BROOKHAVEN NATIONAL LABORATORY

Electron Cloud and Pressure Rise Studies

S.Y. Zhang

I. Performance of NEG Pipes
II. Saturated NEG Pipes
III. Anti-grazing Ridges
IV. Proton Beam Lifetime
V. Proton Beam Emittance
VI. Proton Run Issues
VII. Ion Species Dependence
VIII. Post-Phobos Scenario
IX. Tandem Study

RHIC Accelerator Physics Experiments Workshop, November 9-10, 2005

I. Performance of NEG Pipes

1. Reduce EC and pressure rise

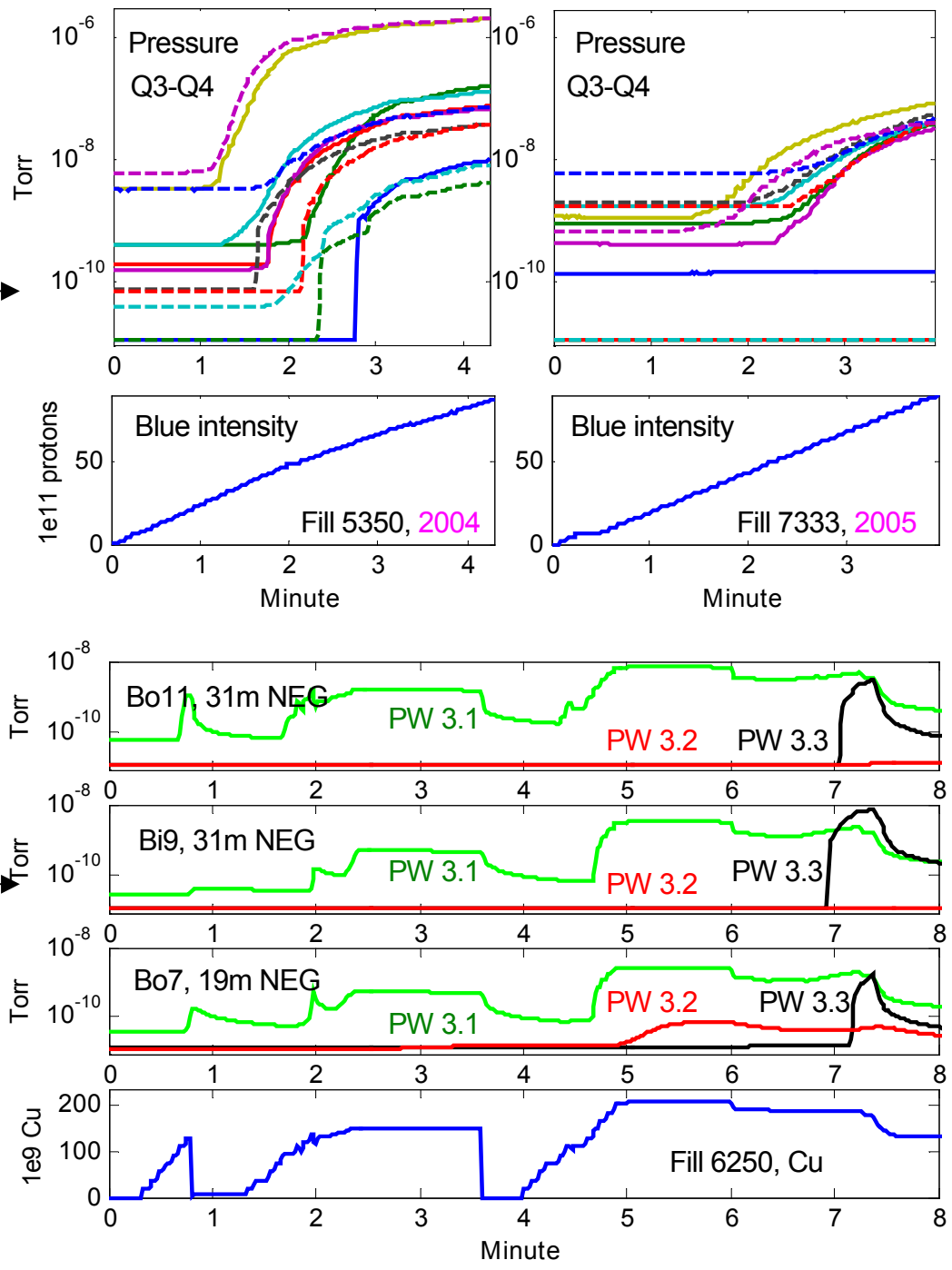
- 250 m NEG pipes installed so far effectively reduced highest pressure rises in both rings.
- 111-bunch beams with 3e11 protons per bunch became possible in both rings with RF switched to 300 kV, which usually causes highest pressure rise in entire energy ramping.

2. Pressure rise pattern changed

- Pressure rise pattern changed, with the center of straight sections, pw3.2, the lowest.
- 2004 Bi9 pressure rise pattern now observed in all mostly NEG coated sections, need better understanding.

