Conditioning of the RF Gun at the Photo Injector Test Facility at DESY Zeuthen, PITZ

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Description and scientific goals

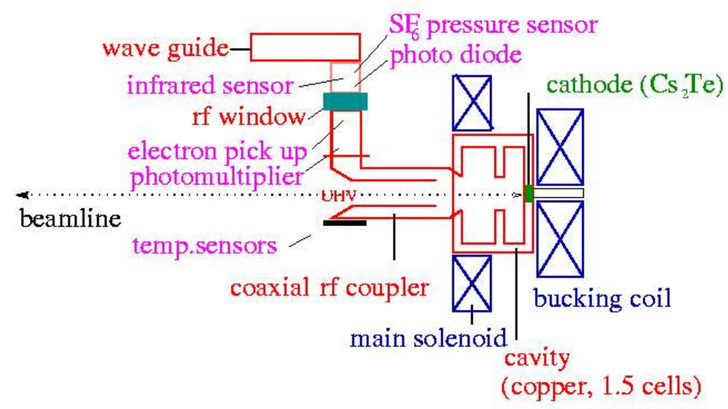
A photo injector test facility is being commissioned at DESY Zeuthen. The aim is to develop and operate an optimized photo injector for future free electron lasers and linear accelerators which require extraordinary beam properties. First operation of the rf gun was done in December 2001. The project is a common effort of collaboration originated by BESSY (Berlin), DESY (Hamburg and Zeuthen), Max-Born-Institut Berlin and the Technical University Darmstadt. It is funded partially by the HGF-Vernetzungsfond.

Conditioning of the rf gun

The heart of the facility is the rf gun consisting of a 1.5 cell L-band copper cavity with coaxial rf coupler, two solenoids for space charge compensation and a Cs_2Te cathode.

First operation of the facility was achieved in December 2001.

An extensive rf commissioning was done to get high gradients in the rf gun.

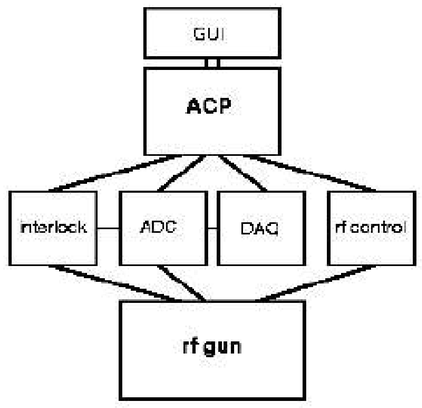


Automatic Conditioning Program (ACP) and Data Acquisition (DAQ)

RF conditioning of a cavity is a time consuming work in which different effects can destroy the rf gun or the rf window. An Automatic Conditioning Program (ACP) has been developed to increase the efficiency and the safety of the conditioning work and to get even higher gradients (>35MV/m) in the rf gun than achieved today in similar normal conducting cavities.

* The ACP controls the rf power and the solenoid currents.
* It reacts appropriately on interlock signals.
* An online analysis allows a quicker and more clever control of the conditioning process.
* A deeper analysis of what's going on during conditioning is realized by an event recorder of ACP.

A first version of the ACP program was written in MATLAB. An improved version based on C++ is under development.



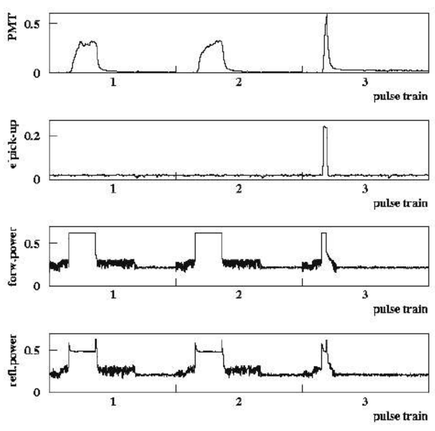
To know the behaviour of the whole system and its parts as well as the correlation between different components a Data Aquisition system (DAQ) has been established. DAQ was developed in the ROOT framework, which supplies an object-oriented data base as well as multiple analysis tools. It uses DOOCS servers to get access to the elements of the facility. The program runs simultaneously on three Sun SPARC workstations and uses a common timing system, which allows to relate different detectors recorded by different computers in different database files. Recorded data are analysed by means of tools developed in the frame of ROOT and MATLAB utilities.

Interlock events

Which effects could happen during conditioning?

* Field emission of electrons from protrusions on the surface.
* Multipacting which is a resonant phenomenon of low energy electrons from field emission depending on a solenoidal field.
* Sparks accompanied by strong light emission and rf power reflections.

All these effects can guide to an increase of vacuum pressure and can destroy cathode, cavity, rf window or rf coupler.

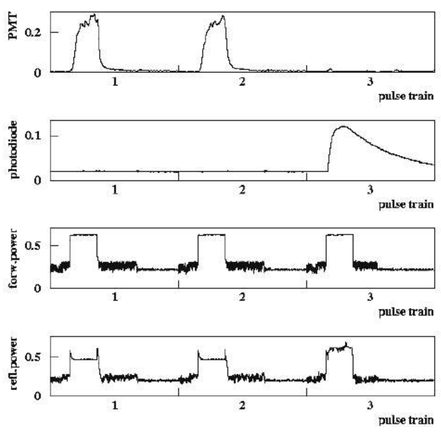


Left diagram:

Fast ADC signals in arb. units during the last three pulse trains of an photomultiplier and electron pick-up event.

Right diagram:

Fast ADC signals in arb. units during the last three pulse trains of an photodiode event.



