Status of the Control System for HICAT at an advanced stage of Commissioning

Functions, Restrictions and Experiences

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CONTENT

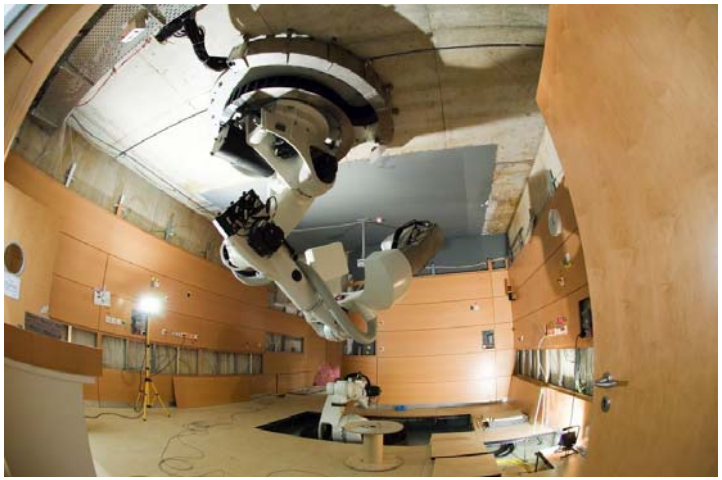
1. DESCRIPTION OF THE FACILITY
2. DESCRIPTION OF THE ACCELERATOR
3. STATUS OF COMMISSIONING
4. FUNCTIONS
5. RESTRICTIONS
6. EXPERIENCES

HICAT FACILITY

General Conditions

- Part of the clinic in Heidelberg
- 1300 patients/year
- High reliability and stability
- Term of 25 years
- Only two operators

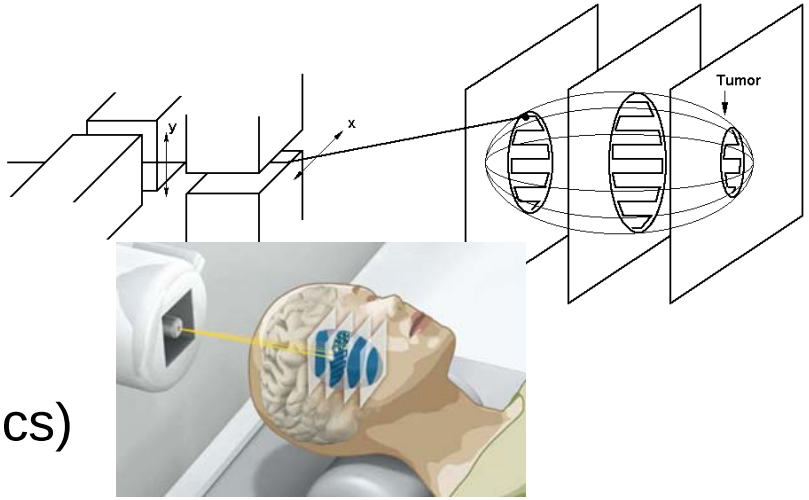
- First combined proton / heavy ion therapy device in Europe operated by a hospital
- Two horizontal treatment rooms
- Target room for medical research
- Rotatable gantry structure



HICAT FACILITY

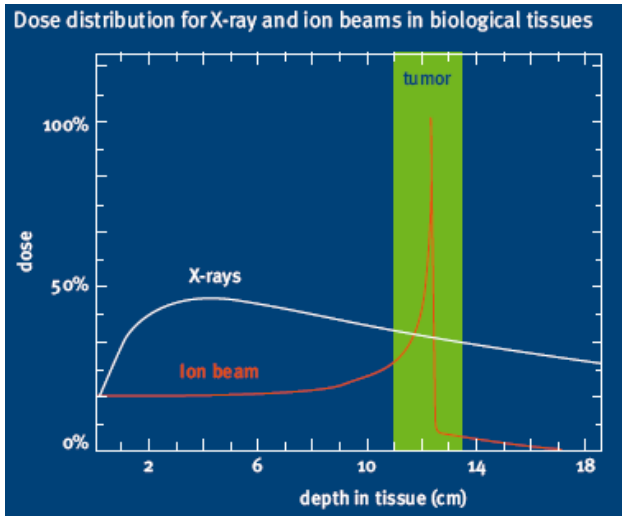
Patient Treatment

- Only device using intensity-controlled raster scan method
- Different ions, energies up to 430MeV/u
- 250 energies, 6 foci, 15 intensities (EFI)
  → LIBC (List of Ion Beam Characteristics)



