Update on the study about the data-driven pp reference

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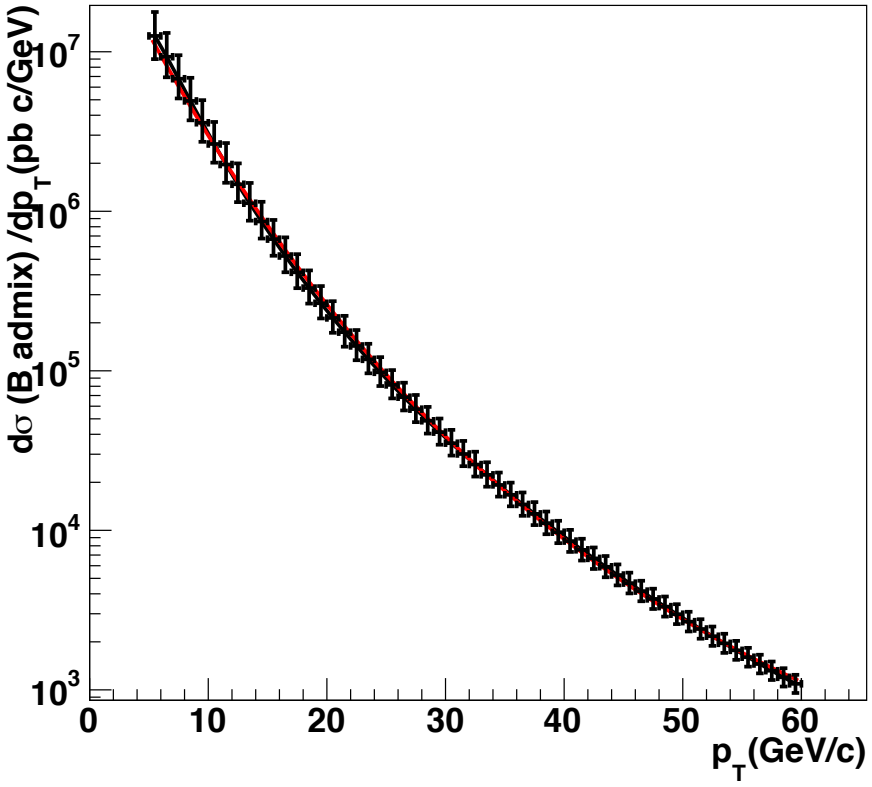
for B analyzers

Summary of the study procesure

- **Purpose : get 5 TeV pp reference with pPb binning**
- **Our present resources**
  - 7 TeV FONLL with fine binning
  - 5 TeV FONLL with fine binning
  - 7 TeV CMS pp data with pp binning (and another measurements)
- **Strategy (improved after HF meeting)**
  - Get the working fit function from 7 TeV FONLL with fine binning
  - With that function, fit on 7 TeV CMS + ATLAS data with pp binning
  - With fitting function, get the 7 TeV CMS pp data with our binning
  - Calculate the ratio of FONLL expectation (5 TeV vs. 7 TeV) with our binning
  - Get the pp data-driven reference (pp+FONLL)
  - Compare the pp data-driven reference (pp+FONLL) and pure FONLL calculation

Step 1

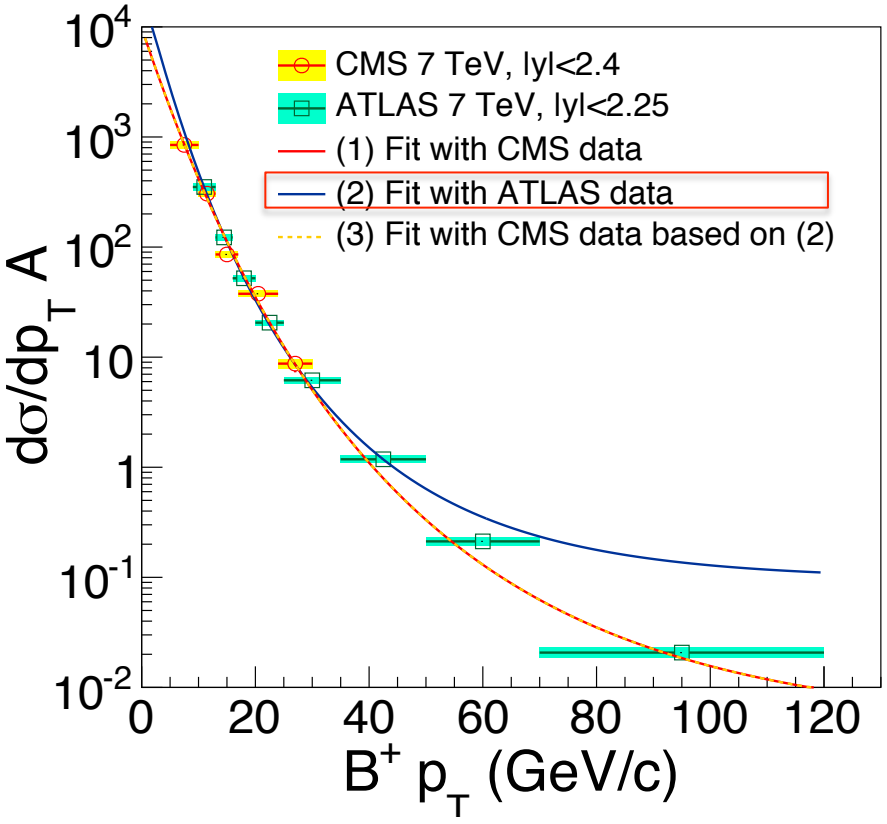
- **1. Get the working fit function from 7 TeV FONLL with fine binning**



pow(10,[0]*exp([1]+[2]*x)+[3])

