

FJPPL HAD_01

Measurements of \bar{J} ets and Photons in Heavy Ion Collisions at the Highest Beam Energy during the LHC-Run 2 by ALICE

FKPPL ALICE-b

b-Jet Tagging in Heavy-ion collisions at the LHC

R. Guernane on behalf of the HAD_01 & ALICE-b projects

2017 Joint Workshop of the France-Korea (FKPPL) and France-Japan (TYL/FJPPL) Particle Physics Laboratories

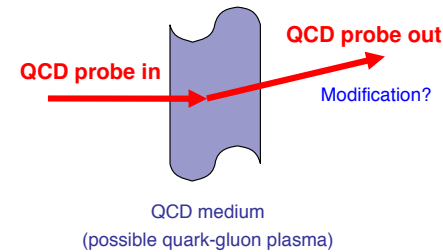
10-12 mai 2017

IPHC Strasbourg (France)

Introduction

Hard probes of the QGP

- Study of *jet quenching* phenomena in HIC
 - Hard scattering processes relative to baseline cross sections precisely calculable w/i pQCD and/or measured in pp and p-Pb collisions ('control experiment')



- Medium properties constrained from a wide range of observables
 - Inclusive production cross-section of (full) jets
 - π^0 /photon-hadron/jet correlations
 - (Full) di-jets
 - Semi-inclusive hadron-jet distributions
 - c/b-tagged jets **FKPPL ALICE-b new proposal**

**FJPPL
HAD_01
extension**

Prospects for 2017-18: More differential study of jet quenching

Organization

- Since 2014 Annual ALICE France-Japan Workshop w/i the FJPPL framework
 - This year 4th edition <https://indico.cern.ch/event/619443/>

France-Japan workshop on physics analysis in the ALICE experiment

Tuesday 9 May 2017, 07:00 → 20:20 Europe/Zurich
 Other Institutes
 Rachid Guernane (Centre National de la Recherche Scientifique (FR)) , Tatsuya Chujo (University of Tsukuba (JP))

Description The Japan - France analysis workshop will discuss seminal topics of the ALICE physics in p+p, p+Pb and Pb+Pb collisions. A list of topics:

- Direct photon and neutral particle identification with calorimeters
- Full jet reconstruction
- Jet composition, B tagging
- Direct photon / Identified hadron-jet correlations
- Calorimeter trigger developments
- Theory in jet quenching and beauty jets
- Open beauty production in the semileptonic and jpsi decay
- Quarkonia
- ALICE upgrade projet

It will also cover parts of the ALICE detector upgrade for Run2 and Run3, perspectives of measurements to be done by ALICE in Run2 as well as theoretical presentations.

It will take place at Strasbourg

- 21 Talks (1 from theory)
- Keynote talks by PC & PWG conveners
- Upgrades & futur experiments

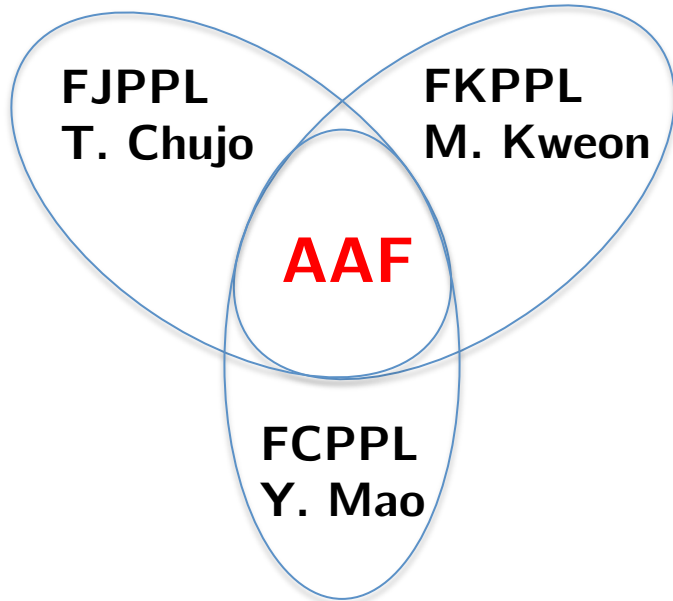
08:00	→ 08:30	ALICE results from Run2 and perspectives for Run3	🕒 30m
Speaker: Dr. Andreas Morsch (CERN)			
08:30	→ 08:45	France-Japan collaboration I	🕒 15m
Speaker: Rachid Guernane (Centre National de la Recherche Scientifique (FR))			
08:45	→ 09:00	France-Japan collaboration II	🕒 15m
Speaker: Gines Martinez-Garcia (Subatech CNRS)			
09:00	→ 09:30	Present and future directions in jet physics	🕒 30m
Speaker: Oliver Busch (University of Tsukuba (JP))			
09:30	→ 10:00	Coffee/Tea break	🕒 30m
10:00	→ 10:20	Charged jet spectra in pp at 5.02 TeV	🕒 20m
Speaker: Ritsuya Hosokawa (University of Tsukuba (JP))			
10:20	→ 10:40	Charged jet spectra in Pb-Pb at 5.02 TeV	🕒 20m
Speaker: Hiroki Yokoyama (University of Tsukuba (JP))			
10:40	→ 11:00	Full di-jets in pp and Pb-Pb at 5TeV	🕒 20m
Speaker: Tatsuya Chujo (University of Tsukuba (JP))			
11:00	→ 11:30	Present and future directions in photon physics	🕒 30m
Speaker: Ana Marin (GSI - Helmholtzzentrum für Schwerionenforschung GmbH (DE))			
11:30	→ 11:50	Photon-hadron correlations in p-Pb	🕒 20m
Speaker: Astrid Vauthier (Centre National de la Recherche Scientifique (FR))			

11:50	→ 13:20	Lunch break	🕒 1h 30m
13:20	→ 13:40	Heavy flavor to electrons	🕒 20m
Speaker: Shingo Sakai (Istituto Nazionale Fisica Nucleare Frascati (IT))			
13:40	→ 14:00	b-tagging	🕒 20m
Speaker: Min Jung Kweon (Inha University (KR))			
14:00	→ 14:20	D mesons in pp	🕒 20m
Speaker: Julien Charles Hamon (Institut Pluridisciplinaire Hubert Curien (FR))			
14:20	→ 14:40	Quarkonia in pp, p-Pb and Pb-Pb	🕒 20m
Speaker: Benjamin Audurier (Centre National de la Recherche Scientifique (FR))			
14:40	→ 15:10	HF plans towards Run2	🕒 30m
Speaker: Elena Bruna (Universita e INFN Torino (IT))			
15:10	→ 15:30	What is RIVET and why we should use it ?	🕒 20m
Speaker: Antonin Maire (Institut Pluridisciplinaire Hubert Curien (FR))			
Conf-2017-WkshpF...			
15:30	→ 16:00	Coffee/Tea break	🕒 30m
16:00	→ 16:20	ITS upgrade & O2	🕒 20m
Speaker: Jouri Belikov (Institut Pluridisciplinaire Hubert Curien (FR))			
16:20	→ 16:40	O2 and future Tiers in Japan	🕒 20m
Speaker: Toru Sugitate (Hiroshima University (JP))			
16:40	→ 17:10	nPDFs and charmed meson cross sections within GM-FVNS	🕒 30m
Speaker: Ingo Schienbein (Universite Joseph Fourier)			
17:10	→ 17:30	FOCAL: the physics	🕒 20m
Speaker: Thomas Peitzmann (Nikhef National Institute for subatomic physics (NL))			
17:30	→ 17:50	FOCAL: the detector	🕒 20m
Speaker: Motoi Inaba (University of Tsukuba (JP))			
17:50	→ 18:10	J-PARC heavy-ion	🕒 20m
Speaker: Hiroyuki Sako			

Thanks to IPHC!

