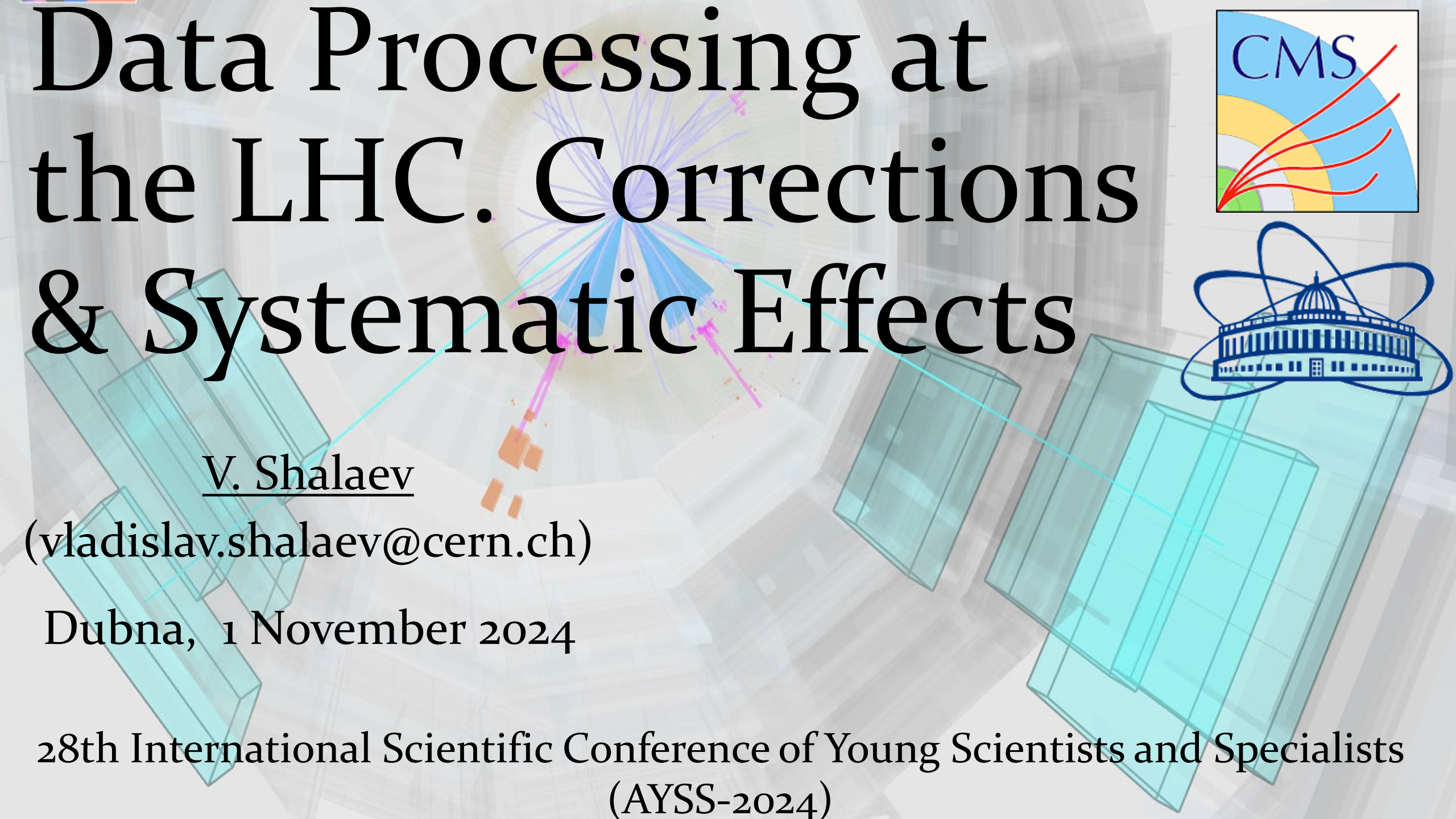
Data Processing at the LHC. Corrections & Systematic Effects



V. Shalaev

(vladislav.shalaev@cern.ch)

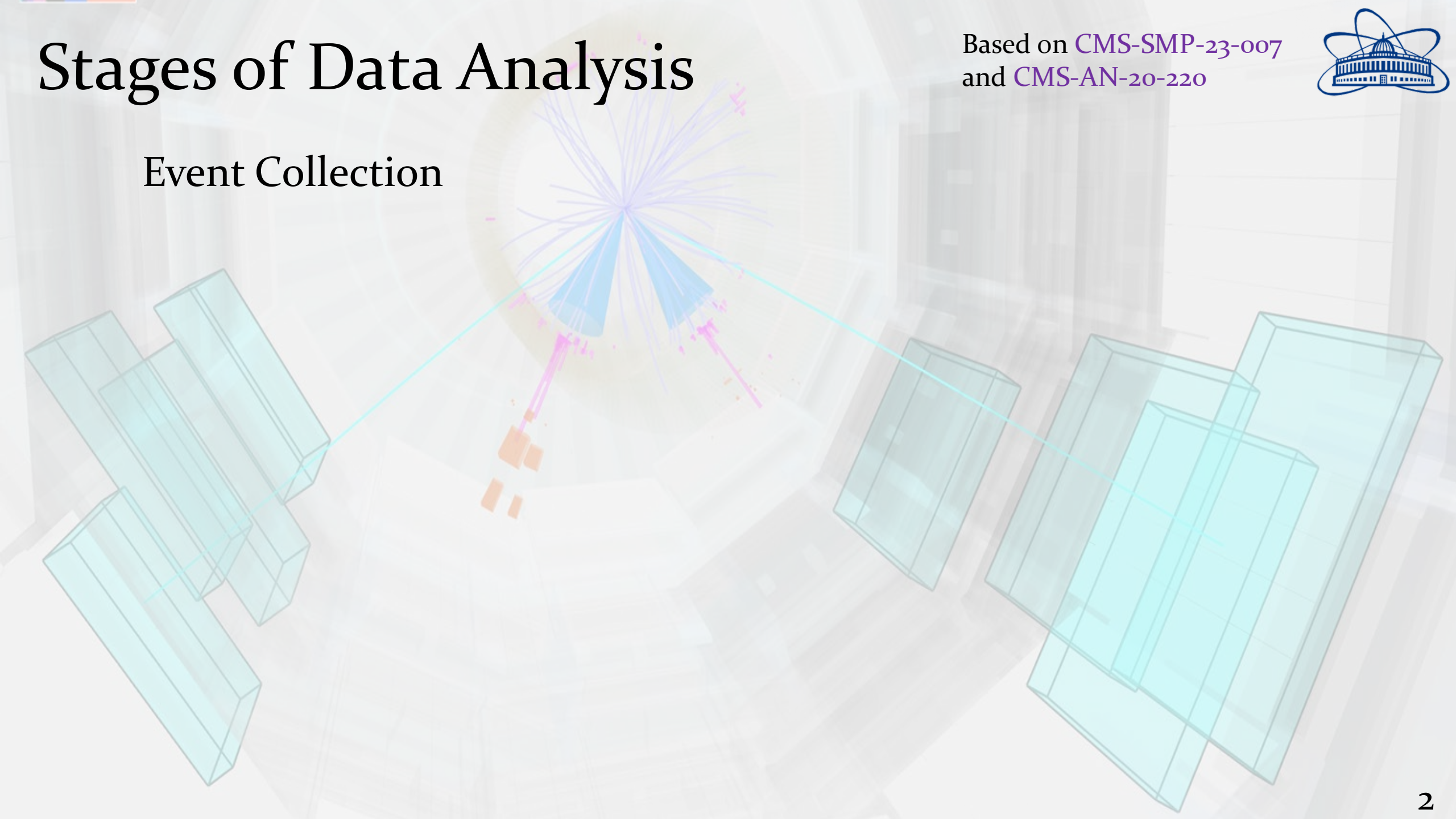
Dubna, 1 November 2024

28th International Scientific Conference of Young Scientists and Specialists (AYSS-2024)

Stages of Data Analysis

Based on CMS-SMP-23-007
and CMS-AN-20-220

Event Collection



Stages of Data Analysis

Based on CMS-SMP-23-007
and CMS-AN-20-220

Event Collection

⬇

Data Certification

Simulation

Stages of Data Analysis

Based on CMS-SMP-23-007
and CMS-AN-20-220

Event Collection

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Simulation

⬇

Event selection

Stages of Data Analysis

Based on CMS-SMP-23-007
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Event Collection

