CMS Physics Objects & Data Analysis School Preparation Meeting, 09 September 2023

POG exercise: Luminosity

The students will be introduced to the luminosity measurement at CMS, perform their own luminosity calibration with 2023 data, and learn how to calculate the integrated luminosity of a data set.

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Objectives

- What is luminosity?
- How is luminosity measured in CMS?
- How is luminosity calibrated in CMS?
- What are the luminosity uncertainties?
- How is luminosity used in physics analyses?
- How do I evaluate luminosity information for my analysis?
- How do I implement luminosity uncertainties in my analysis?

emittance scan analysis with 2023 data

"brilcalc" exercise

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Emittance scan analysis (\sim 3 h)

- we provide notebook with basic function to load, plot, & fit emittance scan data
 - notebook exists, currently simplifying
- use 2023 data files (hd5, ~300 MB)
 - possibly from HI run
- task: evaluate calibration constant & instantaneous luminosity
 - compare different detectors & BCIDs
 - derive corrections: orbit drift, beam current
 - evaluate corrections: length scale, beam-beam deflection
- possibly: assign students to different detectors/corrections, then report results and discuss differences

```
In [226]: def fit gauss Bunch(z,plot=True):
    Fits Gaussian curves to proton bunch rates using VdM scan data.
    Parameters:
    - z (int): Index of the proton bunch.
    - plot (bool, optional): If True, generates a plot. If False, generates :
    Roturne .
    If plot is True, returns None, If plot is False, returns fit parameters,
    rate bunches=bcmlflumi["bx"].T
    if emptybunch(z) == 'unpaired':
         return 'unnaired'
    elif emptybunch(z) == 'Empty':
         return 'empty'
    else:
         rate bunches=bcmlflumi["bx"].T
        rate = rate bunches[z][:103]
         rate2 = rate bunches[z][103:]
    if plot ==True:
         return plot average(rate,rate2,z)
    else
         return plot parameters(rate.rate2.z)
fit gauss Bunch(0, True)
fit gauss Bunch(100, True)
```



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Brilcalc exercise $(\sim 1 h)$

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- \blacksquare brilcalc on lxplus \Rightarrow students required to have lxplus access
- uncertainty evaluation with simple python scripts, no dependencies
- short tutorial on how to use brilcalc and where to find information
- we provide list of questions/tasks that require to use brilcalc and/or to do some simple calculations
 - calculate integrated luminosity for a Golden JSON selection
 - calculate integrated luminosity for a prescaled trigger
 - evaluate combined luminosity uncertainty for full Run 2 data set
 - evaluate combined luminosity uncertainty for a Run 2 data set with limited trigger availability