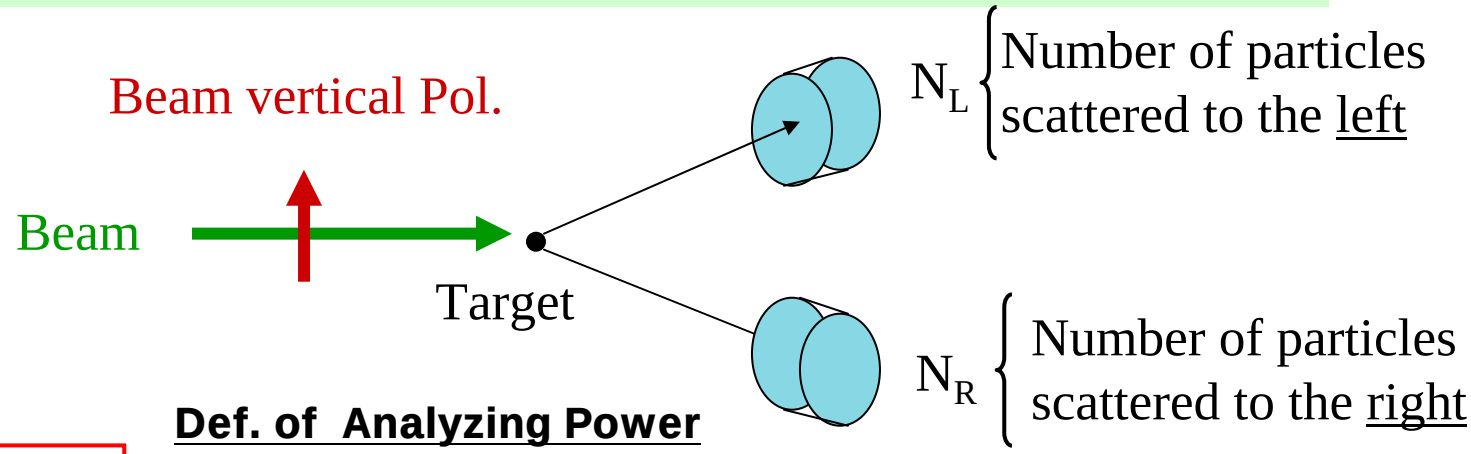
RHIC Polarimeters

— pC CNI polarimeter —

Feb. 6, 2008

How to measure the polarization

- There are some elementary physical processes known to have spin orientation dependence! （e.g. pp→pp)



Def. of Analyzing Power

$$A_N = \frac{N_L - N_R}{N_L + N_R}$$

(When 100% polarized)

A_N determines the precision of a polarimeter

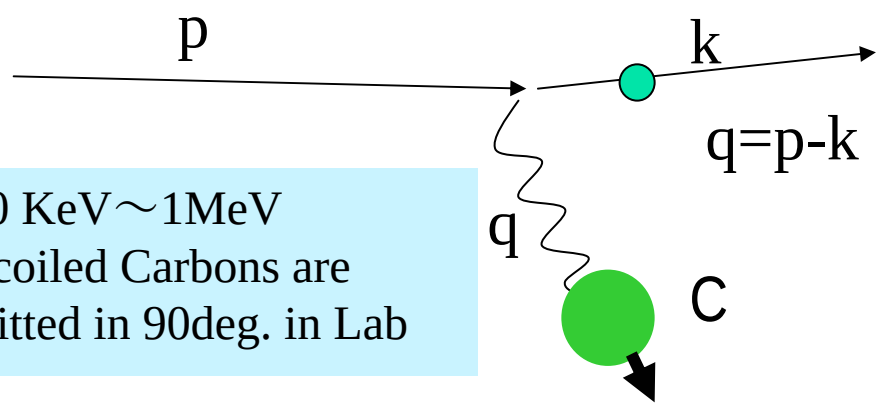
$N_L = N_R$ → unpol.
$N_L \neq N_R$ → polarized

pC CNI Polarimeter

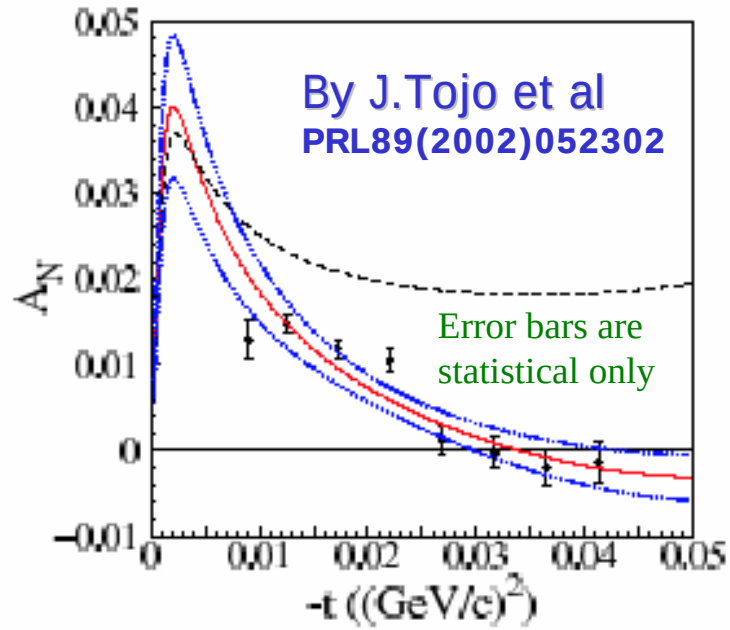
Coulomb Nuclear Interference Region

(forward elastic scattering)

