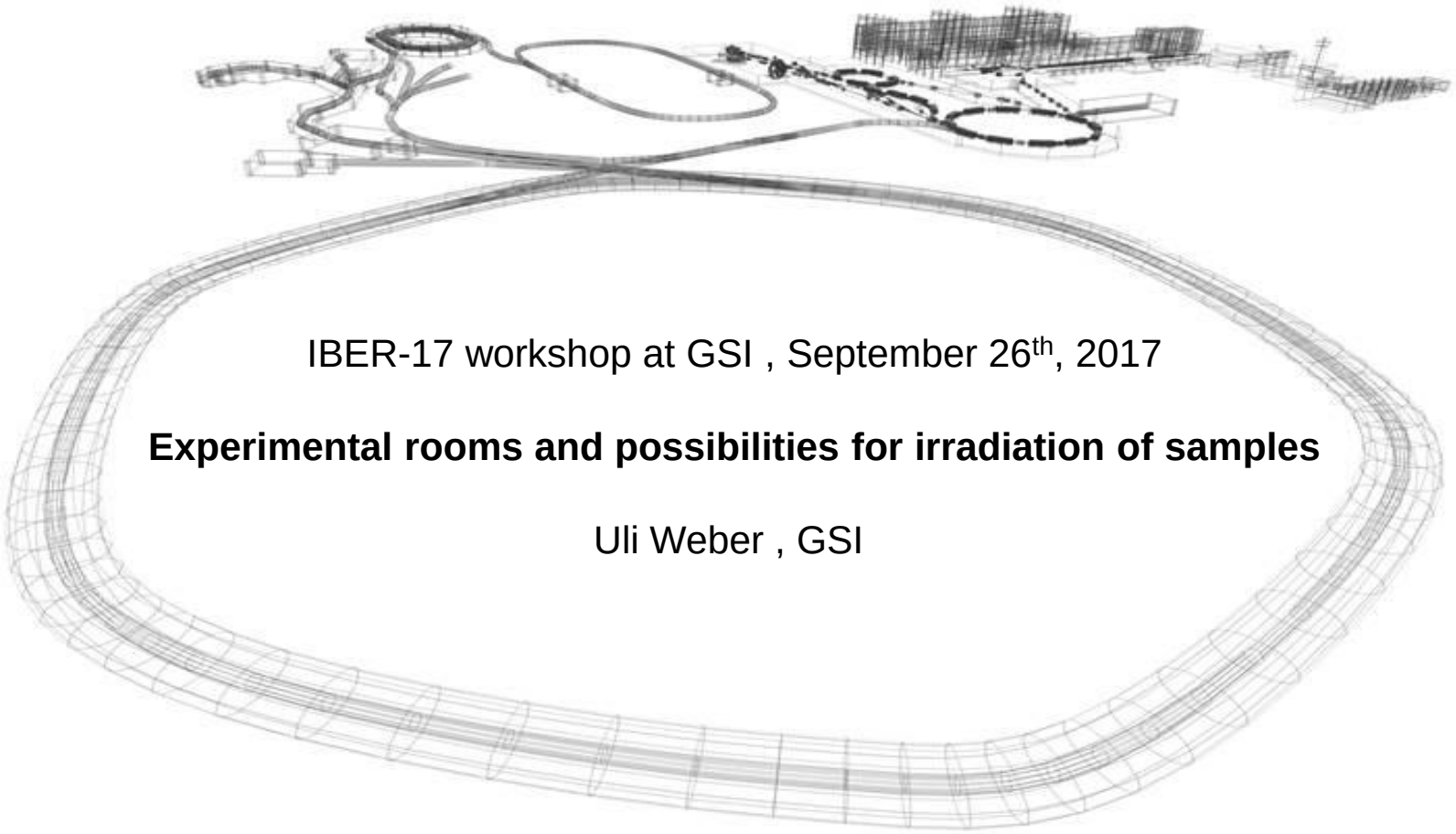
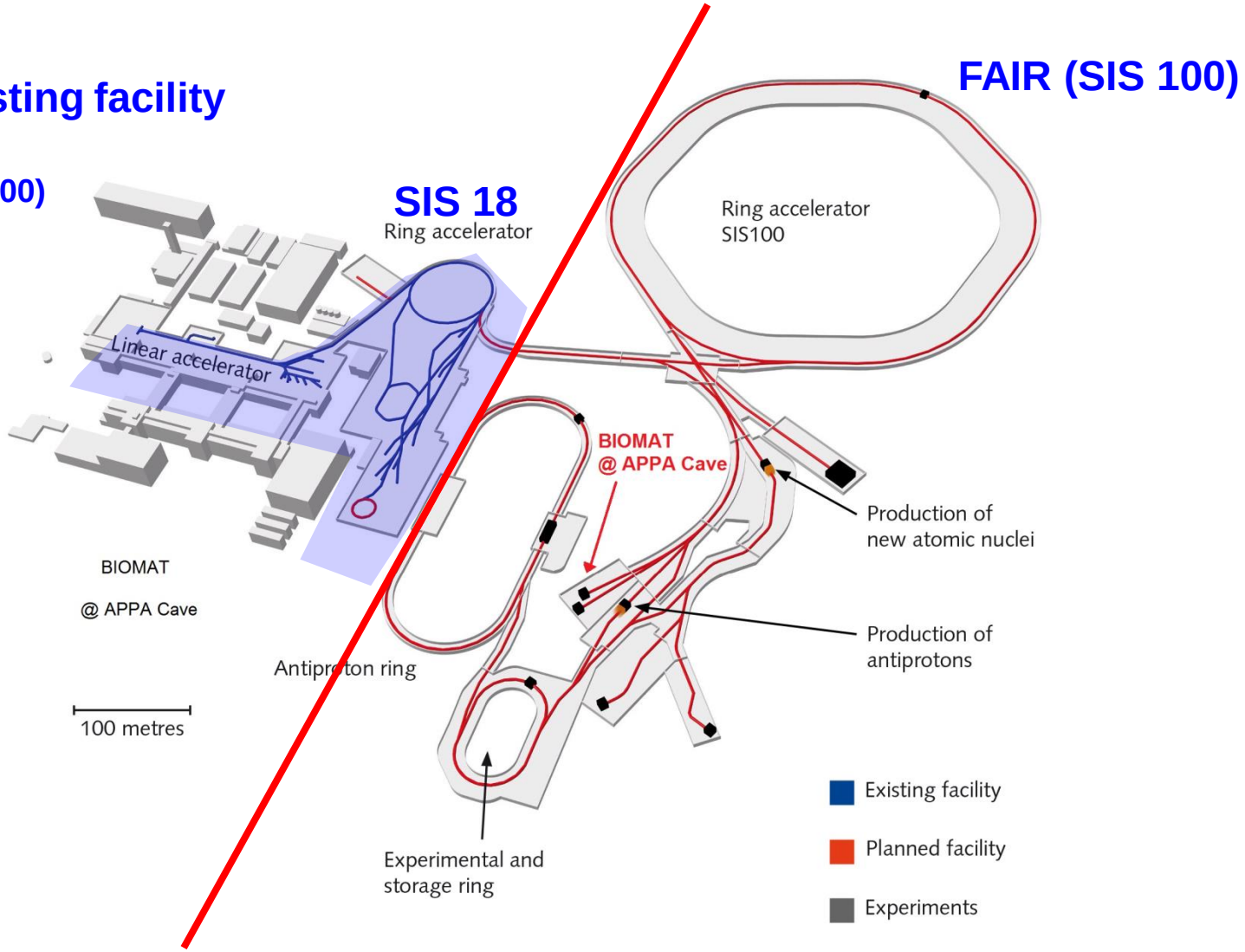


