



TWICE

Taiwan »»» Qatar...



Feature

A facility treating 1,000 patients per year and each patient having 30 fractions, then the facility must treat 100 patients/day (assuming 300 days/year).

If the facility treats patients 16 hrs/day, QA needs 0.5 hr/day and MTFT is less than 16 hrs/year, then each hour needs to treat 6 patients.

This means that one needs 4 treatment rooms and one for non-clinical research.

Design Parameters

Treatment of tumors in depth up to 30cm with 60Gy in total

Energies: p=>60-250MeV, C=>120-400MeV

Basically 4 different intensities each cycle <4*10¹⁰/pulse

4-10 mm Spot size

4 treatment rooms

=> 1 Carbon Gantry

=> 2 Rooms with fixed horizontal and vertical beam line

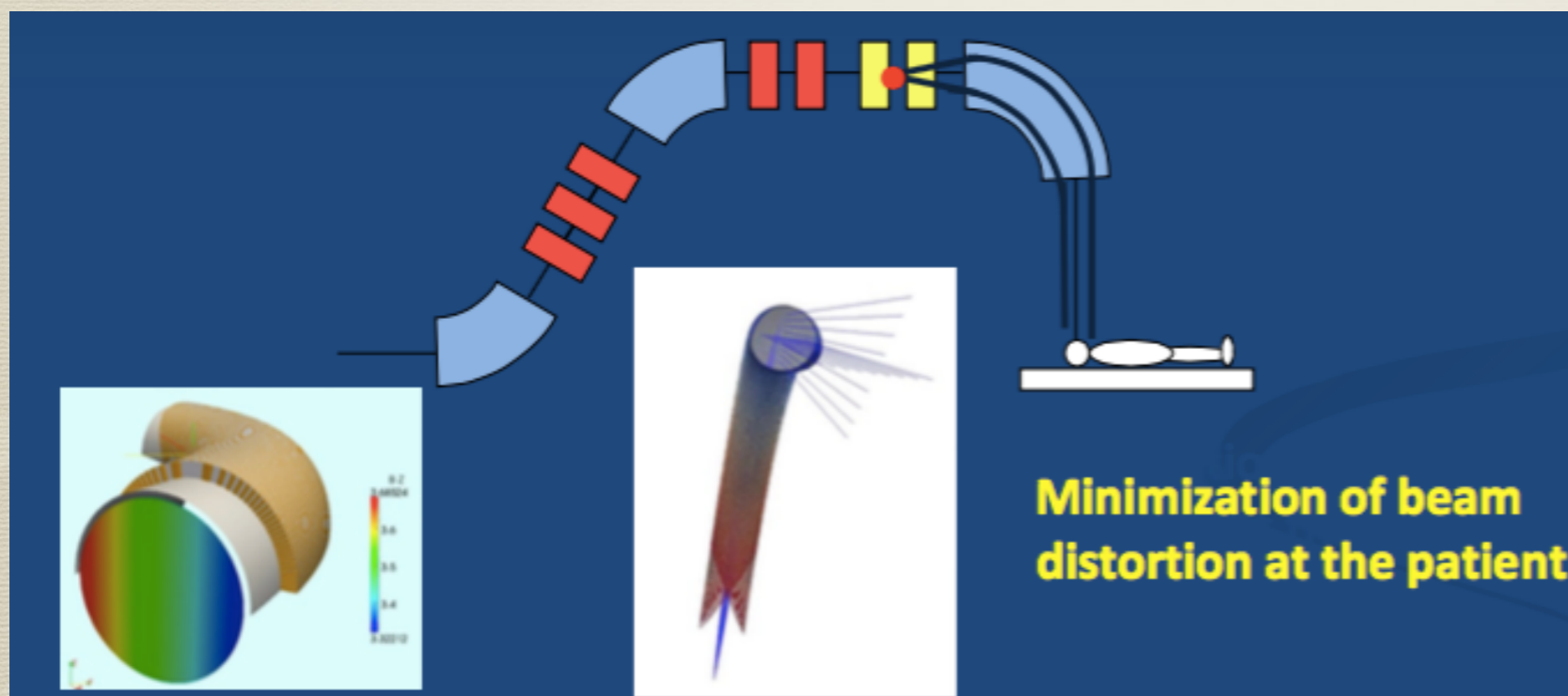
=> 1 Room with both fixed beam or XMS²

=> 1 Research room

Imaging with cone beam CT in every treatment room

Compact Carbon Gantry

High Field	(SC)
Large Bending Angle	(90 degrees)
Large Aperture	(20x20 cm)
Combined Function Fields	(Large SAD and small distortion)
Rotatable	(up to 360 degrees)
Fast Ramp Rates	(Need to pu to 1T/s)
Accuracy	(<=0.5mm)



