE for charged particles using the Time Projection Chamber, the main detector of ALICE located at mid-rapidity, and he has started to compute the expected performance for D and Lambda production in p+W collisions. C. Van Hulse has started to work on antiproton performance with ALICE in p+C collisions. M. Nefedov improved the computation of quarkonium production when integrated over pT by resolving the instability problem of NLO calculation, allowing to compute the integrated cross section at NLO at the FT@LHC energies. Contributions to the physics programme involved as well J. Wagner, A. Kusina and L. Szymanowski in Poland, and I. Schienbien, J.P. Lansberg and S. Wallon in France.

Event organisation:

FTE@LHC STRONG-2020 workshop, <https://indico.cern.ch/event/1143479>

Communication/participation to workshop and conferences:

- Quarkonium as Tools 2022, <https://indico.cern.ch/event/1084752>, (C. Van Hulse, A. Shatat, M. Nefedov, J.P. Lansberg, A. Kusina, D. Kikola, L. Massacrier, C. Flore)

-FTE@LHC STRONG-2020 workshop, <https://indico.cern.ch/event/1143479> (D. Kikola, R. Haque, C. Van Hulse, K. Pressard, C. Hadjidakis, L. Massacrier, M. Patecki, J.P. Lansberg, M. Nefedov)

-HF2022, <https://indico.ijclab.in2p3.fr/event/7656>, (D. Kikola, C. Van Hulse, C. Hadjidakis, L. Massacrier, A. Kusina, J.P. Lansberg, L. Szymanowski, S. Wallon, C. Flore)

- QCD@LHC2022 <https://indico.cern.ch/event/1150707/> (C. Van Hulse, C. Hadjidakis, L. Massacrier, J.P. Lansberg)

- PBC workshop 2022 <https://indico.cern.ch/event/1137276/> (D. Kikola, C. Hadjidakis, M. Patecki, L. Massacrier, C. Van Hulse)

Recent publications:

- B. Trzeciak et al., "Heavy-flavour studies with a high-luminosity fixed-target experiment at the LHC", PoS HardProbes2020 (2021) 190
- M. Nefedov et al., "Matching next-to-leading-order and high-energy-resummed calculations of heavy-quarkonium-hadroproduction cross sections" JHEP05(2022)083
- M. Patecki et al., "Status of Layout Studies for Fixed-Target Experiments in Alice Based on Crystal-Assisted Halo Splitting » JACoW HB2021 (2022) 146 proceedings
- E. Chapon et al., "Prospects for quarkonium studies at the high-luminosity LHC", Prog.Part.Nucl.Phys. 122 (2022) 103906

Internal notes:

- "Performance study of the ALICE TPC for future fixed-target collisions", R. Haque et al., ALICE internal note
- "Conceptual design of a fixed-target system in the ALICE experiment", K. Pressard et al., STRONG-2020 internal note

IV. Renewal of the collaboration for 2023

IV.1 Proposed scientific program

Description

In 2023, we plan to extend the crystal layout studies to the lead beam and to optimise the number of absorbers that need to be installed after the ALICE experiment.

We also plan to study the vacuum and impedance constraints and improve the target design and we will develop the software for the motorization control, and will assembly and test the motorization part of the target system. This will involve engineers and physicists of IJCLab and WUT and will require in particular the visits of G. Kalinowski and D. Kikola at IJCLab.

On the performance study side, we will hire a postdoc thanks to french fundings and will proceed with the performance studies for the ALICE fixed-target programme.

Contributions to the physics programme will also involve J. Wagner, A. Kusina and L. Szymanowski in Poland, and I. Schienbien, J.P. Lansberg and S. Wallon in France.

We finally plan to have a pre-satellite workshop of three days prior of the Quarkonium as Tools 2023 workshop (C. Van Hulse, C. Hadjidakis, L. Massacrier, D. Kikola, J.P. Lansberg, M. Patecki, C. Flore) and possibly a meeting to review our activities at the end of 2023.

IV.2 Estimated duration for IN2P3 scientists in COPIN

Total time requested for 2023	30
List of scientists	1. C. Hadjidakis (5 days) 2. K. Pressard (10 days) 3. L. Massacrier (5 days) 4. C. Flore (5 days) 5. A. Shatat (5 days)

IV.3 Estimated duration for COPIN scientists in France

Total time requested for 2023	35
List of scientists	1. D. Kikola (10 days) 2. G. Kalinowski (10 days) 3. M. Patecki (10 days) 4. A. Kusina (5 days)

Comment Validation	
Unity Director	Fadi IBRAHIM (IJCLab) - 2022-10-14 08:55:49