

HAD_01:

**Measurements of Jets and
Photons in Heavy Ion Collisions
at the Highest Beam Energy
during the LHC-Run 2 by ALICE**

Tatsuya Chujo (Univ. of Tsukuba)

2016 Joint Workshop of FKPPL and TYL/FJPPL
(Particle Physics Laboratories) @ KIAS

May 18, 2016

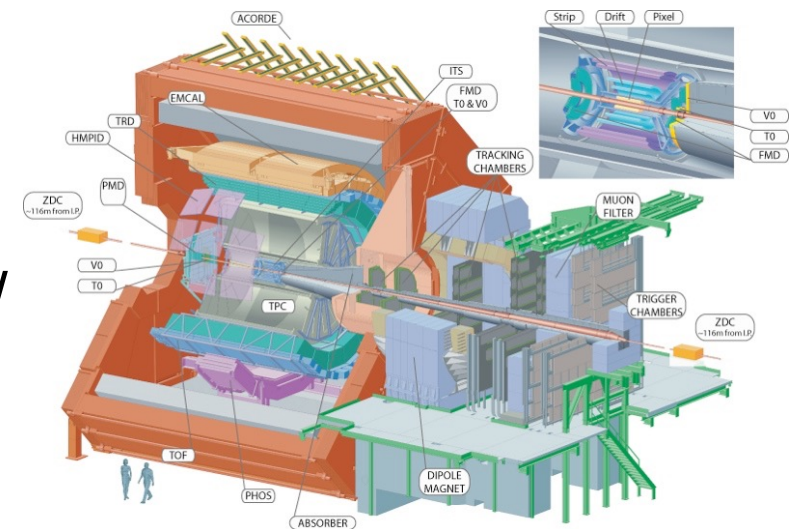
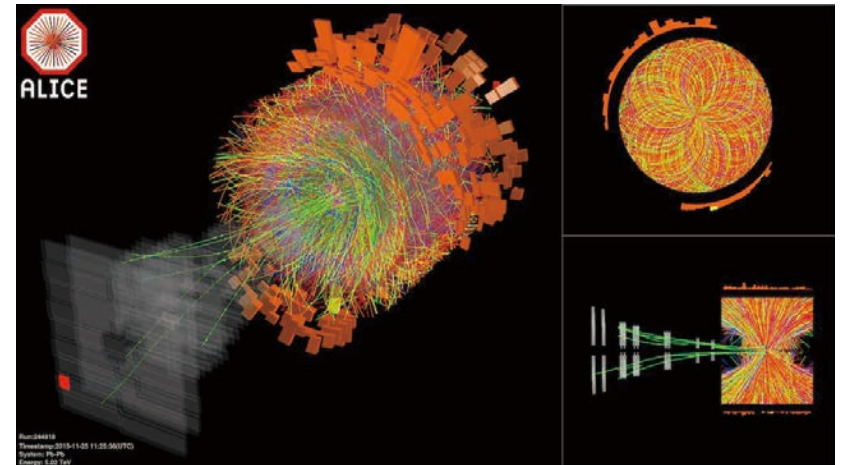
KIAS, Seoul,



