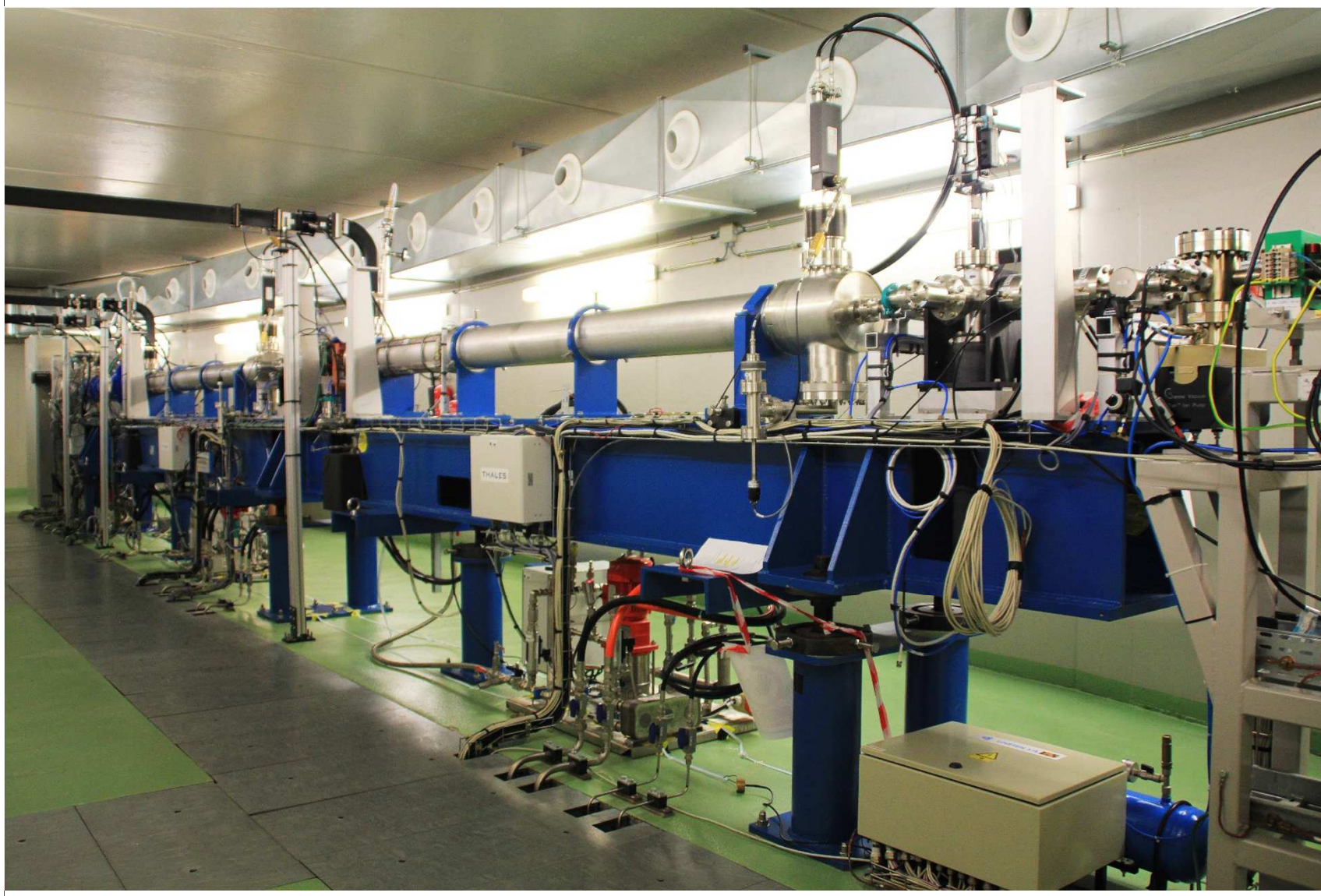




The "ALBA" Linac

The pre-injector of the ALBA Synchrotron Light Source is a Linac that delivers electrons up to a maximum energy of 125 MeV. It was commissioned in 2008 and started routine operation in 2010. Since July 2014, ALBA is operating in top-up mode, and the Linac is delivering 110 MeV electrons in multibunch mode every 20 minutes. Recently, the Linac single bunch mode has been integrated to the top-up operation application, providing the injection of any kind of filling pattern in the ALBA Storage Ring. Furthermore, the injection to the ALBA Booster is now also available with only one of the two klystrons in operation, and the Linac delivering a 67 MeV beam.