3. Activations

- Activation will be studied.



II. Saturated NEG Pipes

1. For EC reduction

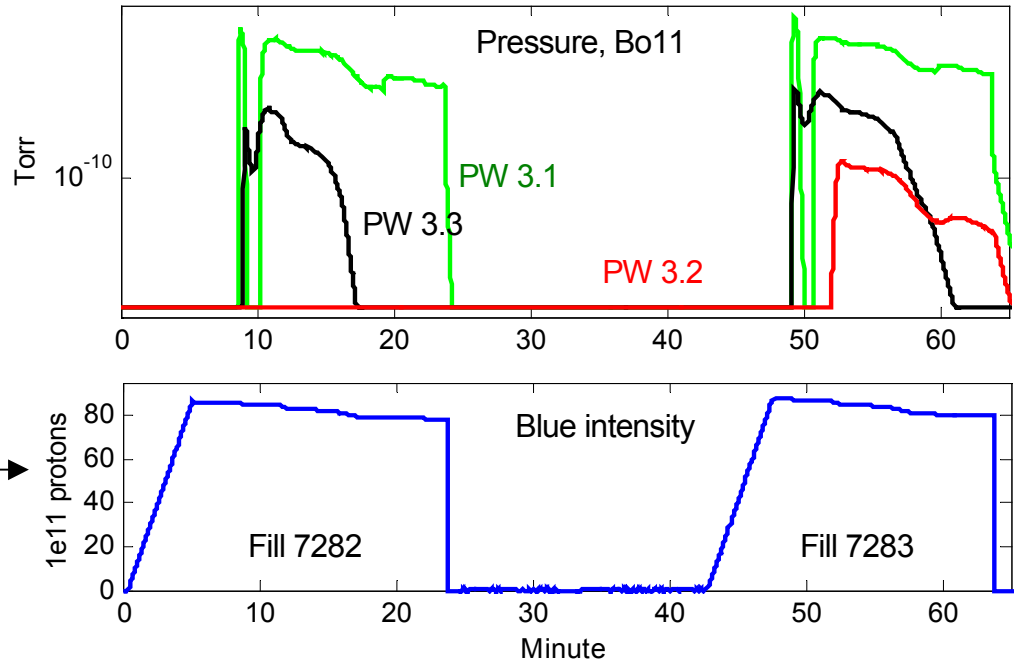
- **Successfully verified that the saturated NEG is still effective for EC and pressure rise reductions.**
- **The pump pw3.2 was off in 7283, indicating that NEG keeps low secondary electron yield.**

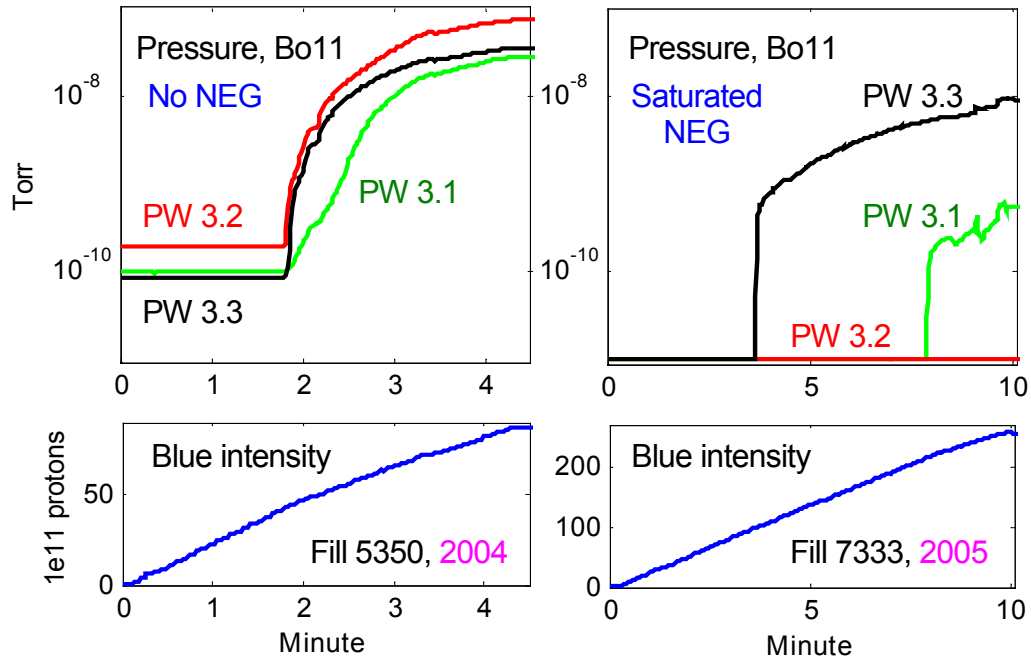
2. Implications for RHIC

- **Re-activation can be eased, in favor of cost and labor.**

3. Potential use at IR

- **Saturated NEG might be used at IR, where activation is very difficult or impossible.**
- **Technically very challenging, but worth R&D?**