Step 2

- **2. With that function, fit on 7 TeV CMS and ATLAS pp data with their binning**
  - Slightly different y range
  - No significant correction factor between two results
  - Fit with three options over (0,120) GeV, No limitation of fitting parameters
    - (1) Fit with CMS results
    - (2) Fit with ATLAS results
  - Fitting function only with CMS data is almost overlapped with that with ATLAS (p_T : 9~30)
  - At higher p_T region, there is visible gap between two functions
  - Now, try to get the weighted center
    - CMS points is not changed
    - ATLAS points might be slightly changed

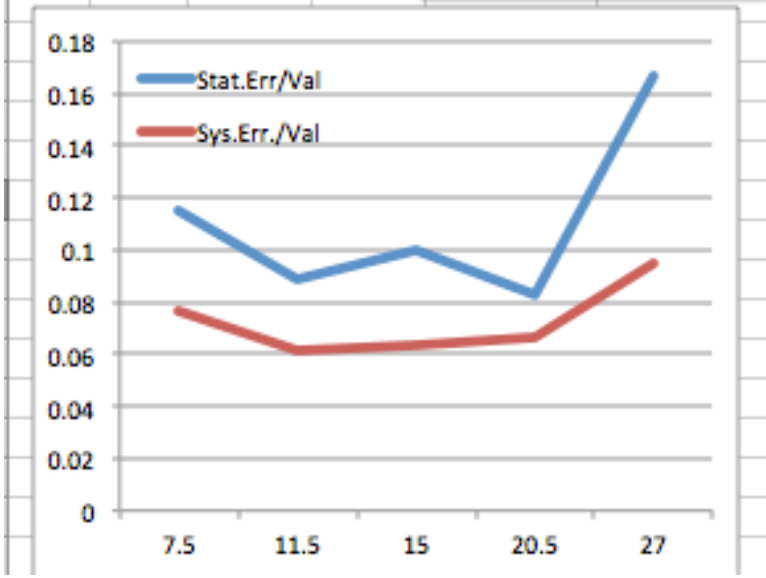


With new fitting function(2), RpA might be decreased so more close to one than in old case

Step 3

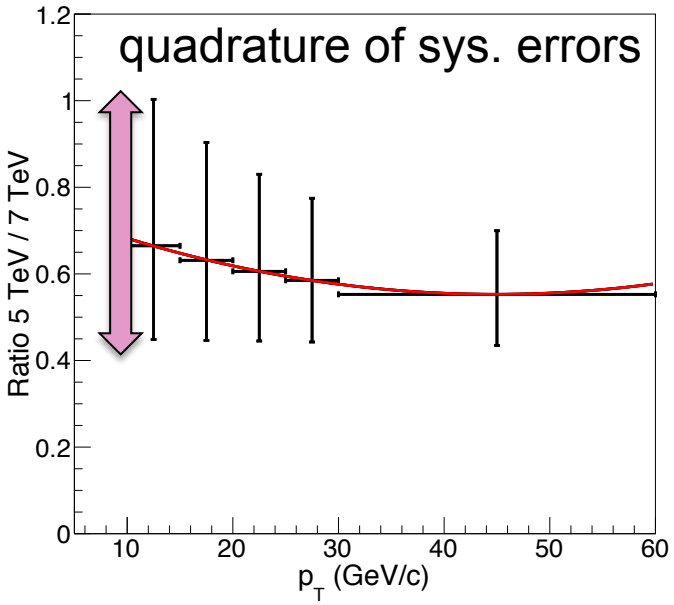
- **3. With fitting function, get the 7 TeV CMS pp data with our binning**
  - Integral the fitting function over our analysis binning, such as (10,15), (15,20), (20,25), (25,30), (30,60)
  - Treat the statistical and systematical error
    - No visible trends in published data
    - Consider the pp and pPb analysis binning, estimate the each error
    - For highest p_T bin, conservatively select maximum values like sqrt(0.167^2+0.095^2)