Organization

ALICE Asian France



- Seminal long standing FJPPL HAD_01 project
- Physics analysis (and more) F[C/J/K]PPL ALICE TF created in 2015 thanks to the very unique/decisive impulsion from LIAs
 - Coordinate our effort to effectively/forcefully impact the worldwide ALICE physics program
 - Maximum use of the (young) talent dispersed throughout the groups
 - 5 (co-supervised) PhD, 3 Master, 2 postdocs
 - Ecosystem to foster new/starting physics analysis
 - 3 papers in preparation
 - Hold detailed discussions during **weekly** meetings

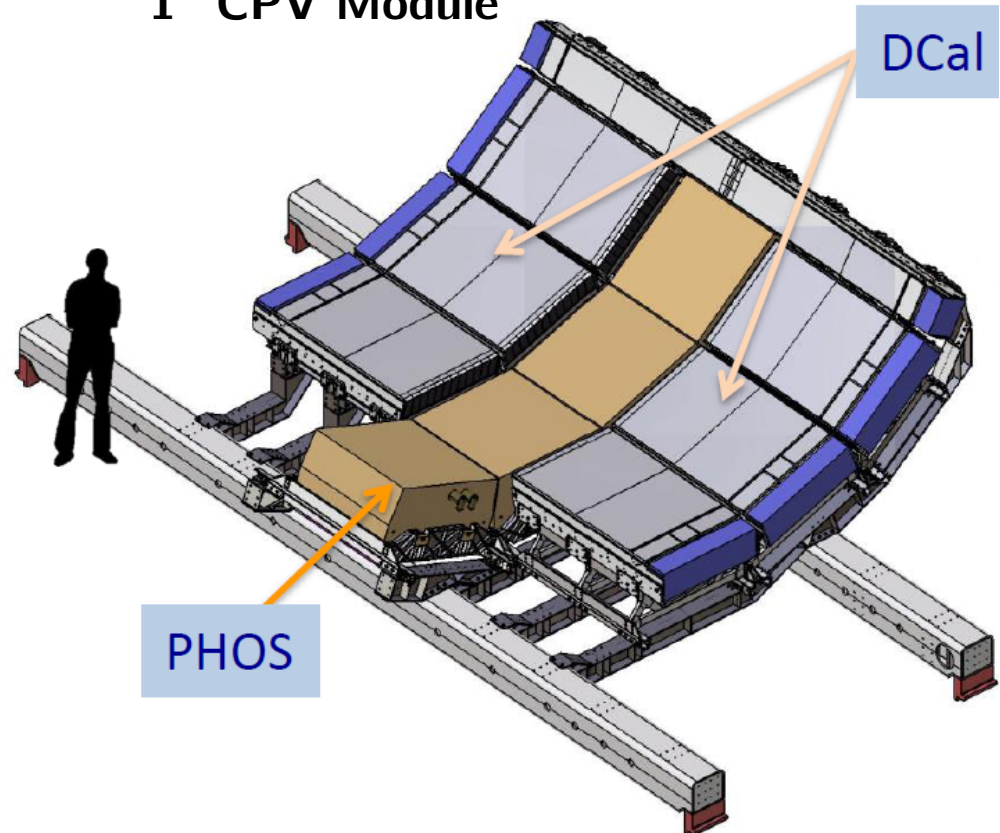
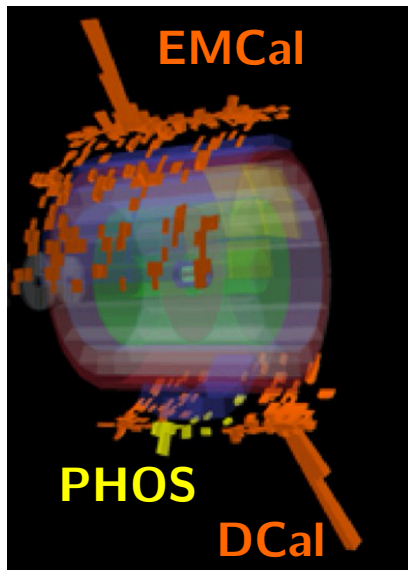
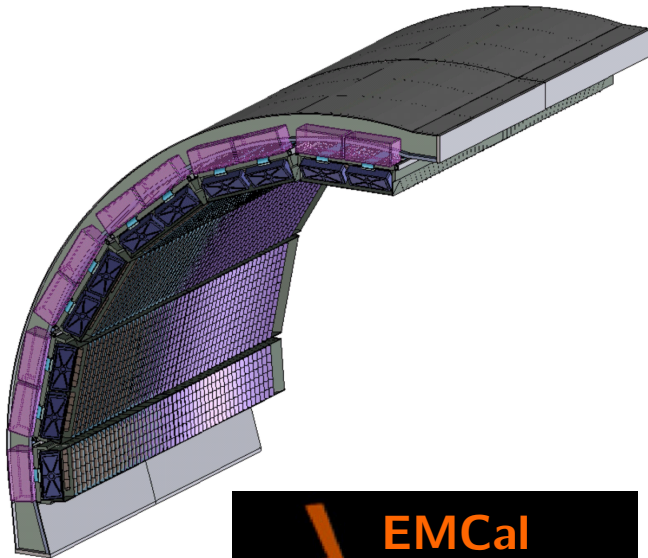
“Synergy is the creation of a whole that is greater than the sum of its parts”

Calorimeters for LHC Run 2

Big challenge for the Japanese & French teams!

- 12 EMCal Super-Modules
- 8 DCal Super-Modules
- 4 PHOS Modules
- 1 CPV Module

Nominal geometry



+ brand new L1 trigger fw! (see next slide)

FJPPPL HAD_01 Calorimeters operation w/ L1 triggers

- New original STU L1 firmware developed and commissioned (+on/off-line) in 2015-2016 by University of Tsukuba & LPSC Grenoble

- for EMCal, DCal, and PHOS (Hiroshima)
 - Aggregate DCal+PHOS
- for gamma and jets (2 patch sizes), 2 threshold levels each
- for pp, p-Pb
 - Constant threshold
- for Pb-Pb
 - Soft background event-by-event subtraction in EMCal estimated from the median of jet patch energies in DCal (and vice versa)

pp $\sqrt{s} = 13$ TeV

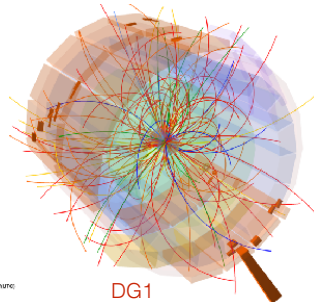
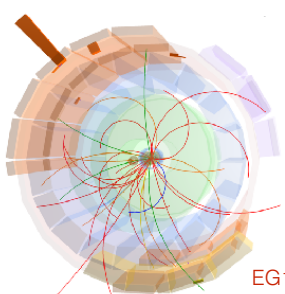
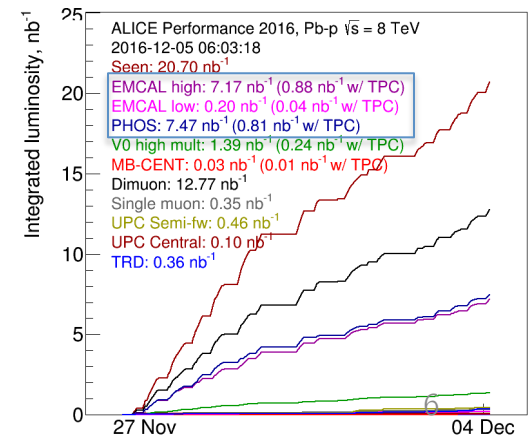
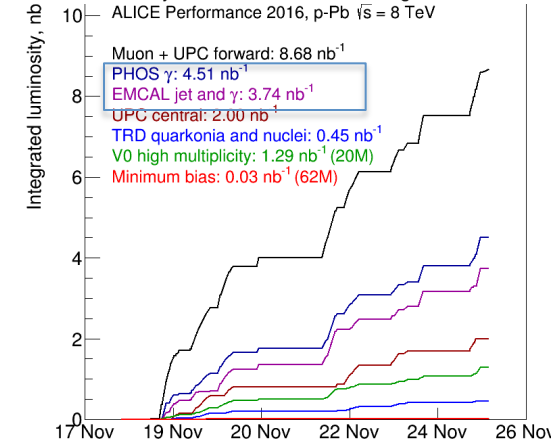
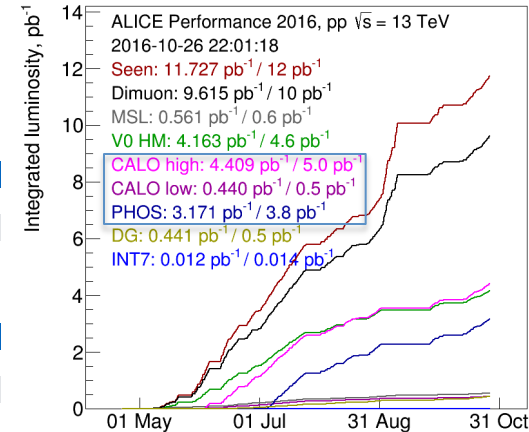
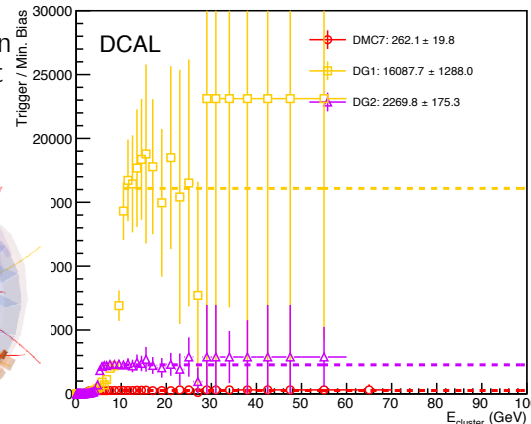
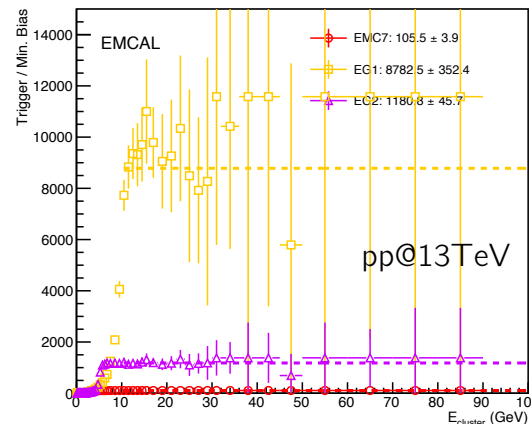
	Thresholds (GeV)				
	L0	G1	G2	J1	J2
EMCAL	2.5	9	4	20	16
DCAL	2.5	9	4	20	16