筑波大学
University of Tsukuba

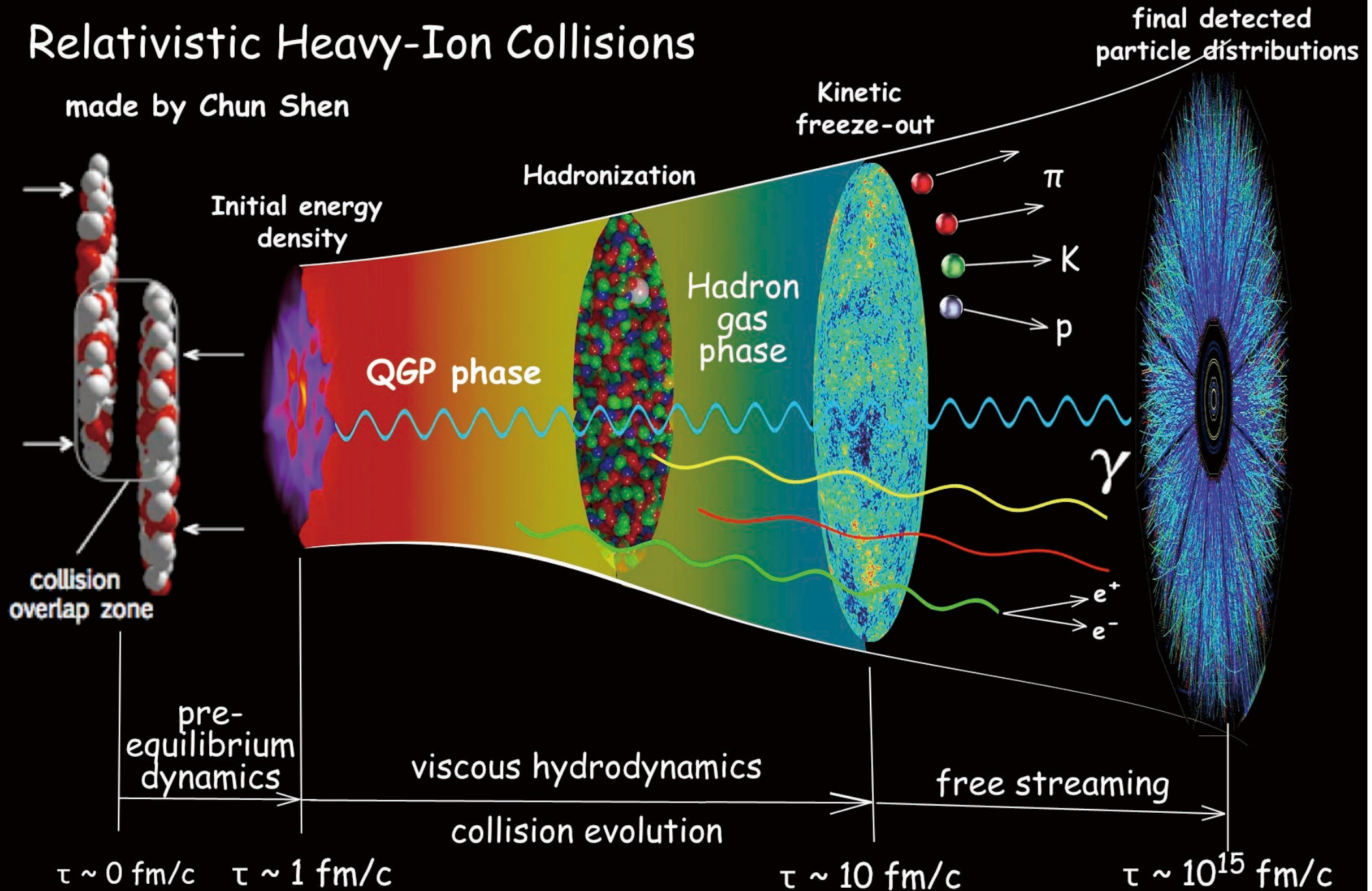
Had_01: project goals

- LHC heavy ion physics at **ALICE experiment**.
- Perform high precision measurements for the quantitative determination of QPG properties at the highest temperature.
- Run-1 (2009-2013) and Run-2 (2015-2018) data.
- **Jets and photons measurements**, Japan and France in ALICE, by EMCal/DCal detectors, which has been built within the framework of France-Japan collaboration.

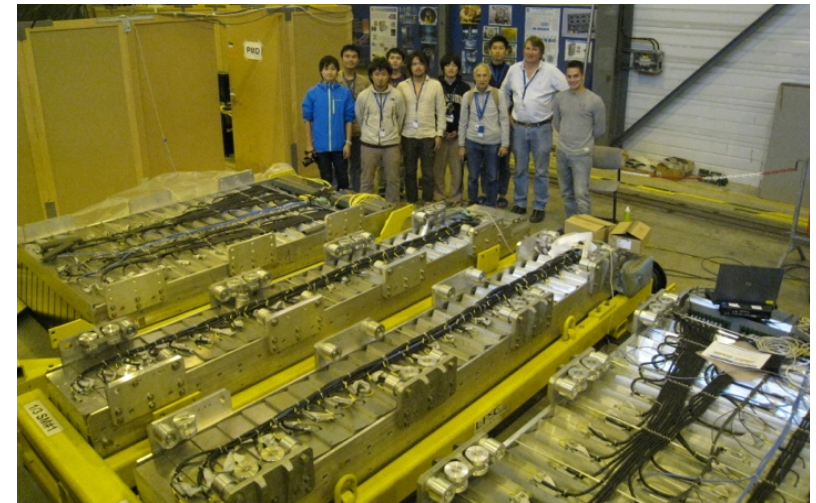
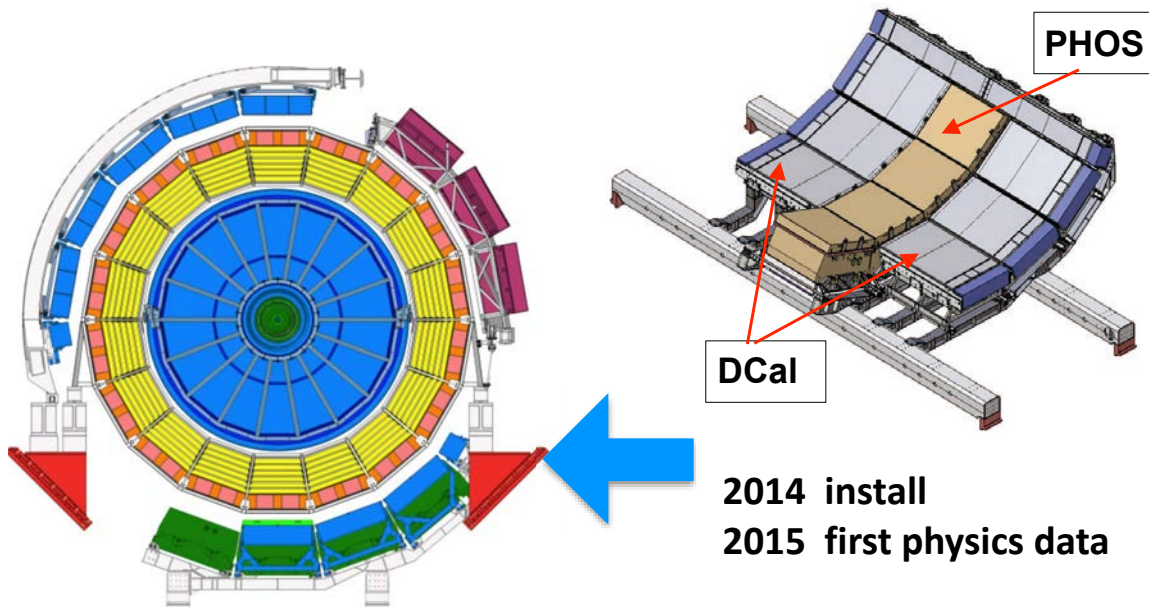


