

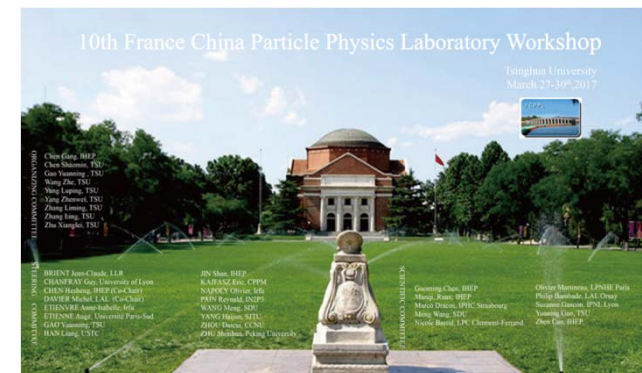
ALICE project within FCPPL

Study of QCD matter with the ALICE detector

Outline

- ❑ China and France in ALICE and FCPPL
- ❑ FCPPL ALICE report (2016)
- ❑ FCPPL ALICE project (2017)
- ❑ Conclusion

Nicole Bastid, LPC, Clermont-Ferrand, France
Daicui Zhou, CCNU, Wuhan, China
10th FCPPL workshop
Tsinghua University, Beijing, China
March 27-30, 2017

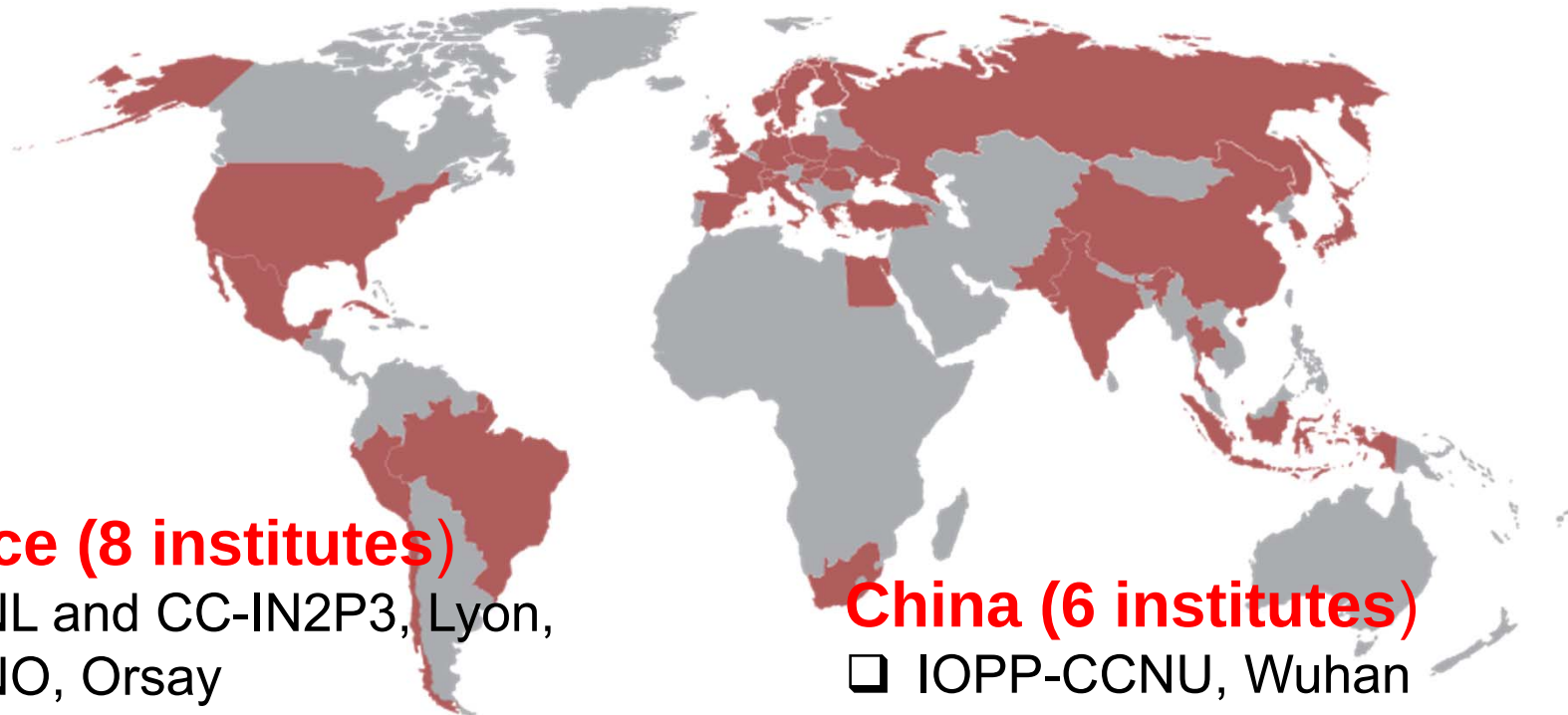




China and France in ALICE



ALICE today: 42 countries, 174 institutes, 1800 members



France (8 institutes)

- ☐ IPNL and CC-IN2P3, Lyon,
- ☐ IPNO, Orsay
- ☐ IPHC, Strasbourg
- ☐ LPC, Clermont-Ferrand
- ☐ LPSC, Grenoble
- ☐ Subatech, Nantes
- ☐ IRFU, Saclay
- 39 physicists, 55 technical staff,
16 PhDs & post-docs

China (6 institutes)