III. Anti-grazing Ridges

1. Reduce EC and pressure rise

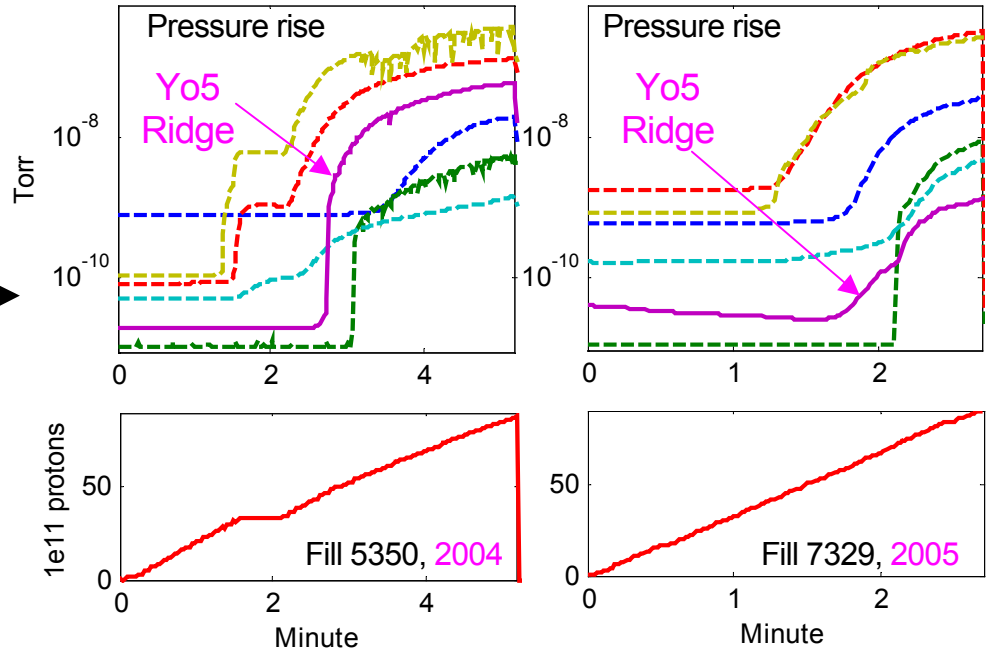
- Successfully verified that anti-grazing ridges are effective for EC and pressure rise reduction.
- Ridge is a new addition to sarrated and grooved surface treatment for EC reduction.

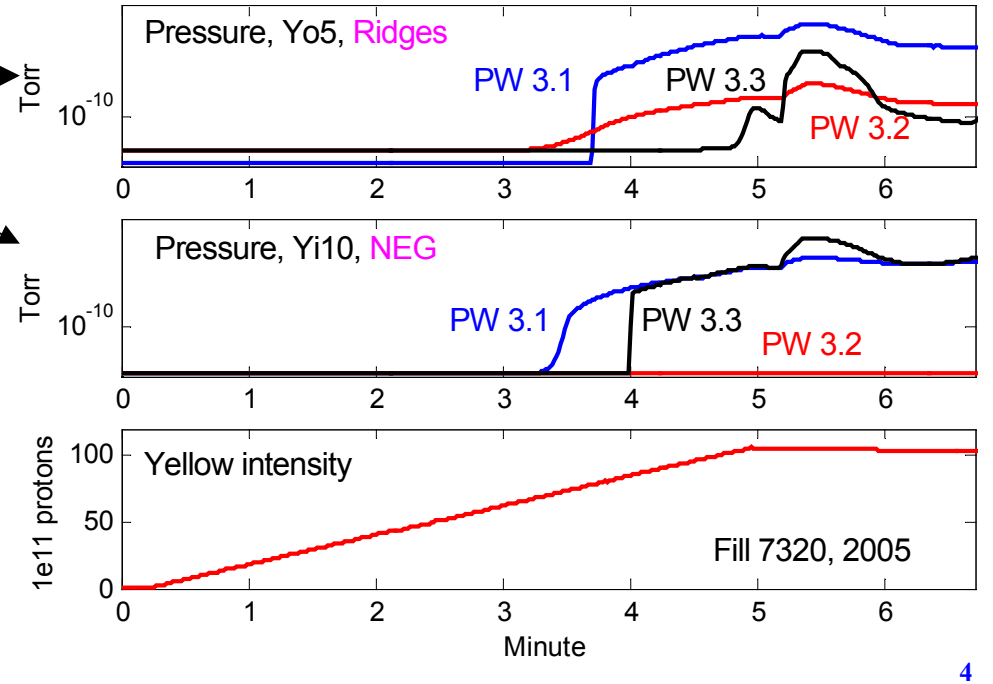
2. Pressure rise pattern changed

- Pressure rise pattern changed with the center of the section, pw3.2, the lowest.
- This pattern is very similar to NEG coated sections.

3. Potential use at IR

- Potential use at IR, to use adjustable ridges?
- Aperture limitation, size of the ridges, etc. need more studies.