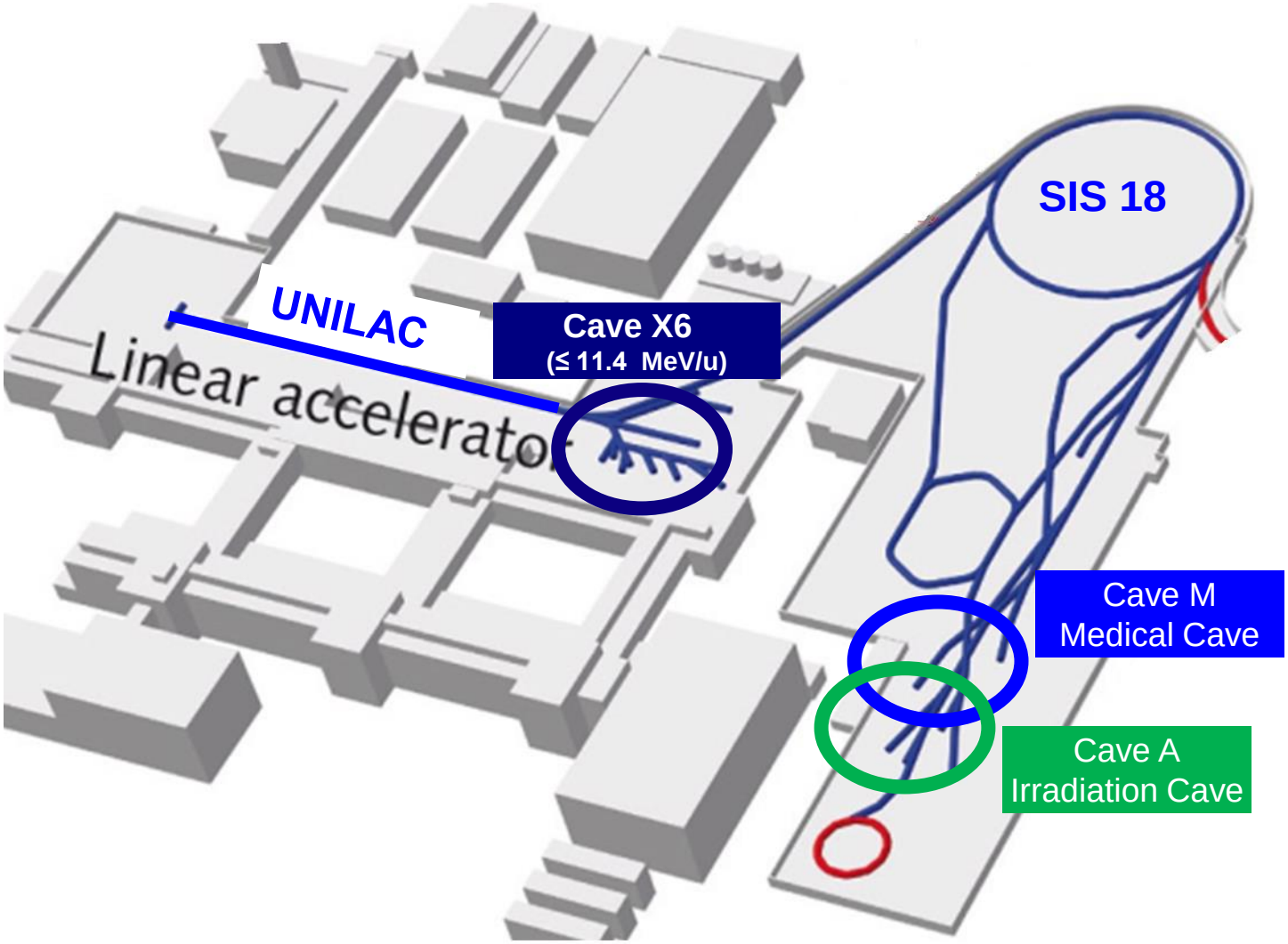
IBER-17 workshop at GSI , September 26th, 2017

Experimental rooms and possibilities for irradiation of samples

Uli Weber , GSI

For IBER-17
only the existing facility
is relevant
(not FAIR - SIS100)




SIS 18
UNILAC
Linear accelerator
Cave X6
(≤ 11.4 MeV/u)
Cave M
Medical Cave
Cave A
Irradiation Cave

Low energy irradiation @ Cave **X6**

- Energy: ≤ 11.4 MeV/u (H…Fe)

  Relevance for space research ?
  (stopping particles)

- Thin samples only !