Business Plan

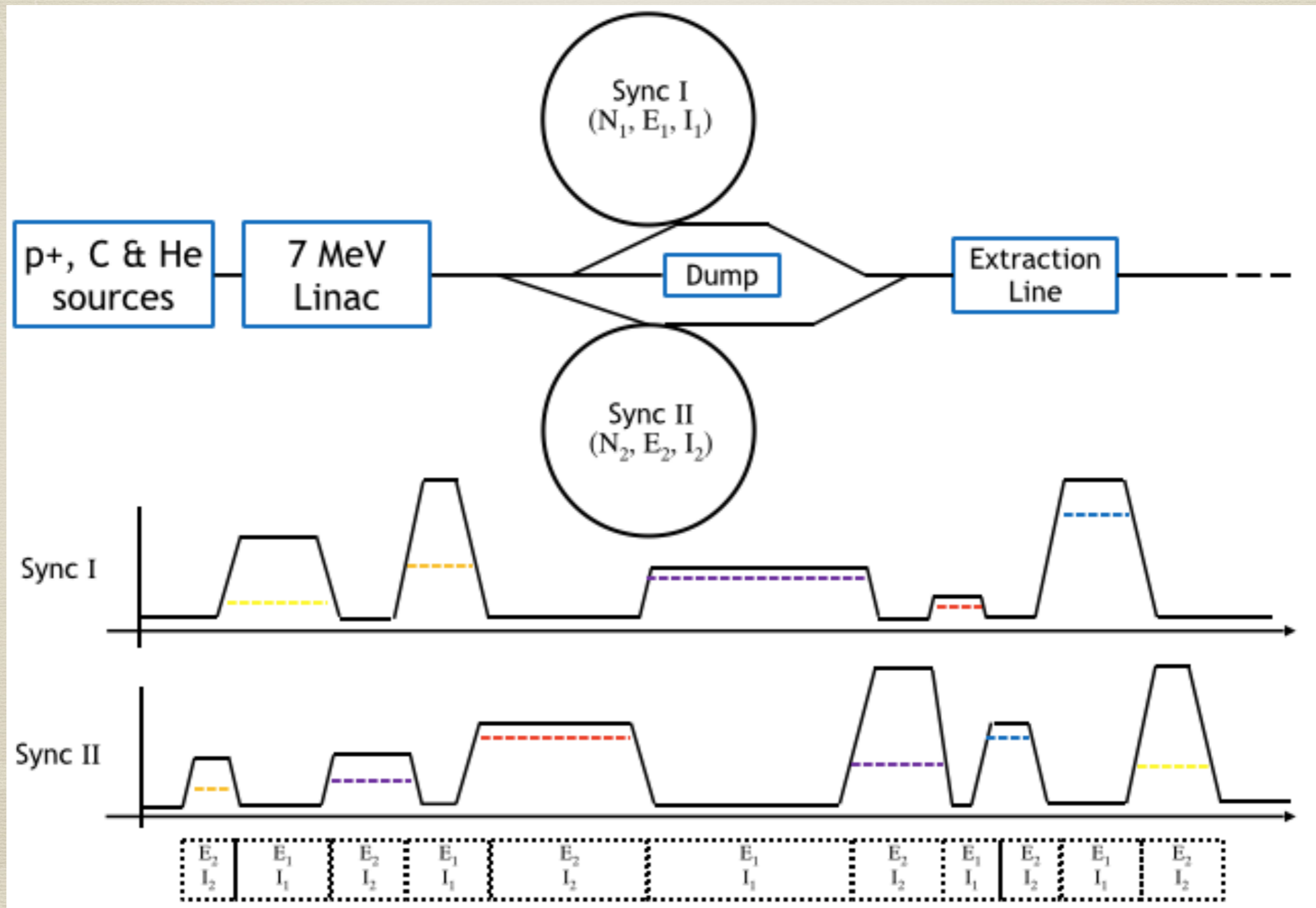
Unit:USD

FY	2017	2018	2019	2020
Revenue	0	0	0	100,666,670
Cost	0	116,670	29,638,740	59,277,480
Gross Profit	0	-116,670	-29,638,740	41,389,190
Expenses	10,655,030	14,724,090	17,229,850	17,229,850
Operating revenue	-10,655,030	-14,724,090	-17,229,850	24,159,340
Sales revenue	1,000,000	-13,333,330	-6,666,660	-6,666,660
Profit Before Tax	-9,655,030	-28,057,420	-23,896,510	17,492,680
Tax	0	0	0	2,274,040
Profit After Tax	-9,655,030	-28,057,420	-23,896,510	15,218,640
Accumulated surplus	-9,655,030	-37,712,450	-61,608,960	-46,390,320

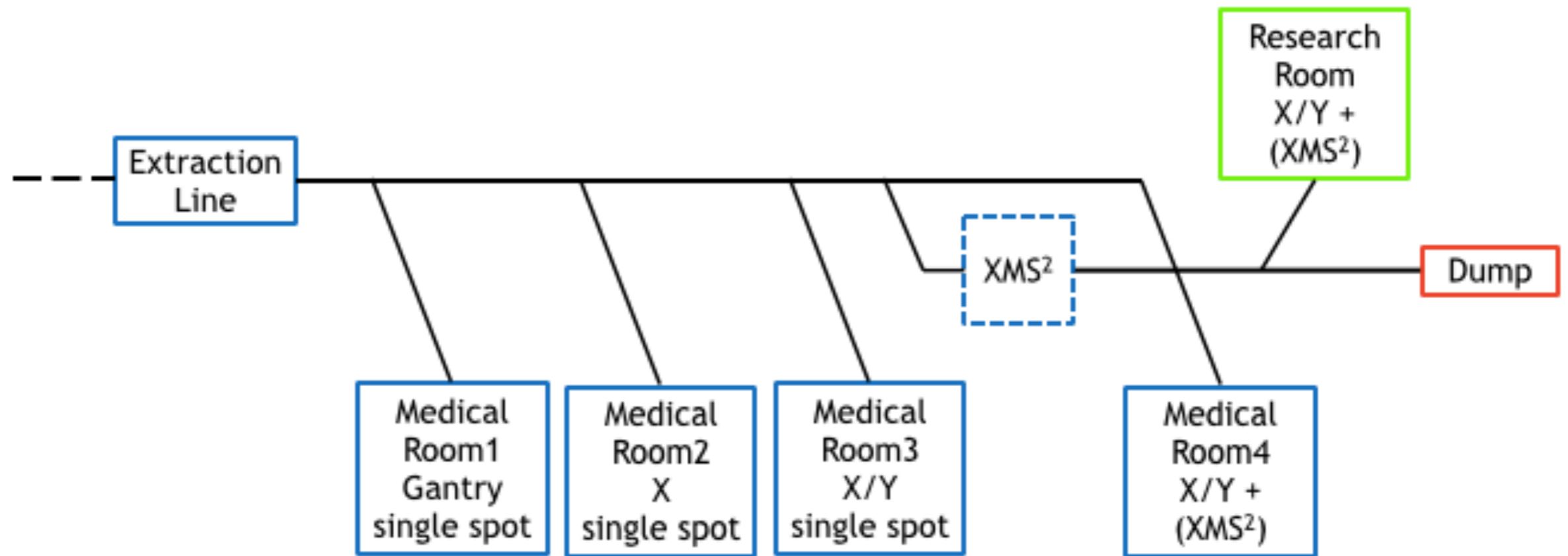
Technical

- **Based on MedAustron facility with re-use as much as possible**
- 7 MeV Linac (intensity of $4 \cdot 10^{10}$ ppp)
- **2 synchrotrons time-multiplexed** with combined extraction lines
 - Variable energy up-to 400 MeV cover p+, He and C
 - multi-turns injection
 - Perform cycle to cycle **energy/intensity variations**
 - Almost **100% duty cycle available beam**
 - 1 machine is prepared when the other one is in coast/extraction
 - Using only **one as spare** in case of the second is failing
 - **CT Extraction** length range (0.1) 1 to 10 seconds
- Finemet cavity (single h1 and/or multi-harmonics for RF manipulations)
- Development of **XMS² painting scheme** in the last room

DMS (Dual multiplexed synchrotrons)



