Status report, Gustav Werner cyclotron, The Svedberg Laboratory, Uppsala

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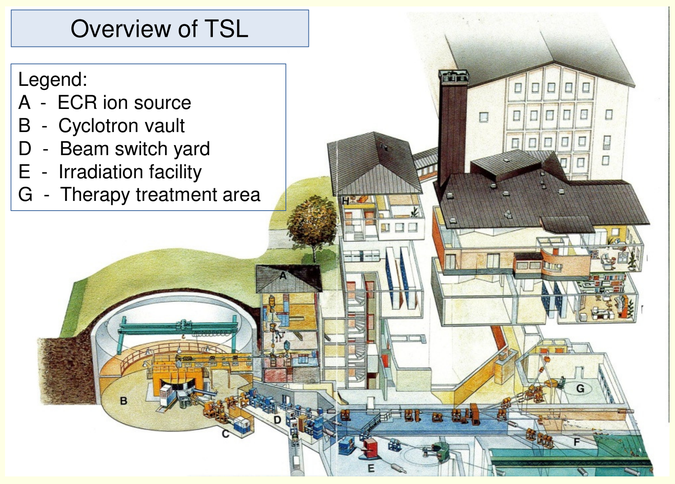
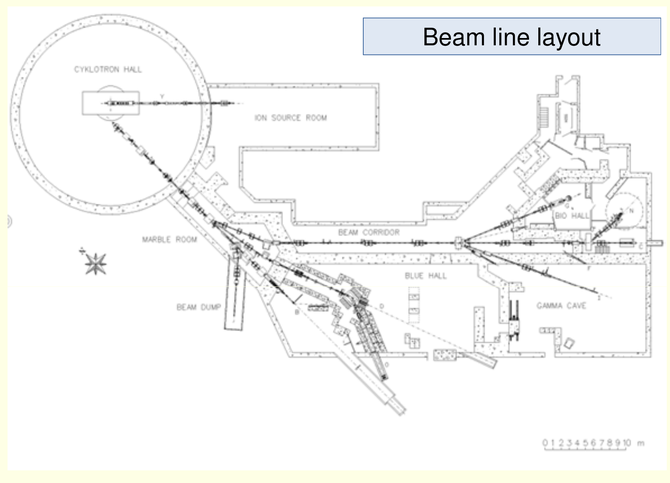
The Gustav Werner Cyclotron at TSL

- Frequency modulation mode up to 180 MeV protons.
- Isochronous mode protons can be accelarated in the range 25 to 100 MeV.
- Heavy ions up to ca 40 MeV/nucleon
- Maximum average magnetic field : 1.75 Tesla
- Extraction radius: 1150 mm
- Precessional extraction in CW mode, where the accelerating voltage is sufficiently high; Regenerative extraction in FM mode.
- User controlled beam-sharing:
  - Primary user: Proton Therapy *(The Uppsala Academical Hospital)*
  - Secondary user: Irradiation of electronics:

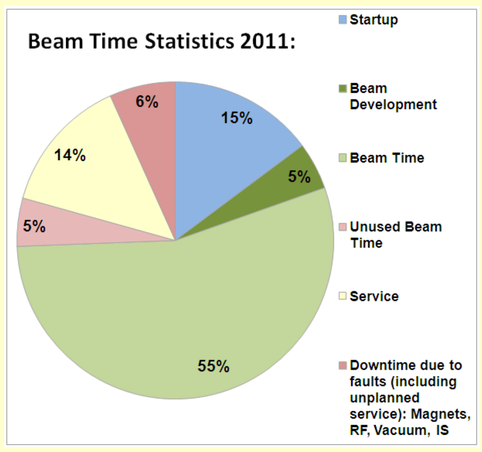
Overview of TSL

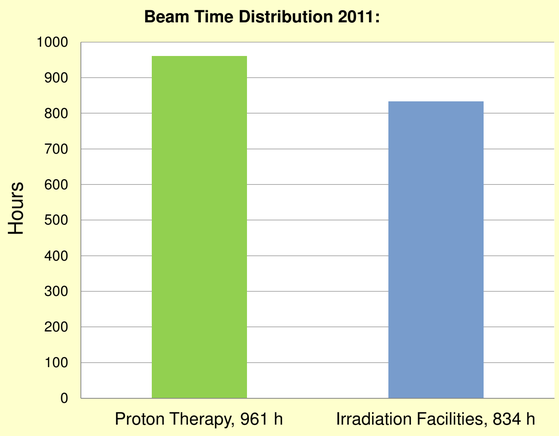


Beam line layout



Beam time statistics





Energy saving considerations

Energy saving considerations: Advantages.