Parameter at Linac Exit	SINGLE BUNCH MODE	MULTI BUNCH MODE
Number of Bunches	1 to 16	18 ... 512
Pulse Length	< 1ns (FWHM)	36 ... 1024 ns
Bunch spacing	6 ... 256 ns	2ns
Charge	$Q \geq 0.25$ nC	$3 \leq Q \leq 4$ nC
Energy	≥ 100 MeV	≥ 100 MeV
Relative energy spread	≤ 0.5 % (rms)	≤ 0.5 % (rms)
Norm. Emittance (1σ)	$\leq 30 \pi$ mm mrad	
Energy Variation Pulse-to-pulse	0.25% (rms)	
Beam position stability pulse-to-pulse	<10% of beam size	
Jitter pulse-to-pulse	≤ 100 ps (rms)	
Repetition rate	1 to 5 Hz	

Two years of the linac in top-up mode

Basic:

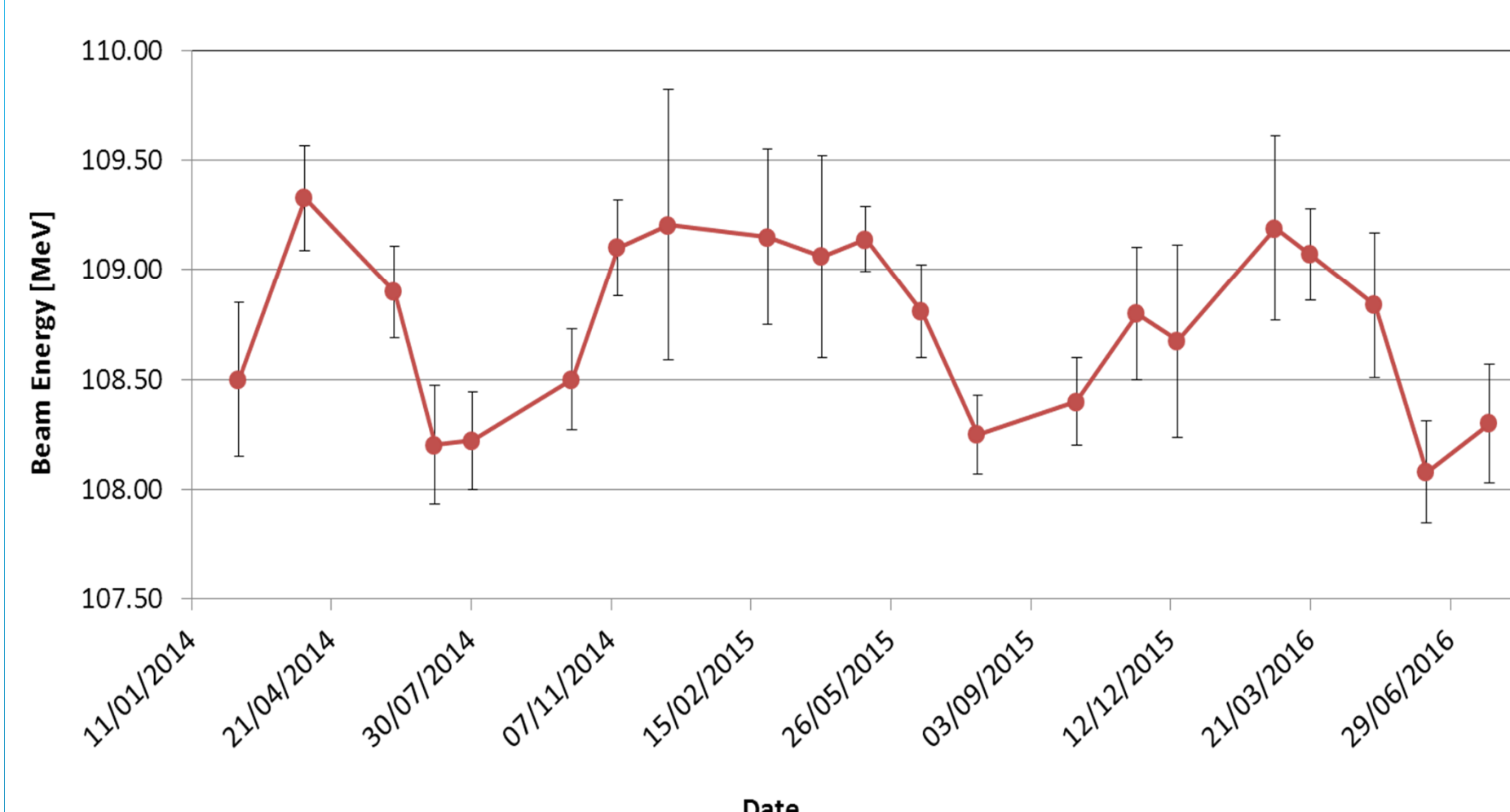
- Trains of 32 bunches and 0.25 nC are delivered every 20 minutes.
- Injections take about 10 seconds.