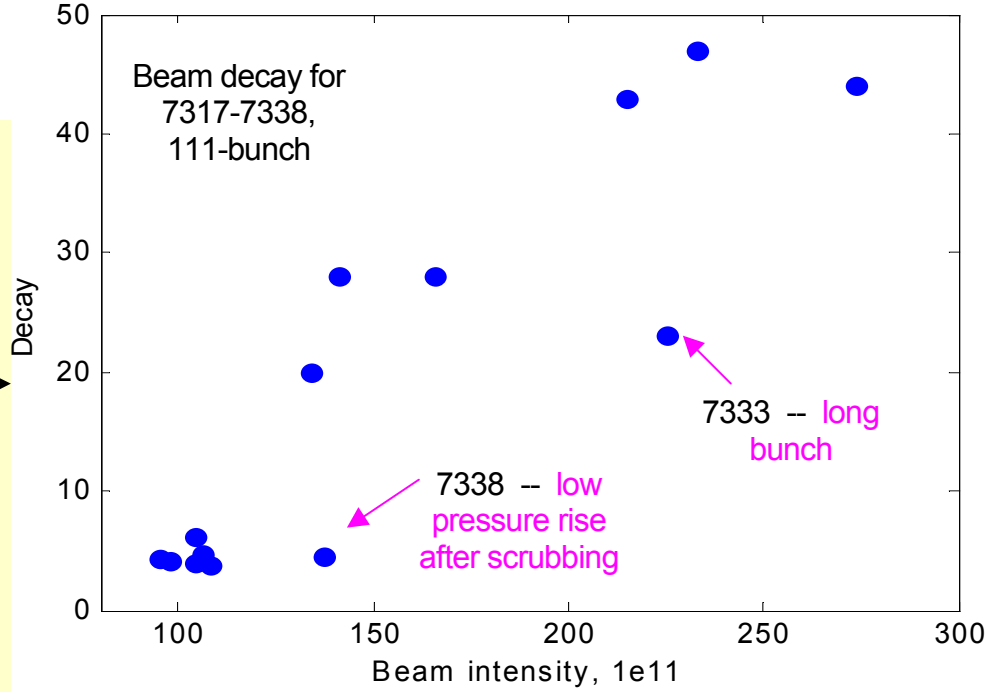




IV. Proton Beam Lifetime

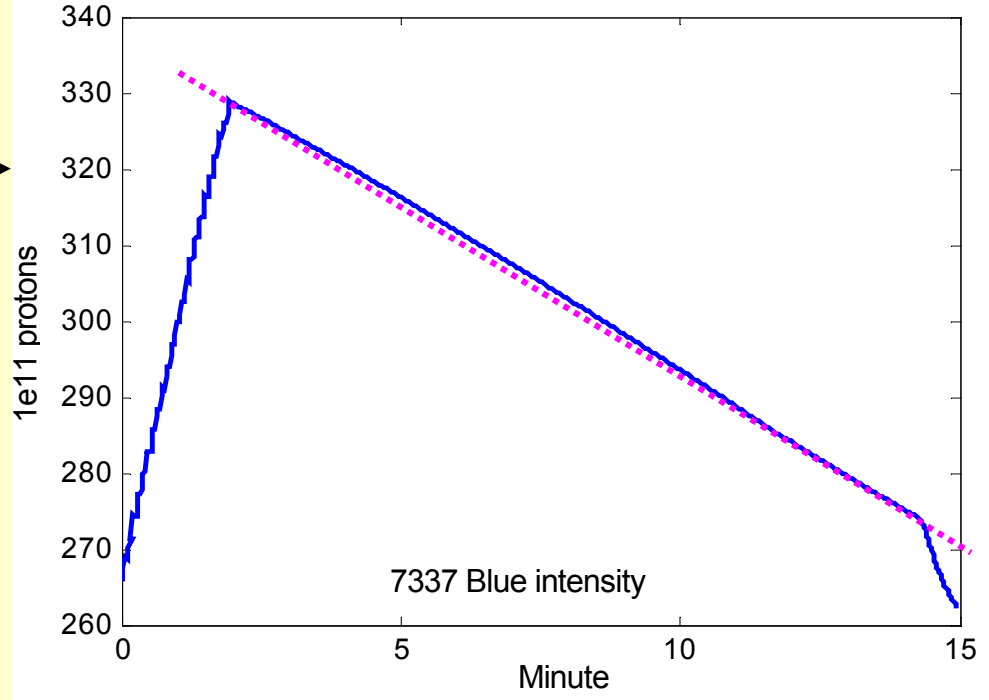
1. Intensity dependence

- Intensity dependence observed for 111-bunch with 1e11 to 3e11 per bunch, 7317-7338.
- Longer bunch and low pressure rise seem to help?



2. Not from beam-gas, but from EC?

- Beam-gas cannot explain the dependence.
- Also, beam-gas caused decay is exponential, but observed is more like linear.
- It is possible due to electron cloud, but how?



3. 7332 and 7338

- The fill 7338 after beam scrubbing has better lifetime than 7332.
- Only difference is lower pressure rise. Worth more beam study?