pPb $\sqrt{s_{NN}} = 8.16$ TeV

	Thresholds (GeV)				
	L0	G1	G2	J1	J2
EMCAL	2.5	8	5.5	23	18
DCAL	2.5	8	5.5	23	18

PbPb $\sqrt{s_{NN}} = 8.16$ TeV

	Thresholds (GeV)				
	L0	G1	G2	J1	J2
EMCAL	3.5	8	5.5	23	18
DCAL	3.5	8	5.5	23	18

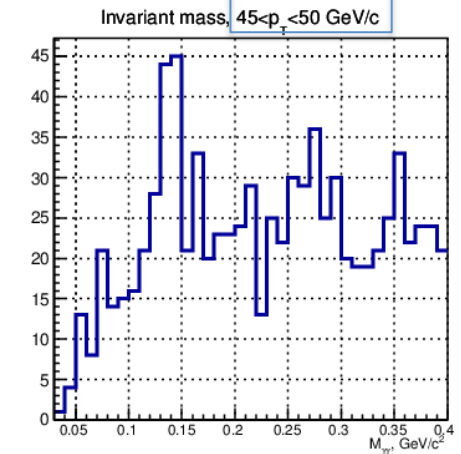
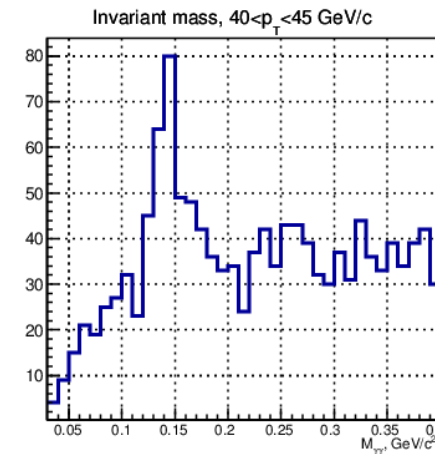
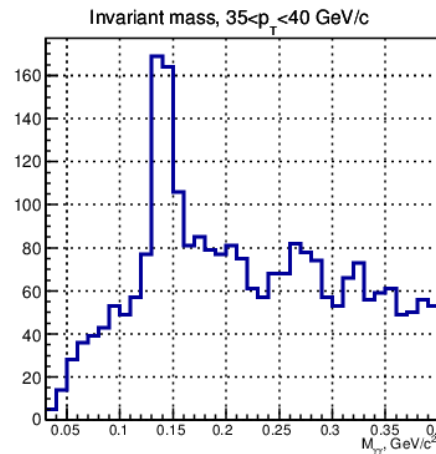
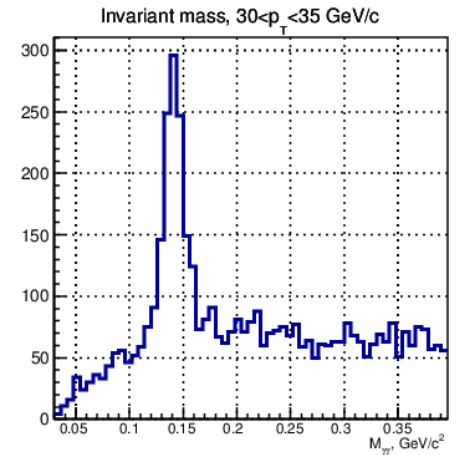
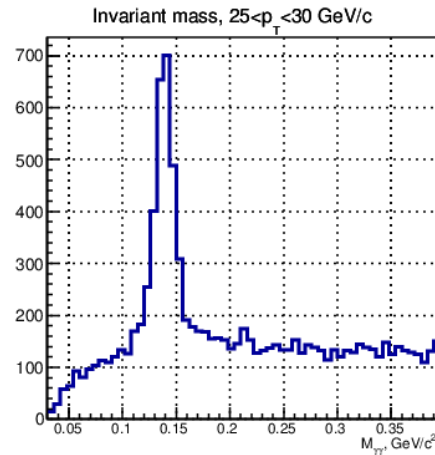
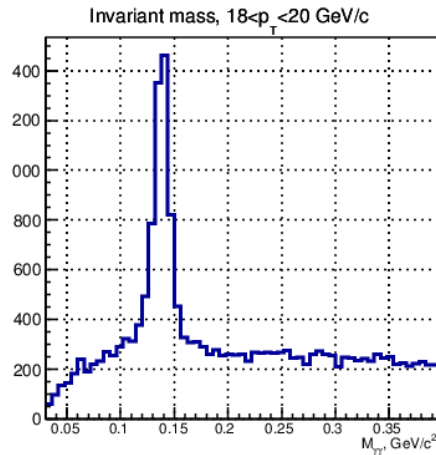