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Data Certification

Simulation

⬇

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⬇

Data and modeling corrections

Stages of Data Analysis

Based on CMS-SMP-23-007 and CMS-AN-20-220

Event Collection

⬇

Data Certification

Simulation

⬇

Event selection

⬇

Data and modeling corrections

⬇

Measurement

Stages of Data Analysis

Based on CMS-SMP-23-007 and CMS-AN-20-220

Event Collection

⬇

Data Certification Simulation

⬇

Event selection

⬇

Data and modeling corrections

⬇

Measurement

⬇

Uncertainty estimation

Stages of Data Analysis

Based on CMS-SMP-23-007 and CMS-AN-20-220

Event Collection

⬇

Data Certification

Simulation

⬇

Event selection

⬇

Data and modeling corrections

⬇

Measurement

⬇

Uncertainty estimation

Stages of Data Analysis

Based on CMS-SMP-23-007 and CMS-AN-20-220

Event Collection

⬇

Data Certification

Simulation

⬇

Event selection

⬇

Data and modeling corrections

⬇

Measurement

⬇

Uncertainty estimation

- Pileup
- Misalignment
- Efficiency

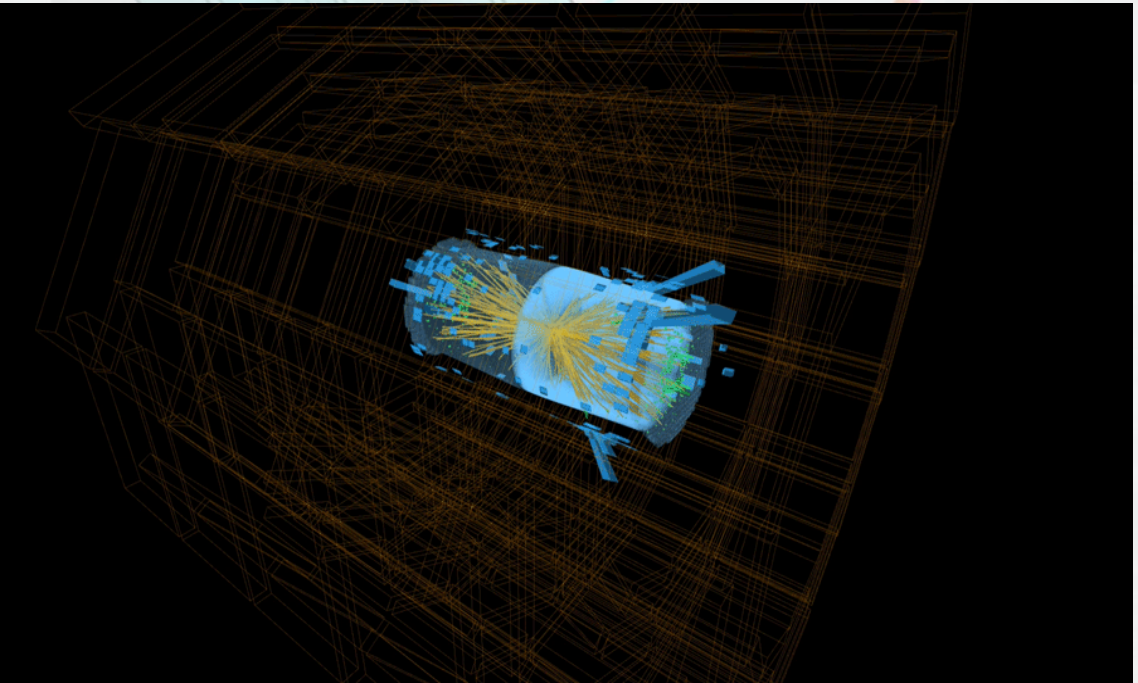
- Prefiring
- Integral Luminosity
- PDF and α_S
- Simulation Cross section
- QCD Scale Factors

Pileup

Origin: $L_{inst} \sim 10^{34}\ cm^{-2}s^{-1}$

- Bunch crossing (BX) every **25 ns**
- ~**60-70** pp-collisions per BX
- ~ **60** charged particles per pp-collision

~**1500-2000** charged particles per BX or $\mathbf{10^{11}}$ per second



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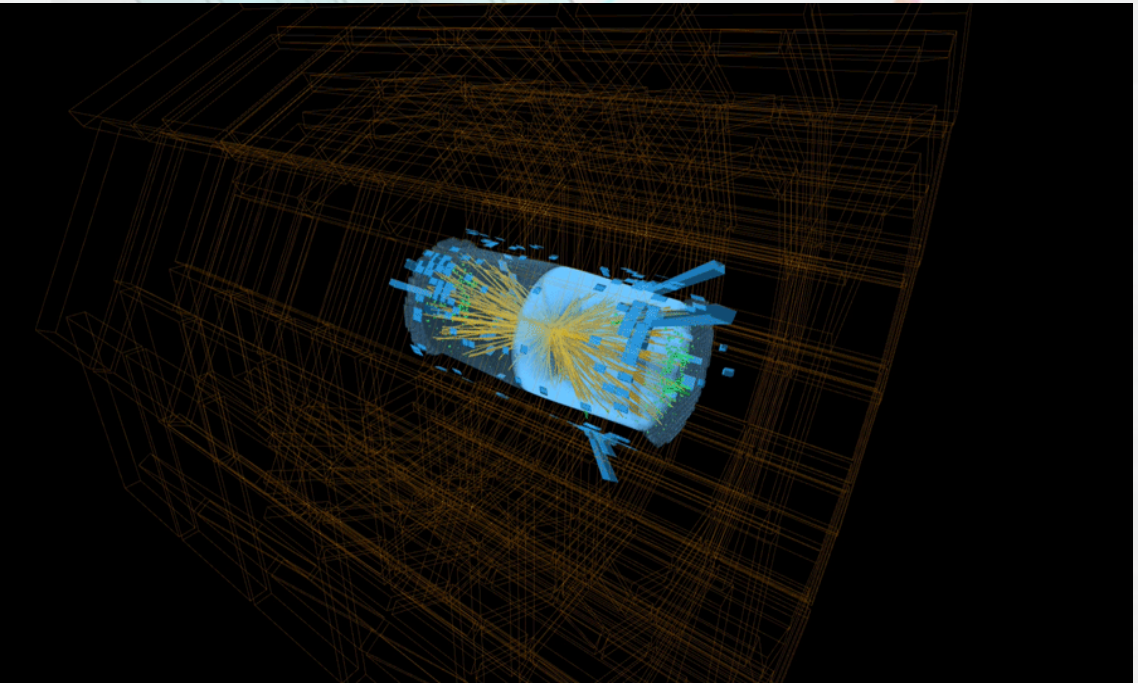
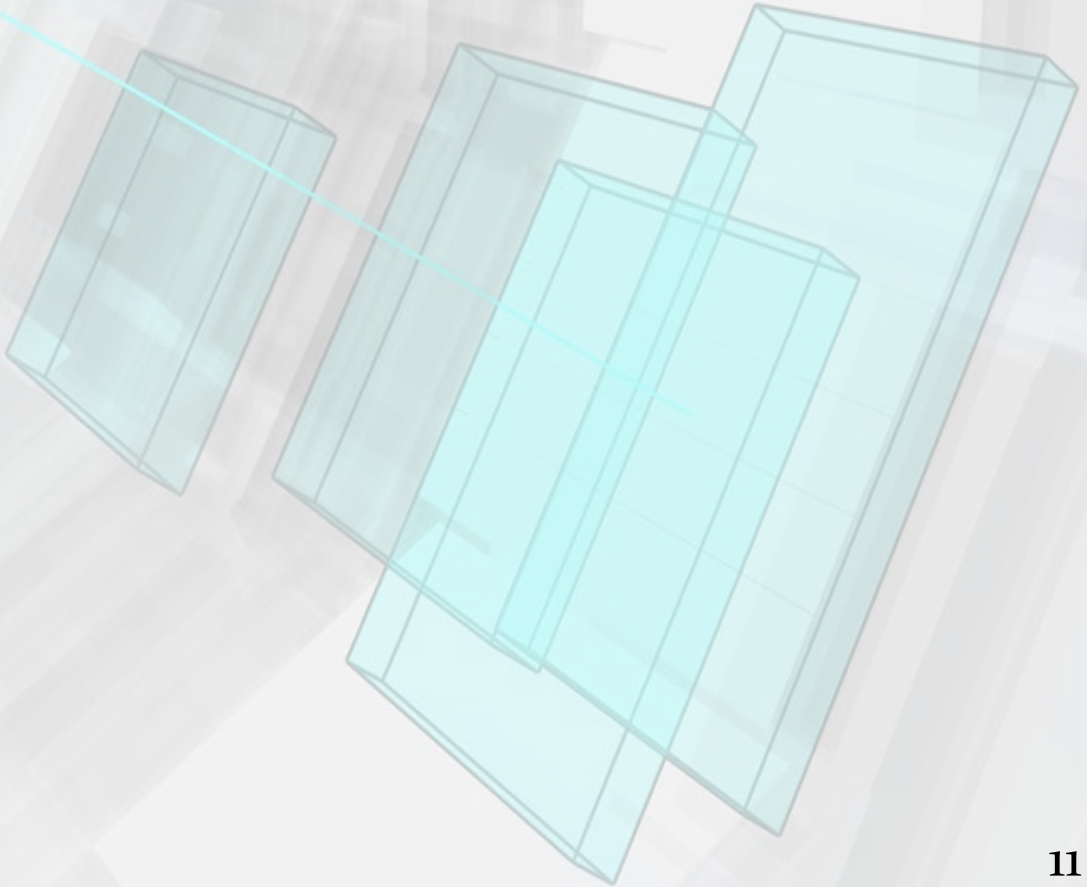


