SpotOn+

Center for Proton Therapy :: Paul Scherrer Institut :: #3_8/2014

Dear Colleagues

Welcome again to this summer edition of our SpotOn+ newsletter. The editorial emphasis of this issue is put on our program for the treatment of Uveal Melanoma (UM), which started in 1984 in Villigen. The picture above represents the end of the beam line and robotic chair that was commissioned in 2010 with the initiation of the OPTIS 2 program. We have treated over 6,270 patients, thanks to the excellent collaboration with the 'Hôpital Ophtalmique Jules-Gonin' in Lausanne. Prof. L. Zografos, with the help of Dr Schalenbourg (HOJG) has pioneered proton therapy for UM with Drs Egger, Verwey and Goitein (PSI) in Switzerland and PSI has one of the largest patients database in the world with outstanding published clinical results. Due to his retirement, Dr Ann Schalenbourg has now taken the lead in Lausanne and is working collaboratively with Dr Hrbacek at our Center for Proton Therapy. One key of our UM program success is probably the stability & motivation of both teams that have provided optimal cancer care for over 30 years. In this edition, we report the influence of silicone oil used in ophthalmology on the range of protons. Dose calculation is based on an eye model with constant homogeneous density and proton stopping power. Intra-ocular density and proton range are substantially modified by clinical silicone oil tamponades after vitrectomy and the two main parameters generated by the treatment planning software (i.e. therapeutic range and the modulation of the proton beam) have to be modified accordingly in order to assure optimal tumor coverage. Speaking of proton dose deposition, we need to ensure that our treatments are safely delivered with our Gantries, especially so when the dose per spot can vary up to three orders of magnitude. A deviation from a pre-planned position of 1 mm or so can lead to a dose deposition error in the patient of several percent. Dr Actis et al., using a ionization strip chamber, shows that we can achieve sub-millimeter precision of spot positions. Last and not least, we have a new website (German and English) that contains relevant information for health professionals and patients alike. More specifically, the emails and telephones of CPT's staff are available. On this website, you will find the date of our Winter School in 2015. Registration is open. Should you want to participate, I would advise you to speedily make your registration, as the number of participants is limited to 40.

I take the opportunity to wish you all a nice & relaxing late summer-early fall vacation.

Sincerely,

Prof. Damien Charles Weber, Head of CPT

Medical-Physics News

Measurement of the stopping power of clinical silicon oil for ocular proton therapy

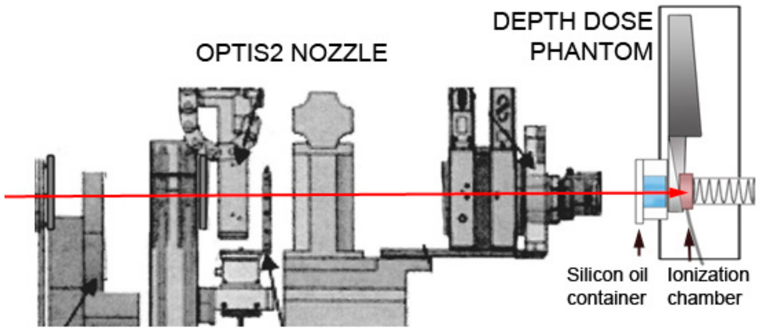
Background and Methods

Vitrectomy is a procedure that consists of a partial or total replacement of the vitreous humour in the patient's eye by silicon oil. In general, conditions treated with vitrectomy include vitreous opacities, retinal detachment, and biopsy. A small number of UM patients undergo vitrectomy as a result of biopsies performed for cytogenetic and molecular purposes.

Silicon oil is a substance with similar diffraction coefficient as vitreous humor, but with a different stopping power. Accurate knowledge of the stopping power is crucial for determination of the range and modulation of the spread-out Bragg peak (SOBP). Negligence of changes in the stopping power can result in shift of dose distribution in respect to the tumor and cause underdosage of the tumor and unnecessary irradiation of healthy tissue.

In order to evaluate changes in the stopping power introduced by silicone oil, the retraction of a pristine Bragg Peak was measured for three different commercially available silicon oil samples and in water (setup in figure 1).

