

Radiation Safety Instructions

for users of the ELSA accelerator
facility



ELECTRON STRETCHER ACCELERATOR

March 19 2014

The Annual Radiation Safety Instructions

ELSA = 'Facility for the production of ionizing radiation'

You may be working in **areas of enhanced radioactivity**

→ You are subject to the **German Radiation Safety Regulations**

→ These regulations are formulated in the

Radiation Safety Ordinance

→ You must **attend the annual Radiation Safety Instructions, otherwise you may be bared from the access to radiation safety areas !!!**

Radiation Safety Organization

- **Radiation Safety Responsibility**

Chancellor of the university
Taken over by the administration
(Div. 4.4)

- **Radiation Safety Officers**

Implementation of the legal rules
in the different institutes

- **Organization in the PI**

Every working field has one or
more radiation safety officers

Accelerator Group	F.G. Engelmann F. Frommberger W. Hillert
Experiments (CB-ELSA, B1)	H. Dutz S. Goertz N. Jöpen M. Lang (HISKP) D. Walther (HISKP)
SiLab	F. Hügging

Danger of Ionizing Radiation

1. Physics effects: Energy deposition of the particles

- **Charged particles** (Electrons, protons, ions, etc...)
 - **Photons** (x- and γ -rays)
 - **Neutrons** (only indirectly)
- **Photons and charged particles**: Ionization and excitation of atoms
 - **Neutrons**: Creation of charged particles in nuclear reactions

2. Biologic effects: Destruction of cells & mutation of genes

- direct effect: Ionisation \Rightarrow Break up of the cell molecules
- indirect effect: Creation of highly reactive radicals (**OH⁻**)
 - \Rightarrow Damage of the cell membranes
 - \Rightarrow Damage of the chromosomes

Consequences: Dead of the cells, sterility, **cell anomalies, cancer**

Measurement of doses = energy deposition

Physics number:

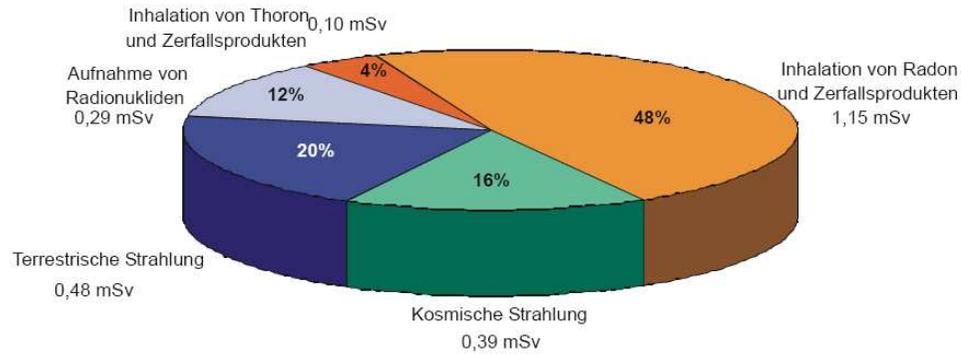
$$\text{Energy dose: } D = \Delta E / \Delta M ; [D] = \text{Gy} = \text{J/kg}$$

Consideration of the biologic effectiveness (ionization density):

$$\Rightarrow \text{Equivalent dose: } H = Q \cdot D ; [H] = \text{Sv}$$

Kind of radiation	Quality factor Q
X- and γ -rays	~ 1
Electrons (β)	~ 1
Alpha (α)	~ 20
Neutrons (n)	2 - 10 (depending on energy)

Radiation Safety Areas



General state territory:

Additional radiation exposition
< 1 mSv/8760 h

Inhalation & incorporation of radioactive particles	64%
Cosmics	16%
Radioactive decay within earth crust	20%
Medical diagnostics (x-rays)	+ ~ mSv

