PROTON IRRADIATION FACILITY PIF and PSI ACCELERATORS

Wojtek Hajdas, Roger Brun – PSI LAP

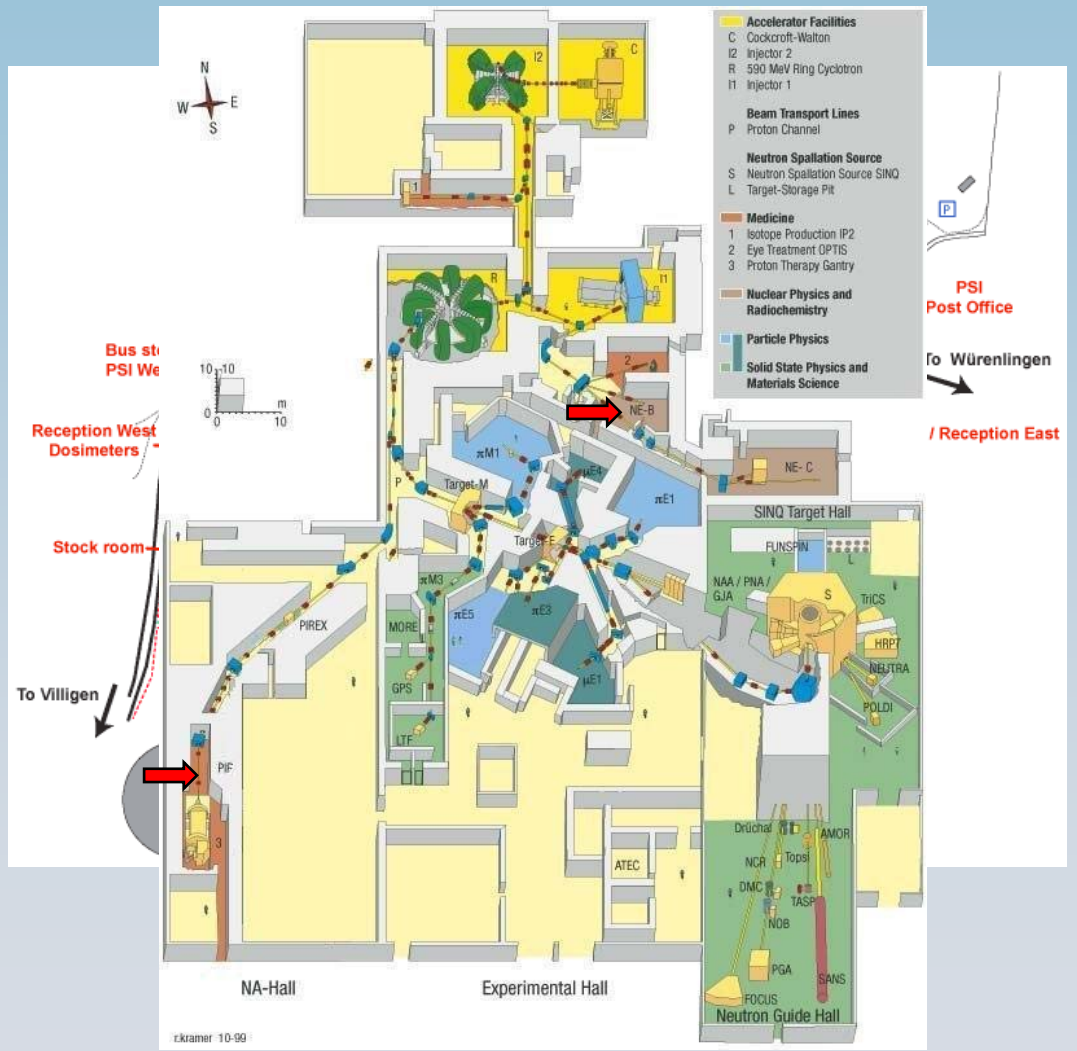
Outline:

