# E-gun modulator

F. Gerigk for W. Hofle, R. Louwerse, E. Montesinos, M. Paoluzzi, 13.04.2021

# Layout from preliminary spec document EDMS 2265592

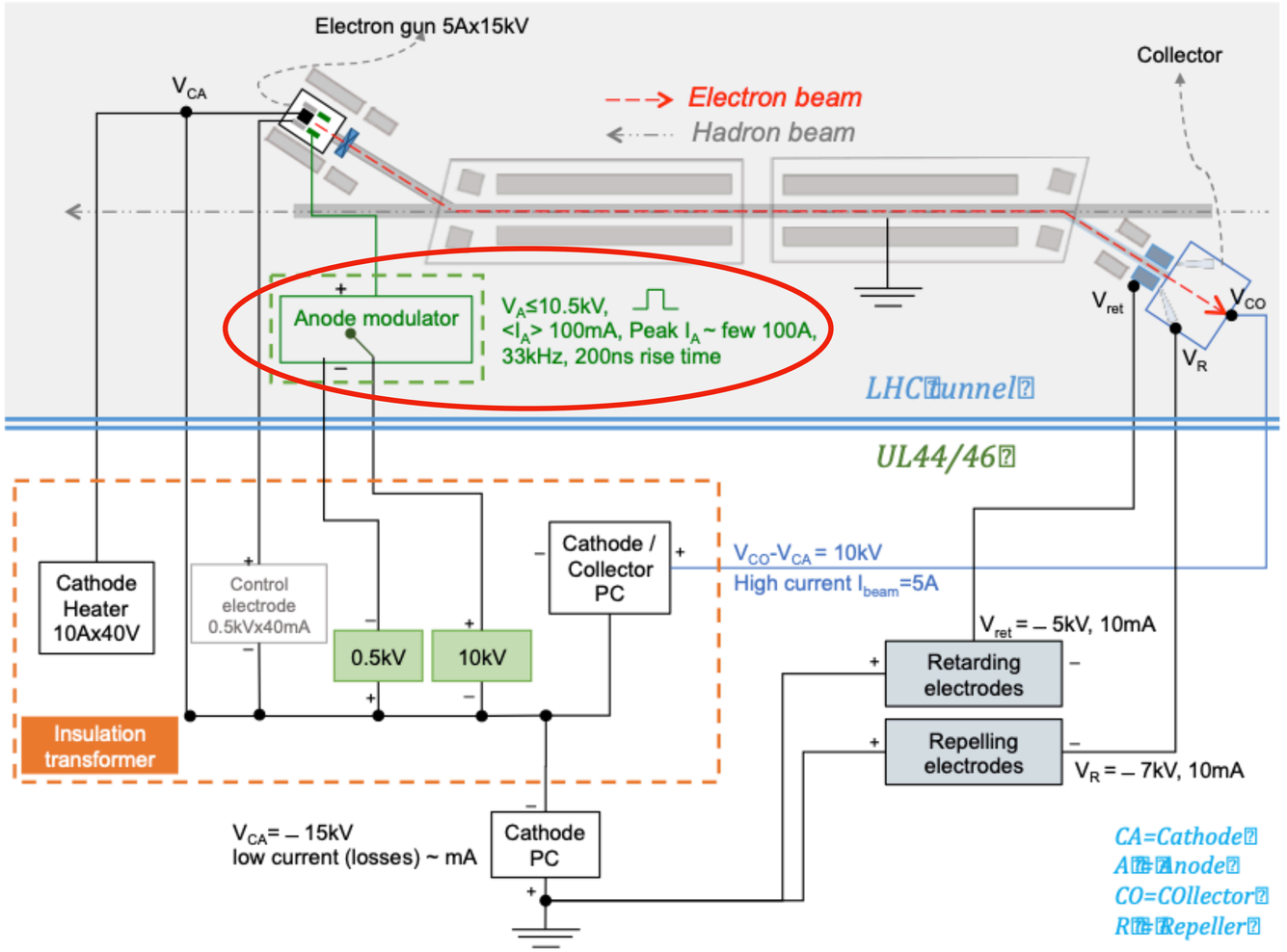


**Figure 1. Schematic of LHC hollow electron lens configuration, showing the anode modulator, sitting benith the gun solenoid of the Hollow Electron Lens (about 1 m cable between the anode and the modulator).**

# Preliminary specs from EDMS 2265592

**Influences peak power**

**Defines location & required radiation hardness**

**No amplifier can fit into this volume!**

| Parameters | Symbol | Value | Comments |
|---|---|---|---|
| **Gun anode modulator** | | | |
| Electron current intensity | $I_e$ | 5 A | |
| Anode modulation voltage (extraction voltage) | | -5k V to -15.5 kV (modulation 10.5 kV) | Voltage difference between the gun and the anode, necessary to modulate the extracted electron current |
| Cathode depression voltage (accelerating voltage) | $V_{CA}$ | - 15 kV | Difference of potential between the cathode and the vacuum chamber (which is grounded) |
| On/Off rise/fall time (10% to 90%) | | ≤200 ns | To fit between SPS batches |
| Pulse duration (excluding rise and fall time) | | 1.2 µs to 86 µs | 48 bunches to full beam with off during abort gap |
| Pulse stability | | ±1% (0.1 kV) | Including overshooting at the beginning of the pulse. [note 1] |
| Turn by turn reproducibility | | ±1% (0.1 kV) | Including overshooting at the beginning of the pulse. [note 1] |
| Anode-cathode impedance | | ~100 pF | Measured without e-beam |
| Cable (1 m) | | ~ 101 pF/m, ~10 mOhm/m | [note 2] |
| Synchronisation error | | ≤ 10 ns | With LHC turn clock |
| Switching delay | | 50 µs | ?? |
| Volume available (under the HEL gun) | | 400x400x600 mm | Including Faraday Cage if needed |
| Radiation environment | | $10^7$ to $10^9$ $cm^{-2}/y$ | HEH particle, to be confirmed with FLUKA |

# What are the options?

- The only radiation-hard solution available within a reasonable time must be based on tubes (e.g. tetrodes as used for the LHC transverse dampers).
- 2 RS2048-CJ tetrodes would be needed for the present rise time requirements. Minimum volume: 600 x 600 x 800 mm. With a longer rise time (e.g. 400 ns) one could consider a more compact one-tetrode solution.
- Development of a radiation hard solid state solution would take many years.
- A regular solid state solution is much bigger (several racks), much more complex, and needs to be located in a well shielded location. Distance will increase peak power requirements from ~60 kW to ~200 kW.

# What can the RF group do?

- Not much before middle of 2022. Maybe some conceptual design work.
- We could elaborate an RF design and guide a development and construction in Russia (BINP):
    - This will need frequent visits and close collaboration between CERN RF and BINP. Count ~2 years from the start of work until reaching a first prototype -> middle of 2024.
- Complete development at CERN (not covered in present HL-LHC budget):
    - Starting in the middle of 2022, it would still need ~1.5 years so until end of 2023 to arrive at a prototype.