

Activities from Cyclotron facility at German Cancer Research Center (DKFZ), Heidelberg



Biggest Transition in the last two years



A Brief Historical Overview

1971: Bought first AEG Cyclotron (proton and He – 22MeV, 3He: 28, Deutrons: 11 MeV). The acceptance test of this cyclotron was not yet finished when AEG closed their cyclotron unit due to financial problems. Thus, the cyclotron team worked for themselves for its maintenance and repairs, ran for around 18 years



Historical overview continues..

- 1988: Approval from International Peer Review Committee
- 1991: MC32NI cyclotron was delivered to Heidelberg.
- First compact cyclotron for the production of negative H and D ions (this year 2016, it complete its 25 years)
- 32 MeV protons, 16 MeV deuterons
- One year later the production of RNs for the PET was started on a regular basis

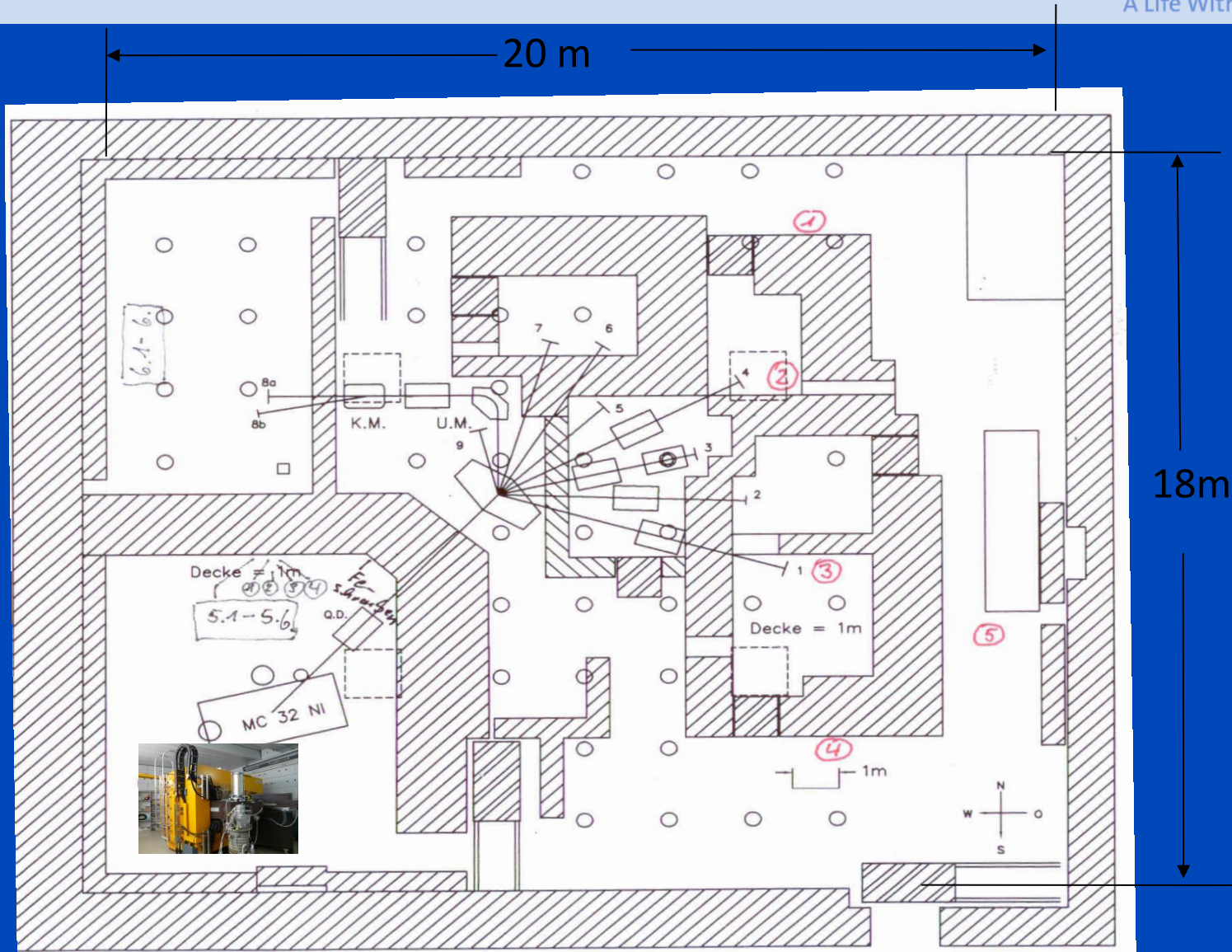


Some Important Parameters of MC32NI

Particles & energies	17 – 32 MeV protons / 8.5 – 16 MeV deuterons
External beam currents	$\geq 60 \mu\text{A}$
Extraction efficiency	$\approx 100 \%$
Magnet design (K = 32)	Conventional open H-shape, 4 spiral sectors
Pole face	135 cm \varnothing , 10 – 18 cm gap
Field strength	1.59 Tesla average
Accelerating system	2 dees, 90° each
Accelerating voltage	24 MHz, 30 kV
Ion source	Dual PIGtyp, arc: 2 kV / 2 A max.
Vacuum	$\approx 2 \times 10^{-7}$ mbar
Gross weight	≈ 53 tons



