# ALICE

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## Introduction

The Run2 will end at December 2018 starting the Long Shutdown 2 (LS2) at the LHC. There will be one more Pb+Pb run before the LS2 in November 2018.

The main focus of our group in 2018 will be on

1. Thedata analysis utilizing p+p, p+Pb and Pb+Pb data collected by ALICE in   
   Run 1 and Run 2.
2. Running of the EMCal L0 trigger hardware in Run 2.
3. Participation in upgrade activities:
   1. ALICE TPC GEM readout chambers upgrade
   2. Forward Interaction Trigger detector – FIT

## Data analysis

The analysis on flow harmonic correlations has been successful. The 2nd paper on the flow harmonic correlations was submitted to Physical Review C followed by the first pioneering paper ([Phys. Rev. Lett. **117**, 182301 (2016)](http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.117.182301)). The first measurement on decomposing the non-linear hydrodynamic response to the initial state energy density profile in heavy-ion collisions was accepted in Physics Letters B (Phys. Lett. B773 (2017) 68). These results can provide stringent constraints of the temperature dependence of the shear viscosity to the entropy density ratio of the Quark Gluon Plasma (QGP). The results were presented in Quark Matter 2017 and Initial stages 2017 conferences. The higher energy Run 2 analysis on the flow harmonic correlations is being finalized for the publication. Newly hired PhD Student, Jasper Parkkila, is finalizing the non-linear hydrodynamic response from Run 2 data. We plan to present these final results in Quark Matter 2018 conference in May 2018.

Two ongoing projects on the di-hadron analysis are close to been completed: (i) Study of the final state soft QCD radiation utilizing the di-hadron correlations. The paper committee has been formed after Hard Probe 2016 conference and the paper is currently under internal review in ALICE. Results are expected to be published in early 2018. The analysis is presented in Jussi Viinikainen’ PhD-thesis. Jussi’s defense day is set to 15th December 2017. (ii) Study of the jet shapes by looking at associated yields in Pb+Pb with di-hadron correlations. This is a subject of Marton Vargyas’ PhD thesis. The results were presented in XII Workshop on Particle Correlations and Femtoscopy (June 2017) and 12th International Workshop on High-pT Physics (October 2017). Marton is finalizing his results for publication and he is expected to defend his thesis in 2018.

In addition we need to strengthen our role in the analysis of ALICE Electro-Magnetic Calorimeter (EMCAL) data. The main purpose is to utilize clean sample of high-pT neutral pions, direct photons and jets as a trigger particles and study their associated yields. These measurements are important for understanding of the parton interaction with exited nuclear medium (see e.g. *Phys. Rev. Lett.,* **2010***, 105*, 142301, *Phys. Rev. D,* **2010***, 82*, 072001). Tomas Snellman has been performing analysis on fully reconstructed jets including the EMCAL cluster energies. His studies are closely connected with Jussi’s analysis but uses jets and jet constituents rather than di-hadron correlations.

New soft-hard interaction analysis has begun around June 2017 where we combined our main analysis topics together, jet and flow. This analysis will try to address how the fast moving jet traveling trough the medium created in Pb+Pb collisions will leave energy and momentum to the medium. We submitted a project application around these ideas to Finnish Academy in September 2017 call. The very preliminary analysis was presented in the aforementioned high-pT workshop 2017 and we plan to develop it further to hunt for solid experimental observables.

## Activities during Run 2

Jyväskylä group has been always actively participating in data taking. Many of us have served as a shift leader as an on-call expert for the T0 and EMCAL detector systems; Jussi was called to Run Manager position in ALICE and he served a two week period for two times during Run 2.

