BEAM CURRENT MONITOR SYSTEM OF THE EUROPEAN SPALLATION SOURCE

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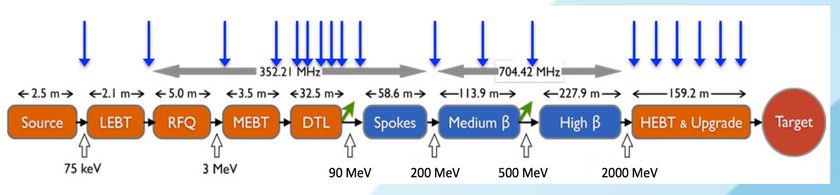
BCM system overview

The Beam Current Monitor (BCM) system of the ESS will be primarily used for beam current and charge measurements in absolute and differential modes. Moreover, it will provide a fast input to the Beam Interlock System (BIS), initiating a trigger to shut the beam off upon a fault detection such as high beam loss or a pulse with wrong width/rate. It is planned to install in total 20 AC Current Transformers (ACCTs) and one Fast Current Transformer (FCT) along the Linac. The FCT will have a larger bandwidth and it will be used to measure the performance of the fast chopper of the Medium Energy Beam Transport (MEBT) with a rise time of 10 ns. A prototype based on a Bergoz ACCT and EPICS-integrated MTCA.4 electronics has been set up and successfully tested with an emulated beam. The ACCT signal has been FPGA processed to compensate for the offset and droop as well as filtering and synchronization to an external trigger. The ACCT data are presented to the user in numerical and graphical formats through EPICS Input/Output Controller (IOC) and Channel Access (CA).

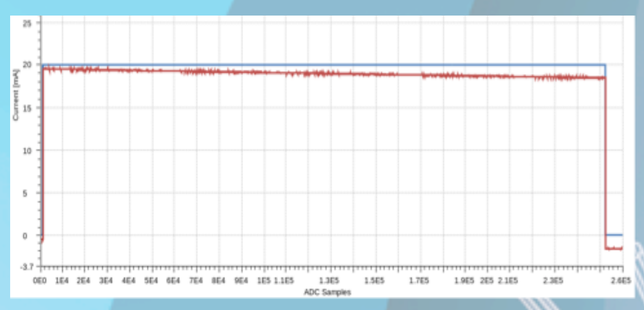
ACCT distribution along the Linac



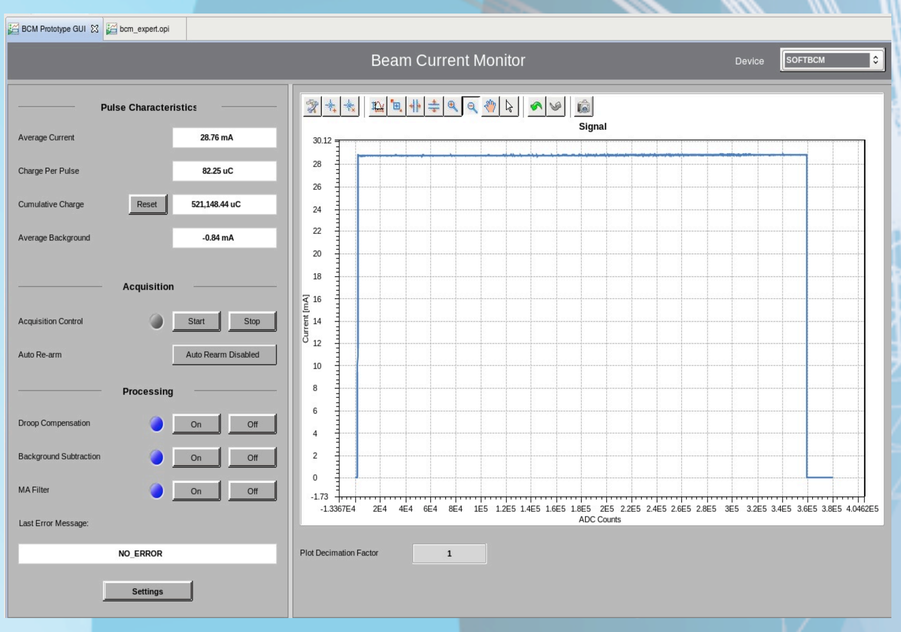
Beam and ACCT specifications

Parameter	Value	Unit
Particle type	proton	
Beam energy	2	GeV
Beam power	5	MW
Pulse repetition rate (nominal)	14	Hz
Pulse duration (nominal)	2.86	ms
Beam current (nominal)	62.5	mA
Beam current (min)	6.25	mA
Bunch frequency	352	MHz
BCM quantity	21	
ACCT accuracy (nominal beam)	+/-1	%
ACCT resolution (nominal beam)	1	%
ACCT response time including electronics	1 - 2	μs
ACCT bandwidth	1	MHz

FPGA processing and GUI



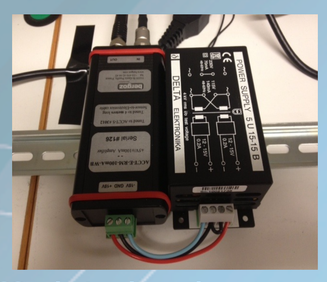
ACCT droop, offset and noise are compensated by FPGA processing