Supervised areas: > 1mSv/2000h

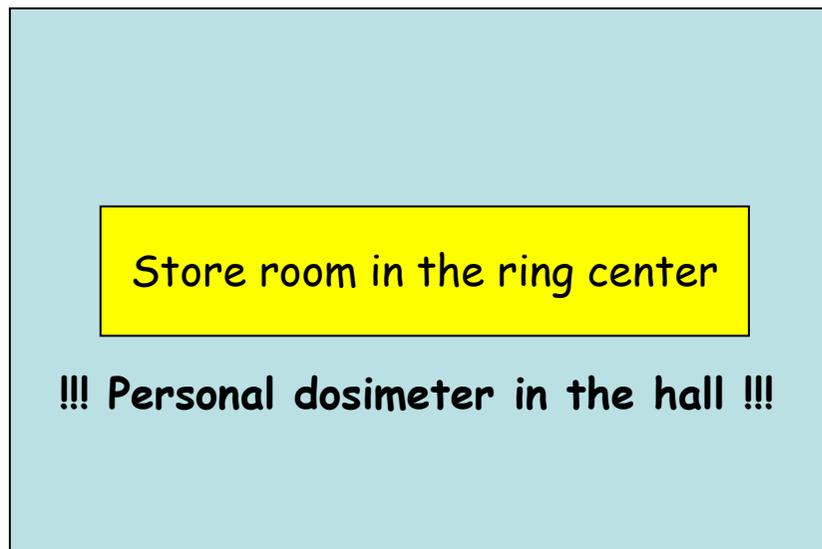
Controlled areas: > 6 mSv/2000h
= 3 μ Sv/h

Restricted areas
> 3 mSv/h

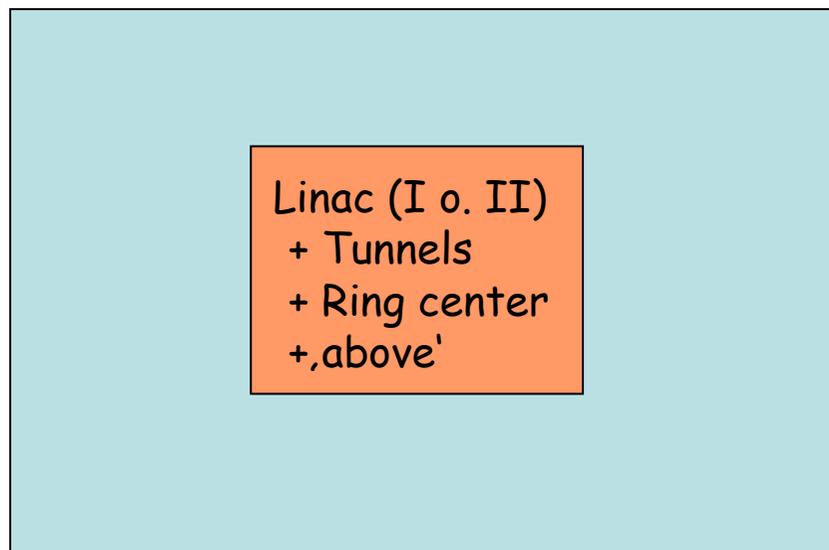
Natural radioactivity ~ 2mSv/a

Radiation Safety Areas at ELSA

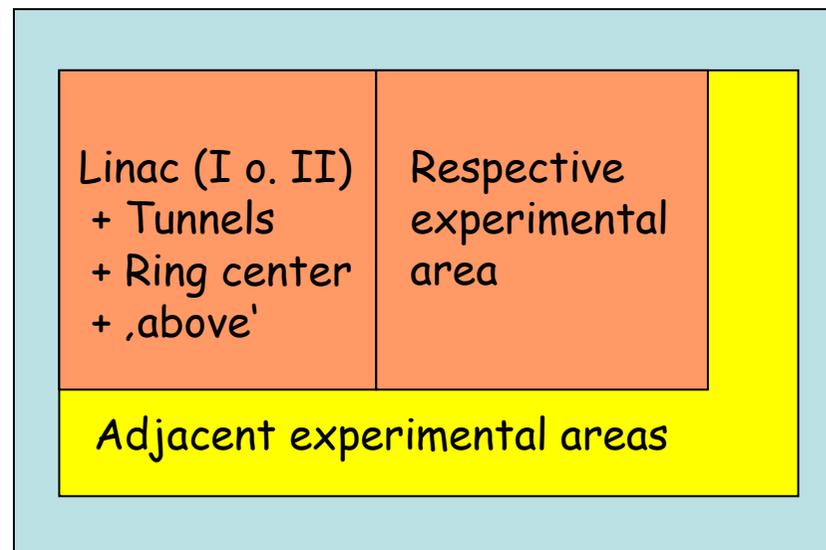
Accelerator off



Accelerator on without extraction



Accelerator on with extraction



ELSA Personenschutzsystem

- keine Freigabe LINAC 1
- keine Freigabe LINAC 2
- Schlüsselkasten OK
- alle Durchgänge OK
- Freigabe ELSA Stromversorgung

