CNAO a facility for beam test of PSD prototypes

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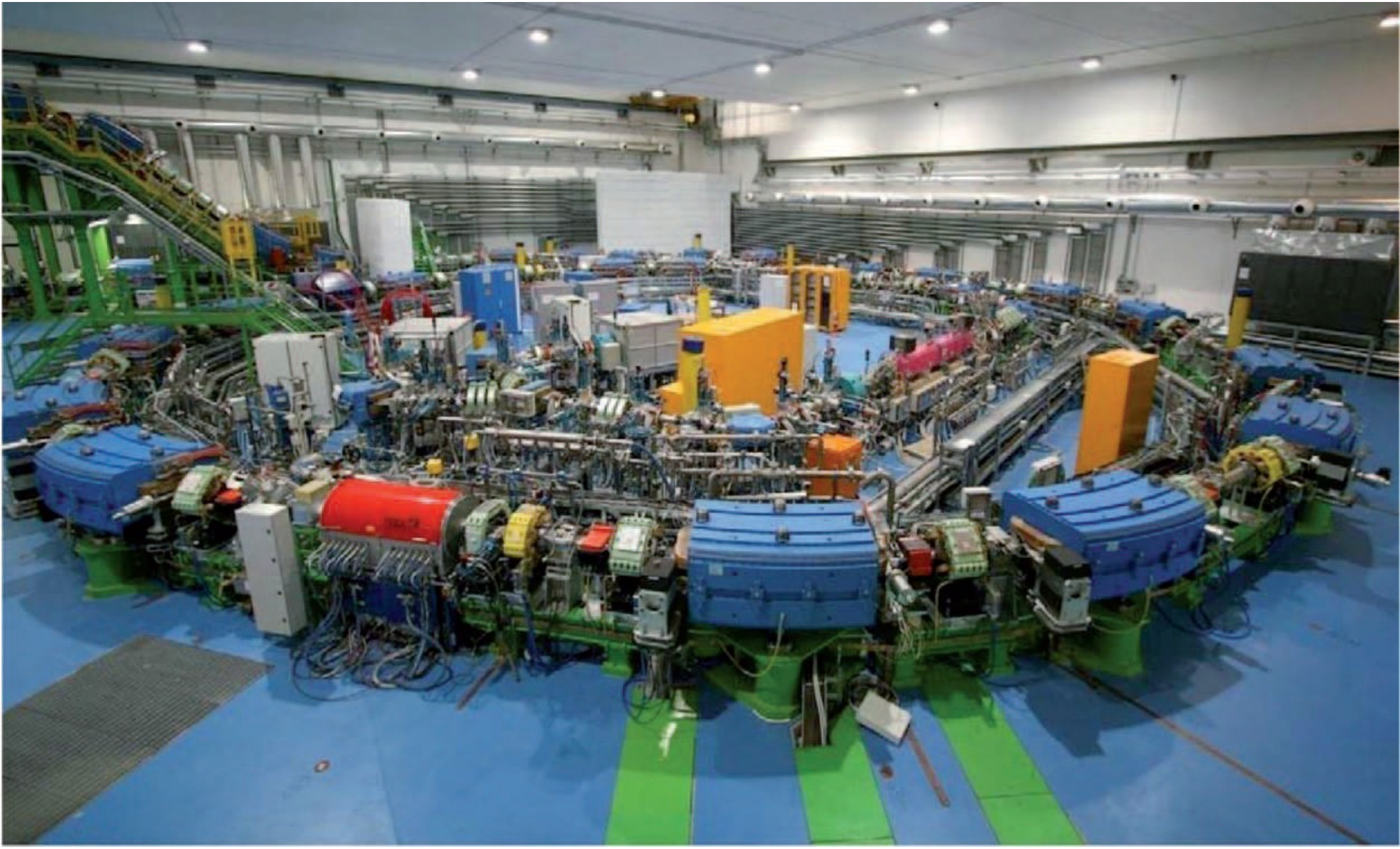