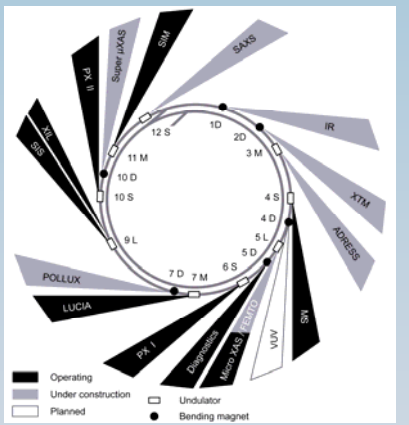
- PSI accelerators, areas, users
- PIF tests sides and operation
- Conducting experiment
- Schedule, exposures and support
- Future plans

PSI ACCELERATORS

- Injector I – protons (72 MeV) and heavy ions (120 MeV Z^2/A)
  - ECR source and polarized proton source
  - radiochemistry (heavy ions), biomedicine, space research PIF
- Injector II – protons up to 72 MeV
  - 1st stage before ring cyclotron and isotope production
- Ring Cyclotron – 2 mA protons, energy 600 MeV
  - Protons for biomedicine and space (PIF) applications
  - Production of pions, muons and cold neutrons
  - 8 pions and muons beamlines in operation
- Synchrotron Light Source – infrared to hard X-rays (1000 μm - 40 keV)
  - 5 beamlines in operation (more under construction)
  - material/environment science, protein crystallography, surface studies
- Cold Neutron Source – high intensity neutrons (E ≈ 0.001 – 10 eV)
  - several instruments and test stations (7 beam pipes, 8 stations)

PSI AND ITS EXPERIMENTAL AREAS





PIF AS USER LAB

FEATURES

- Semi-continuous energy setting
- Wide range of intensities
- Uncomplicated set-up and operation
- User-specific test arrangement
- Realistic proton space environment
- Mono-energetic for radiation tests
- Calibration station for detectors
- Qualification of new technologies

USERS

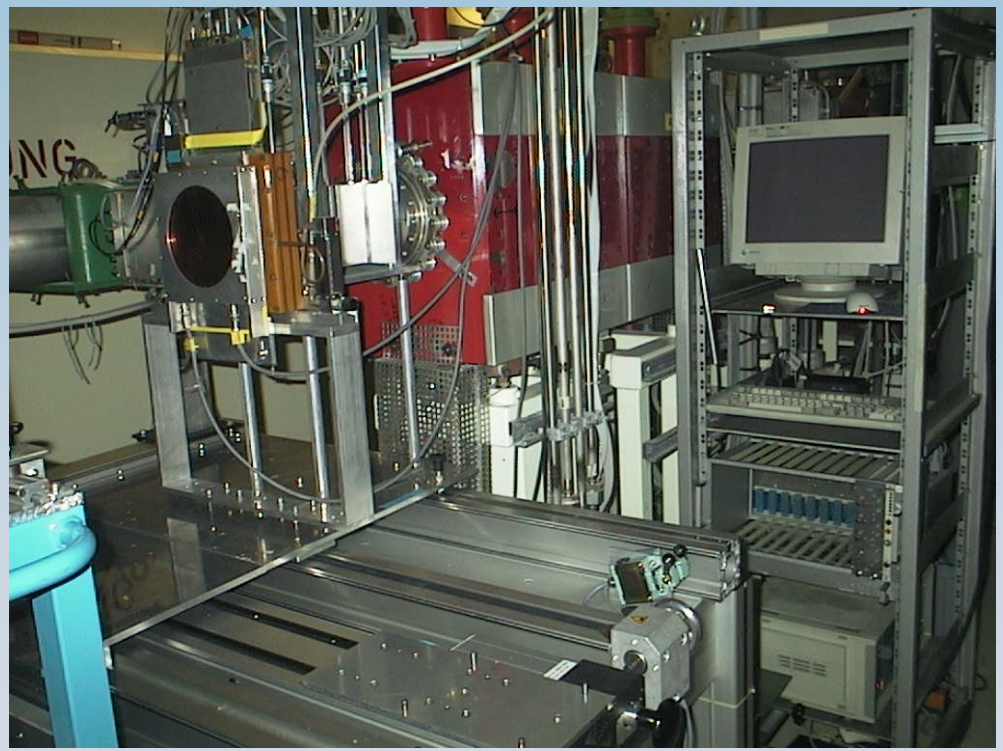
- ESA/ESTEC and subcontractors
- Space Industry (international)
- CERN and Universities
- Other Industry (neutron-proton)
- Internal PSI (new devices)

