

CMS Heavy Ions (CMSIL)



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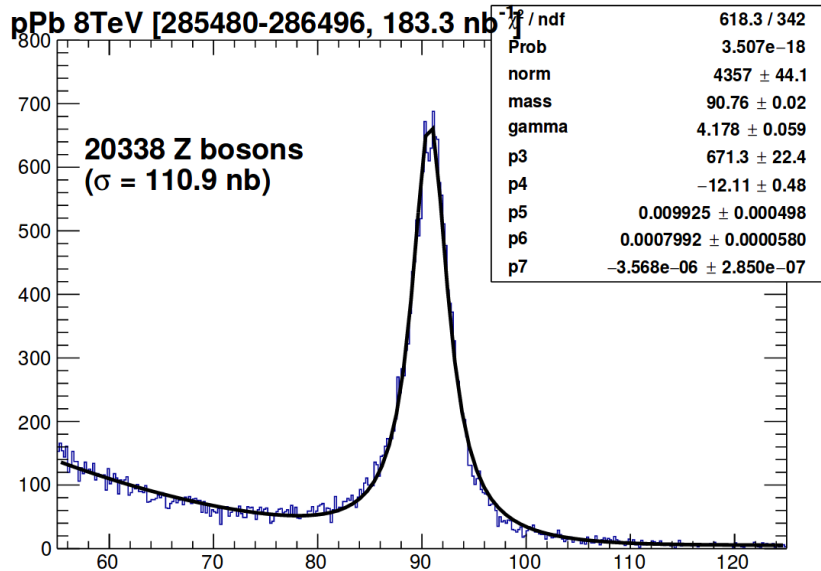
Marie Skłodowska-Curie
Actions

In short...

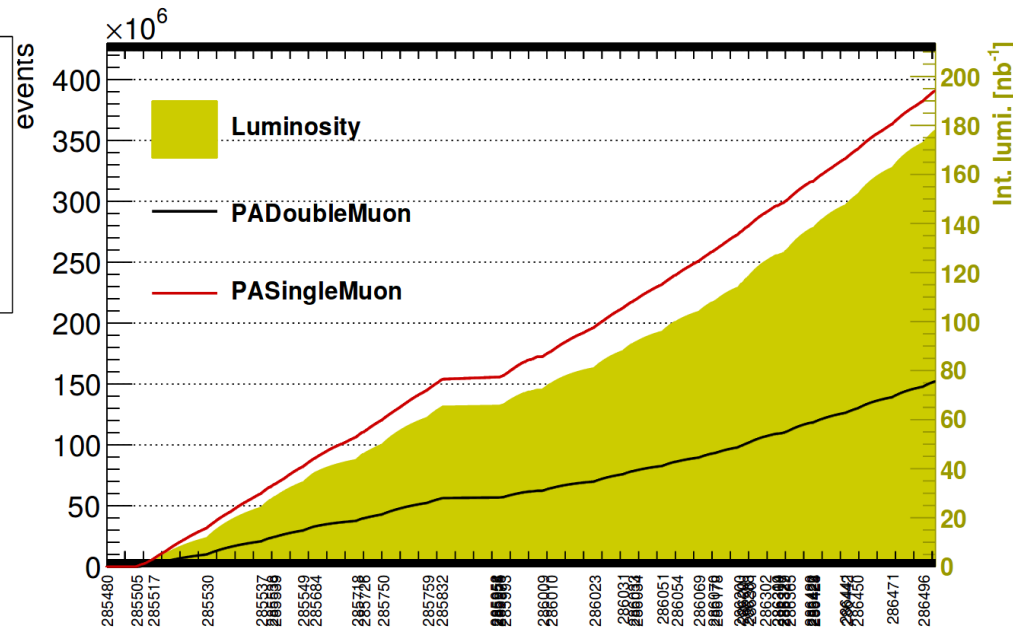
- **Korea University + Laboratoire Leprince-Ringuet since 2010**
 - In the [dilepton] subgroup of the CMS heavy-ion working group, its two main contributors
 - 10+ analyses / 13 papers / 4 preliminary results together
 - Few examples in the next slides
- **The stronger collaboration, the more new physics**
 - With the help of FKPPL, we maintain the physics result flow
→ secured one of the key-player of the effort
- **Our physics: looking for manifestations of the quark gluon plasma with the CMS detector**
 - Looking for particles melting (or not) in the plasma
 - Understanding interactions between flavours and the QGP medium