V. Proton Beam Emittance

1. Sensitive to bunch mode

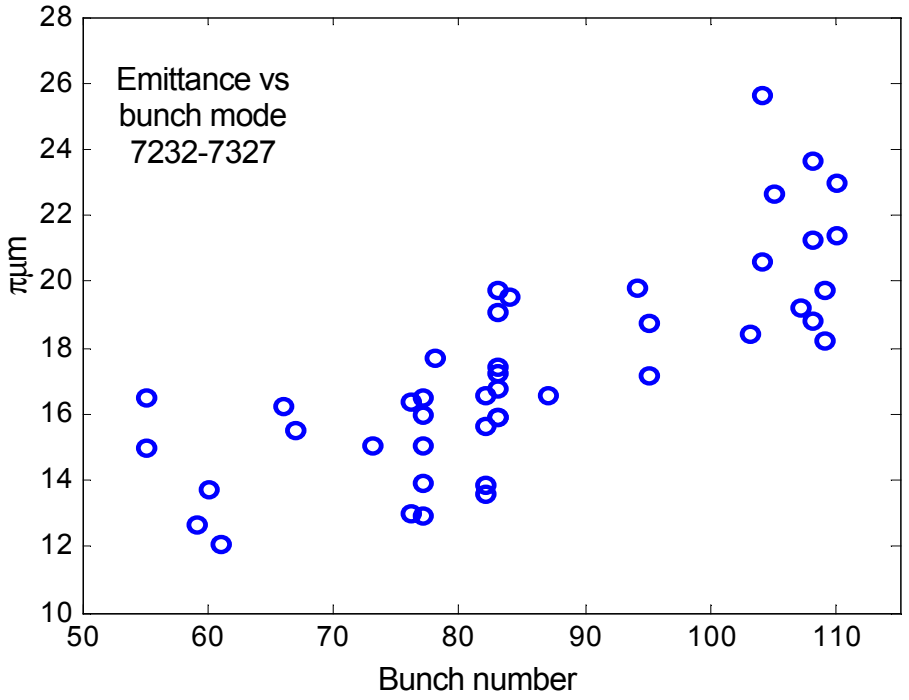
- Beam emittance, derived from ZDC, has a dependence on bunch mode, from 7232 to 7327.

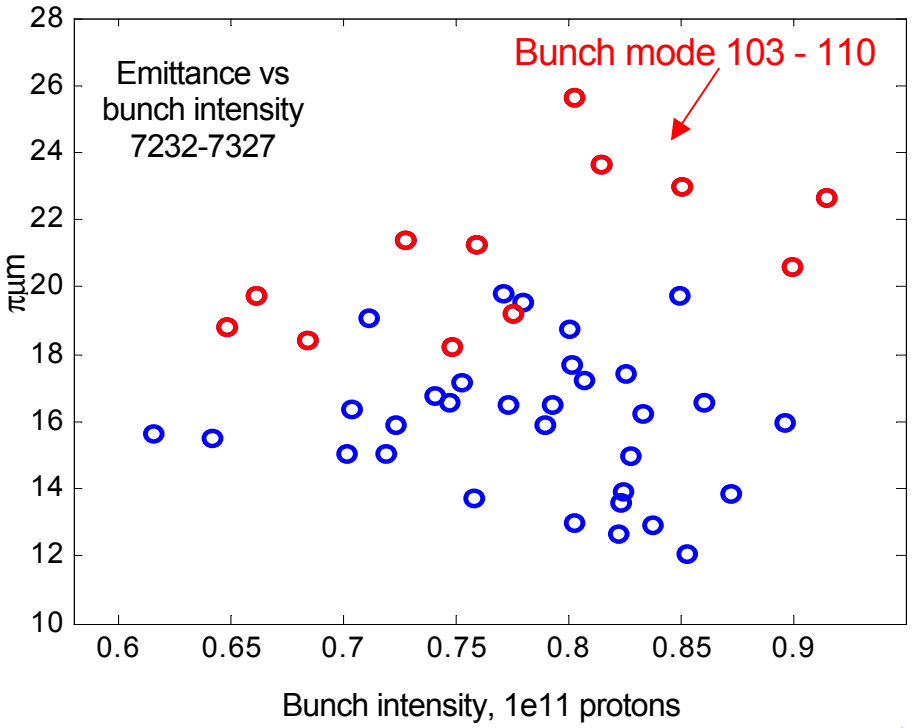
2. Less sensitive to bunch intensity

- No dependence on bunch intensity in overall.
- Some dependence on bunch intensity for same bunch mode.
- Good news for 2006 run, the plan is for higher bunch intensity with 111-bunch.

3. EC effects? but how?

- Electron multipacting is also more sensitive to bunch spacing than to bunch intensity. Due to EC?
- Not understood that how EC affects beam emittance without apparent instability.