Phase 1. A program (PutToSleep) is run which has the following actions: Cyclotron main magnet, RF powers supplies, extraction elements set to 0 A (0 V) – a practice followed already since several years ago.

Phase 2. Based on measurements made in Feb 2012 it was concluded that all beam elements also can be set to 0 A without influencing the beam transport's repeatability. A simple cycling procedure is used to ensure repeatability of magnetic fields.

Results. Energy saving results are shown in the figures below.

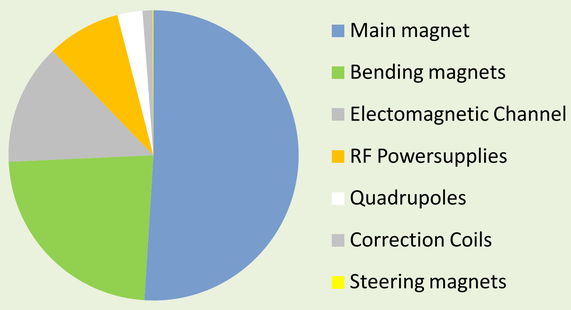


Fig. 1. Energy consumption distribution for various parameters.

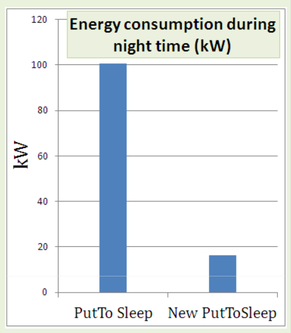


Fig. 2. Energy consumption with cyclotron in "sleep mode".

*The sleep mode energy consumption is **32%** respectively **5%** for the **PutToSleep** and **NewPutToSleep** procedures compared to the normal operation energy consumption.*

Investigation of magnetic field settle time for beam line parameters: Initial test measurements.

Set-up and procedure:

Measure beam position using therapy's ionization chambers; positioning accuracy? Y-scale units correspond to x mm.

Measurement 1 & 2: All bending magnets set to 0 A ; wait 10 minutes; set to the correct set value following a specific cycling procedure.

Measurement 3: All quadrupoles set to 0 A ; wait 10 minutes; set directly to the correct set value (no cycling).

Conclusion: The beam position stabilizes to a sufficient accuracy level within **3 minutes**.

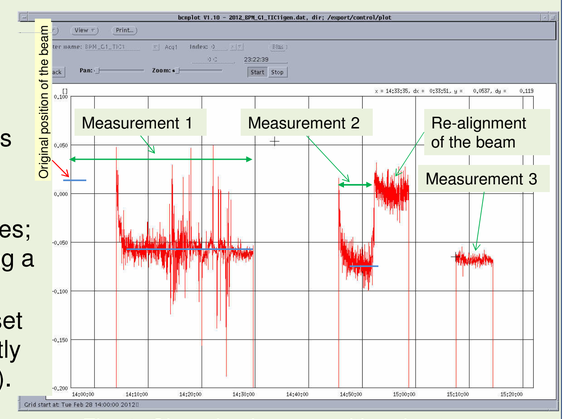


Fig. 1 Changing beam position due to settling of magnetic fields.

Beam intensity stabilization at morning start-up.

