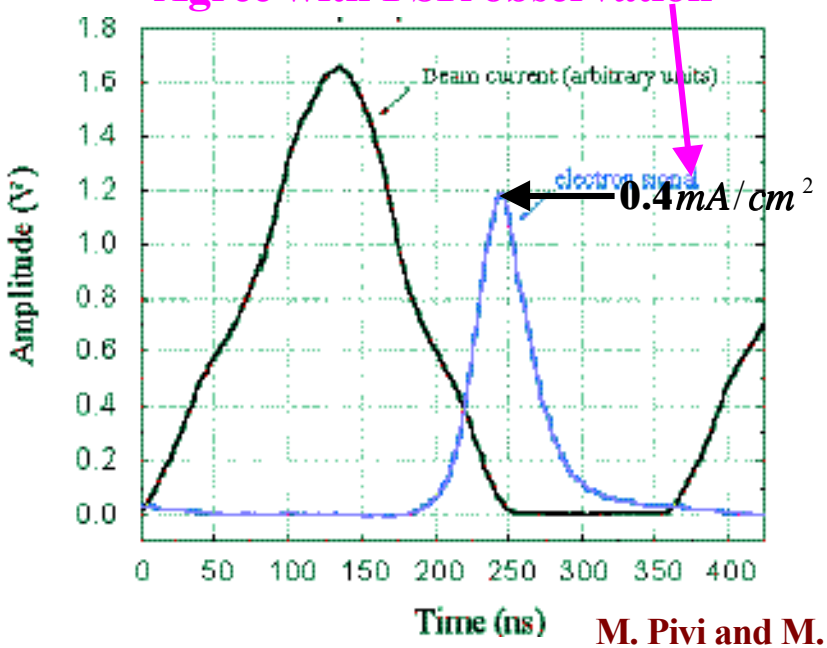
Solenoids between collimators?

S.Y. Zhang and H.C. Hseuh, 8-12-02

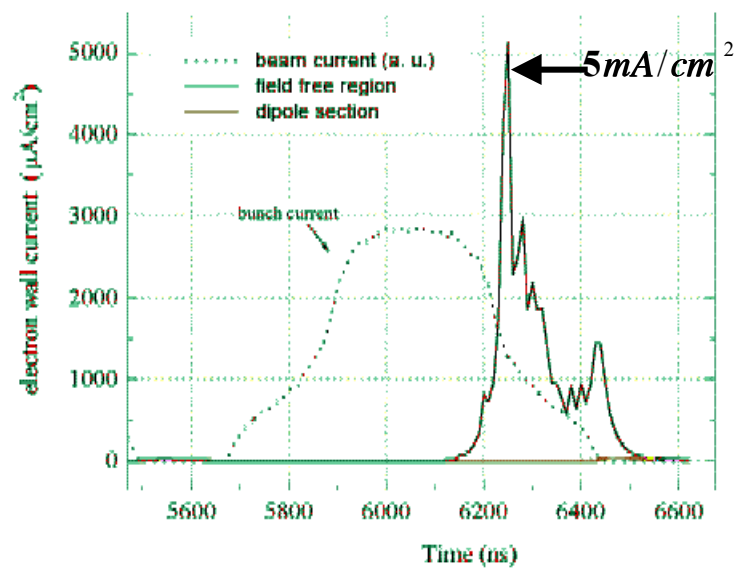
1. Solenoid to prevent e-multipacting

- Assuming plr(proton loss rate per turn) to be 10^{-6} in the 5 m pipe, and one lost proton to produce 100 electrons, then electron line density is $3\times10^{9}/m$.
- PSR observed elctron flux on the wall is $0.4mA/cm^2$, implying electron line density of > $2.8\times10^{10}/m$ at the PSR.
- Pivi predicted SNS electron flux is $5mA/cm^2$. Then the SNS e line density will be $1.9\times10^{12}/m$, 633 times larger than the beam loss created one.