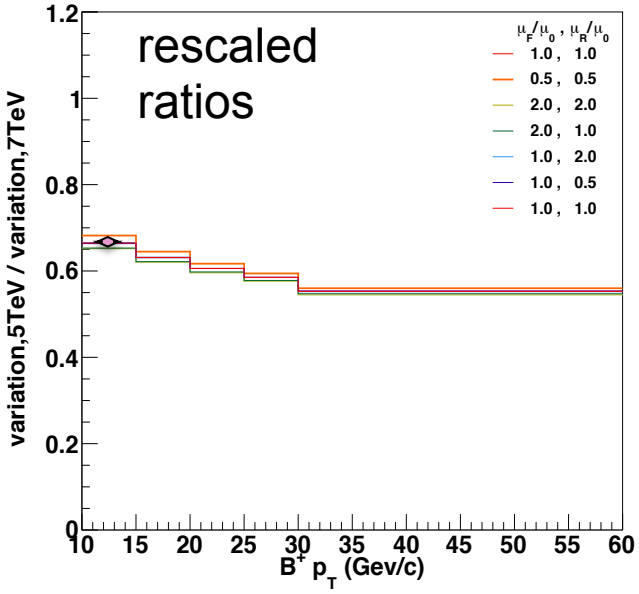
pT	Val	Stat.Err.	Sys.Err.	Stat.Err/Val	Sys.Err./Val
7.5	4.07	0.47	0.31	0.11547912	0.07616708
11.5	1.47	0.13	0.09	0.08843537	0.06122449
15	0.412	0.041	0.026	0.09951456	0.0631068
20.5	0.181	0.015	0.012	0.08287293	0.06629834
27	0.042	0.007	0.004	0.16666667	0.0952381



Step 4

- **4. Calculate the ratio of FONLL expectation (5 TeV vs. 7 TeV) with our binning and related systematics**
  - Issue : how to consider the systematical error from FONLL expectation?
    - Following the former ALICE study, basically systematical uncertainties is independent on the beam energy
    - Get the envelope from ratio of FONLL expectation varying the parameters
    - Choose the width of envelope as the systematical uncertainties
    - Dramatically reduced sys. errors