EG1

DG1

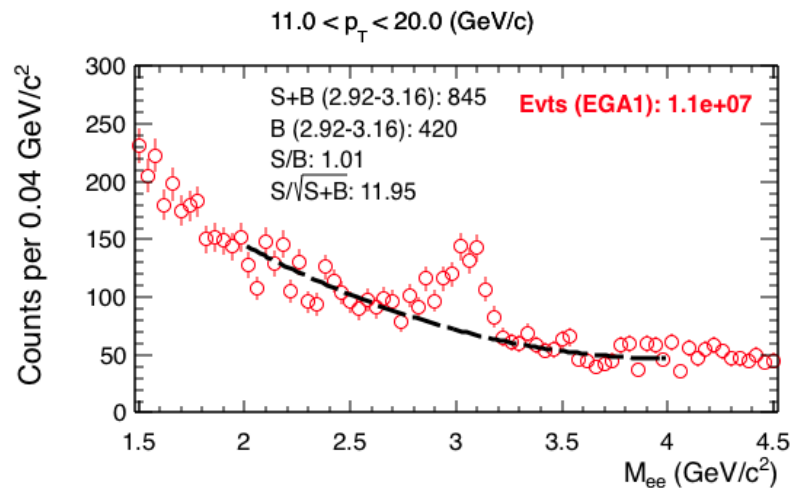
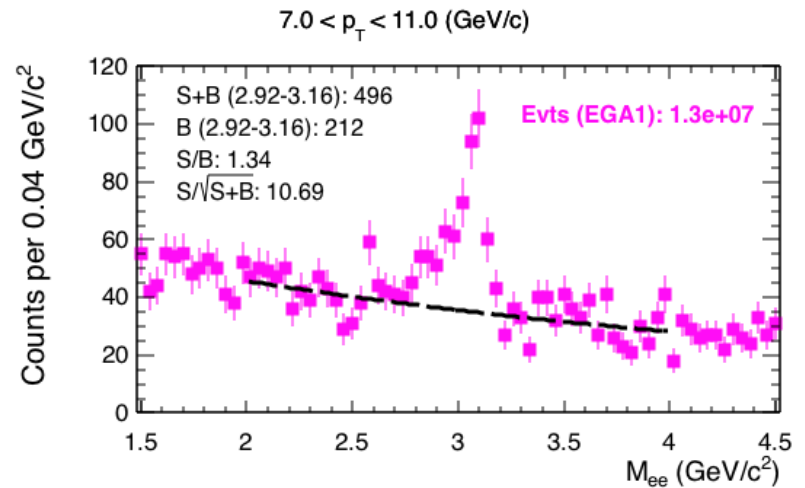
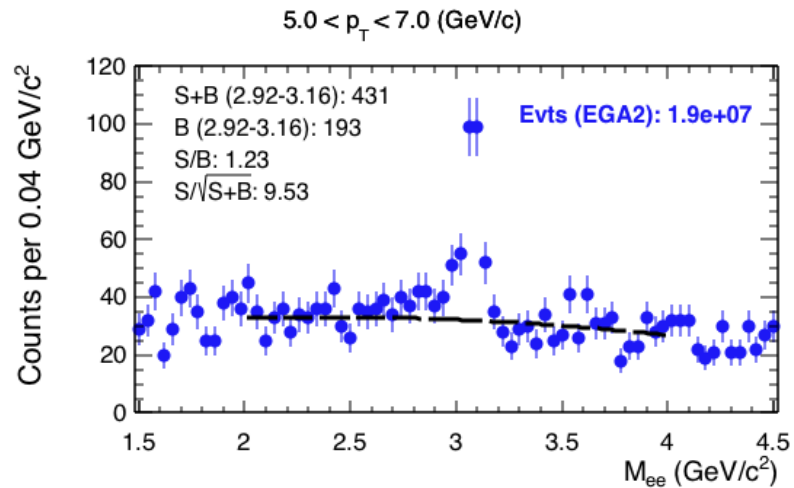
pi0 in p-Pb and Pb-p@8TeV w/ PHOS L1

- Same hw as EMCal/DCal (STU board from Grenoble) + dedicated fw (Tsukuba)



FJPPL HAD_01

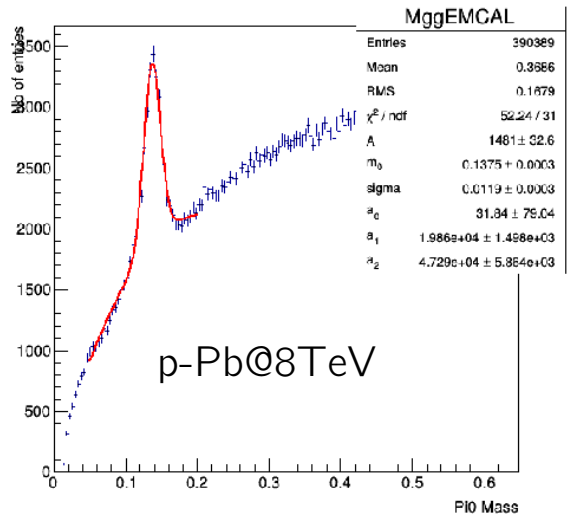
J/ψ with EMCAL L1-gamma trigger



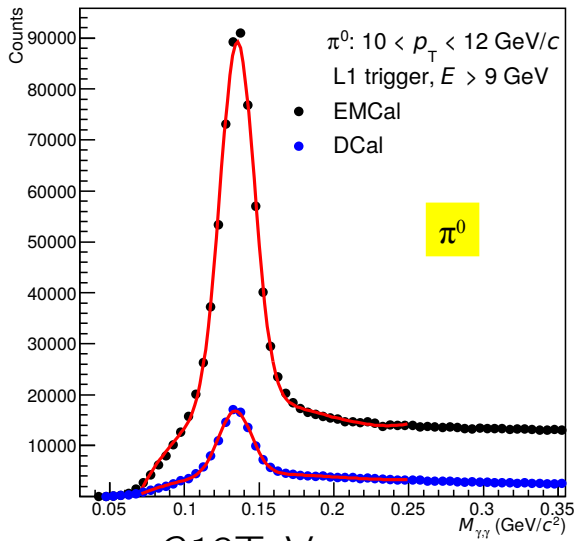
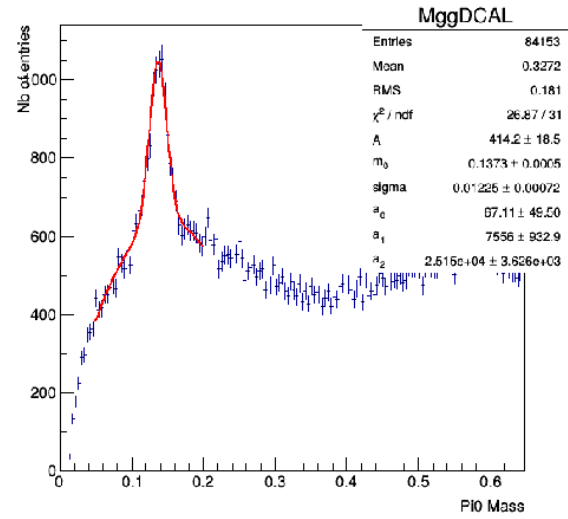
- EG2 E > 4 GeV (16k+16l)
- EG1 E > 7 GeV (16l)
- EG1 E > 11 GeV (16k)

EMCal/DCal Performance w/ L1 triggers in 2016

Pi0 Mass in EMCAL



Pi0 Mass in DCal

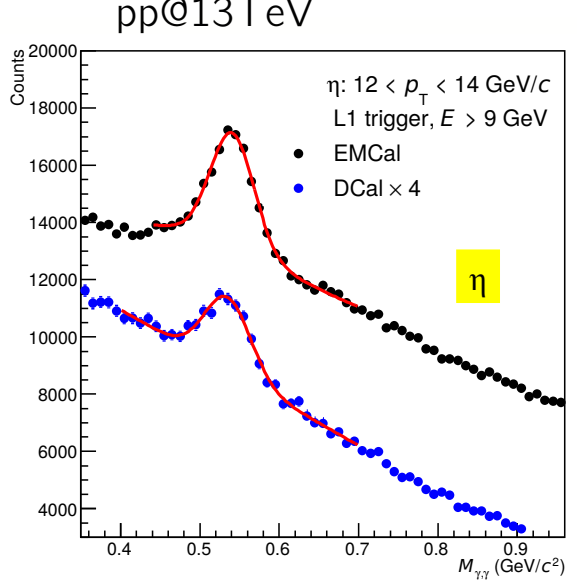
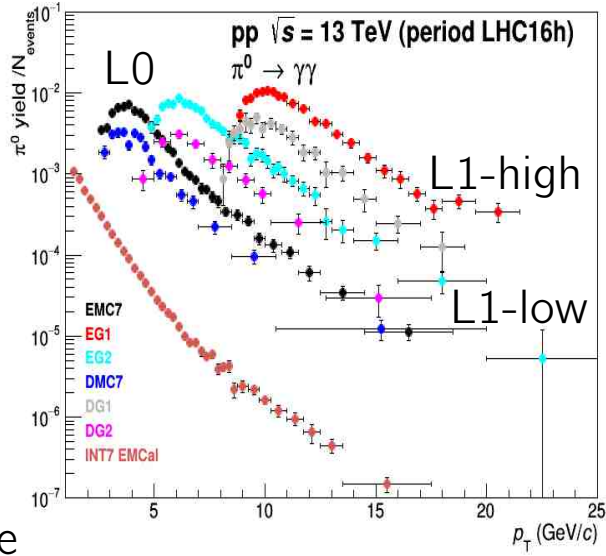