Good performance:

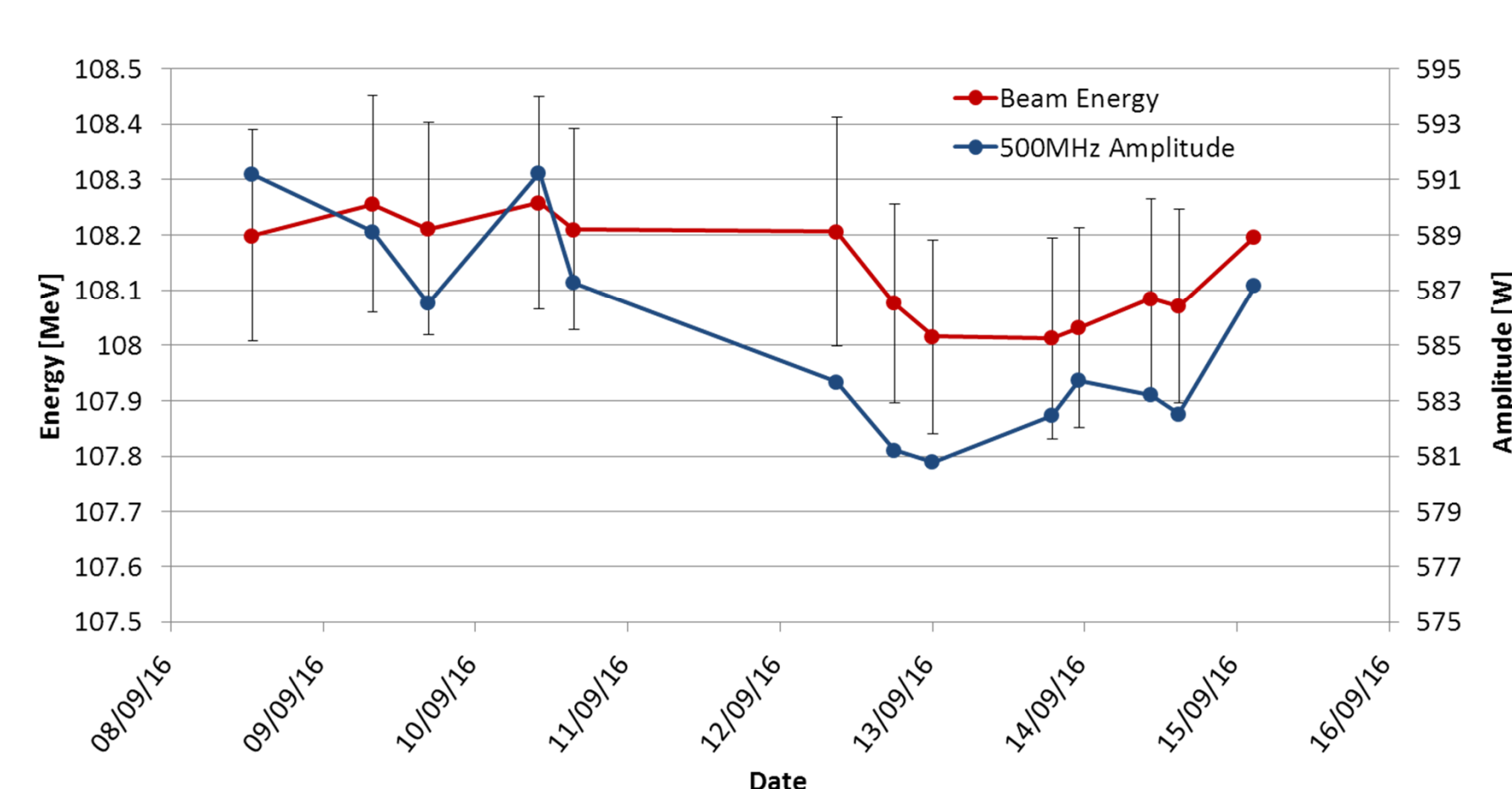
- No failure of the linac system has interrupted the service to users.
- Transmission:
 - Linac to transfer line: 80%
 - Linac to booster: 60%
- Upgrade on the cooling hardware has improved the flow stability.
- Main problems encountered:
 - Electronics of the electron gun.
 - Changes on the cathode emission point requires major adjustment of the linac optics.