- Samples in a magazine

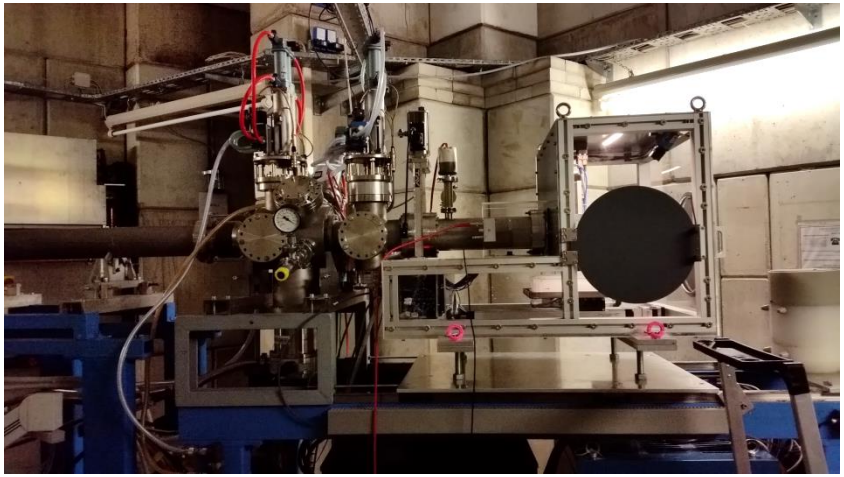
- Beam application: scattered beam

- X-ray source (250 kV, 15 mA)

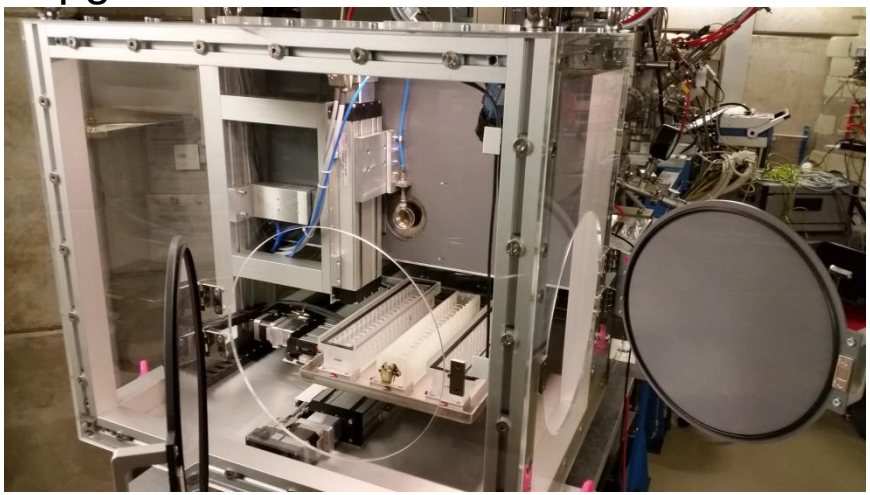
  (near X6)

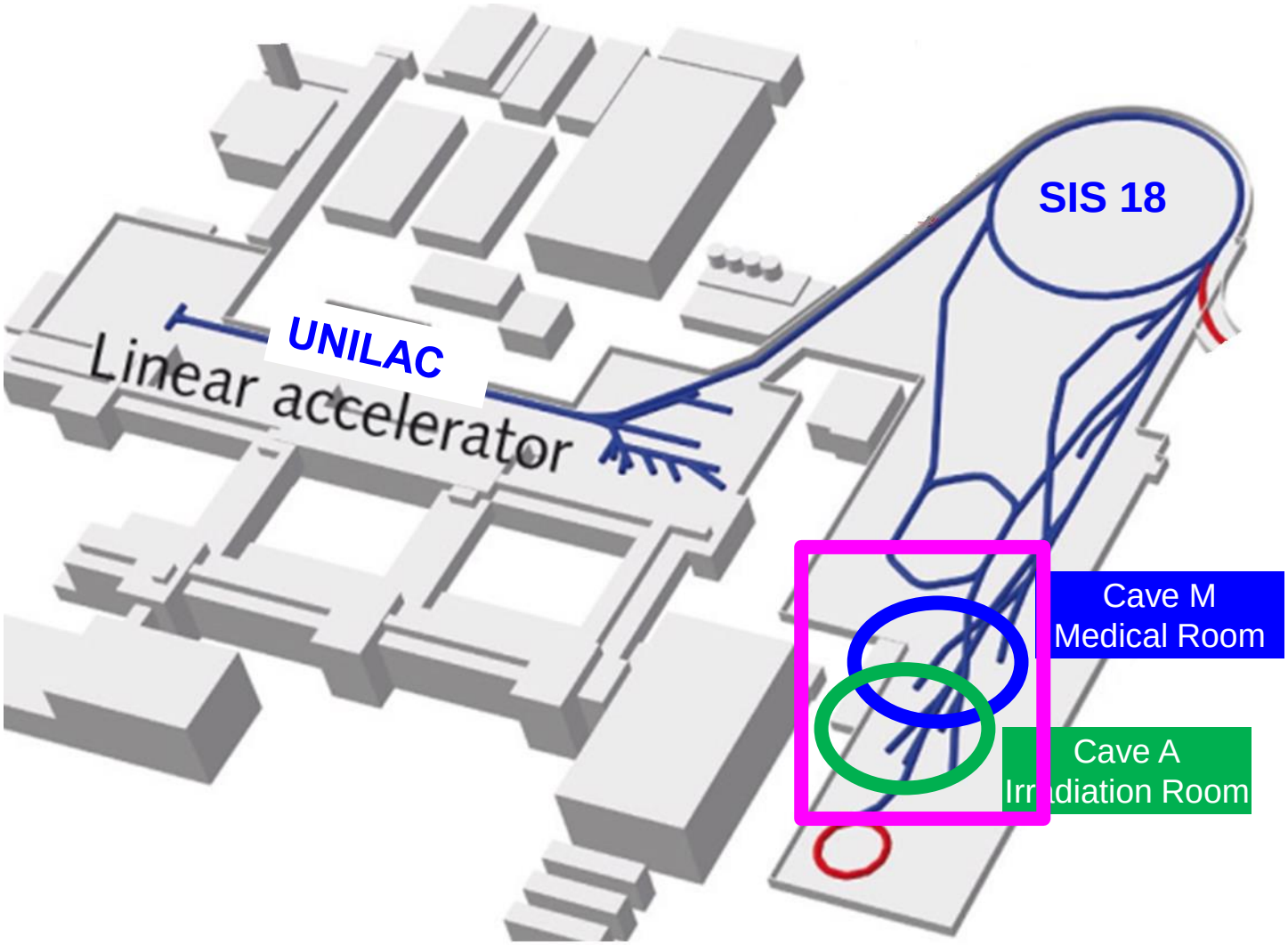
  Several instructions
  for safety and radio protection
  required !