Correction: Average pileup is reweighted in MC in according with Data



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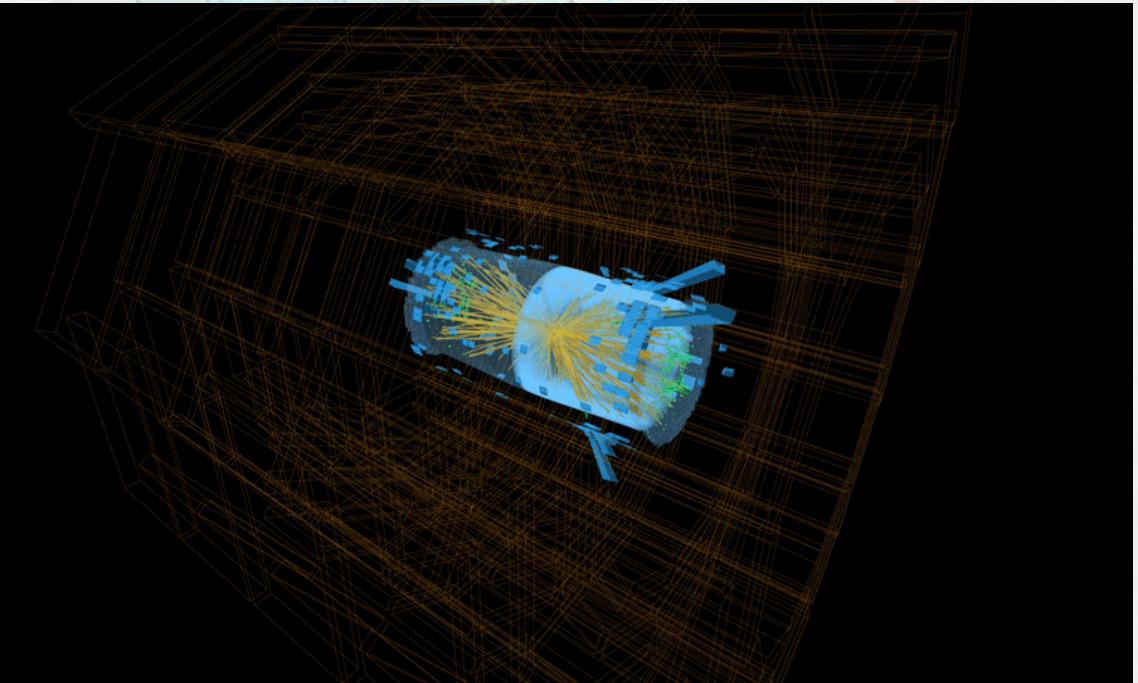

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Uncertainty: Variation of Minimum biased events XS

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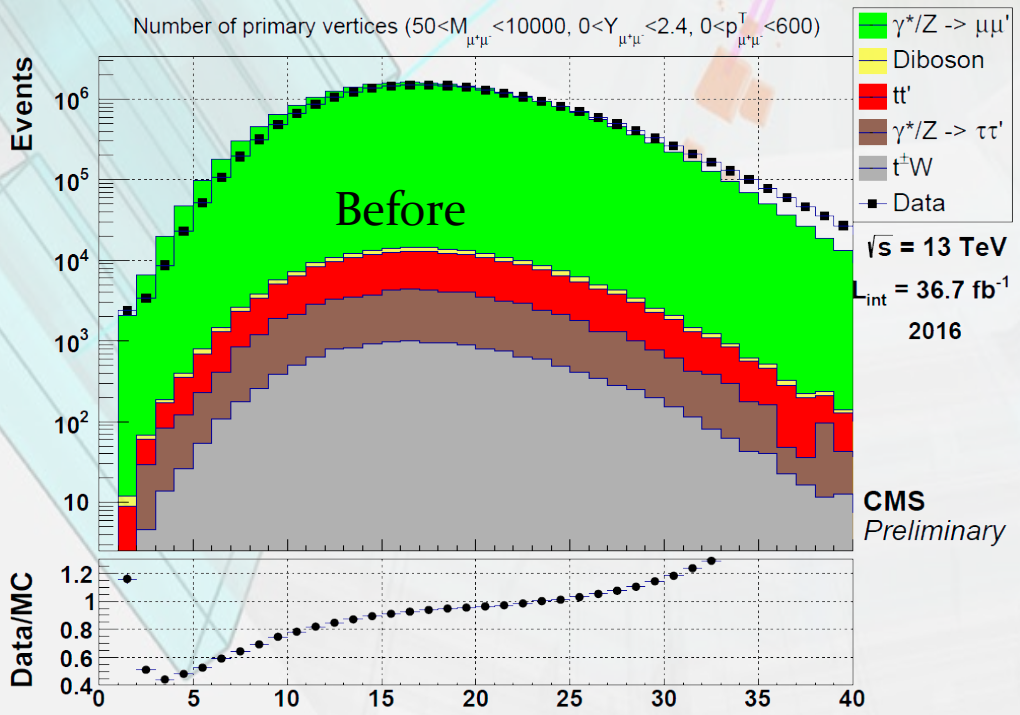
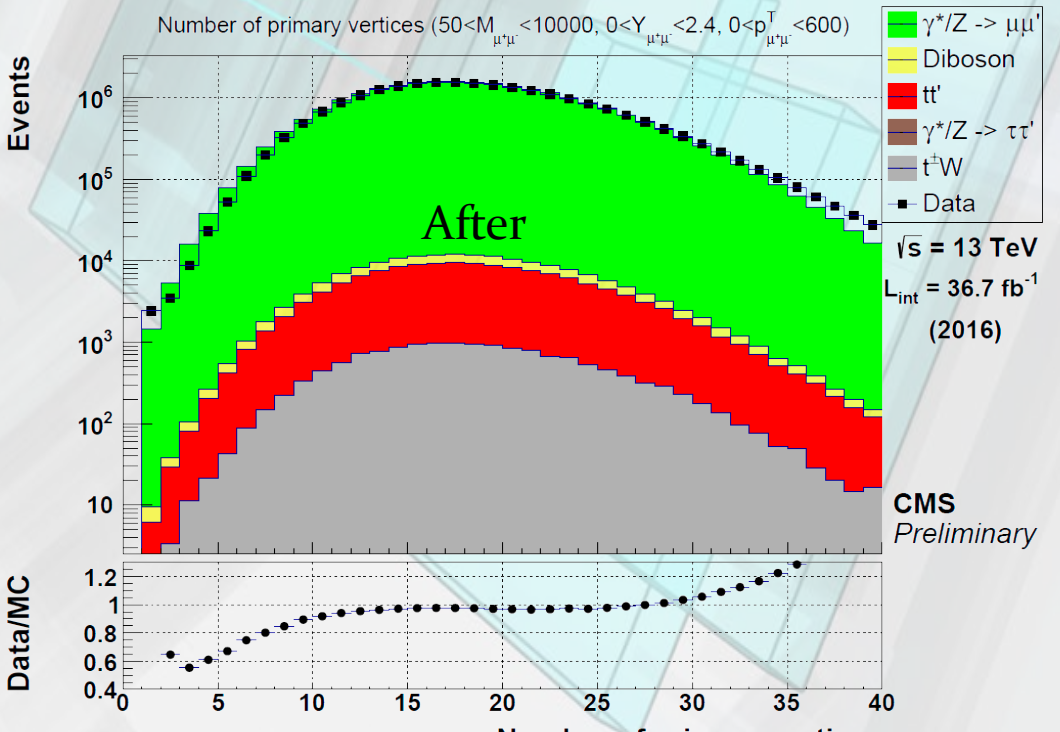


