RADECS Thematic Workshop on European SEE Accelerators
May 26th 2005

- BIBER -
The **B**erlin **I**on **B**eam **E**xposure and **R**esearch facility

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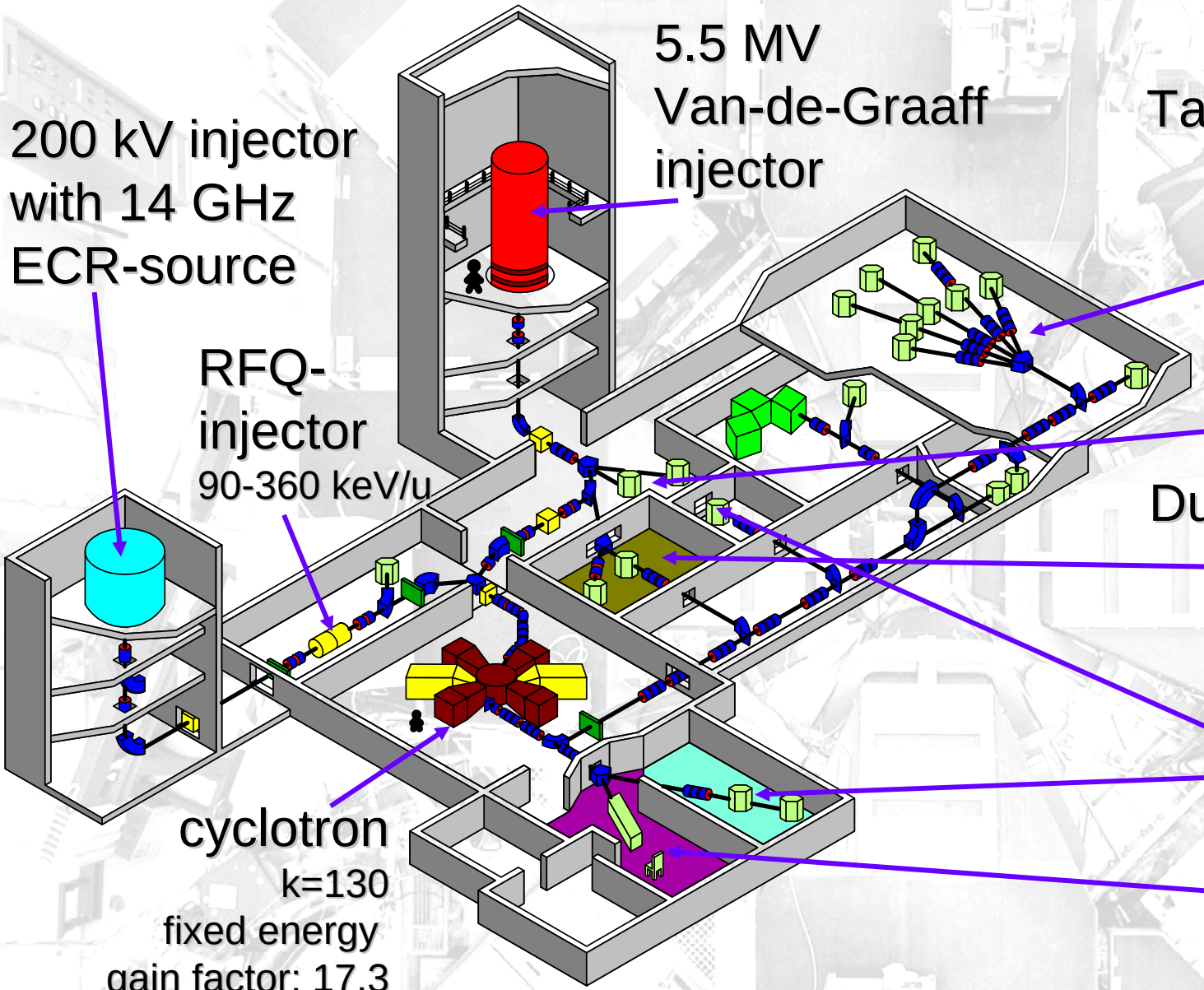
The ion beam laboratory **ISL** of the Hahn-Meitner-Institute

- Situated in Berlin, Germany
- Member of the Helmholtz society
- funded to 90/10 by federal and local government
- About 20% of the annual budget financed by co-operations
- Large scale facility, dedicated to structural research
- Application of ion beams and ion beam technologies
- Service dedicated to internal and external users
- Ions: protons to bismuth
- eV < E_{ion} < 700 MeV

