
Start-up of a Radiation Therapy Program Using Proton Beams Experience at the Paul Scherrer Institute

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Radiation Therapy Using Particle Beams - First Experience with the PIOTRON

PSI's experience with particle beam radiotherapy started out in the early 1980s by using pion beams. It was the first dynamic medical beam application technology for particles

Pions were produced for the physics program and were expected – due to their RBE – to add substantially to curing relatively radio-resistant malignancies



Radiation Therapy Using Proton Beams – First Experience at the OPTIS Facility

In 1984, the horizontal proton beam line for ocular treatments was taken into operation, this was the start of proton radiotherapy at PSI

During 22 years, PSI has treated >4700 patients at the OPTIS-Facility, mainly for choroidal melanomas

This activity has become “a routine”, though the procedures were and still are continuously evaluated for possible improvements (e.g. flat panel detectors to replace Polaroid films)

Excellent local control and survival rates as well as satisfying preservation of the tumor carrying eye are established and match world-wide experience

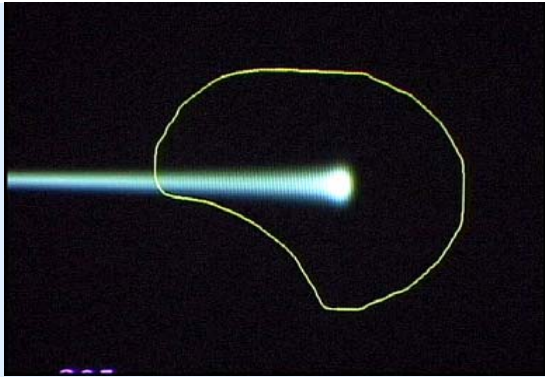
OPTIS Facility at the PSI Injector I



The OPTIS Program has created important experience:

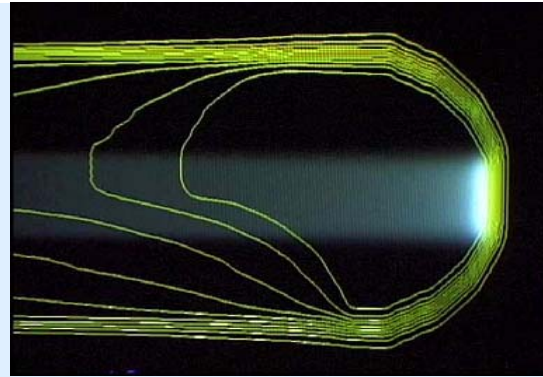
- Good technology has to be combined with good knowledge and experience of the staff operating the facility; maintaining quality must be assured
- Local control matters for survival; the very large patient population supports the fact through long term outcome analysis
- Choroidal melanomas are an almost perfect model for large lesions in relation to the anatomical compartment; conformation is the main requirement, as ...
- ... otherwise the very effective hypo-fractionated treatment with very high single doses of 4 x 15 GyE would not be applicable
- Ophthalmological proton therapy was kind of a “proof of principle”, which has influenced all further development in medical use of protons at PSI

The spot-scanning technique for proton pencil beams

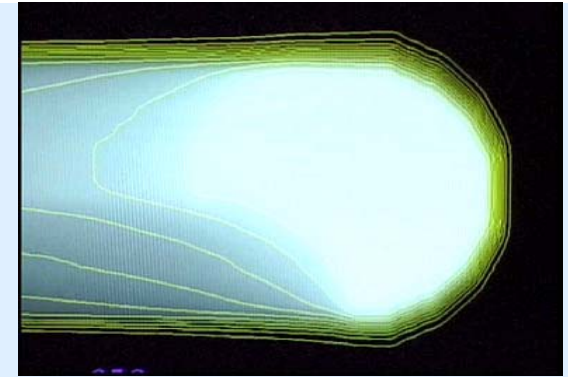


A thin proton beam (**pencil beam**) is directed onto a target within the human body.

The **penetration is defined** by the energy of the beam and the densities of the various tissues, which cause slowing down of the particle.



The **beam and thus the spots** are magnetically deflected = scanned, according to the shape of the target volume in the body.