Layout of Heidelberg Cyclotron Hall



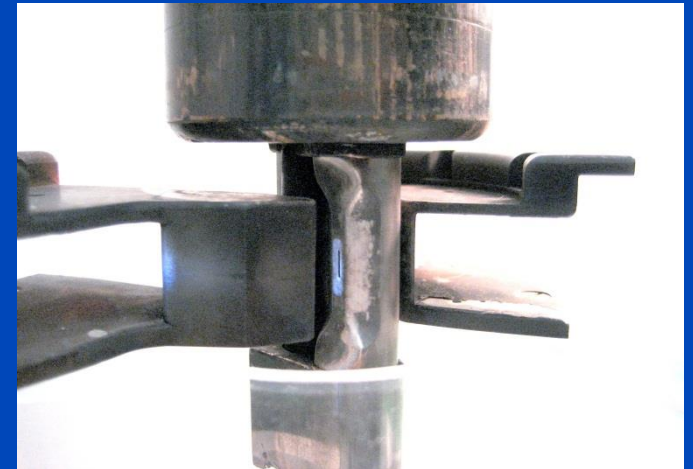
Zyklotron EG

Ion Source



Tantalum Cathode

Slit Opening: $0.5 \times 5 \text{ mm}^2$



Currently radioisotopes production from our cyclotron

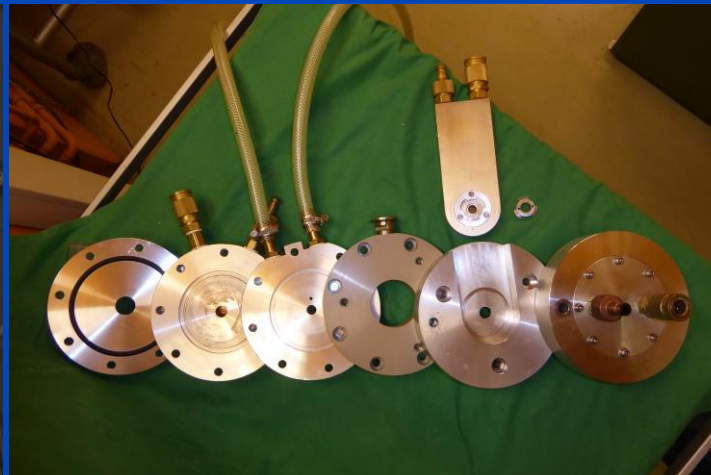
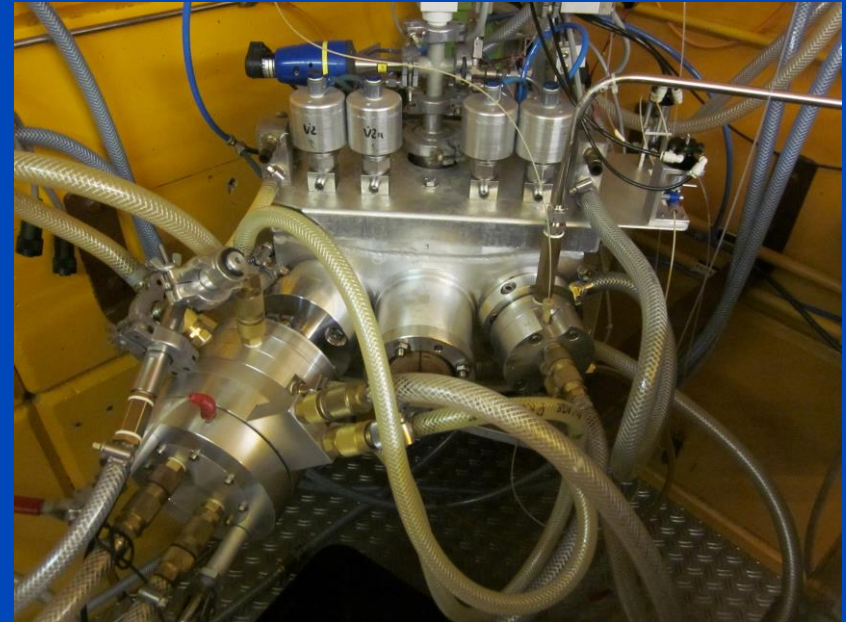
The cyclotron is employed for daily production of ^{18}F - which is further used for labelling of precursors of ;

[^{18}F]Fluorodeoxyglucose (FDG),
 [^{18}F]Fluorethyltyrosine (FET),