$$0.003 < -t = q^2 \leq 0.01 (GeV/c)^2$$



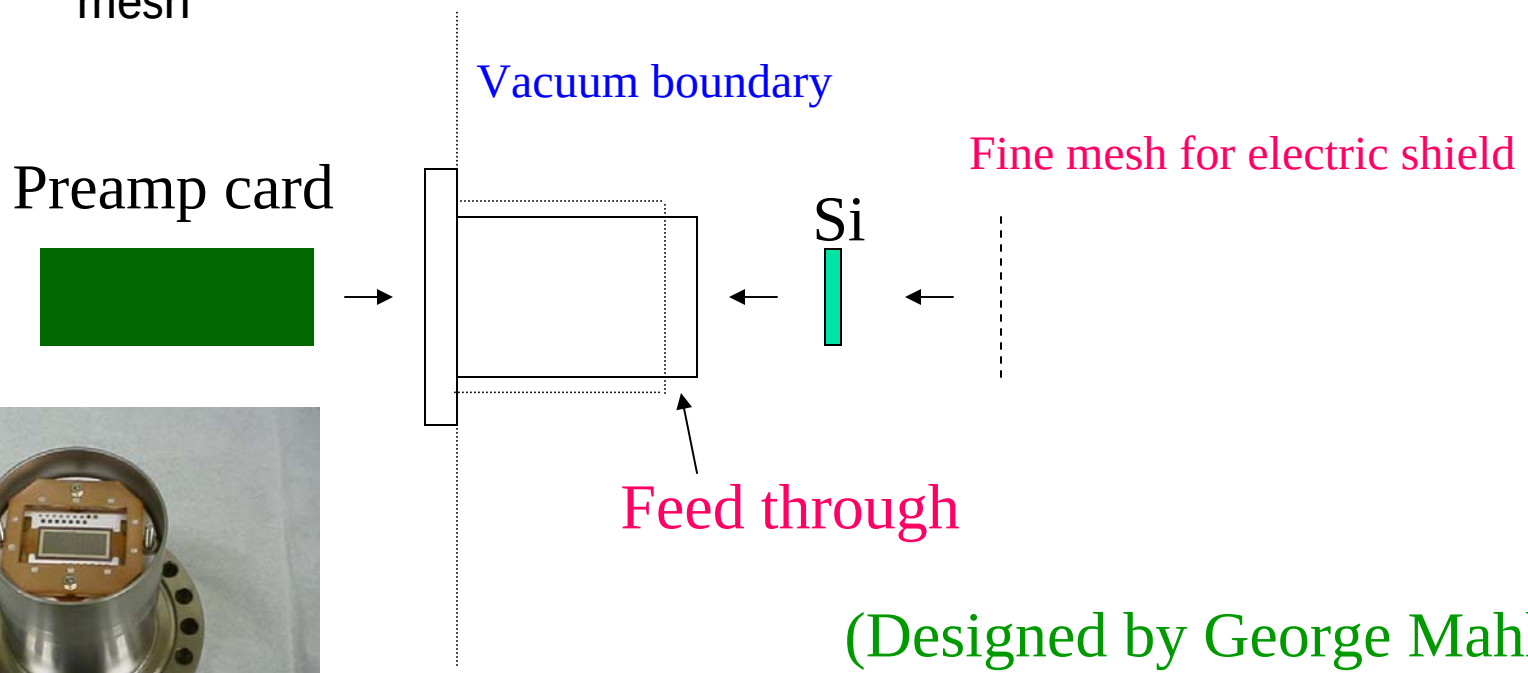
100 KeV～1MeV
Recoiled Carbons are
emitted in 90deg. in Lab



- AGS-E950confirmed the feasibility of asymmetry measurement in beam

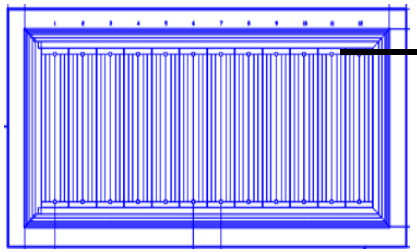
Si ports Design

- 1, Preamp cards removable for baking
- 2, Minimizing distance between Si and preamp input
- 3, Reduce the effect of induced current by beam with fine mesh



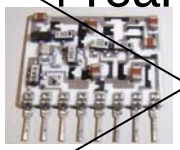
(Designed by George Mahler)