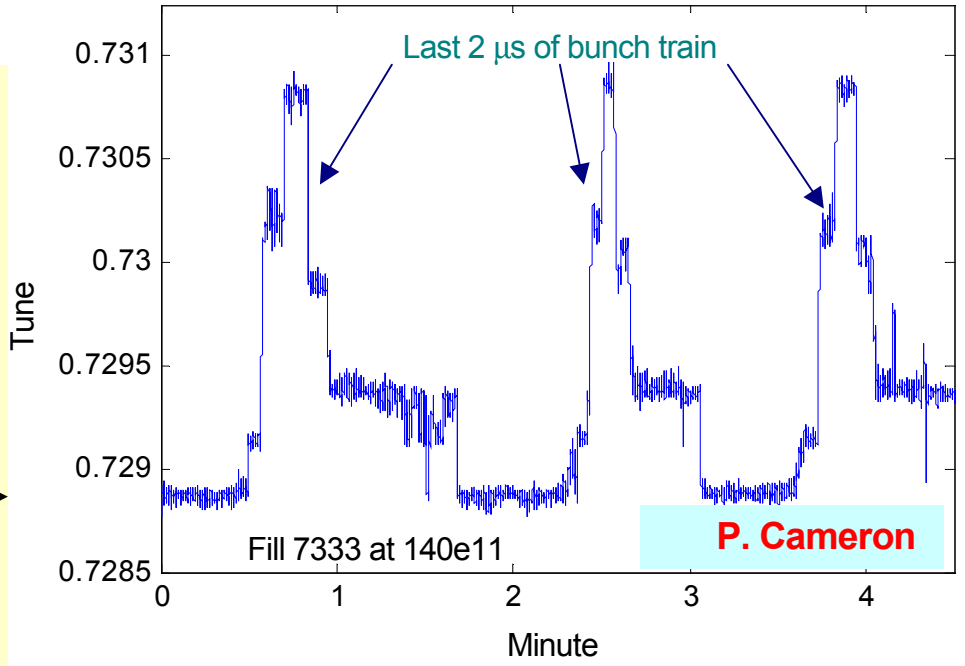
VI. Proton Run Issues

1. EC in operation

- 2006 proton run will have EC in operations, even though more NEG pipes have been installed.

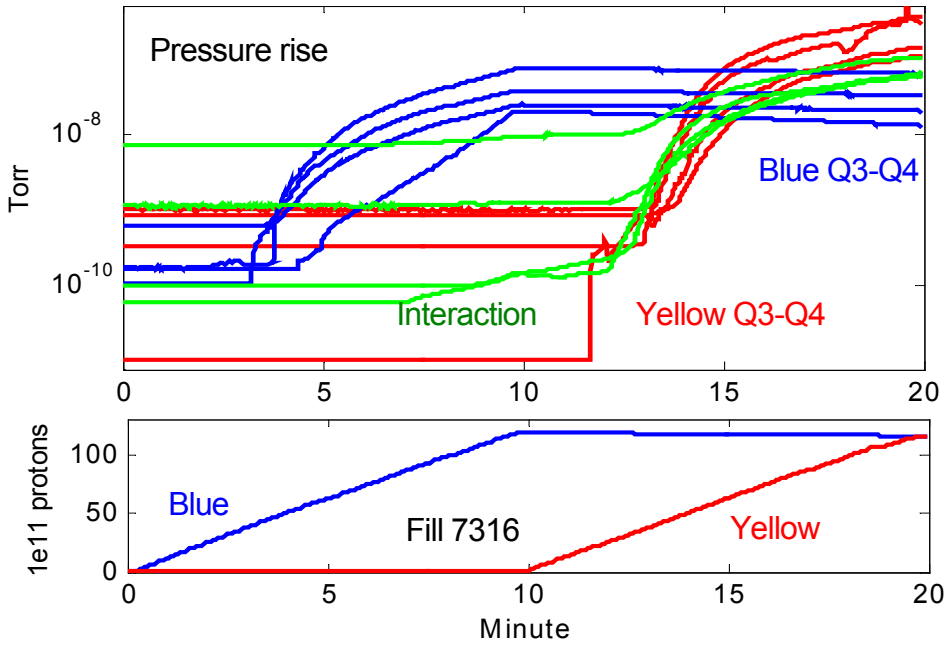
2. Tune shift and emittance

- Tune shift at last 2 μs of bunch train observed, not completely understood.
- Emittance variation along the bunch train is also possible.
- Better measurements not only necessary for operation, but could be useful beam diagnostics.



3. Yellow pressure rise

- Yellow ring now have several highest pressure rise sections compared with blue and IR.
- With dynamic aperture and injection problems, Yellow beam may need more attentions.