Thermal effects on beam energy observed:

Thermal variations do not affect operation because the energy acceptance to booster is 1%.



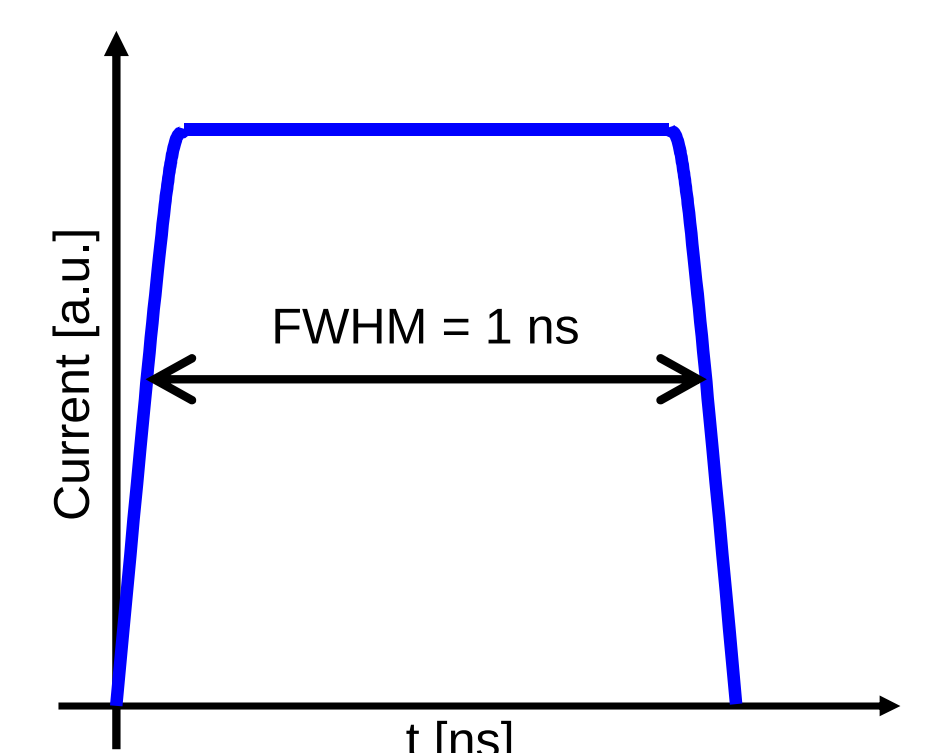
Long term beam energy variations due to seasonal temperature variations on the ALBA building.