Layout of the ion beam laboratory ISL



5.5 MV
Van-de-Graaff
injector

200 kV injector
with 14 GHz
ECR-source

RFQ-
injector
90-360 keV/u

cyclotron
k=130
fixed energy
gain factor: 17.3

Target places for basic
research in ion-solid
interaction

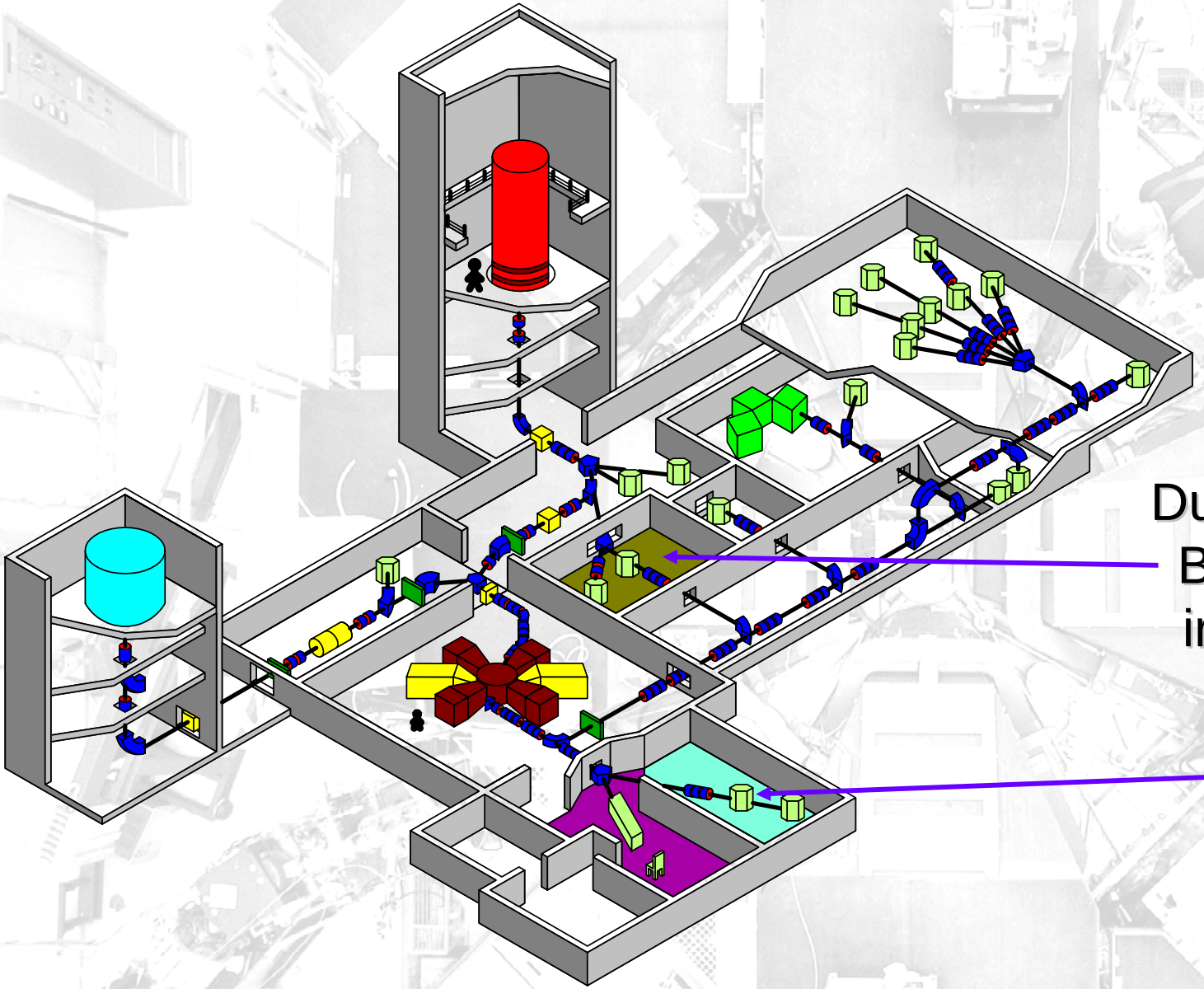
Low energy
target places

Dual beam target place
for low- and high
energy irradiations

Materials analysis
with ion beams

Eye tumour therapy

Target places at ISL for radiation effects experiments

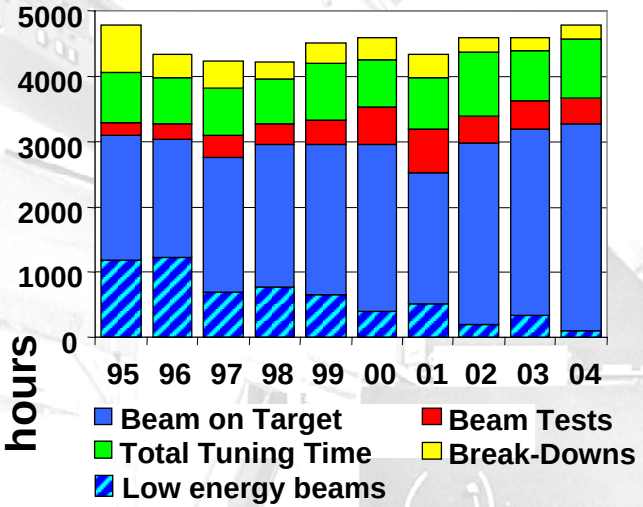


Dual beam target place
BIBER – for heavy ion
irradiations in vacuum

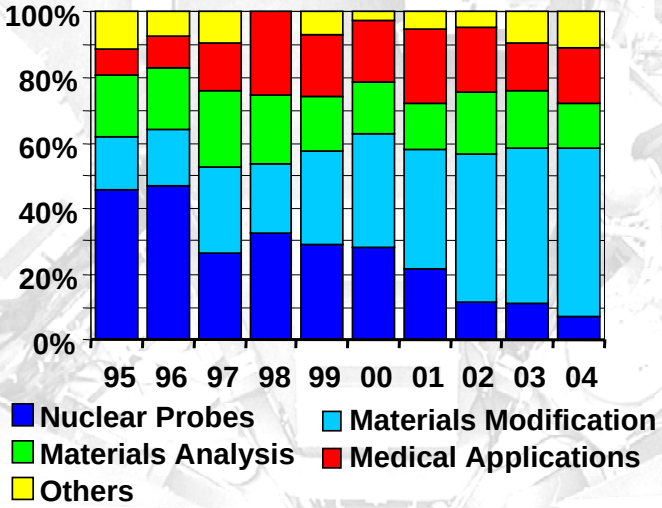
Irradiations in air
with protons
of up to 72 MeV