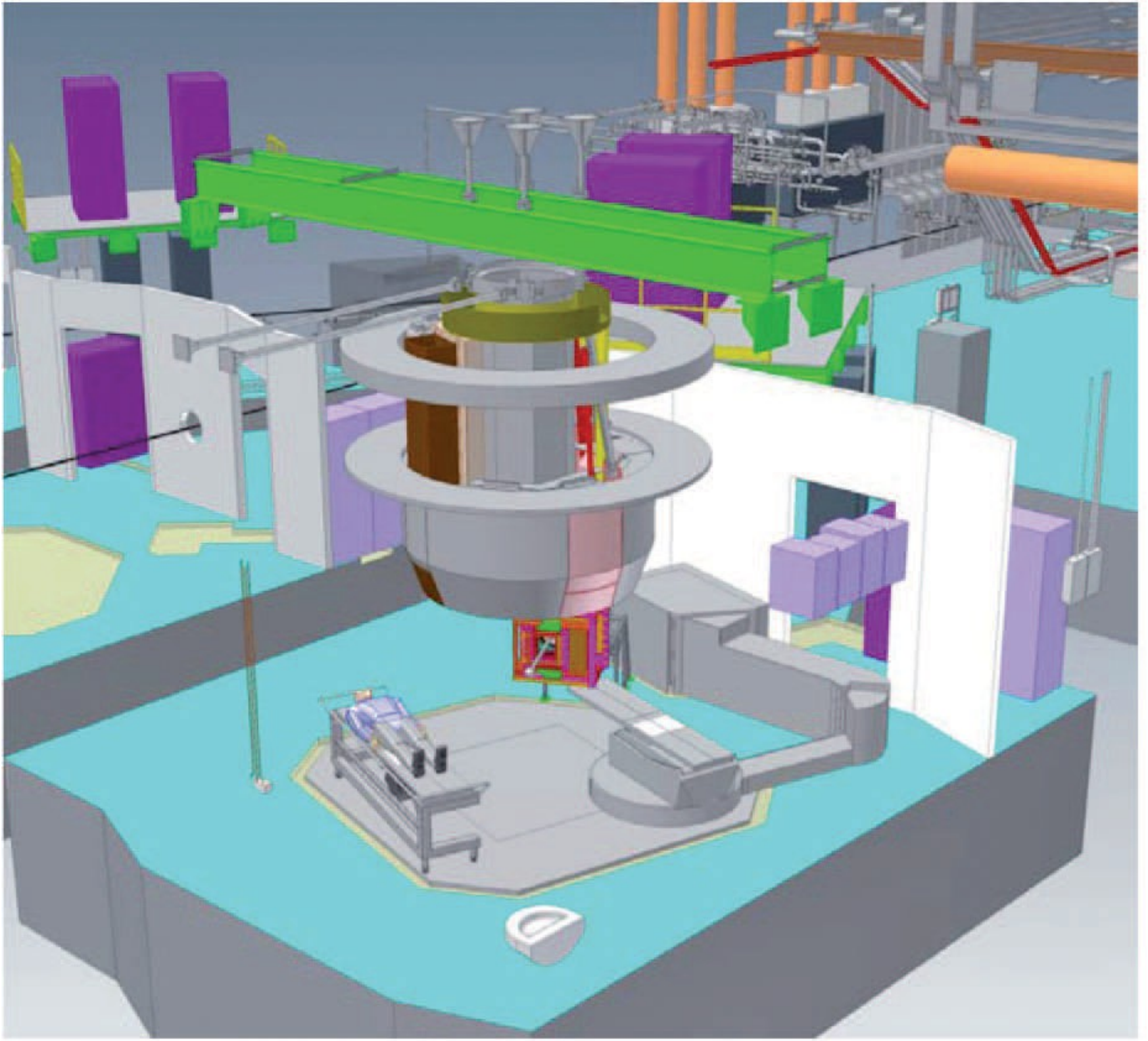
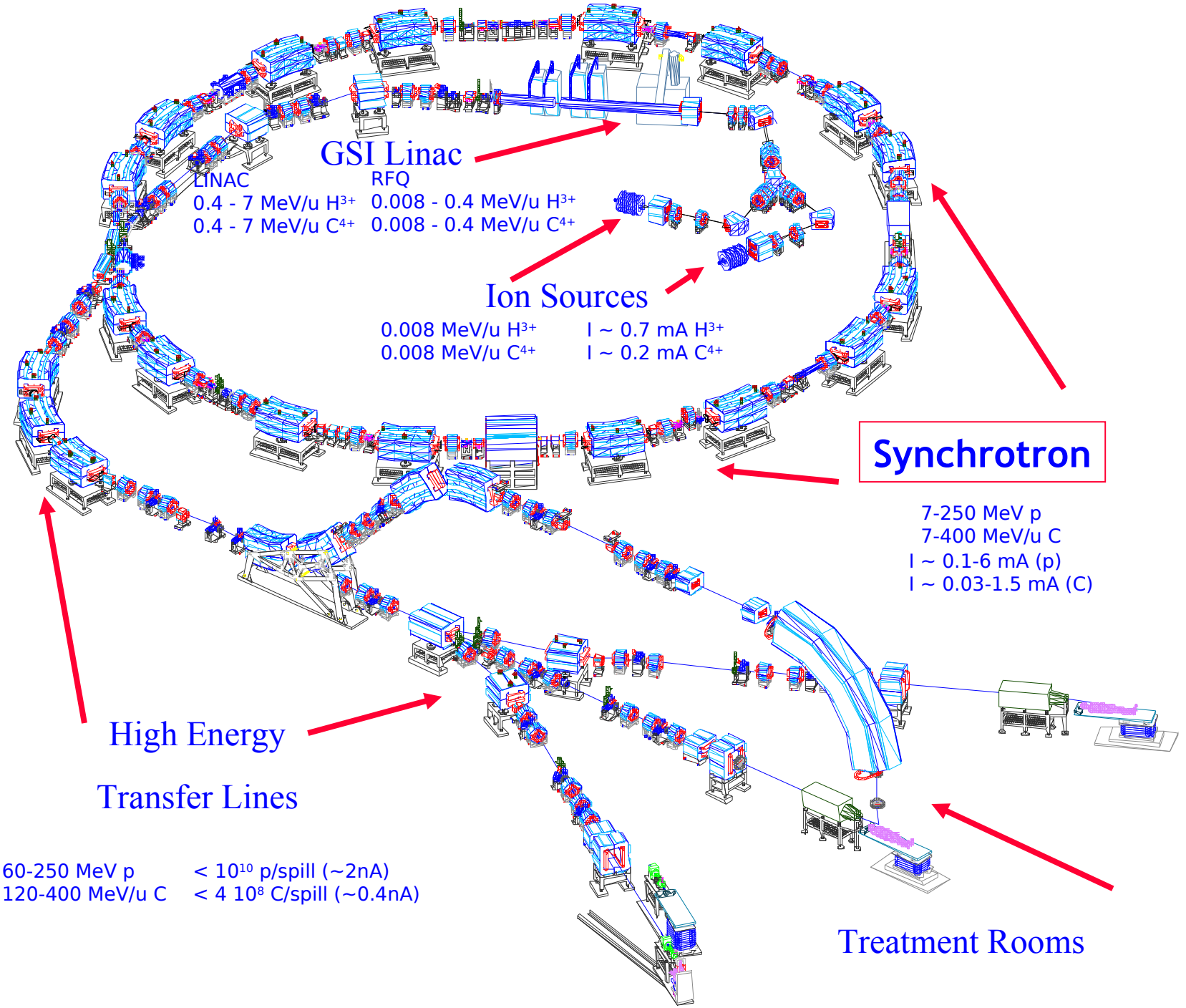