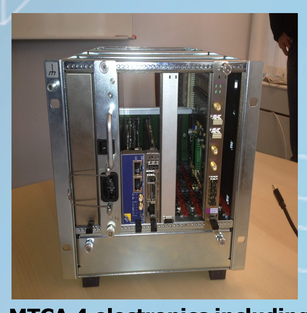
Preliminary ACCT GUI implemented using CSS OPI screens

Test and future setups

Bergoz ACCT toroid

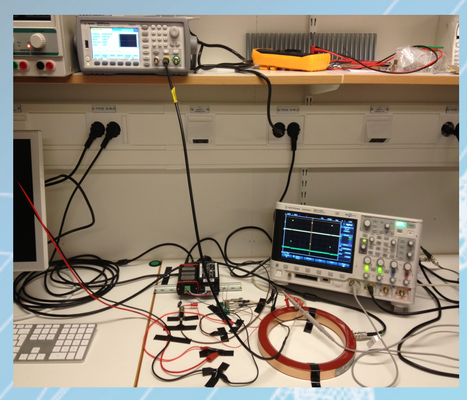


ACCT electronics and power supply

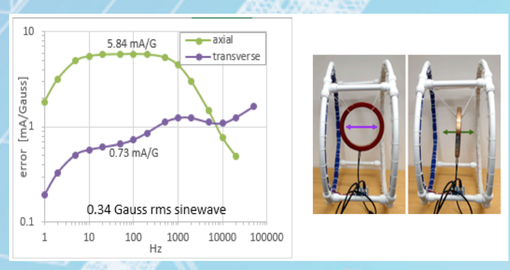


MTCA.4 electronics including Struck digitizer and NAT MCH

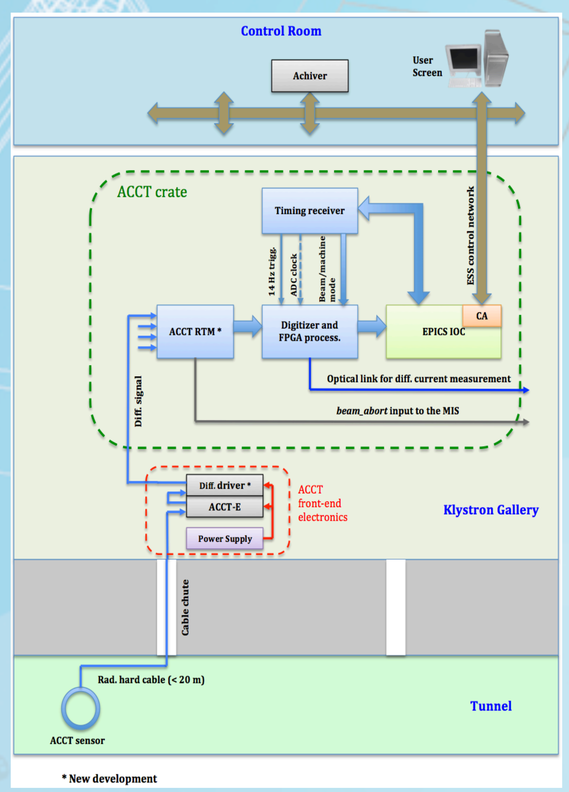
MRF timing system



ACCT test setup (ESS electronics lab.)

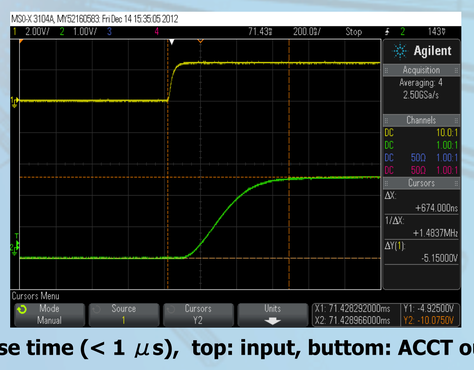


ACCT tests with an external magnetic field

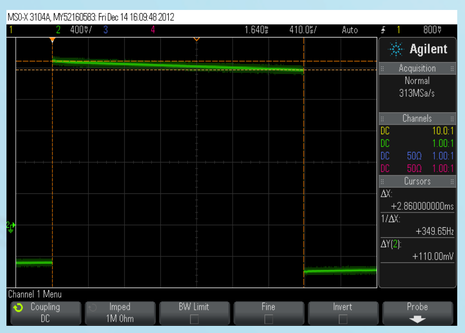


Simplified schematics of a potential solution for final ACCT implementation

ACCT tests without electronics



Response time (< 1 μs), top: input, buttom: ACCT output



Droop (4.2% for a 2.86 ms pulse)

Outlook

The ACCT system is currently being improved in the following areas: modification of the FPGA code to improve its performance, an RS-422 digital interface to the Beam Interlock System, development of a differential driver/receiver for ACCT signal transmission to the data acquisition crate, an optical fiber link for differential beam current measurement over large distances and an appropriate ACCT shielding against external magnetic fields. It is planned to use a new version of the system in the second half of 2015 for LEBT commissioning.