Figure 1: Experimental setup for the measurement of the retraction of a Bragg-peak.



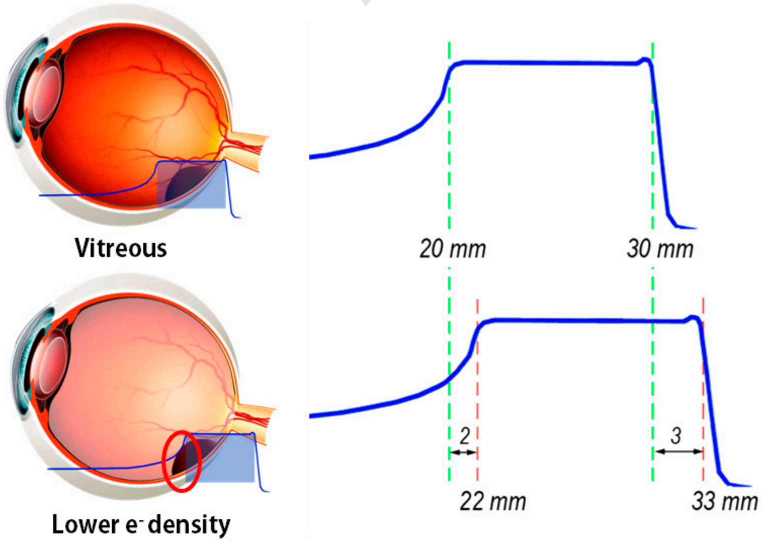
Results

The results show that the stopping power of the three samples of oil varies within 2 % and the average stopping power of the silicon oil is 10 % lower than the one of human tissue, resulting in a prolongation of the beam range by 10 % of the path length, as shown in the figure 2. This measurement is in agreement with theoretical calculation [1].

Conclusion

Treatment planning system, EyePlan, calculates dose distribution in homogeneous tissue equivalent medium. Hence, for patients who underwent the vitrectomy, the range and modulation should be both reduced by 10 % in order to compensate for the “stretching” of the SOBP caused by the presence of silicone oil in an eye.

Figure 2: Effect of the silicon oil on the range and modulation.



[1] Weber A, Cordini D, Stark R, Heufelder J. „*The influence of silicone oil used in ophthalmology on the proton therapy of uveal melanomas,*“ Phys. Med. Biol. 57 (2012), p. 8325-8341.

For any further information, please refer to CPT:

Maria de Prado,
Tel. +41 56 310 36 95
maria.de-prado@psi.ch

Dr. Jan Hrbacek
Tel. +41 56 310 37 36
jan.hrbacek@psi.ch

Physics News

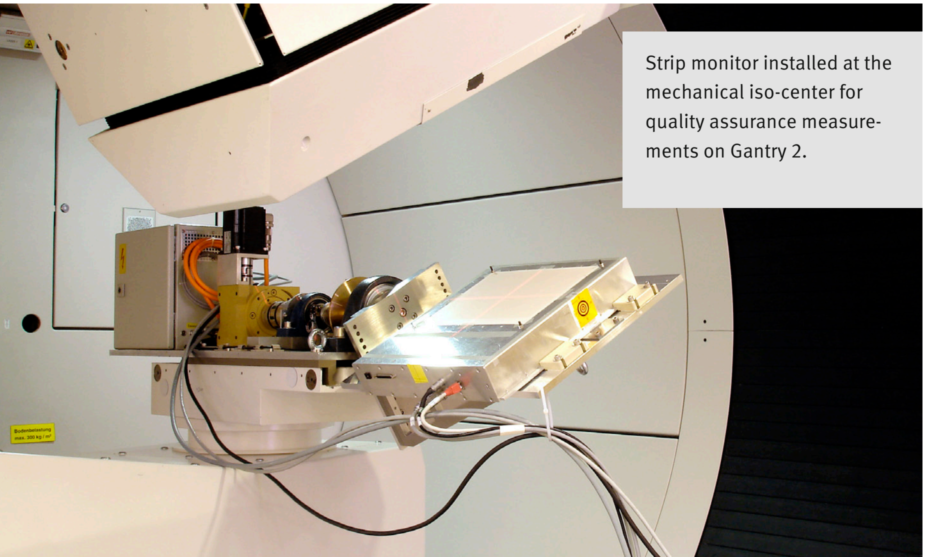
Precise On-Line Position Measurement for Particle Therapy