VII. Ion Species dependence

1. Transition pressure rise

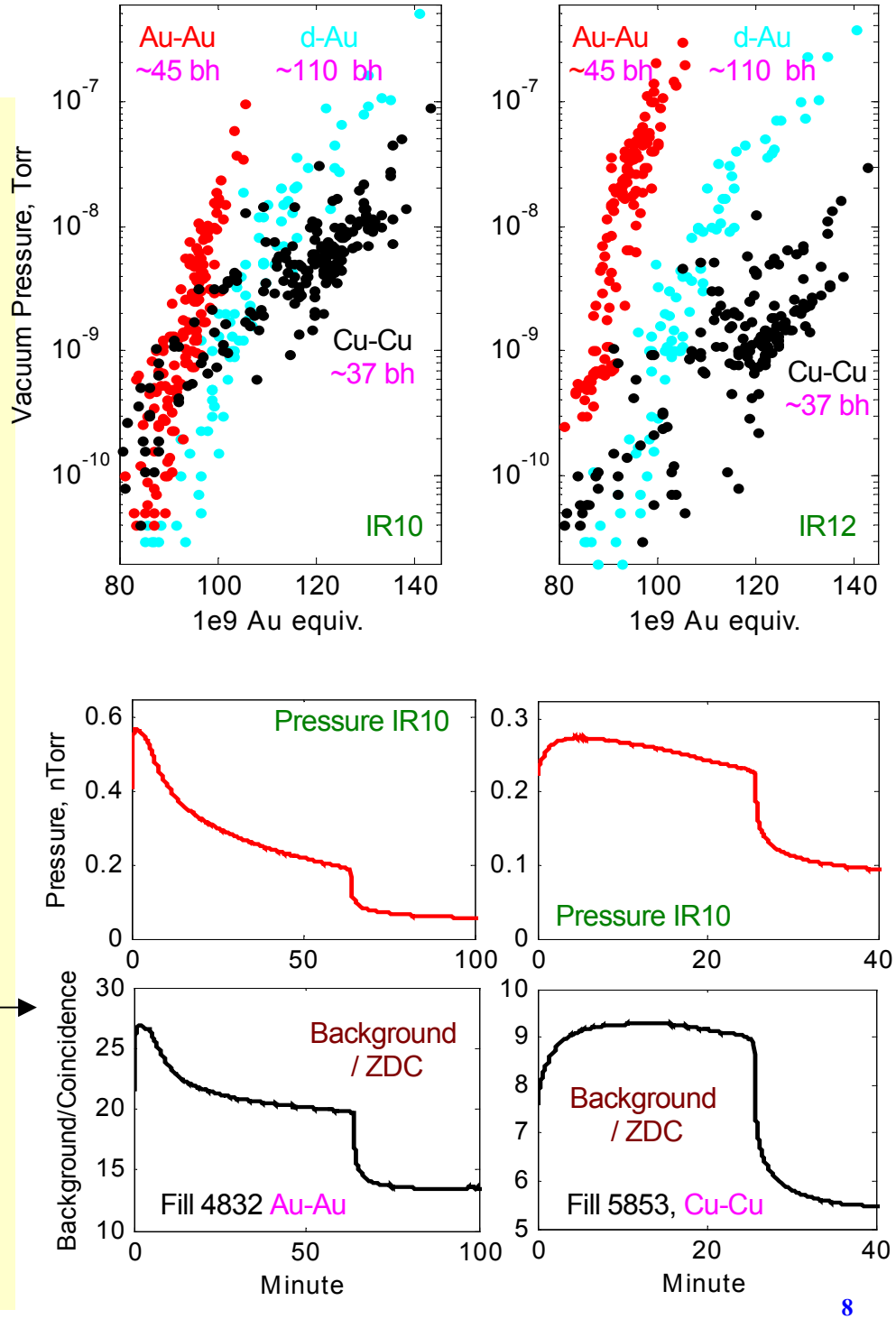
- Dependence of transition pressure rise on ion species has been observed from d-Au, Au-Au, and Cu-Cu runs.
- For same intensity, pressure rise in Cu-Cu run lower than Au-Au.

2. Beam-beam and beam-gas

- Beam-beam background is due to single Coulomb dissociation. Cu-Cu background is about 1/3 of Au-Au for same intensity.
- Background due to beam-gas not understood, so it depends on measurement. Cu-Cu background is about 1/3 of Au-Au for same pressure.

3. U-U run?

- Interesting to see what happens.