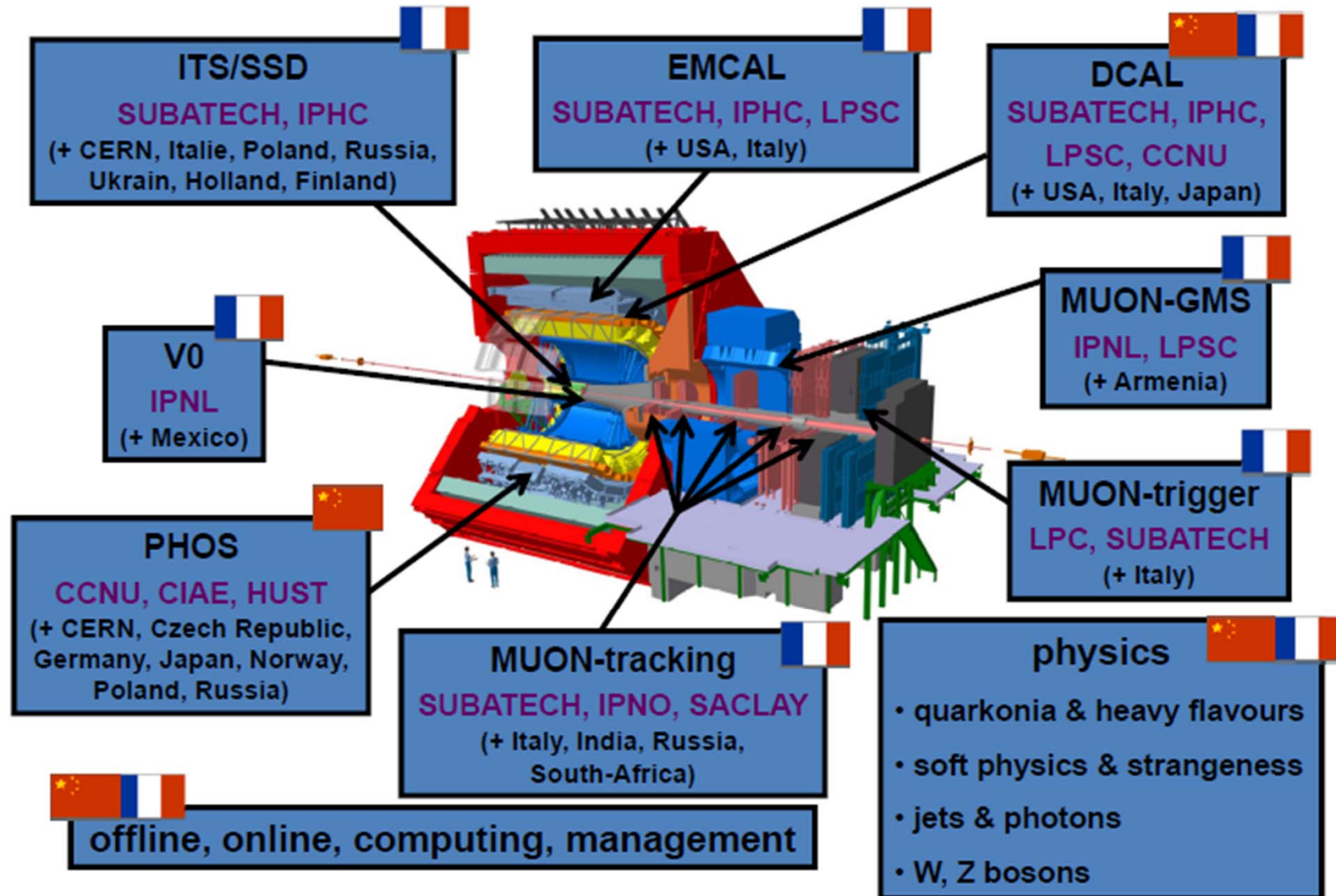
- ☐ IOPP-CCNU, Wuhan
- ☐ CIAE, Beijing
- ☐ HUST*, Wuhan
- ☐ HBUT*, Hubei
- ☐ USTC, Hefei (from end 2016)
- ☐ SINAP, Shanghai (from end 2016)
- 17 physicists, 11 technical staff,
11 PhDs



China and France in ALICE



Detector involvements: MUON, V0, ITS, Electromagnetic Calorimeters, ITS & MFT upgrades

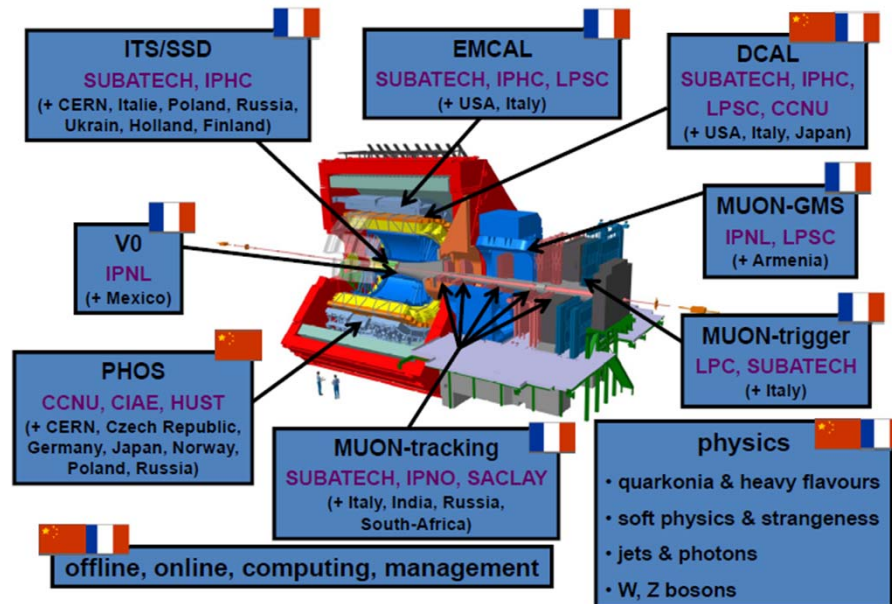




China and France in ALICE Involvements within FCPPL



Very strong cooperation program between the ALICE groups from CCNU-Wuhan (China) and IN2P3/CEA (France) since several years



□ Data analysis

- Open heavy flavours & W bosons via μ
- Quarkonia via $(d\bar{d})\mu$
- γ/π^0 & correlations with hadrons
- Jets

□ Performance studies

- Open heavy flavours with MUON & MFT
- $\gamma(\pi^0)$ & jets with EMCAL, DCAL & PHOS

□ Data taking

□ Offline, online, computing, management

□ Detector: R&D, installation, operation

□ Upgrade projects: ITS-MFT

□ Present responsibilities:

- Management Board, Conference Committee, Physics Analysis Group, detectors & upgrades

Future: extend the collaboration between French & Chinese institutes

- LHC Run-2 analyses, detector upgrade & preparation of physics program beyond 2021 (Run-3 & Run-4)



ALICE within FCPPL: a brief history of our collaboration



- ❑ Co-PhD students: **7** since 2008, main funding from China (CSC, French embassy)
 - 6 co-PhD defended or about to be defended:
Y. Mao (LPSC, 2011), R. Wan (IPHC, 2011), X. Zhang (LPC, 2012),
S. Li (LPC, 2015), M. Wang (Subatech, 2016), J. Zhu (Subatech, 2017)
 - 1 co-PhD in preparation: Z. Zhang (LPC, 2015-2018)
 - 1 co-PhD CSC application submitted (1.5 years, IPNL/CCNU, no candidate yet)
- ❑ Post-docs: **3** since 2009
- ❑ Master students: **10** since 2007 + **several ongoing demands for 2017** for the analysis of large amount of Run-2 data
- ❑ Several visits of senior physicists & engineers/technicians: data analysis & detector related activities (upgrades)

- ❑ Numerous **presentations in international conferences**, ALICE meetings
- ❑ Numerous conference proceedings, internal/analysis ALICE notes
- ❑ **Direct contribution in several publications**

- ❑ Organization of the 2nd FCPPL workshop (CCNU) & 7th FCPPL workshop (LPC) and co-organization of the 9th FCPPL workshop (IPHC)



