Gun and Prebunchers Performances

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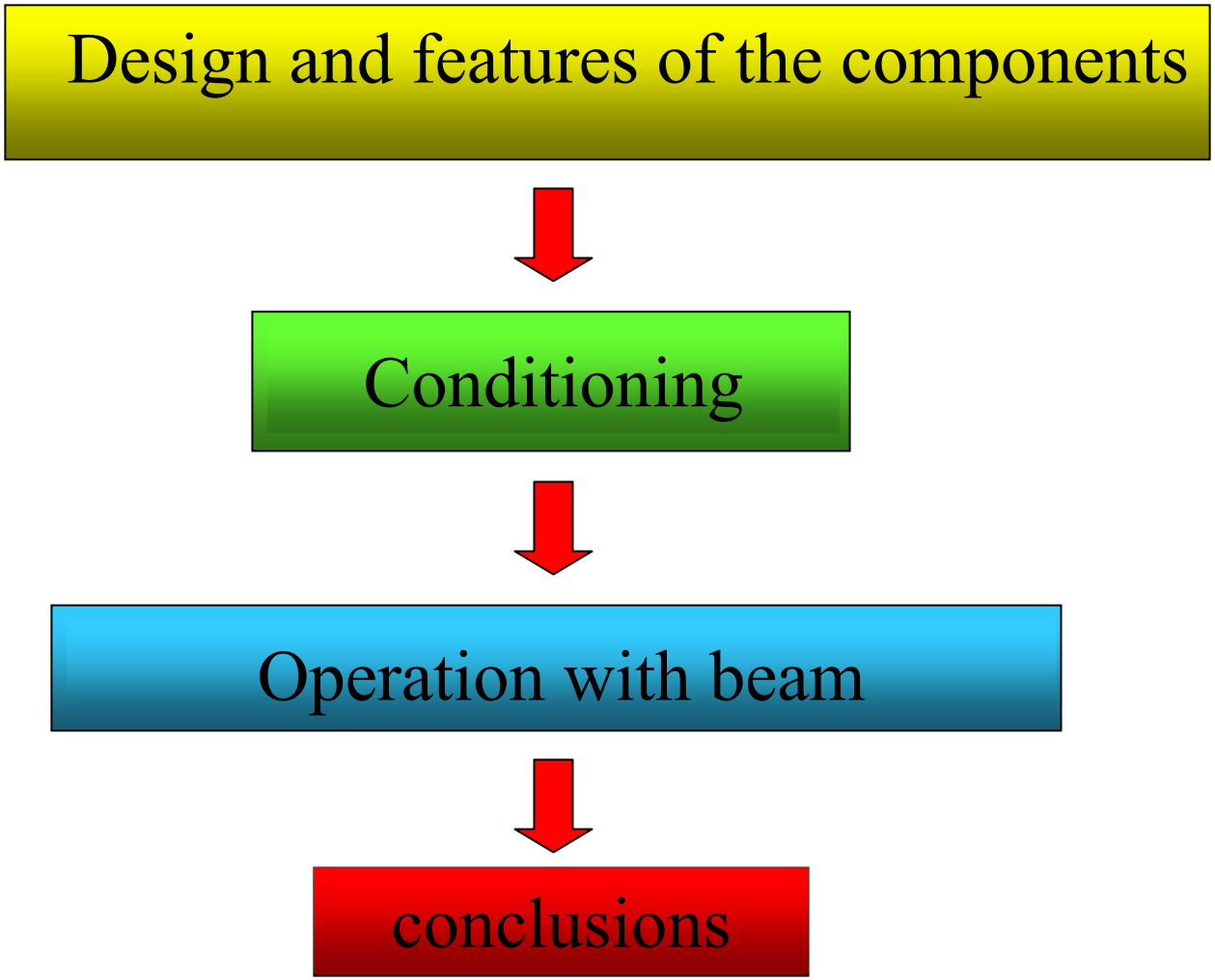
In the name of the LAL Team


Design and features of the components
Conditioning
Operation with beam
conclusions