Si detector readout



Si strip detector

Preamp



IO446-2

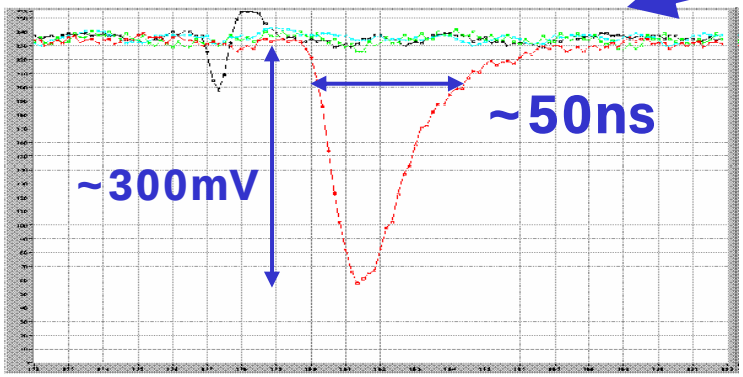
RG59

~300ft

shaper

WFD*
(FPGA)

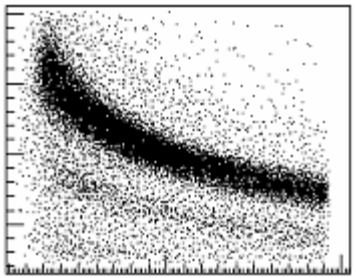
Mode 1



Carbon pulse after shaping

Mode 2

E,T



Mode 3

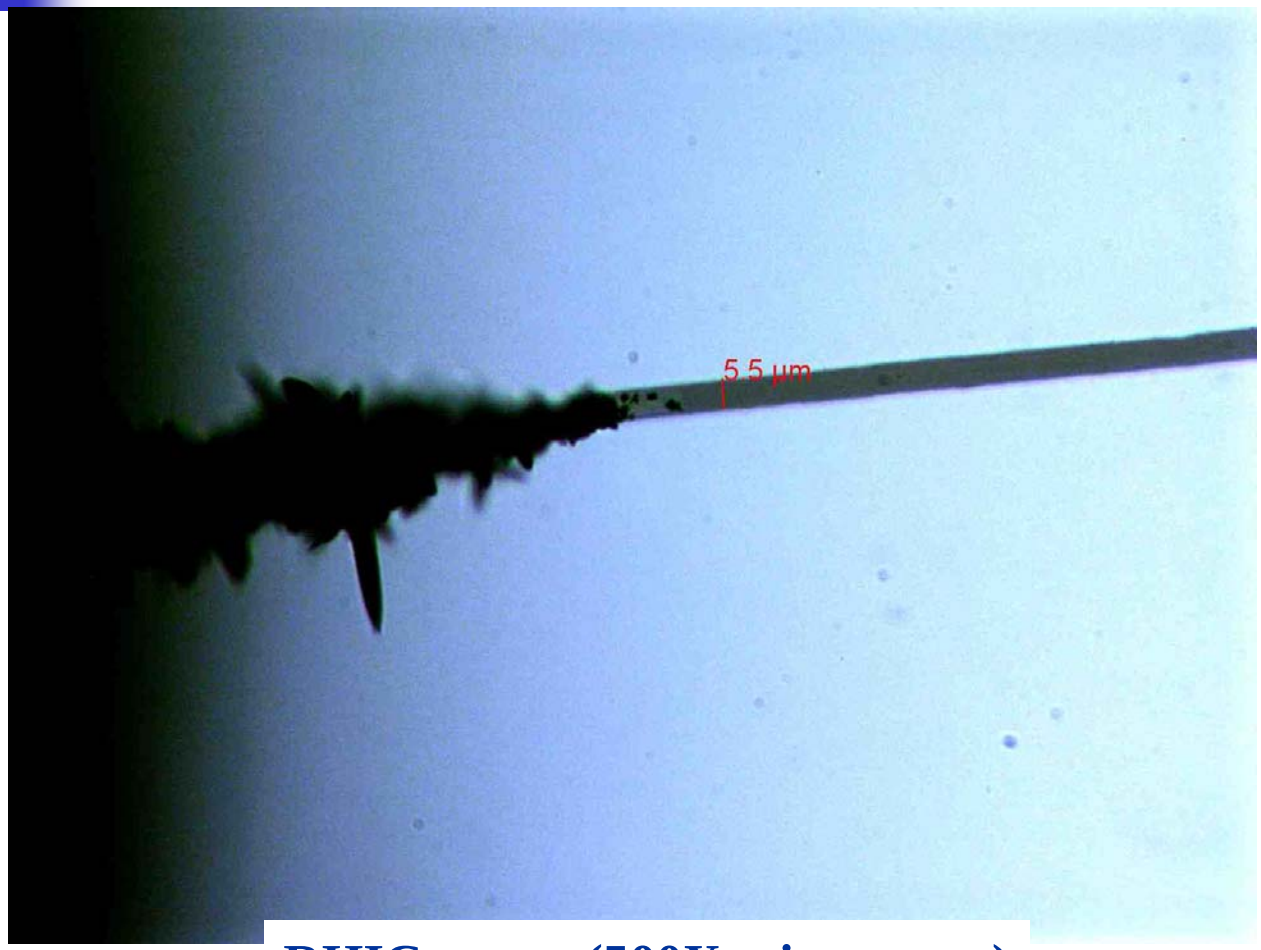
Identify Carbons using lookup table and records counts bunch by bunch

