

Dose Delivery Challenges at HIT / MIT

Torino, February 2017

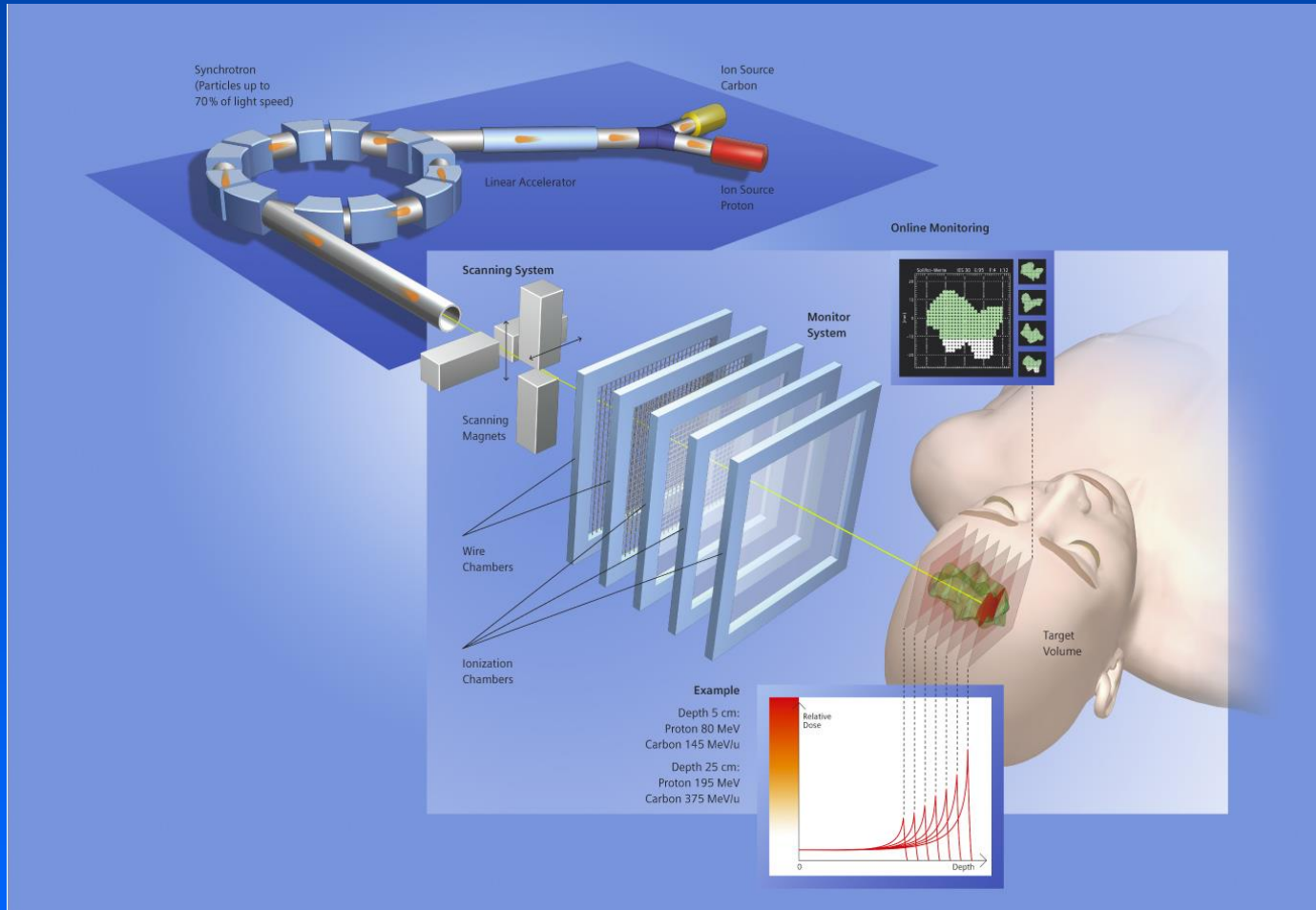
Stephan Brons

Heidelberg Ion Beam Therapy Center, Germany

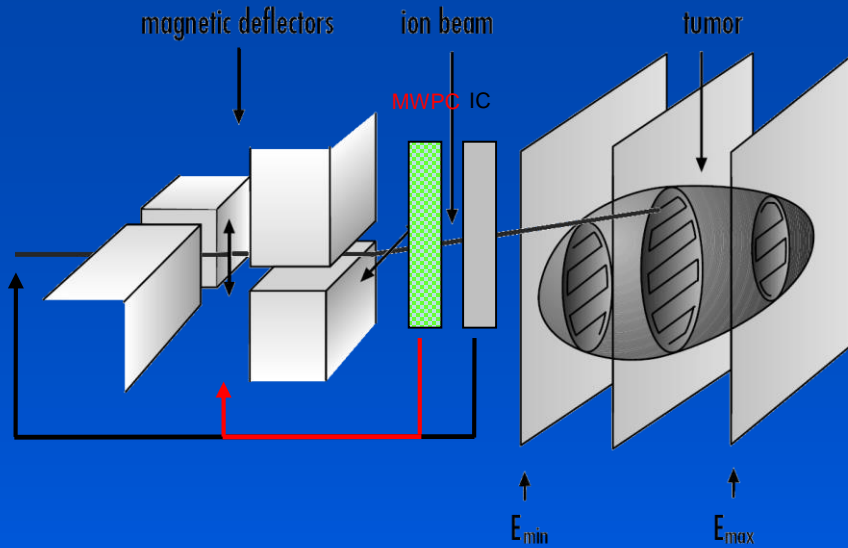
Overview

- Raster Scanning Control:
Advantages and Disadvantages
- The Ion Gantry
- Patient operation HIT/MIT
- Development & Updates

Raster Scanning



Position Feedback System



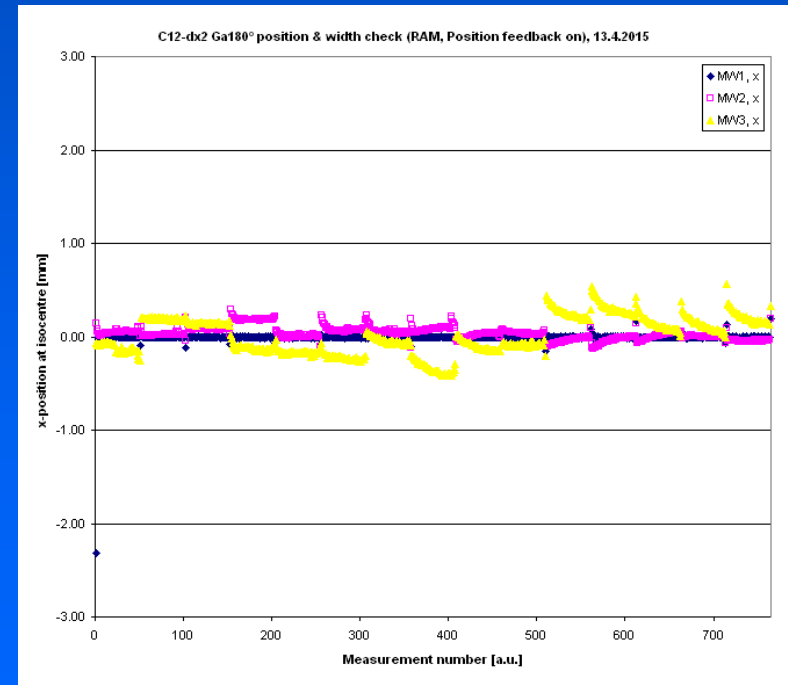
Pro:

Utmost precision

But:

