# ALICE

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## Introduction

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. Production and commissioning of the new Trigger Region Units (fast L0 single photon trigger electronic) for the four new super-modules of ALICE EMCal.

## Data analysis.

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 are presented in Quark Matter 2017 conference (Feb. 2017) and Initial stages 2017(Sep. 2017).

The higher energy run2 analysis on the flow harmonic correlation are being finalized for the publication. Newly hired Phd Student, Jasper Parkkila is finalizing the non-linear hydrodynamic response from run2 data. We plan to present these final results in Quark Matter 2018 conference (May 2018).

Two ongoing projects on the di-hadron analysis are close to be 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 Committee in ALICE. We plan to publish it during 2018. Jussi Viinikainen’ PhD-thesis will be build around this topic and he aims to defend his thesis in end of 2017. (ii) Study of the jet shapes by looking at and associated yields in Pb+Pb with di-hadron correlations. This is a subject of Marton Vargyas PhD thesis (should be defended in summer 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 2016 call. The very preliminary analysis was presented in high pT workshop 2017 (Oct. 2017) and we plan to develop it further to hunt for solid experimental observables to address the interaction of jet in the QGP.

## Preparation for upcoming ALICE run-2

Jyväskylä group has been always actively participating in data taking. Many of us has served as a shift leader as an on-call expert for the T0 and EMCAL detector systems. ALICE is almost back in the fully operational mode. We have to (i) to train new shifters from our group and (ii) to modify TRU and EMCAL trigger systems to adapt the improvements of the ALICE data taking system during the long shutdown.

## L0 single photon trigger electronics

Because of our interest in high-pT physics, Jyvaskyla group took a responsibility in design/development and commissioning of Trigger Region Units (RTU) 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. EMCAL consists of 12 super-modules and every super-module is equipped with 3 TRU boards. Jyväskylä team has produced TRU modules and J. Kral implemented the L0 trigger decision logic into a FPGA firmware. The whole EMCAL trigger system developed in our group was fully operational since 2010 and gave us an opportunity to study the fully reconstructed jets in ALICE. Jiri Kral defended his PhD-thesis in 2014 and moved to CERN beam department where he has fellowship. Jussi Viinikainen took the major responsibilities from Jiri since he left. Trigger has been running well also in Run-2 that started in 2016.

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. We have supported this project with working time from Filip Krizek, Astrid Morreale and lately Beomkyu Kim to T0 running. As Jussi will defend his PhD-thesis in 2016, Beomkyu Kim is now learning the trigger maintenance and he will continue the work at CERN. Hence Beomkyu has become an important person we aim to hire to ALICE project.

## 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.

## Personnel

The personnel situation is summarized in the following table:

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| --- | --- | --- | --- | --- | --- |
|  | Family name | First name | Position | Since | Pay roll |
| 1 | Rak | Jan | Professor | 2005 | JYFL |
| 2 | Räsänen | Sami | University Researcher | 2008 | HIP |
| 3 | Kim | Dong Jo | University Researcher | 2006 | HIP |
| 4 | Brücken | Erik | Postdoc | 2013 | AKA 251737 |
| 5 | Hildén | Timo | Postdoc | 2013 | AKA 271838 |
| 6 | Viinikainen | Jussi | PhD Student | 2010 | Foundation |
| 7 | Vargyas | Marton | PhD Student | 2013 | HIP |
| 8 | Snellman | Tomas | PhD Student | 2013 | JYFL |
| 9 | Parkkila | Jasper | PhD Student | 2017 | JYFL |
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