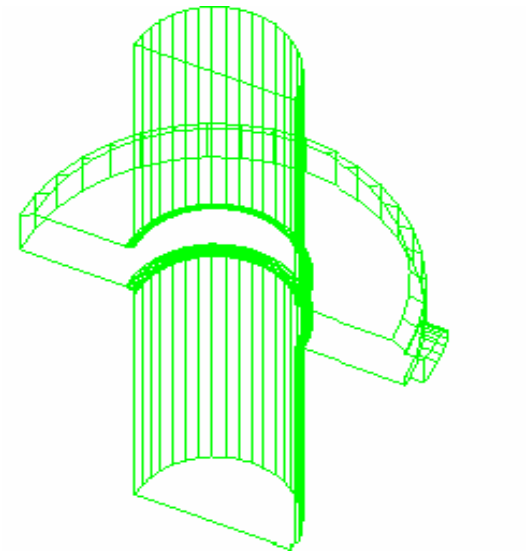
Thermionic gun provided by SLAC

- LAL added :
  - electronics low level
  - HV components
  - solenoids

Parameters	
Voltage (kV)	140
Current (A)	0.1 → 9
Stability (%)	1
Pulse width (μs)	0.2 →1.6
Rep. Freq (Hz)	5 →100
Current modul. (MHz)	20

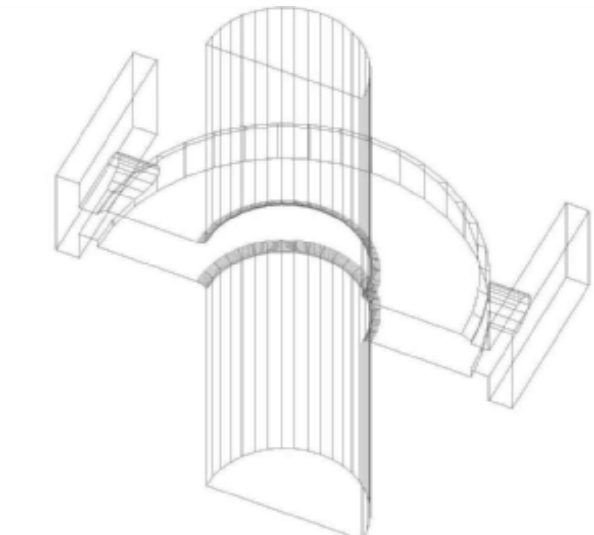
2 prebunchers built by the LAL
F_t = 2998.55 MHz

PB1 : in copper



Waveguide coupling, β = 1
R_s = 1.02 MΩ
Q = 10600
F_r mechanically adjusted (<10 kHz)
R = 0.46 %

PB2 : in stainless steel to reduce the beamloading



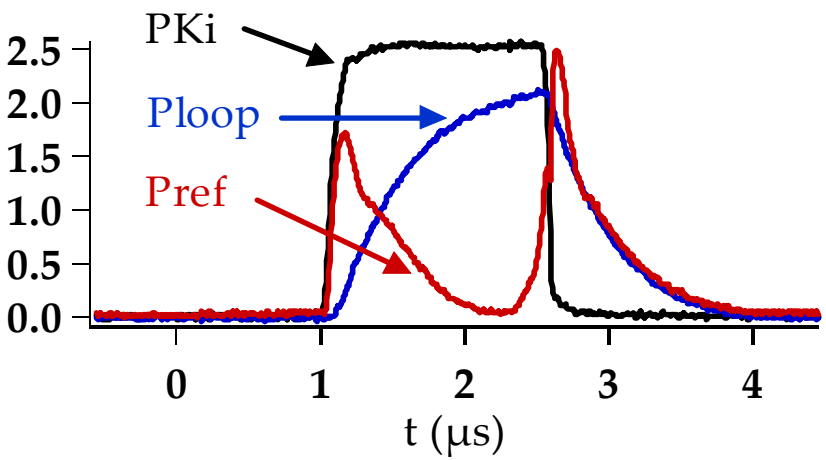
HF input, β = 4 HF load, β = 3
R_s = 140 kΩ
Q lowered to 125 by external load
R = 0.63 %