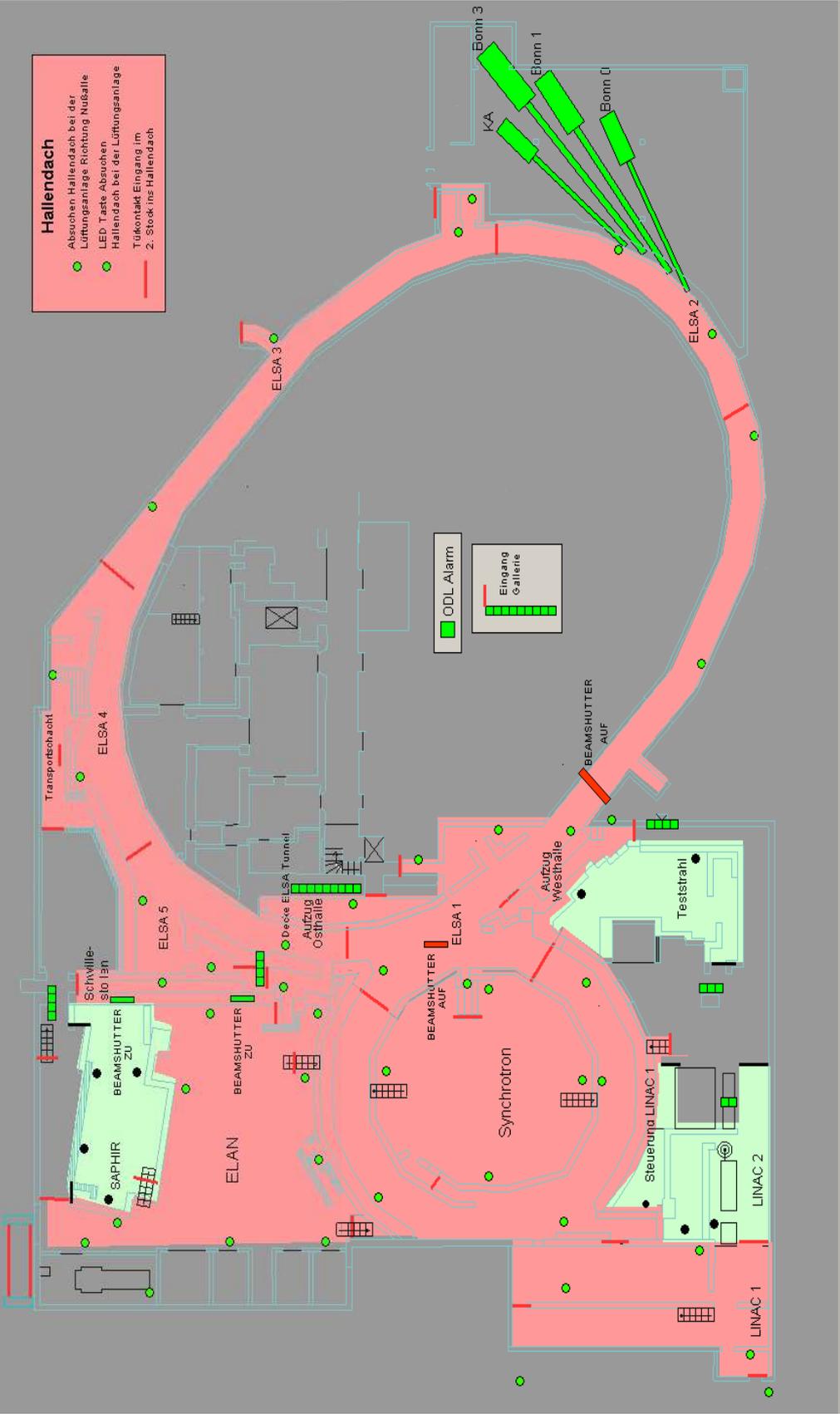
- Strahlung AUS
- ELSA einschalten

- Schlüsselkästen
- freigeben
- verriegeln
- verriegelt

- Lebenszeichen, SPS:
-
-
-

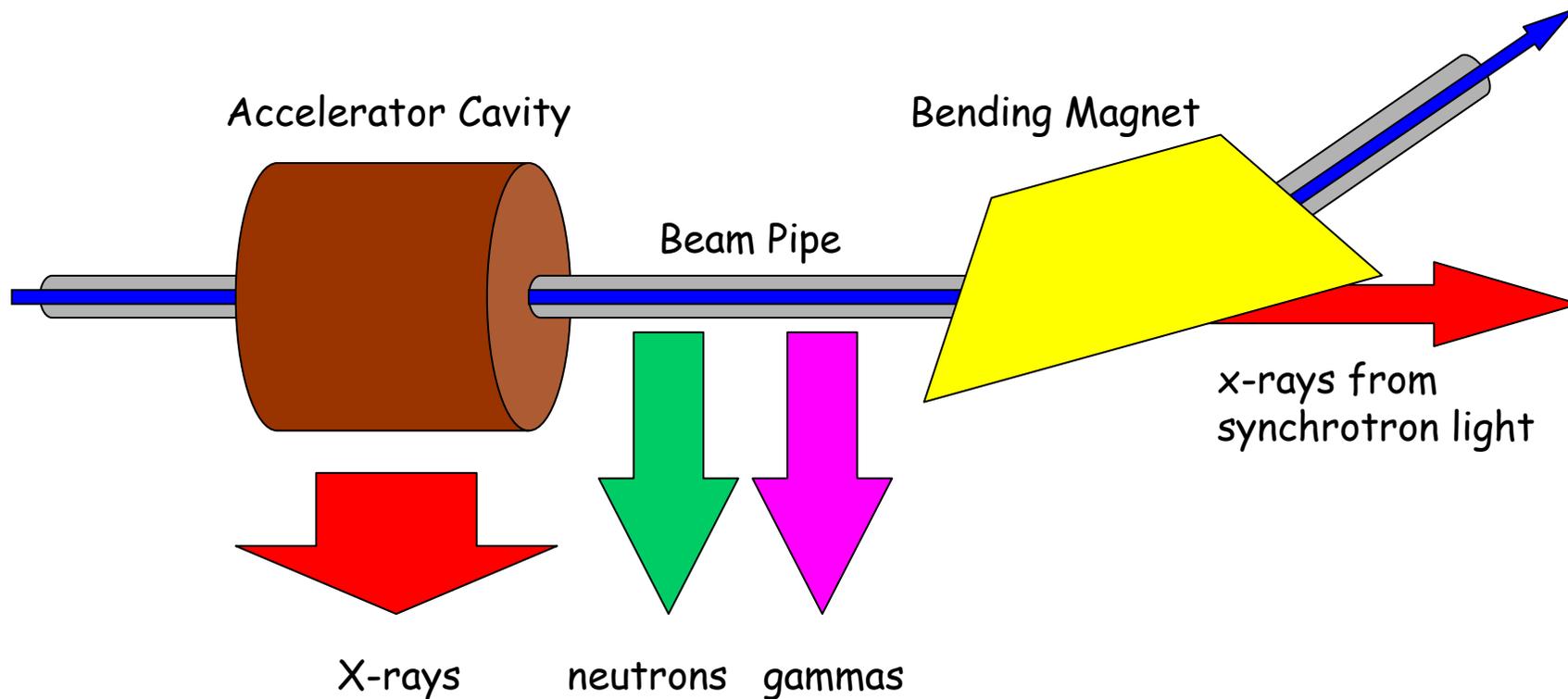
Hallendach

- Absuchen Hallendach bei der Lüftungsanlage Richtung Nußalle
- LED Taste Absuchen Hallendach bei der Lüftungsanlage
- Türkontakt Eingang im 2. Stock ins Hallendach