Key Aspects Control System

- Part of a medical product (MDD)
- 500 components
- µs timing
- Pulse-to-pulse variation
- Modes for commissioning / QA / therapy
- Interface to therapy CS



ACCELERATOR

Ion Sources

LEBT

MEBT

Linac

Synchrotron

Gantry treatment room

horizontal treatment rooms

Gantry

HEBT

QA / medical research

CONTROL SYSTEM

- Design and functional specifications from GSI
- Realization by an industrial partner (could decide about implementation)
- Commissioning by GSI
- Handing over to operation company (HIT) by GSI
- CS briefing by industrial partner

Implementation:

OS Windows XP / RTX
Oracle Database
TCP/IP based communication
Real-time bus for µs-timing
Special device control units
C++ and Delphi (GUIs)

CONTROL SYSTEM

Device Control Units

- designed as standard for all beam guiding devices
- 64 MB RAM / 32 MB flash
- FPGA for real-time control (100 MHz)
- 7 device classes / interchangeable
- Special timing master DCU
- Special DCUs with interface to the therapy control system for e.g. fast beam cutoff

Beam Diagnostic Devices

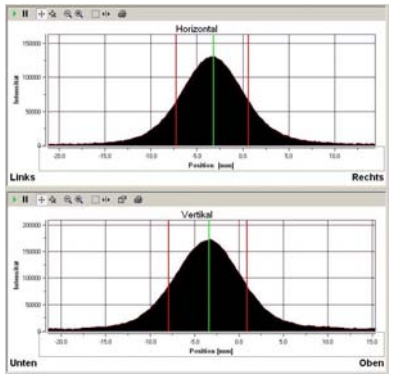
- NI PXI systems
- Trigger pulses provided by special DCUs

Further Systems

- Ion sources
- rf generators
- Vacuum CS
- Personal safety system

STATUS OF COMMISSIONING

- Commissioning for horizontal treatment rooms almost finished:
  - Verified device settings for protons / carbon ions
  - Beam properties meet therapy requirements for most EFI-combinations
- Beam requests by therapy control system
- Integration of all devices finished
- First ion beam in gantry within next few weeks



- Commissioning shifts: GSI / SAG (24/6), HIT-support

FUNCTIONS

Virtual Accelerators

- Device settings and/or control of all necessary elements

  → Experimental VAccs
  → Therapy VAccs including all EFI parameters

Device Settings for Therapy VAccs

- EFI dependencies have to be considered
- Interpolation of whole EFI parameter space necessary
- Persistent storage of device settings