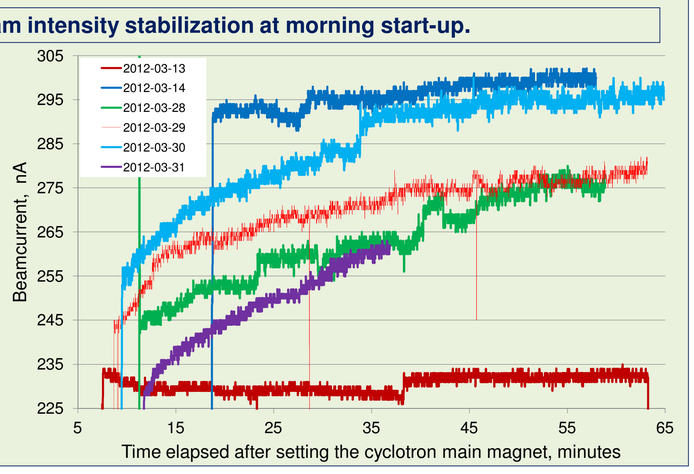


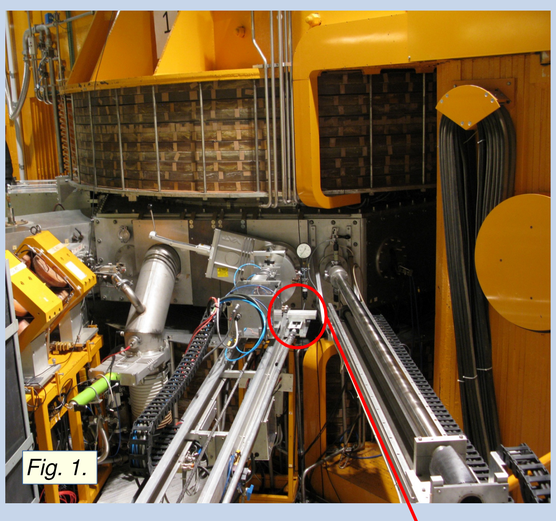
Fig. 2. Beam intensity stabilization curves as function of time in minutes after t_0 when the cyclotron main magnet is set to the final set value. Therapy start with calibration measurements 90 minutes after t_0. Patient treatments start 3 hours after t_0.

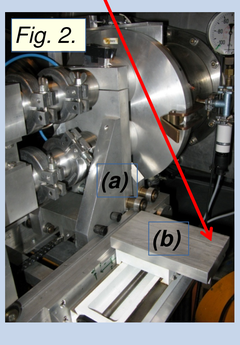
New projects

Internal Ion Source Positioning System

Background. For optimization of the positioning of the Dees relative to the internal ion source, the philosophy of the original design of the GW cyclotron was to have only the Dees adjustable.

To improve the time needed to make energy changes, it was realized that we need to have this parameter (IS radial position) remotely controllable.





New construction. Intending to keep the changes simple, the existing base (fig. 2 (a)) of the ion source is kept.

Radial displacement of the ion source will be affected by transferring the necessary force via the X-Y table - see fig. 2 (b).

Positioning of this plate is accomplished via a drive rod driven by a stepper motor well away from the cyclotron magnet.

New Camera System

Background. Instead of harps or scanners, fluorescent viewers are used to diagnostize beam characteristics.

Motivation for upgrade.

(1) Mostly Vidicon cameras are still in use. They are not replaceable and spare parts are difficult to find.

(2) Replacing the old TSL-built multiplexing system.

Solution. Extensive tests of various CMOS and CCD cameras were done leading to the choice of Eyseo CCD cameras (Fig. 2) which will replace the Vidicon cameras currently in use.

The old mux system will be replaced by a video matrix switch.

Vidicons will be used at some of the 21 viewer positions (at these positions the radiation level causes an unacceptably short CCD camera life-time). The Vidicon cameras are adapted (Fig. 3) to output a video signal instead of VHF.

A new PLC system controls the following signals:

a. Switch the camera ON/OFF
b. Switch on illumination (a ring with LEDs illuminating the viewer screen.
c. Controlling the viewer IN/OUT position
d. Feedback as to the viewer position (micro switches)

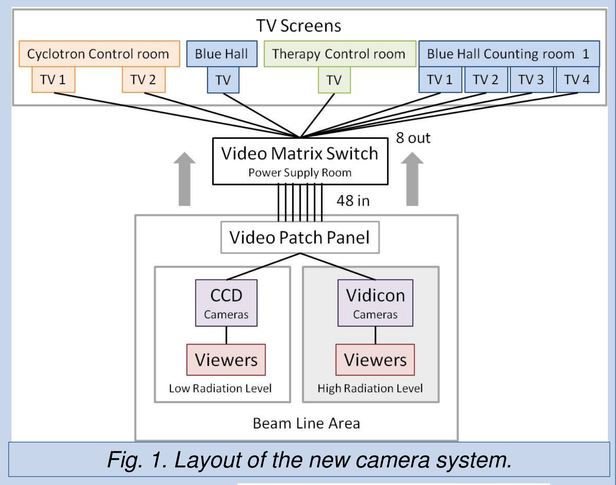


Fig. 1. Layout of the new camera system.

Fig. 2. The Eyseo Ecoline Standard CCTV camera.

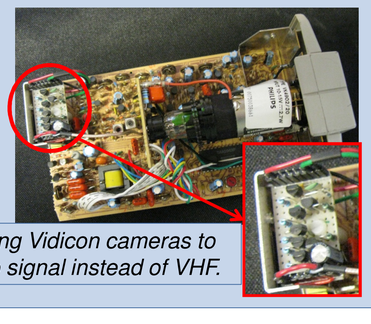


Fig. 3. Adapting Vidicon cameras to output a video signal instead of VHF.

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