Because of our interest in high-pT physics, Jyväskylä group took a responsibility in design/development and commissioning of Trigger Region Units (TRU) electronics. TRU electronics is a FPGA based system performing a fast (<600 ns) on-line analysis of EMCAL data and searches for high-energy single photon hits to generate level-0 trigger. Jussi Viinikainen took major part of the responsibilities related to the L0 trigger once Jiri Kral, who was a key person in designing and implementing the system, defended his thesis and moved to work in the CERN beam department. Jussi participated to EMCAL level 0 (L0) trigger commissioning in beginning of Run 2 and has now trained Tomas Snellman to continue his work in making the trigger performance studies during the ongoing run. Providing fluent continuation of the know-how over the LS 2 is one of the important challenges we shall meet in 2018.

## ALICE TPC upgrade

The central parts of the ALICE detector are the Time-Projection Chamber (TPC) and the Inner Tracking System (ITS). TPC is the main tracking detector of the central barrel (|η|<1.5) and is optimized to provide charged-particle momentum measurements down to ~50 MeV/c with excellent two-track separation, particle identification (d*E*/d*x*), and vertex determination. With the current design and readout configuration the maximum data acquisition rate in Pb–Pb collisions is about 500 Hz. The main limitation of the existing design comes from the TPC gating grid, which is needed to prevent the ion flow back to the drift volume, and can be operated with the maximum rate about 3.5 kHz. In order to optimize the ALICE performance after the second long LHC shutdown in 2018 the ALICE collaboration decided to upgrade TPC to be able to record Pb–Pb collisions at a rate of 50 kHz. This requires replacing all the multi-wire proportional readout chambers with the Gas Electron Multiplier (GEM) technology, which allows preserving the same tracking performance (momentum resolution and dE/dx resolution) as with the current readout chambers.

There is a need to produce 32 m2 of triple-GEM ROC’s, which corresponds to a total area of 96 m2 of GEM foils. Helsinki Institute of Physics has agreed to contribute to the TPC upgrade by providing a suitable infrastructure (100 m2 clean room of class 1000) and expertise in the GEM technology area. The ALICE/Finland team will participate, in collaboration with the GEM expert team of the HIP detector laboratory, in the triple-GEM ROC R&D (first phase) and in the GEM production and quality assurance tests. In the later stage we are also committed to participate in the ROC assembly and commissioning. A part of the ALICE TPC upgrade project includes a strong synergy and connection with the FAIR Super FRagment Separator beam-tracker project carried out in collaboration with the Center of Excellence on Nuclear and Accelerator based Physics at the University of Jyväskylä.

At the end of 2013 we hired a postdoc Erik Brücken to coordinate the TPC upgrade activities in HIP detector laboratory and PhD student Timo Hildén as a GEM expert. The R&D activities at CERN and GSI are still ongoing but we expect that in the second half of 2015 the mass production of 100 m2 GEM foils and the optical scan in HIP clean room should start.

## Forward Interaction Trigger – FIT

Wladyslaw Trzaska from JYFL has been the project leader in designing, building and maintaining of the T0, another important Finnish contribution. He is also currently a project leader in the new Forward Interaction Trigger (FIT) detector development that will be implemented to ALICE during the second long shutdown starting at the end of Run 2 in December 2018.

## Personnel

The personnel situation is summarized in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Family name | First name | Position | Since | Pay roll |
| 1 | Rak | Jan | Professor | 2005 | JYFL |
| 2 | Trzaska | Wladyslaw | University Researcher | 1998 | JYFL |
| 3 | Räsänen | Sami | University Researcher | 2008 | JYFL/HIP (50-50 %) |
| 4 | Kim | Dong Jo | University Researcher | 2006 | HIP |
| 5 | Brücken | Erik | Postdoc | 2013 | HIP ? |
| 6 | Hildén | Timo | Postdoc | 2013 | HIP ? |
| 7 | Viinikainen | Jussi | PhD Student | 2010 | HIP |
| 8 | Vargyas | Marton | PhD Student | 2013 | JYFL |
| 9 | Snellman | Tomas | PhD Student | 2013 | HIP |
| 10 | Parkkila | Jasper | PhD Student | 2017 | JYFL |
| 11 | Saarimäki | Oskari | Undergraduate | 2017 |  |