FCPPL-ALICE project: members



PART-CCNU-IN2P3-ALICE: Study of QCD matter with the ALICE detector					
French Group			Chinese Group		
Name	Title	Affiliation (institute)	Name	Title	Affiliation (institute)
Leader			Leader		
BASTID Nicole	PR	IN2P3	ZHOU Daicui	PR	CCNU
Aphécetche Laurent	CR	IN2P3	Cai Xu	PR	CCNU
Baldisseni Alberto	Physicien	IRFU	Yang Chunbin	PR	CCNU
Batigne Guillaume	MC	IN2P3	Yin Zhongbao	PR	CCNU
Belikov Igor	DR	IN2P3	Bartolini Paolo	PR	CCNU
Cheshkov Cvetan	CR	IN2P3	Sun Xiangming	PR	CCNU
Cheyris Brigitte	CR	IN2P3	Huang	PR	CCNU
Conessa-Balbastre Gustavo	CR	IN2P3	Guangming	PR	CCNU
Crochet Philippe	DR	IN2P3	Liu Fumin	PR	CCNU
Ducroux Laurent	CR	IN2P3	Zhou Daimei	PR	CCNU
Dupieux Pascal	DR	IN2P3	Li Xiaomei	PR	CIAE
Erazmus Barbara	DR	IN2P3	Wang Yaping	Engineer	CCNU
Estienne Magali	CR	IN2P3	Pei Hua	Ass. PR	CCNU
Faivre Julien	MC	IN2P3	Mao Yaxian	Ass. PR	CCNU
Feuillard Victor	PhD student	IRFU	Zhang Xiaoming	Ass. PR	CCNU
Furget Christophe	PR	IN2P3	Zhang Fan	Engineer	HBUT
Germain Marie	CR	IN2P3	Wang Dong	Engineer	CCNU
Guerin Cyril	IR	IN2P3	Liu Jun	Engineer	CCNU
Guernane Rachid	CR	IN2P3	Zhu Jianlin	Engineer	SCUBC
Hippolyte Boris	MC	IN2P3	Yang Ping	Engineer	CCNU
Kox Serge	DR	IN2P3	Gao Chaosong	Engineer	CCNU
Kuhn Christian	DR	IN2P3	Shou-Qi-Ye	Post-doc	CCNU
Lopez Xavier	MC	IN2P3	Prabhakar Palni	Post-doc	CCNU
Maire Antonin	CR	IN2P3	Li Shuang	Post-doc	CCNU
Martinez-Garcia Gines	DR	IN2P3	Wang Mengliang	Post-doc	CCNU
Pillot Philippe	CR	IN2P3	Zhang YongHong	PhD student	CCNU
Rami Fouad	CR	IN2P3	Zhu Hongsheng	PhD student	CCNU
Rosnet Philippe	PR	IN2P3	Zhu Jianhui	PhD student	CCNU
Roy Christelle	DR	IN2P3	Ran Xiaowen	PhD student	CCNU
Schutz Yves	DR	IN2P3	Zhang Zuman	PhD student	CCNU
Shabeita Alexandre	CR	IN2P3	Peng Xinye	PhD student	CCNU
Silvestre Tello Catherine	CR	IN2P3	Ran Xu	PhD student	CCNU
Stocco Diego	CR	IN2P3	Ding Yanchun	Master student and PhD student from Sept. 2017	CCNU
Stutzmann Jean Sébastien	IE	IN2P3	Zhu Ya	Master student and PhD student from Sept. 2017	CCNU
Teyssier Boris	PhD student	IN2P3	Chang Wan	Master student and PhD student from Sept. 2017	CCNU
Uras Antonio	CR	IN2P3	Zhu Guangpu	Master student	CCNU
			Yan Li	Master student	CCNU
			Tang Siyu	Master student and PhD student from Sept. 2017	CCNU

PART-CCNU-IN2P3-ALICE Study of QCD matter with the ALICE detector

- ❑ Composed of several projects
 - MUON
 - Calorimeters: EMCal/Dcal
 - PHOS
 - ITS-MFT upgrade
- ❑ 36 members in 2009, ..., 64 members in 2016
- ❑ Now: **73** members
 - China-France Collaboration still increasing



Student exchanges (physics analyses):

❑ Co-PhD

- Mengliang WANG: CCNU/Subatech, 2012-2016 (3 year-CSC grant)
- Jianhui ZHU: CCNU/Subatech, 2013-2016 (2 year-CSC grant)
- Zuman ZHANG: CCNU/LPC, 2015-2018 (2 year-CSC grant)

❑ Master II training

- Ran XU: CCNU/LPSC, Nov.-Dec. 2016 (FCPPL)

Visits

❑ Several visits of senior physicists/post-docs from France to China and vice-versa for discussions on common activities related to:

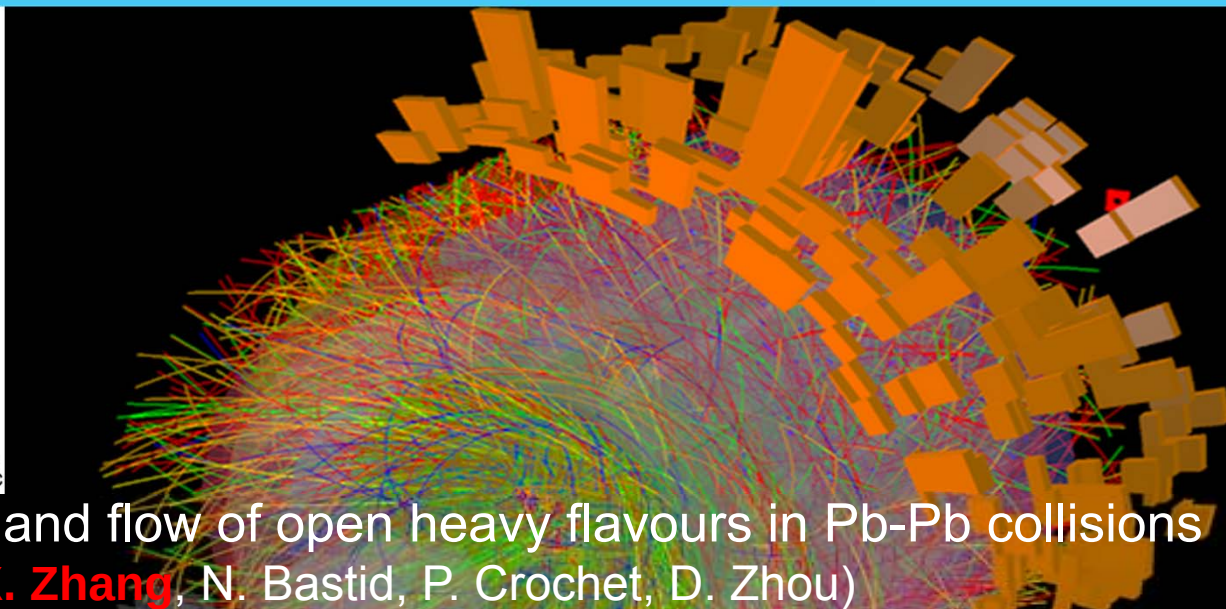
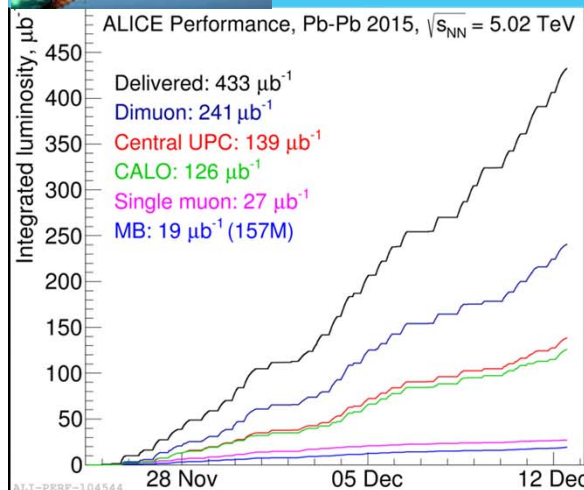
- Physics analyses
- Detector upgrades: MFT readout electronics, ITS silicon pixel design
- Participation to the ITS upgrade, MFT and O2 workshop (each 6 months in Asia)
- Future collaboration plans