Sources of ionizing radiation with the accelerator on

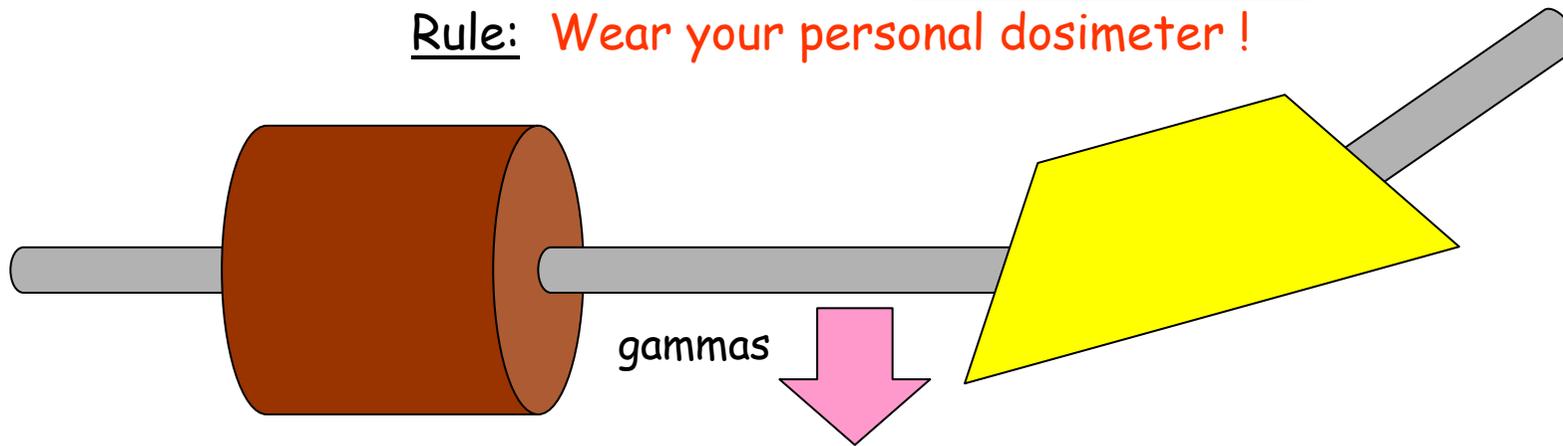
Accelerator tunnel is a restricted area



Sources of ionizing radiation with the accelerator off

Accelerator tunnel is a **Supervised Area**

Rule: **Wear your personal dosimeter !**



Rules for the access of Radiation Safety Areas

- To the Supervised Areas if
 - you have a real working task
 - for education or as a visitor
- To the Controlled Areas if:

Same rules as for Supervised Areas valid + Dosimeter

Strictly forbidden in Control Areas

- Eating / Drinking / Smoking

PREGNANT PERSONS ARE NOT ALLOWED TO ENTER CONTROLLED AREAS !!! PREGANCIES MUST BE REPORTED TO THE RADIATION SAFETY OFFICER !!!

- To the restricted areas:

NOT POSSIBLE guaranteed by a Safety System

Conditions for the assignement of a dosimeter

- You must be **formally registered** for our **Radiation Safety Supervision** (Ms Germann, room PI 0.040 in the afternoon).
- You are assigned to a **catagory** (B: 1...6 mSv/a).
- Visit the **Radiation Safety Physician** (once), or bring a respective certificate from your home institute.
- Bring a certificate, which states the total dose you received so far in your working life.
- Attend to the **Radiation Safety Instructions** given by the responsible RSO.

Additional rules for collaborators of foreign german institutions:

- You have to bring your **,'radiation passport'**.
- You have to bring your **,'official dosimeter'** from your home institute and to wear it together with the dosimeter from the Physics Institute.

The Safety System (PSS)

Purpose: Protection of persons against the ionizing radiation produced by the accelerator

Possibilities of getting exposed to radiation

1. **Due to entering a restricted area**
 - ⇒ System of doors and light barriers
2. **Background radiation** outside of the accelerator areas
 - ⇒ System of $n + \gamma$ probes (local dose rate measurement)

Both systems lead to an immediate 'destruction' of the beam



The Interlock System:

1. System of interlock doors and light barriers:

- ⇒ PSS breaks down when a door or barrier is passed
- ⇒ Beam is destroyed immediately