PIF LOW ENERGY SITE

- **Initial energy:**
  63 MeV
- **Energy range:**
  6 to 63 MeV
- **Max flux (6-63 MeV)**
  < $5 \cdot 10^8$ p/cm^2/sec
- **Max beam spot**
  φ = 90 mm
- **Beam uniformity**
  90% in of 50 mm circle

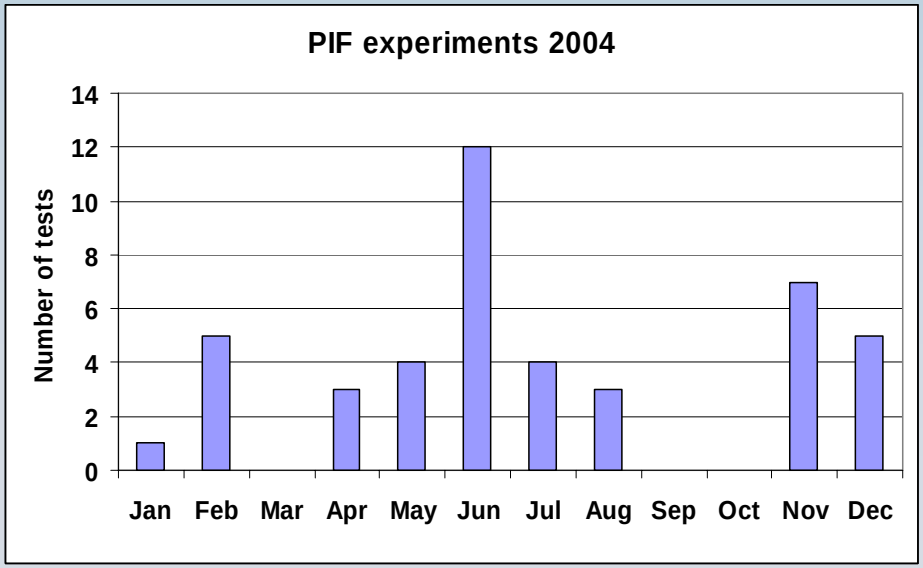
PIF HIGH ENERGY SITE

- **Initial energies:**
  250, (100, 60) MeV.
- **Energy range:**
  35 - 250 (6-60) MeV.
- **Max flux at 250 MeV:**
  $\approx 2.5 \cdot 10^8$ /sec/cm^2, 1 nA.
- **Gauss-form profiles**
  FWHM=6 cm (or flat).
- **Max exposure diameter:**
  φ = 90 mm.
- **Neutron background:**
  10^{-4} /proton/cm^2.