 [^{18}F]Natrium Fluoride (NaF),
 [^{18}F]Fluorothymidine (FLT),
 [^{18}F]Fluoroazomycin Arabinoside (FAZA)
 [^{18}F] ???

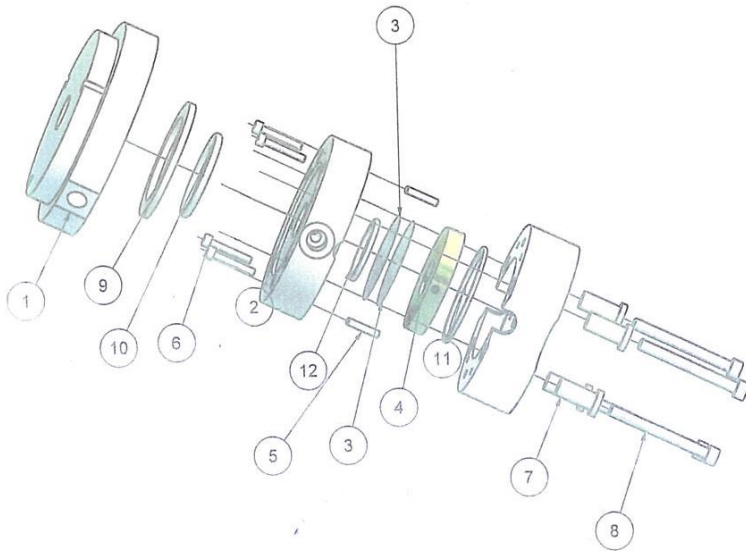
Nuclides	Nuclear Reactions Production in Cyclotron	$T_{1/2}$ [min]
^{11}C	$^{11}\text{B}(p,n)^{11}\text{C}$	20,3
^{13}N	$^{16}\text{O}(p,\alpha)^{13}\text{N}$	9,97
^{15}O	$^{15}\text{N}(p,n)^{15}\text{O}$	2,03
^{18}F	$^{18}\text{O}(p,n)^{18}\text{F}$	109,8
^{64}Cu	$^{64}\text{Ni}(p,n)^{64}\text{Cu}$	12,8 h