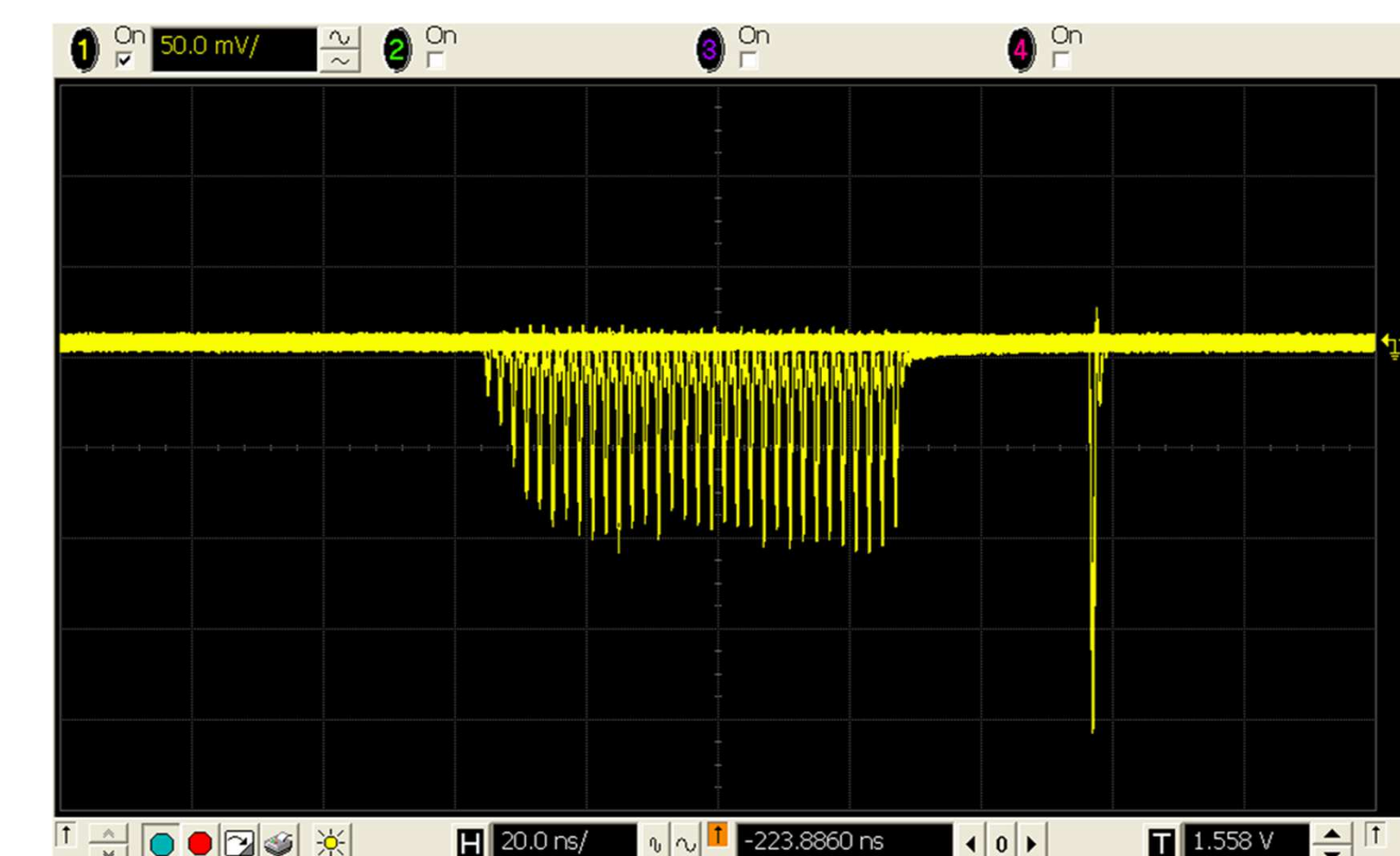
Day-to-day beam energy variations are correlated with the 500MHz RF amplitude that feeds PB1.

