System for voltage control and for data acquisition of Retarding Field Energy Analyzer

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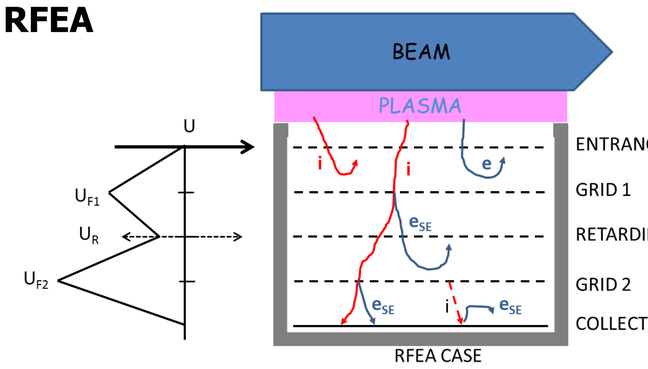
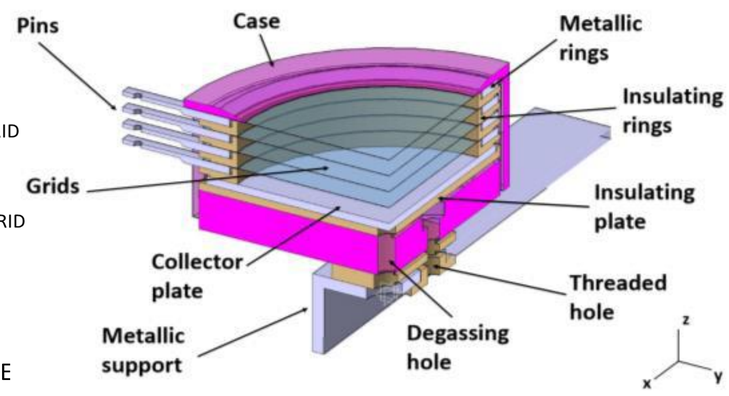
INTRODUCTION

One of the main concerns when working with negative ion beams is collimation during propagation. The beam is composed of like charged particles; therefore they tend to repel each other causing the beam to widen after acceleration. In environments where the beam needs to travel long distances before reaching its target, the compensation of its space charge is necessary; the most straightforward way of achieving this is the creation of a plasma around the beam, created by ionization of the background gas by the beam itself. This effect, called space charge compensation, plays therefore a key role in the beam propagation [1,2] and a deep understanding of this phenomenon is fundamental when operating negative ion sources. In order to perform measurements of the particles forming such beam-generated plasma, a retarding field energy analyzer (RFEA) can be adopted, which is an indirect non perturbing instrument, analysing the particles emitted radially from the beam plasma, and allowing to estimate the plasma parameters from the energy distribution function of ions and electrons [3,4]. The poster presents the design and the layout of the system for voltage control and data acquisition of the RFEA, developed at Consorzio RFX and used for the experimental campaigns in NIO1 to study the phenomena that cause space charge compensation [5].

RFEA



Principle and bias potential arrangements for an RFE operating in ion analysis mode



