Conclusions

Although there is a wealth of expertise on slow extraction in the high-energy accelerator laboratories and an equally extensive experience of cancer treatment using conventional techniques, the field of conformal tumour treatment by active scanning in a synchrotron-based facility is a relatively new field. The slow extraction and accelerator design need to be optimised for very different boundary conditions to those normally applied in high-energy laboratories and, on the medical side, the usage of ion beams presents an entirely new field of clinical research. The precision of active scanning opens new possibilities for treatment but, on the technical side, treatment programs, scanning systems etc. all require complete redevelopment.

This thesis has given a contribution to this development by improving the understanding of the slow extraction from a synchrotron, the extracted-beam characteristics and the techniques needed to master the machine operation. The changes in philosophy for the matching to the gantry and for the beam size control are direct results of this optimisation and understanding of the synchrotron extraction. The introduction of the ‘rotator’ is an example of an academic idea that has languished in a ‘drawer’ until the need was fully understood.

This thesis is also an example of technology transfer from high-energy physics to a practical application in medical physics. It shows that technology transfers are not automatic. The problems need to be identified and studied. It does show that such developments furnish interesting topics and provide the possibility for novel development.

The main subject of the thesis is a theoretical analysis of the slow extraction from a synchrotron, but that analysis opens practical problems which are faced and solved both in the extraction technique and in the beam handling field. Many other problems arise from the results of this thesis, as for example the need for a new approach to treatment planning due to the extracted beam distribution, which will have to be studied if a “centre-of-excellence” in hadrontherapy is to be built.