And bimonthly/monthly production of ^{64}Cu for PET studies

Solid Target Design

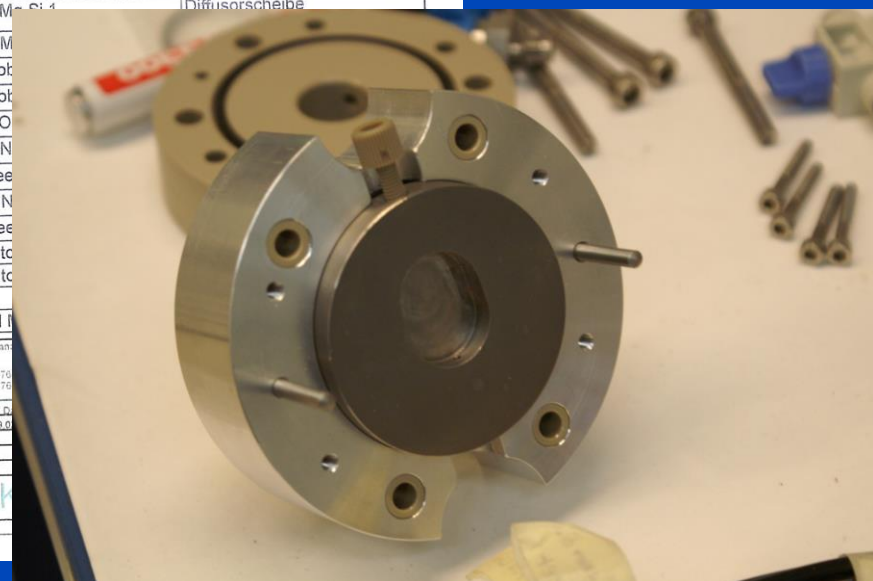
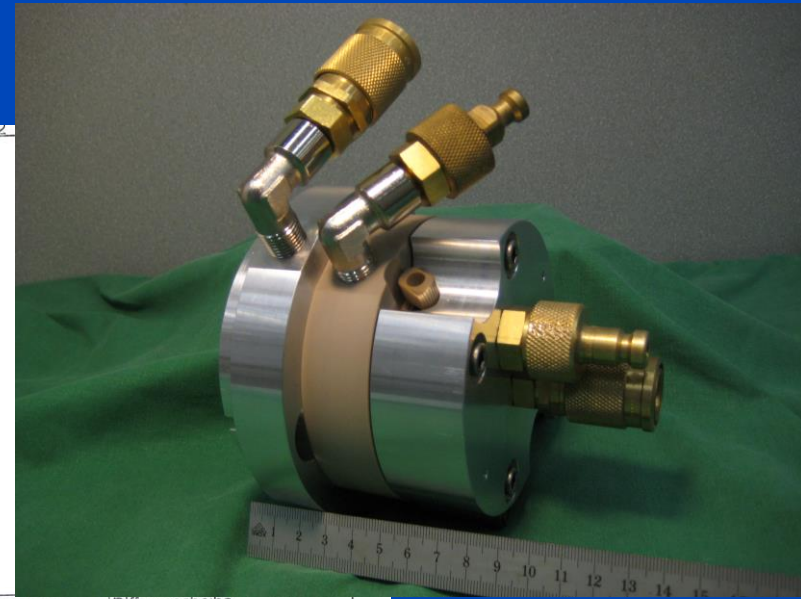


Liquid Target Design (180)