- Calorimeter trigger meetings during ALICE Weeks chaired by T. Chujo

• Next challenges

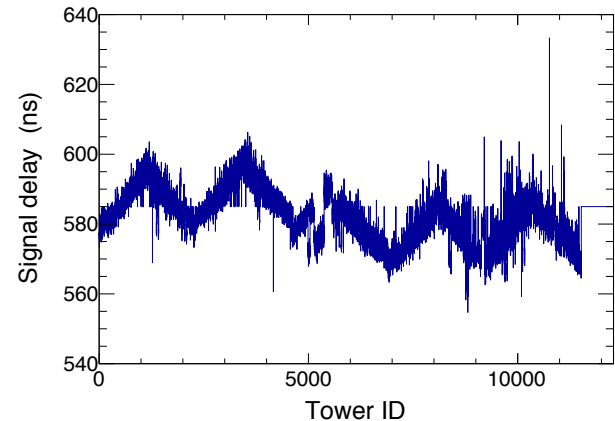
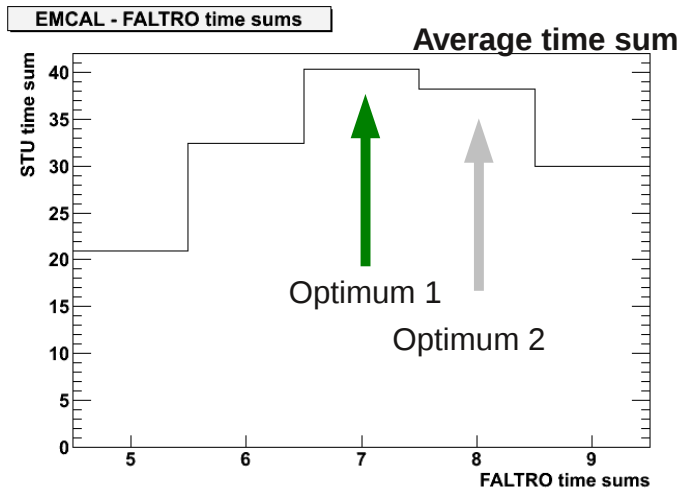
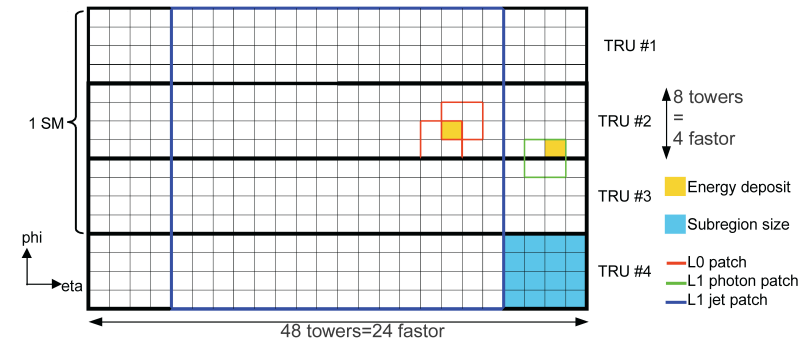
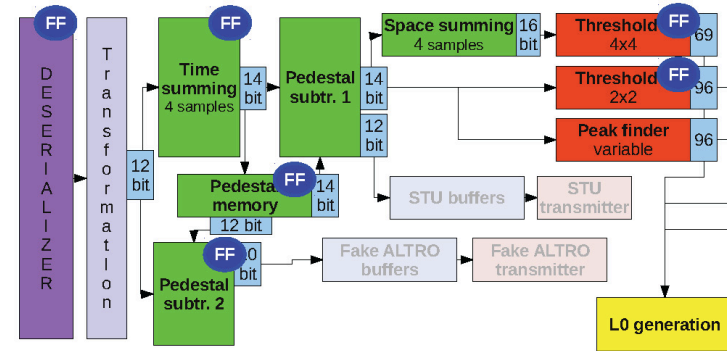
- Pb beams in 2018
- Enable PHOS in **DCal Jet Trigger**

- ALICE Calorimeter L1 trigger performance paper in preparation



ALICE Calorimeters Trigger Simulation

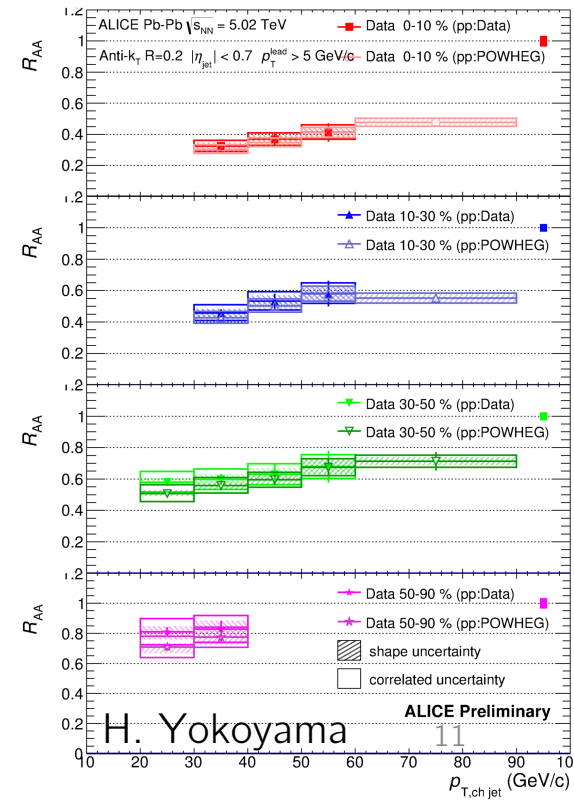
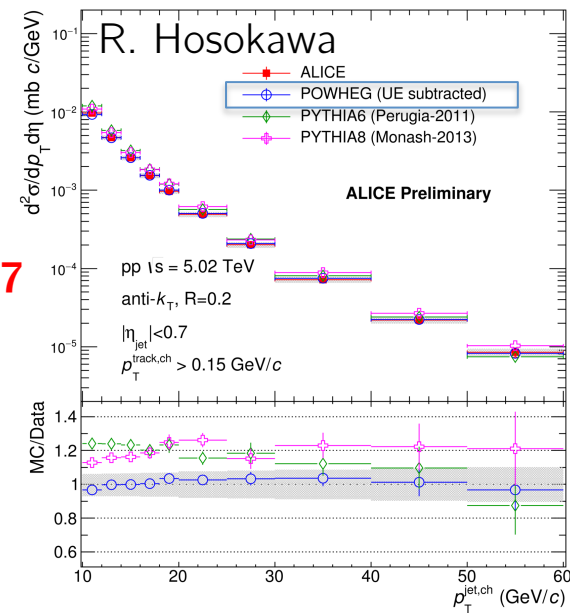
- Assess trigger performance
- Full simulation describing the whole trigger electronics chain
 - Include timing effects
- Sakurako Ishimaru Master 2 student from Nara
 - Awarded MEXT 'TOBITATE! Young Ambassador Program'
 - 6 months internship at LPSC Grenoble



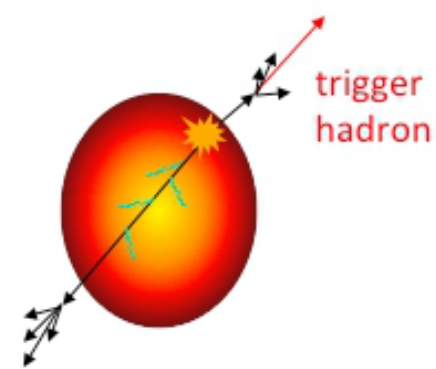
FJPPL HAD_01 [2016-2017]

