Luminosity Monitoring and Bunch Current

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- Introduction
- Features of bunch-by-bunch current
- Comparison of bunch-current product and event rate at PHENIX

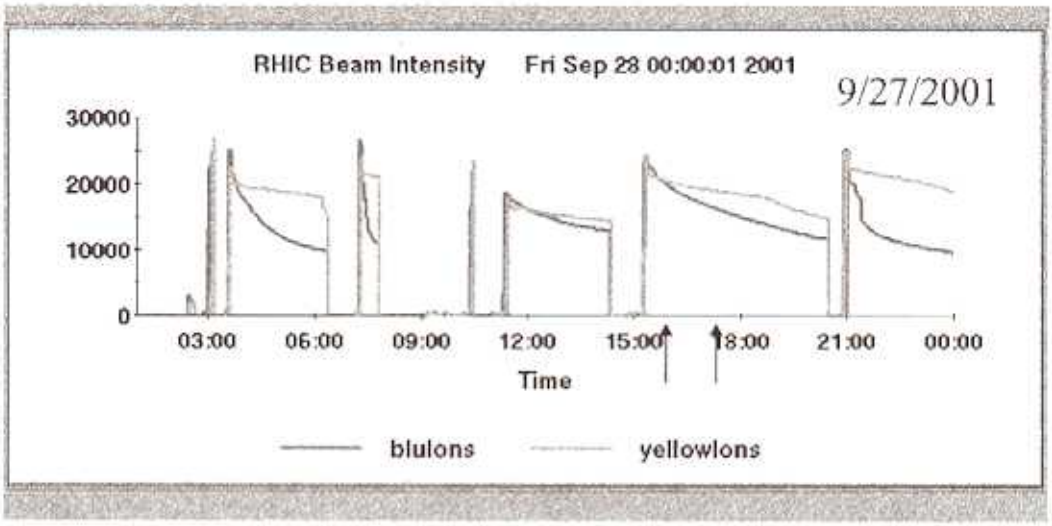
Needs for luminosity measurement for spin physics

$$A_{LL} = \frac{1}{P_{B1}P_{B2}} \frac{N_{++}/L_{++} - N_{+-}/L_{+-}}{N_{++}/L_{++} + N_{+-}/L_{+-}}$$

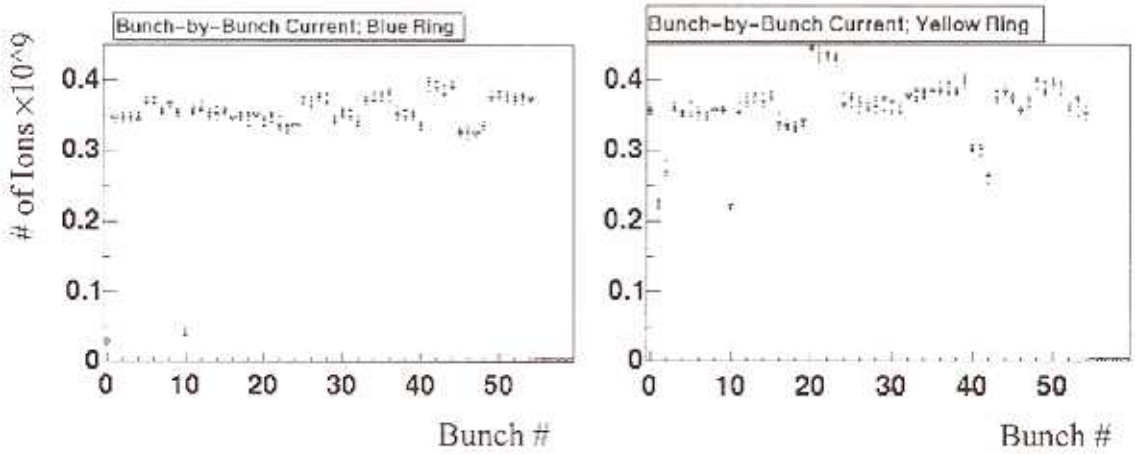
- Need to measure crossing-by-crossing luminosity to obtain physics asymmetry
- Our goal is $\delta(L_{++}/L_{+-}) \sim 10^{-4}$
- How to measure luminosity?
  1. Use bunch-current product (from CDEV)
  2. Use scaler values from experiment (BBC,ZDC,NTC,...)