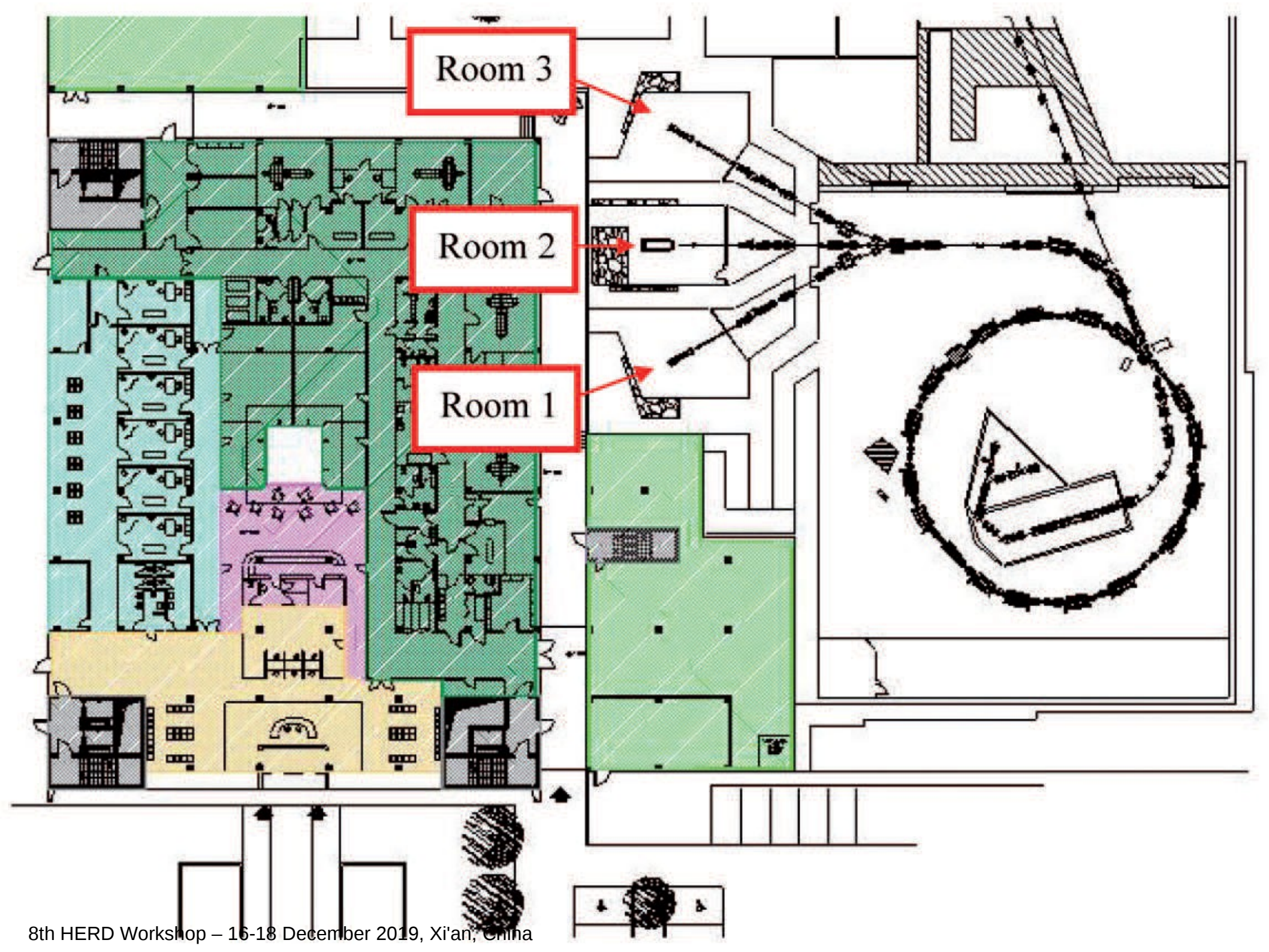
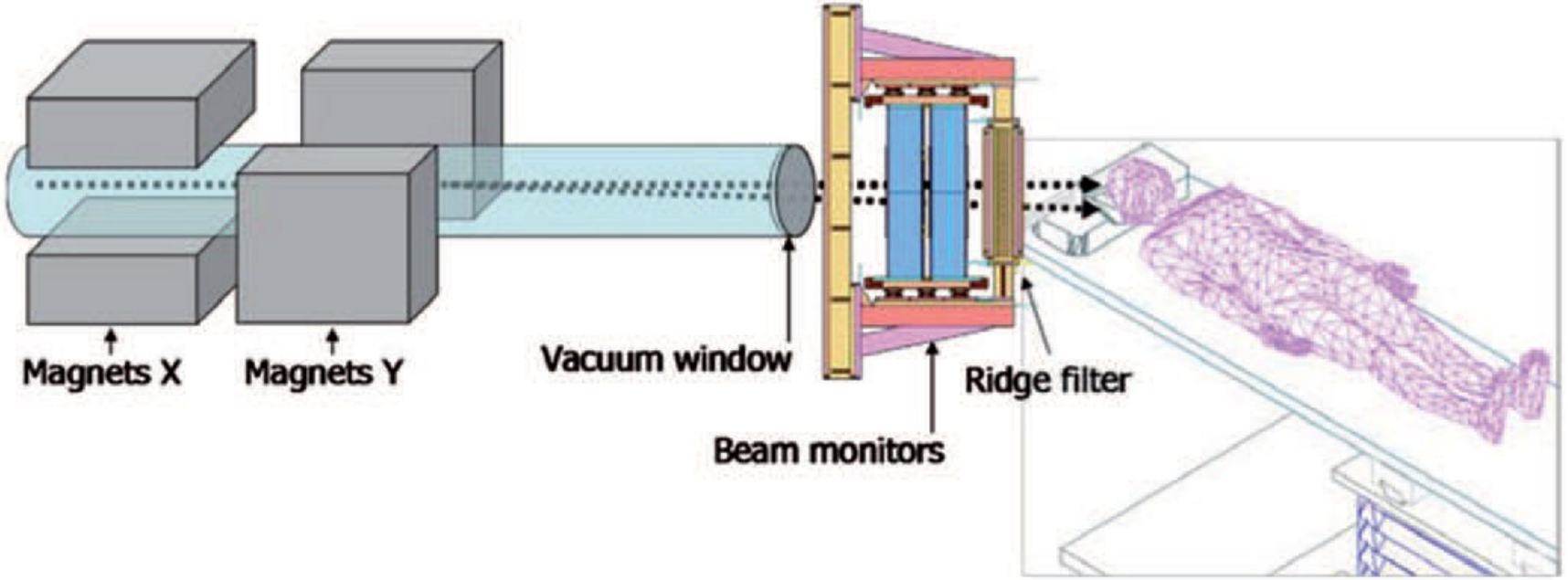
The syncrotron