The **dose of each single spot and of the entrance region (plateau)** are added up to the prescribed dose for the whole volume. The use of several beam angles results in **excellent, 3-d conformation of the high dose to the target volume.**

The Spot Scanning Gantry at PSI



Proton therapy of deep seated tumors using the PSI Spot Scanning Gantry

Experience of a non-hospital based proton therapy facility (1)

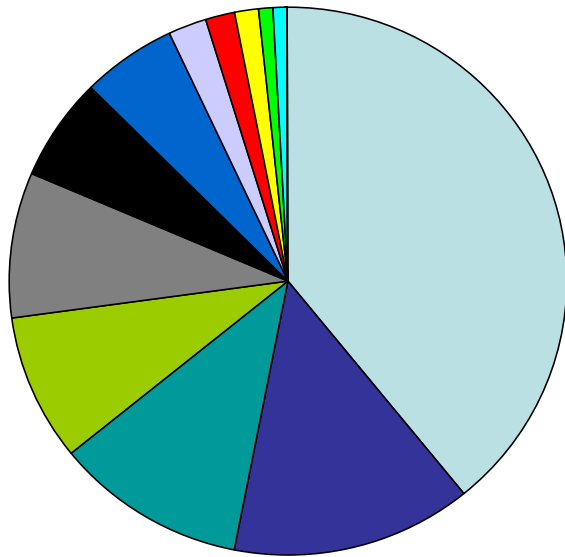
- Relying on patient referral from outside the institution means very limited control of referrals on start-up of the facility.
- Though programs and indications-to-treat had been agreed upon with the national centers for radiation oncology, the variety of tumors, sites and situations (curative/palliative) was large at the beginning.
- Networking is one of the key issues for a non-hospital based facility. Outside clinics and doctors have to become partners rather than competitors. We created the Swiss Proton Users Group, *SPUG*, an informal association of interested Swiss and international radiation oncologists.

Proton therapy of deep seated tumors using the PSI Spot Scanning Gantry

Experience of a non-hospital based proton therapy facility (2)

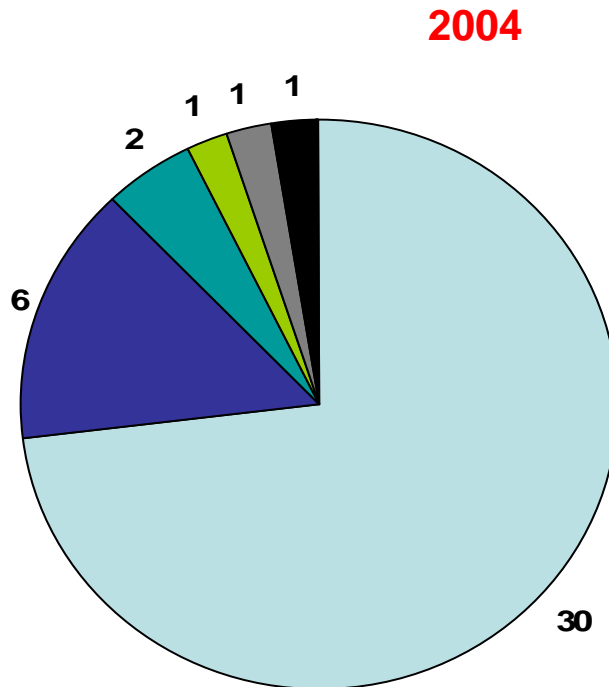
- Over time, referrals became more focused on tumors, which had been „established“ by other proton centers (HCL/MGH, LLUMC). Their results helped getting Health Insurance Coverage.
- Patient numbers were slowly but constantly increasing; local (PSI in-house) conditions were a limiting factor for patient numbers. The medical gantry program was depending on the institute's large 590 MeV proton accelerator. This machine had not been designed for medical purpose, the beam availability was 7 – 8 months /year and only 4 days/week.