Electron pulse generation

Thermionic cathode: 90 keV electrons, 1ns pulses



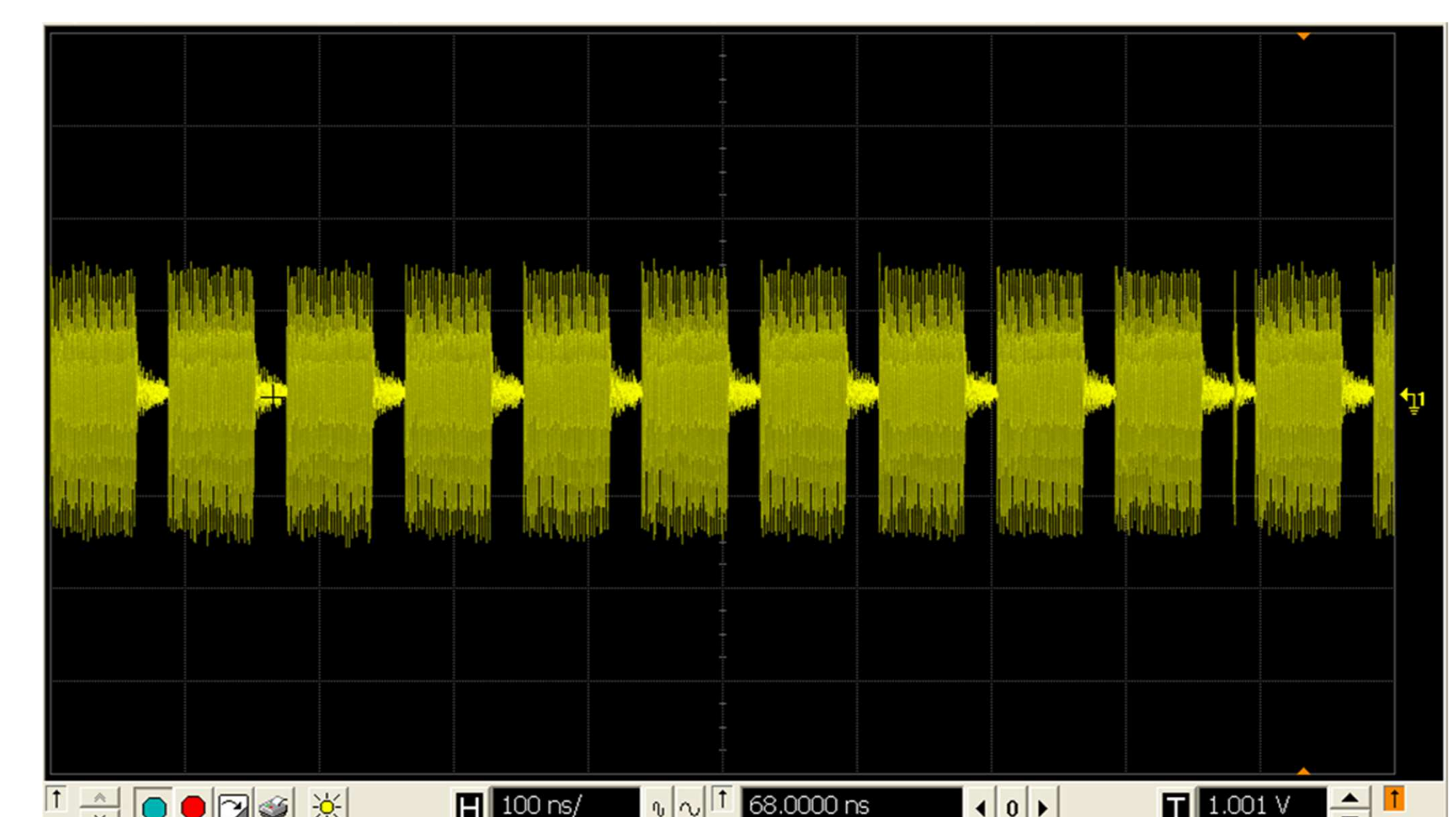
- Production of Multibunches or Single Bunches
- Charge per bunch: from few pC to 0.25 nC



Train of 32 bunches and one single bunch at FCT right after the electron gun, taken in a two-stage measurement