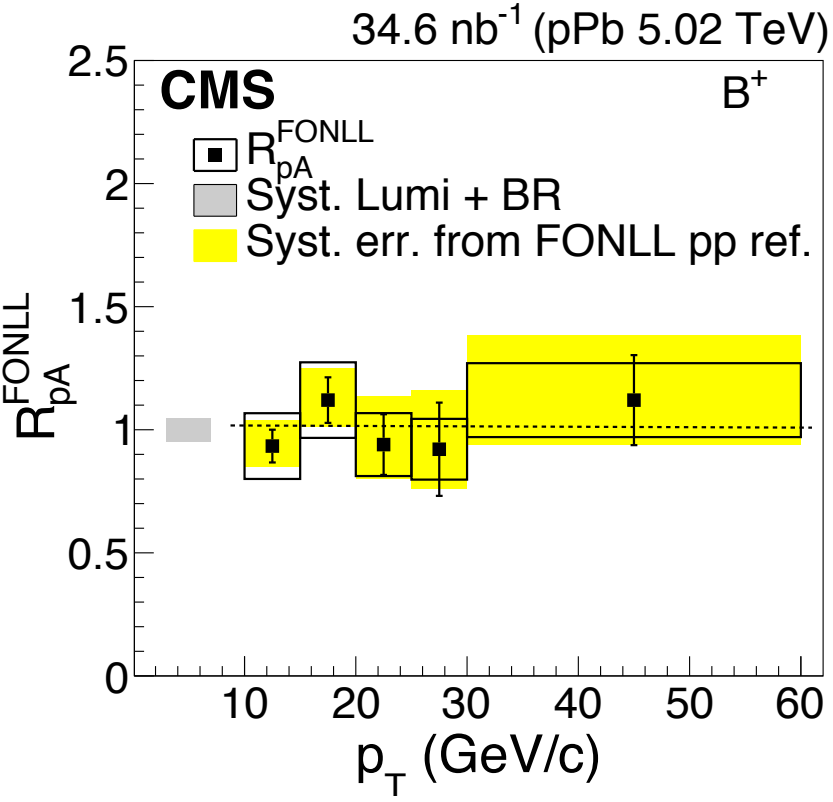


Step 5

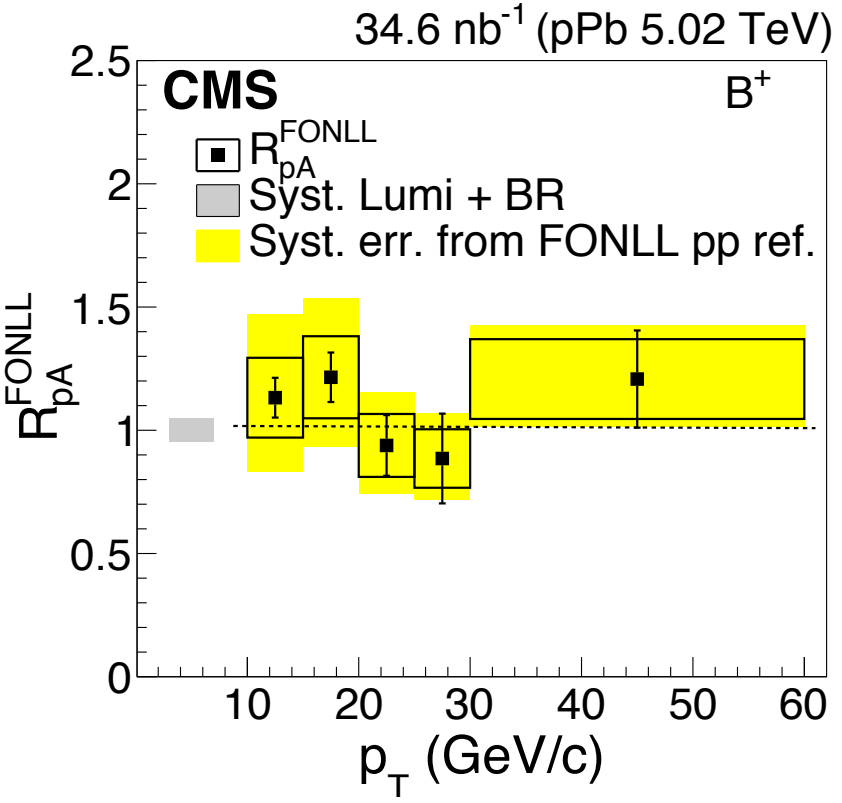
- **5. Get the pp data-driven reference (pp+FONLL)**
  - Central value : estimated pp 7 TeV with our binning * ratio of FONLL with our binning (5TeV / 7TeV)
  - Systematical and statistical error : estimated pp 7 TeV error with our binning * ratio of FONLL with our binning (5TeV / 7TeV)
    - Main source of systematical uncertainties of pp+FONLL