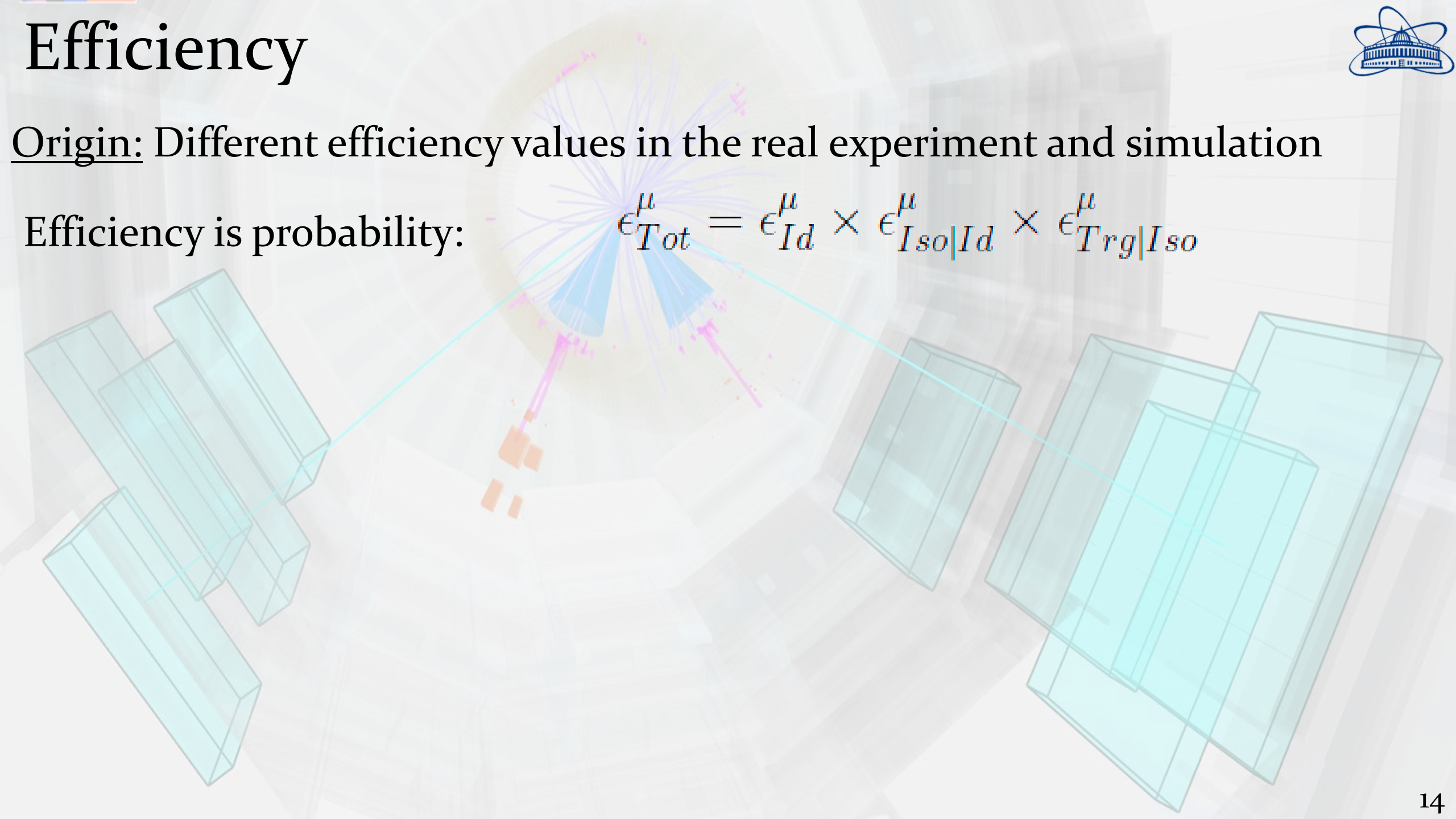


Efficiency

Origin: Different efficiency values in the real experiment and simulation

Efficiency is probability:

$$\epsilon^{\mu}_{Tot} = \epsilon^{\mu}_{Id} \times \epsilon^{\mu}_{Iso|Id} \times \epsilon^{\mu}_{Trg|Iso}$$



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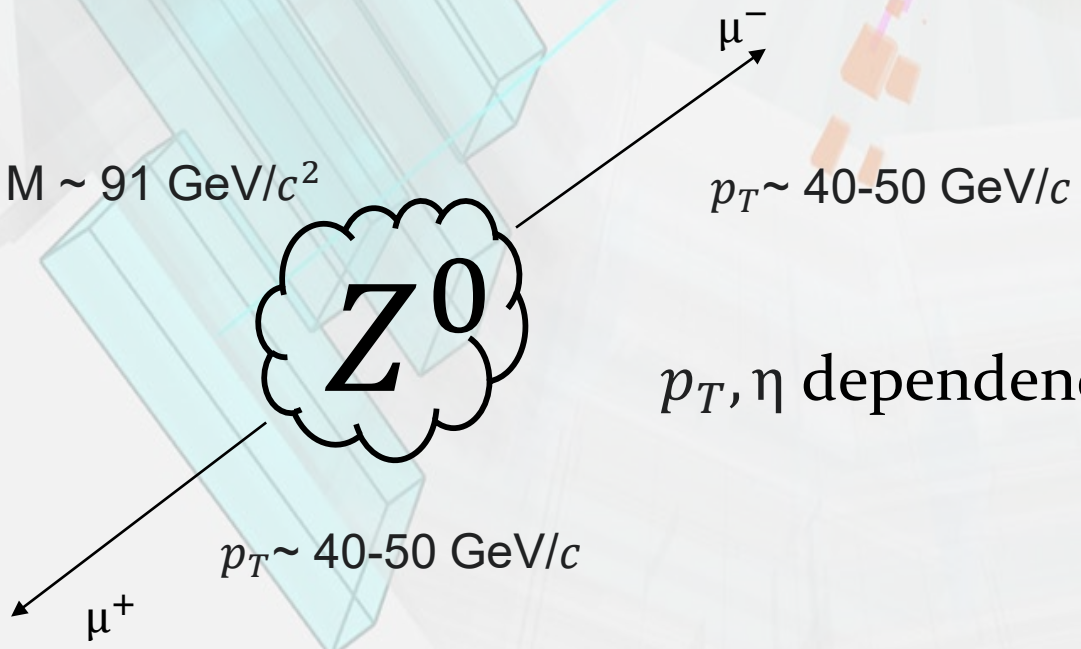

p_T, η dependence!

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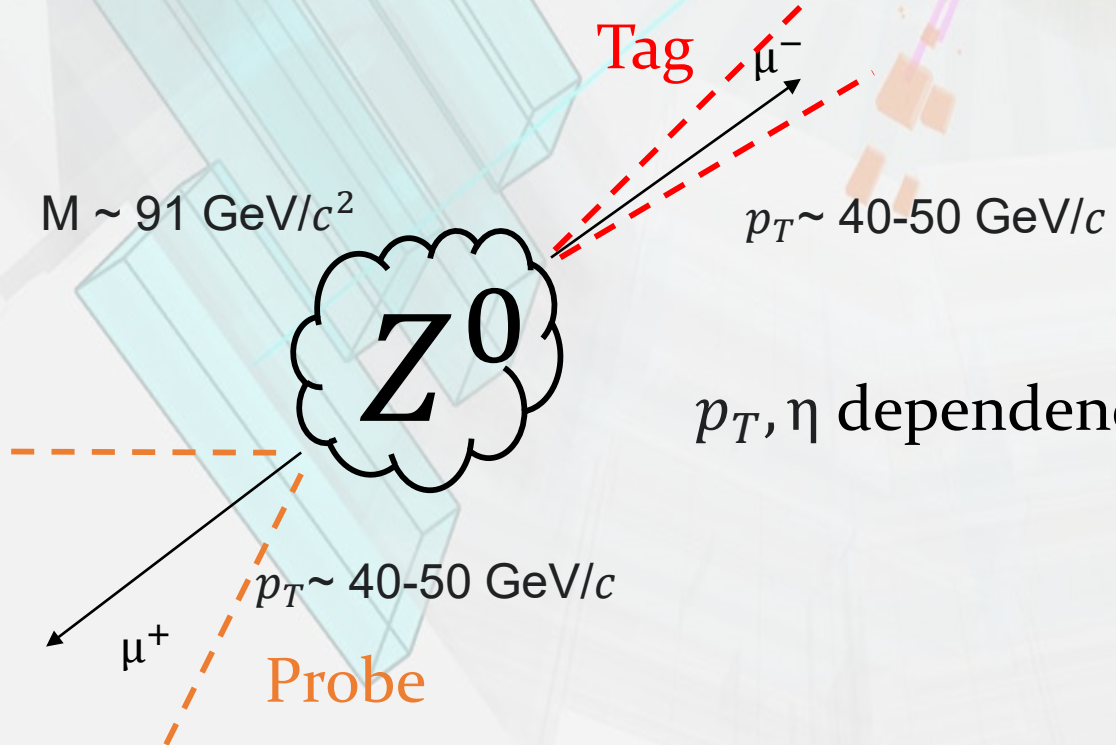

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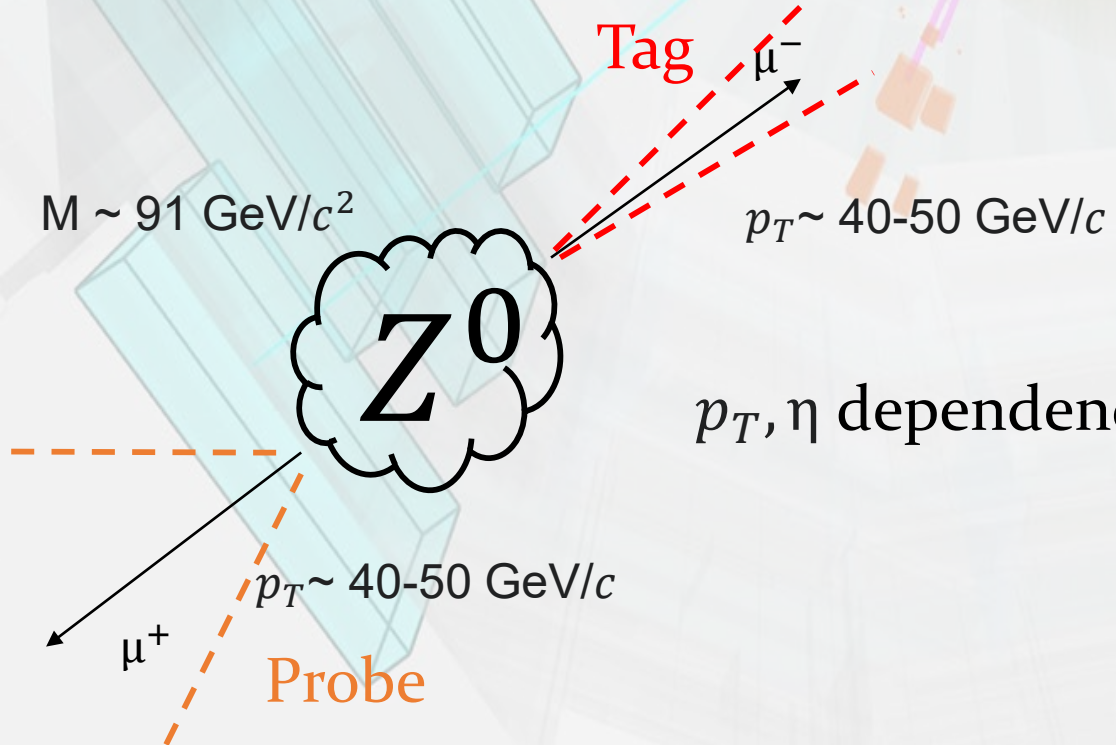


p_T, η dependence!