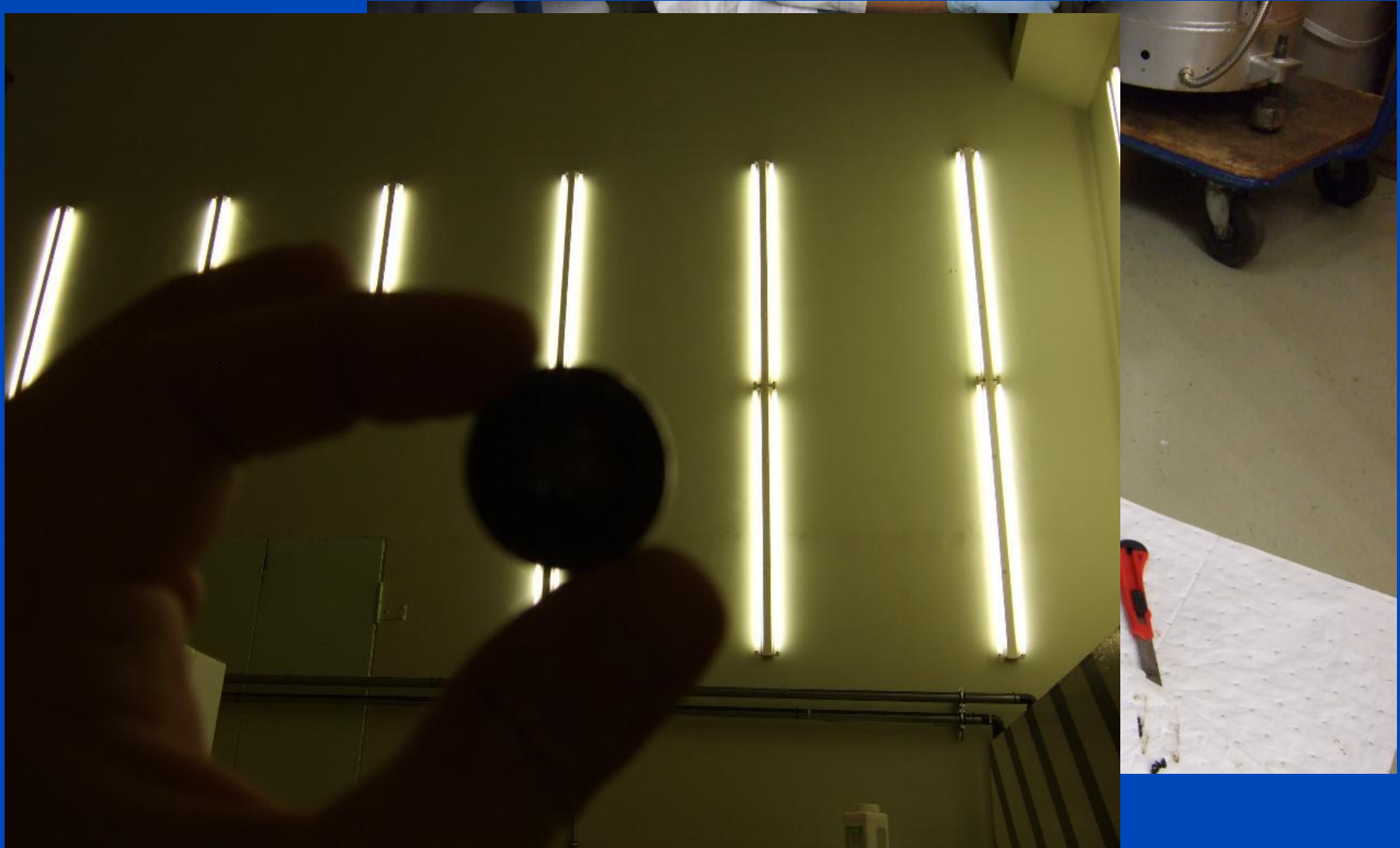


1	1	Al M... Si 1
2	1	Al M...
3	2	Niob
4	1	Niob
5	2	ISO
6	4	DIN
7	4	Pee
8	4	DIN
9	1	Pee
10	1	Vitc
11	1	Vitc
12	1	
13	1	Al M...