Step 6 : Results with pp references

pp+FONLL

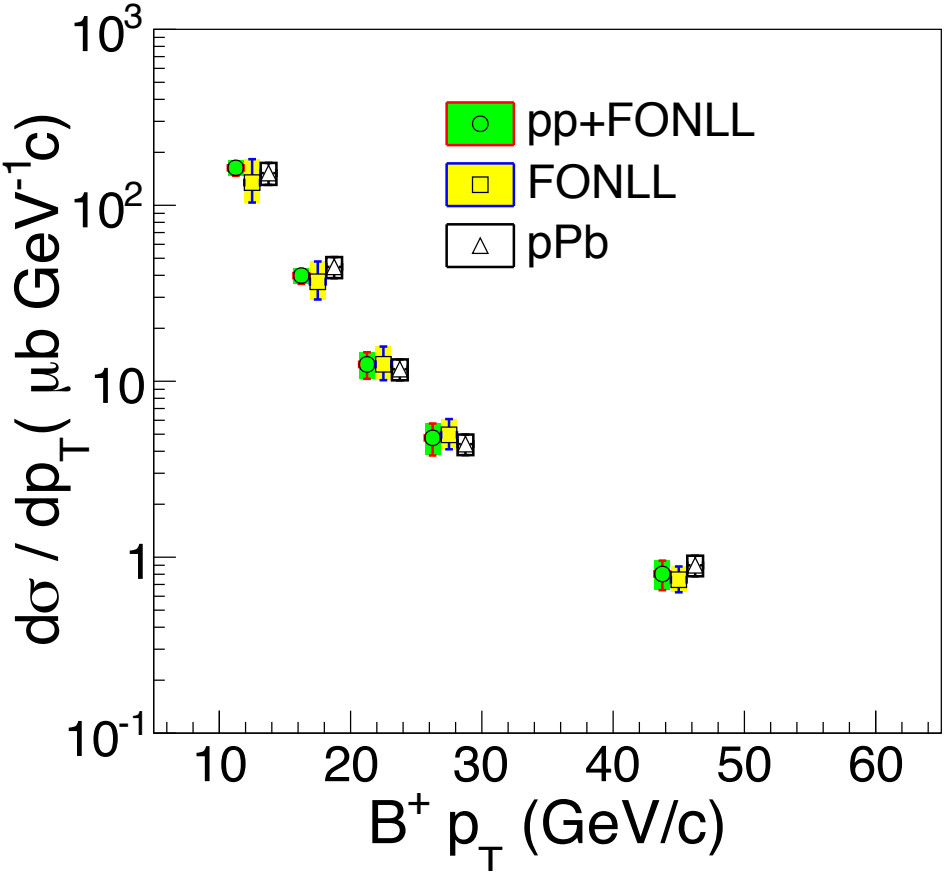


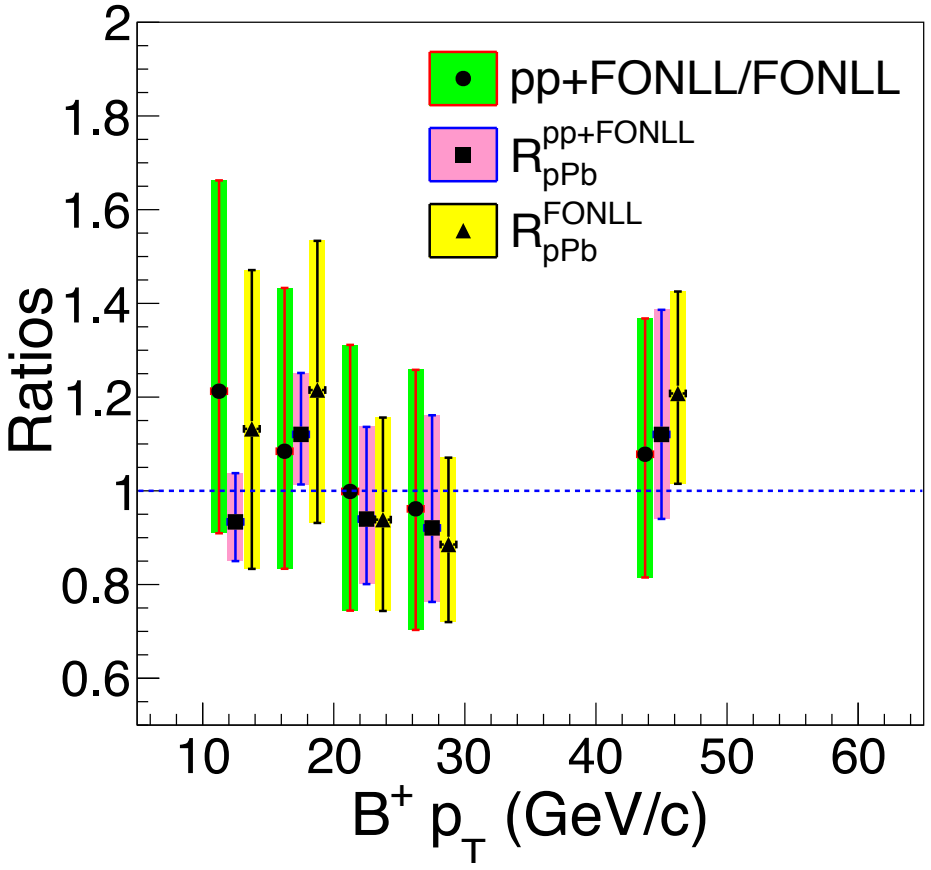
pure FONLL (present)



- **With pp+FONLL,**
  - In all bins R_{pA} would be more close to 1 than with pure FONLL
  - In lower p_T region, systematical error from data driven reference is much decreased than that from only FONLL reference