2016 pPb runs

- Korea University + Laboratoire Leprince-Ringuet led muon-oriented data-taking of 2016 pPb runs
 - Muon trigger development (A. Stahl, C. Mironov)
 - Data monitoring in real-time (M. Jo, G. Oh, D. Moon)
 - Prompt data analysis (E. Chapon, J. Martin, Y. Kim)



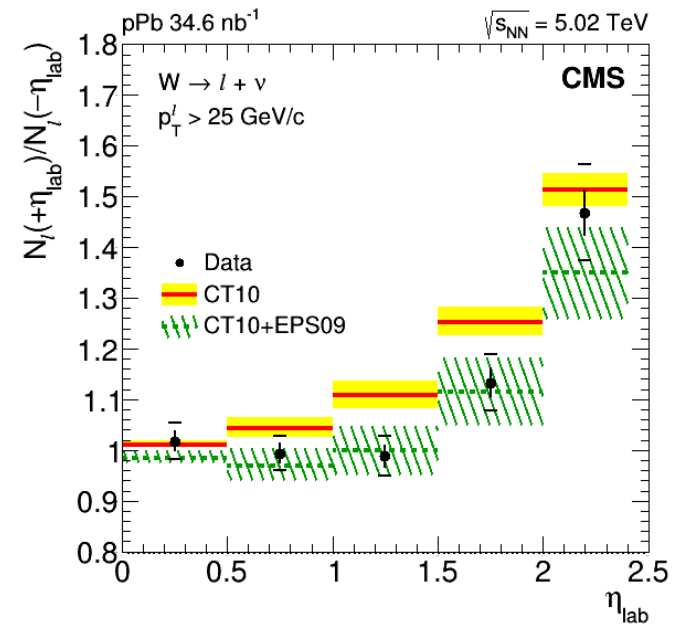
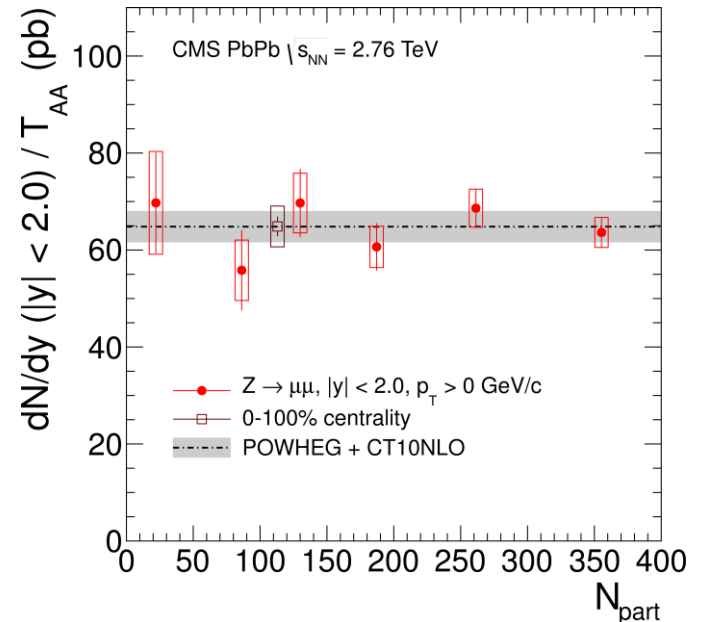
2016 pPb Z events



1. Z & W bosons

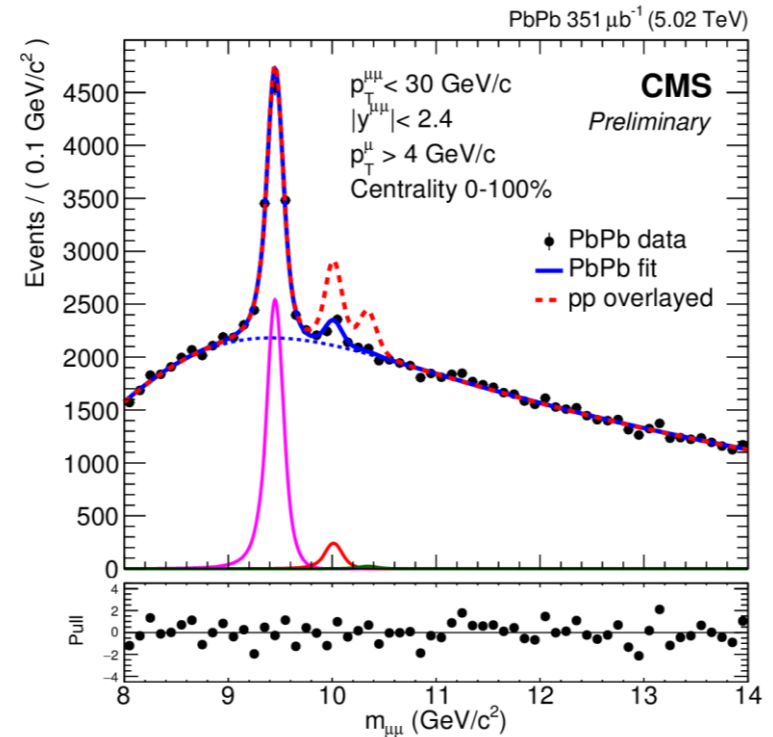
- Unmodified by the plasma
 - Standard candles
- Z boson: A. Florent (doctoral student at LLR)
- W boson: 1 on-going analysis on pPb by A. Stahl (doctoral student at LLR) M. Jo (doctoral student at KU, postdoc at LLR)