Status	Änderungen	Datum	Name



Diffusion Pump maintenance last week



After 3 hours of scrubbing



• Problems

- 1) Vacuum Pumps Oil
- 2) Vacuum Pumps and their maintenances
- 3) Sparking in the tank
- 4) Strange Patches on Dees
- 5) PLC Control Panel (Tableau) defected after blackout

- Confusions
- Upgrade is needed ?
- Which ? What ?
- Automation Software ? Which PLC
- RF Upgrade ?
- Pumping upgrades ?

Vacuum Pump Oils

- 1) Which Diffusion Pump Oils are readily available and recommended ?
- 2) Cheap and the best ?
- 3) Is Santovac 5 only solution for long run? Any improvement seen?
- 4) Which oil now replaces the old 66A oil which is not available, Balzer 71 A or Silicon oil DC 704, or mineral oilits availability ??

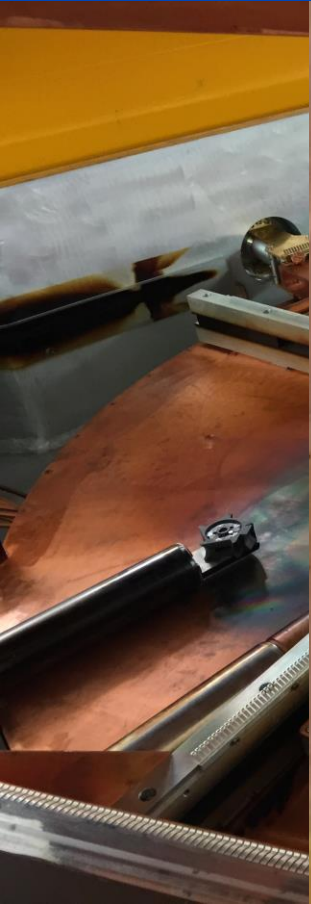


- Diffusion Pumps for next 20 years ?
- Combination of 2 set of prevacuum systems (can it be replaced by 1 pump, efficiency in vacuum ??)
- Maintenance ??
- Oil Change ?? According to color and use or according to time interval?

- Occuring since years. Explanation ?
- Bad transparency between radius 15cms and 50 cms
- Frequency of occurence increasing day by day
- Ion Source ? Vacuum at the center ??

Strange Patches on Dees

Cant be only due to Oil in the tank or bad vacuum in the tank !!!!!!!!!!!!!!!