Relativistic Heavy-Ion Collisions

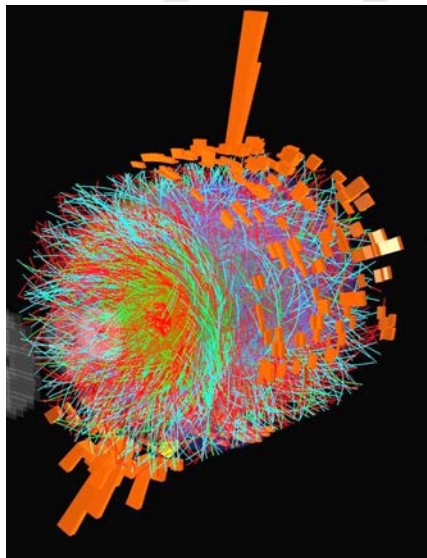
made by Chun Shen



Probing new physics by ALICE-DCal



DCal super modules @ CERN (before installation)

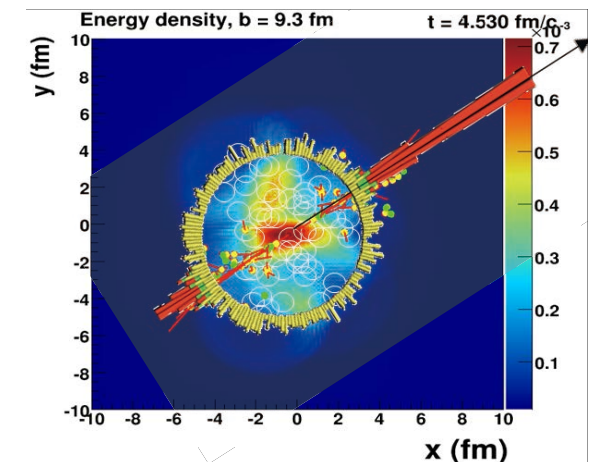


Pb-Pb 5.02 TeV with di-jet candidate (Run-2 data, 2015)

ALICE DCal

New electromagnetic calorimeter for jet and photon physics, by **US, Japan, France, China, Italy**

• T. Chujo : EMCal • DCal deputy project leader



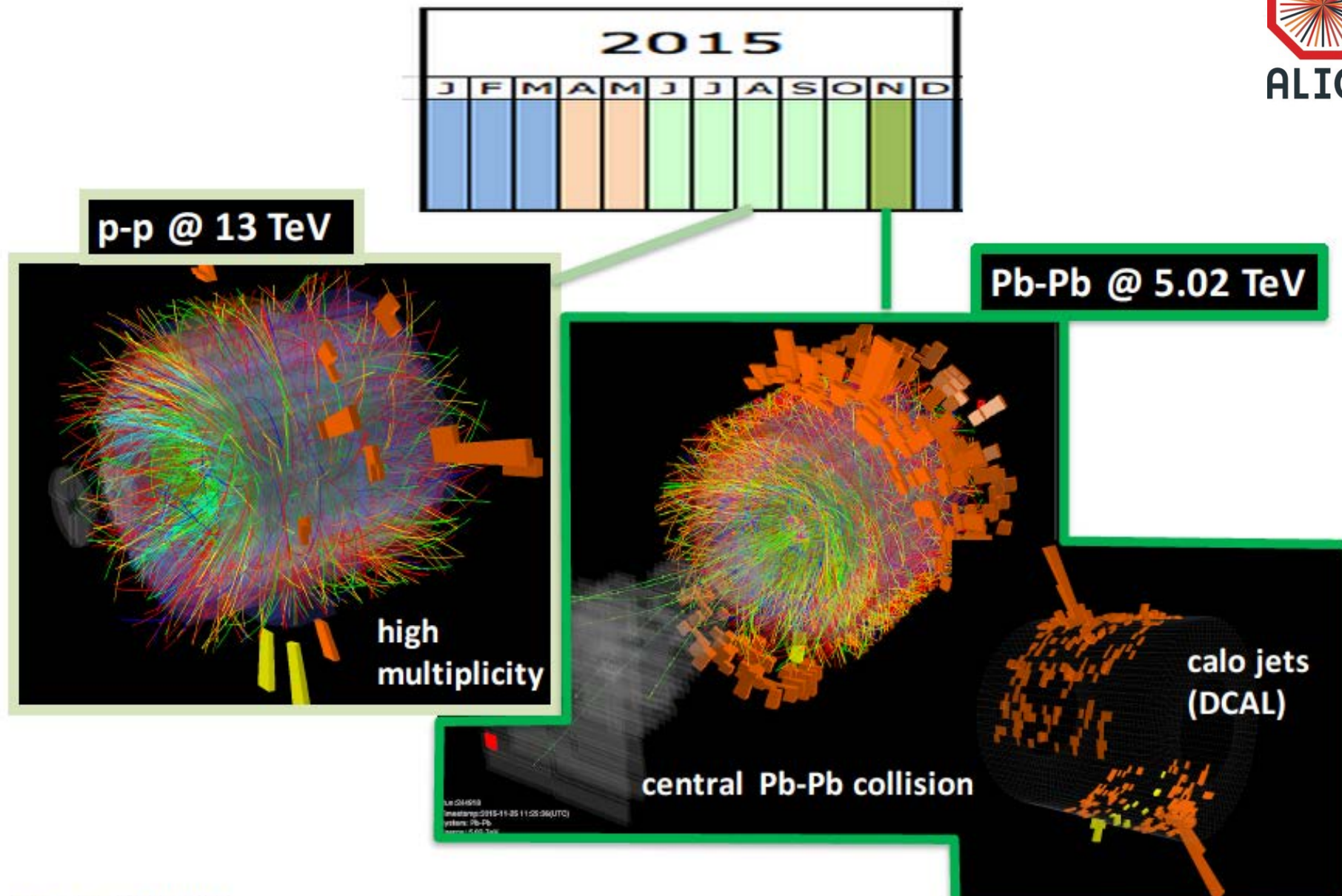
di-jet with mach cone radiation (theory)

