# Build-up of electron cloud in DAFNE in the presence of solenoid field

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- Build up simulations in the presence of solenoids
- Cyclotron Resonance Threshold
- Effect of solenoids on vacuum pressure rise
- Conclusions and outlook

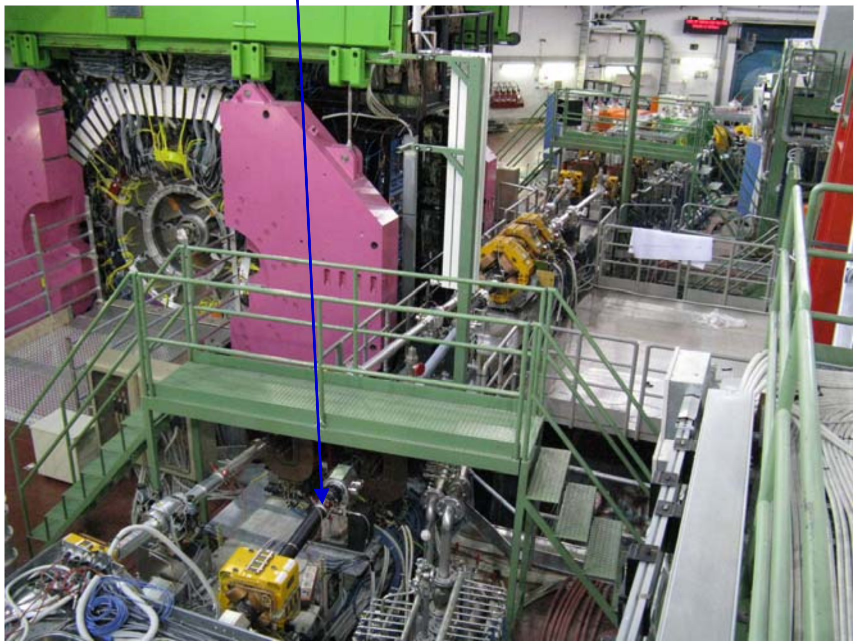
# Electron cloud at DAFNE

Indications of electron cloud in the DAFNE positron ring [A. Drago et. Al DAFNE Tech. Note: G-67]:

- e+ current limited to 1.2 A by strong instability
- instability rise time (~ 10 μs) cannot be explained only by the beam interaction with parasitic HOM or resistive walls and increase with bunch current
- a larger positive tune shift is induced by the positron beam current
- the anomalous vacuum pressure rise with beam current in positron ring
- bunch-by-bunch tune shifts measured along the DAFNE bunch train present the characteristic shape of the electron cloud buildup

At the startup after the recent shutdown for the setup of the crab waist collision scheme the instability threshold dropped to 270mA for the positron current.
In the attempt to find a remedy solenoids were installed in the field free regions of DAFNE, leading to an increase of the threshold to 400mA.