X6 Cave



Upgraded irradiation device in X6




SIS 18
UNILAC
Linear accelerator
Cave M
Medical Room
Cave A
Irradiation Room

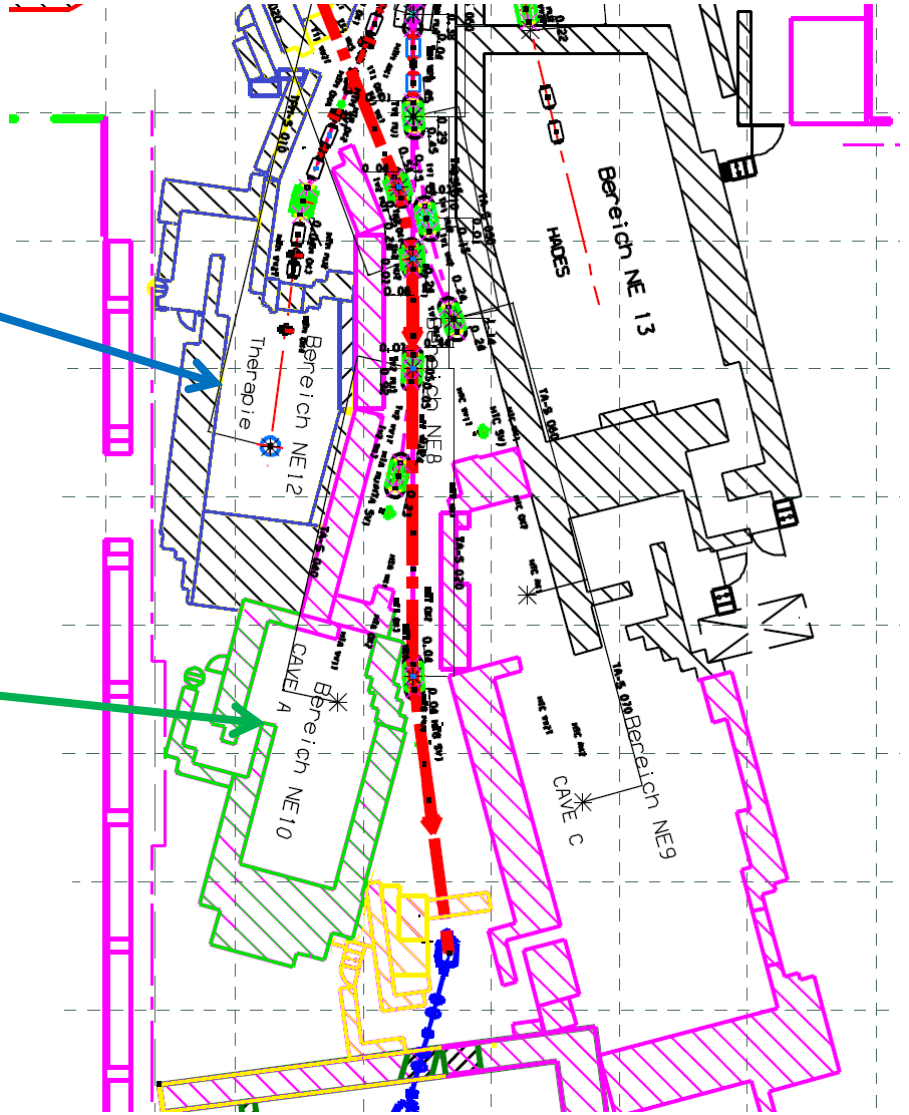
Cave M / Cave A

Cave M (medical)

- Patient treatment until 2009
- now used for experimental research in ion beam therapy (motion target irradiation)
- Irradiation for radio biology
- Beam scanning

Cave A

- Technical irradiation room
- Irradiation with beam scanning
- Experiments:
  - **Biophysics**
  - Material research
  - Atomic physics



Infrastructure for irradiation

- **The irradiation infrastructure for the IBER-17 campaign <u>will be very similar</u> compared to the recent IBER08 and IBER10 programs !**

- Both experimental rooms (Cave M and Cave A) will be available even for complex irradiations.

- Scanning application for various applications:

  - Simple mono-energetic patterns
    - small precise fields , e.g. 2 x 2 cm
    - large fields up to 20 x 20 cm

  - **3D** iso-dose irradiations (spread-out Bragg peaks, cubes, spheres)
    energy variation: passive with range-shifter (at least for 2018 due to the FAIR extension)

  - Complex fields (like clinical treatment plans)

  - Dosimetry or Accuracy of applied fluence:
    - ± 10% (conservative)
    - ± 5% for carbon and clinical energies

Possible intensities and energies in Cave A / M

SIS-18 Cave A / Cave M Experiments							
	Ion type						
	protons	He	C	Ne	Ar	Fe, Kr, Xe, U	others
Time structure	slow extraction, spill length typically 1- 10 sec						
Experiments using higher particle rates (high dose)							
Max. number of ions per cycle	$2x10^{10}$	$1 x10^{10}$	$2x10^{9}$	$5x10^{8}$	$1.5 x10^{8}$	-	-
Typical number of ions per cycle	$2x10^{9}$	$1 x10^{9}$	$2x10^{8}$	$5x10^{7}$	$1.5 x10^{7}$	-	-
Max. energy	230 MeV	230 MeV/u	430 MeV/u	430 MeV/u	500 MeV/u	-	-
Beam spot radius FWHM [mm]	8-30	6-20	4-12	4-12	4-12	-	-
Other experiments (space research, low-lose effects, etc.)							
Max. number of ions per cycle	$2x10^{8}$	$1 x10^{8}$	$1 x10^{8}$	$1 x10^{8}$	$1 x10^{8}$	$1 x10^{8}$	$1 x10^{8}$
Max. energy	2 (4) GeV	2 GeV/u	2 GeV/u	2 GeV/u	1 GeV/u	1 GeV/u	1 GeV/u
Beam spot radius FWHM [mm]	4-30	4-20	4-12	4-12	4-12	4-12	4-12