**From discovery to determination of properties
Quark Gluon Plasma (QGP) by using jets and photons**

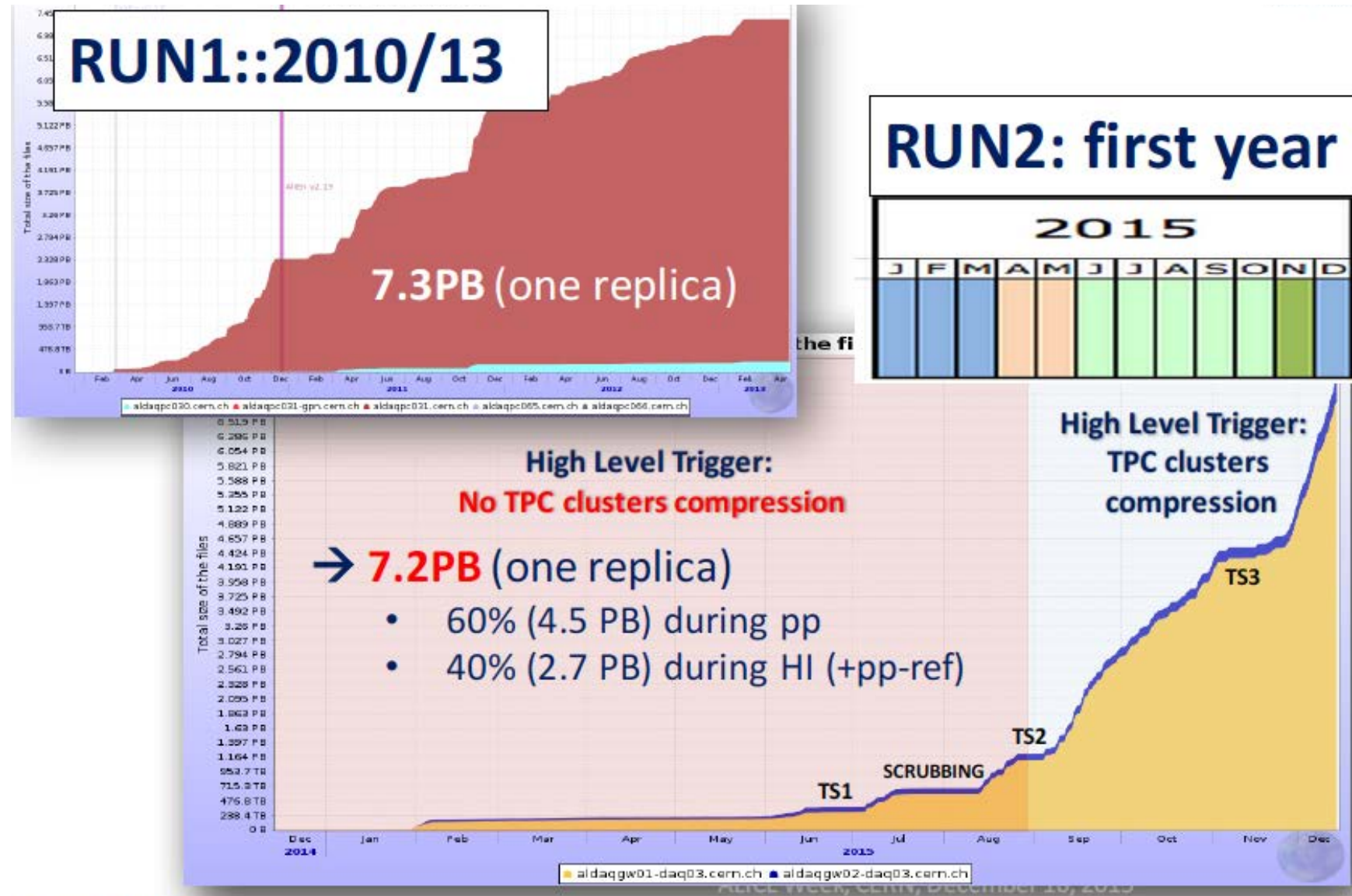


Search for the gluon radiation, Equation of state of QGP

Overview of ALICE 2015 data taking

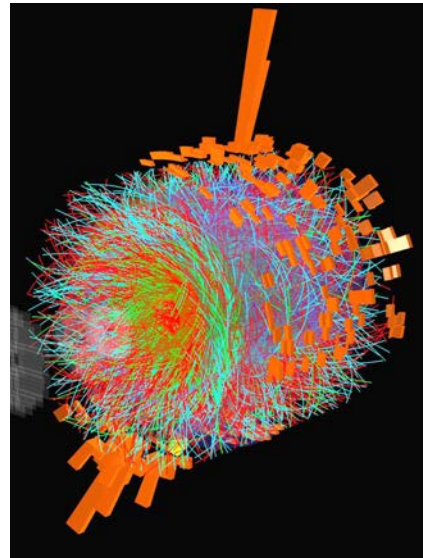
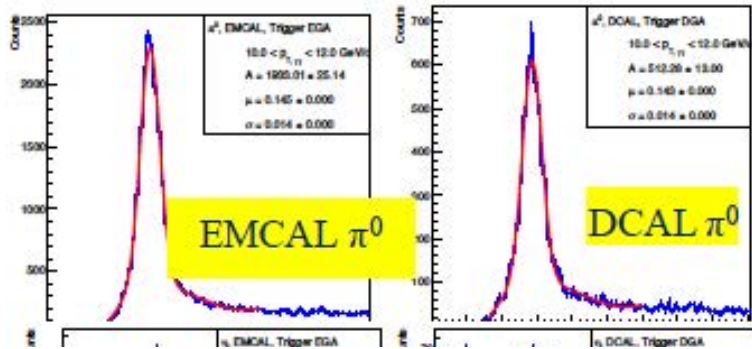


ALICE data taking profile: Run-2 vs. Run-1

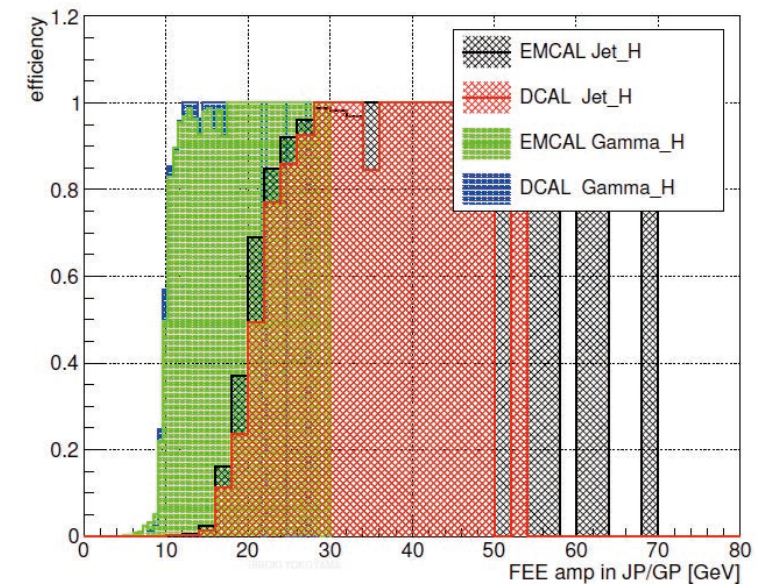


Project report (FY2015)