Step 6 : Results with pp references



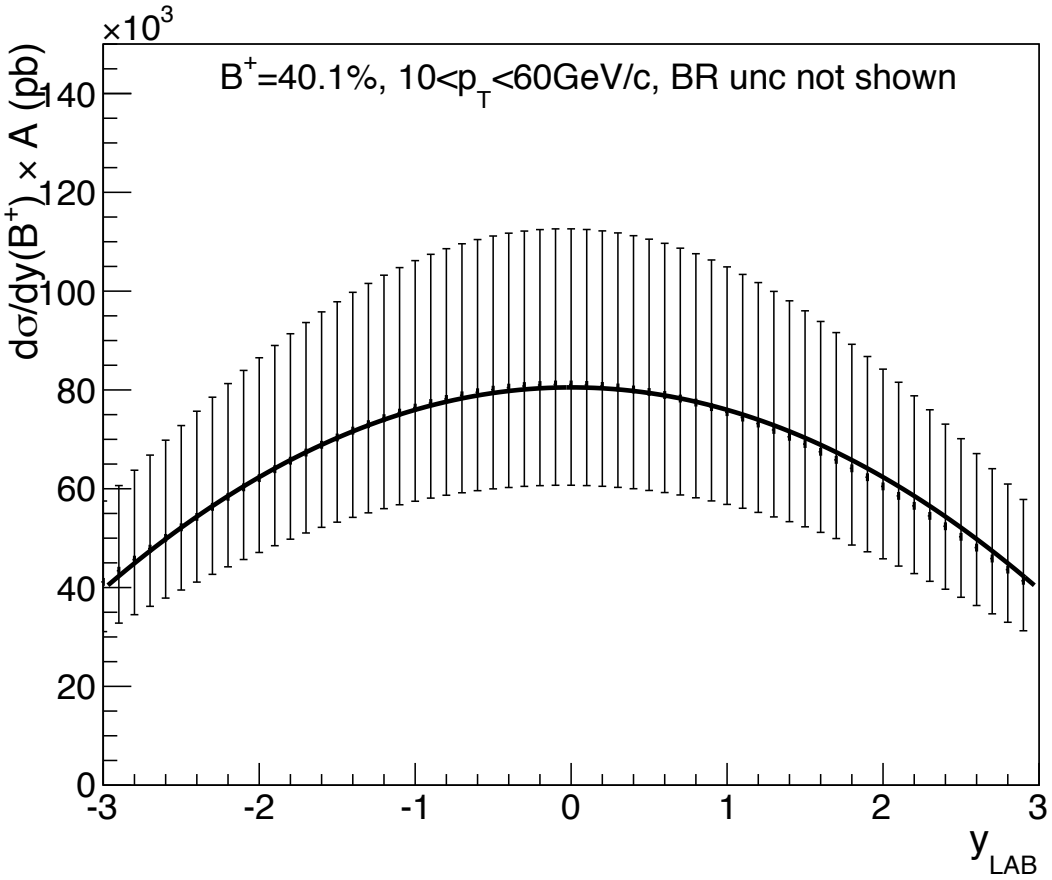


- **Notice : all the error is systematical error**
  - Left : pPb only includes systematical error
  - Right : errors from (pp data+FONLL or FONLL itself)
- **Compare central value and systematical error**
  - Confirm trends commented at previous slide