The ion beam laboratory ISL: statistics

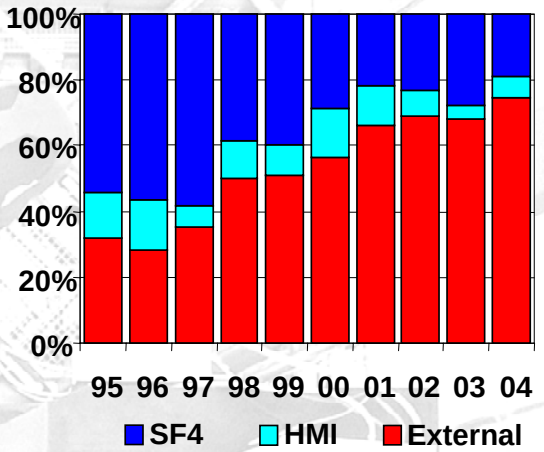
beam time balance



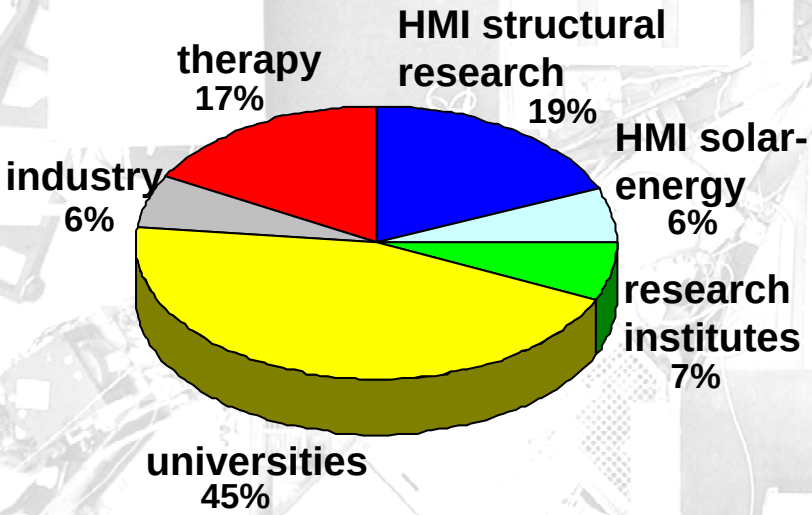
application fields



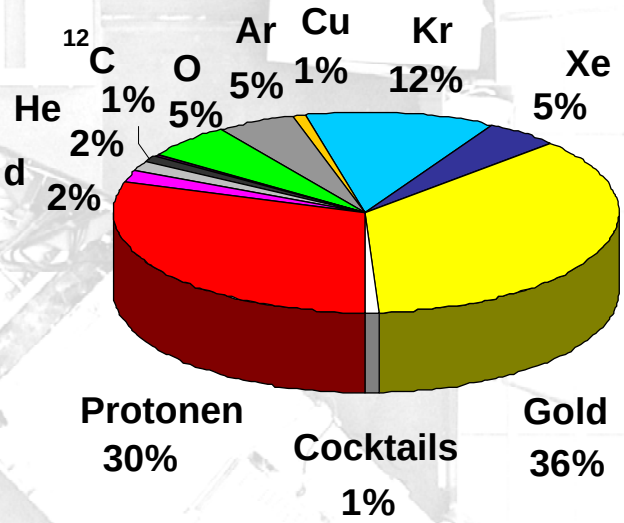
user service



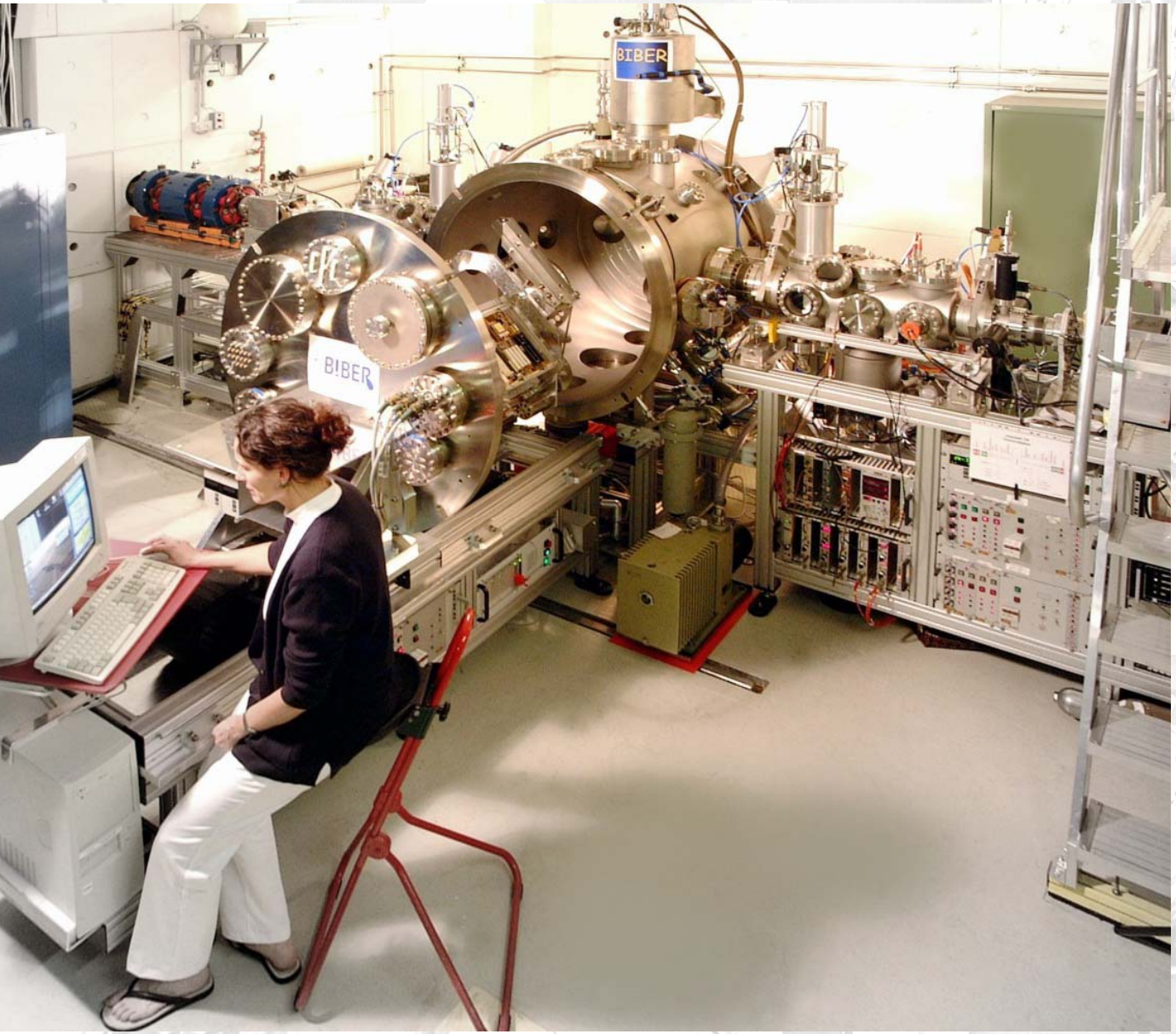
origin of our users:



high energy ions:



BIBER – The Berlin Ion Beam exposure and research facility



- BIBER is placed in between high- and low energy beam line ends

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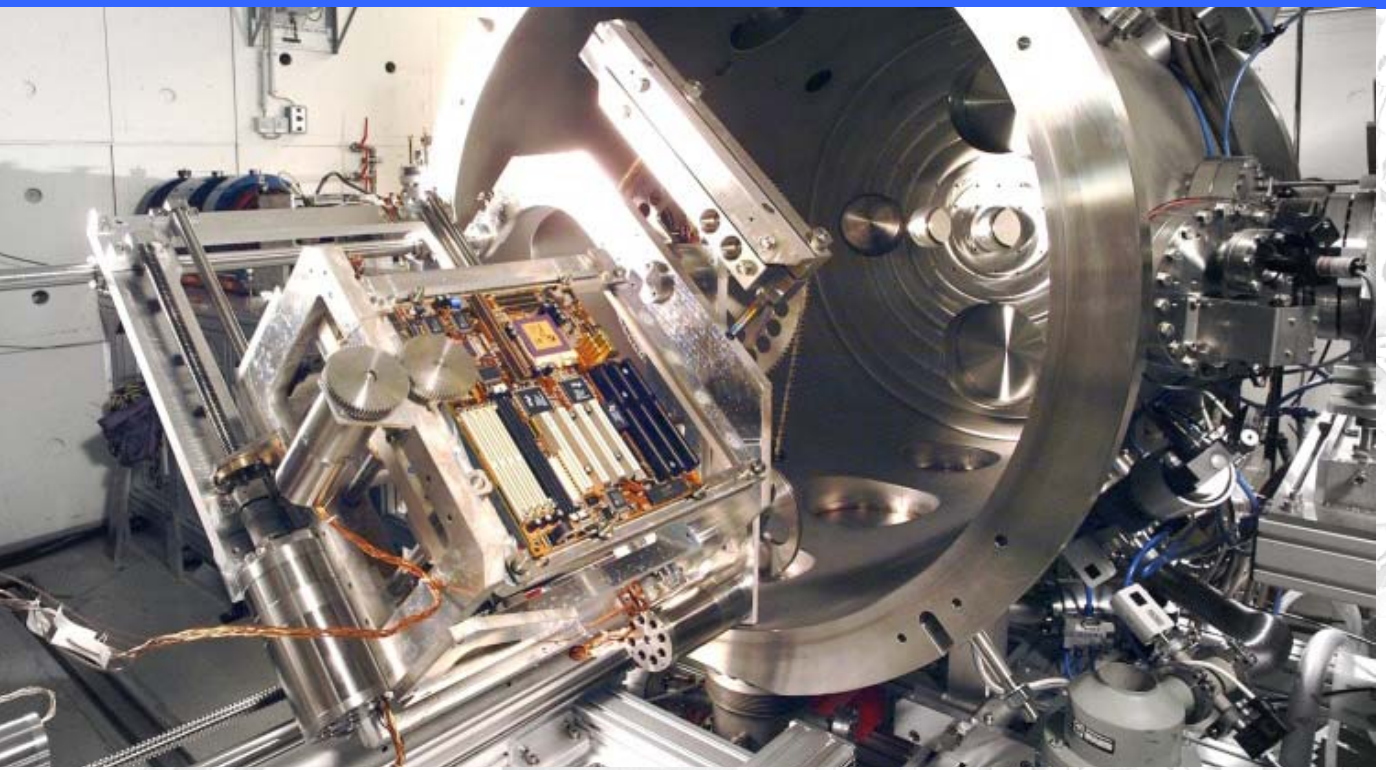
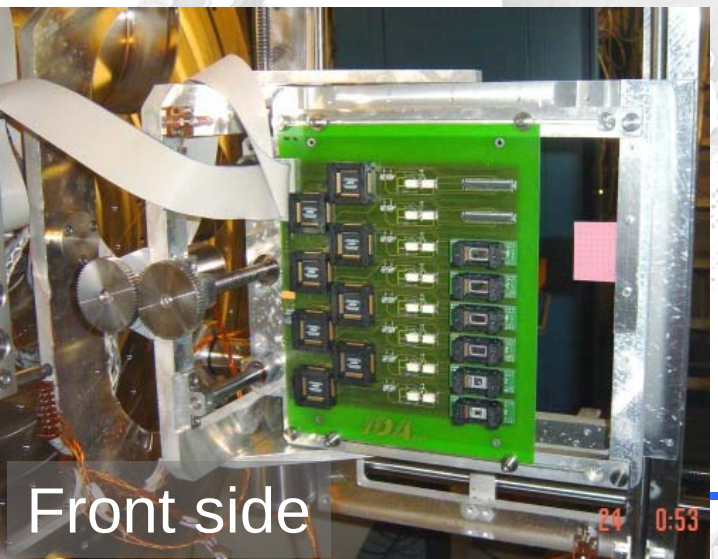
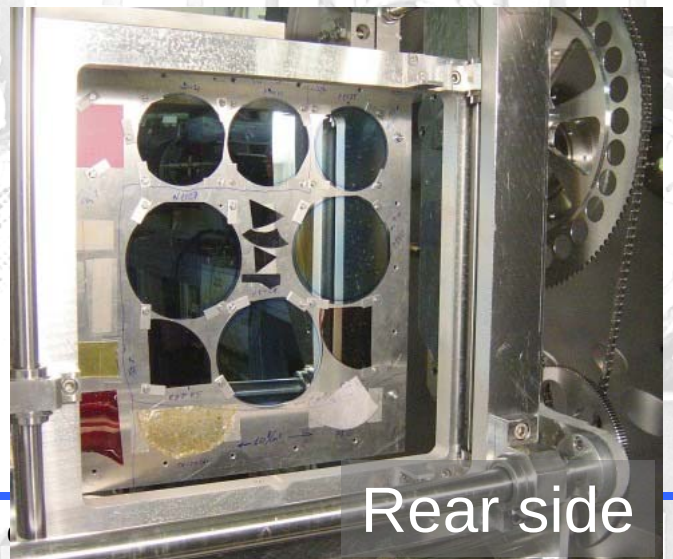
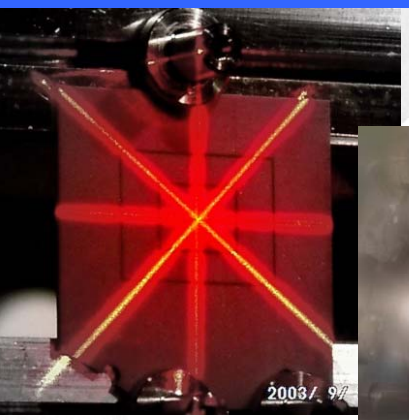