PRL106 (2011) 212301, 115 citations
 JHEP 1503 (2015) 022, 32 citations
 PLB750 (2015) 565-586, 38 citations



2. $Y(nS)$

- First observation of the melting of $Y(2S)$ & $Y(3S)$
 - Iconic plot of the HI programme at LHC
- $Y(nS) R_{AA}$:
N. Filipovic (doctoral student at LLR)
- 2 on-going analysis on PbPb by Y. Kim (postdoc at Korea U.)



$$R_{AA}(Y(1S)) = 0.364 \pm 0.014 \pm 0.048$$

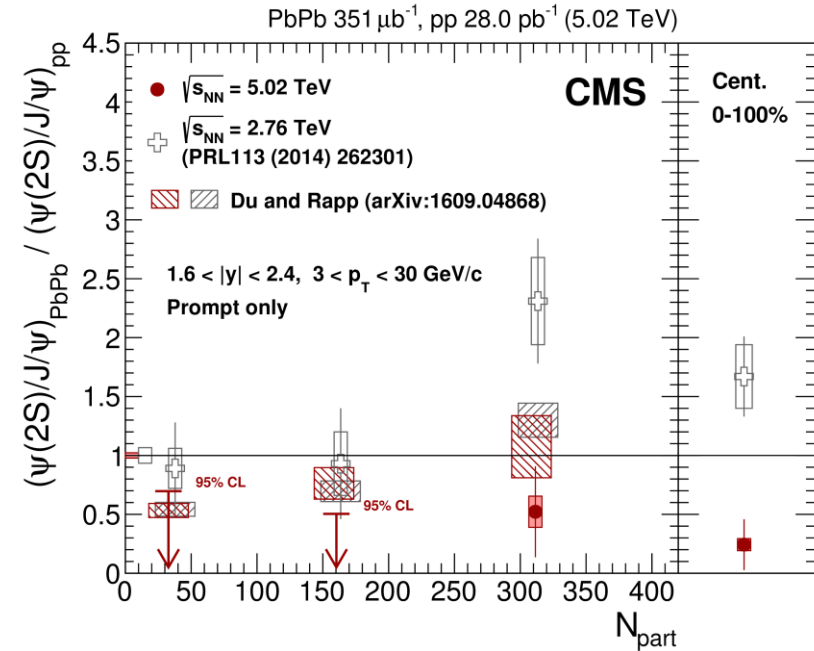
$$R_{AA}(Y(2S)) = 0.104 \pm 0.021 \pm 0.014$$

$$R_{AA}(Y(3S)) < 0.071 \text{ at } 95\% \text{ C.L.}$$

PRL107 (2011) 052302, 200 citations
 PRL109 (2012) 222301, 236 citations
 JHEP 1404 (2014) 103, 75 citations
 PLB (2017) 2017.04.031, 9 citations
 CMS-PAS-HIN-16-008
 CMS-PAS-HIN-16-023

3. J/ψ , $\psi(2S)$ & $B \rightarrow J/\psi$

- All suppressed in QGP
 - First direct observation of b-quark energy loss
 - Binding energy dependent suppression
- J/ψ R_{AA} :
 - J. Martin (postdoc at LLR)
 - M. Jo (doctoral student at KU, postdoc at LLR),
- $\psi(2S) / J/\psi$ double ratio:
 - E. Chapon, A. Abdulsalam (postdoc at LLR)
 - A. Stahl (doctoral student at LLR)
- 1 on-going analysis (PbPb) by lots of Korea Univ. and LLR crews