9th FCPPL workshop at IPHC (Strasbourg)

- Co-organisation
- **19** physicists/PhDs/Post-docs in total (13 from IN2P3/IRFU, 6 from CCNU) and **7** talks



FCPPL-ALICE 2016 report: physics



- ☐ Production and flow of open heavy flavours in Pb-Pb collisions
(**Z. Zhang**, **X. Zhang**, N. Bastid, P. Crochet, D. Zhou)
- ☐ Production of open heavy flavours via muons in p-Pb collisions
(**S. Li**, **X. Zhang**, N. Bastid, P. Crochet, D. Zhou)
- ☐ Electroweak probes: W-boson production in p-Pb collisions
(**J. Zhu**, D. Stocco, G. Martinez, D. Zhou)
- ☐ Jet structure & fragmentation function moments in pp collisions
(**M. Wang**, A. Shabetai, M. Estienne, Z. Yin, D. Zhou)
- ☐ Isolated photons in pp collisions
(**R. Xu**, G. Conesa Balbastre, Y. Mao)
- ☐ New measurements under investigation: double-parton scattering measurements in p-Pb collisions
(D. Stocco, P. Bartalini, P. Palni)

Run:244918
Timestamp:2015-11-25 11:25:48 UTC
System: Pb-Pb
Energy: 5.02 TeV



Open heavy-flavour production in heavy-ion collisions



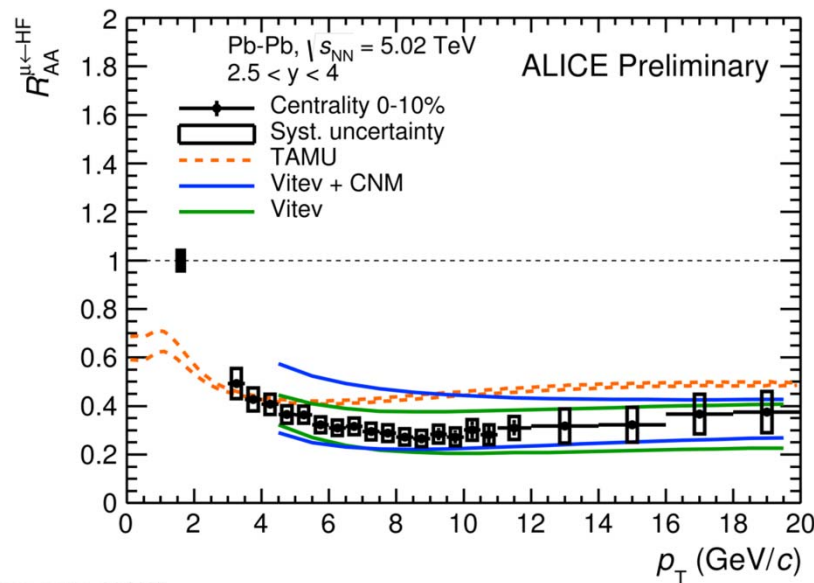
Charm and beauty quarks produced in **initial hard scatterings** with a short formation time, experience the **full collision history**

➤ **Sensitive probes of the medium properties**

Open heavy flavours in Pb-Pb collisions probe

- ☐ In-medium parton energy loss
- ☐ Heavy quark participation in the collective expansion

$$R_{AA}(p_T) = 1 / \langle N_{\text{coll}} \rangle \times \frac{dN_{AA}/dp_T}{dN_{pp}/dp_T}$$



☐ **Strong suppression** of heavy-flavour hadron decay muons of **~a factor 3** in central Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, similar to that at $\sqrt{s_{NN}} = 2.76$ TeV

☐ **Better precision** w.r.t. to LHC Run-1

☐ Constraints on energy loss models

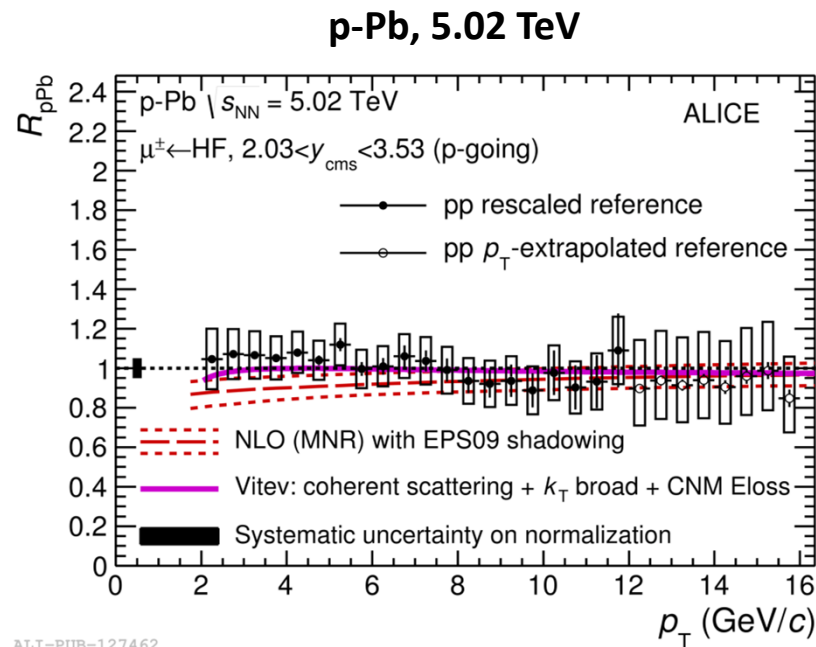
Results presented at HP2016 & QM2017, publication in preparation

**Zuman Zhang (co-PhD LPC/CCNU),
Xiaoming Zhang (CCNU)**

More: see Zuman Zhang's talk

Open heavy-flavour measurements in p-Pb collisions

- ❑ Reference for Pb-Pb measurements
- ❑ Investigation of cold nuclear matter effects