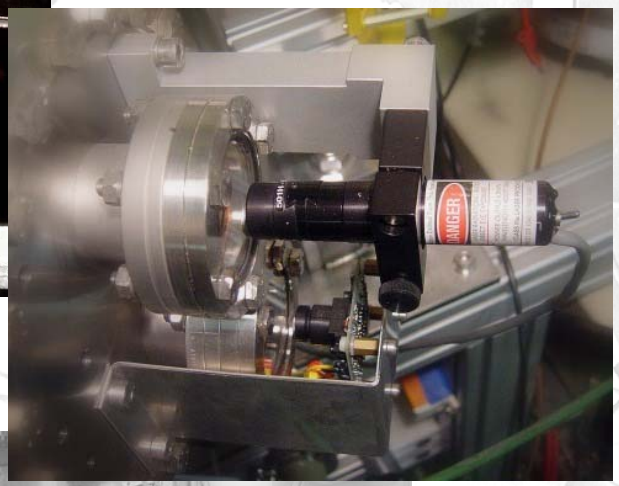


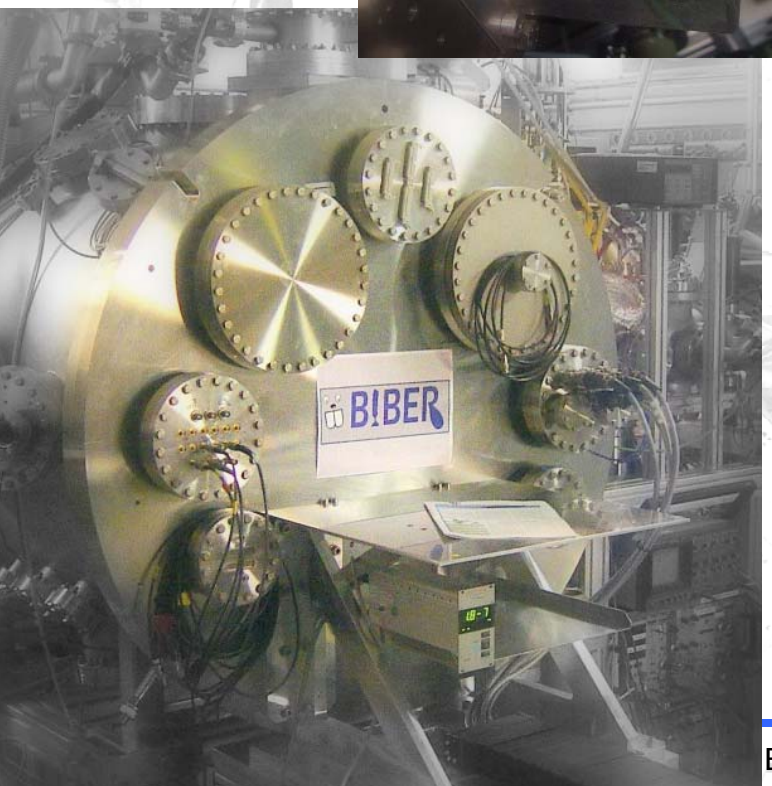


- The manipulator:
  - Holds up to 4 kg
  - Δx, Δy: ± 150 mm
  - Δz: ± 50 mm
  - Θ: 360°
  - Fast movement
  - Fixture: universal clamping system + thread hole pattern
  - Double placement of samples due to open rear side