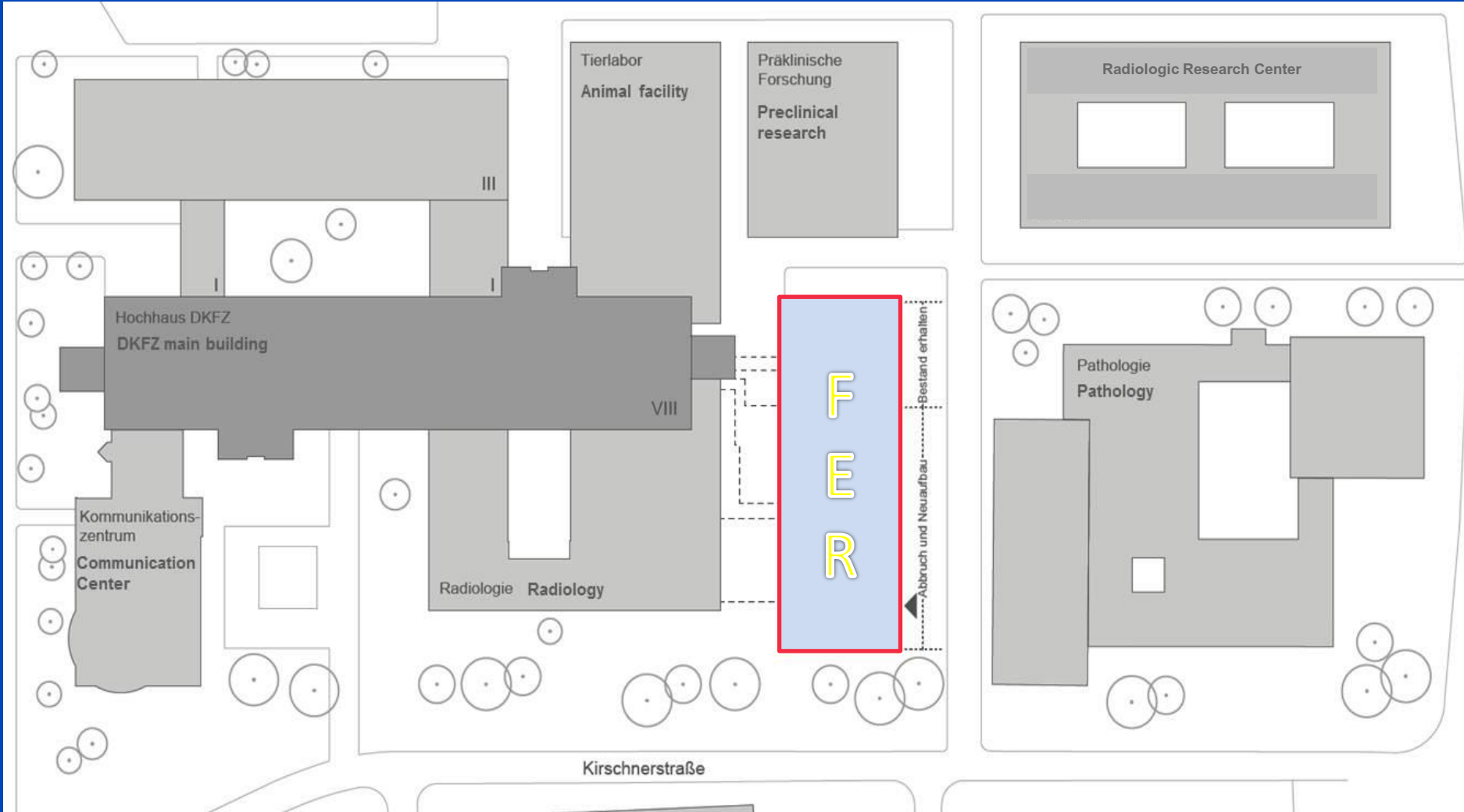
- In February 2016 there was a complete black out here and one of the PLC Tableau for feedback signals got defected.
- Since then looking for drawings, and the company that was responsible then in 1994 to built it in the system.
- It was from AEG Mannheim. The company is now overtaken by Schneider elcectric. The responsible gentlemen is retired now.
- In future how to deal with these problems ????
- Do we have all the drawings ? If not then whom to contact ?

- 1) Upgrade SIMATIC S5 ??
 - Future of S5 ????????
 - S7 ?????
 - Labview ??
 - Any other??
 - Time issue ?
 - Money issue ???
- 2) RF Upgrade ??
 - Is it feasible economically ??
 - Needed ??
- 3) Pumps ?? Oil diffusion is enough or Turbos ??

Radiology Research Center (starts 2014...)



Proposal for Research and Development Center for Radiopharmaceutical Chemistry (FER)



Proposal for Research and Development Center for Radiopharmaceutical Chemistry (planned ...)