$$j_c = j_0 q_i K \int_u^{\infty} v_{//} f(v_{//}) dv_{//}$$

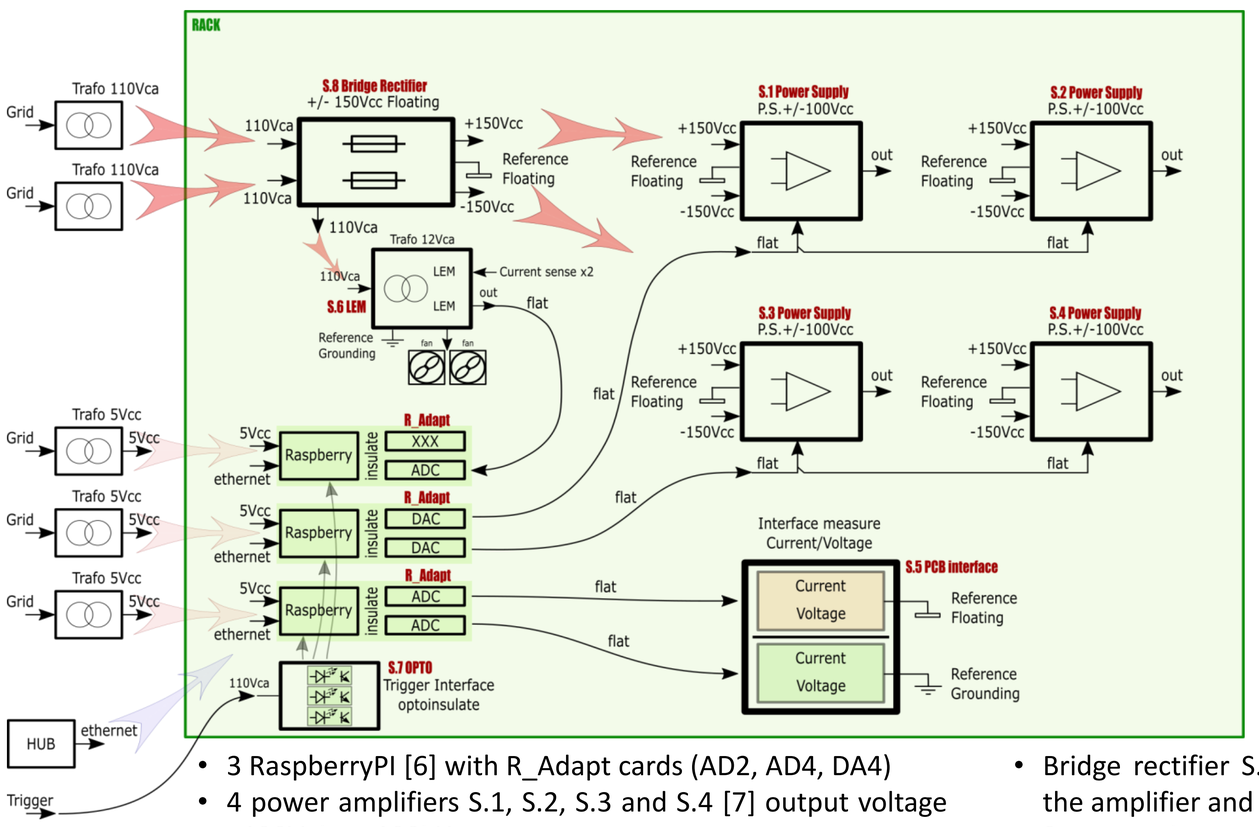