BIBER – The Berlin Ion Beam exposure and research facility



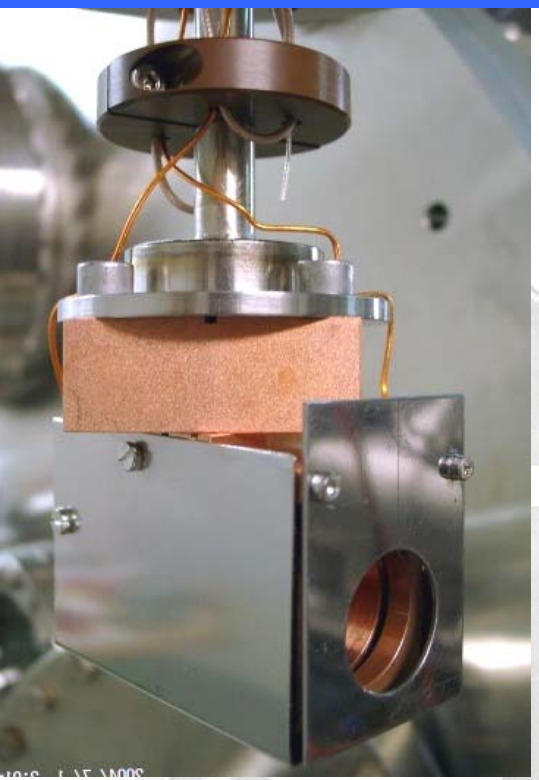


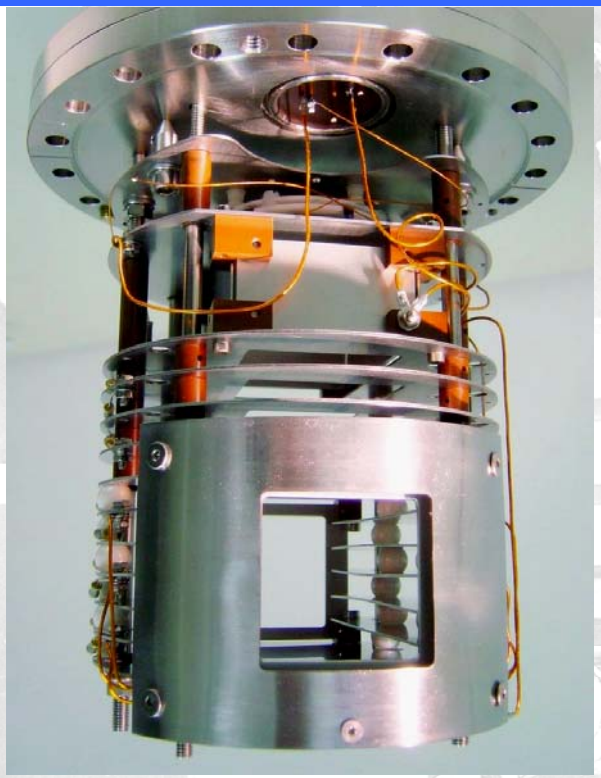


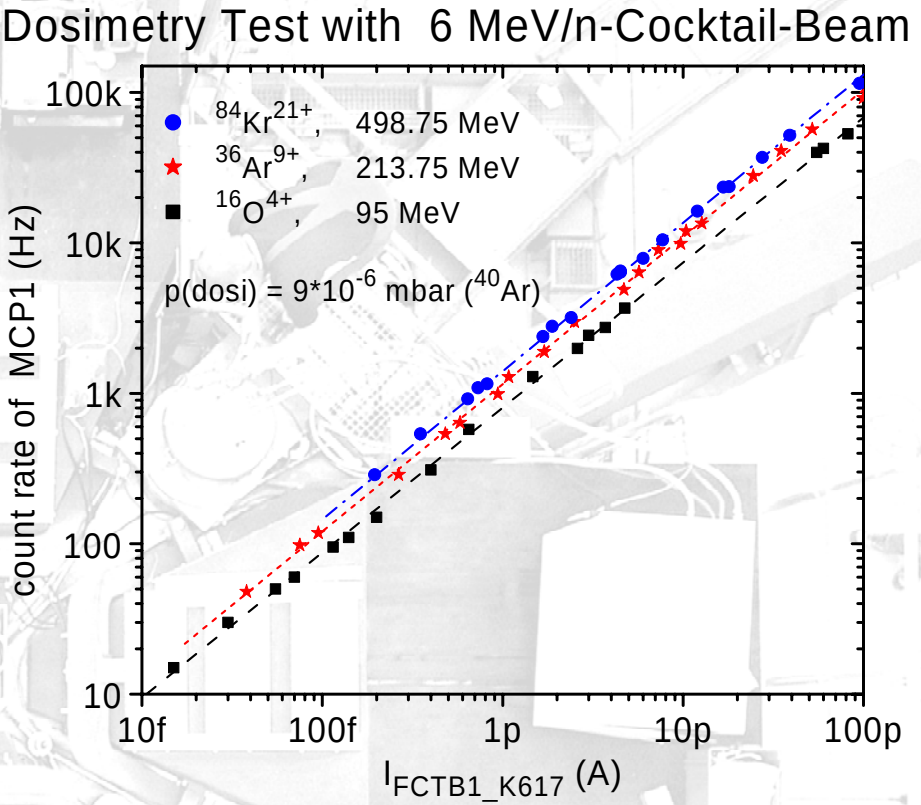
- Imaging system (all external)
  - Marking of the irradiation position: Two cross hair laser pointers
  - Surveillance of the sample: Two TV-cameras (wide angle and telescope optics) and two video channels to the control room
- Available electrical feedthroughs

40-pin flat ribbon cable	4x	Sub-D 9 pin	6x
MHV	3x	Sub-D 15 pin	4x
SMA / BNC	18x	Sub-D 25 pin	6x
Others: on request		Sub-D 50 pin	4x