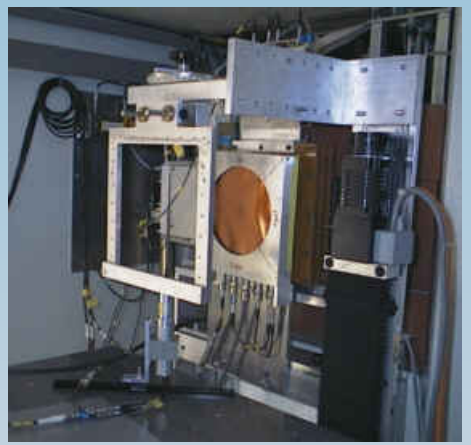
FACILITY OPERATION

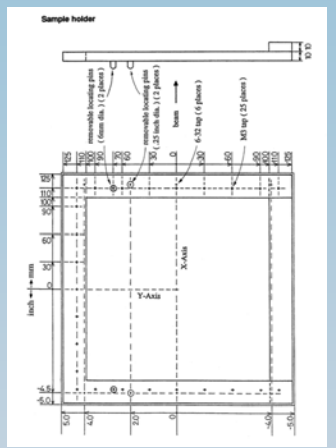
- 240 beam hours/year reserved for ESA/ESTEC
- Another 240 hours available for other users
- Low energy side operates monthly during OPTIS weeks
  - 12 times/year including weekends
  - 3x12+60 hours/w
- High energy side available on weekends after Biomed
  - 20 times/year
  - from end of April
  - 50 hours/week
- 30 beam blocks-tests/year
  - 20 at Low Energy PIF,
  - 10 at High Energy PIF
  - 25 research groups



EXPERIMENTAL ARRANGEMENT I.
mounting, positioning, control

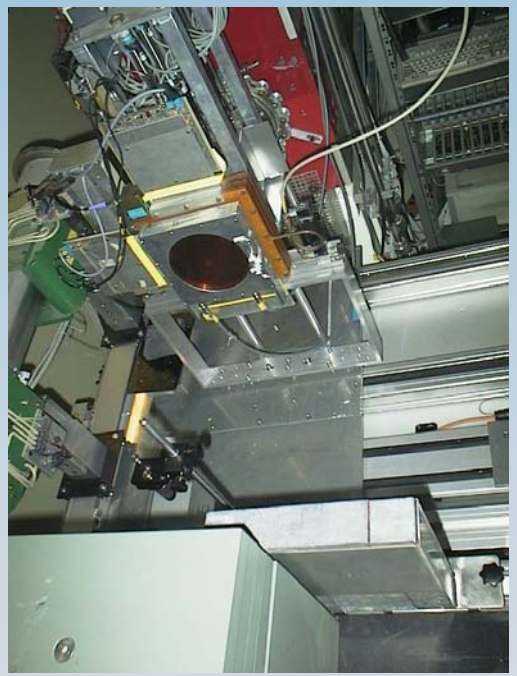
- **Mounting:**
  - **Sample Holder or by User**
  - **compatible with HIF, Brookhaven**
  - **platform, suspension etc.**
- **Position: XY table**
  - **two step motors**
  - **manual and remote control**
- **Control:**
  - **Degrader for setting energy**
  - **XY - NI SW, identical for LE, HE**