FUNCTIONS

Beam Requests / Operation Modes

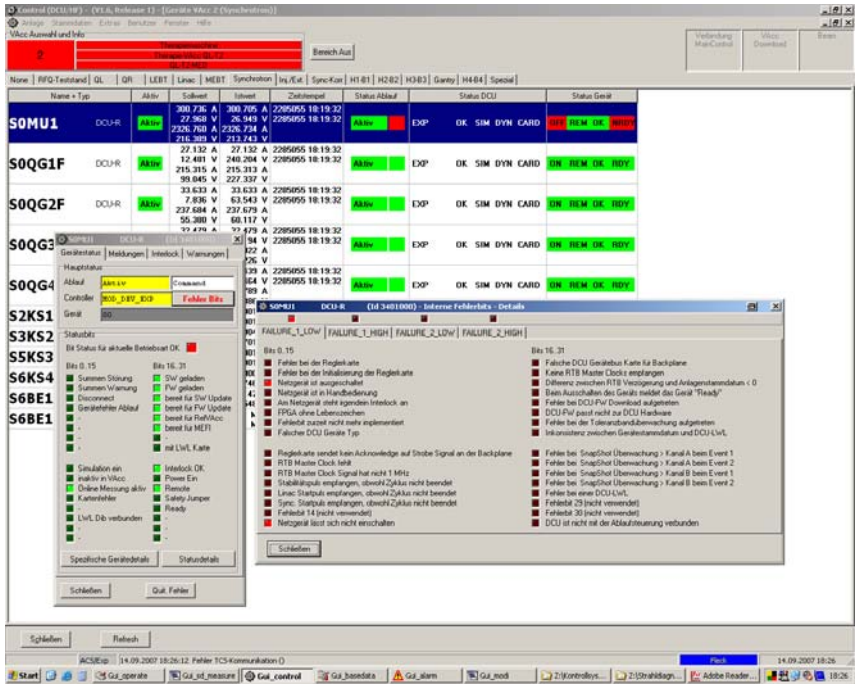
- (10 Hz Stability cycles)
- 5 Hz Linac mode
- Pulse to pulse variation of
  - Beam parameters (EFI)
  - Source-target combination
- Procedures for QA
- Therapy control system (safe patient mode)

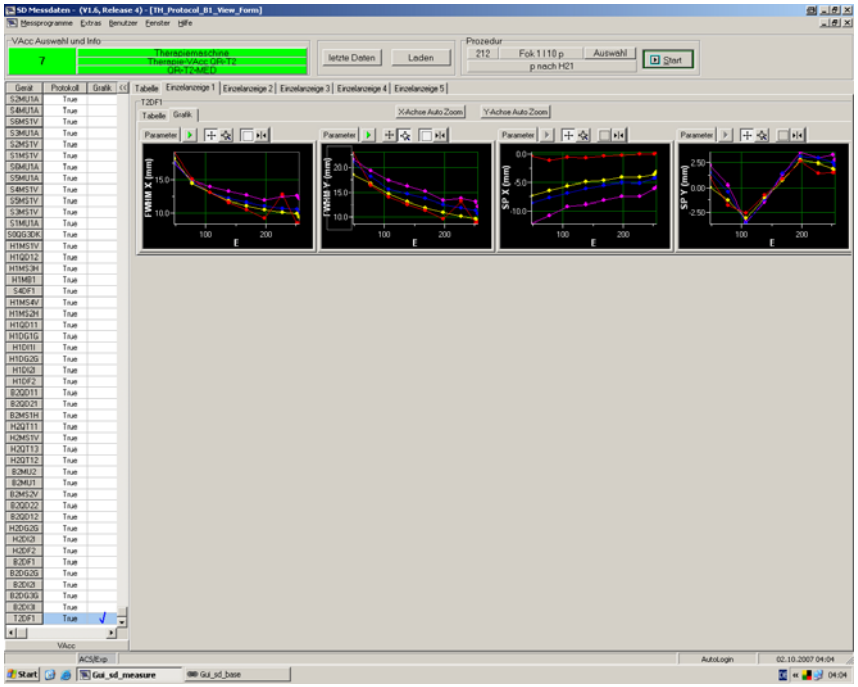
Measurement / Verification

- Online Data visualization during cycle (magnets / beam diagnostic)
- Snapshot data of all components
- Storage of snapshot data