VIII. Post-Phobos Scenario

1. Brahms tolerance high

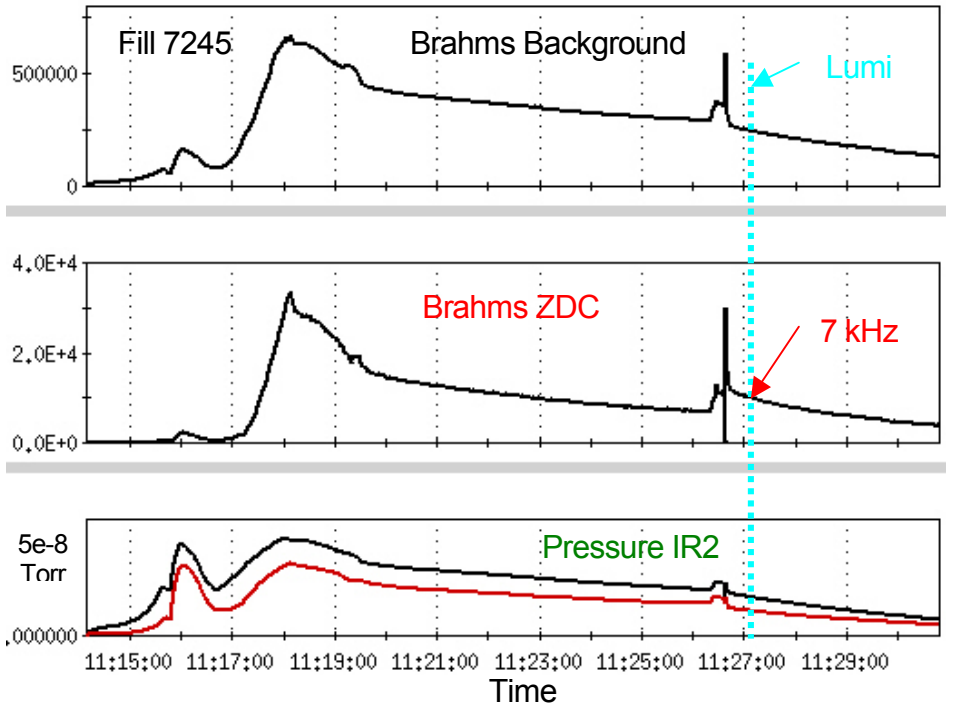
- Dependence of Brahms background on pressure rise.
- ZDC corrupted. At Lumi it is 7 kHz, should be ~ 1 kHz.
- Brahms tolerance is high, due to local shielding installed in 2003?

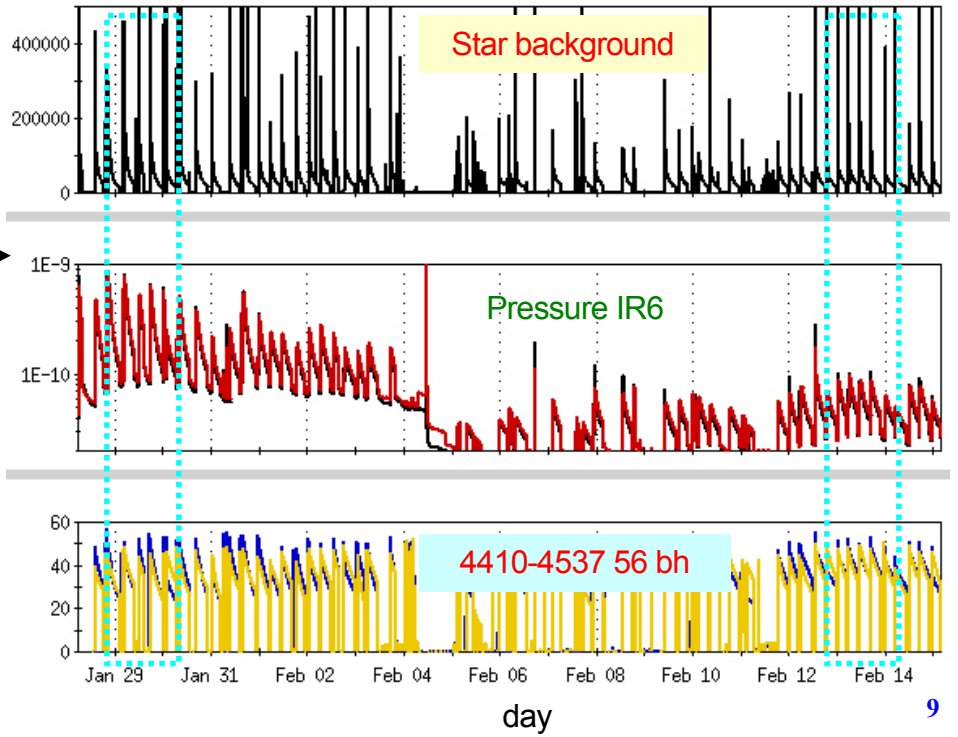
2. Star sensitive to static pressure?

- 4410- 4537 in 2004, all 56-bunch, and similar intensity, ~95 e9 Au.
- With static pressure at 8e-11 Torr, the pressure rise is larger than that at 3e-11 Torr static pressure. Why?
- This high pressure rise has caused background problems.

3. What will be a new limit?

- Phobos has limited luminosity in past runs, next limit?





IX. Tandem Study

1. Three new results

- Higher desorption rate than Mahner 2003, PRST.
- NEG has lower desorption than steel – different from Mahner 2005, PRST.
- Angular effect of 1/cos θ extended to 10 mrad. Molvik, 2004, PRST, and PAC05, peaked at 87°.

2. Activation and re-activation

- Raised some question about NEG activation. Need more study.

3. Further studies at Tandem

- Serve the needs of RHIC, such as NEG activation, re-activation, saturation, venting, aging, etc.
- May serve needs of field, such as NEG pumping speed, pumping capacity, adsorption, electron desorption, SEY, surface, etc.