# Solenoids

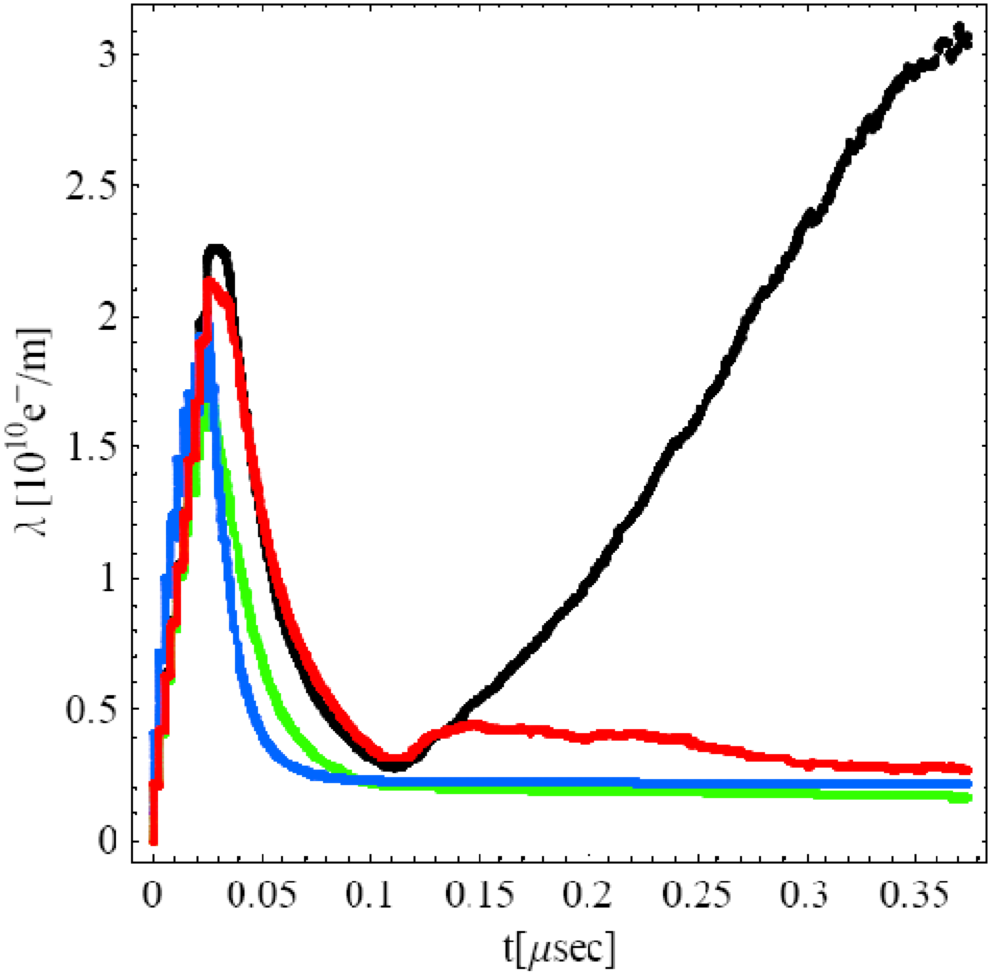


# Input Parameters for ECloud

| | | |
|---|---|---|
| Bunch population | $N_b$ | $2.1 \times 10^{10}$ |
| Number of bunches | $n_b$ | 100 |
| Missing bunches | $N_{gap}$ | 20 |
| Bunch spacing | $L_{sep}$[m] | 0.8 |
| Bunch length | $\sigma_z$ [mm] | 18 |
| Bunch horizontal size | $\sigma_x$ [mm] | 1.4 |
| Bunch vertical size | $\sigma_y$ [mm] | 0.05 |
| Chamber Radius | $R_{cham.}$ [mm] | 44; 30 |
| Uniform Solenoid Field | $B_z$ [G] | 0 -(10)-90 |
| Al Photoelectron Yield | $Y_{eff}$ | 0.2 |
| Primary electron rate | $d\lambda/ds$ | 0.26 |
| Photon Reflectivity | R | 50% |
| Max. Secondary Emission Yeld | $\delta_{max}$ | 1.9; 2.4(*) |
| Energy at Max. SEY | $E_m$ [eV] | 250 |
| SEY model | Cimino-Collins (50% refl.) | |

(*) M.Pivi et Al., EPAC08 paper MOPP064.