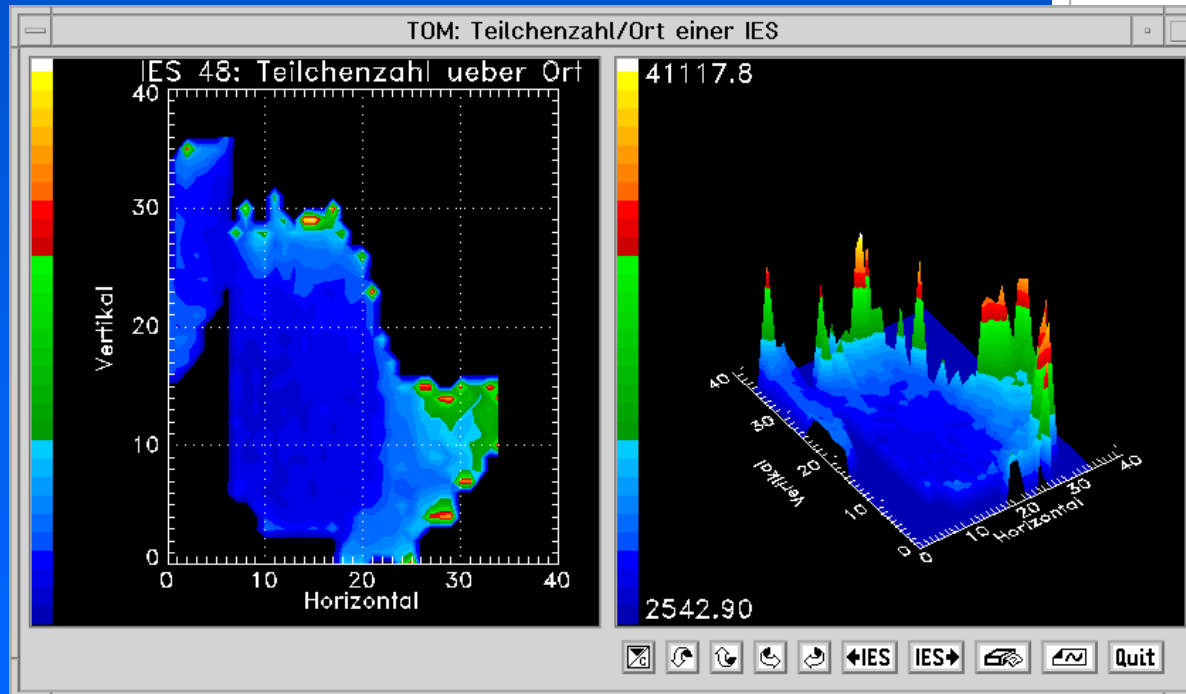
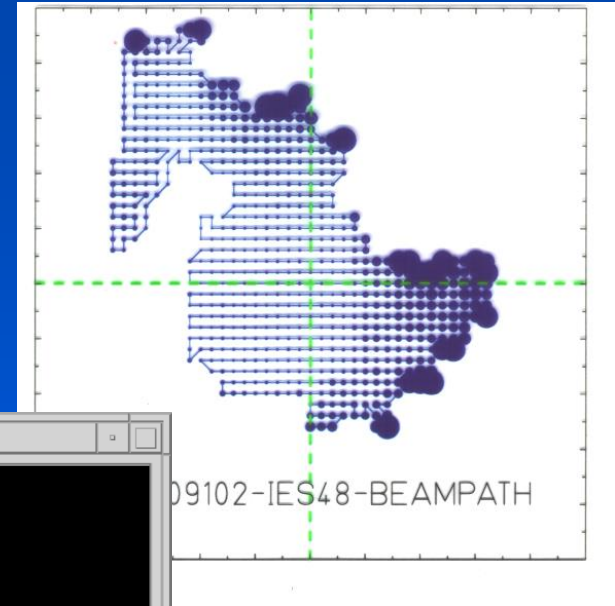
Slow

(3x250 μ s / raster point)