2. Interlock keys: No beam without all keys in place !

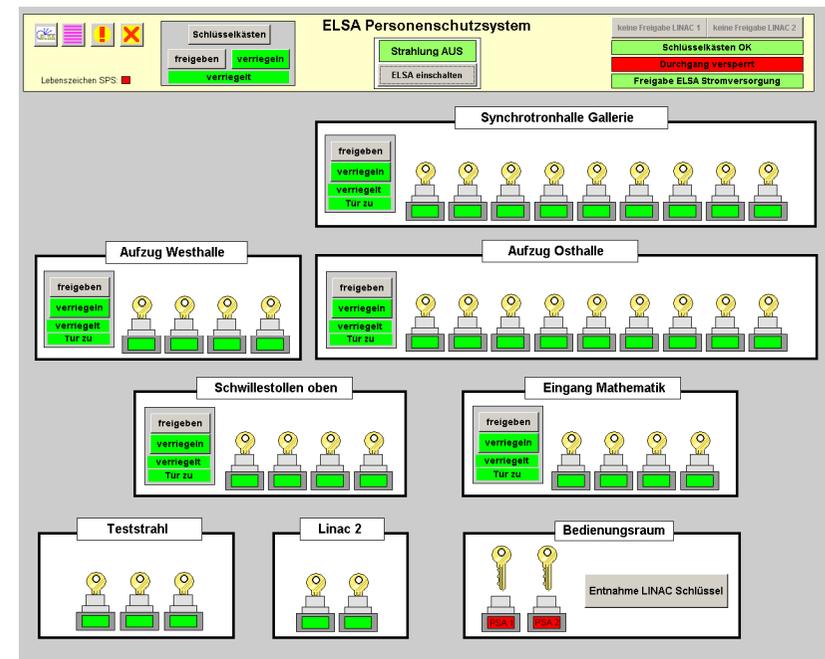
- ⇒ During activation of the PSS:
Search of the hall for persons
- ⇒ Everybody found is handed out a key
- ⇒ The key is your personal life insurance !
- ⇒ When the beam is off, the key system allows the access to restricted areas without breaking the PSS



In case of a urgent access during beam time:

1. **Tell the accelerator operator** that you like to enter the hall
He will unlock one of the key boxes (CB-ELSA/BGO-OD: Entr. Wegeler Str.)
2. **Everybody** entering the hall **must take his/her own key** !
3. The PSS (doors and light barr.) can be bridged with the key for 10 sec.
4. Afterwards: Put back the keys to the keybox.

Tell the operator, when you finished your work.



Red lights on at the entrances to restricted areas



- You may bridge the door for 10 sec by turning your key clockwise once.
- Don't hold the key, it will break the interlock !
- You may turn the key several times, if more than 10 sec are needed.

The PSS is completely set ⇒ The accelerator may be switched on

Indications for the presence of the beam: 1. Siren (20 sec long)

3. At the doors/barriers:

- yellow light on
- red sign on

2. At the walls:

- yellow light on



What to do, when

- you are in the hall and you actually **think that the beam may be on ?**
- you are in the hall and you see a **yellow flashlight** blinking ?



Then:

- Leave the hall quickly
Follow the emergency exit signs
but: **don't panic, don't run !!!**
- Inform the radiation safety officer

Immediate measures:

- Press the red **NOT AUS** button
- or: Leave the hall, you will pass a door / barrier after some seconds



This system is safe if you follow the rules !

But: It's only a machine, thus no problem to outwit !

Strictly forbidden:

- During the search of the hall
to play some hide and seek game
- When the PSS is set
to bypass the entrance doors in any way
to enter the hall without having your own key

Final remarks

1) Shift organization outside of normal working hours

At least 2 persons on shift:

- 1 with diploma or equivalent (responsible person)
- 1 shift student in control room

2) What to do if the PSS is broken outside normal working hours ?

a) In the experimental area only (CB-ELSA & BGO-OD):

Selected persons (e.g. the shift leaders) are allowed to reset the PSS without contacting a RSO. The resetting has to be documented in the ELSA radiation safety book.

b) In the machine area:

- Call the RSO in duty. Telephone numbers \Rightarrow radiation safety board
- Tell the RSO what was the reason for the broken PSS.
- The RSO decides, whether or not the PSS may be reset.
- If the RSO agrees to reset the PSS:
 - before 11pm: Call the operator in duty
 - after 11pm: Call the physicist in duty and ask for coming.
- If the RSO in duty is not available, try to contact another one !
- If nobody is on the phone, wait and try later again !!!

3) When your work is finished and you don't plan to come back, please inform the ELSA secretary (Ms Germann). Your registration for the Radiation Safety Supervision will be cancelled.

Radioactive sources and activated materials

Radioactive sources for detector tests etc.

- **are available** from a radiation safety officer
- may be used during **normal working hours**
(or in a time period in agreement with a radiation safety officer)
- have to be **given back immediately** after finishing the work !!!

Material used or stored within the accelerator hall during a beam period

- **must not be removed** from the hall or even given to workshops
- unless it was **measured by a radiation safety officer**
and declared as free of enhanced radiation.

Thanks for your attention !