F
E
R

Abluft GMP-Bereich
+ Radionuklid-Labore



Upcoming Plans

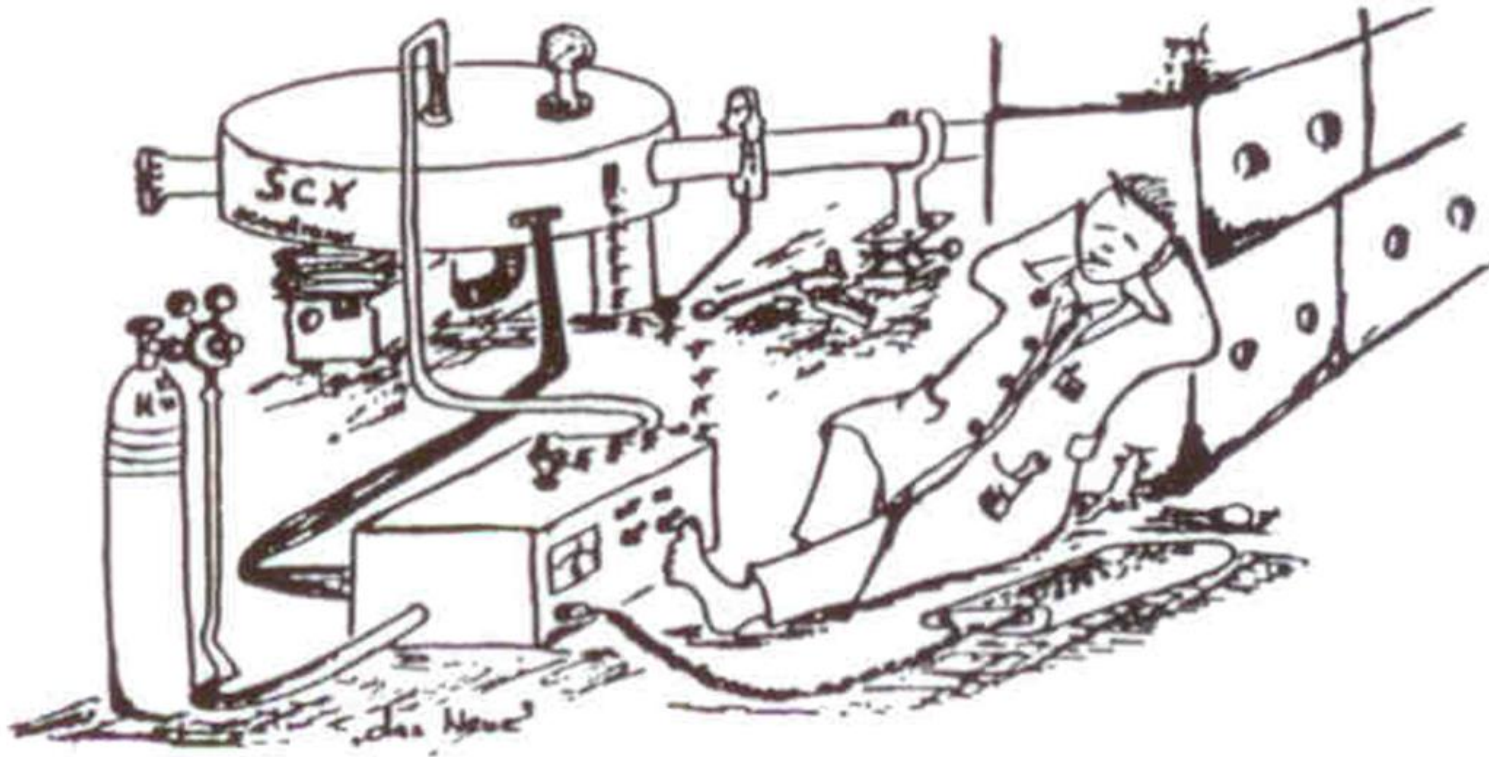
In coming years plans are:

- Production of more RN's from our Cyclotron for PET studies for e.g ^{66}Ga , ^{44}Sc , ^{89}Zr etc.....
- Looking forward for acquiring a new Cyclotron (2018 probably) that could be used for routine production (^{18}F , ^{11}C) and utilizing the existing Scanditronix machine for more research work (production of more radiometals).
- Complete automation of our target system, beamlines, vacuum system with the help of existing automation tool SIMAT
- Collaborations with other partners to work more closely towards a similar goal.

We Intend to run our machine, our **Rolls Royce** for next 20 years atleast !!

‘Together we can and we will make difference 😊’ !!

Ultimate Goal ☺



Thank You

