FROM STANDBY OPERATION TO PATIENT TREATMENT IN 13 MONTHS: SETTING UP THE MIT ACCELERATOR TEAM

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Abstract

When the University Hospital Heidelberg took over the responsibility for the Marburg Ion-Beam Therapy Centre (MIT), HIT as their daughter company was mandated to build up the operation team, especially for the accelerator. Based on long-standing experiences of HIT a very similar personnel concept was already available to be adapted to the MIT specialties. Within 9 months the directly started hiring process resulted in three technical teams with excellent engineers and technicians but with little or no accelerator experience. In parallel, three accelerator physicists were appointed for the executive team of MIT. Nevertheless for all hired persons a training program was set up consisting of technical instructions, lectures on fundamental accelerator physics and control system basics. These common trainings were complemented by individual skills development schedules for the tasks in the technical teams. HIT accelerator experts substantially carried out the recommissioning but in addition the new MIT employees were trained in designated shifts in the control room. Thus after only 13 months the MIT operation crew was able to operate the accelerator facility from the first patient treatment day on.

THE MIT FACILITY – A SHORT OVERVIEW

The core of the Marburg Ion-Beam Therapy (MIT) Centre is an accelerator facility designed to optimally support the raster scanning dose delivery method by producing light ion pencil-beams having energies that allow for the treatment of deep-seated tumours. It is comprised of two ECR ion sources (for proton and carbon ion production), a compact linac consisting of a RFQ and an IH-DTL and a synchrotron of 65 m circumference to accelerate the ions to predefined end energies: for protons from 48 to 221 MeV/u in 290 steps and for carbon ions from 88 to 430 MeV/u in 291 steps [1]. The beam is delivered to four treatment rooms, of which the first three have a horizontal beam entrance and the last one has a 45°beam angle from above, see Fig. 1.

At the beginning of the project in 2007, the particle therapy centre in Marburg was founded by the Rhön-Klinikum AG, a private hospital owner, which was also responsible for the construction of the building. The accelerator part and all medical equipment were delivered