FUNCTIONS

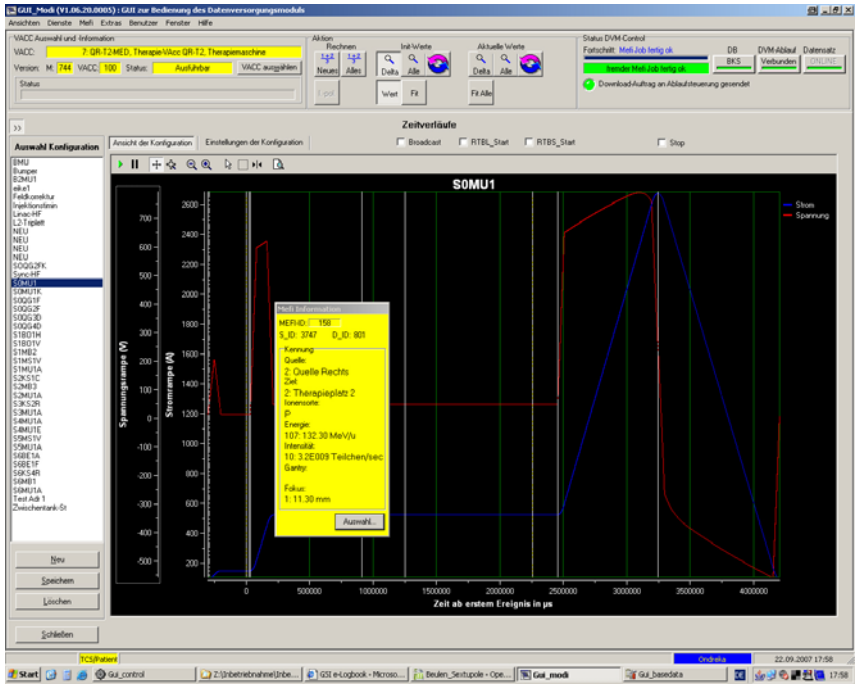
Device Control Program and Therapy Protocol Function