BIBER – The Berlin Ion Beam exposure and research facility

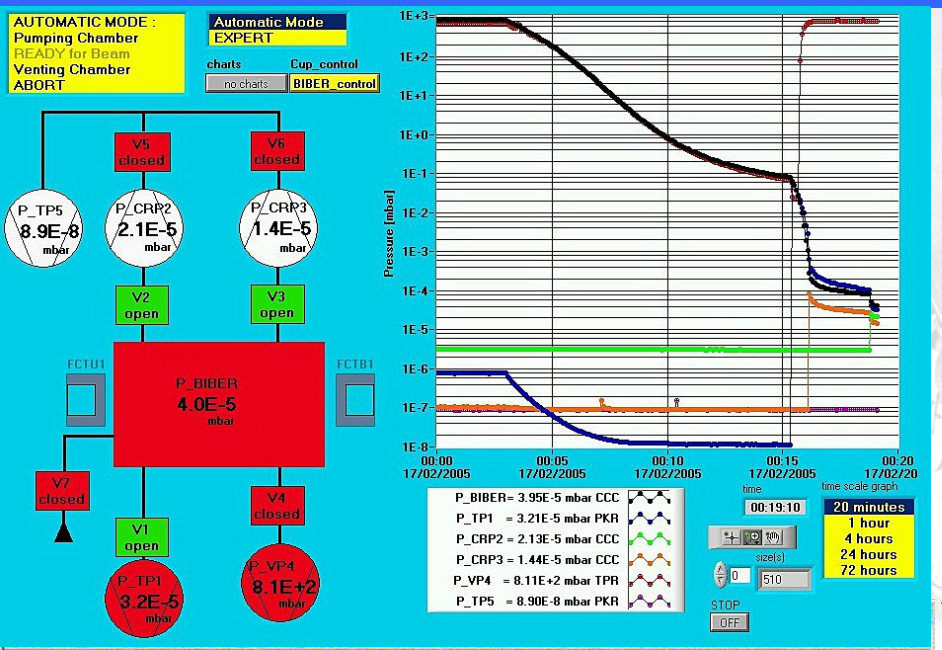


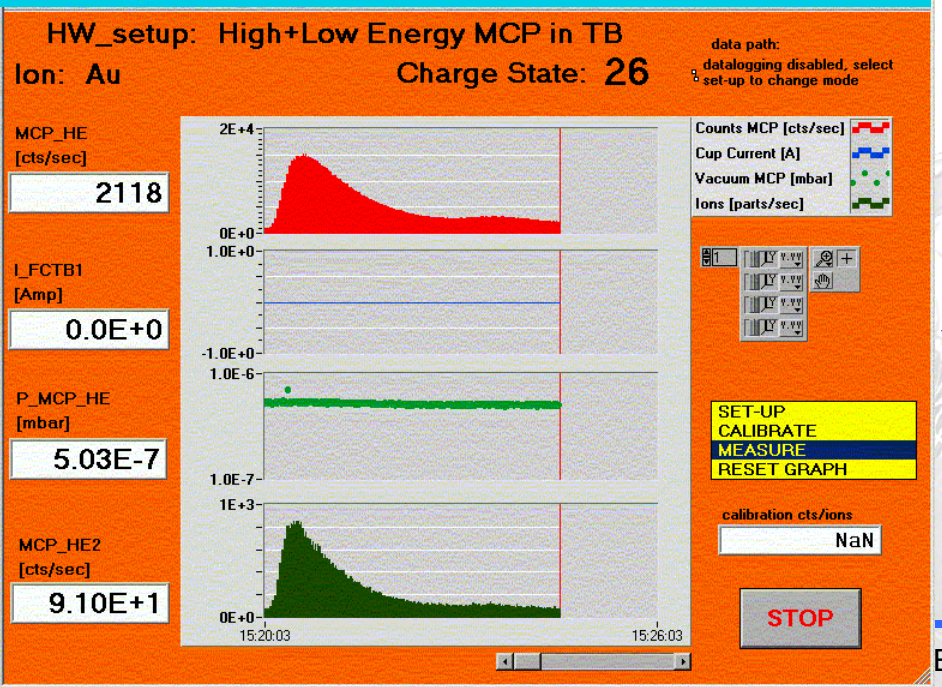




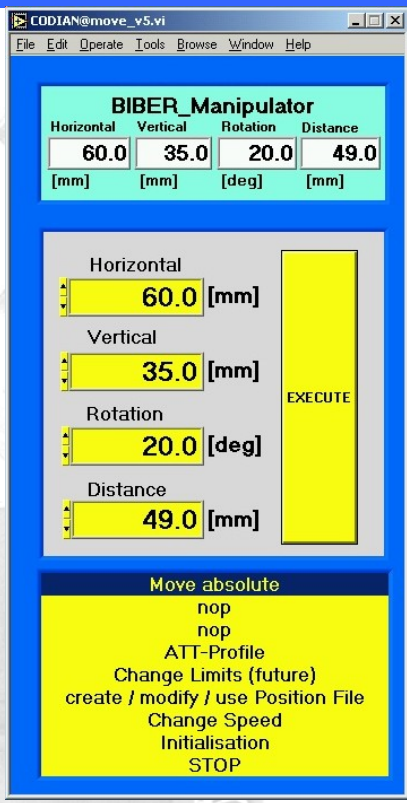
- Beam dosimetry and monitoring
  - absolute beam current measurement: shielded Faraday cup and electrometer
  - non-destructive online beam monitoring: residual-gas-ionisation dosimeter
  - linear down to 100 Hz @ 100 fA (≤10000 /cm²/s)
  - Ion distinction

BIBER – The Berlin Ion Beam exposure and research facility

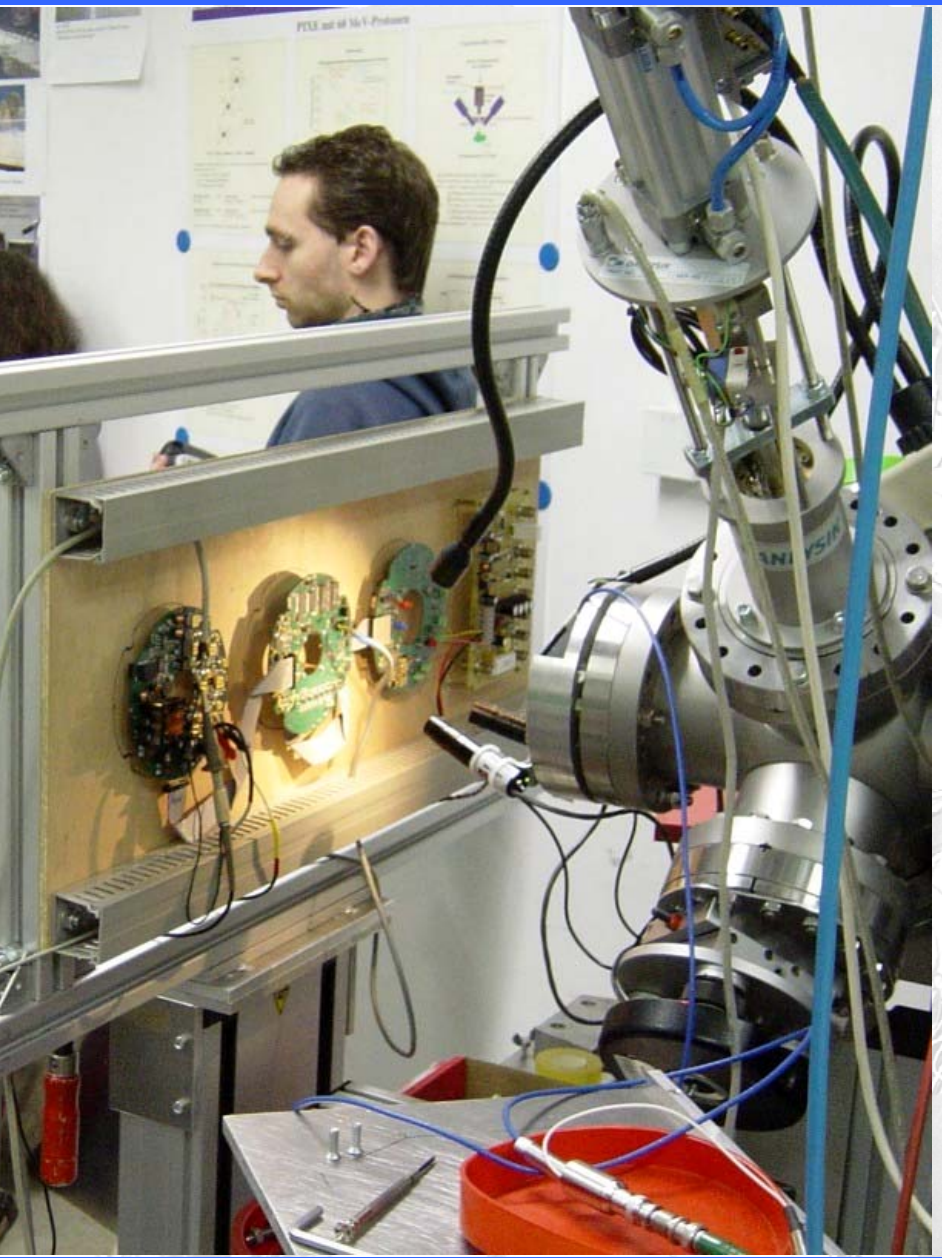




- Graphical user interfaces for easy access to
  - Vacuum system, automatic pumping/ venting procedures ←
  - Manipulator →
  - Dosimetry system ←



Proton irradiation station at ISL: features



- Proton irradiations in air
- Regular use of 68 MeV protons
  (during day time: eye tumour therapy)
- Degraders for lower energies
- Homogeneous irradiation field
  - scattering foil or scanning system
- Non-destructive online dosimetry: ionisation chamber
- x-y-manipulator for support and movement of the samples
- No limits to size and weight
- BNC connections and video surveillance

BIBER + proton irradiation station at ISL: training + safety

- Training
  - Not necessary →
    preparation and irradiation is assisted by staff personnel
- Radiation safety,
  for persons:
  - Registration of external personnel to the radiation safety department in cases of frequent independent work
  - Individual registration for accompanied visits and experiments
- Radiation safety,
  for irradiation objects:
  - All irradiated objects have to be checked individually for activation and / or contamination by the radiation safety department