Physics experiments

- Energy: full energy range of the SIS18 synchrotron (see last slide)
- Intensities: ca. 1000 ions/sec - 10^8 (10^9) (see last slide)
- Beam width: pencil beam typ. 5- 10 mm FWHM , adjustable by quad magnets
- Scanning or straight beam
- Nuclear physics experiments (fragmentation etc.) better in Cave A

4D-irradiation experiment with pics, cardiac arrhythmia ablation, 2015

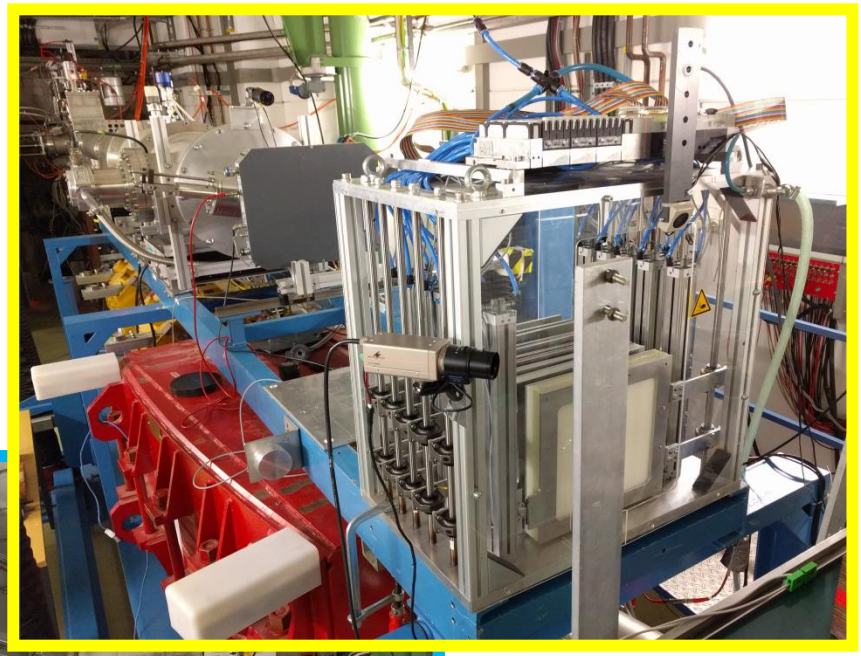
Cave M

- Fully equipped irradiation room
- Optimized for biological and technical samples
- High dose and high LET beams (>10Gy Fe) could stress the vacuum window (polymer foils)
- Currently under construction (upgrade for faster scanning),
  availability in August 2018 not guaranteed

4D-irradiation experiment with pics, cardiac arrhythmia ablation, 2015

Cave A

- Fully equipped irradiation room
- Optimized for biological and technical samples
- Good for high dose and LET irradiation (steel window)
- Available in any case (08/2018 - 2019)



Equipment:

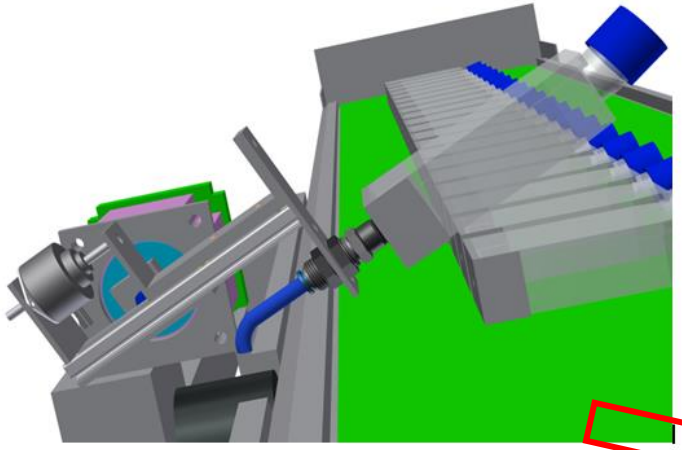
- Beam Scanning
- Laser (adjustment)
- Video
- Cables/network
- Compressed air
- Sample holders
- Etc. …

Sample holder / changer

Cave M (irradiation of cell culture flasks)

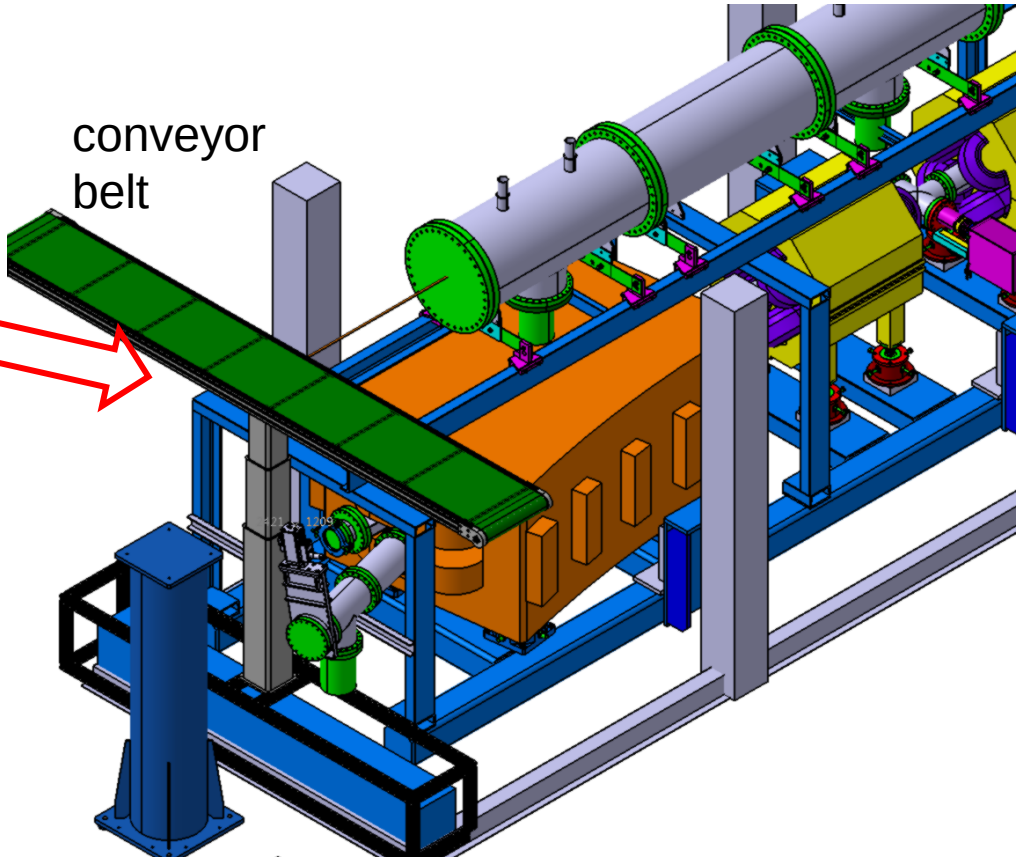
using the conveyor-belt in combination with camera and Iso-centre lasers is very robust, easy and reliable