Gun conditioning

- HV increased easily up to 150 kV while monitoring vacuum
- Few problems:
  - -HV power supply out of order (now problem is fixed)
  - -trouble with the connector to the cathode (heating)
- Current up to 7 A at LAL
- Current up to 6 A at CERN

Conditioning without magnetic field

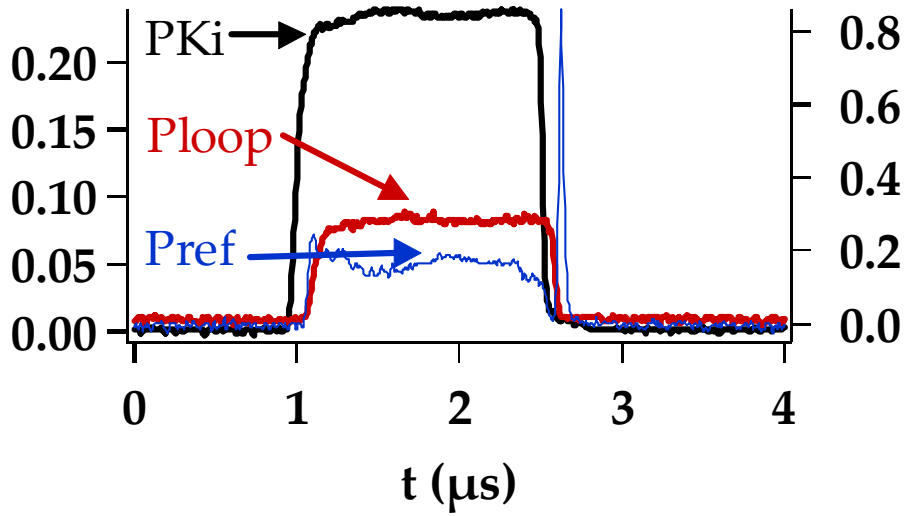
PB1



✓Power up to 600 W easily (while required power is 500 W)

✓Low reflected power

PB2

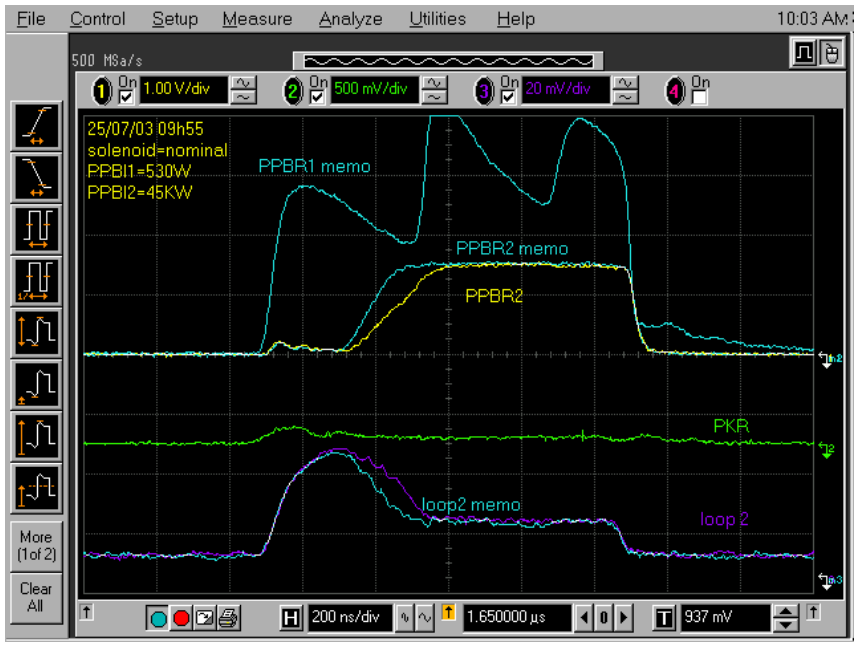


✓Up to about 200 kW input power without big problems (while only 100 kW are required)