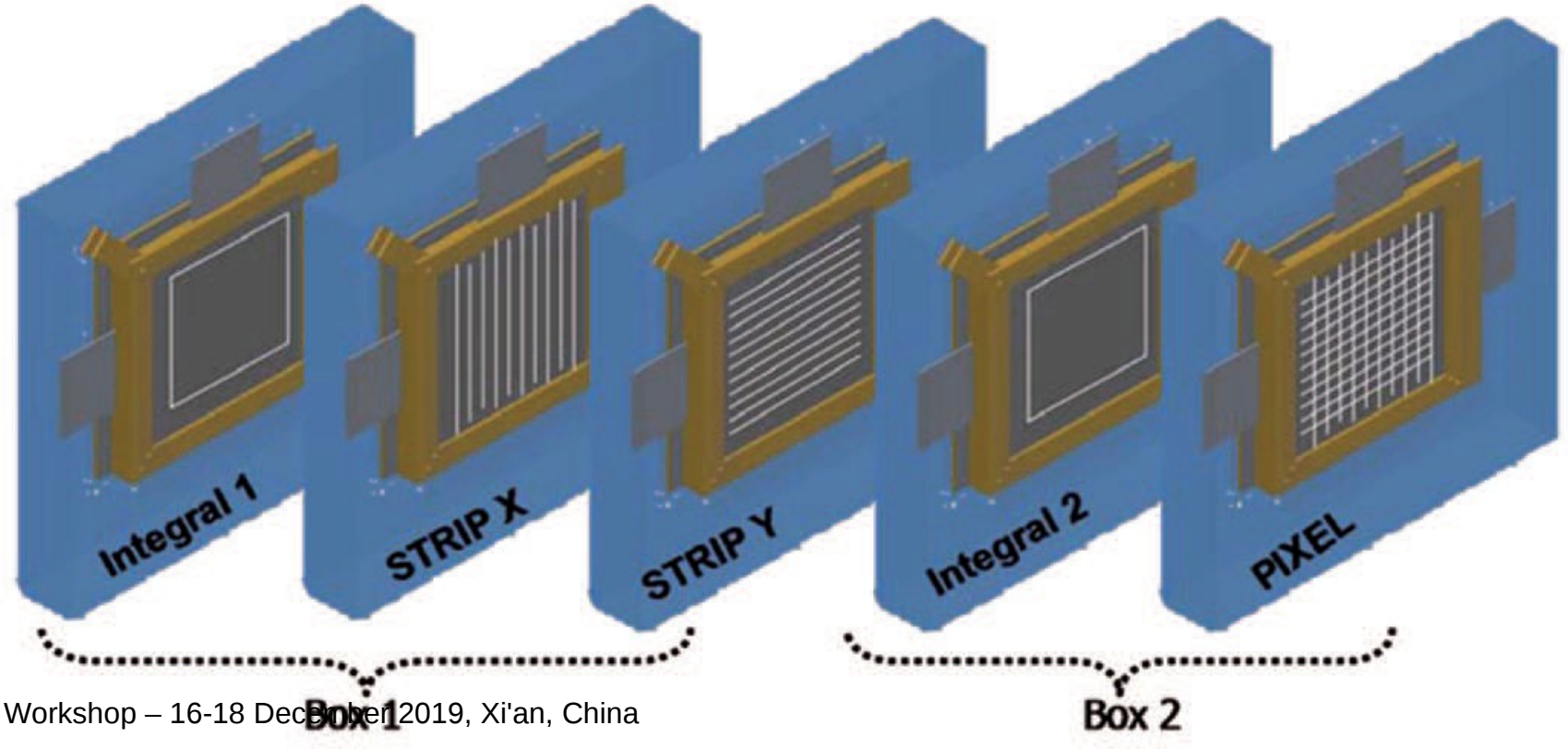





GSI Linac
LINAC
0.4 - 7 MeV/u H3+
0.4 - 7 MeV/u C4+
RFQ
0.008 - 0.4 MeV/u H3+
0.008 - 0.4 MeV/u C4+
Ion Sources
0.008 MeV/u H3+
0.008 MeV/u C4+
I ~ 0.7 mA H3+
I ~ 0.2 mA C4+
Synchrotron
7-250 MeV p
7-400 MeV/u C
I ~ 0.1-6 mA (p)
I ~ 0.03-1.5 mA (C)
High Energy
Transfer Lines
60-250 MeV p
120-400 MeV/u C
< 10^10 p/spill (~2nA)
< 4 10^8 C/spill (~0.4nA)
Treatment Rooms


Room 3
Room 2
Room 1


Magnets X
Magnets Y
Vacuum window
Beam monitors
Ridge filter


Integral 1
STRIP X
STRIP Y
Integral 2
PIXEL
Box 1
Box 2

Ion beams