*WFD=Wave Form Digitizer (420MHz, 8bit)

Carbon Target

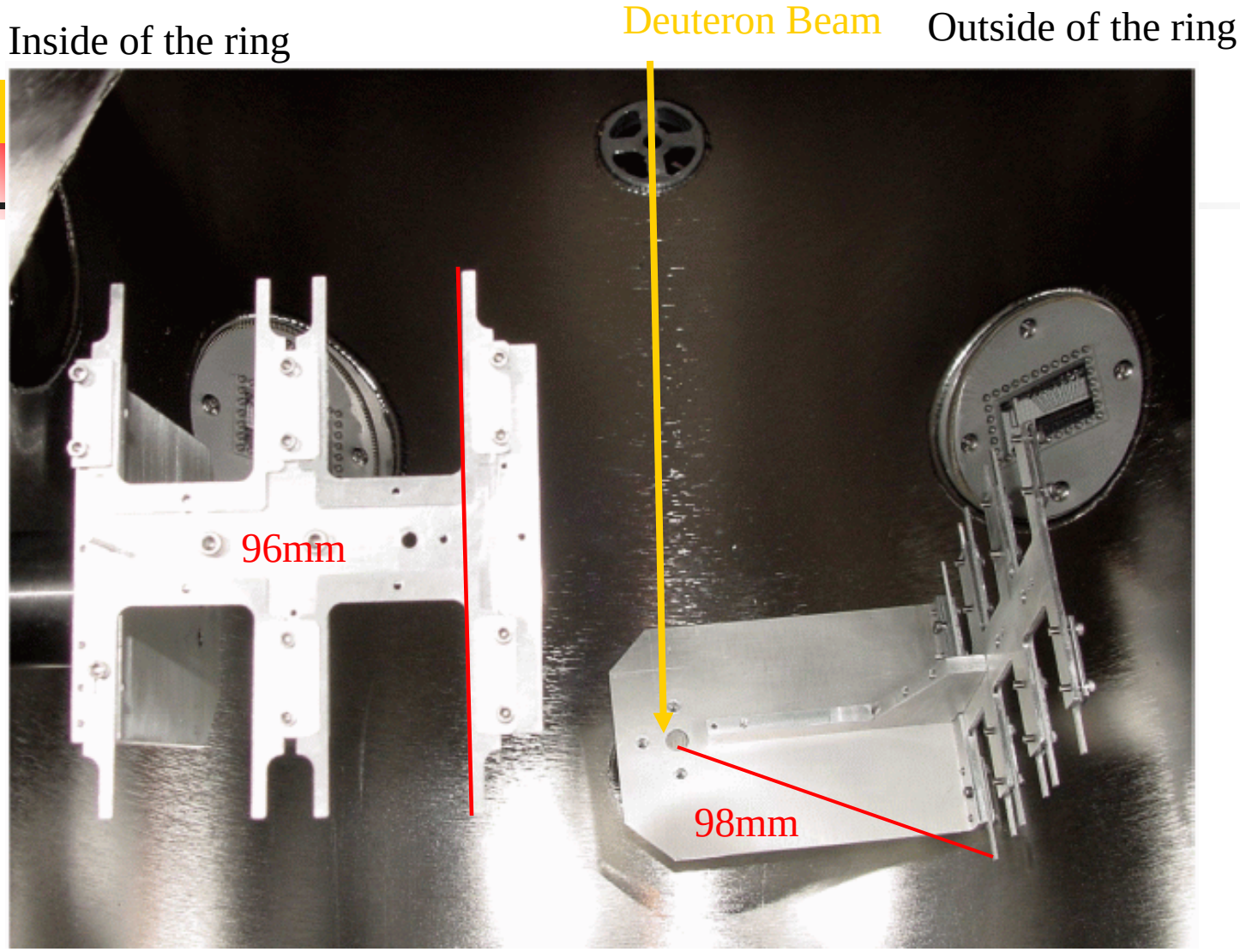
- Thickness 3—5 μg/cm^2 (15 nm, only ~100 atom layers)
- Width 6—10 μm with 50 mm length (200-600 μm for AGS)
- Dimension ratio is 1 : 400 : 3000000
- Target lifetime is about 2-4 weeks in RHIC
- Very small effect on the stored beam lifetime, allows tens of minutes for measurements in a single store
- Event rate up to ~1 per RHIC bunch crossing (~110 ns) at design luminosity
- Advanced technique using carbon deposited through mask (Indiana University)

Polarimeter Targets



RHIC target (500X microscope)