# Multipacting Suppression



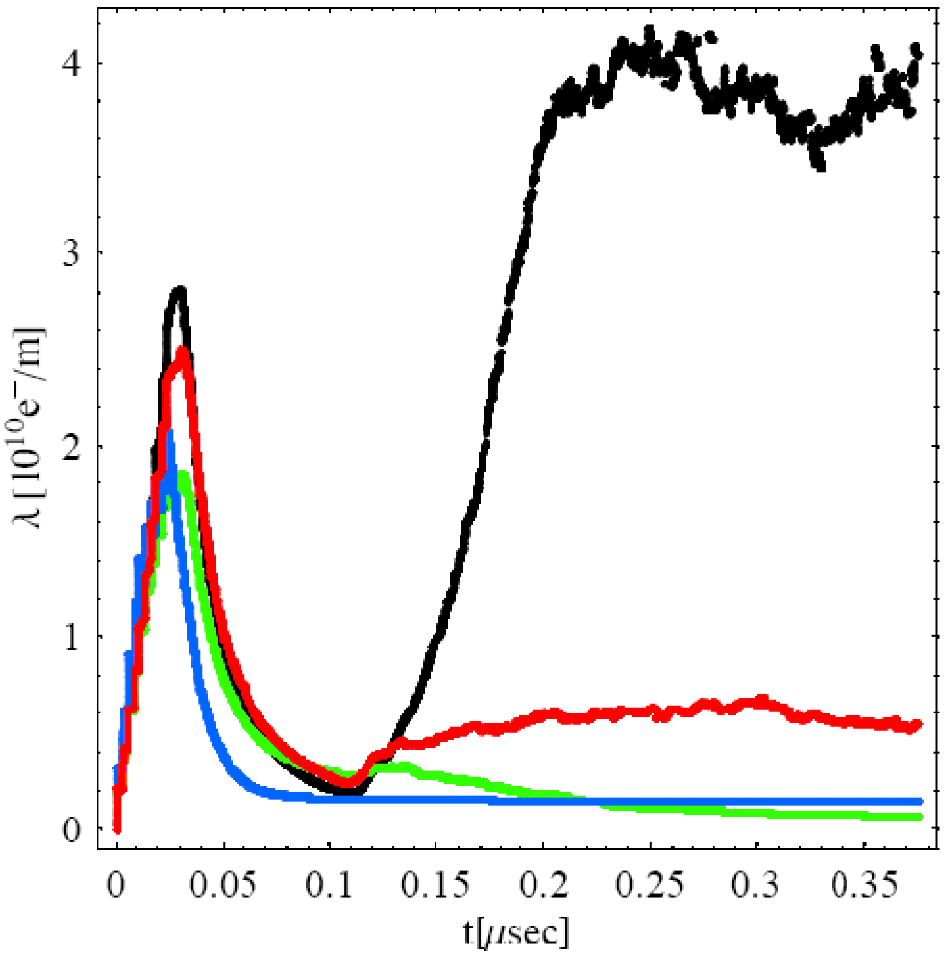

$N_b$=2.1x10$^{10}$
$L_{sep}$=0.8 m
R = 44 mm
$\delta_{max}$ =1.9

(10f-30e-100f)

Bz=0 G
Bz=10 G
Bz=20 G
Bz=40 G

Photoelecrons are produced only during the passage of the first 10 bunches.