First year of DCal, jet/photon L1 trigger

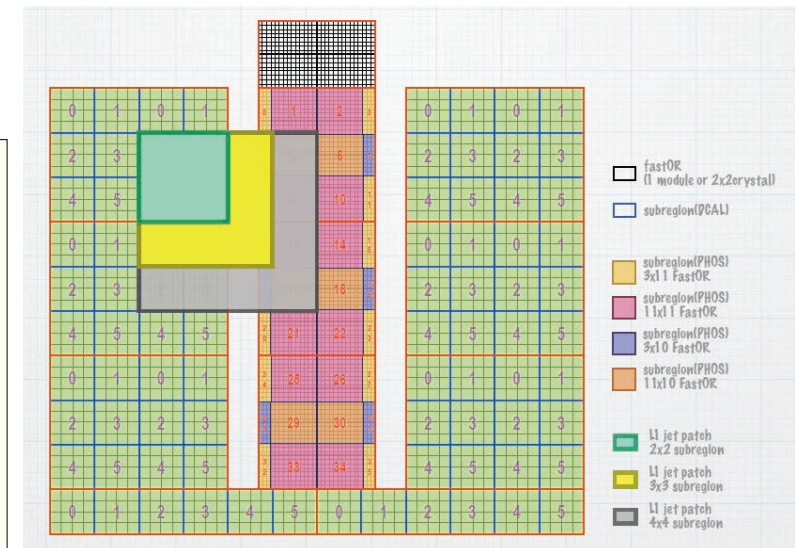


Jet trigger efficiency



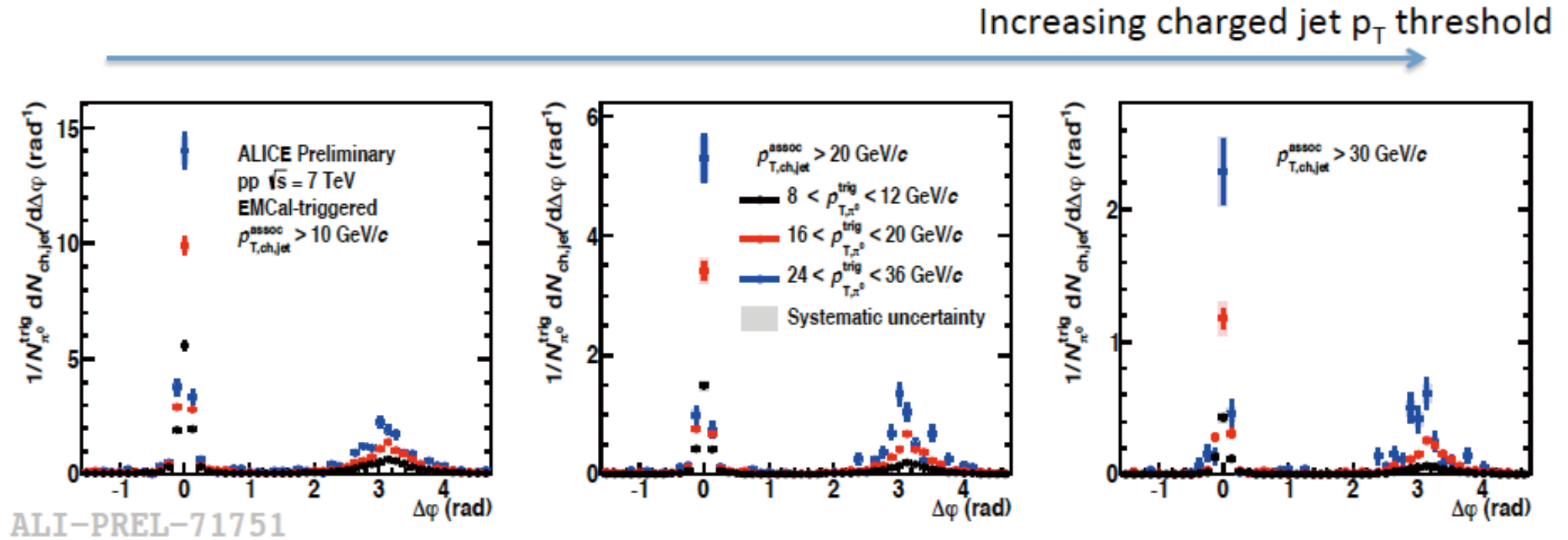
H.Yokoyama, R. Hosokawa, R. Guernane, J. Kral, T. Chujo

- **DCal and L1 trigger: Operational in 2015, first year of physics data taking.**
- Grenoble LPSC - Tsukuba- Jyvaskyla team for L0/L1 trigger
 - **Tsukuba: EMCal/ DCal /PHOS Level-1 jet & photon trigger, FPGA firmware development.**
- Reasonable turn-on curve on jet trigger.
- Rejection factor 10^4 at 30 GeV jet.
- **Physics data analysis is on-going.**



↑ DCal + PHOS trigger patch (H. Yokoyama)

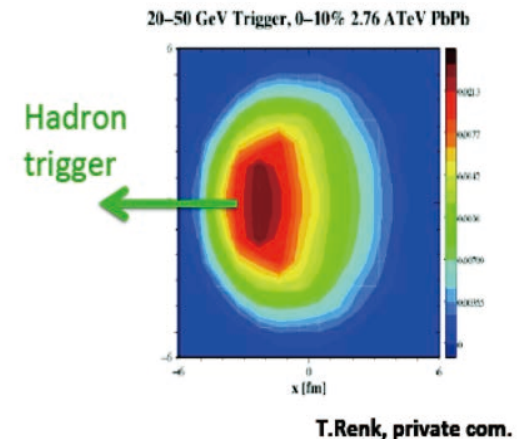
π^0 -jet correlations to determine path length dep. of energy loss



D. Watanabe (PhD)

π^0 -jet correlations in pp and PbPb

- **Daisuke Watanabe (Tsukuba), obtained PhD in 2016, March.**
- Developed by FJPPL, presented at QM2015 (Kobe)
- Study of jet structure by triggering high p_T π^0 hadrons.
- pp 7 TeV finished, and Pb-Pb 2.76 TeV finalizing for the publication.



Dual Degree Program (Ph.D) Grenoble U. - U. of Tsukuba

- Grenoble University (Joseph Fourier) and University of Tsukuba, agreed to start **the joint double degree program (Ph.D) in 2015.**
- Supervised by two institutes (Grenoble and Tsukuba) on same thesis topics.
- Ph.D from both Grenoble and Tsukuba after successful defense.
- URL (in Japanese): <http://www.pas.tsukuba.ac.jp/overview/program/double-degree/>