Polarimeter Target Chamber



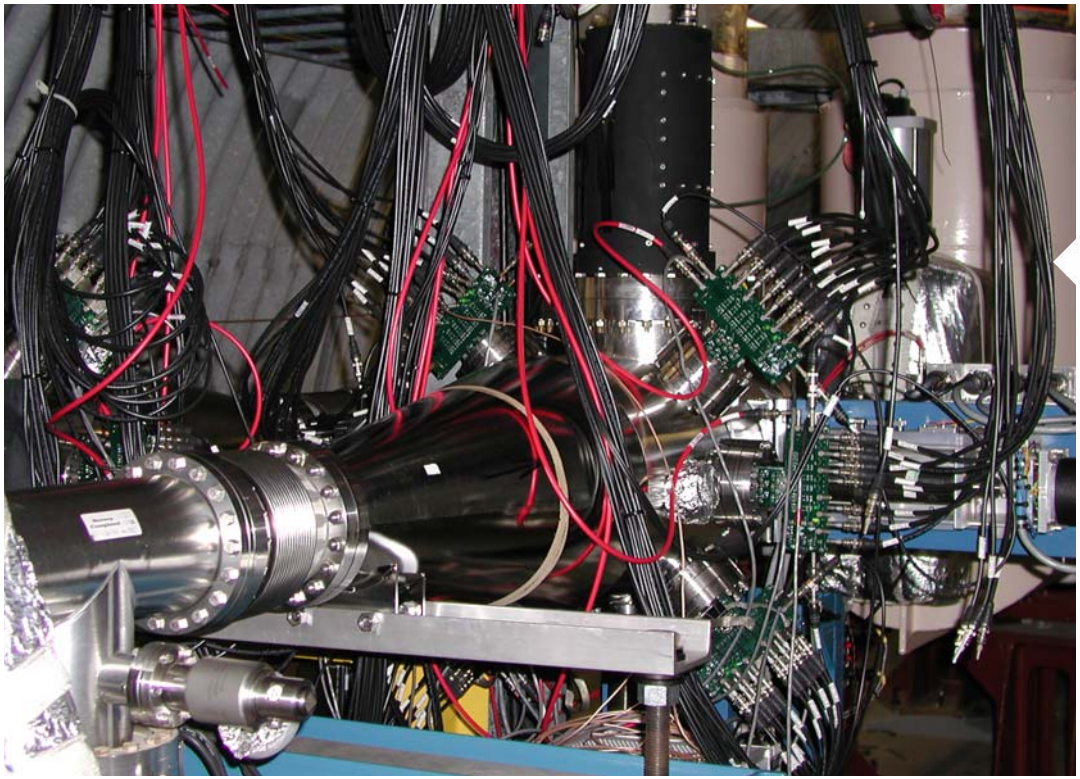
Both design drawing and target scan confirmed that the conversion coefficient is 730 counts/mm.