New sample changer (under construction)

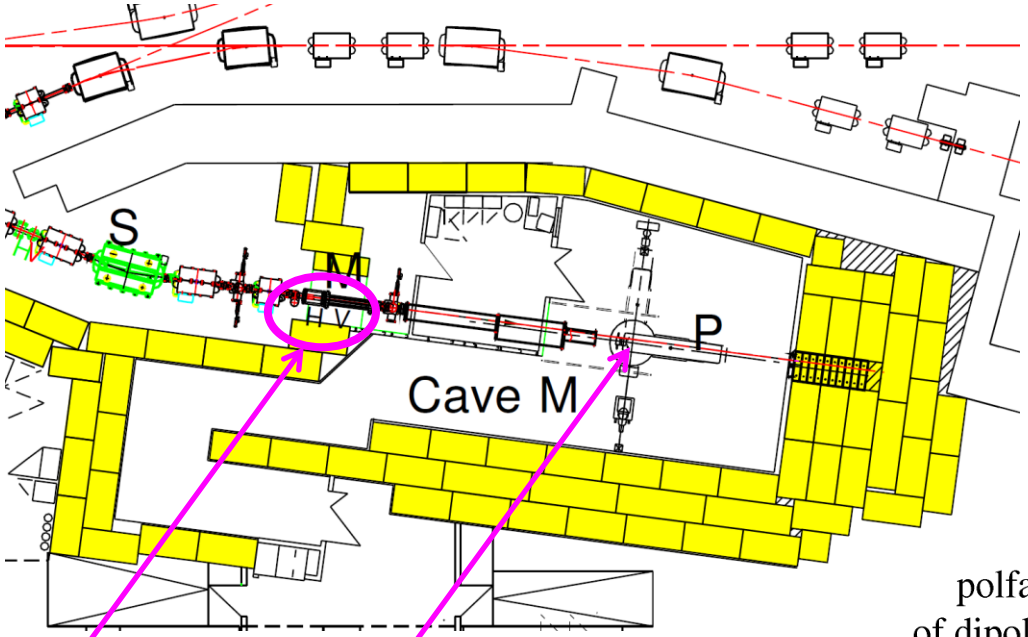


Cave A

conveyor belt



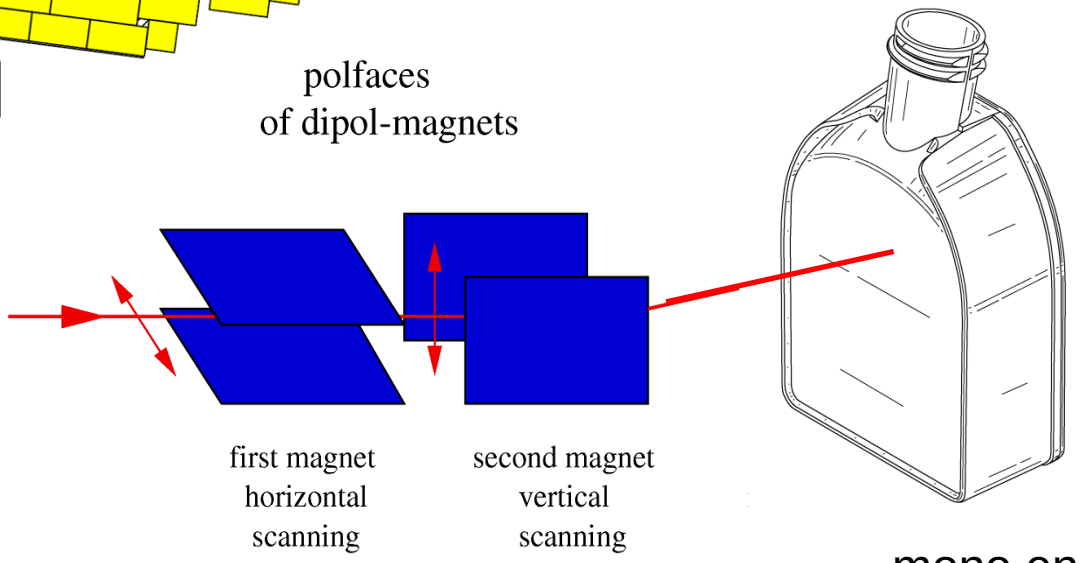
Flexible Beam Application by Scanning



Scanner magnets

Iso-centre (reference point)