  * Actually we need both since 2 can be spin-dependent

Features of Bunch Current…



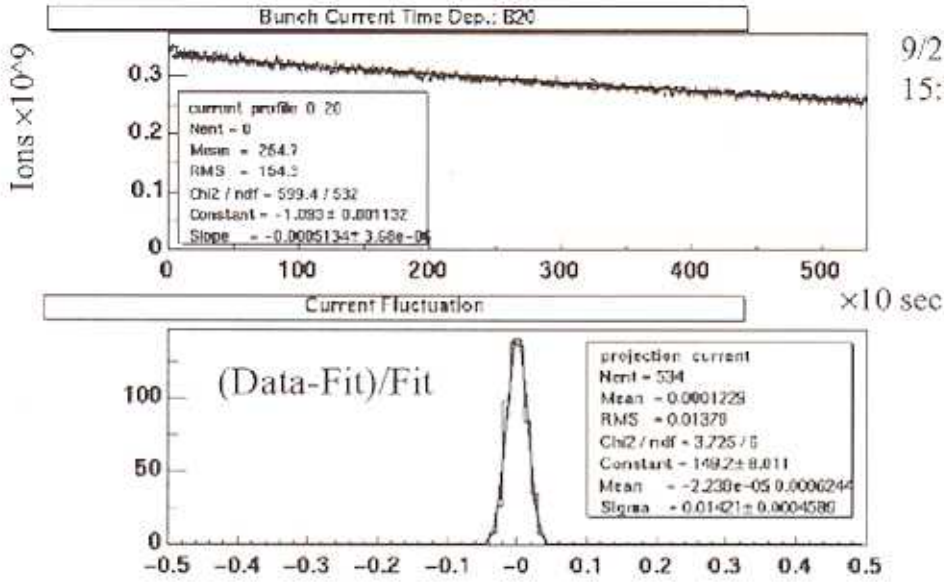
Bunch Current
Bunch-by-Bunch Dependence



9/27/2001,15:53
1 min.
(6 data points)

- Maximum difference ~20%

Bunch Current; Time Dependence



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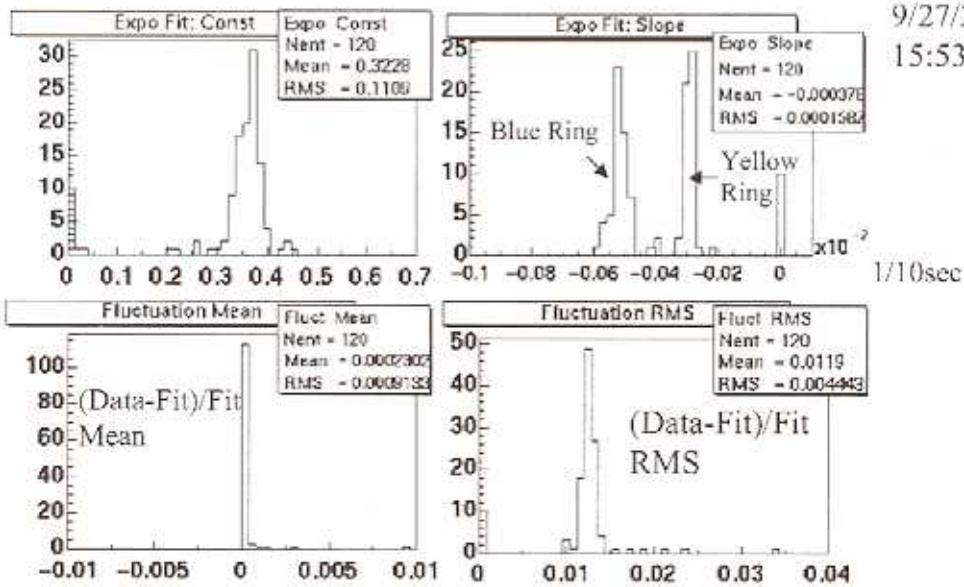
- Bunch current attenuation ~ 0.3%/min.
- Time fluctuation ~ 1.3%