<u>Uncertainty:</u> Variation each of weights. Sum in quadrature

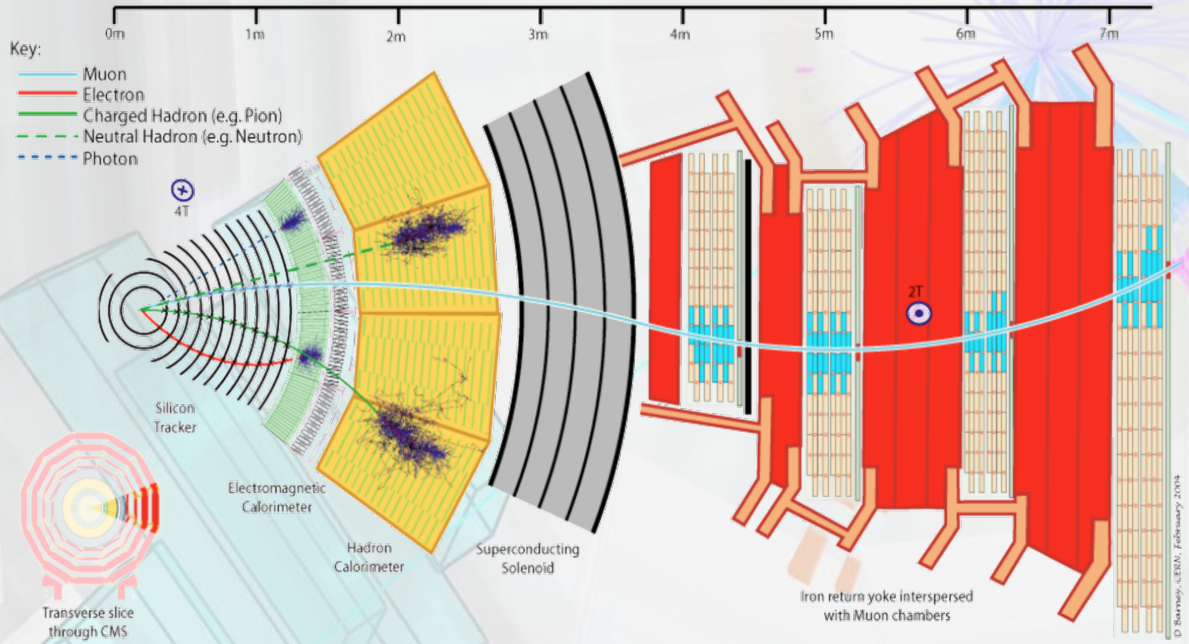
$\Delta = \sqrt{\sum_k^N \delta_k^2}$

- A_i^k - Variated value of A_i coefficients results from variation of uncertainty source
- A_i^0 - central value of A_i coefficient

Most significant type of uncertainty!

Misalignment

Origin: Non-accuracy of detector model



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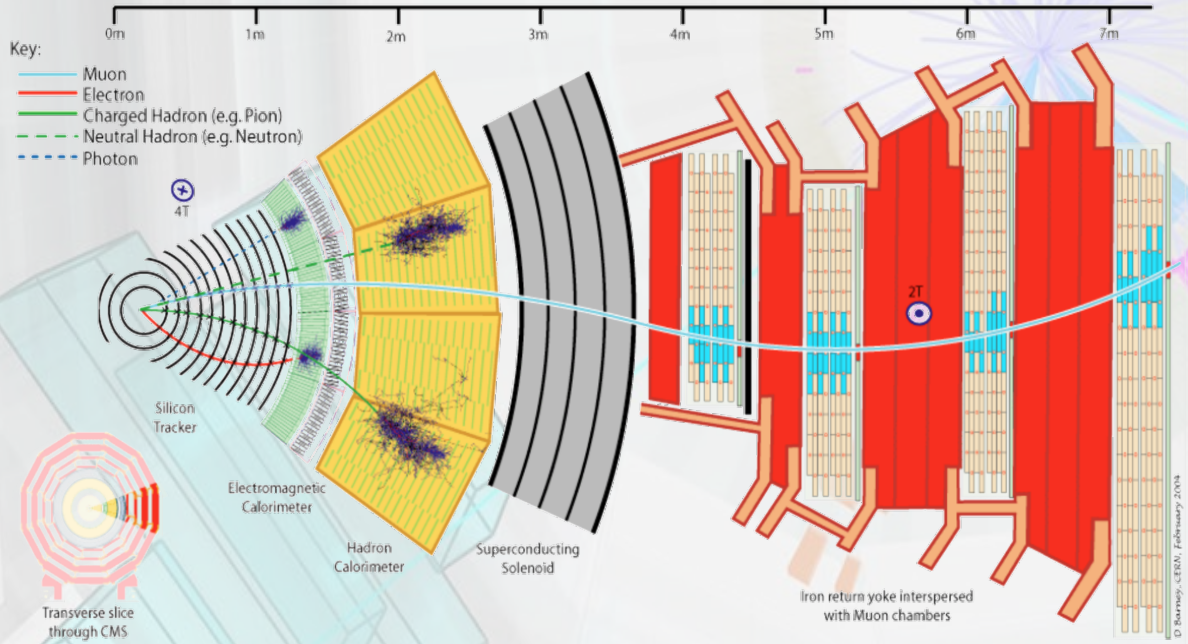

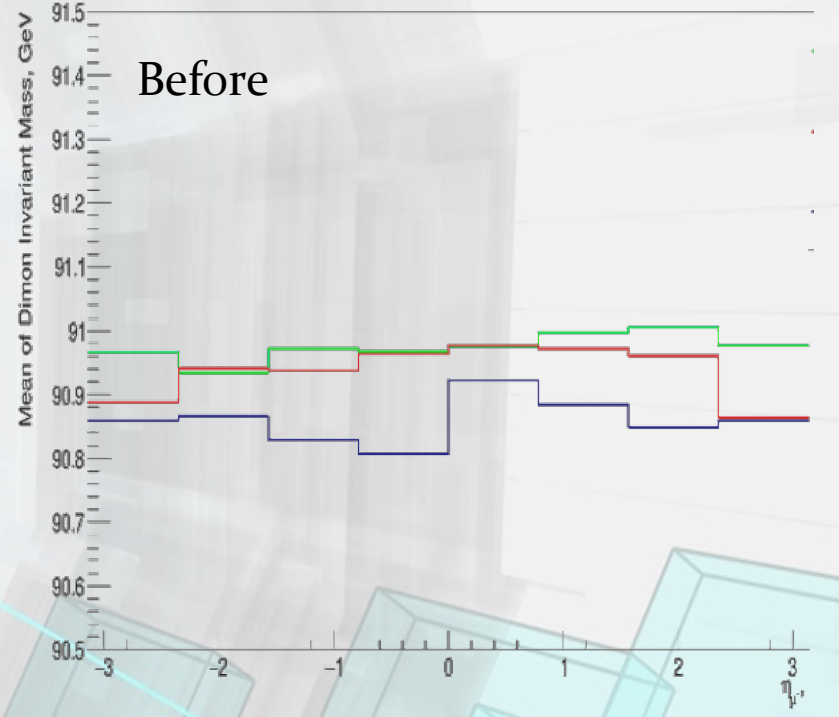

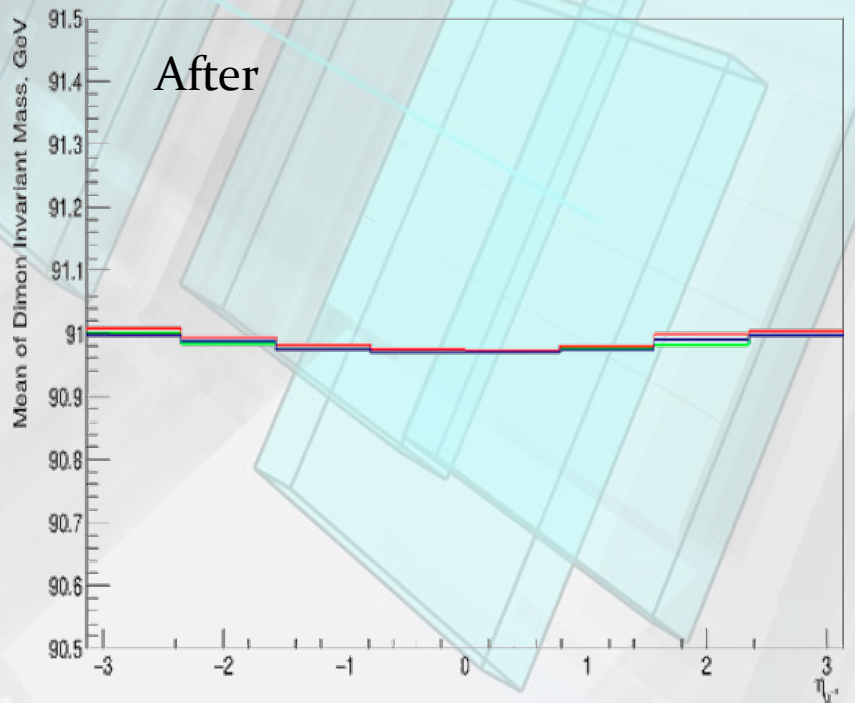

Correction: Tag & Probe with Rochester correction (Eur. Phys. J. C 2012. V. 72, P.)