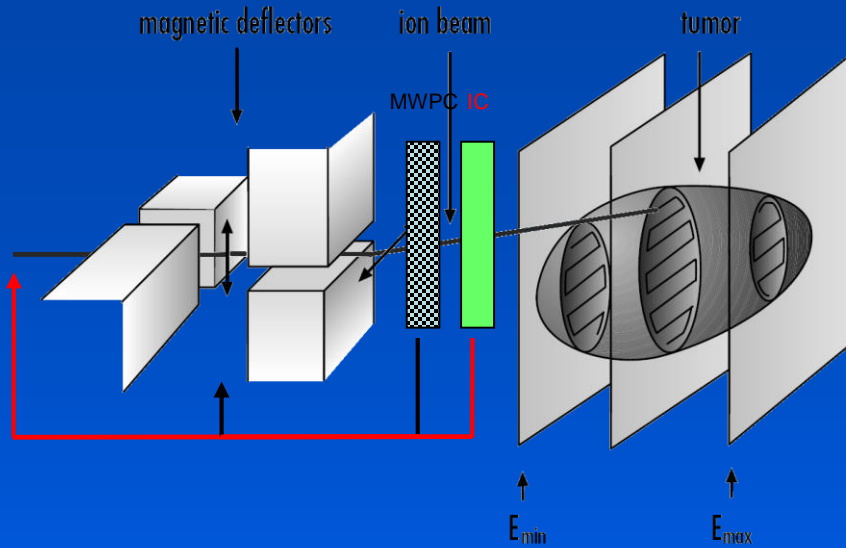


IMPT / Intensity Modulation

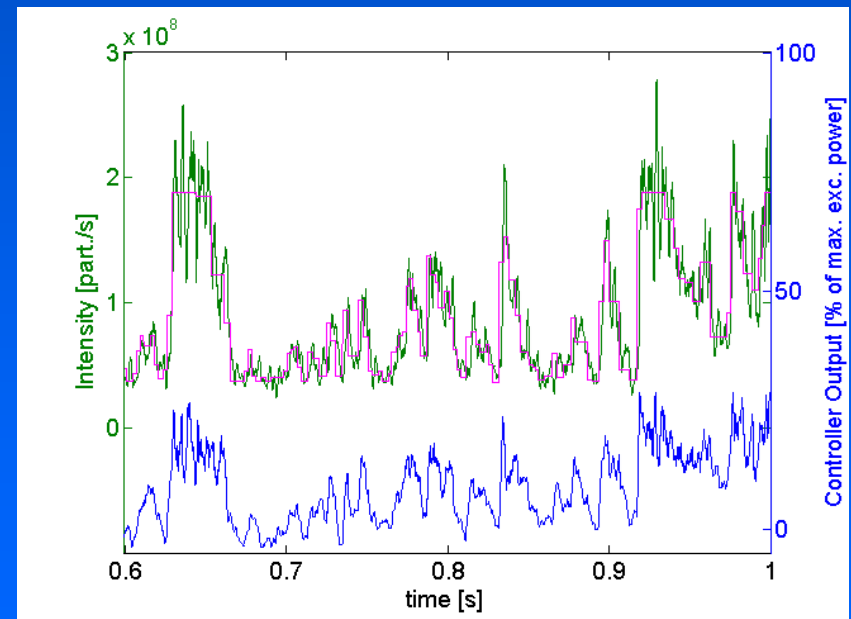
Fluence distribution of a single slice through the target volume



Intensity Feedback System



- Individual intensity for each raster point
- Much **faster** than scanning at constant rate



HIT / The Ion Gantry

Dimensions:

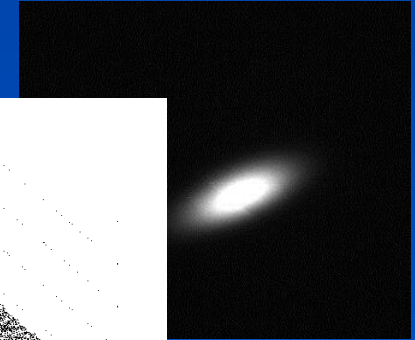
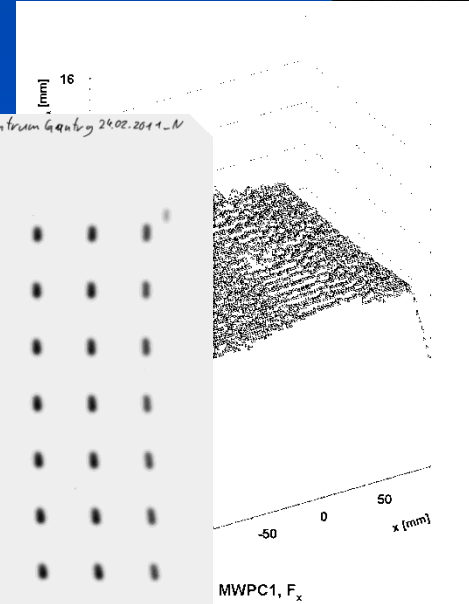
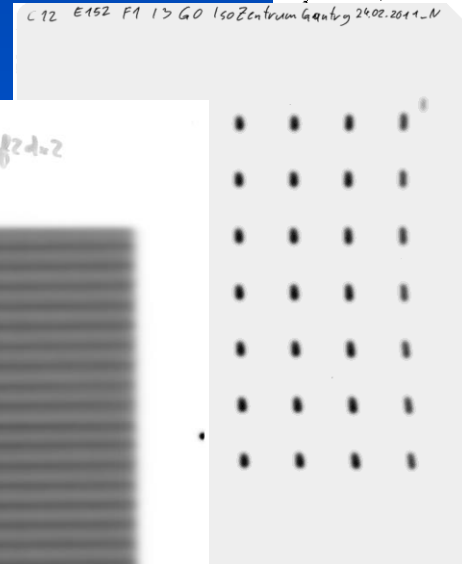
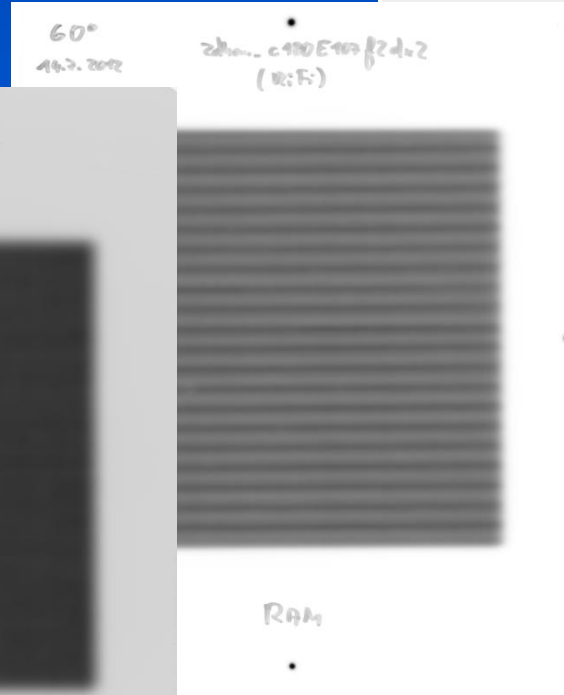
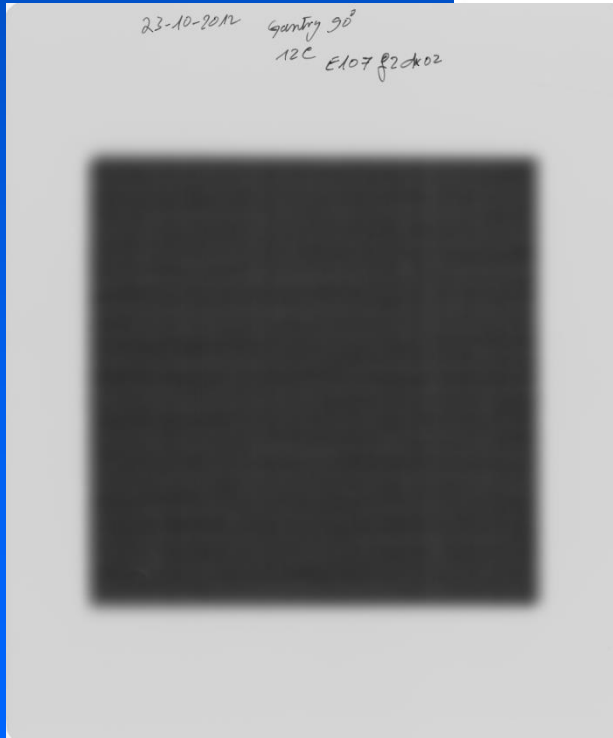
- Length: 25 m
- Diameter: 13 m
- Rotational Mass: 600 t