The CNAO (*National Centre for Oncological Adrotherapy*) is a facility for hadron therapy for treating solid tumors using beams of proton and carbon ions located at Pavia next to the physics department.

Available beams: protons with energy range 60-250 MeV
C ions with energy range 120-400 MeV/u

Beam trasverse size $\sigma_{x,y}$ ~ 5 mm

The intensity of beams for therapy is very high:

up to 10^{12} for protons
up to 10^{9} for C ions

Energy loss of ions

$dE/d(x\rho) \sim (z/\beta)^2$ 2 MeV/(g/(cm^2)) (Bethe-Bloch)

The low-β beam behaves like a high-z particle

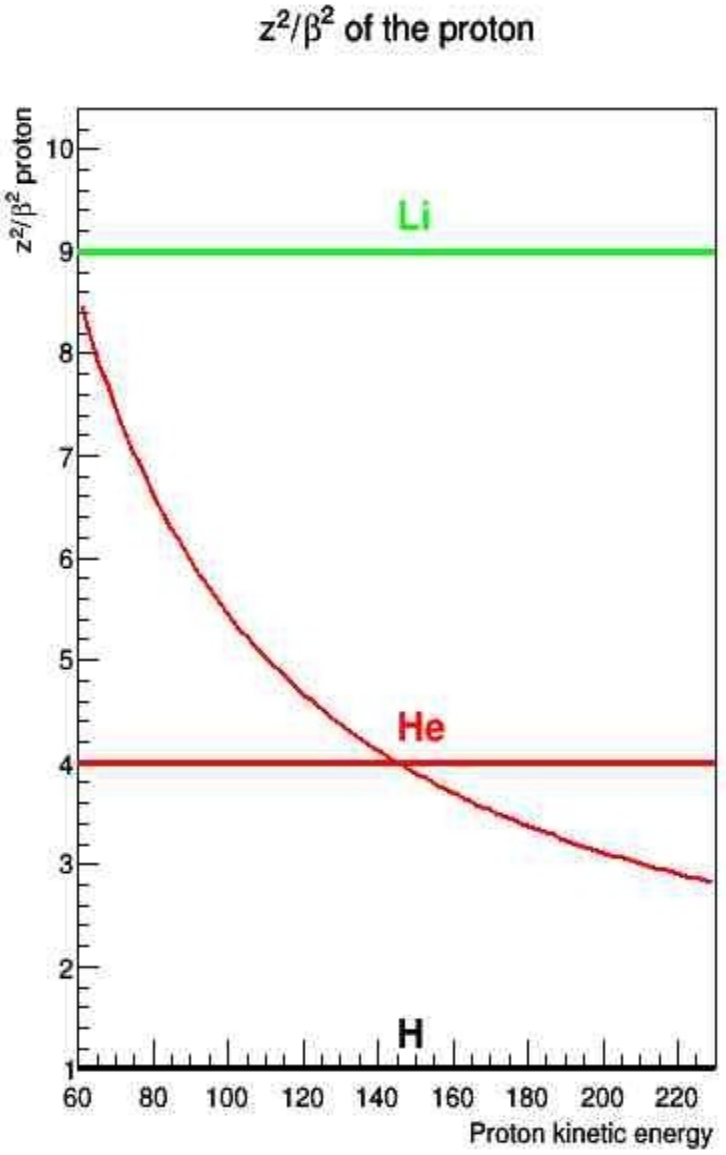
The high energy ion (m.i.p.) interaction with scintillator can be mimicked by low β ions.