✓Big P_{ref} peak due to short τ_c = 13 ns

Conditioning with magnetic field

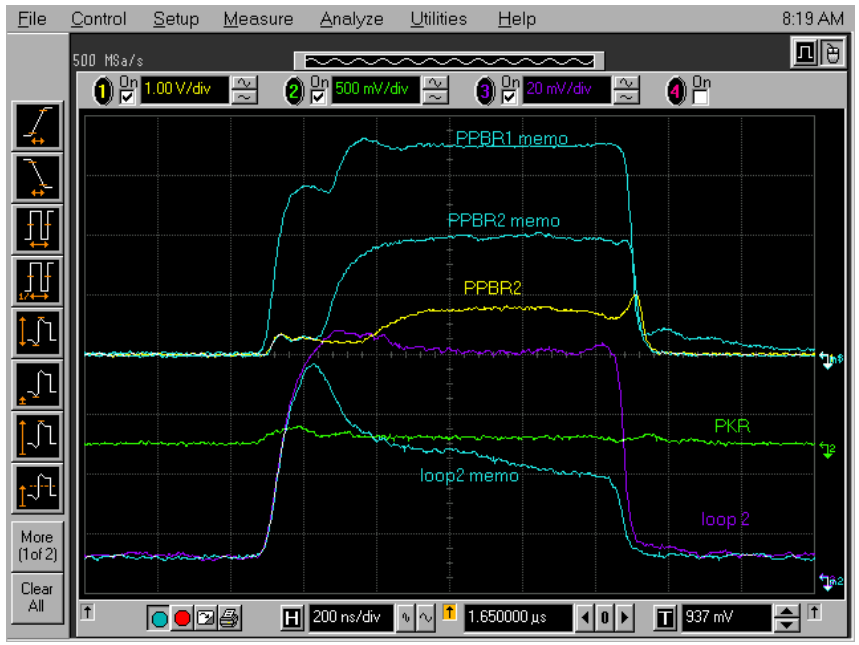
PB1



Multipacting!

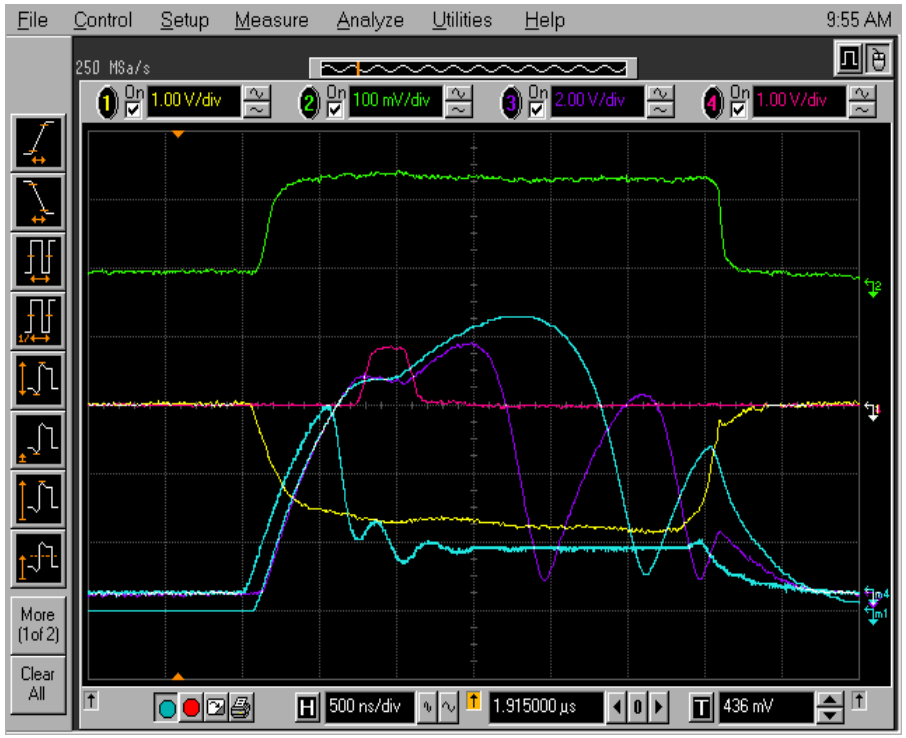
No memory!