- **Two students** in this program within the framework of FJPPL:
 - **Hiroki Yokoyama** (U. Tsukuba): started April 2015.
 - “Jet spectra at 5.02 TeV in Pb-Pb (ALICE)”
 - Defence expected Sep. 2017
 - **Ritsuya Hosokawa** (U. Tsukuba): started Sep. 2015.
 - “Full jet pT spectra in 13 TeV p-p” and “jet-hadron correlations in PbPb(future)”

ALICE Calo meeting in Osaka (2015)

- Discussed EMCal/DCal/ PHOS, jet and photon physics, within FJPPL, including Russian collaboration.
- 2.5 days, around 30 participants.
 - <https://indico.cern.ch/event/439906/>



ALICE CALO meeting in Osaka

5-7 October 2015
OSAKA
Asia/Tokyo timezone


ALICE
A JOURNEY OF DISCOVERY

Overview
Scientific Programme
Timetable
Contribution List
Author List
My Conference
My Contributions
Registration
Participant List
Videoconference Rooms

ALICE CALO meeting in Osaka

- Date: Oct 5 - 7, 2015
- Venue:
 - Osaka University Nakanoshima center
 - Room 302 on 3F: discussion space
 - Room 303 on 3F: meeting space
 - Address: 4-3-53 Nakanoshima Kita-ku Osaka-city Osaka Japan 530-0005
 - Google map: [here](#)
 - Access map: http://www.onc.osaka-u.ac.jp/others/map/img/map_en.pdf
- Agenda (tentative):
 - Oct. 5 (Mon) AM: Registration, PM: PHOS related discussions
 - Oct. 6 (Tue) AM/PM: Physics by using PHOS/DCal + EMCal
 - Oct. 7 (Wed) AM: CALO trigger
- We also plan to have presentations by all graduate students participated in this workshop, and to show their current work and plan in 20 min. each.