Proton Therapy of Deep Seated Tumors - Histologies



1996 - 2002

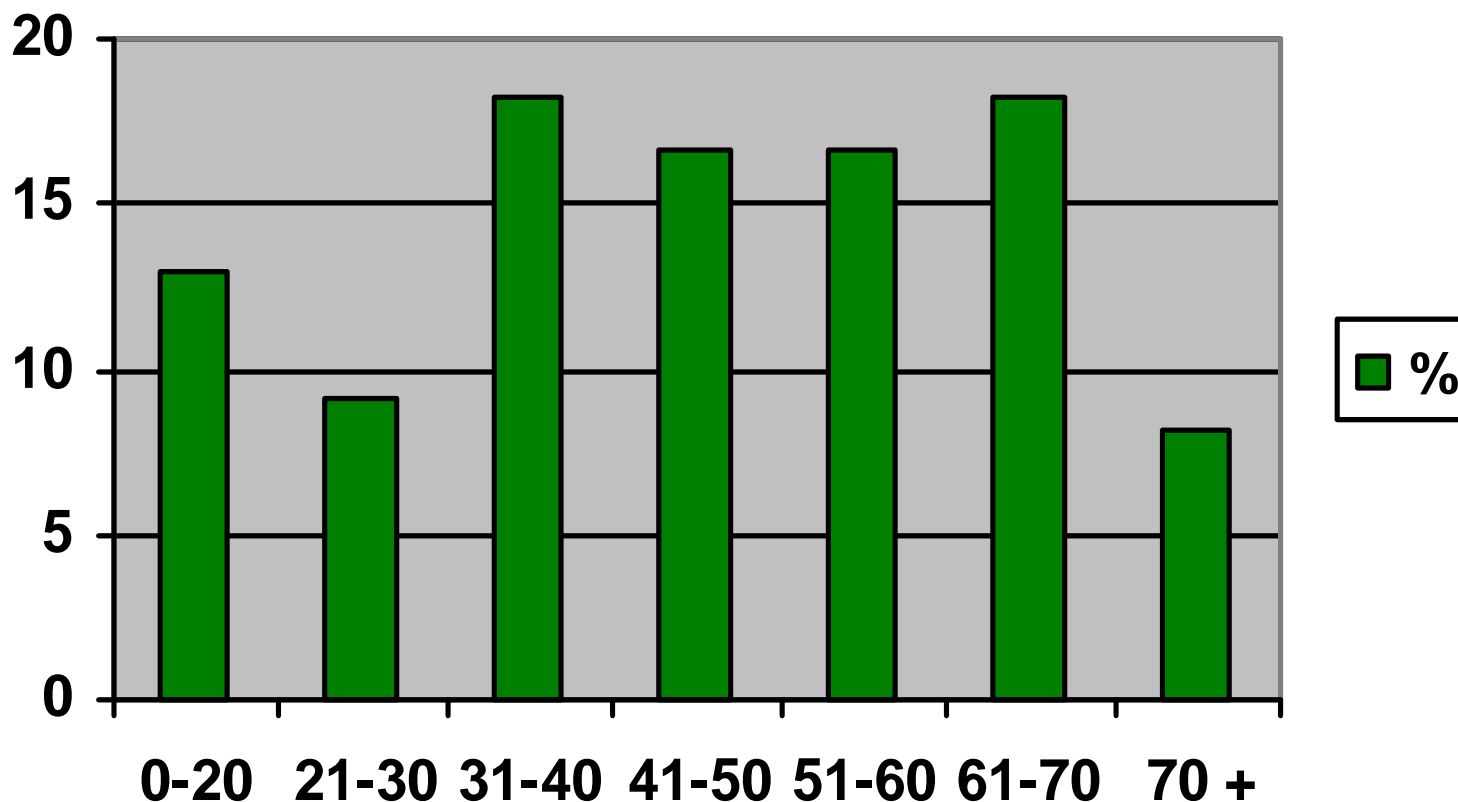
- chord/chondros
- meningioma
- sarcoma (STS & bone)
- glioma
- prostate
- sing. metastasis
- nasoph. ca.
- esthesion.
- desmoid
- local TU-relaps
- basalioma
- ependymoma
- gangliocytoma



2004

- chord/chondros
- sarcoma (STS & bone)
- tumors H&N
- meningioma
- ependymoma
- medullobl