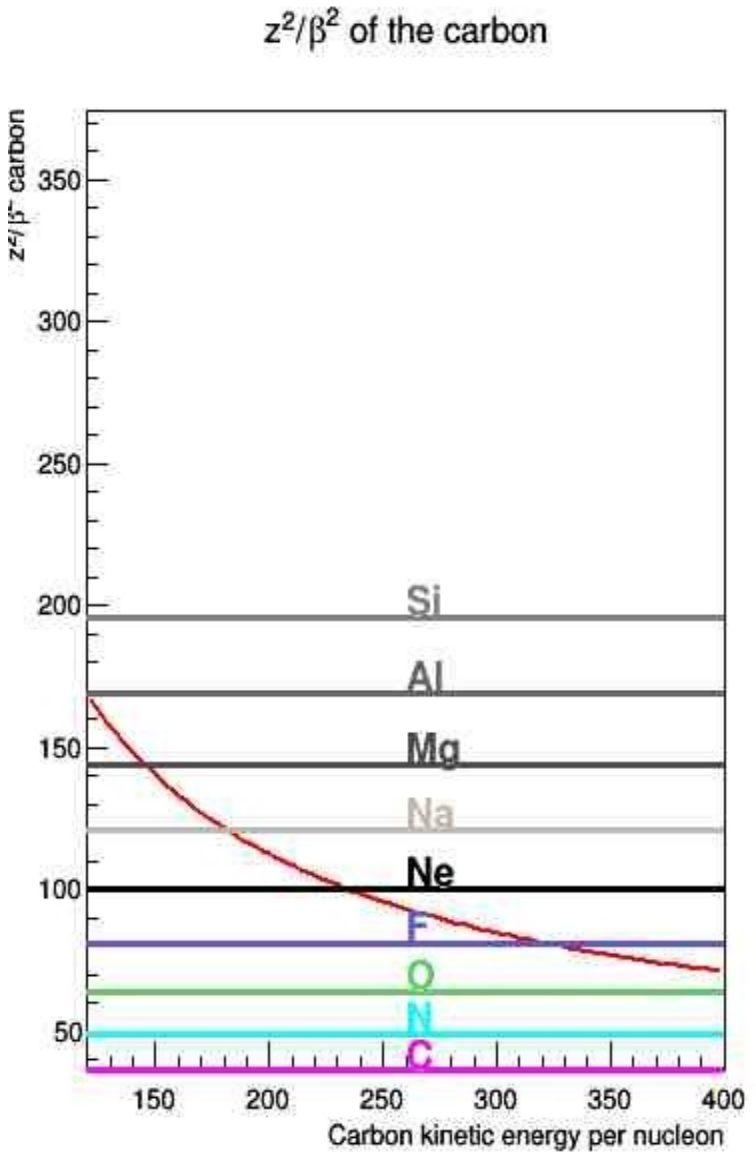
Scanning β allows to study Birks' law: saturation of light yield in presence of large local release of energy.

Are δ-rays making the distributions dfferent?
To be cross-checked with real ions.

Positioning layers of absorbers in front of the detector, lower β can be achieved increasing (z/β) by a factor of 2-3.
To be studied.

Energy loss range





There are gaps in the achievable energy loss in the detector.

Data taking

CNAO delivers beam for therapeutical purposes 12-14 h/day for five days/week.

Beam time for research must be negotiated on a friendly base with the sinchrotron director.

Intensity is lowered on purpose to few kHz.