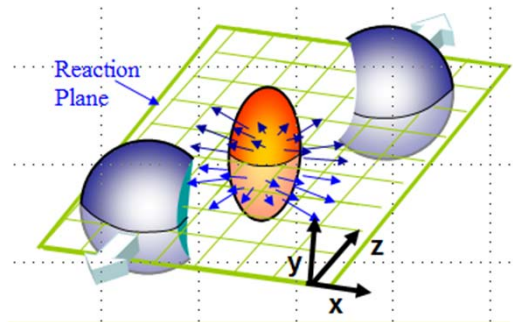
arXiv: 1702.01479,
Accepted in Phys. Lett. B

More: see Zuman Zhang's talk

- ❑ R_{pPb} compatible with unity: cold nuclear matter effects small
- ❑ R_{pPb} in agreement with models including cold nuclear matter effects
- ❑ R_{pPb} being consistent with unity, **the strong suppression measured in central Pb-Pb collisions is due to the hot and dense medium**
- ✓ Final results, presented at QM2017

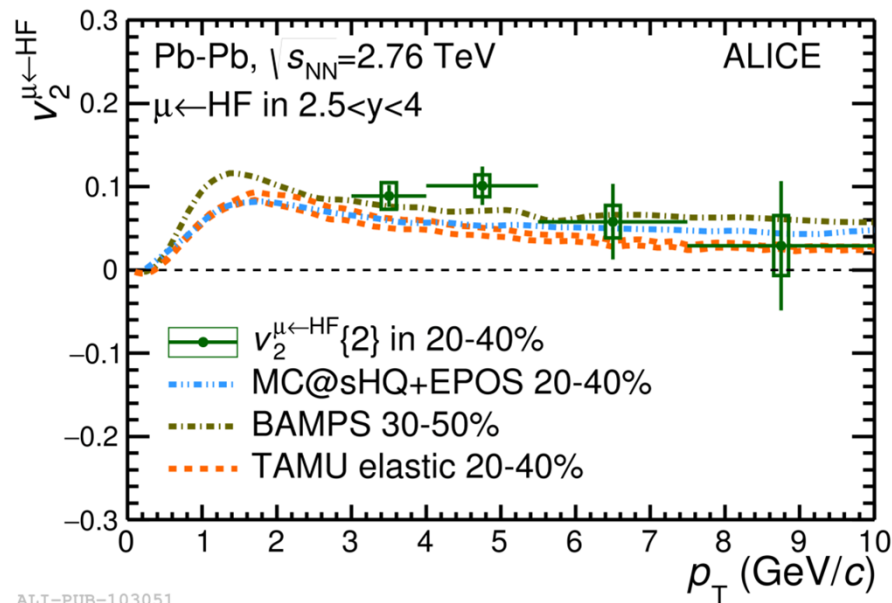
Shuang Li (co-PhD LPC/CCNU (2012-2015), now at three Gorges University),
Xiaoming Zhang (CCNU)

Next: extend the analysis **to p-Pb collisions at**
 $\sqrt{s_{NN}} = 8.16$ TeV: R_{pPb} & elliptic flow (Siyu Tang,
Master training at LPC)



initial spatial anisotropy $\rightarrow$ momentum anisotropy

$$\frac{2\pi}{N} \frac{dN}{d\varphi} = 1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\varphi - \Psi_n)] \quad v_2 = \text{elliptic flow}$$



ALI-PUB-103051

Phys. Lett. B 753 (2016) 41

- Complements R_{AA} measurements
- **Positive v_2** at intermediate p_T and semi-central collisions: a **4σ effect** for $3 < p_T < 5$ GeV/c in 20-40% centrality class
- **Participation of heavy quarks in the collective expansion of the system**
- ✓ Final results, presented at HP2016 & QM2017

Xiaoming Zhang (CCNU)



W-boson production via muons in p-Pb collisions



W bosons in heavy-ion collisions: produced in initial hard scatterings, unaffected by the strong interaction

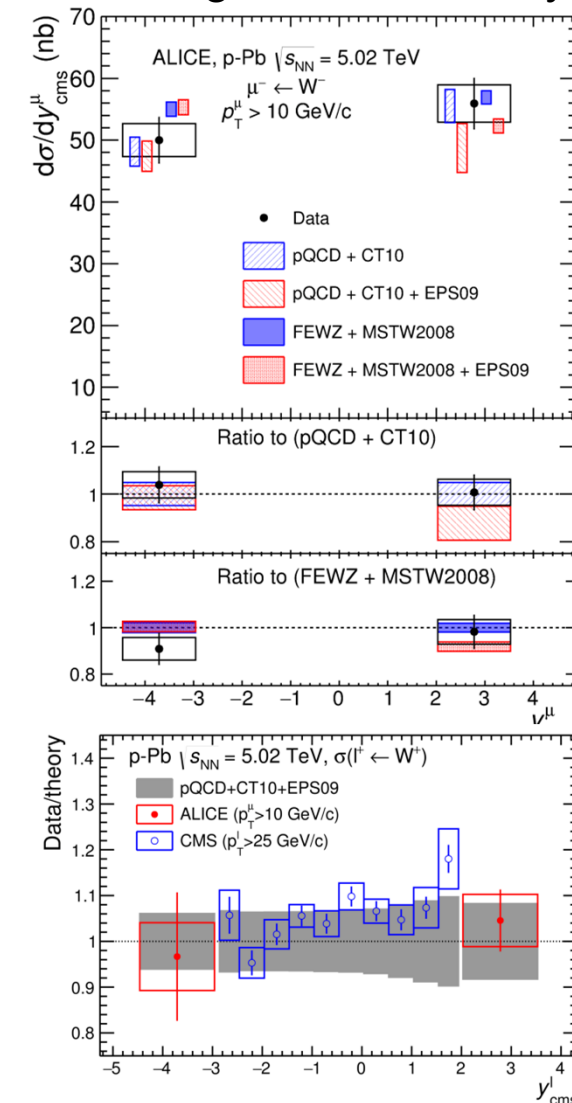
- Sensitive to the nuclear modification of the PDFs
- Reference for hard-probe measurements

- ❑ First measurement at forward & backward rapidity in p-Pb collisions
- ❑ In agreement with model predictions **with** and **without** including nPDFs
- ❑ Calculations with **nPDFs describe ALICE & CMS** data over the full rapidity range