Bunch Current Fit Parameters



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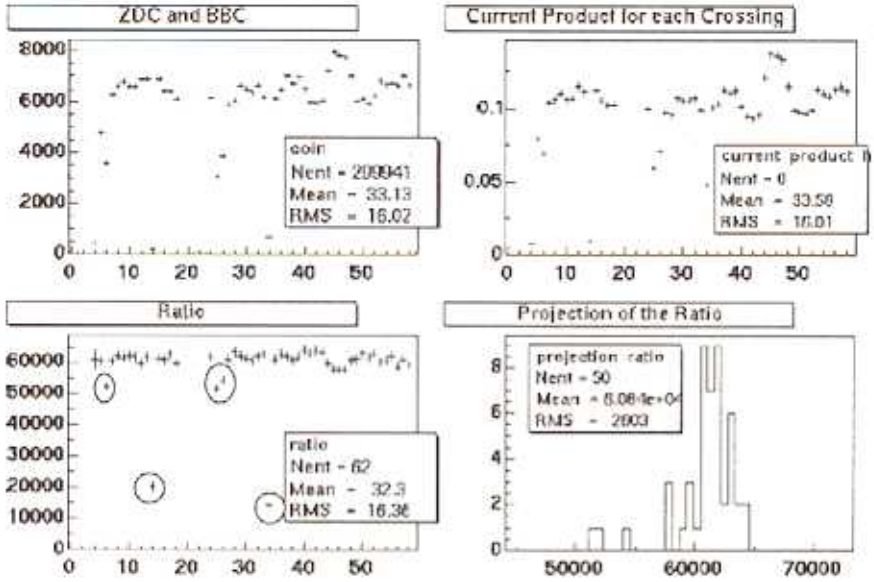
- Bunch current and decay slope are different bunch by bunch as well as ring by ring

Event Rate vs. Bunch Current Product



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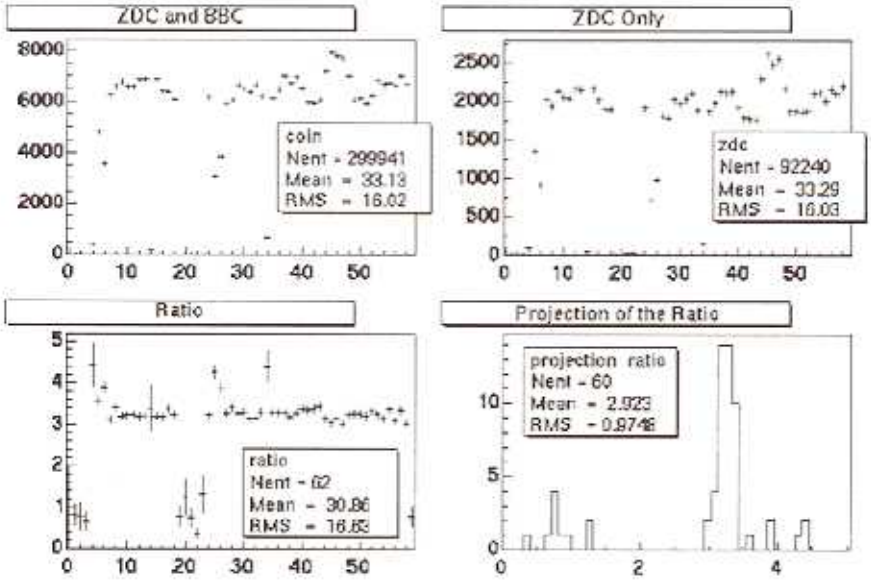
- Fluctuation found on some bunches

Coincidence vs. ZDC only



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Fake Asymmetries

Spin cofiguration	+-+-...	++--++--...	++++---- ++++----...
Event rate (BBCxZDC)	-0.0025	0.0076	-0.035
Event rate/current product	-0.0002	0.0040	0.0077

Stat. Error ~ 0.003
"bad" crossings are removed

Summary

- We need to get crossing-by-crossing luminosity to obtain physics asymmetry.
- Bunch current differs bunch by bunch (~20%).
- Current decay rate also differs bunch by bunch.
- There is 1~2% time fluctuation of bunch current
- Fluctuation of the ratio of the bunch-current product to trigger rate at PHENIX was found for some bunches.
- Fake asymmetry < 0.003 is achieved