- Next meeting in Tokyo 2016, May-June.
 - <https://indico.cern.ch/event/506125/>



ALICE CALO Meeting in Tokyo 2016

from 30 May 2016 to 1 June 2016
Tokyo
Japan timezone

ALICE
ALICE Calo meeting in Tokyo 2016

Overview
Scientific Programme
Timetable
My Conference
Registration
Participant List

Starts 30 May 2016 08:00
Ends 1 Jun 2016 18:00
Japan

Torui Sugitate
Tatsuya Chujo

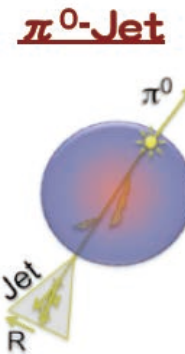
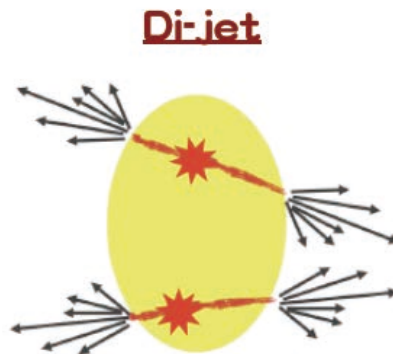
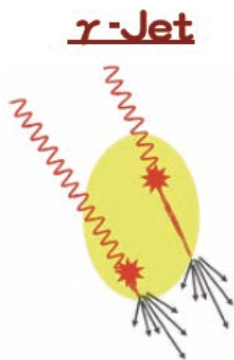
Tokyo
3-3-6 Shibaura Minato-ku Tokyo 108-0023
Japan

Materials
There are no materials yet.

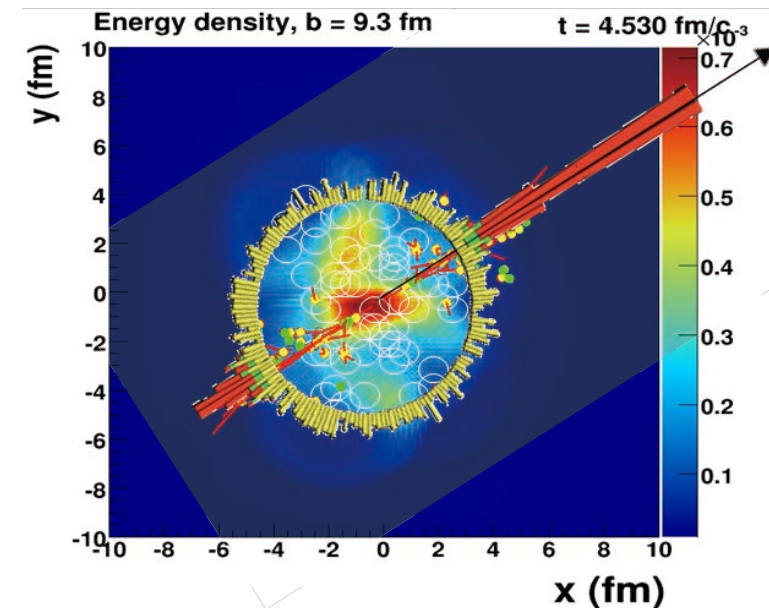
Project proposal (FY2016)

Keys to understand dE/dx in QCD plasma

1. Control path length (parton scattering point)
2. Energy calibration (e.g. γ -jet)
3. Detection of medium response by jet (parton) propagation



- Within the framework of FJPPL and FCPPL, we developed the new analysis team in ALICE, called **AAF (ALICE Asian France) collaboration**.
- First results on jet at “Hard Probe 2016 (Wuhan)”, and continue for the future jet/ photon analysis.



QGP fluid + jet model

Y. Tachibana, T. Hirano
(QM2015)

1. Mach cone as a hydrodynamic response

- Fluidity of the bulk medium
- Properties of QGP e.g. sound velocity, viscosity, stopping power, etc.

2. Bulk dynamics of the QGP in jet events in HIC

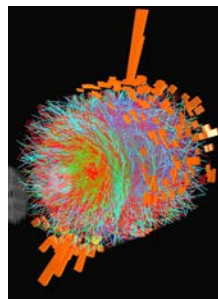
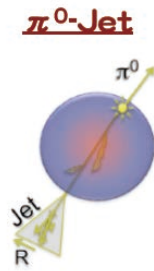
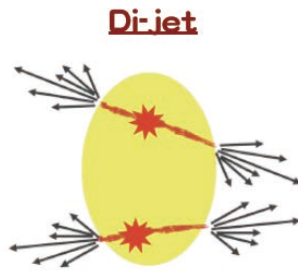
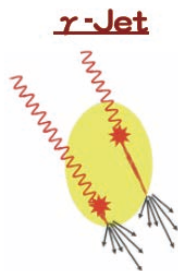
- Hydrodynamic response to jets in the expanding QGP
- Consequent spectra of particles from the bulk medium