y dependence

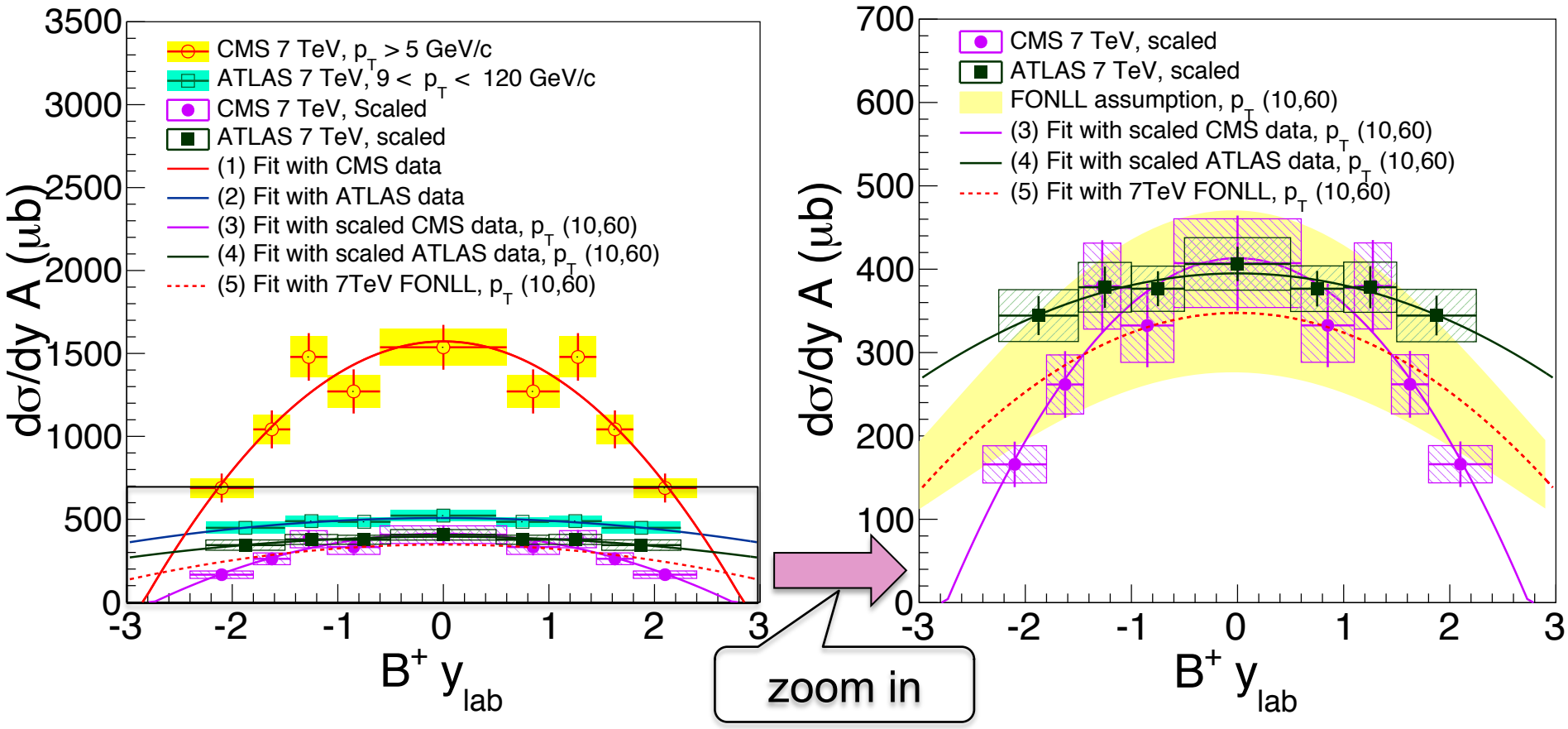
Step 1

- **1. Get the working fit function from 7 TeV FONLL with fine binning**



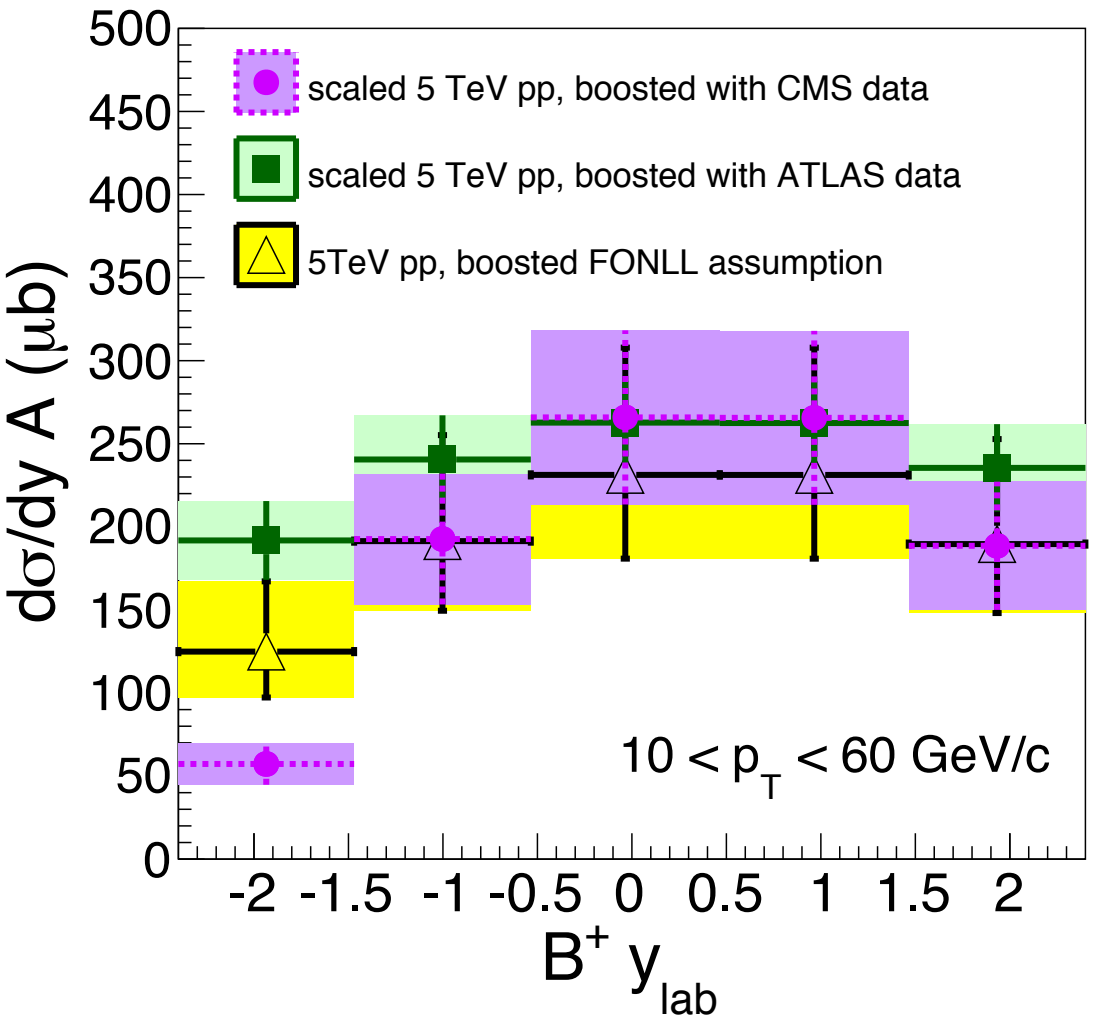
pol2 : [0]+[1]*x*x

Step 2 & 3



- **Data is scaled with ratio of FONLL**
  - CMS*(10,60)/(5,120), ALTAS*(10,60)/(9,120)
- **In mid-rapidity scaled CMS and ATLAS data are duplicated**
- **Central value of FONLL expectation is underestimated in mid-rapidity than in data**
- **At forward region, scaled ATLAS>FONLL>scaled CMS data**