Background and Methods

In a typical treatment plan for spot scanning, the dose per spot can vary up to three orders of magnitude. Additionally on PSI Gantry 2 [1], the beam size changes from 2 mm to over 1 cm depending on energy, nozzle and pre-absorber position. The homogeneity of the delivered dose distribution directly depends on the lateral spot position accuracy. A position deviation of more than one millimeter can lead to dose errors of several percent; therefore the required position precision has to reach the sub-millimeter level. In order to verify a reliable high-quality patient treatment the on-line dose and position monitoring of the proton beam during the treatment as well as regular stability checks are of the highest importance for the Quality Assurance (QA).

The detector has to be placed right in the beam in front of the patient for on-line position verification. In order to minimize a multiple Coulomb scattering which is significant particularly for proton therapy a low amount of material is required. Using the experience of the Gantry 1 [2], the Gantry 2 chooses an ionization strip chamber for the on-line lateral position verification which is installed in the gantry nozzle [1]. This chamber covers the full scanning area with two perpendicular planes of 88 and 128 strips with a size of 2 mm. The strip chamber is equipped with advanced readout electronics which transfer the data to the therapy verification system. The spot position is propagated to the iso-center taking into account the Gantry 2 beam optics and is cross-checked with the expected value within one millisecond.

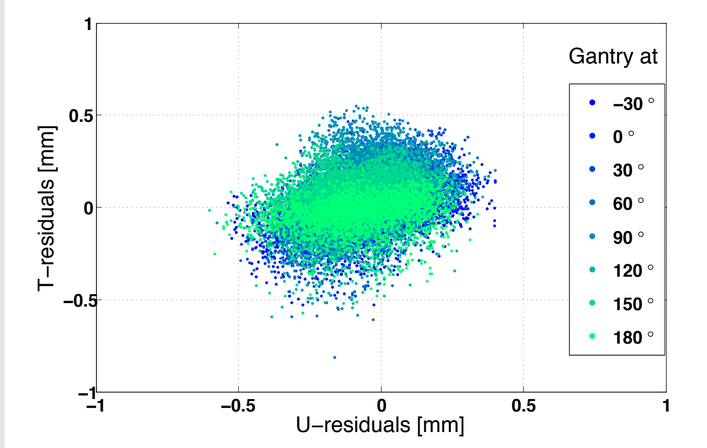
Apart from on-line position monitor an ionization strip chamber of the same type is used for regular position cross-checks. In addition to that, two smaller strip chambers with an active area of 7 by 7 cm and a strip size of 2.2 mm are used for the daily verification of the beam size, position and direction.



Strip monitor installed at the mechanical iso-center for quality assurance measurements on Gantry 2.

Results

Spot positions of the full range from high-weighted spots down to lowest spot dose (order of tenth of a milligray) as used by our therapy planning system can be reconstructed on the level of sub-millimeter precision due to the low detector noise. The detector granularity of 2 mm allows the same reconstruction precision for all spot sizes used on Gantry 2 . The daily QA routine which is performed prior the patient treatment verifies the precision, reproducibility and stability of the delivered beam for the whole scanning area.



Deviation of measured spot position from planned location for the full scan range in energy (every 5 MeV) and in lateral position (every 2 cm) and for various gantry angles. Delivered spot position precision is better than 1 mm for any energy-position-angle combination.

The strip ionization chambers have proven to be an appropriate verification and QA tool for the scanning proton beam therapy system. Its suitable design allowed operating in a simple, efficient and extremely stable way over several years. The system demonstrates a sub-millimeter precision of the position reconstruction which is needed for dose homogeneity of better than 1% to guarantee a patient treatment quality at the highest achievable level.