BIBER - Cocktails

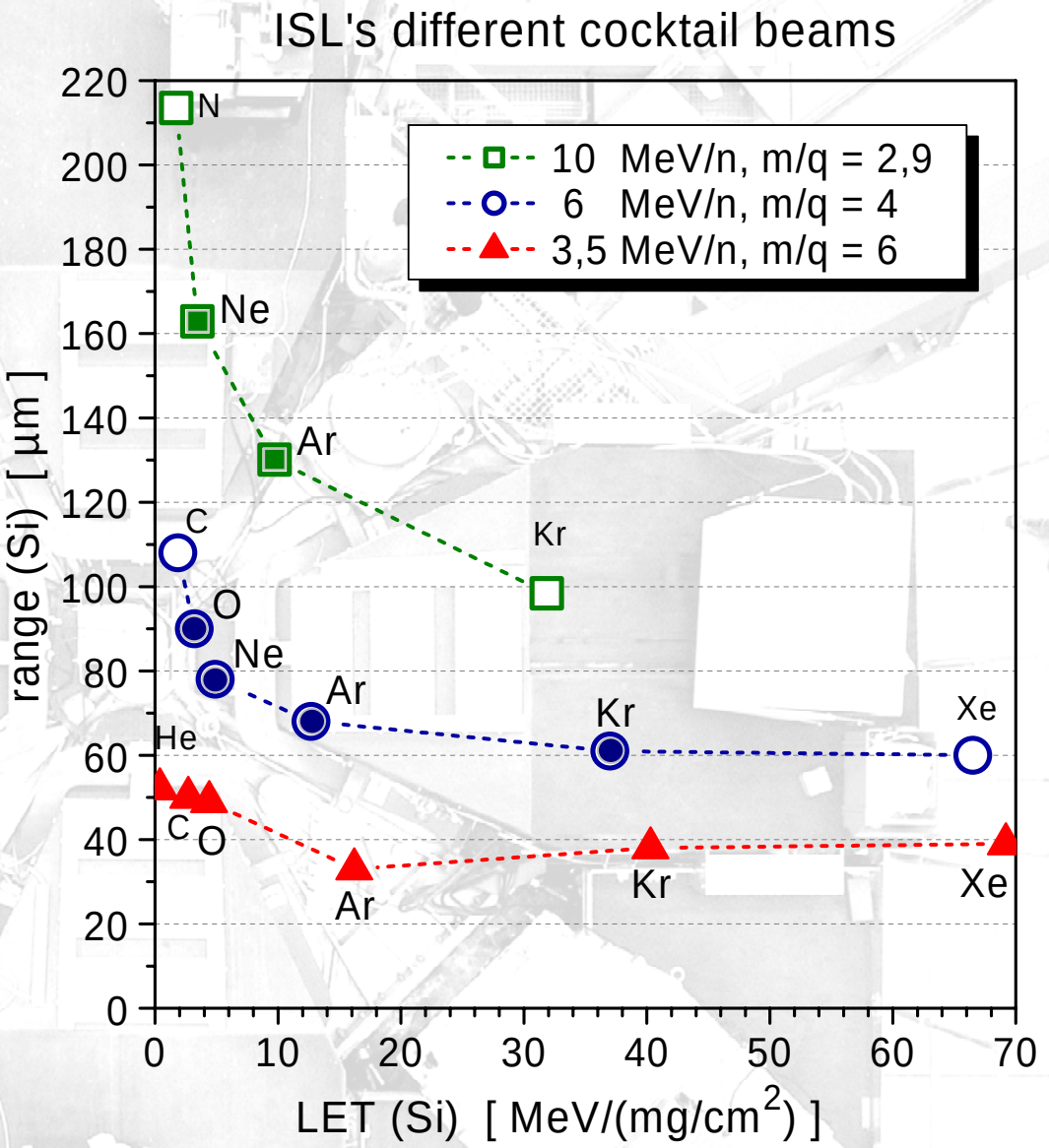
Cocktail beam: E = 3.5 MeV/n ; m/q = 6

ion	Energy [MeV]	Incidence angle [°]	$LET_{surface}$ $\frac{MeV}{mg/cm^2}$	Range in Si [µm]
$^{3}He^{2+}$	7.5	0	0.4	52
$^{12}C^{2+}$	42	0	2.7	50
$^{18}O^{3+}$	63.15	0	4.4	49
$^{36}Ar^{6+}$	126.2	0	16.2	33
$^{84}Kr^{14+}$	294.4	0	40.3	38
$^{132}Xe^{22+}$	462.8	0	69.2	39

Cocktail beam: E = 5.94 MeV/n ; m/q = 4

$^{12}C^{3+}$	71.25	0	1.9	106
$^{16}O^{4+}$	95	0	3.2	88
$^{20}Ne^{5+}$	118.8	0	4.9	77
$^{36}Ar^{9+}$	213.75	0	12.8	60
$^{84}Kr^{21+}$	498.75	0	37.1	61
$^{132}Xe^{33+}$	783.75	0	66.6	59

These carbon- and xenon-beams are under development.



BIBER - Cocktails

- Ion change and tuning time:

  twenty minutes up to one hour,

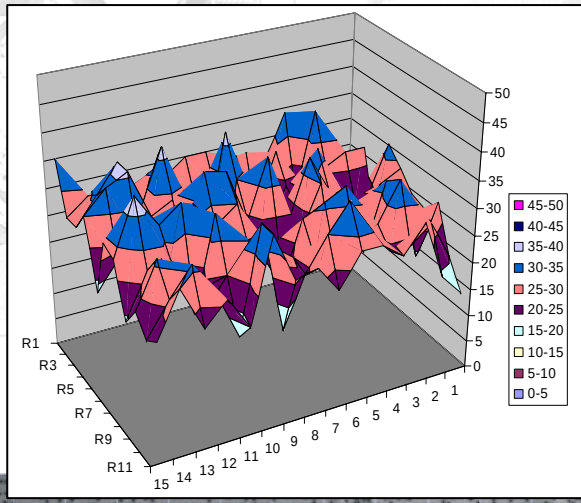
  due to

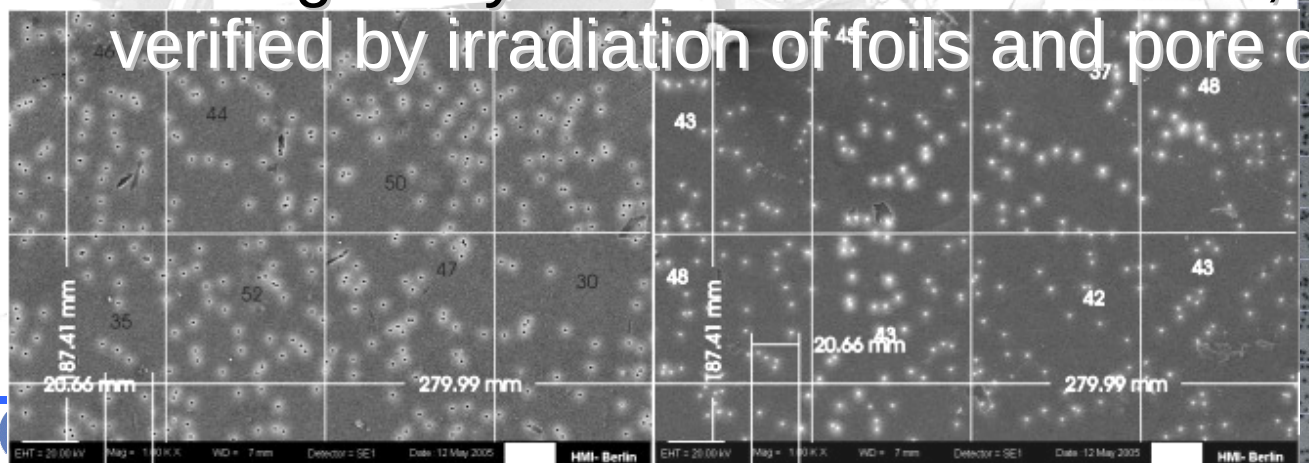
  - Gas change at the ion source
  - Tuning of the cyclotron