Agree with PSR observation



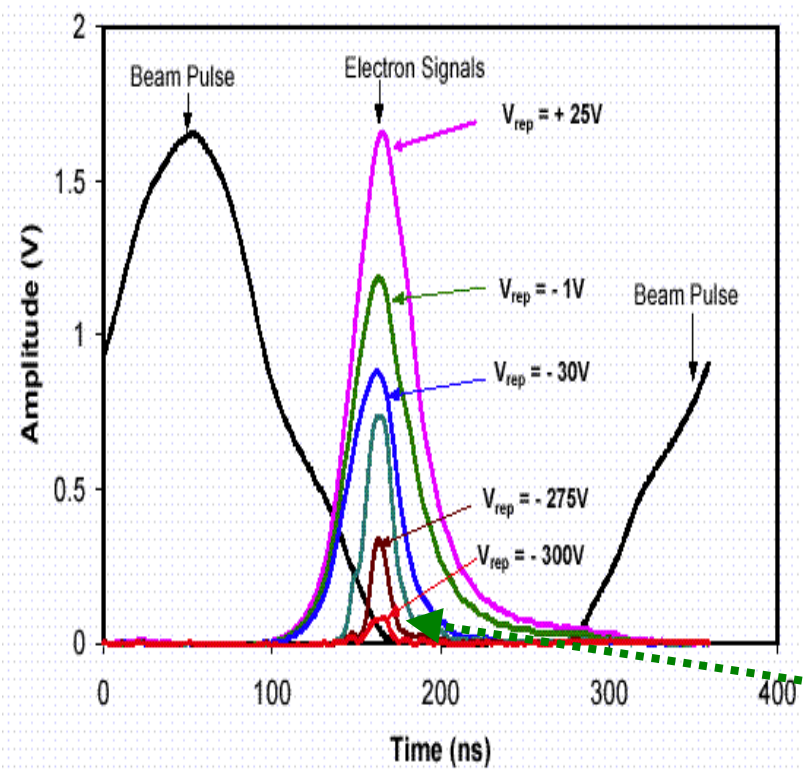
SNS simulation



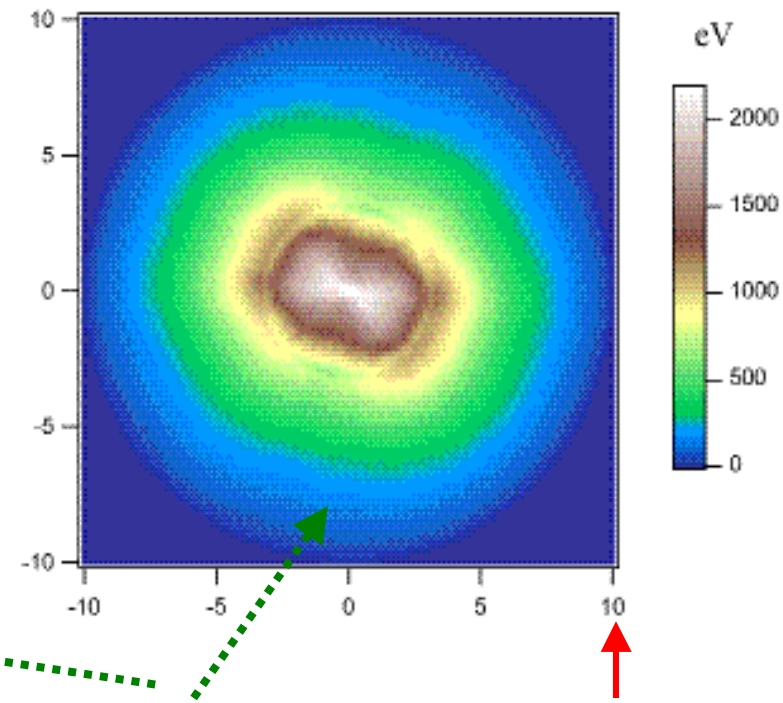
M. Pivi and M. Furman, ECLOD'02

2. Most electrons hitting the wall have energy below 300 eV. The solenoid field should be high enough to confine these electrons.