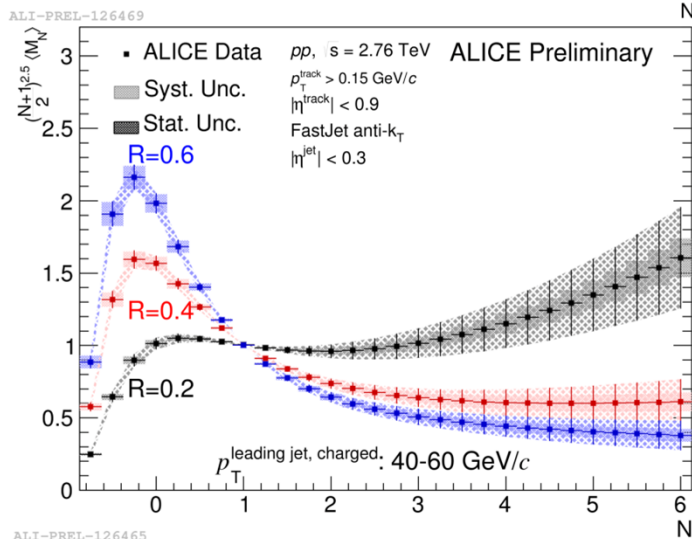
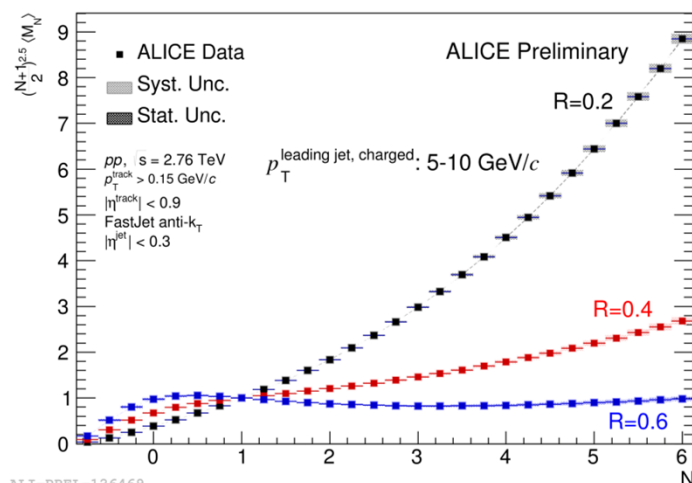
- ✓ Presented at BEACH2016 & QM2017
- ✓ Published in ***JHEP 02 (2017) 077***

Jianhui Zhu (co-PhD Subatech/CCNU)
PhD defense: April 1st, 2017

More: see Jianhui Zhu's talk



- ❑ **Measurements in pp collisions:** test pQCD & reference for Pb-Pb measurements
- ❑ Jet fragmentation function moments: new observable less sensitive to background fluctuations than jet fragmentation functions.

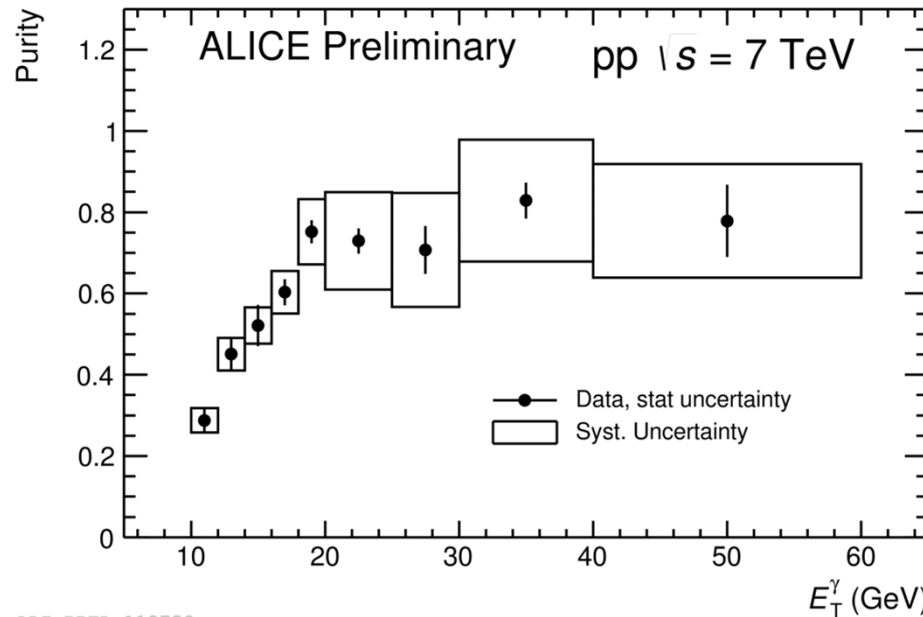


- ❑ **First measurement of jet Fragmentation Function Moments (FFM) in pp collisions at $\sqrt{s} = 2.76 \text{ TeV}$**
- ❑ Strong dependence on resolution parameter R : harder fragmentation for $R = 0.2$
- ❑ Dependence of FFM on R decreases with increasing p_T jet: indication that high p_T jets are more collimated

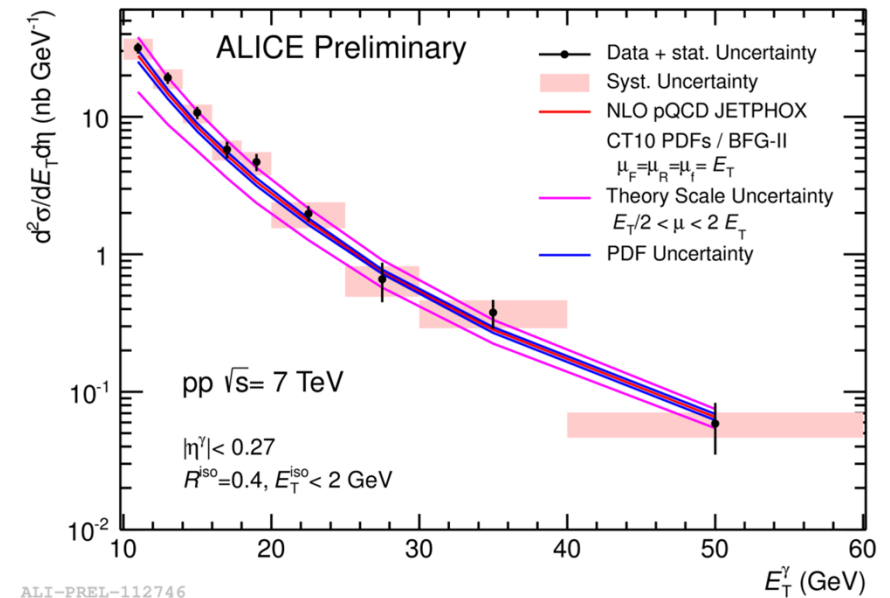
- ✓ Analysis approved for QM2017
- ✓ Paper proposal to come

Mengliang Wang (co-PhD Subatech/CCNU)
 PhD defense: December 10th, 2016,
Yaxian Mao (CCNU)

Isolated photon production in pp collisions



ALI-PREL-112758



ALI-PREL-112746

- Training to the different steps in the measurement of the production cross section of isolated γ in pp collisions
 - Tuning of MC parameters to improve the description of the EMCal shower shape
 - Purity of the identified photon sample vs. E_T
- Next: measurement of isolated photons in pp collisions at $\sqrt{s} = 13$ TeV