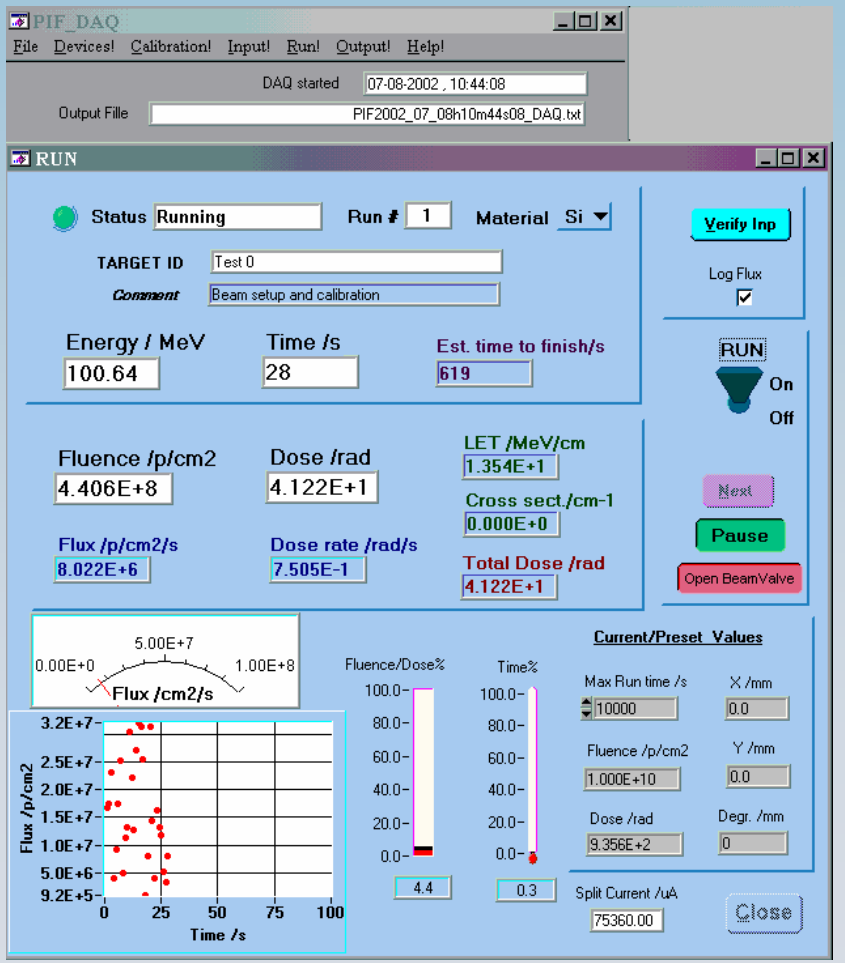
EXPERIMENTAL ARRANGEMENT II. dosimetry

- **Ionization Chambers**
  - air filled
  - total current readout
- **Plastic Detectors**
  - known area
  - single proton count
- **Wire Chamber**
  - beam profiles
  - centering
- (Option Si, NaI(Tl), NE213)
- Flux/Dose accuracy about 5%



EXPERIMENTAL ARRANGEMENT III. acquisition

- Software – user Friendly !
- Users runs PIF themselves
- Identical Scheme for LE,HE
- Run Flow:
  1. Initialise
  2. Calibrate
  3. Input
  4. Verification
  5. Run
  6. Output
- Important:
  - Calibration Factors



CONDUCTING EXPERIMENT
training and radiation safety

- Software and test step-by-step procedure available on web
- Device exposure training before starting irradiation (15 min)
- How-to enter and exit experimental area available on web
- Area enter and exit demonstration and training before test (10 min)
- Dosimetry and radiation safety course required for new users
- Course has to be completed before test (ca. 35 min, 3 end-questions)
- All experimental materials (from area) must be checked after irradiation

SET UP, EXPOSURE and COSTS

- User has several hours to prepare its experiment
- PIF setup is arranged in accordance to test needs
- Exposure campaign starts with beam setup (1 - 2 h)
- Dosimetry devices are calibrated (0.5 - 1 h)
- User test runs are carried out in accordance to schedule
- After exposures all materials are checked for activation
- Activated materials are stored in special magazine
- Beam costs are 500 (650) Euro/hour (min 8 hours, flat rate)
- Penalty for cancelled runs with large PIF pre-work
- For common research projects – cost reduction

PERSONNEL, SUPPORT and CONTACTS

- Roger Brun and Wojtek Hajdas run PIF at PSI
- PIF stuff available during setup and first exposures
- Further support on request /
  - on-call immediately
  - SW and PC controlled HW remotely
  - picket availability within 5-30 min
- Cyclotron operators – permanent presence
- SU physicist either as picket or after exposures (morning)
- Services available during week working hours:
  - mechanical and electronic workshop
  - central magazine
  - vacuum group, area services, crane operators
- All contact addresses and phones on web (pif.web.psi.ch)

FUTURE DEVELOPMENTS
all in one - PROSCAN

- Construction in accordance to schedule
- First protons extracted on 1st April 05
- Cyclotron commissioning in progress
- New PIF commissioning – end of 2006
- PIF PROSCAN operation from 2007