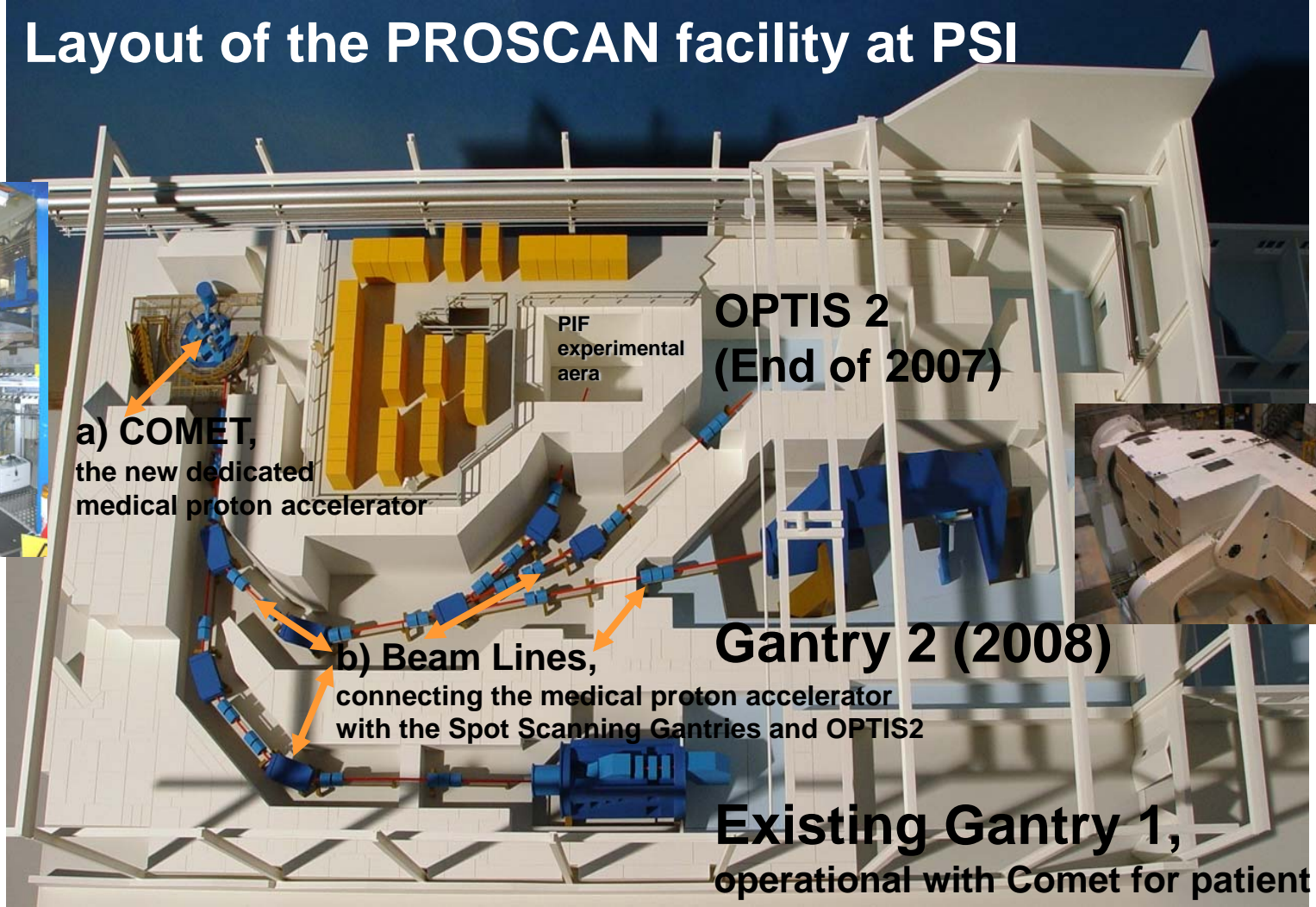
Age Distribution 1996 –2005 (262 patients), with 20 Very Young Children Treated under Anesthesia (since 2004)



Layout of the PROSCAN facility at PSI



a) COMET,
the new dedicated
medical proton accelerator



b) Beam Lines,
connecting the medical proton accelerator
with the Spot Scanning Gantries and OPTIS2

OPTIS 2
(End of 2007)

Gantry 2 (2008)

Existing Gantry 1,
operational with Comet for patient
treatments since February 2007

Acceptance of Proton Therapy by Swiss Health Insurance System

Indications for PRT, which are accepted by the Swiss Health Insurance System as obligatory service (evaluation period of 5 y mandatory)

- tumors in the region of the base of skull (chordomas, chondrosarcomas, H&N lesions)
- meningiomas, benign and atypical/malignant
- low grade gliomas
- sarcomas/chordomas outside the base of skull
- pediatric tumors where conformal irradiation is required

Acceptance of Proton Therapy by Swiss Health Insurance System

Indications for PRT, which are not yet accepted by the Swiss Health Insurance System as obligatory service (evaluation period of 5 y mandatory)

- will have to be introduced to PSI's medical activities via grants from e.g. OncoSuisse, Swiss National Foundation and others
- first results of granted studies can be basis for application for health insurance coverage
- decision is taken by the Swiss Federal Office for Public Health; 5-y evaluation period for every „new“ indication will be mandatory

Starting new Proton Therapy Projects --- Conclusions

- New PRT projects should be driven by radiation oncologists (and physicists).
- Radiation oncologists (from conventional radiation therapy) and also physicists should get familiar with the special requirements (and the limitations) of particle therapy (compared to other treatments).
- Visits for 1 or 2 weeks in existing PRT centers is essential for specifying and managing a new project; to be consulted from outside is not enough.
- Radiation oncologists should be strongly involved in the specification of the technology for the PRT center from the beginning.

Starting new Proton Therapy Projects --- Conclusions

- About 1 year before start of treatment the medical staff for the first treatment room should be recruited.
- To get familiar with the technology, training of the professional staff in 1 or 2 existing PRT centers -- may be in combination with special training centers -- should be considered.
- The staff should be involved from the beginning in the commissioning and QA processes of the facility.
- Additional staff for the operation of the full center can be trained by the own professionals, but a combination with parallel training in other centers should be taken into consideration.

Starting new Proton Therapy Projects --- Conclusions

- Inside of the PTCOG community we should keep the tradition for exchange of personnel (as guest scientists; not for days, but for 2 to 3 months).
- This will help to keep and to advance the quality of patient treatments at our facilities through the exchange of knowledge and experiences.
- PTCOG could define a 'standard of requirements' (in the form of recommendations) for responsible professionals (physicians, medical physicists) for starting up new facilities.

Starting new Proton Therapy Projects

Thank you