Requirements and Coherent Realization of the HICAT Control System functionality for Tests, Commissioning and Operation

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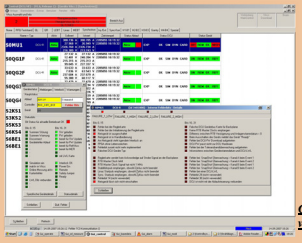
Abstract

The control system for the HICAT project comprises several rather different functionalities for the whole range of demands starting from tests of single components up to the specified operation mode where the accelerator has to deliver a beam of high-energy ions with requested energy, focus and intensity for tumor treatment. We outline the concept and realization of this system which is capable of fulfilling all those needs within the implemented functions and GUIs. The range of functionality spans from test environments and trace-possibilities for single front-end controllers up to complete integrity tests of the whole accelerator for the designed operation mode. E.g. for commissioning of the LINAC division the control system utilizes a 5Hz mode while typical synchrotron cycles last for several seconds and can be used with similar adjustments. In normal operation mode diagnostics like beam current are only evaluated at special times in a cycle, but it is possible to monitor and record these data at high sampling rates in a continuous mode over several hours. Furthermore it is possible to accomplish long-term stability tests of single components during normal operation.

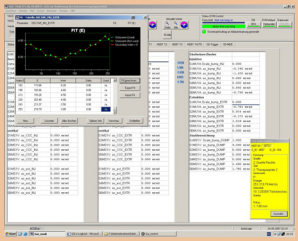
Front End Control – Device Control Units



- Test possibility with serial connection
- Bus communication with up to 5 interface cards
- µs timing / real-time bus
- 7 different device classes
- different HW/SW versions

GUI to control all DCU device state in a certain section, status of a selected virtual accelerator and to analyze device errors (inset: a DCU).

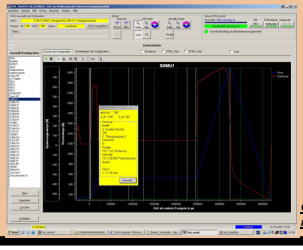
Interpolated Device Data for Therapy



- Combinations of 255 energies, 6 foci, 15 intensities (EFI)
- Device dependencies / independencies of
  - Beam parameters
  - Ion source - target room combination
- Therapy device settings in nonvolatile memory (flash)
- Interpolation of settings between different combinations

GUI to control and set device parameters. The inset shows interpolation results of one parameter for all energies and one pair of intensity and focus.

Virtual Accelerators



- Experimental accelerator settings
- Accelerators for therapy including all EFI combinations
- Pulse to pulse variation of beam properties
- Pulse to pulse variation of ion source / target room

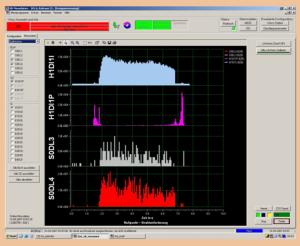
GUI to verify calculated device settings. Shown are current and voltage ramps for synchrotron dipoles including conditioning at the end of the cycle.

Real-Time Beam Diagnostic Data

- Data displayed already during cycle
- Trending functionality

Beam diagnostics device classes

Event counting, profile grids, phase probes, AC/DC transformers, viewing screens, BPM



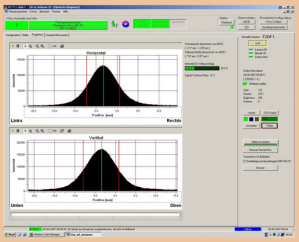
Quality Assurance and Beam Diagnostics

- Verification of beam properties for therapy
- Automated test procedures / protocol functions
- Monitoring of all devices along the beamline
- Storage of necessary device read values
- No changes allowed during therapy

GUI to measure online profiles and trend of the beams center and width.

Global System Properties

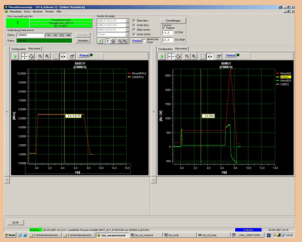
- Single components can be commissioned during normal operation.
- Parallel operation of both ion sources.
- Coupling of accelerator CS and therapy CS impose constraints for e.g. commissioning due to safety functions.
- Different system modes for commissioning, QA, therapy.



GUI analyzing optical beam information at the isocenter

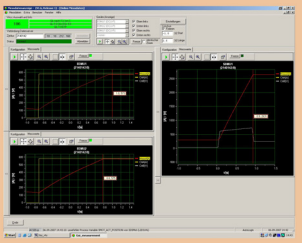
Online Device Data

- Control of single devices during cycle
- Monitoring of individual device properties
- Monitoring of set/read values at important times



Commissioning Tools

- 5 Hz Mode for LINAC commissioning
- Long time stability tests
- Possible parallel test system
- Tracing possibilities



GUI to measure online data of one cycle. upper picture: voltage and current ramps of synchrotron dipoles for one cycle with low energy. lower picture: begin of one cycle shown for two slow dc dipoles and synchrotron dipols.

HICAT Facility

- 1300 patients a year
- Different ions
- Energies up to 430MeV/u
- 500 components
- µs timing for most components
- High reliability and stability for at least 25 years
- Combinations of 250 energies, 6 foci and 15 intensities (EFI)
- Pulse-to-pulse variation
- Only two operators in normal operation mode
- CS modes for therapy, quality assurance, commissioning