Solenoid between collimators

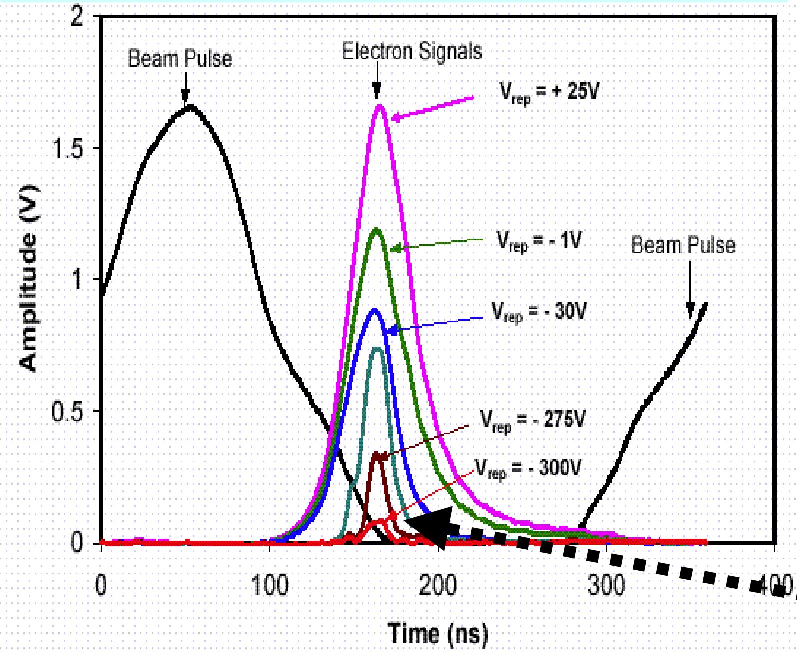
S.Y. Zhang and H.C. Hseuh, 8-27-02

1. Solenoid to prevent e-multipacting

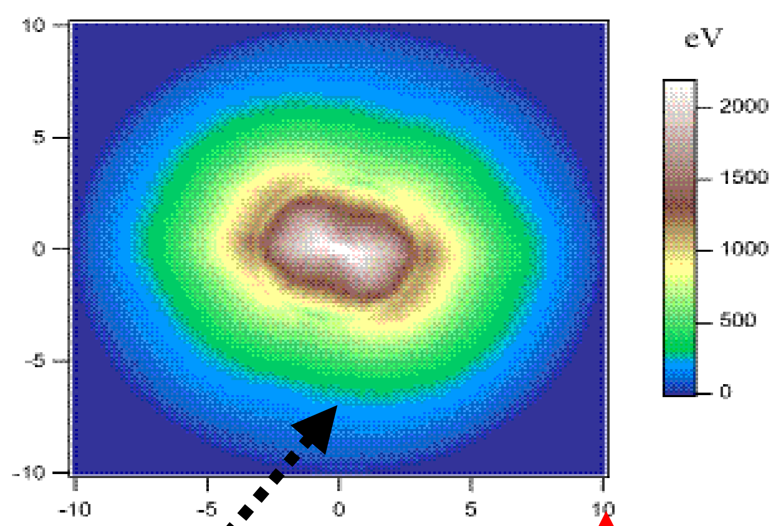
The predicted electrons (with e-multipacting) in the 4.5 m pipe is at least several hundred times more than the lost proton produced ones. Solenoid can be used to prevent the electron multipacting.