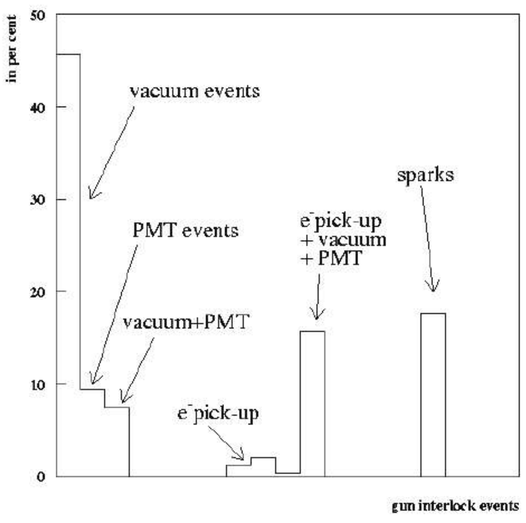
Results of rf commissioning

In December 2001, we started with a low average power corresponding to short rf pulse lengths (50 - 100us) and a low repetition rate (1Hz). The solenoids were switched off in the beginning.

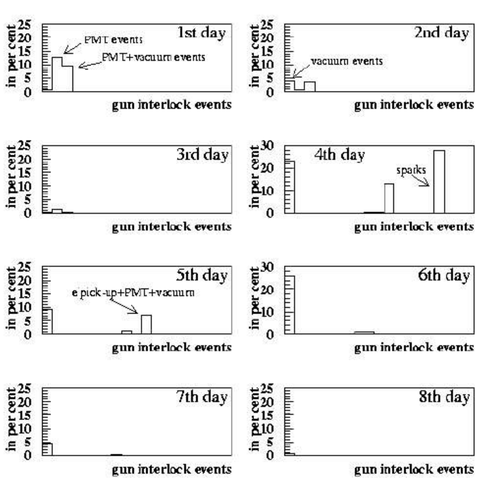
We configured ACP to achieve higher gradients. Based on the fact that the present gun had been partially conditioned at DESY in Hamburg before the first conditioning work was very smoothly. First photo electrons were produced in January 2002.

A mechanical damage of the rf window in March 2002 resulted in a small vacuum leackage, so that the rf vacuum window had to be exchanged by a new one which never was in use before.

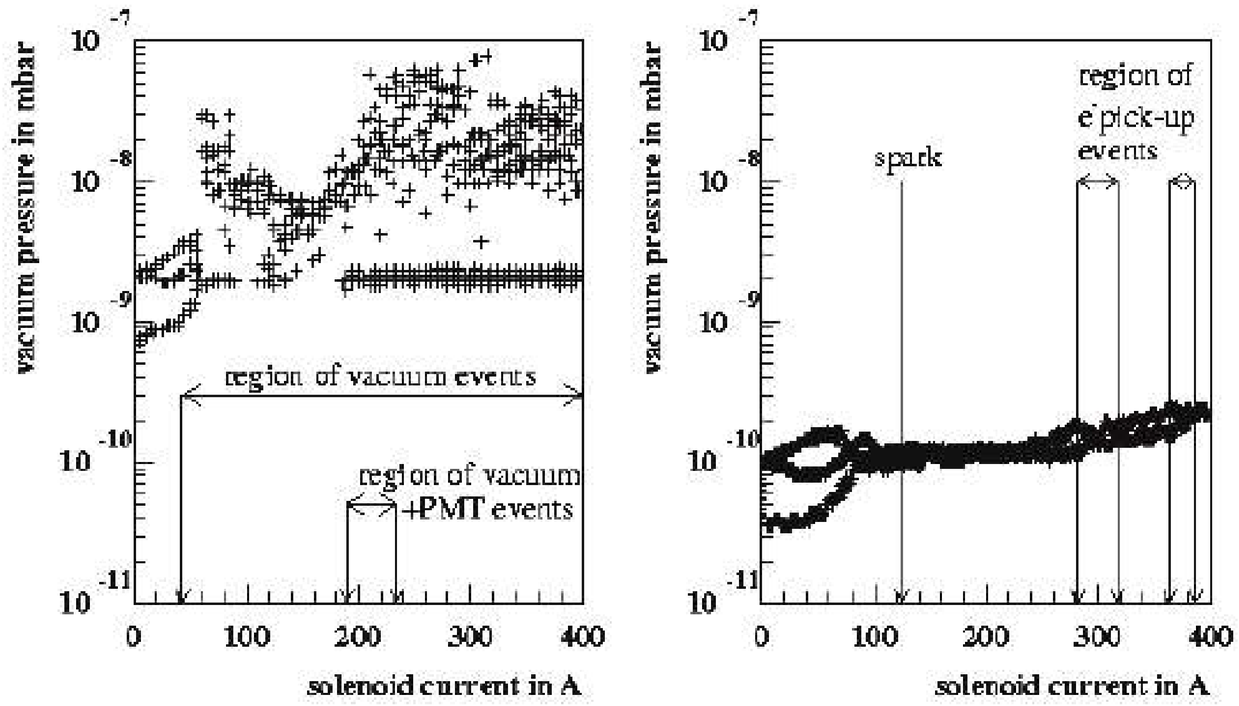
The following conditioning work was more challenging and events like sparks occured more often than during the first running period.



Gun interlock events in per cent after the rf window conditioning.



Gun interlock events in per cent during the rf window conditioning from the 1st to the 8th day.



Vacuum pressure as a function of the main solenoid current in the beginning (left diagram) and at the end (right diagram) of the rf window conditioning.

The conditioning procedure with ACP obtained a stable operation for rf pulses up to a length of 400us at a repetition rate of 5Hz including a solenoidal field between 0 and 0.25T with a compensated field a the position of the cathode. The maximum gradient was 34MV/m which was limited by the present high voltage power supply of the rf system which will be upgraded soon.

http://desyntwww.desy.de/pitz/