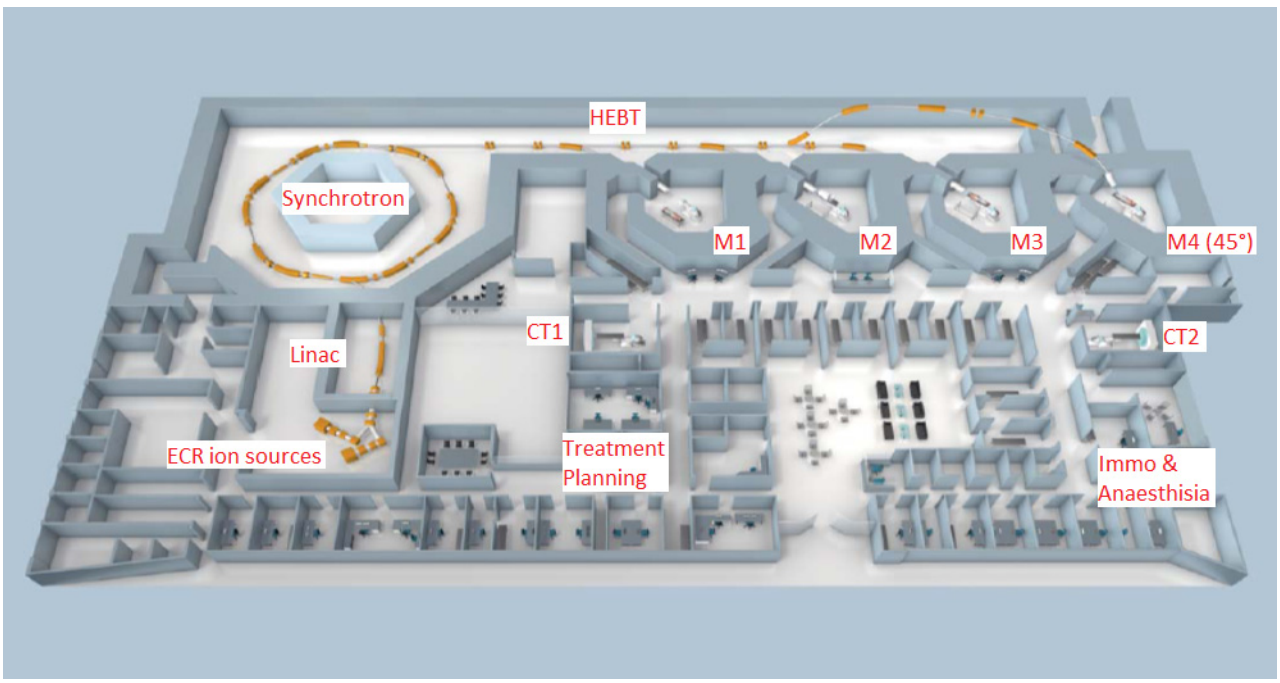

Figure 1: The MIT facility: the accelerator complex composed of two ECR ion sources, the linac with a RFQ and an IH-DTL, the synchrotron of 65 m circumference and the high energy beam lines to the four treatment rooms M1-M4, of which the first three have a horizontal beam entrance and the last one has a 45°beam angle.

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by Siemens Healthcare GmbH based on a licence agreement with GSI. The detailed history of MIT is listed in Table 1. To operate the centre the MIT company – ownership: 75 % by the University Hospital Heidelberg and 25 % by Rhön-Klinikum AG – was founded in September 2014. The mission of the company is to deliver a quality assured dose distribution to treat tumour patients with ion beams. About half of the personnel work in the accelerator section, the other half takes care about treatment planning, quality assurance and medical physics.

Table 1: History of MIT

Milestone	Event
August 2007	Ground-breaking
August 2008	Start of accelerator installation
January 2009	Start of beam commissioning
July 2011	Rededication to "Siemens Test Center"
February 2012	Certification as medical product (EN 60601, 2nd Edition)
Sept. 2013	Start of preservation phase (Standby operation)
Sept. 2014	Formation of MIT company
October 2014	Start of reconditioning and maintenance
February 2015	Start of beam re-commissioning
March 2015	1st beam in one treatment room
October 2015	Operation approval and 1st patient treatment

The concept to form the MIT accelerator team was to copy as much as possible from the structure and experiences of HIT [2]. Necessary modifications were only done where the two facilities differ technically, e.g. the MIT complex has no gantry in contrast to HIT. Some coordination tasks are still rendered by HIT to create synergies between both centers.

STAFF RECRUITMENT FOR THE ACCELERATOR

The organization of the accelerator part of MIT is shown in Fig. 2. Three experienced accelerator physicists form the management team, whereas three technical teams take care of all installed accelerator equipment.

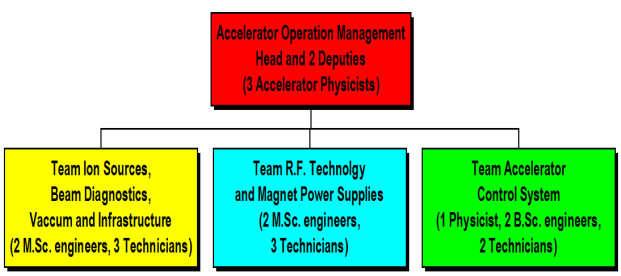

Figure 2: Accelerator team organization.

The technical teams consist of individual mixtures of engineers as well as technicians with professional educations in electronics, mechatronics or information technology. Additionally, all accelerator team members together form the operator´s crew of MIT to carry out the 7/24 operation with always two persons on duty. Due to the regional, public attention to the project and an intense recruitment process the build-up of the teams was very fast, within the first 6 months 2/3 of the vacancies could be filled, see Fig. 3. At the beginning of the patient treatment only one position in the accelerator teams was not staffed.