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



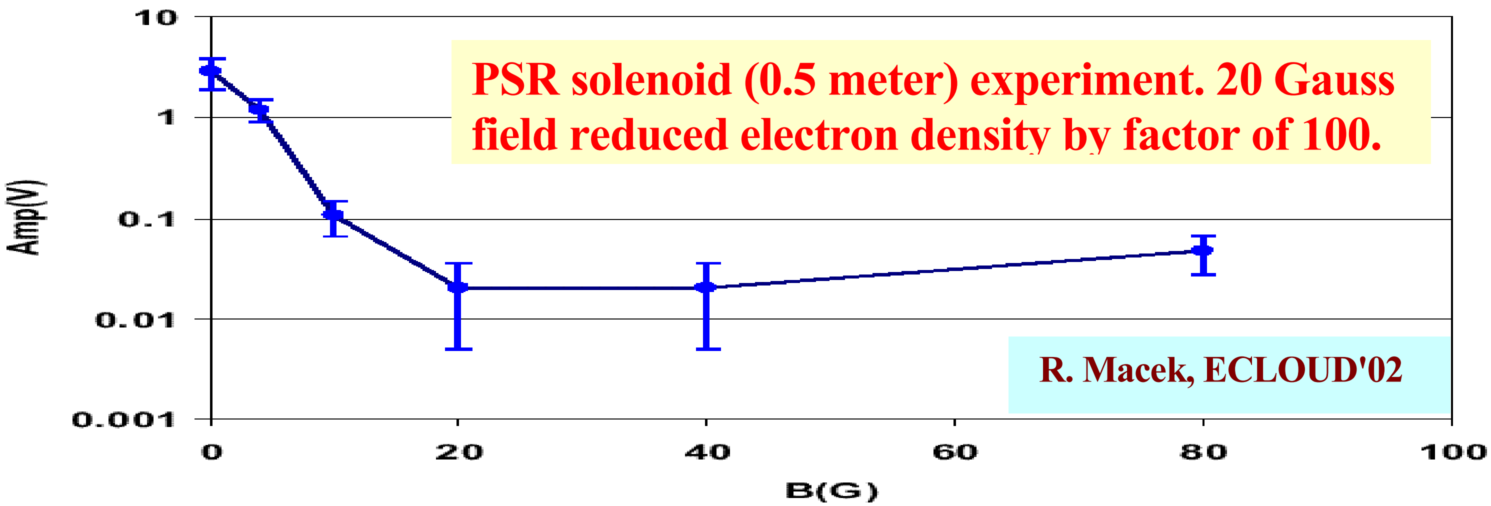
SNS simulation, Pivi & Furman, ECLOUD'02



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.



4. Parameter, cost, and other issues

- **With #10 wire at 200 turns/m, 20A current gives rise to a 50 Gauss field.**
- **The surface contact temperature of the solenoids at 20A will be within safety limit based on RHIC measurement of 65° C at 25A. Kapton wire should be used.**
- **Cost estimate for solenoid at collimator - $35K**
- **The possible solenoid coverage for the whole SNS ring is ~ 18m (~7%)**
- **PSR plans to cover 10% of the ring with the solenoid in next run.**
- **KEKB solenoid coverage 2190m/3000m, >70%, PEPII 1340m/2200m, >60% .**

SNS Beam Scrubbing?

S.Y. Zhang, 8-27-02

- **Beam scrubbing - 1mC/mm^2 may reduce SEY from 2.2 to 1.3**
  - **SPS 2000 - Scrubbing at P=7 x 10^{-7} Torr, 24 hrs' total dose 0.1 mC/mm^2, pressure rise was reduced by a factor of 5.**
  - **SPS 2002 - Scrubbing at P=5 x 10^{-6} Torr, 24 hrs' total dose 0.5 mC/mm^2, pressure rise was reduced by a factor of 100. LHC beam requirement was achieved in first time. Planning LHC scrubbing.**
  - **PSR - 24 hrs' dose is about 0.035 mC/mm^2, estimated from the observed electron current on the wall. Mild pressure rise and threshold increase.**
  - **RHIC - Making commissioning plan of scrubbing for coming run.**
- **SNS scrubbing estimate**
  - **Taking LBNL (Furman and Pivi) simulation, SNS peak e-current on the wall is 5 mA/cm^2, then the 24 hrs' dose is 1.6 mC/mm^2. (LBNL simulated PSR e-current is 0.4 mA/cm^2, PSR observed 0.14 mA/cm^2.)**

- With effective pumping speed of 13 liter/s/m, pressure rise will be $P=1.6 \times 10^{-5}$ Torr, i.e. vacuum valve closed (Threshold is usually set at 5×10^{-6} Torr. Beyond 10^{-5} Torr, ion pumps stop working).

- Two schemes
  - Scenario 1: If the predicted electron density can be reached, then the beam should be injected up to pressure rise of 5×10^{-6} Torr. Once the pressure is reduced, then inject again by increasing the injection turns or Linac intensity (beam instabilities is treated separately).
  - Scenario 2: If the real situation is similar to, or better than the PSR, then to keep the stored beam on for a while can help. Or put some stored beam time on for each pulse?
  - Keeping on the stored beam is a big challenge. The capabilities of the power supplies and RF system need to be checked for how long circulating beam can be supported. Will other systems be overheated? Control systems? Beam loss? ...
  - As long as the pressure rise is presented, scrubbing can be used to reduce electron activity.
  - Normal PSR pulse is 1ms injection + 0.5 ms store before the extraction.