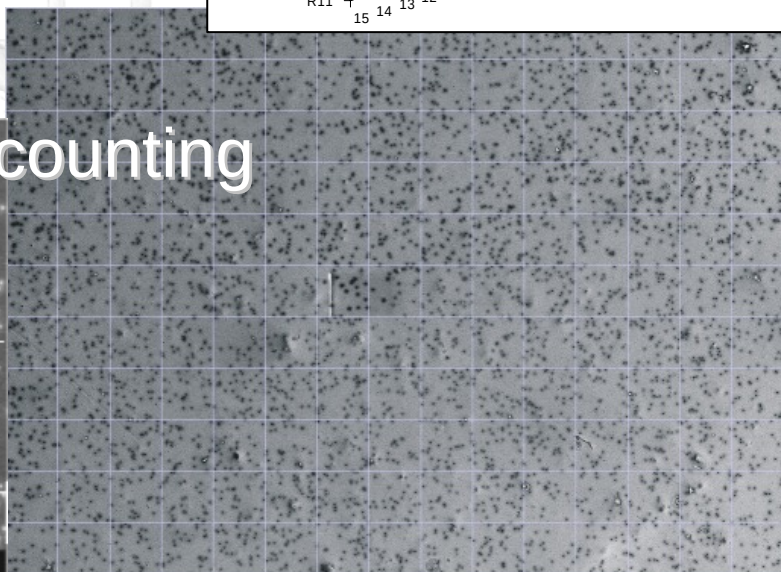
- Pumping time: twenty minutes
- Venting time: five minutes

BIBER: Beam characteristics

- Focused spot size: ∅ ≤ 2 mm
- Larger spots by x-y-beam scanning with wobbler magnets
  → size: up to 35 × 35 mm²
- Even larger irradiation areas:
  x- or y-line (by scanning, up to 70 mm) and perpendicular moving of the sample
- Ion beam current: < 100 fA – 10 µA
- Lower limit for flux: ca. 5000 ions/cm²/s
- Beam stability: mean deviation ≤ 10 %
- Homogeneity: mean deviation ≤ 20 %, verified by irradiation of foils and pore counting





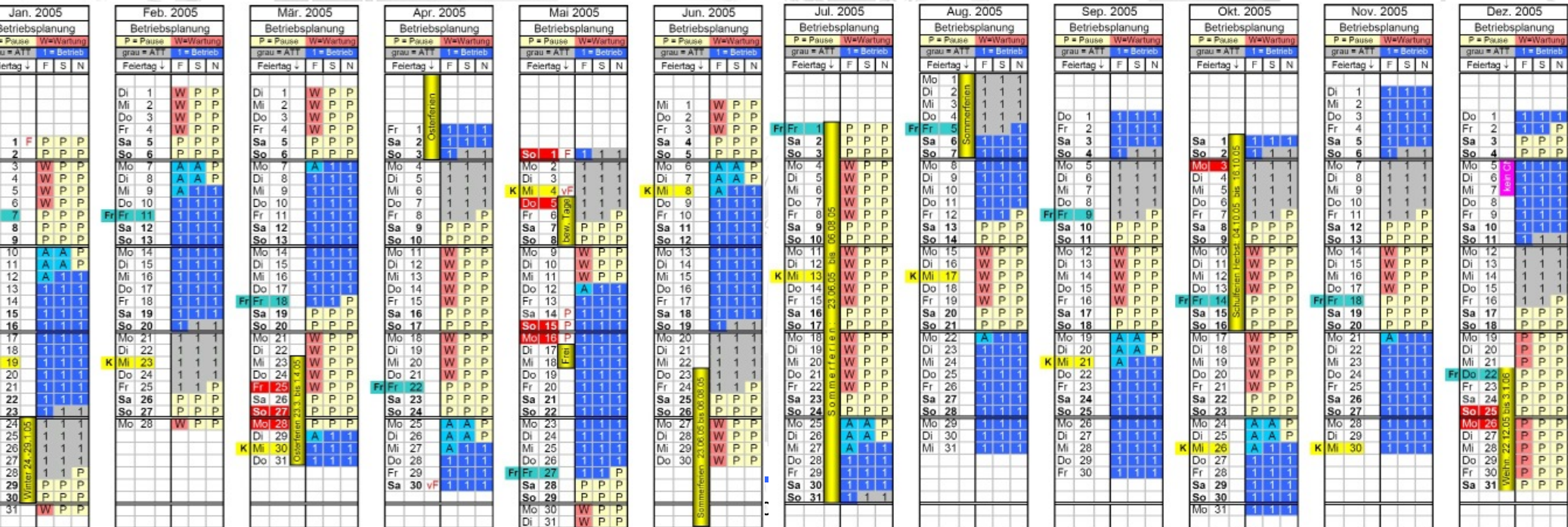


ISL's Proton irradiation station: Beam characteristics

- Focused spot size: ∅ ≤ 1 mm
- Larger spots by x-y-beam scanning with wobbler magnets
  → size: up to 40 × 40 mm²
- Even larger irradiation areas:
  x- or y-line (by scanning, up to 40 mm) and perpendicular moving of the sample
- Ion beam current: < 1 pA – 30 nA
- Lower limit for flux: ca. 700000 p/cm²/s
- Beam stability: mean deviation ≤ 10 %
- Homogeneity: mean deviation ≤ 20 %,

Scheduling and beam time request at ISL

- 3000 hours high energy beam time are to be allocated
- Longer shut-downs (yellow) in summer + winter holidays
- Ten weeks reserved for eye tumour therapy (grey)
  (nights are available for proton irradiations)
- Beam time (blue) is scheduled about six weeks in advance
- New experiments: application to the program advisory commit.
- Test irradiations possible at training days (light blue)



Costs at ISL

- Irradiations free of charge for public financed research institutes and research projects
  → results have to be published with reference to ISL
- All other irradiations are with costs
  - Hourly costs: 800 €
  - Additional charges (e.g. for beam set-up time) and minimum billing:
    - Depending on the irradiation volume
    - Negotiated with the economic management of HMI

Support and contact

- Mechanics and a machine shop are available to manufacture special equipment
- Engineers set-up and control accelerator and beam
- A physicist is preparing and assisting the irradiation

- Contacts:

www.hmi.de/isl

Dr. Andrea Denker

Dr. Jörg Opitz-Coutureau

Future developments and projects

- Work in progress: cocktail beams (6 + 10 MeV/n) and lower switching time with second injector to the RFQ
- There is a political decision of the Helmholtz-society to close the accelerator ISL (end of 2006)
- ➔ big danger of end of service
  ➔ Is there a future for ISL?
- As long as we are there – as long we'll provide you with our service.
- Thank you very much.