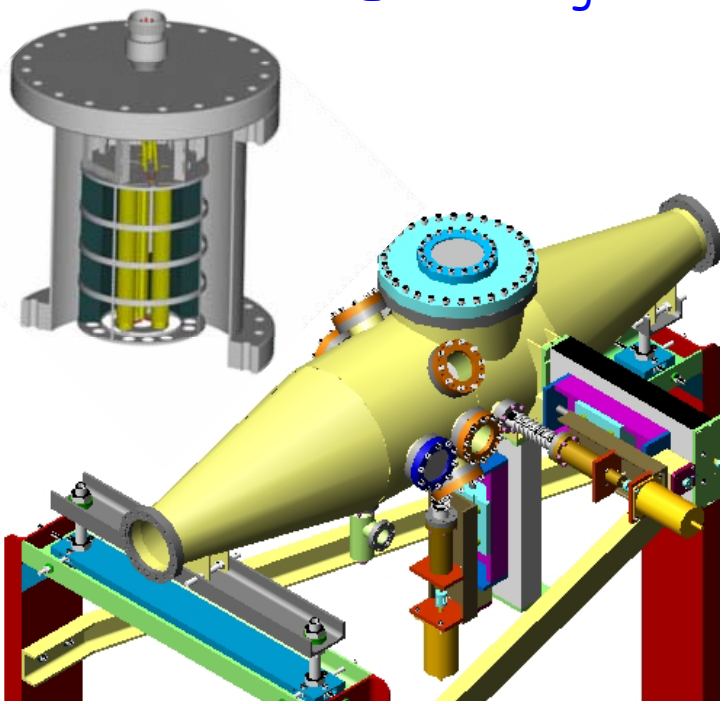
Polarimeter Vacuum Upgrade

Reduce outgassing, faster pump down, add UHV pumping

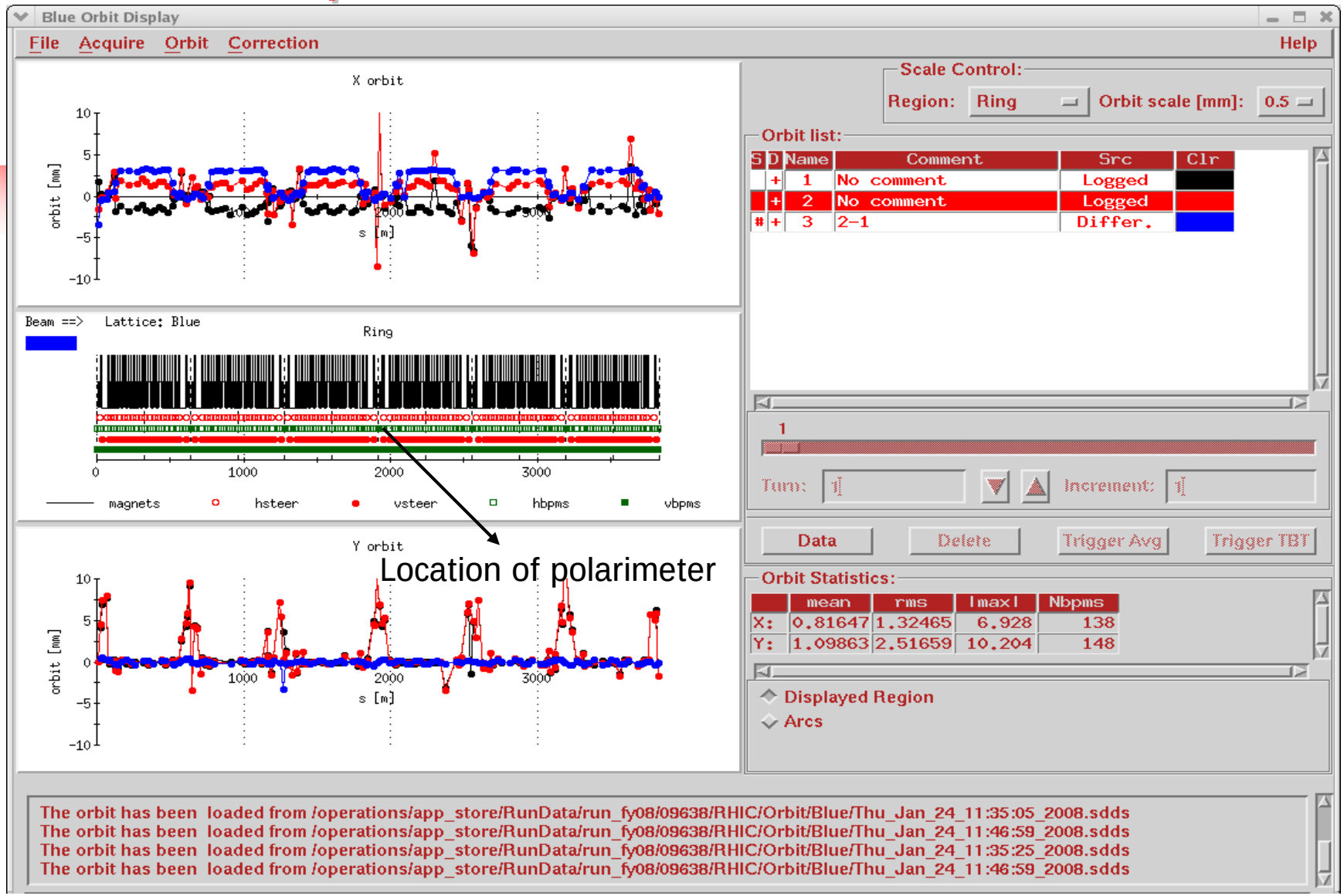
- Identified high outgassing components: Peek insulators (x 5)
- Higher UHV pumping speed by adding NEG cartridge pump (x 2)