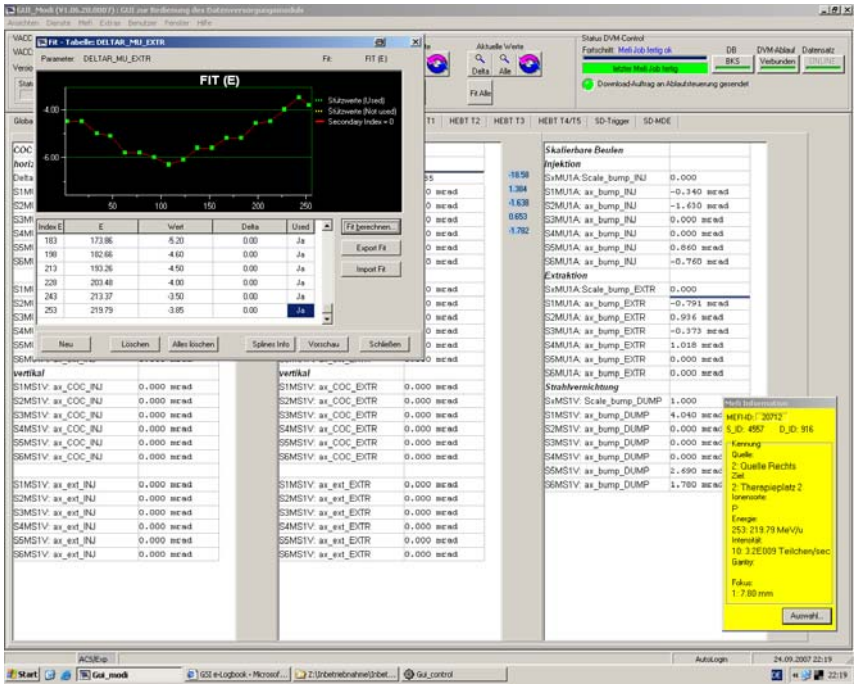




FUNCTIONS

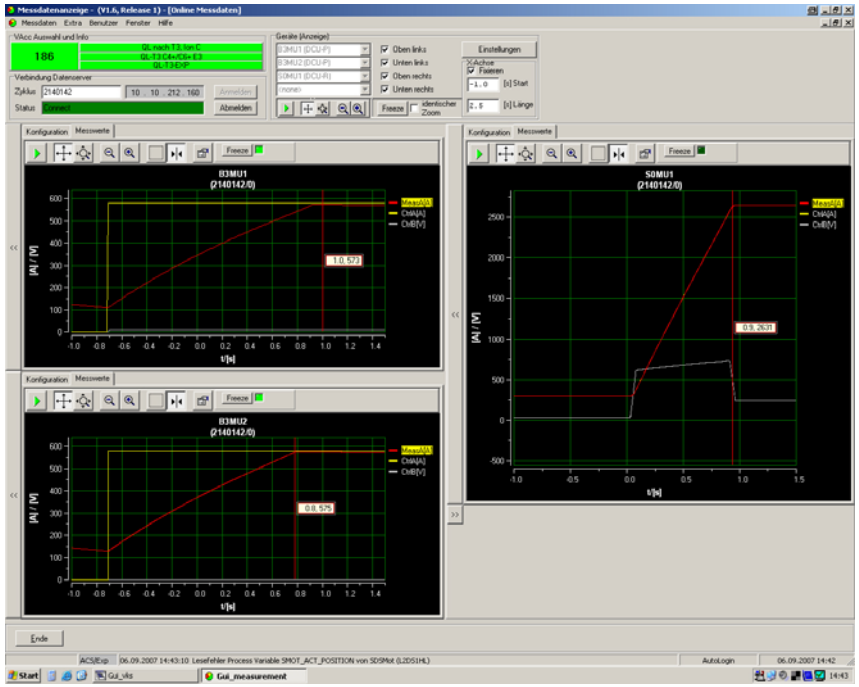
Calculation of Device Settings and Verification

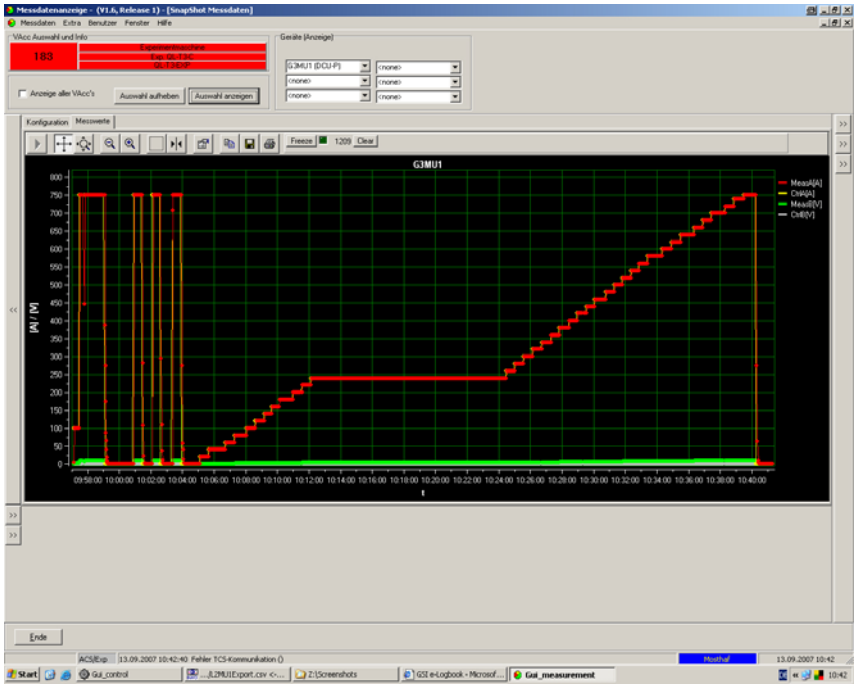




FUNCTIONS

Online Data and Logged History Data





RESTRICTIONS

Present Restrictions

- No read values outside accelerator cycles
- Standby mode has to be implemented
- Control of dipoles zero magnetic field
- Integration of e.g. cooling water temperature monitoring
- No real parallel operation of ion sources
- Common look and feel (Application programs still prototypes)

EXPERIENCES

- **Major problems during commissioning:**
  - Time schedule (6 months delay of CS functionality)
  - Lacking time for extended CS tests
  - Bottleneck for beam diagnostic data
  - Performance and stability
  - Complexity of EFI dependencies
  - Implementation of automated procedures / therapy protocols
  - Only few CS experts

- **Additional requirements came up**
- **On-site CS support by industrial partner necessary**
- **Remote login and experts on call important**
- **User aspects need high priority**
- **Industrial partner: high flexibility / short reaction time / good cooperation**

Thanks for your attention

Further details / discussion:

poster presentations TBBP39 and RPPB29

www.klinikum.uni-heidelberg.de/
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