Inclusive jet production

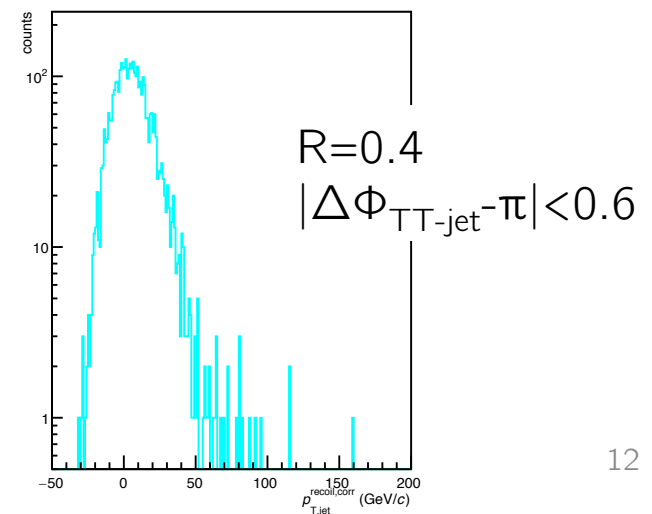
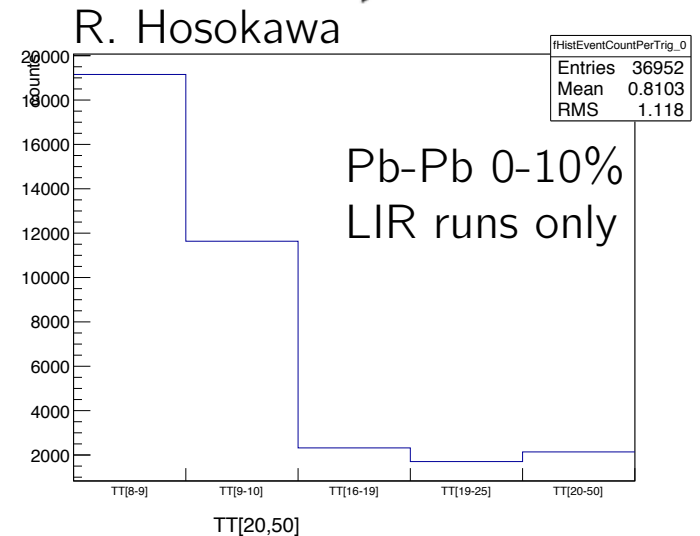
- See Hiroki's Talk
 - Co-supervised (Grenoble-Tsukuba) thesis defense **end of 2017**
 - Winner of the 2017 TYL-FJPPL Young Investigator Award!
- Fully reconstructed charged jets
 - Anti- k_T FastJet algorithm
 - Corrected event-by-event for average background density
 - Unfolded for residual background fluctuations & detector effects
- R_{Pb-Pb} measurements
 - Increasing suppression w/ increasing centrality
 - Weak p_T dependence
 - No significant increase of the suppression from 2.76 to 5.02 TeV
 - Similar to hadron $R_{AA} \rightarrow$ h-jet correlations (see next slide)
- Talk & poster at Hard Probes 2016 Conference in Wuhan, China
- 2017-2018
 - Add up HIR run statistics (largest fraction)
 - Description by models
 - POWHEG for pp collisions (H. Hassan)
 - JEWEL PLB735 (R. Hosokawa)
 - 2 papers publication



Semi-inclusive h-jet correlations in Pb-Pb@5TeV

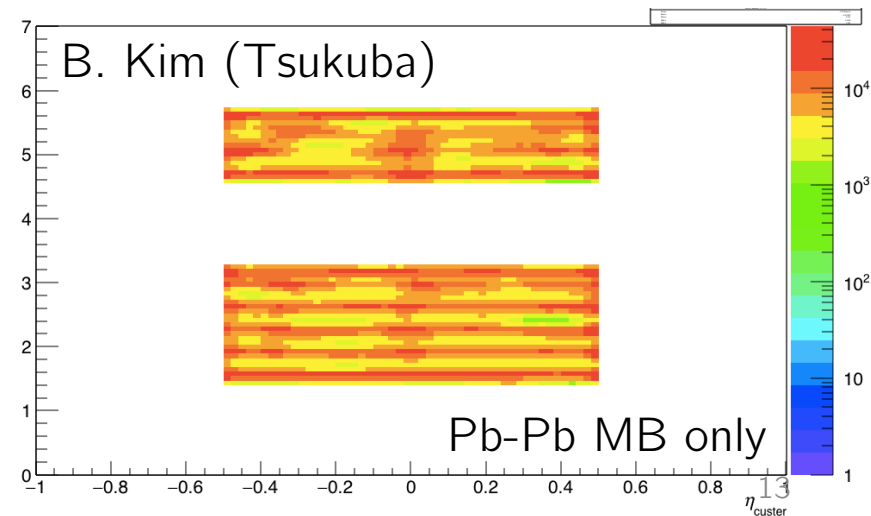
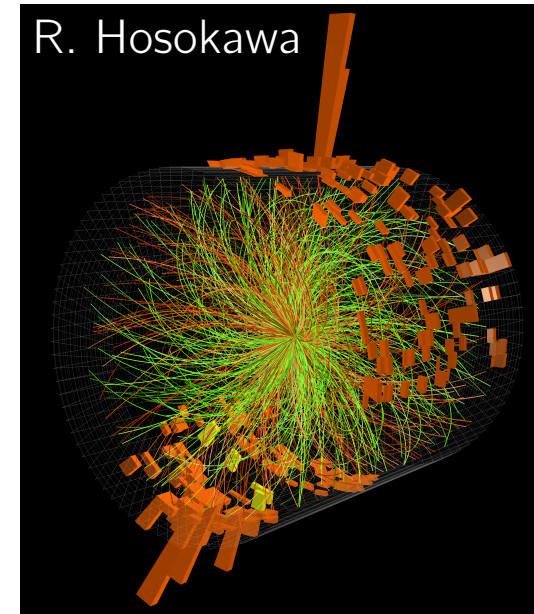


- R. Hosokawa's PhD thesis
 - Co-supervised Grenoble-Tsukuba defense foreseen for end of 2018
- Enables study of intra-jet and inter-jet angular broadening
 - from 2.76 [JHEP 09 (2015) 170] to 5.02TeV
- Directly comparable to analytic pQCD calculations
- No jet fragmentation bias & very low IR cut-off
 - Unique sensitivity to jet energy redistribution due to jet quenching
 - High- p_T hadron trigger imposes a significant “surface” bias
 - Maximize path length in matter for recoiling jets
 - Measure more differentially V. EV for (semi-)peripheral collisions
 - path-length dependence of jet quenching (in-plane = shorter path-length in the medium = less suppression)
- Work towards publication



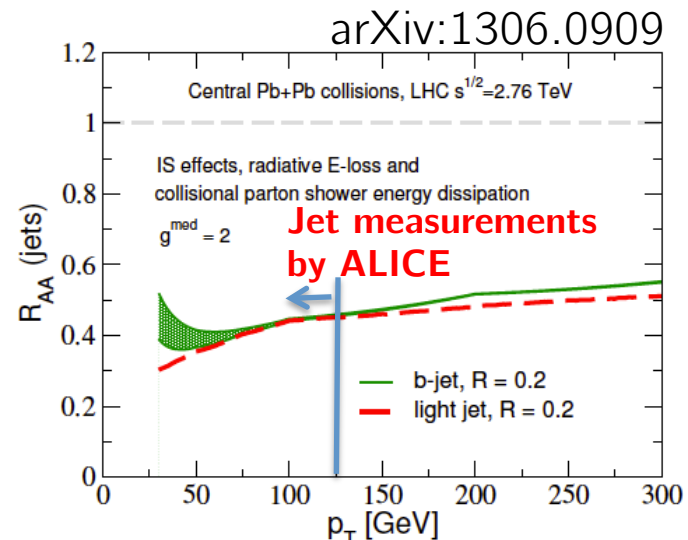
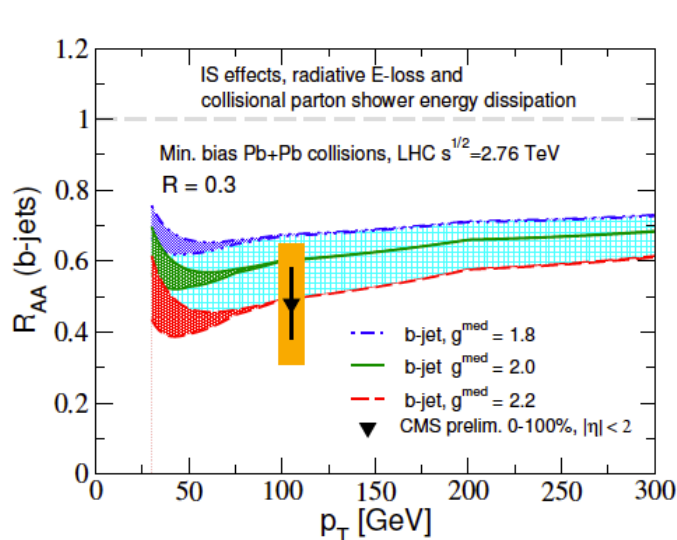
Full di-jets in pp&Pb-Pb@5TeV