# Multipacting Suppression



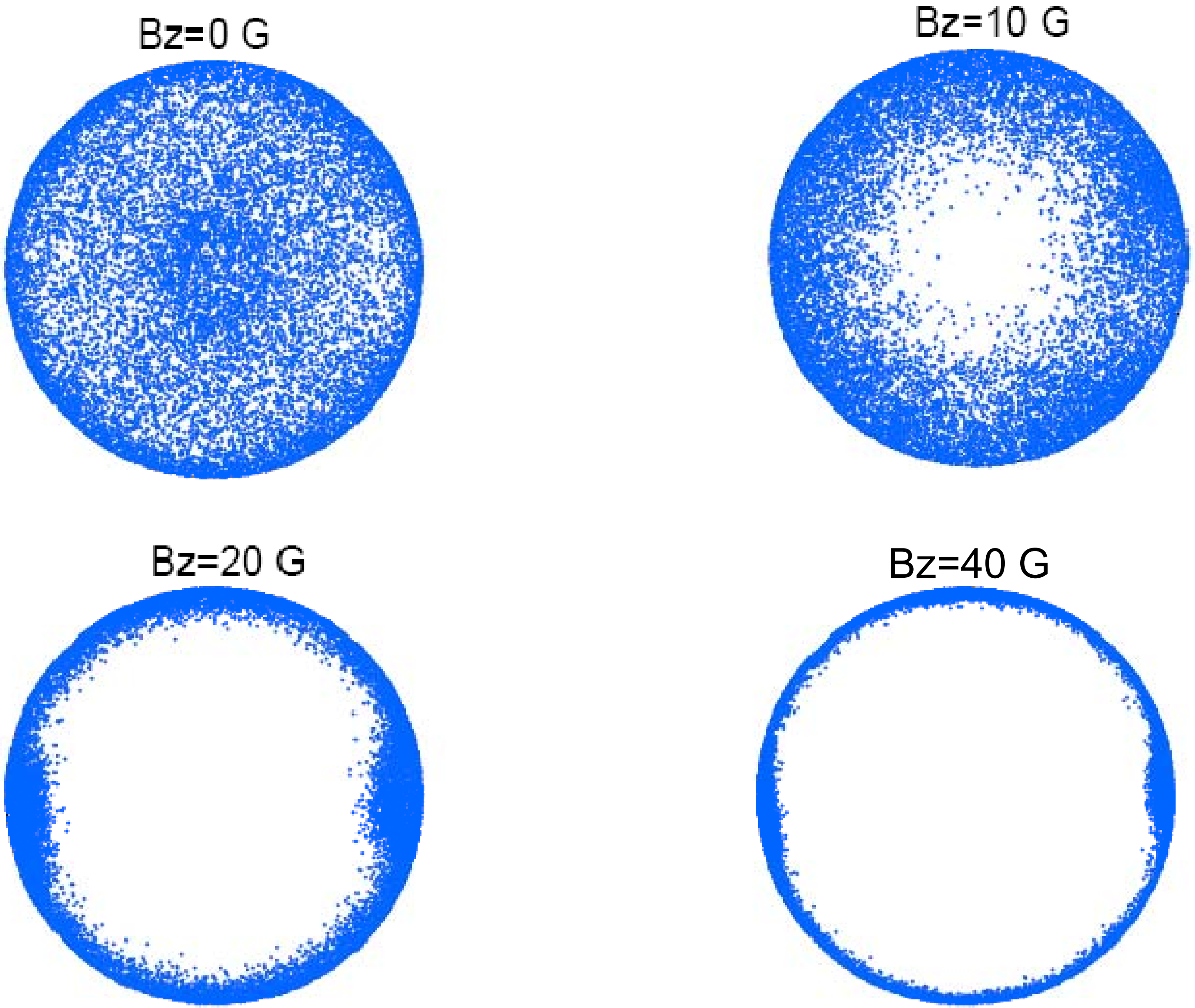

$N_b$=2.1x10$^{10}$
$L_{sep}$=0.8 m
R = 30 mm
$\delta_{max}$ =2.4

(10f-30e-100f)

Bz=0 G
Bz=10 G
Bz=20 G
Bz=40 G

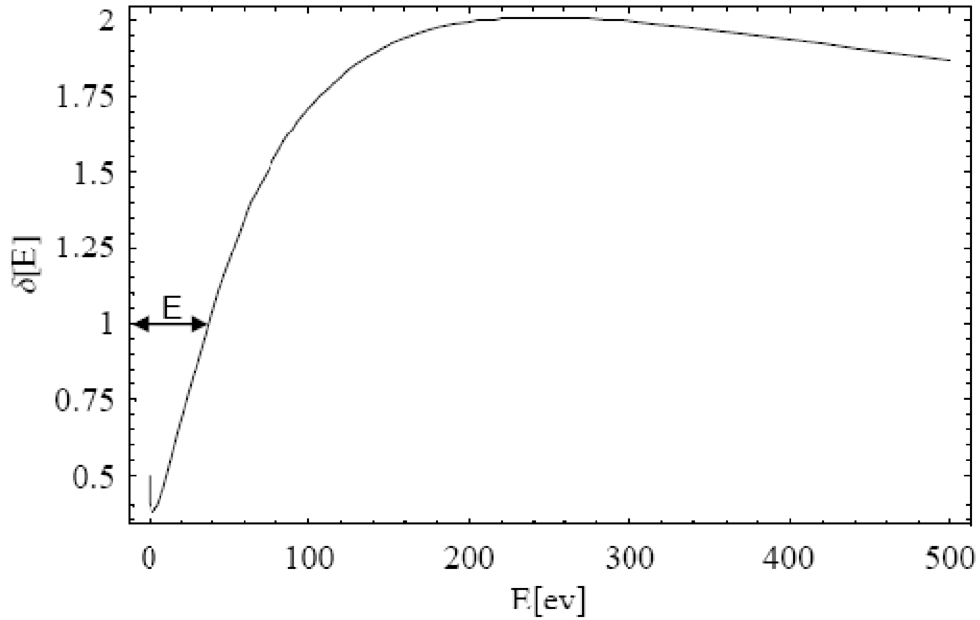
Photoelecrons are produced only during the passage of the first 10 bunches.