Top-up in Single Bunch Bucket Selection mode

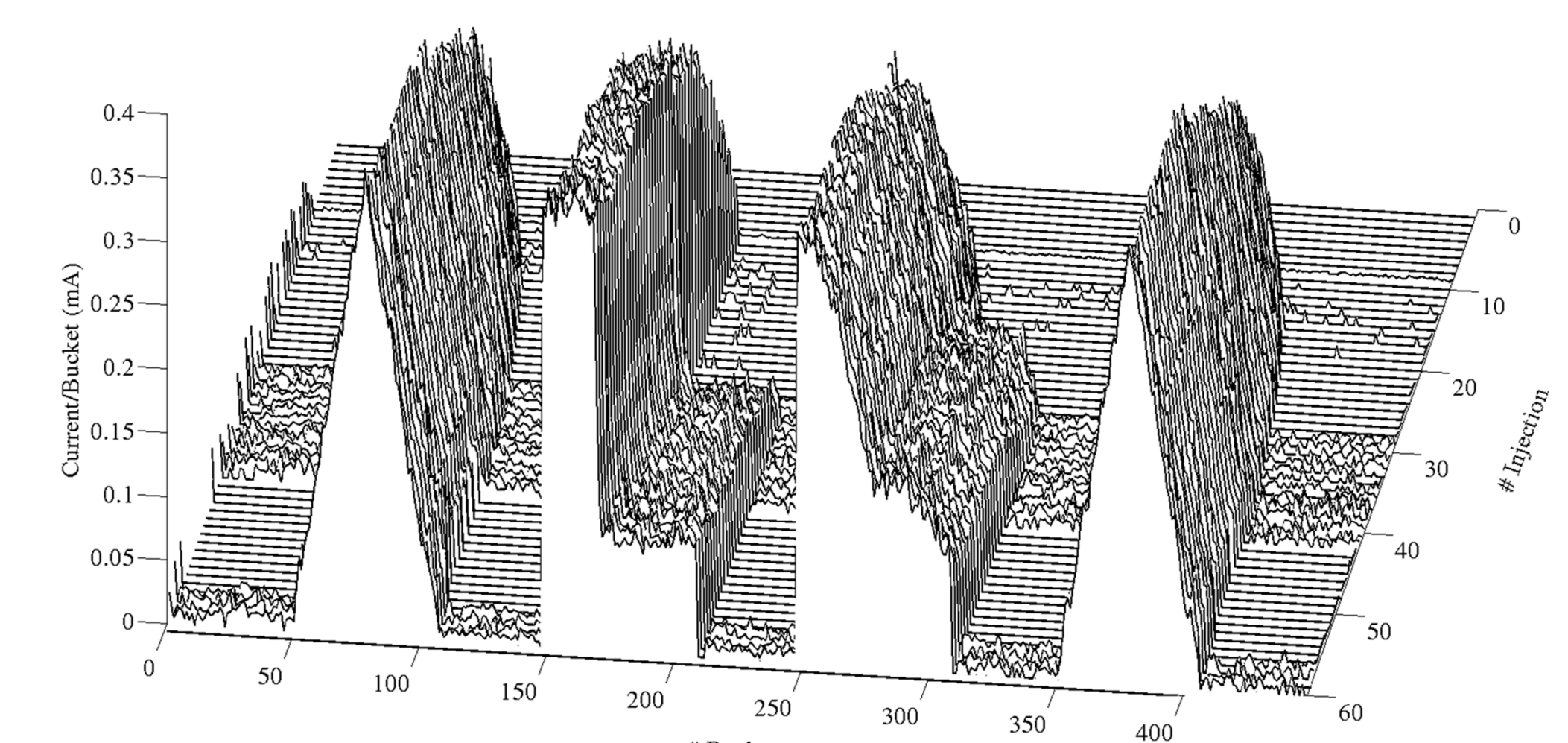
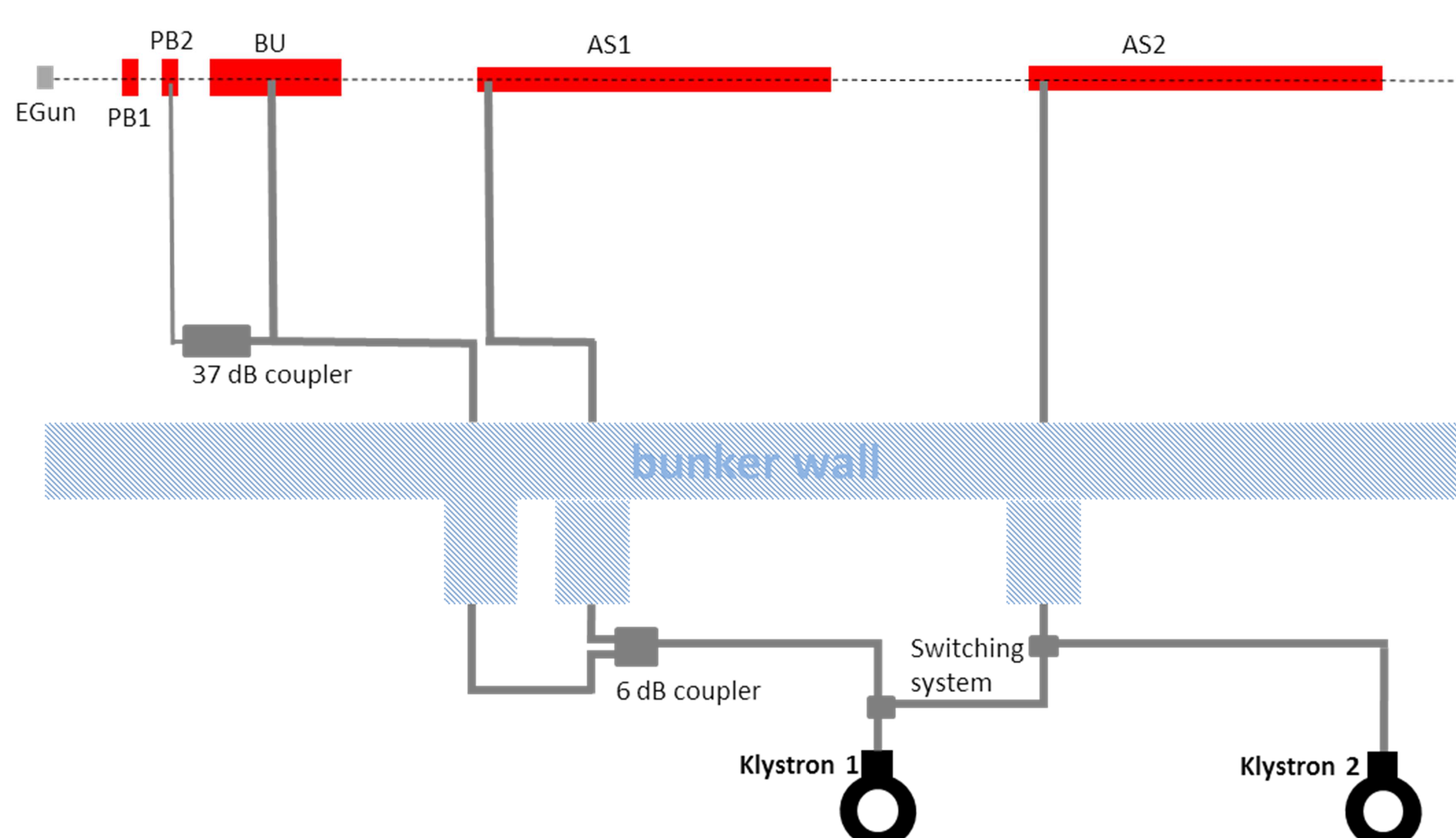
- The ALBA storage ring consists of 448 buckets, each of 2 ns.
- Injection into a determined bucket: by adjusting the delay that triggers the electron gun, whose resolution has been increased from 8ns to 10ps.
- The SBBS mode is provided of an algorithm that injects first on those buckets with less current in order to keep a uniform distribution of the filling pattern.



Hybrid mode consisting of 10 trains and one single bunch after some hours of top-up refilling using the SBBS mode.

67 MeV with single klystron working mode

Injection to booster is possible using only one klystron and a linac beam of 67 MeV. A S-band switching system allows operating at 67 MeV with any of the two klystrons.



Storage ring filling pattern were ALBA has been written using the SBBS mode.