Scanning principle



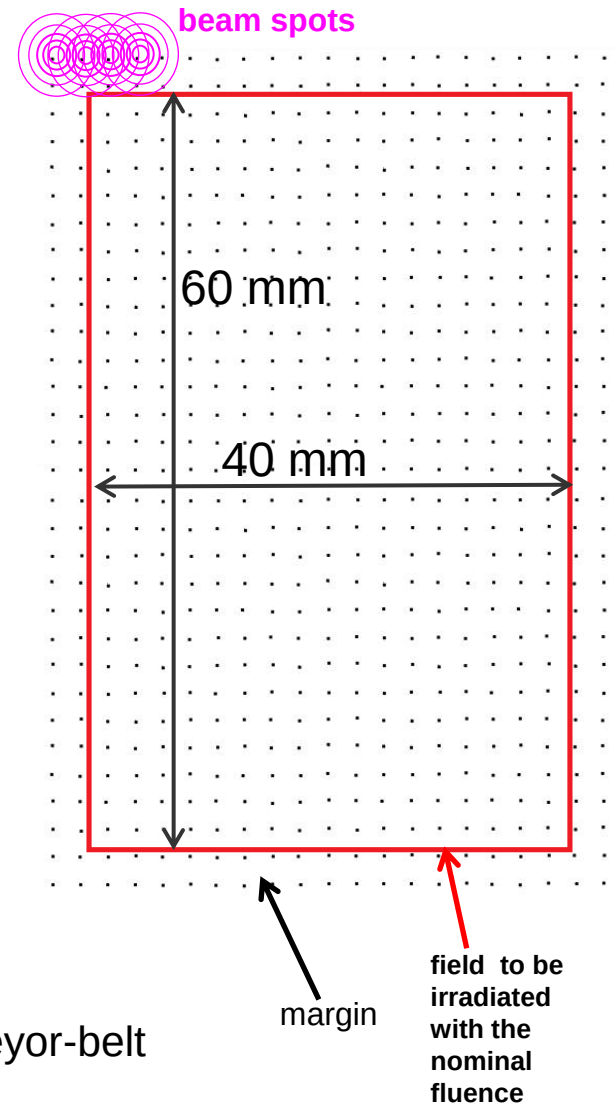
mono energetic

Flexible Beam Application by Scanning

We support and consult you through the whole workflow:
- in advance: how to irradiate, etc. (per eMail or tel.)
- e.g. converting dose ↔ fluence, energy, intensity, etc.

Your request (example):

- Cell culture flask 40 x 80 mm^2
- field must cover 40 x 60 mm^2
- ^4He 600 MeV/u
  - sample A : 1e7 ions/cm^2
  - sample B : 1e7 ions/cm^2
  - sample C : 2e7 ions/cm^2
  - sample D : 2e7 ions/cm^2
  - …
  - …



- We calculate the scanning plan and apply the beam
- You handle and adjust the biological samples on the conveyor-belt

Flexible Beam Application by Scanning

… or even more complex irradiations with multiple energies, for instance:

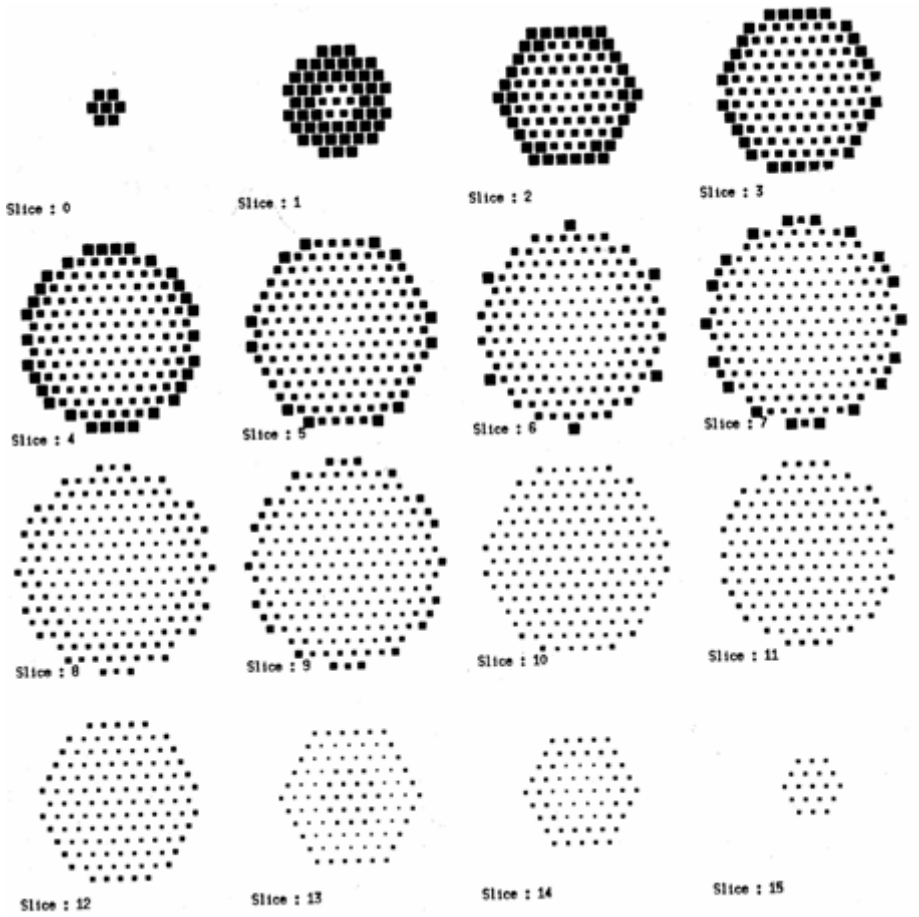
iso-dose to a cube

or

iso-dose to a sphere

(this is normally relevant for therapy related research)

In 2018 for energy variation probably a range shifter has to be used (if SOBP is needed).