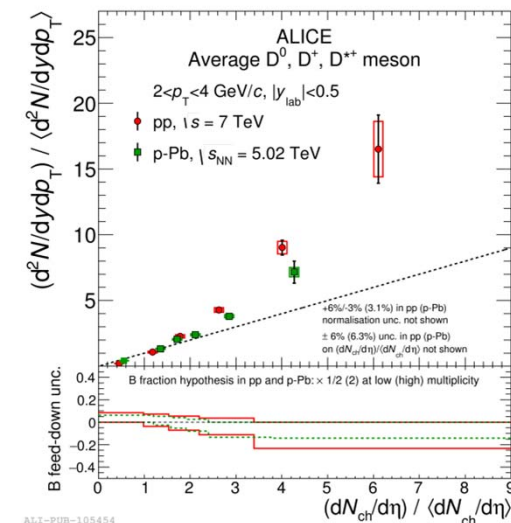
Ran Xu (master II student, 2-month training at LPSC Grenoble, now PhD student at CCNU), Yaxian Mao (CCNU)



Double-parton scattering measurements in p-Pb collisions with ALICE



- Particle yields vs. charged-particle multiplicity
 - Key observable to study **Multi-Parton Interactions**



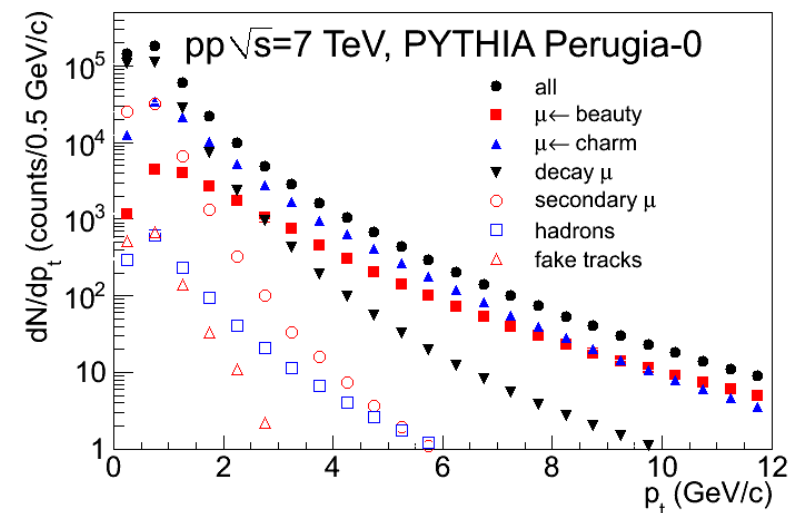
- Investigate **Double Parton Scattering (DPS)** in the **heavy-flavour sector** focusing on **p-Pb collisions** (enhanced probability of DPS compared to pp collisions)

- High- p_T muons at forward rapidity (heavy-flavour decay muons, mainly)
- search for same-sign high- p_T muons

- Feasibility study ongoing with MC

Paolo Bartalini (CCNU),
Diego Stocco (Subatech)

ALICE, JHEP 09 (2015) 148



ALICE, PLB 708 (2012) 265 15

More: see Diego Stocco's talk



☐ Publications with direct contribution & conference proceedings: 8

- J. Adam et al. (ALICE Collaboration), “Elliptic flow of muons from heavy-flavour hadron decays at forward rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV”, Phys. Lett. B 753 (2016) 41
- J. Adam et al.. (ALICE Collaboration), W and Z boson production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV”, JHEP 02 (2017) 077
- S. Acharya et al. (ALICE Collaboration), “Production of muons from heavy-flavour decays in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV”, arXiv:1702.01479, submitted to Phys. Lett. B
- J. Adam et al. (ALICE Collaboration), “Jet-like correlations with neutral pion triggers in pp and central Pb-Pb collisions at 2.76 TeV”, Phys. Lett. B 763 (2016) 238
- J. Zhu for the ALICE Collaboration, J. Phys. Conf. Ser. 770 (2016) 012022
- M. Wang for the ALICE Collaboration, EPJ Web Conf. 117 (2016) 03009
- X. Zhang for the ALICE Collaboration, to be published in Nuclear and Particle Physics Proceedings
- Z. Zhang for the ALICE Collaboration, to be published in Nuclear and Particle Physics Proceedings

☐ Talks in international conferences & workshops: 13 (+ 1 poster)

- P. Palni, Y. Mao, X. Zhang, J. Zhu, 2nd China LHC Physics Workshop, Beijing, China, 16-19 Dec. 2016
- X. Zhang, Y. Mao, International Workshop on “Flow, Jet Quenching and Strong Coupling Physics”, Huzhou, China, 17-19 Dec. 2016
- J. Zhu, BEACH 2016, Fairfax, Virginia, USA, 12-18 June 2016
- X. Zhang, Z. Zhang, X. Peng, Qi-Ye Shou (poster), Hard Probes 2016, Wuhan, China, Sept. 23-27, 2016
- Z. Zhang, Rencontres QGP-France, Etretat, France, 10-13 Oct. 2016 : Z. Zhang
- X. Zhang, Z. Zhang, Muon Workshop 2016, Pornichet, France, 23-27 May 2016

☐ Many presentations in weekly ALICE Physics Analysis Group meetings & monthly ALICE Physics Working Group meetings

☐ Several papers to come (several Run-2 analyses being finalized)

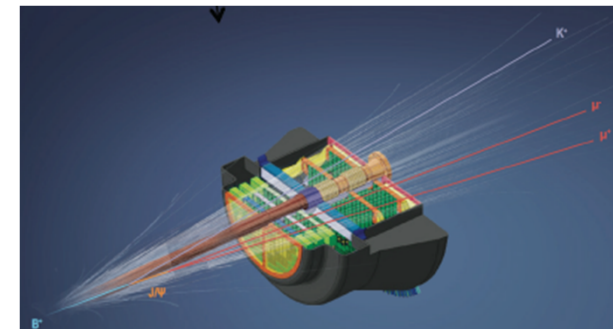
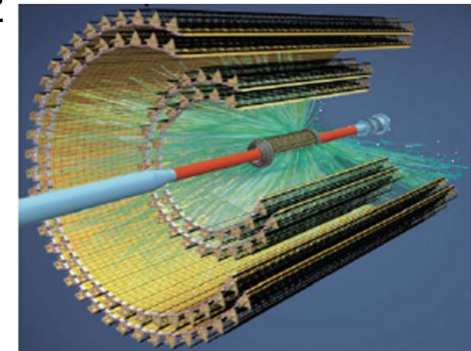
- ❑ **Major upgrade** currently in preparation for LHC Run-3 (2021-2023) and beyond
 - New conditions with Run 3: Pb-Pb interaction rate may reach **50kHz** (now ~ 8 kHz)
 - Ongoing R&D, some construction already started, installation during the second Long Shutdown

- ❑ **Goals of ALICE Run-3:**
 - High precision measurements of **rare probes with main focus on the low p_T region**
 $\rightarrow$ **x 100 larger minimum-bias sample compared to Run 2** ($\sim 10^{11}$ events)
 - Increase **readout rate to 50 kHz**, presently limited to ~ 1 kHz
 - **Improvement of pointing resolution at both central and forward rapidity**

- ❑ **New Inner Tracking System (ITS)**
 - Improved pointing resolution, reduced material budget, faster readout