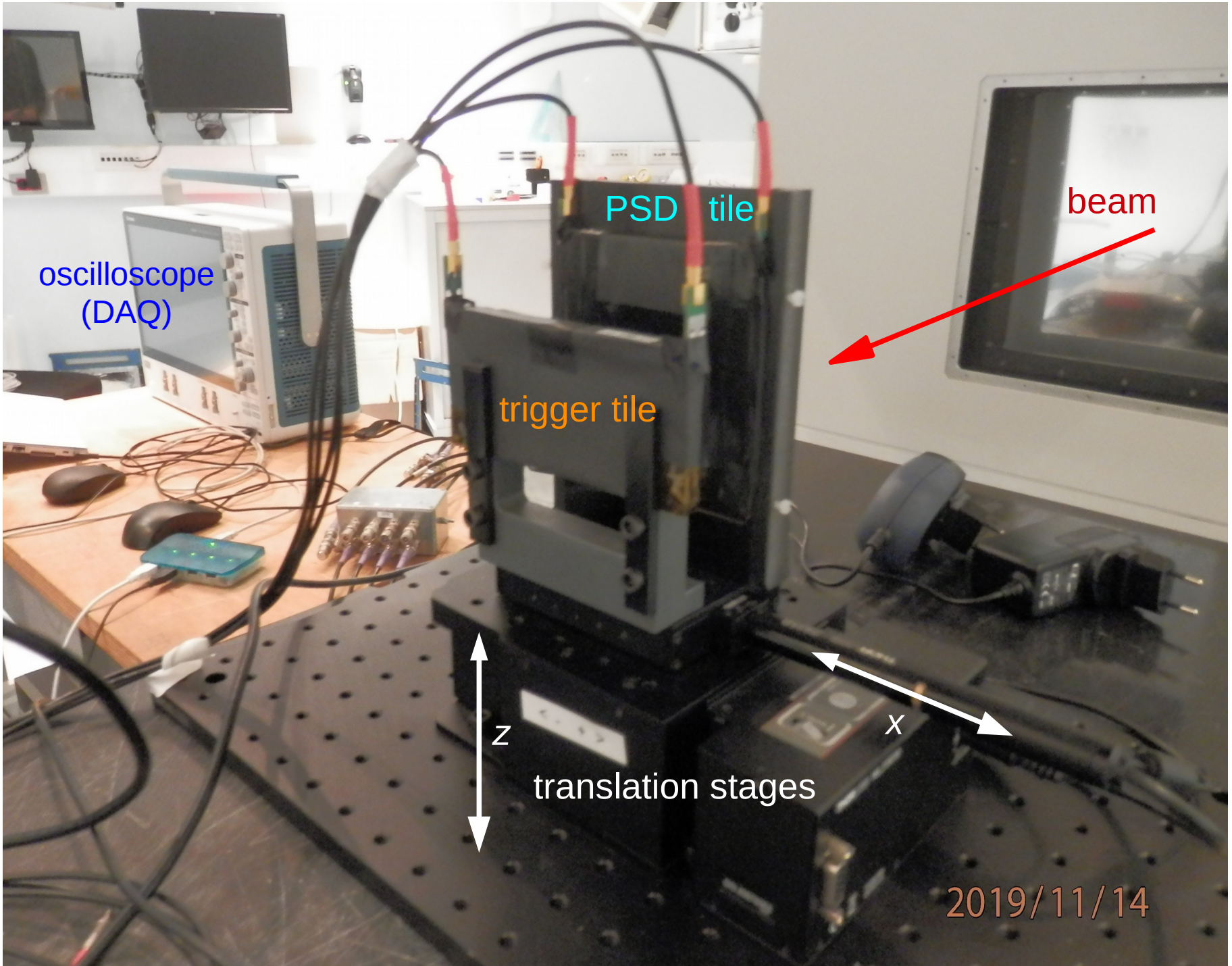
At such low rates CNAO monitoring systems are not effective
We must monitor the rates ourselves.

Time is allocated for one night (~10h including setup time).
Or a week end: two shifts ~8h each.

Approximately one slot per month is available.

The treatment room

Beam test setup



Future data taking

We have already reserved at CNAO two slots for data taking:
- one night 19 January
- one week end (29th February – 1st March)

Other PSD groups can take part at the data taking.

Are other subdetector groups interested?
Silicon tracker? Fiber tracker?

In a few months a beam line dedicated to research is expected to become operative.

Access should be easier and for longer time but details of the procedure are not yet available.

Data acquisition

- all the SiPM signals are sent to a Tektronix MSO64 oscilloscope
- 5000 samples at 12.5 GS/s rate (0.4 μs window), 12 bit ADC
- signal saved on network storage in *wfm* binary format (Tektronix)
- offline rewriting in a more compact format

Beam	Energy	Events
p	70 MeV	5000
p	120 MeV	5000
p	170 MeV	5000
p	226 MeV	18270†
C	115 MeV/u	20000*
C	190 MeV/u	2500
C	260 MeV/u	2500
C	330 MeV/u	2500
C	400 MeV/u	1182

† 6 different beam positions
* 7 different beam positions