$$j_c = K' e^{-q_i (E - U_d)/kT_i}$$

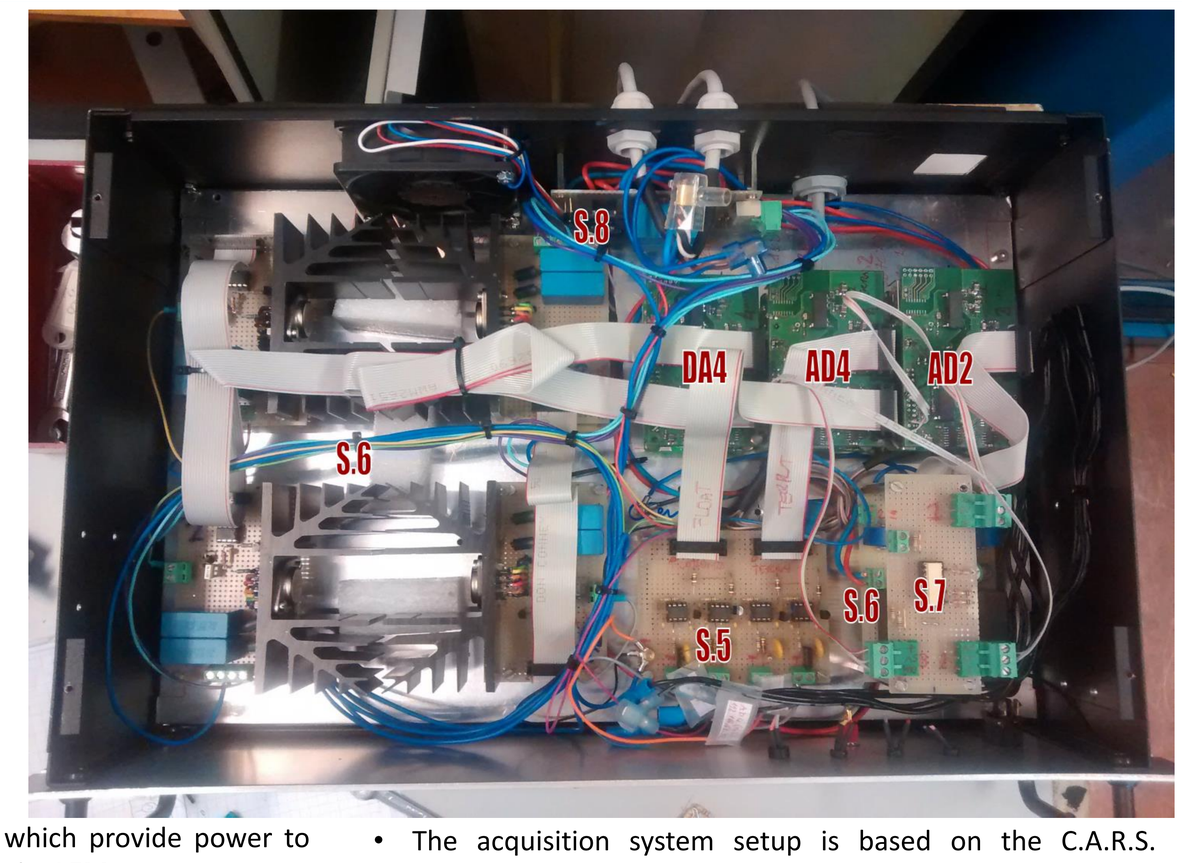
THREE OPERATING MODES:

- ION ANALYSIS, → IEDF, V_p
- ELECTRON ANALYSIS, → EEDF, V_p
- LANGMUIR PROBE → T_e, V_p, n_p

Assembled RFEA

ELECTRONICS



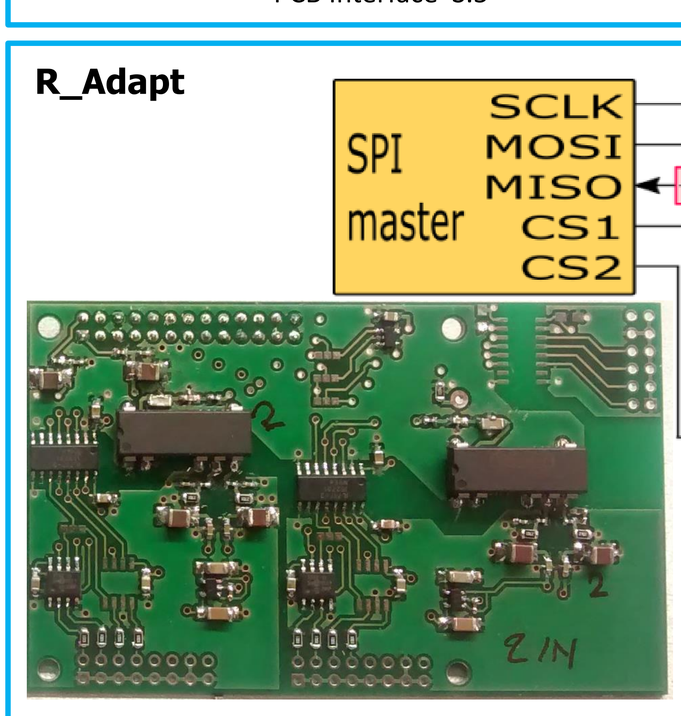


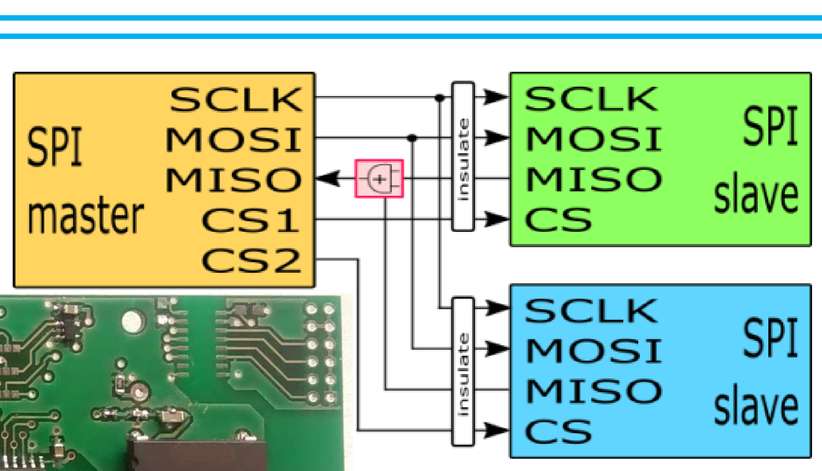
- 3 RaspberryPI [6] with R_Adapt cards (AD2, AD4, DA4)
- 4 power amplifiers S.1, S.2, S.3 and S.4 [7] output voltage ±120Volt at 100kHz
- Trigger to start the voltage generation and the data collection
- S.6 card for the measurements of the currents based on LEM transducer device
- PCB Interface S.5

- Bridge rectifier S.8 which provide power to the amplifier and to the LEM sensors
- 2 external power transformers to deliver isolate voltage (110 Vac)
- 3 external power supplies for the 3 RaspberryPI
- External Ethernet hub to manage the communication

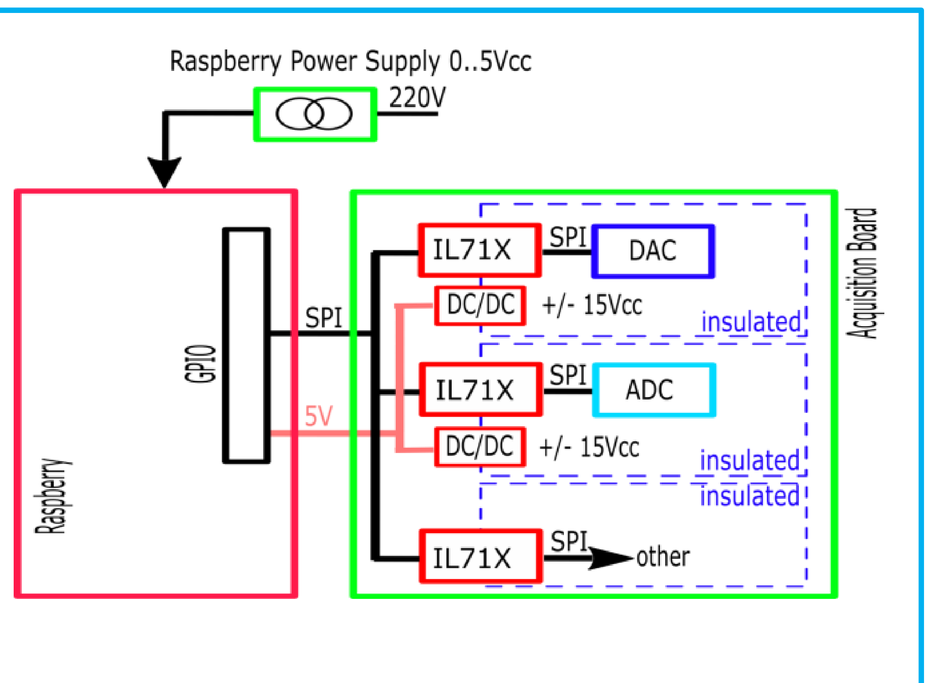
- The acquisition system setup is based on the C.A.R.S. (Control and Acquisition on RaspberryPI Systems) solution, using WebSocket and a webserver present on the RaspberryPI.
- Data is stored locally and can be accessed via web browser, Secure Shell (ssh) or File Transfer Protocol (ftp).

R_Adapt





- Each isolated channel can provide a dual power supply ±12V and 1W.
- The two slaves are isolated via a IL717 [8] isolator and connected to master through an OR logic gate .
- The IL717 is not open-drain and hence not suitable for SPI. An OR logic port has been adopted to solve conflicts on SPI. The isolated channels are : two for DAC or ADC and one for expansion. This last is available only if one of the previous is disabled.



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