- ❑ **Forward Muon Tracker (MFT)**
 - New Silicon tracker, heavy-flavour vertices also at forward rapidity

- ❑ **New TPC readout chambers based on GEM**
- ❑ **Upgraded readout for many detectors**
- ❑ **Integrated Online-Offline (O^2) system**
- ❑ **New Fast Integration Trigger detector (FIT)**



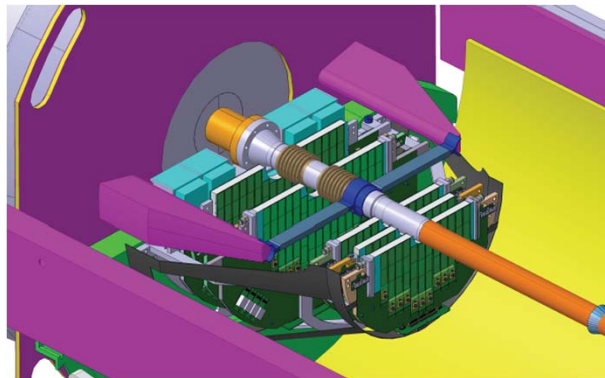
More: see Antonio Uras's talk

❑ DCal installed and PHOS completed before Run-2, operated in Run-2

❑ Involvement of CCNU in the ITS-MFT project:

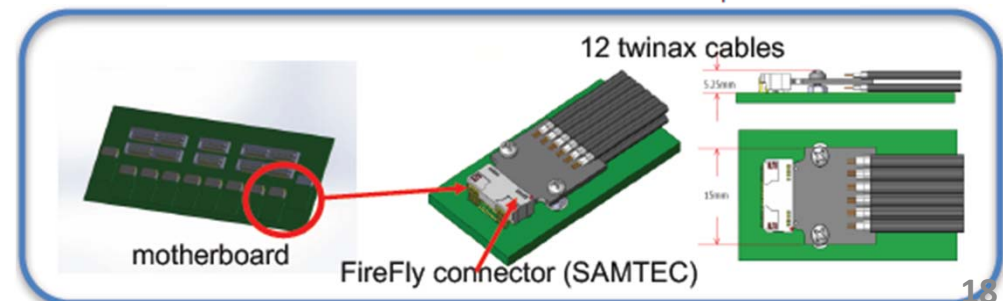
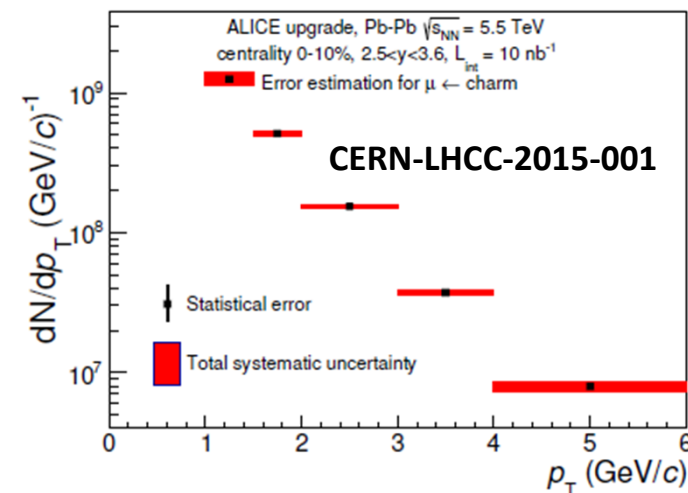
- Performance studies for both ITS & MFT: charm & beauty measurements via single muons with MFT-MUON and D-meson fragmentation function with ITS
- Contribution to the global readout electronics design of MFT (PCB design, motherboards to interface disks)

MFT



- 10 half-disks, 2 detection plane each in the muon spectrometer acceptance, between absorber & interaction point
- 920 silicon pixel sensors in 280 ladders

charm





Prospects in 2017 (I)



□ Continue the involvement in data analysis: analysis of large samples of Run-2 data (pp, p-Pb and Pb-Pb collisions)

- Open heavy-flavour measurements: production and flow
LPC/CCNU Collaboration: **Zuman Zhang (co-PhD), Siyu Tang (Master), Xiaoming Zhang (physicist)**
- Charmonium (J/ψ , $\psi(2S)$) production at high multiplicity in small systems
Subatech/CCNU Collaboration: **Yanchun Ding (Master), Xiaoming Zhang**
- Double-parton scattering measurements in the heavy-flavour sector
Subatech/CCNU Collaboration: **Paolo Bartalini**
- Jets and γ/π^0 production
LPSC/CCNU Collaboration: **Ran Xu (PhD)/Guangpu Zhu (Master), Yaxian Mao**

□ Continue to strengthen the involvements in the ALICE upgrade projects

- Technical involvements (UITS-MFT): Collaboration with all French institutes
- Software developments (UITS with O² framework): IHPC/CCNU Collaboration: **Peipei Zheng (Master)**
- Physics program with Run-3 & Run-4: co-PhD demand (IPN Lyon)

➡ FCPPL support for student, senior physicist & technician/engineer exchanges between China-France



Prospects in 2017 (II)



❑ Funding from France: request of 29.5 kEuros

- Travel costs for French physicists for the 10th FCPPL workshop (Beijing)
- Travel costs for members of the committee of Jianhui Zhu's PhD defense (CCNU Wuhan)
- Stay costs a Master training (Guangpu Zhu, 1 month) and a PhD (Ran Xu, 1 month) at LPSC Grenoble
- Stay costs for a Master training (Siyu Tang, 2 months) and a physicist (Xiaoming Zhang, 1 month) at LPC Clermont-Ferrand
- Stay costs for a Master training (Yanchun Ding, 2 months) at Subatech Nantes
- Stay costs for a Master training (Peipei Zheng, 2 months) at IPHC Strasbourg
- Stay costs for a senior physicist (Paolo Bartalini) at Subatech Nantes
- Stay costs for a engineer & student (1 month) in French institutes involved in MFT readout electronics

❑ Funding from China: request of 211700 Yuans

- Stay/travel for ALICE Chinese members for the 10th FCPPL workshop (Beijing)
- Stay costs for members of the committee for Jianhui Zhu's PhD defense
- Travel cost for 9 students/senior physicists/engineers in French institutes
- Additional stay costs for 2 students at LPSC Grenoble
- Additional stay costs for one student at LPC Clermont-Ferrand

❑ Other fundings

- Ongoing CSC demand (1.5 years) for a PhD student at IPN Lyon (no candidate yet)



Solid China-France cooperation in the ALICE scientific program with a recognized visibility within ALICE

- ❑ **Strong contribution to data taking, data analysis and performance studies**
 - Excellent contributions of students
 - Significant contributions to scientific production
 - Many talks in conferences
- ❑ **Contributions to ALICE upgrades: detector and software developments**
- ❑ **Preparation of the Run-3 & Run-4 physics program**

**Continue to extend the collaboration in more and more
common activities**



Thank you for
your attention