Expected gain (24 hrs after pump down): ~ 10

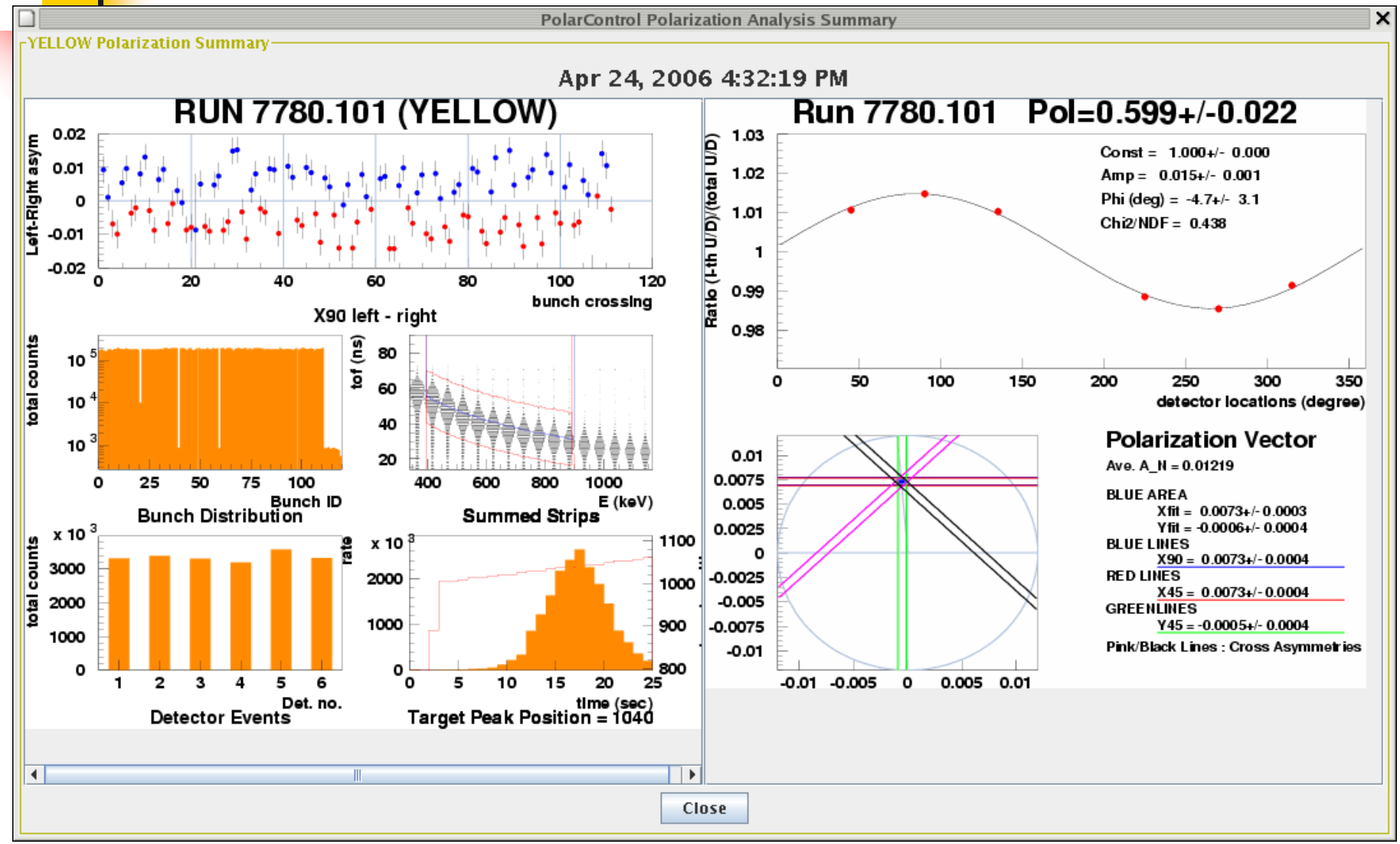




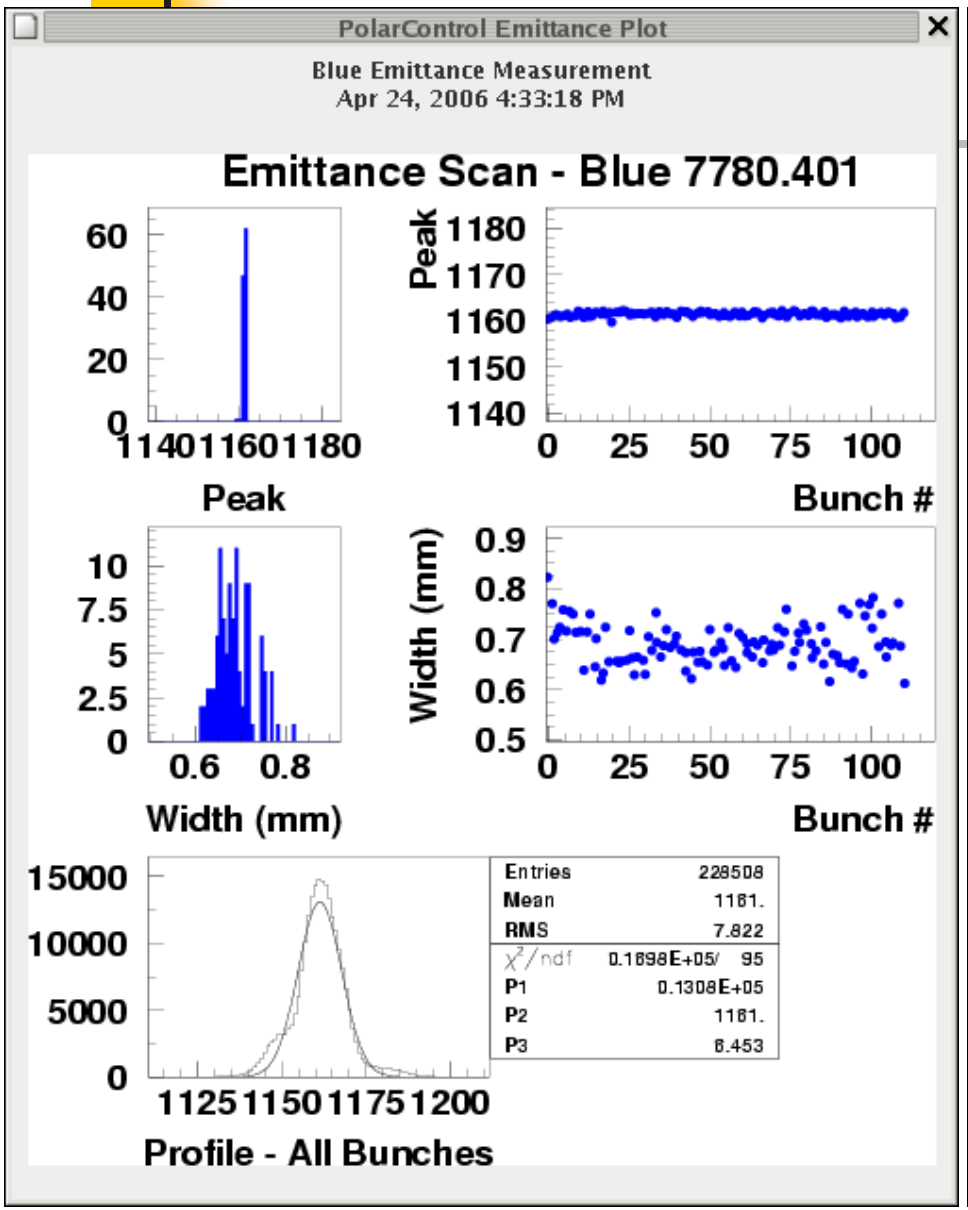
Location of Polarimeter

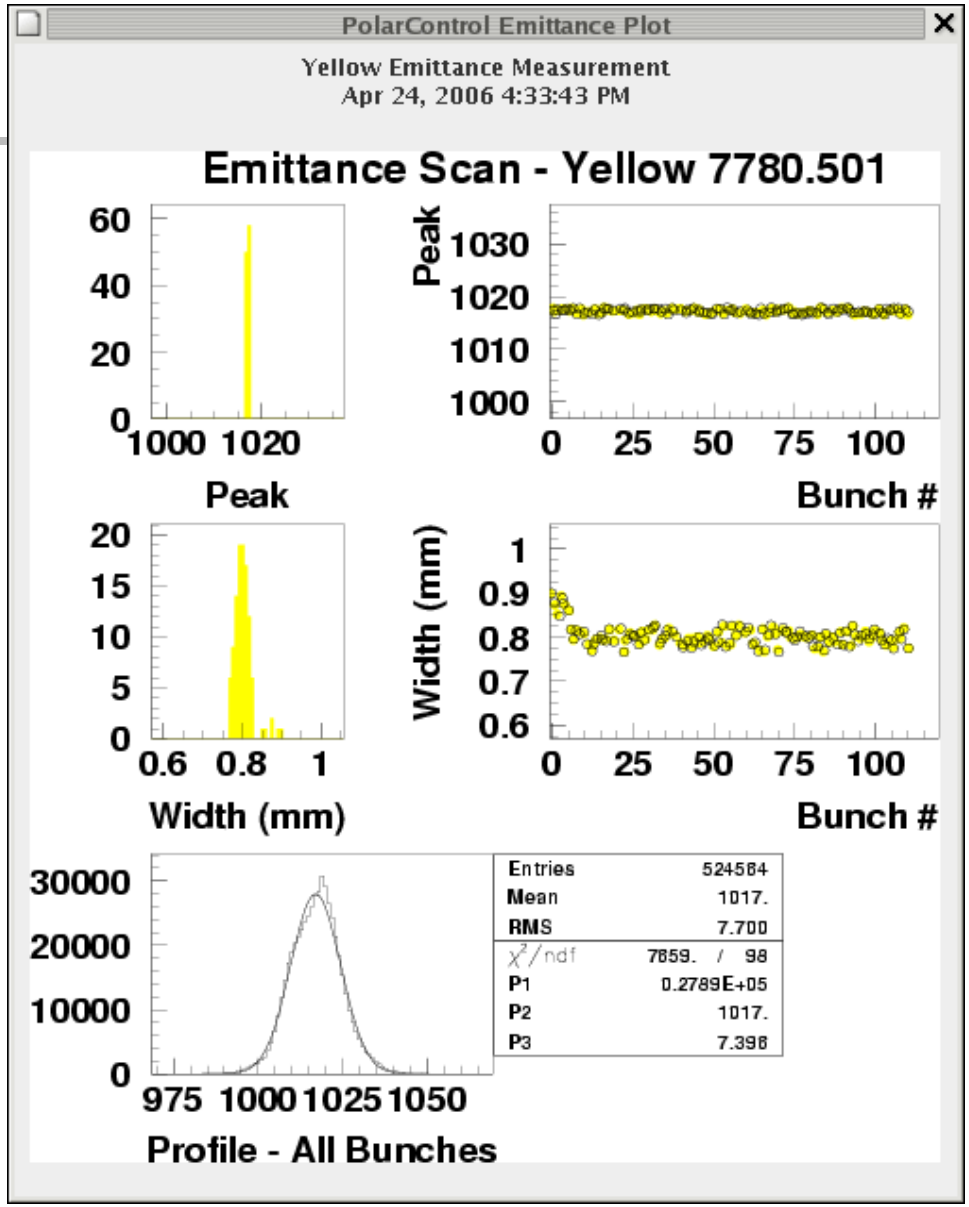


Yellow Polarization Measurement



Transverse Emittance Measurement





Summary

- Excellent performance, meet all requirements.
- The polarimeters can provide both fixed position polarization measurement and polarization profile measurement.
- Up to 2M events/s seen in RUN2006.
- 20 – 60 sec target-in-the-beam time for 20M carbon events.
- It also provide emittance measurement for RHIC operation, bunch by bunch.
- The polarimeter target replacement turn around time is about 24 hours after installation of NEG pumps.
- The absolute polarization calibration has been done and is going on for almost every RHIC store with jet target.

It's a team work

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