# x-y Phase-Space Snapshot



# Cyclotron Resonance

Y. Cai et Al., Phys. Rev. ST-AB 7, 024402 (2004)




- Resonance condition

$$T_c / 2 = L_{sep} / c \quad \Rightarrow \quad B_z^{res} = \frac{\pi m_e c^2}{e L_{sep}} \approx 66G$$

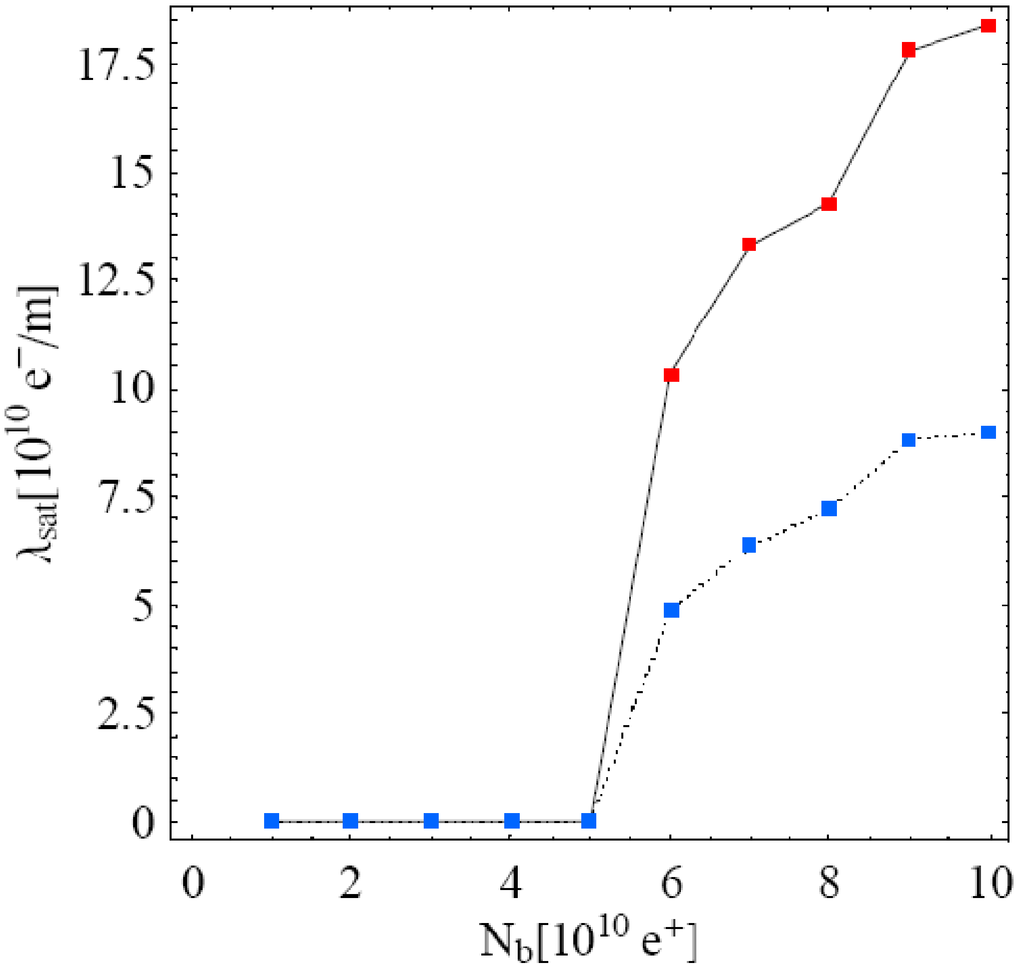
- Intensity threshold

$$\Delta E_{kick} \geq E_{\delta=1} \quad \Rightarrow \quad N_b = \frac{R}{r_e}\sqrt{\frac{E_{\delta=1}}{2 m_e c^2}} \approx$$

→ $7.1 \cdot 10^{10} e^+$ (R=33 mm, $\delta_{max}$ =2.4 )

→ $9.5 \cdot 10^{10} e^+$ (R=44 mm, $\delta_{max}$ =1.9 )

# Simulated Intensity Threshold




Bz=66 G; Lsep

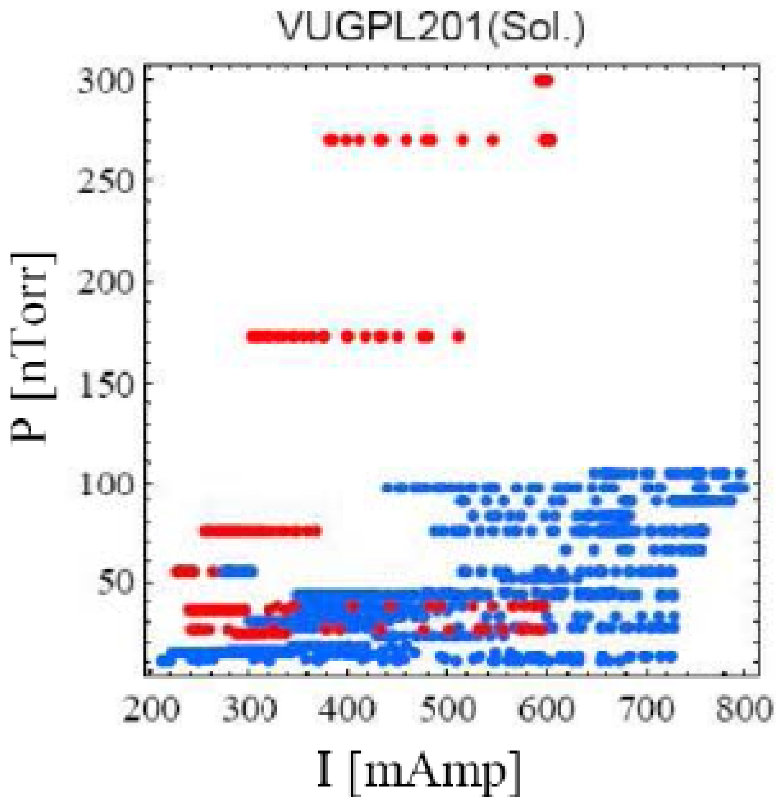
Bz=33 G; 2Lsep

R=30mm

$\delta_{max}$ =2.4

$N_b \approx 5x10^{10}$ for both Lsep and 2Lsep is above the DAFNE operated current.

# Effects of Solenoids on Vacuum Pressure Rise




(100f,20e)

Lsep=0.8 m

Bz= 40 G

Sol. Off/Sol. On

Vacuum pressure read-out vs. total current as recorded in a straight section of the positron ring where a 40 G solenoidal field was turned on (blue dots) and off (red dots).

# Summary

• Simulations show that Solenoids reduce the e-cloud density inside the drift lines confining the electron near the wall. In the case of pure multipacting the suppression of e-cloud density is very effective.

• Intensity threshold for the cyclotron resonance is above the bunch population currently available in DAFNE.

• Multi-bunch and single-bunch instability simulations are being prepared to directly compare results with measurement planned for the next future.