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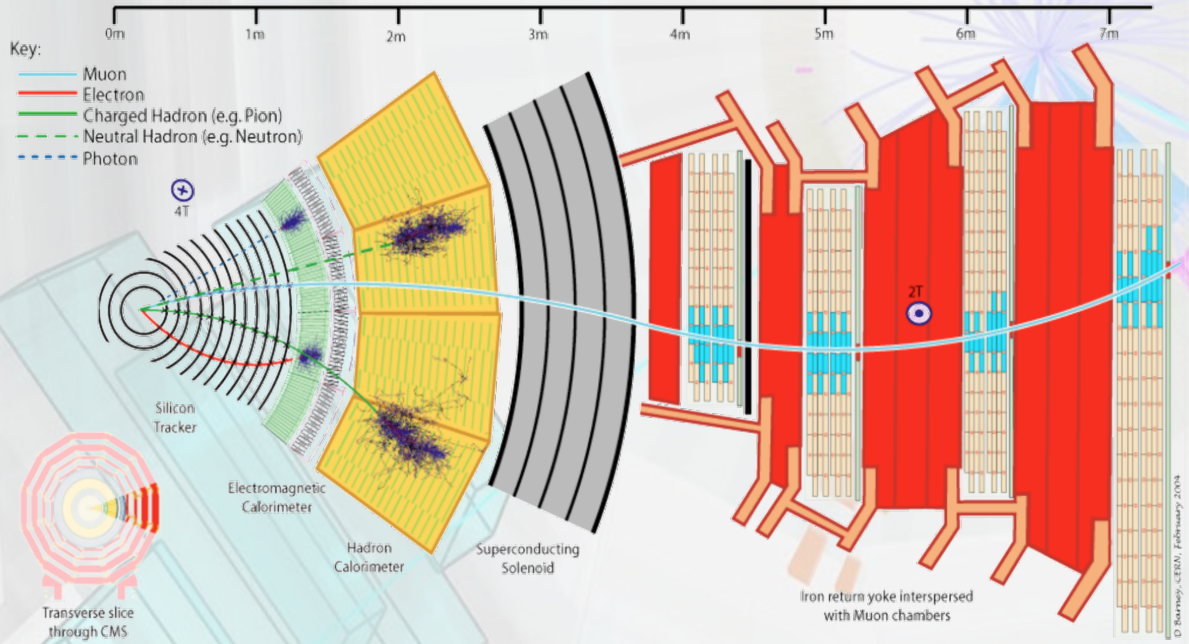

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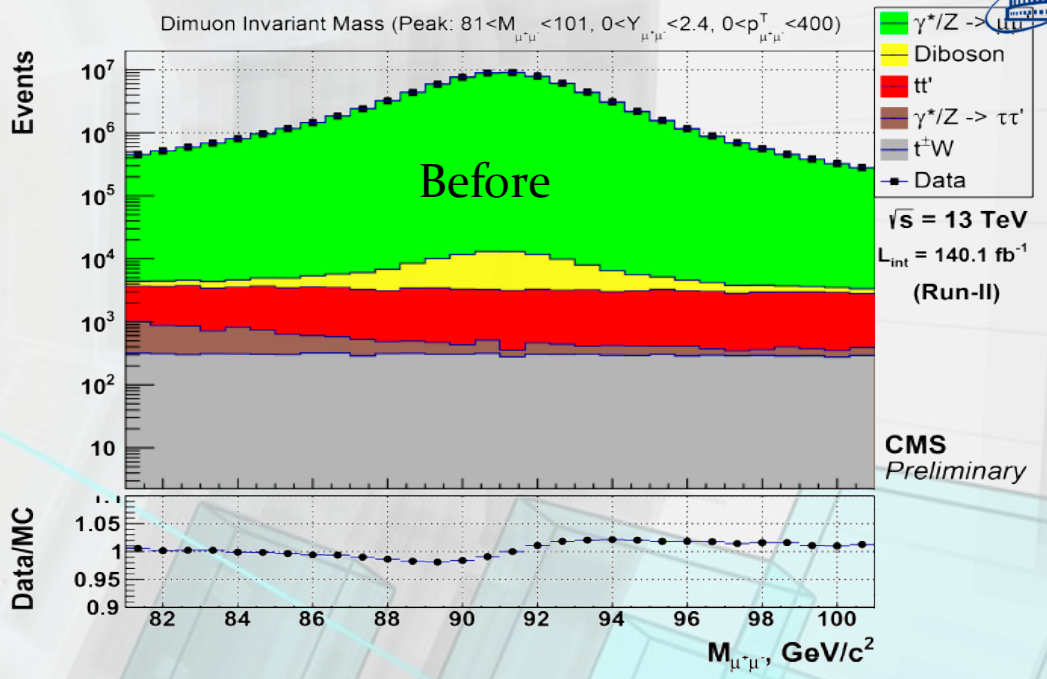

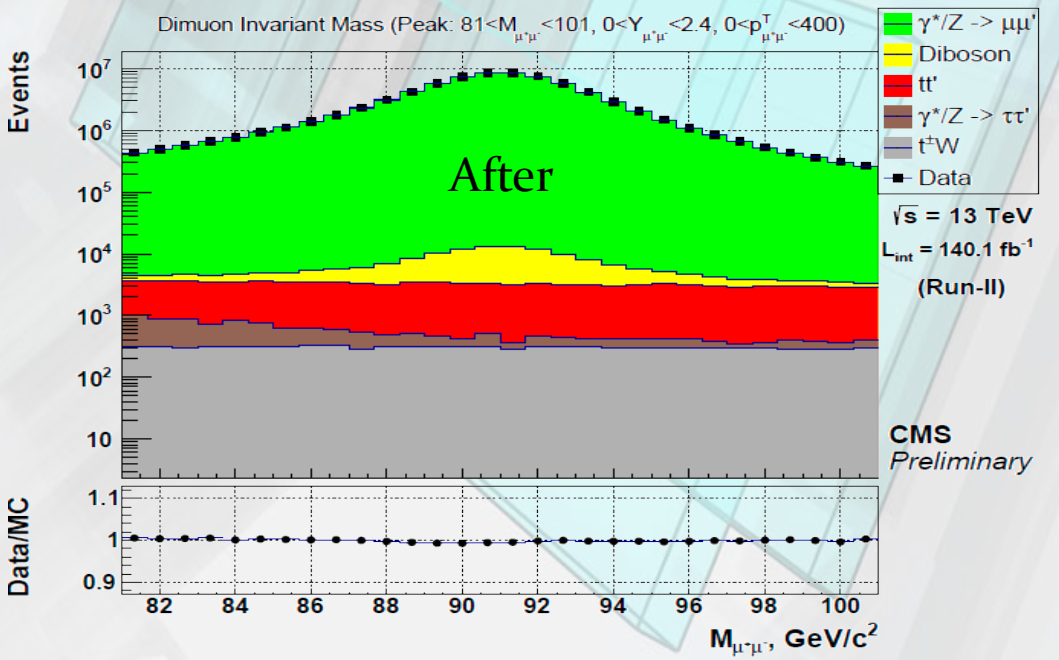

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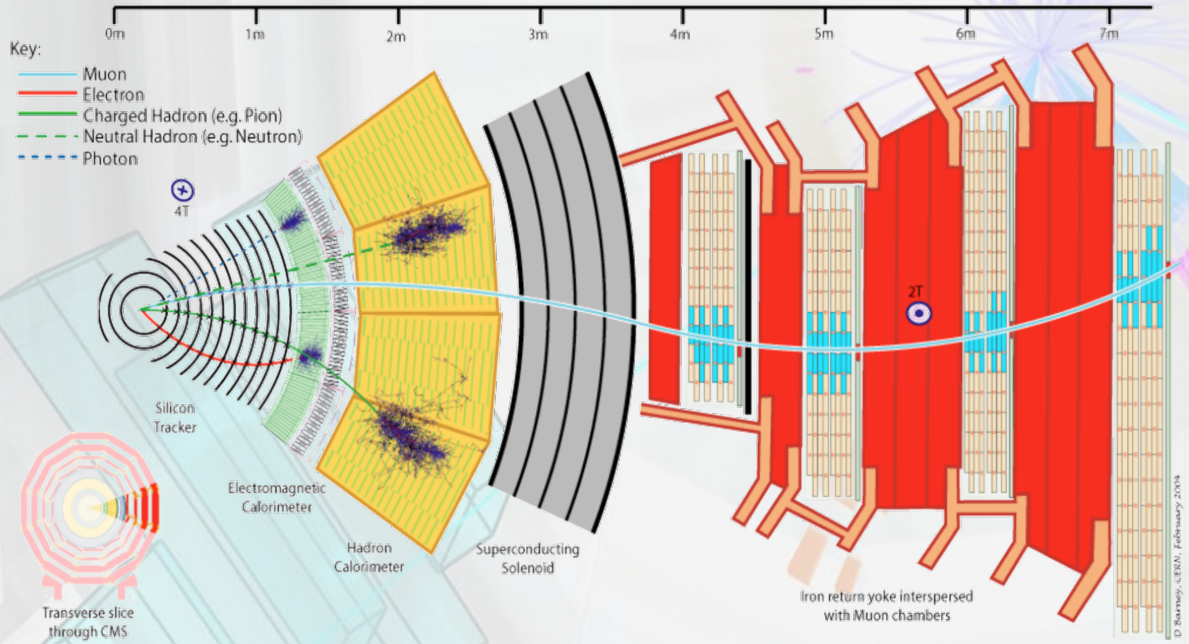