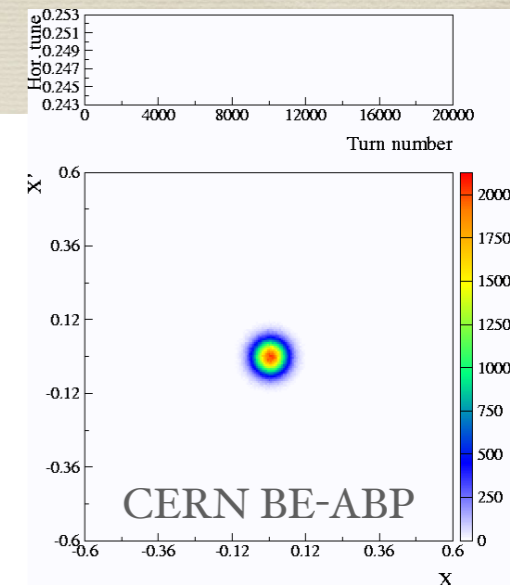
Beam delivery



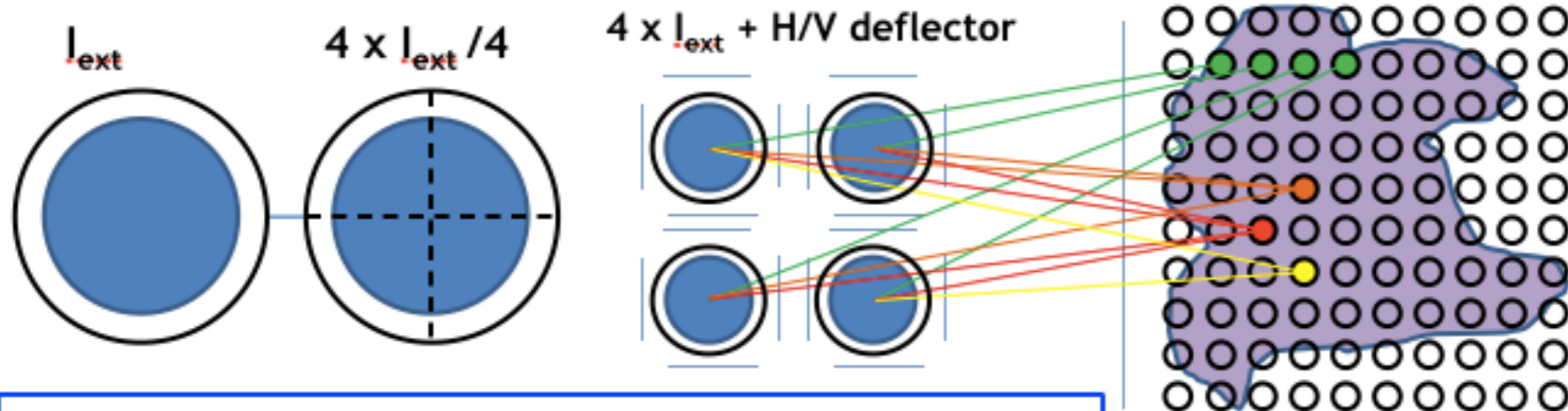
- Separation between Treatment and Research rooms
- High priority to treatment rooms
- Default destination to Dump for safety
- XMS developments to be in advance in this field

XMS² (eXtended Multi Spot Scanning)

- 4 spots in one time or variable intensity on less spots
- intensity 4x higher than single spot scheme
- Normal extraction debunched CT scheme
- X metallic blades in the vacuum chamber to split in $4 I_{\text{ext}}/4$
- Not clean in the cense of Losses and beam Quality
- Need refocusing and collimators
- Improvements with MTE extraction scheme



area 20x20cm, 4mm spots



3 different modes of operation:

- ⇒ 1) Only one cell is used to paint a single spot $I_{\text{ext}}/4$
- ⇒ 2) 4 cells painted at the same time with $I_{\text{ext}}/4$
- ⇒ 3) 1, 2 or 3 cells painted with multiples of $I_{\text{ext}}/4$

Outlook

Fast and improved beam delivery

Flexible energy and intensity variations

Dedicated room for research

Therefore Collaboration with

MedAustron (Medical Physics, DDS, TPS)

CERN (Accelerator)

Taiwan NSRRC (XMS² development)

HIMAC (Superconducting Carbon Gantry)

Final installation in Doha