PSR observation, R. Macek, ECLOUD'02



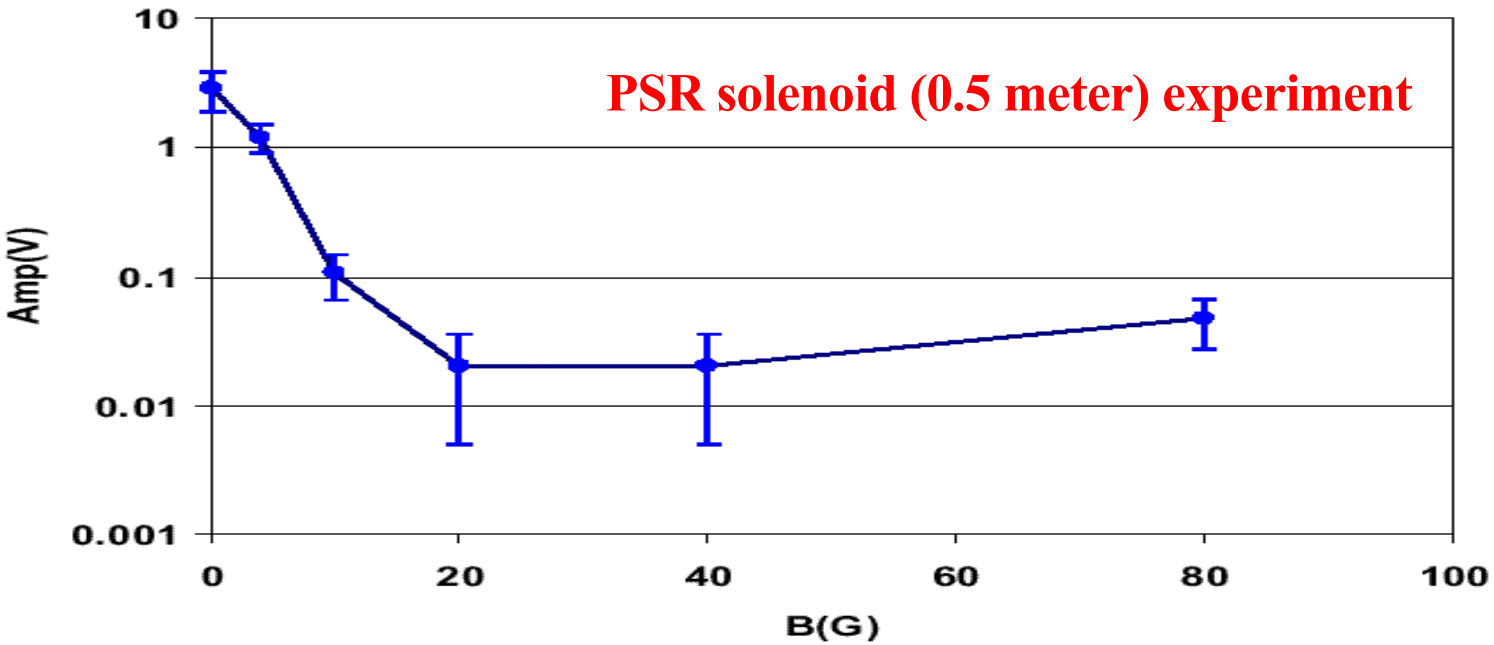
SNS simulation, Pivi & Furman, ECLOUD'02



300 eV

SNS pipe 10cm

3. The radius of 300 eV electron orbit in 50 Gauss field is about 1.2 cm, sufficiently small for chambers with ID $\geq$ 20 cm.
With #10 wire at 200 turns per meter, a current of 20A gives rise to a field of ~50 Gauss.



R. Macek, ECLOUD'02

PSR plans to cover ~10% of the ring with the solenoid in next run for test.

4. Parameters and cost

- For beam pipe of 11.5” OD, the length of solenoid cable is ~ 600ft/m and the estimated power requirement is ~ 0.65 kW per meter at 20A. Power supply is a few dollars per W for a small quantity purchase.
- The surface contact temperature of the solenoids at 20A will be within safety limit based on RHIC measurement of 65° C at 25A.
- Kapton insulated wire (needed for radiation resistance) is ~ $ 1.5/ft or $900 per linear meter for 11.5” OD pipe.
- The maximum solenoid coverage for the whole ring is ~ 18m (~7%)
- ~8 m at collimator straight section, ~ 5 meters at injection SS.
- ~ 3 meters at extraction SS, ~ 2 m at RF SS.
- Cost estimate for 4.5 meters at collimator SS - $35K
- #10 kapton wire - $4K
- # 6 lead wire pairs (2) - $2K
- 1.5kW PS (2) - $8K
- Solenoid winding - $10K
- Misc item, cable pulling, termination - $11K
- KEKB solenoid coverage 2190m/3000m, 70%, PEPII is >1340m/2200m, 60% .
- Other issues such as polarity and drifting space etc.