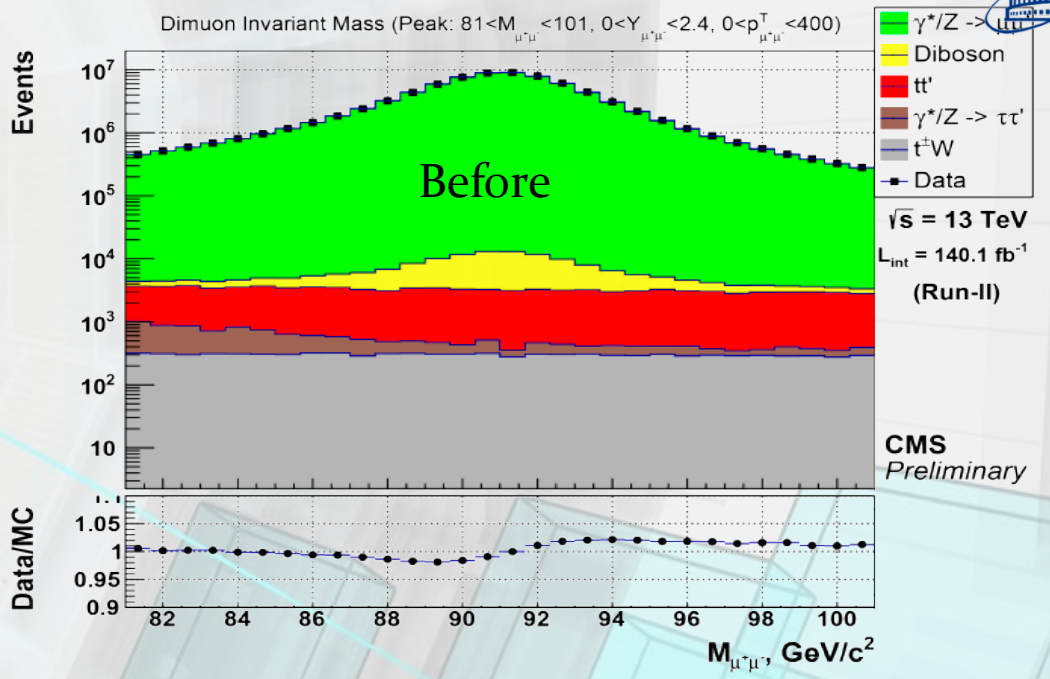

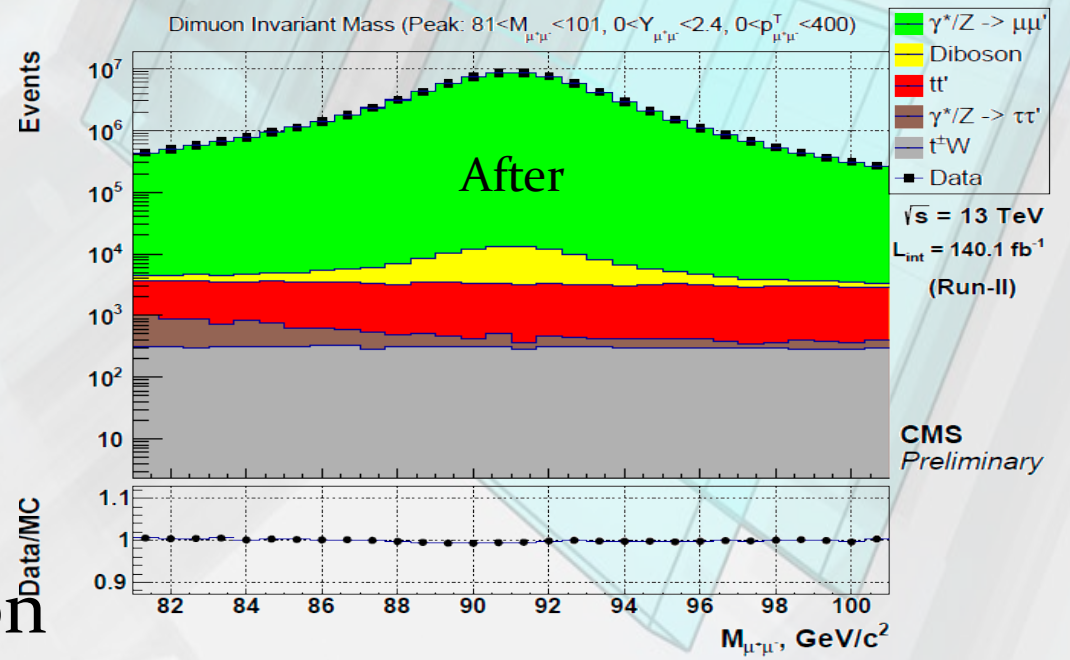

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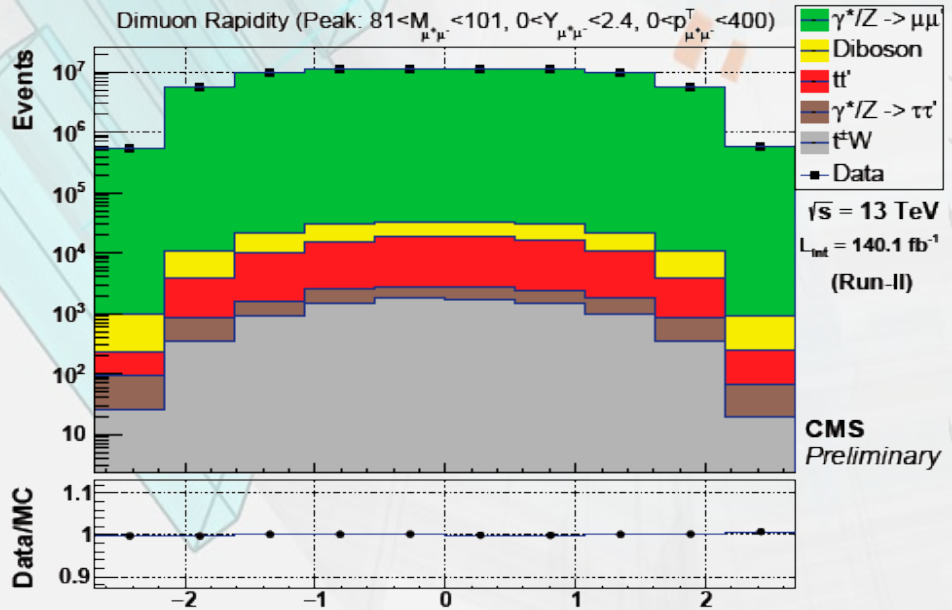
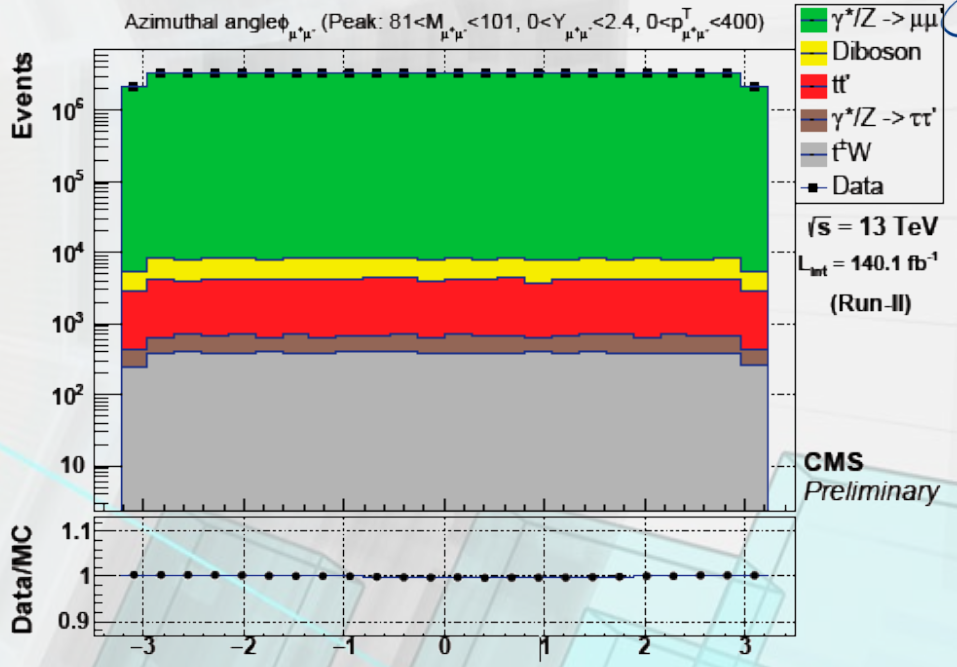
Uncertainty: 100 “toys” and RMS calculation

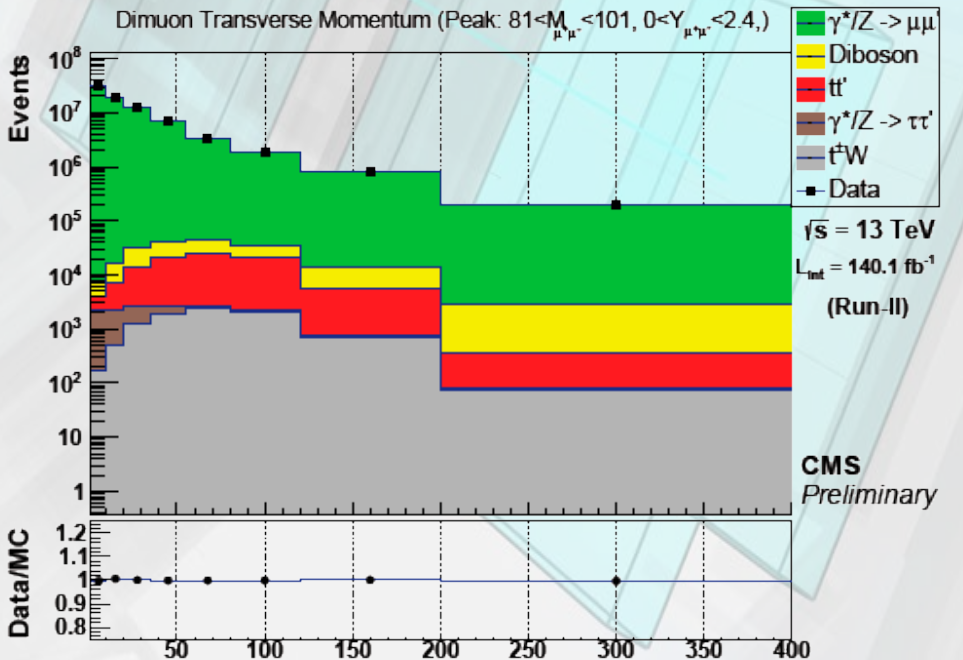
Conclusions

- Effects of difference between data and simulation are constantly being studied and could be successfully corrected.