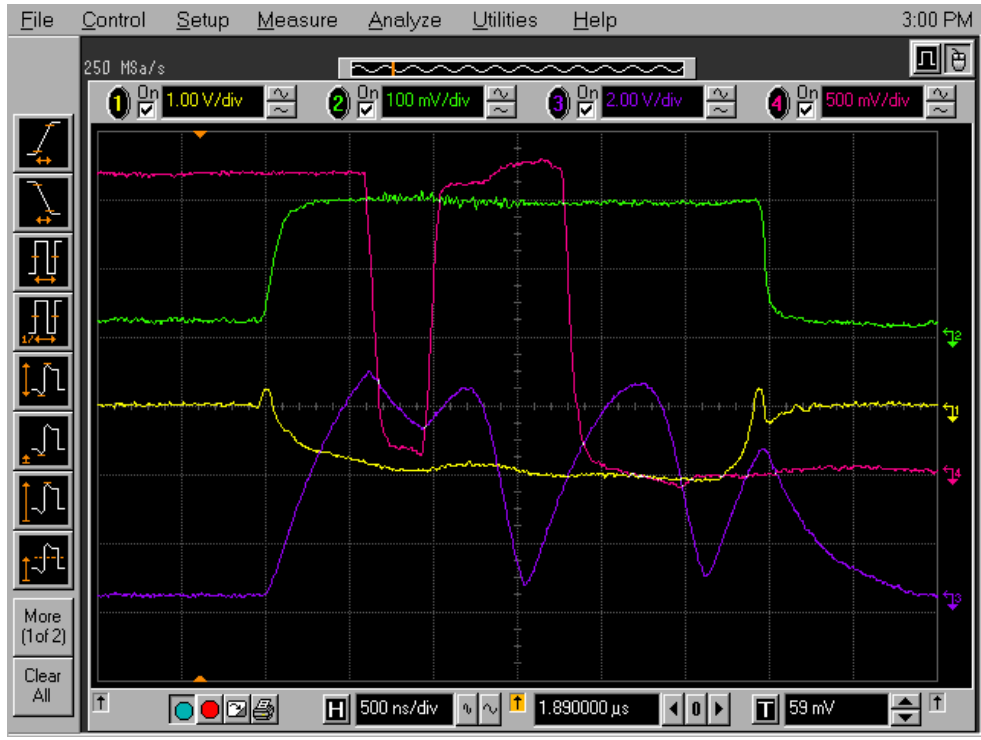
PB2



Normal conditioning

Beam operation





I = 1.5 A

➡ flatten the PB1 voltage

I = 3.9 A full loading

★ decrease the PB1 voltage

And multipactor is worse in presence of beam

Beamloading in PB1???

➡ It seems impossible as beam is cw

But it could be: $\frac{\Delta f}{f} = \frac{\Delta U}{U}$ Slater Theorem

Electron beam = plasma with $\varepsilon_r = n^2 = 1 - \frac{\omega_p^2}{\omega^2}$

Simplified model: $\frac{\Delta U}{U} = (\varepsilon_r - 1)\frac{\phi_{beam}}{\phi_{cavity}}$

$$\frac{\Delta f}{f} = (\varepsilon_r - 1)\frac{R_b^2}{R_c^2}$$

For I = 1 A, $\varepsilon_r = 0.996$ ➡ $\Delta f = 180$ kHz Enough to produce a big reflexion

Cure: low Q = wide bandwidth

CONCLUSION

- Electron gun is able to provide the required current
  - improvement: to modulate the triode to get 0.1% stability
- PB2 is OK
- PB1 shows relentless multipactor and "beamloading"
  - possible cures: better baking, titanium coating
    Or build a new PB1 with a low Q!

But, is PB1 indispensable?