For any further information, please refer to CPT,
Dr. Oxana Actis, Tel. +41 56 310 53 95
oxana.actis@psi.ch

[1] E. Pedroni *et al.*, Pencil beam characteristics of the next-generation proton scanning gantry of PSI: design issues and initial commissioning results. Eur. Phys. J. Plus (2011) 126: 66

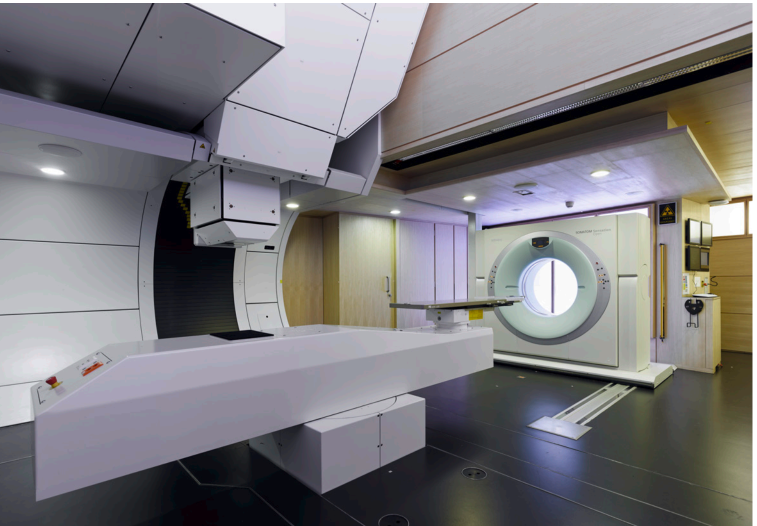
[2] Lin S *et al.*, More than 10 years experience of beam monitoring with the Gantry 1 spot scanning proton therapy facility at PSI. Med Phys. 2009 Nov; 36(11): 5331-40

Announcements

Symposium

On September 22nd 2014 (1:00 pm – 5:45 pm), PSI is hosting a scientific symposium on Proton Therapy for the inauguration of Gantry 2. Please find here an excerpt from the scientific program:

Lessons learned from research and clinical practice	Radhe Mohand, MD Anderson Cancer Center Texas, USA
Proton therapy at the Scripps Proton Facility	Carl Rossi, Scripps, San Diego, USA
Optimizing proton therapy in lung cancer	Joe Chang, MD Anderson Cancer Center, Texas, USA
Gantry 2: from vision to realization	David Meer, Center for Proton Therapy CPT
Particle physics and medicine: a success story	Guenther Dissertori, ETH Zürich
Gantry 2: realising the potentials	Tony Lomax, Center for Proton Therapy CPT
Treatment of moving targets with Gantry 2	Ralf Schneider, Center for Proton Therapy CPT



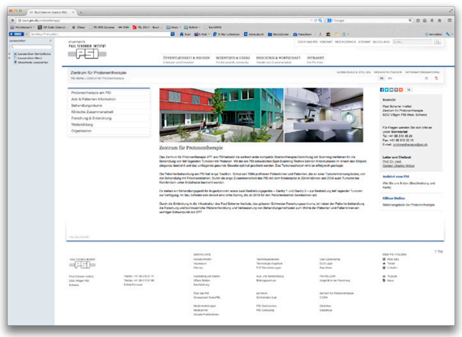
If you like to participate, please send a request per email to **Yvonne.Aebli@psi.ch** in order to register for this symposium.

PSI Winter School for Protons 2015 24th – 28th of January 2015

Please note that registration for this training course can be made using the following link: **www.psi.ch/winterschool**

Website

We would like to call your attention to our updated website: **www.protonentherapie.ch**. The website, being available in English and German, provides information for patients and referring physicians as well as an overview about technical equipment and main research topics.



Imprint

Editor
Dr. Ulrike Kliebsch

Chairman
Prof. Damien C. Weber

Chief Medical Physicist
Prof. Tony Lomax

Design and Layout
Monika Blétry

Contact

Center for Proton Therapy
CH-5232 Villigen PSI
protonentherapie@psi.ch
www.protonentherapie.ch
Tel. +41 56 310 35 24
Fax +41 56 310 35 15

Villigen PSI, August 2014