- Byungchul Kim's PhD thesis started in 2017
- Di-jet p_T asymmetry observed in central Pb-Pb collisions due to jet quenching
- Study path length dependence dependence of quenching
- Include calorimeter clusters in jet finding
- Make use of the new L1 triggers



Motivations for *b*-tagging in HIC

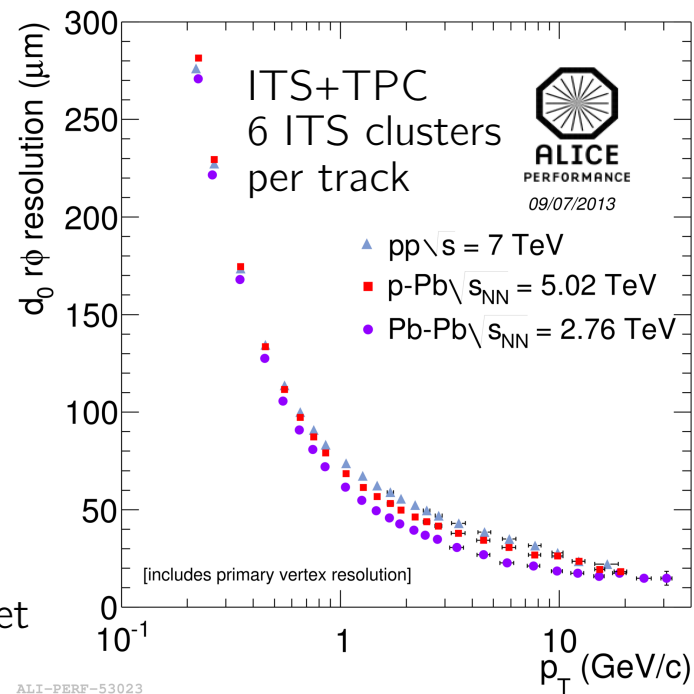
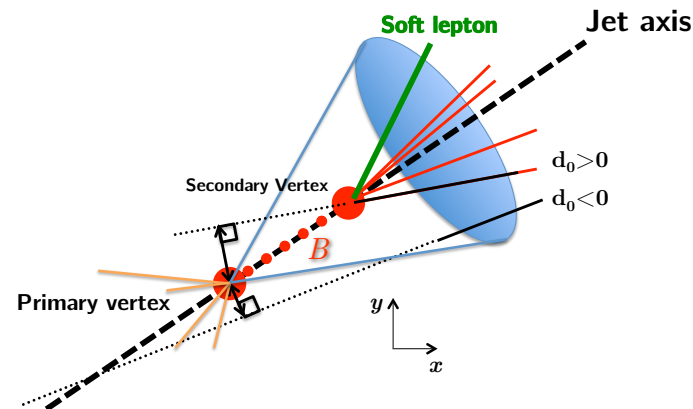
- Main investigators
 - Inha University (6), IPHC&LPSC (8)
- Determine *b*-quark production via the measurements of beauty jets
 - Jets *V.* heavy-flavor hadrons
 - Access the kinematics of hard scattering in an unbiased way
- Color and mass dependence of parton energy loss in the Quark-Gluon Plasma (QGP)



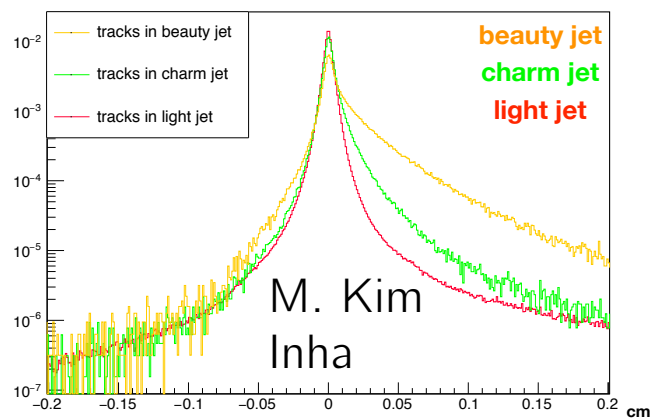
FKPPL ALICE-b [2017-]

b-tagging in p-Pb@5TeV

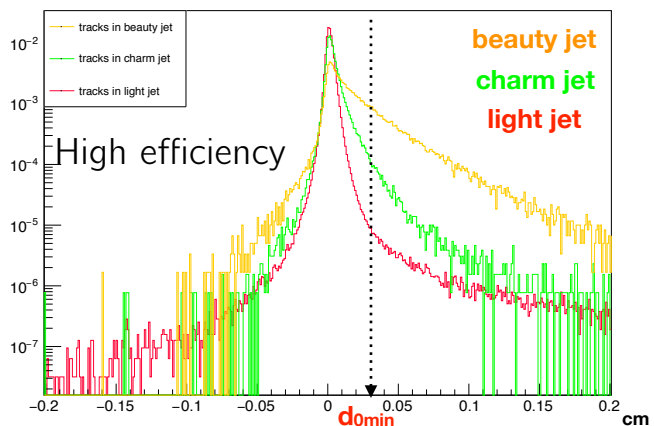
- p-Pb system as a testbench for Pb-Pb
- Jet *b*-tagging
 - Exploit long lifetime & large mass of beauty hadrons
 - Track Counting algorithm (Grenoble & Inha)
 - Very simple
 - Discriminator defined as the signed impact parameter significance of the Nth most displaced track (N value driven by efficiency & purity)
 - Soft electron tagger w/ calorimeters (Grenoble, Inha & Tsukuba)
- Jet finding
 - Jet reconstruction with charged tracks
- Corrections
 - Correction of jet transverse momentum p_T (or jet energy) for background and detector response (unfolding)
 - Corrections for *b*-tagging efficiency and charm/light jet contamination
 - Extracted from MC