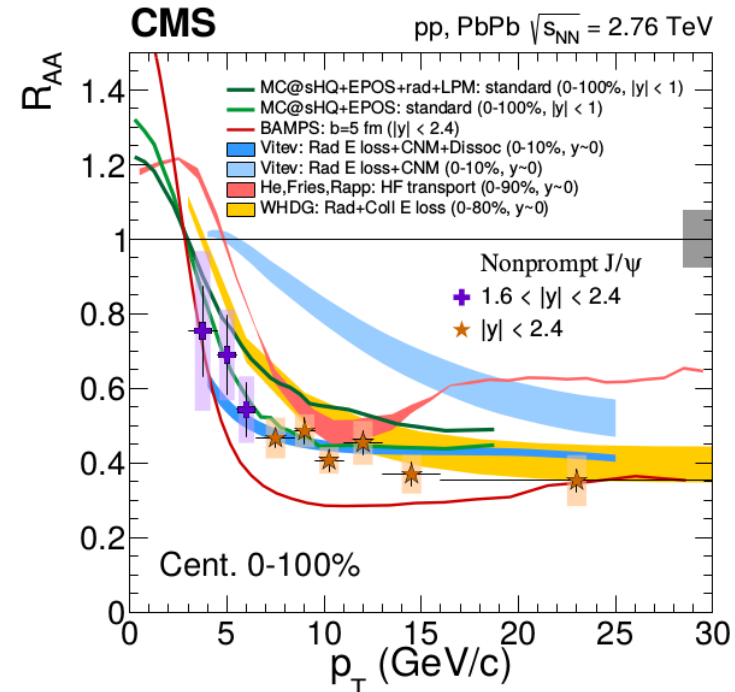
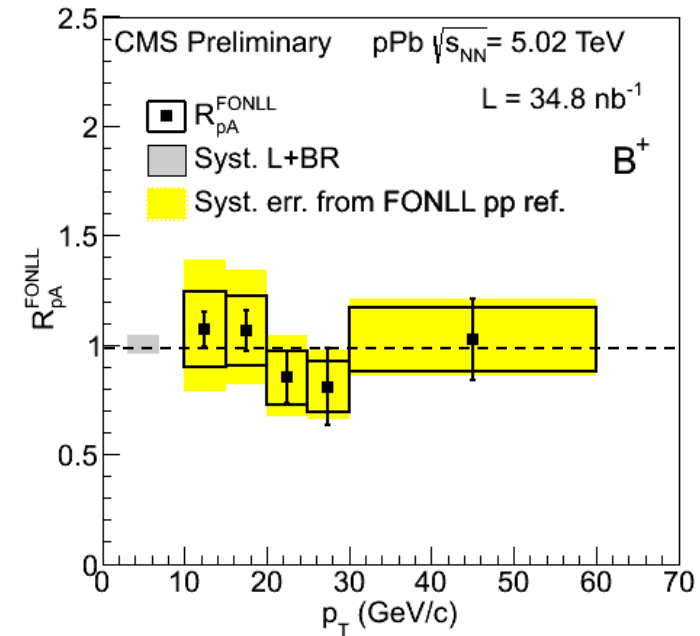


JHEP05 (2012) 063, 335 citations
 PRL113 (2014) 262301, 42 citations
 PRL118 (2017) 162301, 7 citations
 EPJC 77 (2017) no. 4, 252, 11 citations
 EPJC 77 (2017) no. 4, 269, 0 citation
 CMS-PAS-HIN-16-025

4. B mesons

- Unsuppressed in pPb collisions
 - Exclusive decay of B^+ , B^0 and B_S
- B meson R_{pA} :
 H. Kim (doctoral student at KU,
 postdoc at Chonnam Univ.)
- Displaced J/ψ is the area of expertise
 of the Korean group

PRL116 (2016) 032301, 29 citations



Training PhD students / researchers

- During LHC Run 1 period: 2 (LLR) + 3 (Korea U.) PhD students graduated
- 2 years of LHC Run 2: 1 (LLR) + 2 (Korea U.) + α PhD students are working on
- 5+4 (LLR) + 1 (Korea U.) postdoc researchers are involved
- Inter-institutional efforts have been given to train PhD students and young postdocs
 - Researches are stimulated by collaboration
- Bridging PhD students to postdocs, postdocs to faculties
 - e.g. M. Jo got a PhD at Korea U, postdoc continued at LLR