Scanning pattern for a sphere irradiation

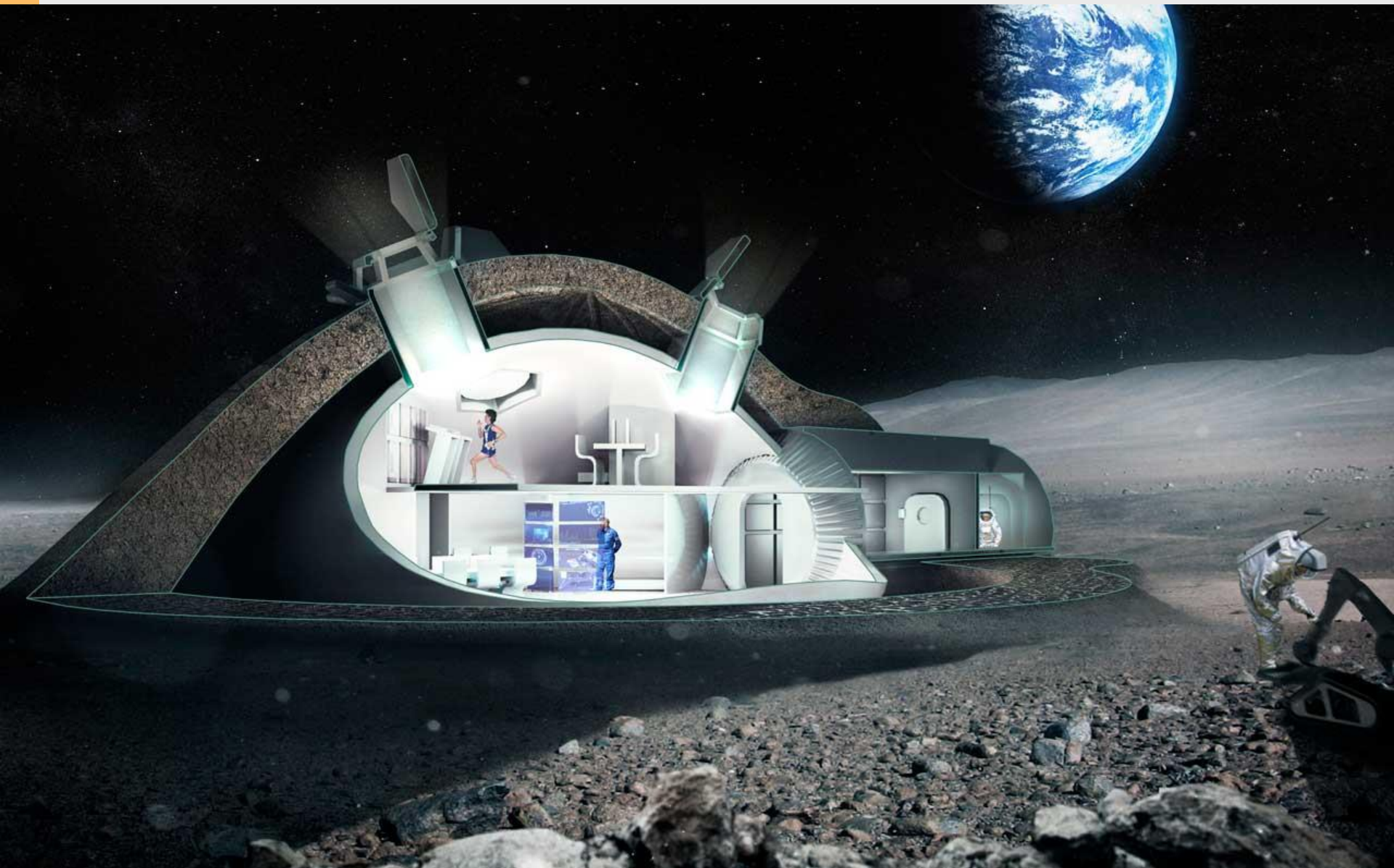
Radiation protection requirements

- Online instruction (& test) for safety (general) → For everybody who works @ GSI
- Online instruction (& test) for radiation protection
- Medical examination letter
  - from your home institute
    or
  - from GSI
- Dosemeter badge (also for neutron dose)
  - own badge (from your home institute)
    or
  - badge from GSI (can take a couple of days)
- Radiation passport
- On-site instruction (before experiment)

For all persons who will enter the Cave = radiation protection area

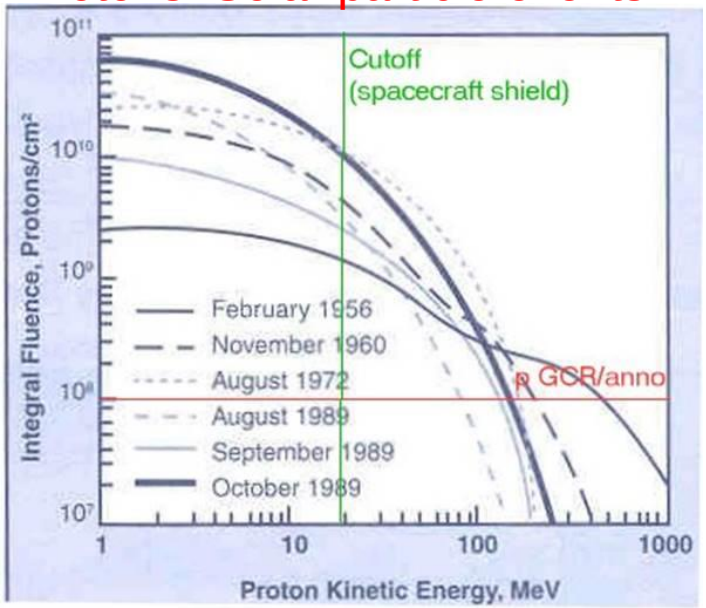
(min. 1 person of the research group)

Thank you …

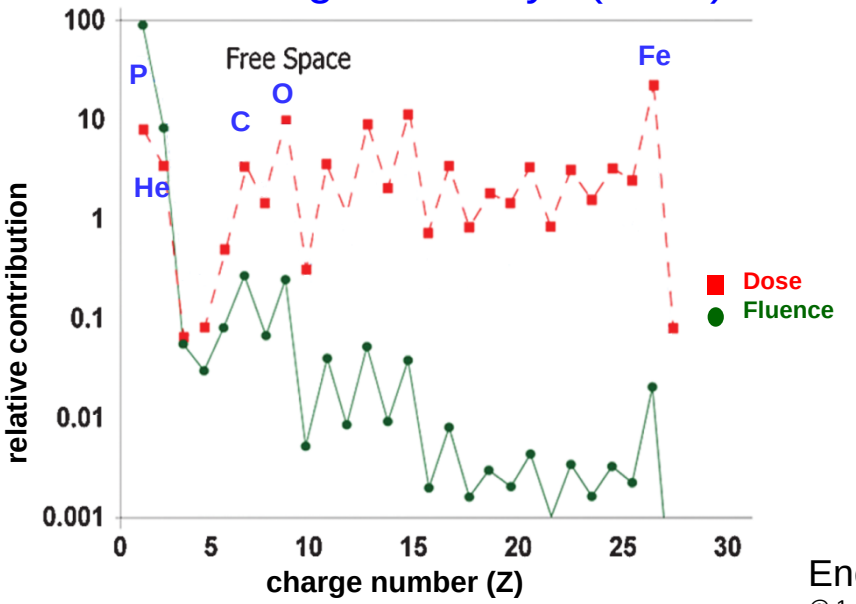


Ion species in space

Protons: Solar particle events



Cosmic galactic rays (CGR)



Energy spectra

@ 1 AU distance from sun