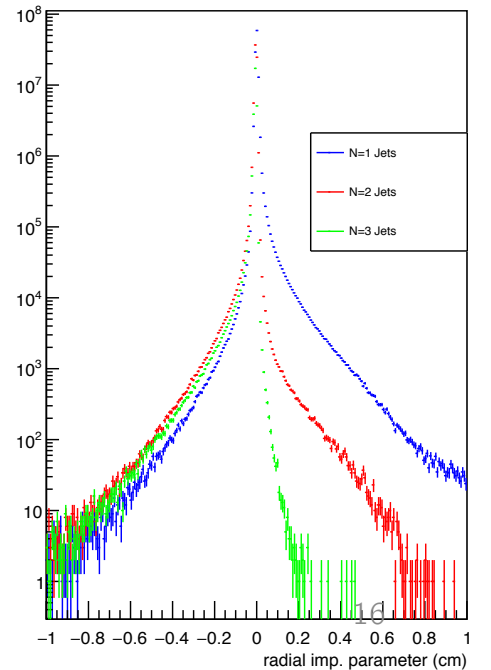
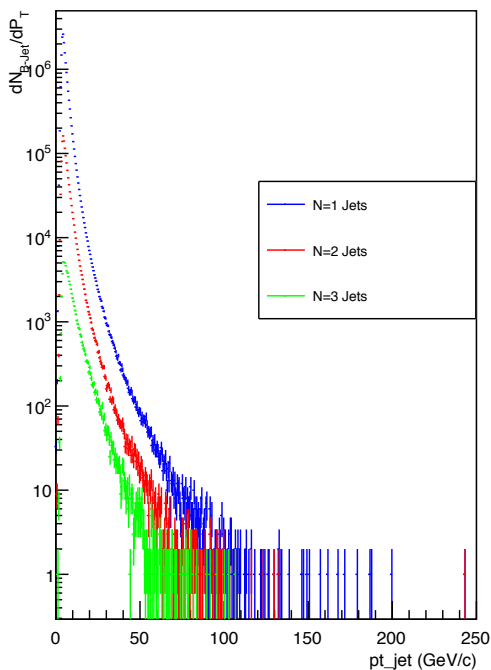
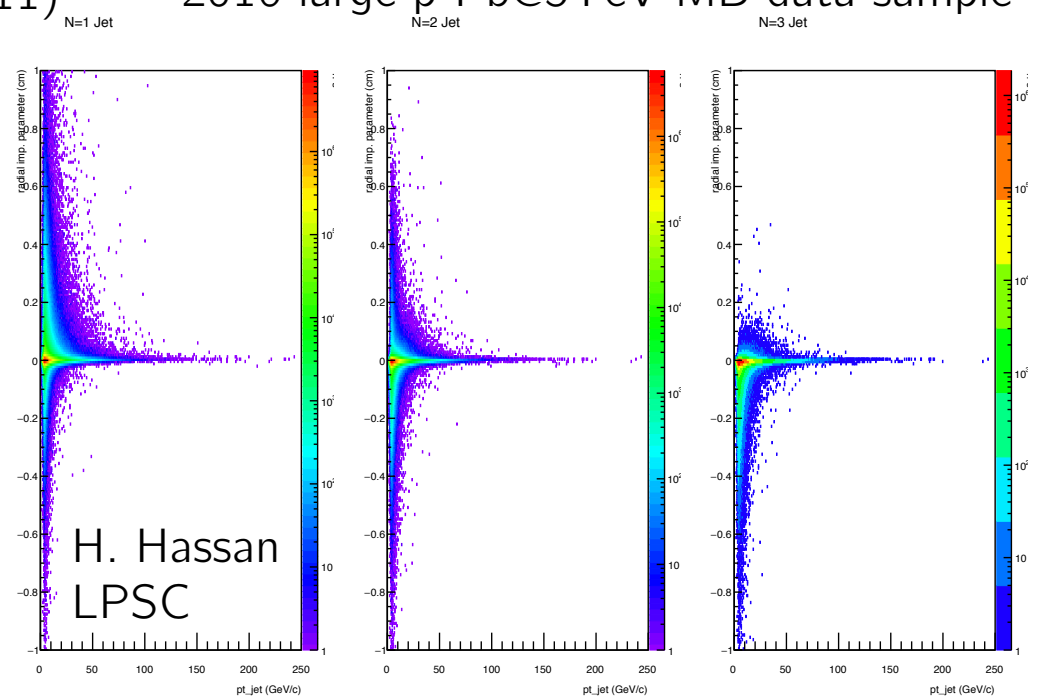
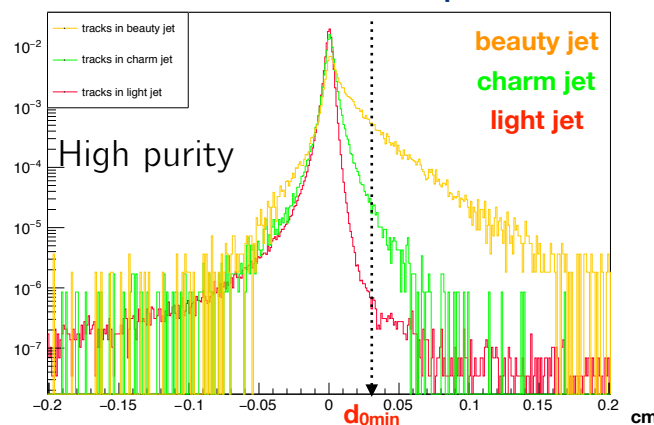
ALI-PERF-53023



SIP distribution of 2nd most displaced track



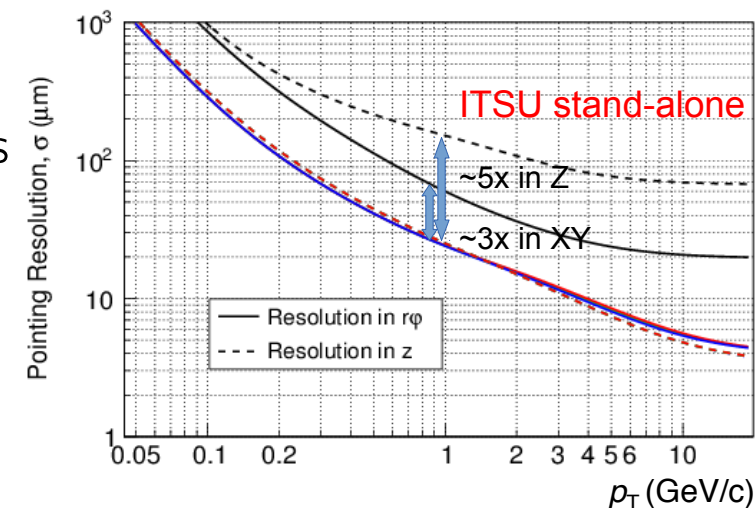
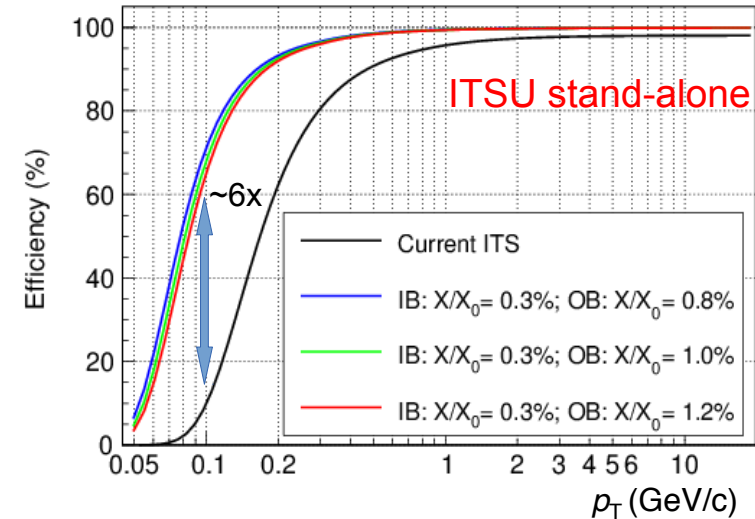
SIP distribution of 3rd most displaced track



FKPPL ALICE-b

b-tagging after ITS upgrade

- Improvement of track impact parameter resolutions by a factor 3 (5) in the transverse (longitudinal) direction
 - Better light flavor rejection
- Higher integrated luminosities
 - $\sim 10 \text{ pb}^{-1}$ for pp collisions at $\sqrt{s} = 14 \text{ TeV}$ & $\sim 10 \text{ nb}^{-1}$ for Pb-Pb collisions at $\sqrt{s}_{\text{NN}} = 5.5 \text{ TeV}$ required by the ALICE upgrade program
 - High precision heavy-flavor measurements
 - Possibility to study on-line *b*-jet tagging
 - Photon+c/*b*-jet correlations [JHEP1101(2011)152] I. Scheinbein LPSC
- + ALICE (O2) upgrades (IPHC-J/K)



Summary & Outlook

- FJPPL HAD_01 project is in continued ramp up
 - Study jet quenching through more differential measurements
 - 5 PhD + 3++ Master students
 - 3 publications in preparation (done by end of 2018)
- FKPPAL ALICE-b will open new avenues towards post-LS2 ALICE physics program after ITS upgrade
 - Warm up w/ Run 1&2 p-Pb@5TeV data
 - 1 publication in preparation
 - Performance studies for Run 3
- Application to 'Programme Exploration Japon' → rejected
- UGA (delegation at UT Oct 2016) IdEx International Strategic Partnerships (UGA Office at UT)
 - ESIPAP (LabEx ENIGMASS)
 - Master double degrees...