Responsibilities

- Technical aspects (muon reconstruction and triggering in the HI environment) covered by LLR & Korea U.
 - C. Mironov, E. Chapon, A. Stahl, J. Martin, Y. Kim, M. Jo
- Analysis coordination
 - R. GdC & M. Nguyen CMS heavy-ion conveners
 - R. GdC, E. Chapon, T. Dahms, C. Mironov [dilepton] leaders
 - J. Martin [centrality] leader
- Member of the CMS international committee
 - R. GdC, seeking new collaborators, in particular in Korea, and for heavy-ion physics

Present situation

- [dilepton] group, driven by our institutions
- Increased activities
 - New analysis on J/ψ and $\psi(2S)$, $Y(nS)$ with 2015 PbPb runs
 - New analysis on W with 2016 pPb runs
 - Many ingredients of analysis are done in common
- Help from FKPPL
 1. 3 parallels (E. Chapon, Y. Kim, M. Jo) talks were given at HP2016
 2. 1 parallel (J. Martin) talk was given at QM2017
 3. Initiate a longer term collaboration
 1. Dual PhD degrees
 2. Sabbatical
 3. Other institutions (Chonnam Univ.) join the FKPPL

Short- and Mid-term prospect

- Preparations for 2018 PbPb runs
 - Lots of works to cope with upgraded detector
 - Muon trigger development
 - Centrality package development
 - Muon reconstruction algorithm development
- Proving muon + α channels
 - More exotic measurements can be explored with muons + charged particles and others
- Analyse the 2015 PbPb/pp, 2016 pPb data

BACK UP

List of participants

| | French Group | | | Korean Group | | |
|----------------------|--|-------------|---------------------|------------------------------|---------------|------------------------|
| | Name | Title | Affiliation and FTE | Name | Title | Affiliation and FTE |
| List of participants | <u>Leader:</u> Granier de Cassagnac, Raphael | CR | LLR-IN2P3 (1.0) | <u>Leader:</u> Byungsik Hong | Prof. | Korea University (0.3) |
| | Nguyen, Matthew | CR | LLR-IN2P3 (1.0) | Yongsun Kim | Postdoc | Korea University (1.0) |
| | Arleo, François | CR | LLR-IN2P3 (0.5) | Songkyo Lee | Ph.D. student | Korea University (1.0) |
| | Chapon, Émilien | Postdoc | LLR-IN2P3 (0.5) | Kisoo Lee | Ph.D. student | Korea University (1.0) |
| | Mihee Jo | Postdoc | LLR-IN2P3 (1.0) | Yeonju Go | Ph.D. student | Korea University (1.0) |
| | André Stahl | PhD student | LLR-IN2P3 (1.0) | Bumgon Kim | Ph.D. student | Korea University (1.0) |
| | | | | Jaebum Park | Ph.D. student | Korea University (1.0) |

Money chart

| Requested LIA specific funding from France | | | | | | |
|--|---------------------------------|--------------|---------------|--------------------------------|------|-----|
| Description | Euro/unit | Nb of units | Total (euros) | Requested to: * | | |
| Visit to Korea | 150/day | 28 | 4200 | IN2P3 | | |
| Travels to Korea | 1250 | 4 | 5000 | IN2P3 | | |
| | | | | | | |
| Total | | | 9200 | IN2P3 | | |
| Requested funding from Korea | | | | | | |
| Description | Won/Unit | Nb of units | Total (Won) | Requested to: ** | | |
| Visit to France(Flight + Local Expenses) | 4,000,000/visit/man | 3 visits*men | 12,000,000 | NRF, Korea University | | |
| | | | | | | |
| | | | | | | |
| Total | | | 12,000,000 | NRF | | |
| Additional funding | Additional funding from France | | | Additional funding from Korea | | |
| | Provided by or requested to *** | Type | Euro | Provided by or requested to ** | Type | Won |
| | | | | | | |
| | | | | | | |

6. b-jets

- Flavor dependence on jet quenching
 - Heavier quarks are expected to lose less energy than lighter quarks or gluon
- Contact: M. Nguyen (faculty) and Y. Yilmaz (postdoc), Stanislav Lisniak (doctoral student) at LLR
 - Invited talk by M. Nguyen at QM'15
 - Parallel talk by M. Nguyen at QM'12

PRL113 (2014) 132301, 55 citations
 PLB754 (2016) 59, 6 citations