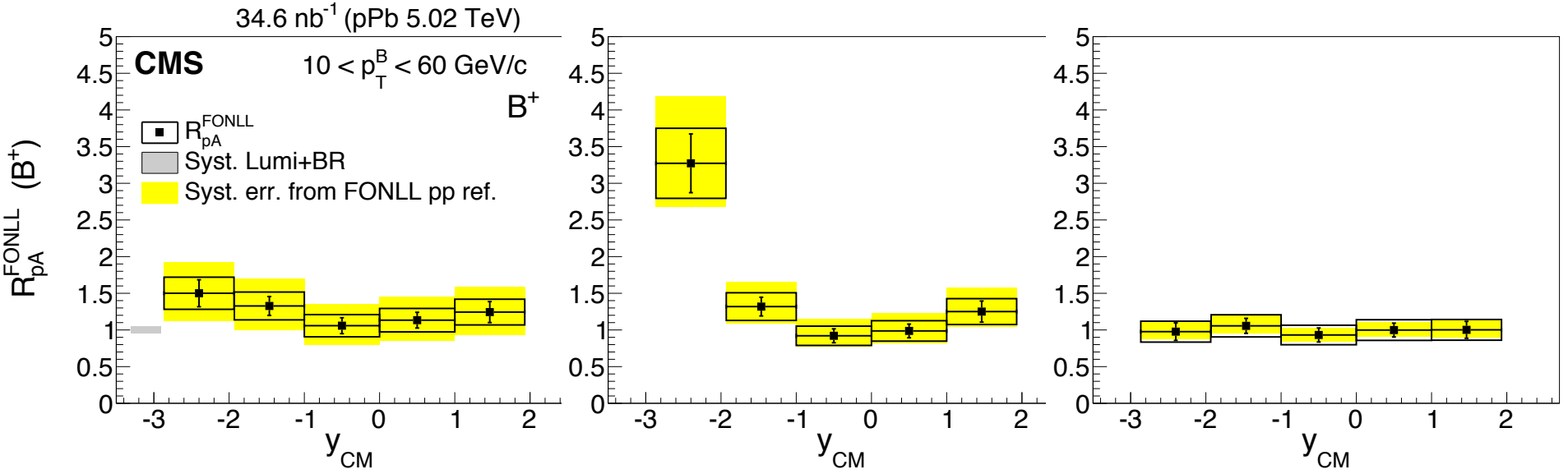
Step 4 & 5



- At backward bin, ATLAS>FONLL>CMS, difficult to believe this bin
- At 2,5 bins, ATLAS>CMS~FONLL, but within FONLL uncertainties consistent
- At 3,4 bins, CMS~ATLAS>FONLL, maybe FONLL might be underestimated, but within uncertainties consistent

Different R_{pA}

FONLL reference CMS+FONLL reference ATLAS+FONLL reference



- At $|y_{CM}|<1$, all results looks similar
- At backward y_{CM} bin, all R_{pA} varied so much

- For public, only show $|y_{CM}|<1.93$?

Question and plan for near days

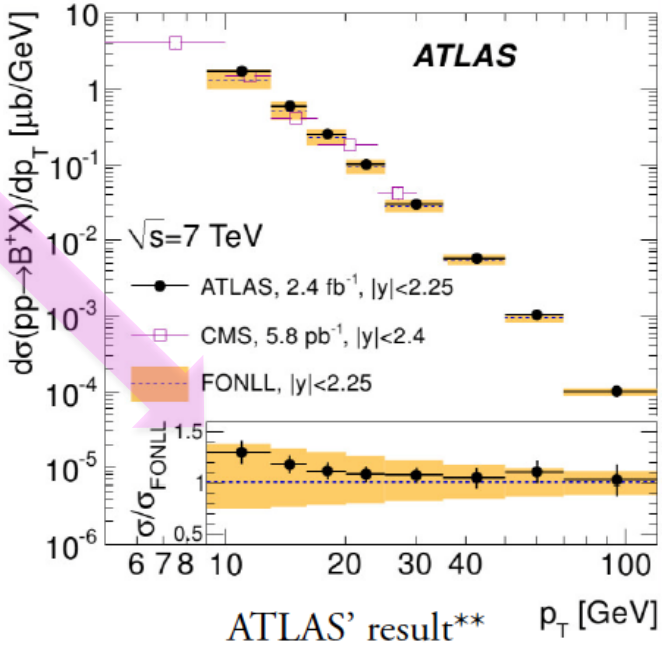
- **Question**
  - How can we treat the result with “pp+FONLL” for main results?

- **Next step**
  - Same study for B^0, B_s
  - Try to get weighted points (especially with ATLAS points)

Backup

Reminder : comments about pp reference

- **Now : use FONLL expectation at 5 TeV collision**
- **Julia's comments**
  - We have published 7 TeV pp CMS and ATLAS measurements
  - The theoretical calculations at 7 TeV have been shown to deviate from the data by factors up to 1.5, and this is rapidity and p_T dependent
  - The theoretical uncertainties are so large, that they prevent a meaningful statement about R_{pPb} to be made vs p_T or rapidity.
- **Need to consider a data-driven method to determine the pp reference at 5.02 TeV moving from present model-based pp reference (FONLL assumption)**
- **Detailed approach**
  - Use the published 7 TeV data
    - also adding low energy data (CDF, D0, UA1)
  - Then FONLL scaling to 5.02 TeV
  - Adding 2.76 TeV pp data is also a possibility



Rapidity conversion in between lab and CM frame

- **General**
  - Proton going direction have plus rapidity in CM frame
  - Merge bins with same rapidity in CM frame(same color in tables)
- **1st run**
  - proton going to minus eta $y_{CM} = -y_{lab} - 0.465$

yLAB	-2.4	-1.465	-0.465	+0.535	+1.470	+2.4
yCM	1.935	1.0	0.0	-1.0	-1.935	-2.865

proton going direction

- **2nd run**
  - proton going to plus eta $y_{CM} = y_{lab} - 0.465$

yLAB	-2.4	-1.470	-0.535	+0.465	+1.465	+2.4
yCM	-2.865	-1.935	-1.0	0.0	1.0	1.935

proton going direction

Reminder : Status of HIN-14-004

- **Paper draft and AN submitted on CADI**
  - AN : http://cms.cern.ch/iCMS/jsp/openfile.jsp?tp=draft&files=AN2013_322_v10.pdf
  - paper draft : http://cms.cern.ch/iCMS/analysisadmin/get?analysis=HIN-14-004-paper-v0.pdf

Analyzers would like to ask you to look at the draft and any comments about that