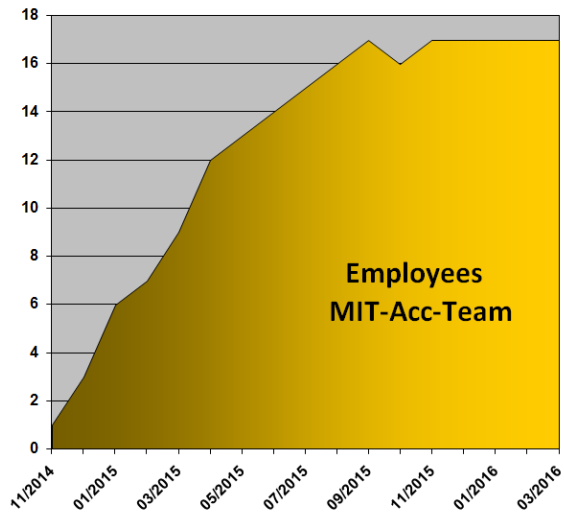

Figure 3: Accelerator team recruitment process.

TRAINING PROGRAM FOR NEW ACCELERATOR PERSONNEL

At the MIT facility the accelerator is part of the medical product. Along German laws concerning the operation and maintenance of such systems only specifically trained personnel is allowed to carry out the accelerator set-up and control. Therefore an advanced training concept was worked out by HIT covering the following topics:

- The employees must possess a vocational or academic qualification linked to the team´s competence. In addition, about half of the personnel need a qualification as "electrically skilled persons".
- A team specific job training was defined including instruction courses by external companies (manufacturers) or skilled HIT personnel. Furthermore, phases of hands-on practice and system specific tutorials for self-study were included.
- An accelerator related series of lectures was held by skilled HIT personnel covering topics like theory and practical handling of ion sources, beam transport lines, linac and synchrotron. Additionally, overview talks were given on all technical systems like beam diagnostics, power supplies, R.F. and controls. Multiple safety briefings were an obligatory part of these lectures.

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- An important part of the training was to learn how to operate the accelerator. As the control systems of HIT and MIT are very similar, the accelerator physicists of HIT trained all new MIT employees in special education shifts.

As the recruitment process took almost one year, parts of the above described training steps had to be repeated once or twice so that all employees got a complete course, which was necessary to qualify them legally.

TRAINING ON THE JOB AND GENERAL OVERHAUL OF ACCELERATOR SYSTEMS AND INFRASTRUCTURE

When the particle therapy facility in Marburg was committed to the newly formed MIT company in September 2014 most maintenance actions dated back about two years. Therefore a general overhaul was started immediately using external companies for the infrastructure systems like e.g. the machine cooling. In parallel, HIT engineers and technicians, assisted by the first MIT employees, began to maintain the accelerator systems starting at the ion sources, the vacuum system and the power supplies for the LEBT. In further steps the linac, MEBT, synchrotron and HEBT sections of the facility were checked up with the linked technical systems to prepare the subsequent re-commissioning actions [3]. Every maintenance task was directly used for training on the job of the newly recruited MIT personnel so that they became familiar with the installed equipment step-by-step.

RE-COMMISSIONING AND OPERATOR BRIEFING IN THE CONTROL ROOM

As soon as one section of the MIT accelerator was maintained completely a technical commissioning without beam followed to check the functions of all components in connection with the control system. In a next step each section was re-commissioned with beam based on the datasets handed over by Siemens Healthcare. In most cases only a retuning was necessary, see [4] for more details.

Figure 4: Training shift in the MIT control room.

The re-commissioning was performed in 24-hour operation (3 shifts) almost from the beginning to minimize the necessary working days. Theses phases were closely interlinked with further maintenance periods and sometimes also repair actions. From month to month more beam time could be achieved and used for enhancing the beam parameters and later on also for re-commissioning the irradiation systems in the treatment rooms.

In addition, an important part of the shifts was used to train the new operators in the control room by skilled HIT personnel how to handle the different processes like start-up of the accelerator, error detection, regular checks of the beam quality, retuning, etc. Any MIT operator had to undergo a minimum of 20 education shifts to be qualified for regular patient treatment operation of the accelerator, see Fig 4.

CONCLUSION

All the above described actions were optimally interleaved and carried out in a massively parallel manner to shorten the time from taking over the responsibility for the facility to the first patient treatment down to a minimum. However, this was only possible by high engagement of the HIT accelerator team members and the freeze of other running projects at HIT. But the result was obvious: After only 13 months the newly formed MIT operation crew was able to operate the accelerator in Marburg on its own just before the first patient treatment day end of October 2015.

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