Hydrodynamic equations with source terms

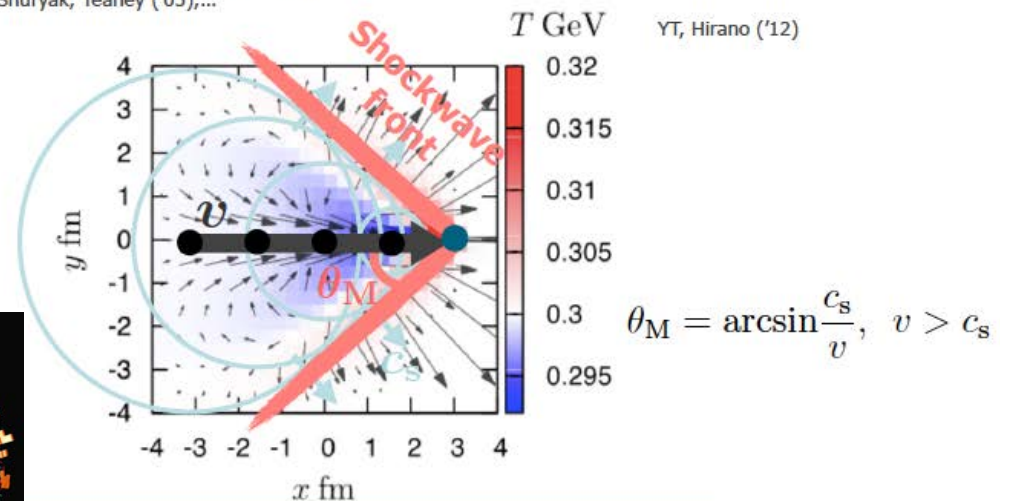
$$\partial_\mu T^{\mu\nu} = J^\nu$$

Energy-momentum tensor
of the QGP fluid

Energy and momentum
deposited from the jets



Stoecker ('05), Casalderrey-Solana,
Shuryak, Teaney ('05),...



HAD_01: Project Members

FJPPL (TYL) application 2016-2017

Fiscal year April 1st 2016 – March 31st 2017

Please replace the red examples by the appropriate data in black

| ID ¹ :HAD_01 | Title: Measurements of Jets and Photons in Heavy Ion Collisions at the Highest Beam Energy during the LHC-Run 2 by ALICE | | | | | |
|-------------------------|--|-------|----------------------------|------------------------------|-------|---------------------------|
| Leader Members | French Group | | | Japanese Group | | |
| | Name | Title | Lab./Organis. ² | Name | Title | Lab/Organis. ³ |
| | <u>Leader:</u> Yves Schutz | DR1 | IPHC | <u>Leader:</u> Tatsuya Chujo | Dr | U. Tsukuba |
| | <u>Deputy leader:</u> Christophe Furget | Pr | LPSC | Yasuo Miake | Pr | U. Tsukuba |
| | Gustavo Conesa Balbastre | CR2 | LPSC | Shinichi Esumi | Dr | U. Tsukuba |
| | Renaud Vernet | IR | CCIN2P3 | Oliver Busch | Dr | U. Tsukuba |
| | Alexander Shabetai | CR1 | SUBATECH | Toru Sugitate | Pr | U. Hiroshima |
| | Marie Germain | CR1 | SUBATECH | Kenta Shigaki | Pr | U. Hiroshima |
| | Rachid Guernane | CR1 | LPSC | Hideki Hamagaki | Pr | U. Tokyo |
| | Julien Faivre | MC | LPSC | Taku Gunji | Dr | U. Tokyo |
| | Gines Martinez | DR2 | SUBATECH | Yosuke Watanabe | Dr | U. Tokyo |
| | | | | Motoi Inaba | Pr | U. Tsukuba Tech. |
| | | | | Ken Oyama | Pr | NiAS |

HAD_01: Funding request (2015-2016)

| France | | | | |
|-------------------------------|---------|---------------------------|------------|-----------------------------|
| Funding Request from France | | | | |
| Description | €/unit | Nb of units | Total (€) | Requested to ⁴ : |
| Visit to Japan (Travels) | 1200 | 4 travels | 4800 | |
| Stay in Japan (local expense) | 90/day | 40 days | 3600 | |
| Stay in France | 90/day | 20 days | 1800 | |
| Total | | | 10200 | |
| Japan | | | | |
| Funding Request from KEK | | | | |
| Description | k¥/Unit | Nb of units | Total (k¥) | Requested to: |
| Travels (students) | 150 | 4 travels (Round trip) | 600 | KEK |
| Stay in France (students) | 10/day | 60 days | 600 | KEK |
| Total | | | 1,200 | |

* Requested same amount as last year for the travel support in France and Japan, most for the students and young researchers.

Summary

✓ 2015:

- Successful first ALICE DCal data taking with L1, developed by FJPPL
- Started double degree PhD program between Grenoble - Tsukuba, two students enrolled.
- Presented jet results (Run-1) developed by FJPPL at QM2015
- Held “ALICE Calo meeting in Osaka (2015)” within FJPPL
- New “AAF analysis team” formed by FJPPL, FCPPL, work on Run-2 data.
- D. Watanabe obtained Ph.D (2016, March, Tsukuba U.)
- Two master students in Tsukuba have been supported by “TYL-FJPPL Student or Early Stage Researcher Secondment”). **Thank you!**

✓ 2016:

- Continue 2015 activities:
 - **Data analysis (Run-2 jet and photon results) → physics outputs & publications (by FJPPL, AAF)**
 - Double degree program, EMCal/DCal and L1 trigger

Thank you for the continuous and strong support by TYL/FJPPL !