- In analysis SMP-23-007 this steps are successfully done. Good agreement between data and MC is observed



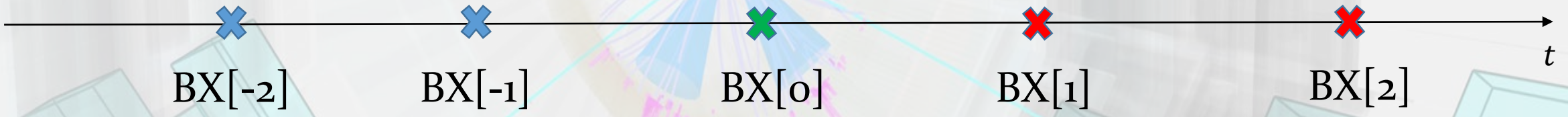




Prefiring

Origin: L_{inst} ~10^{34} $cm^{-2}s^{-1}$ and L1 Trigger time desynchronization

Normal Case:



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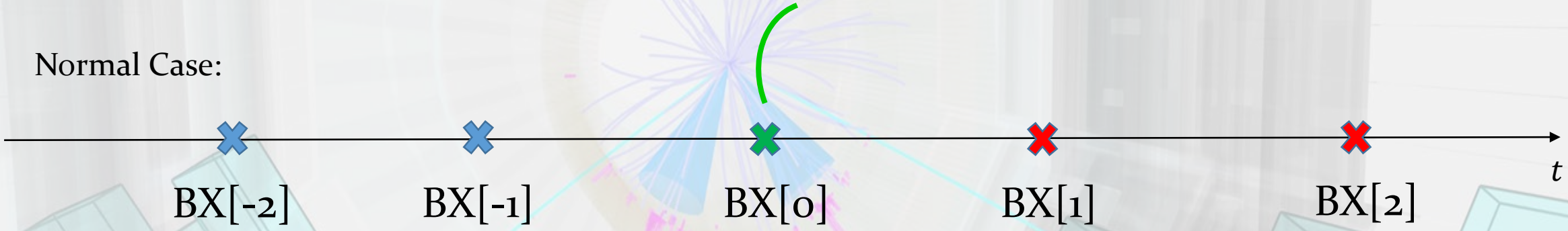
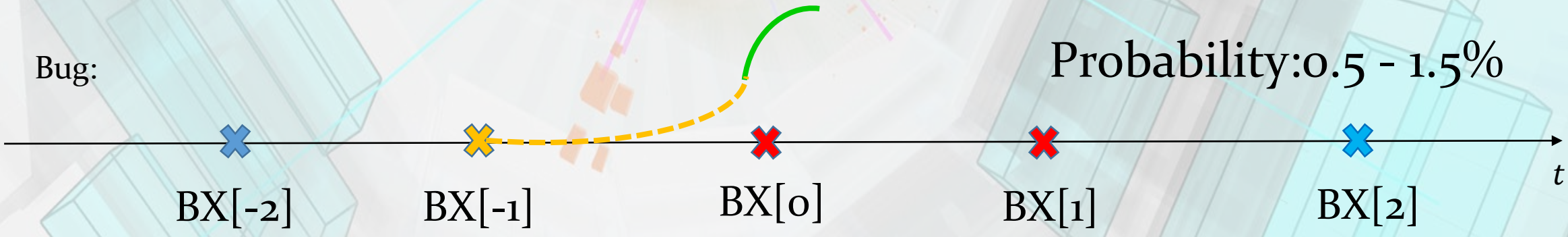


Bug:

Probability:0.5 - 1.5%



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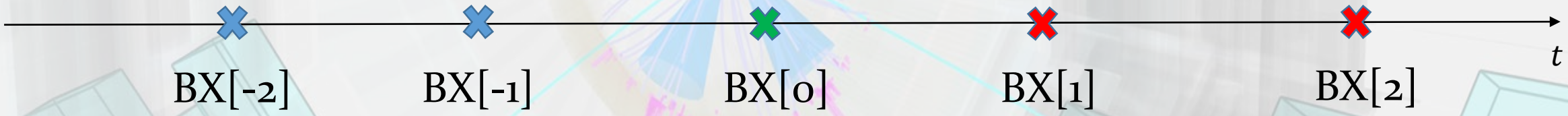

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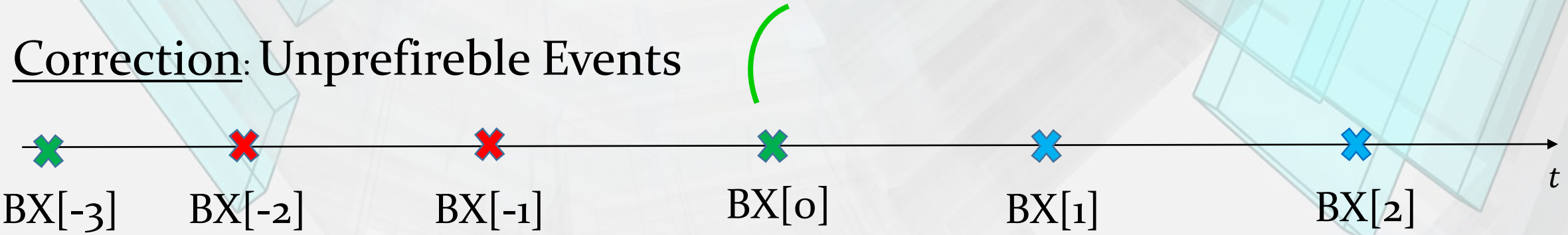
Correction: Unprefireble Events



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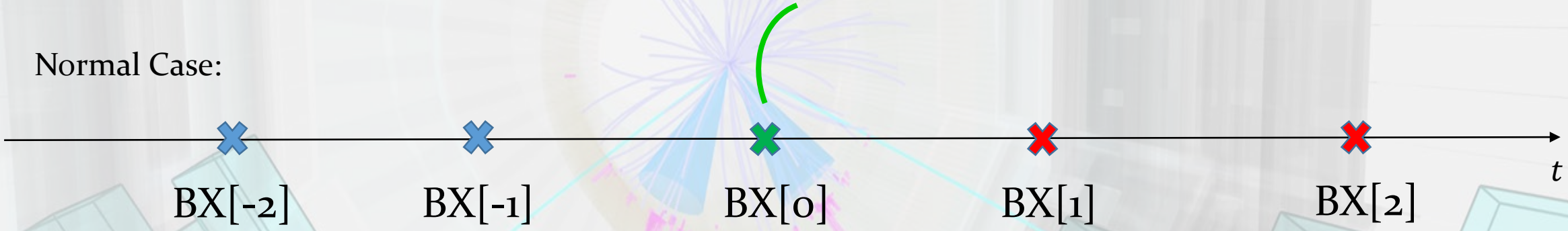

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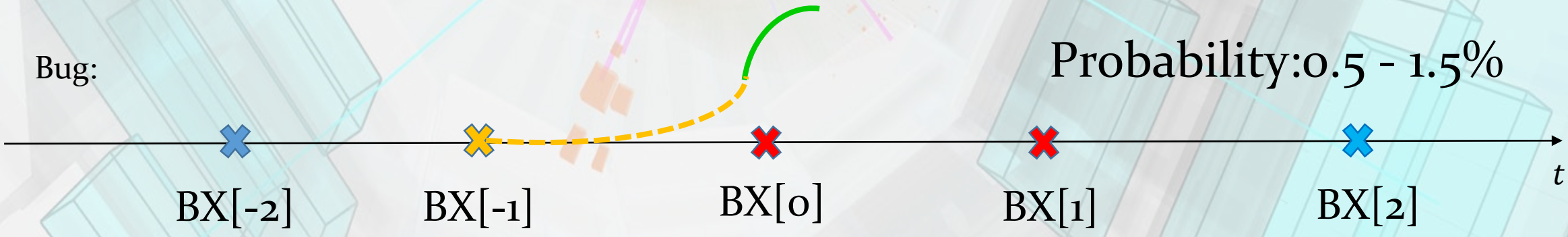

Correction: Unprefireble Events

Uncertainty: variation within unc.