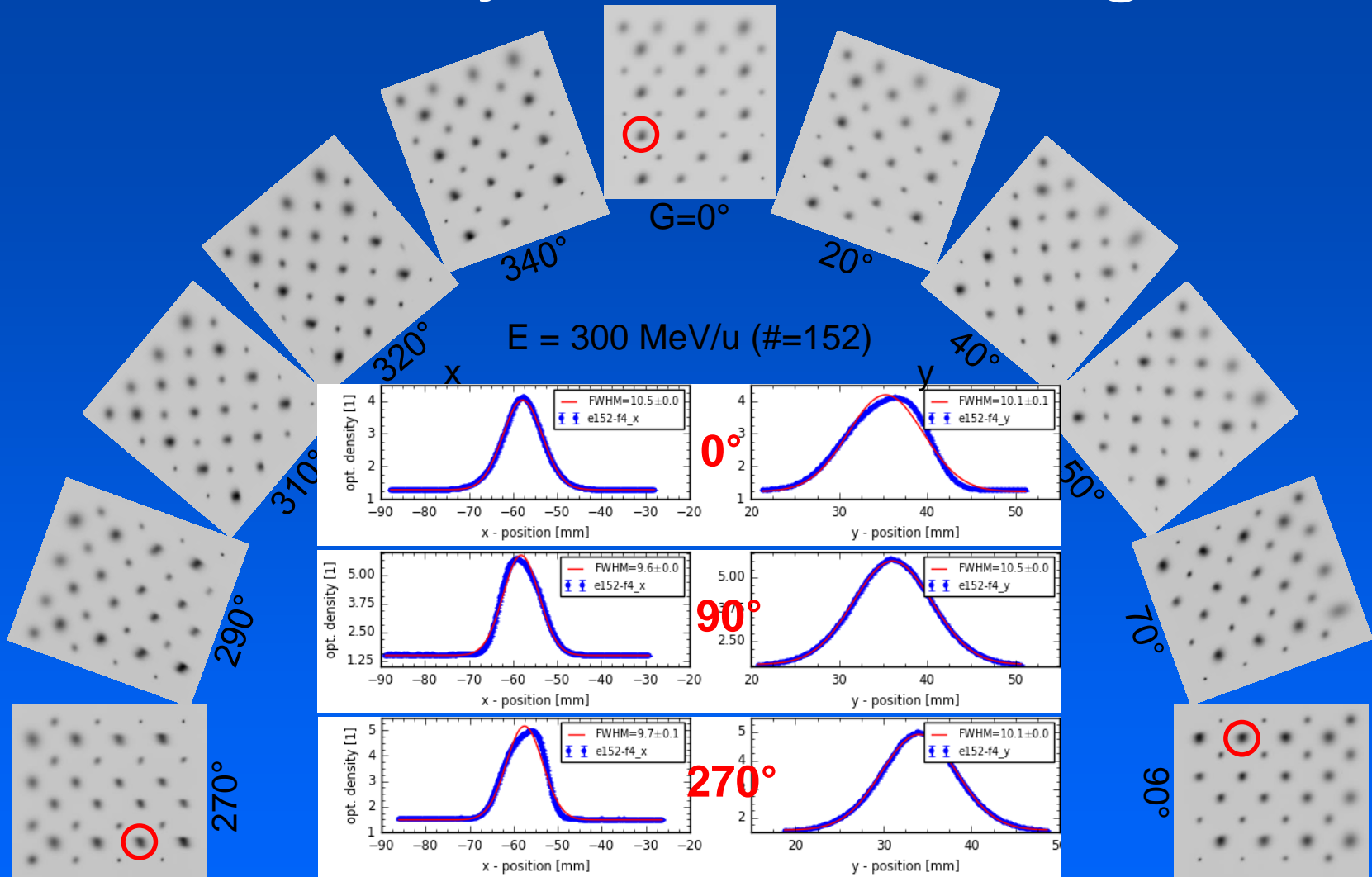
S. Brons, Heidelberg Ion Beam Therapy Center

Gantry / Commissioning

therapy quality



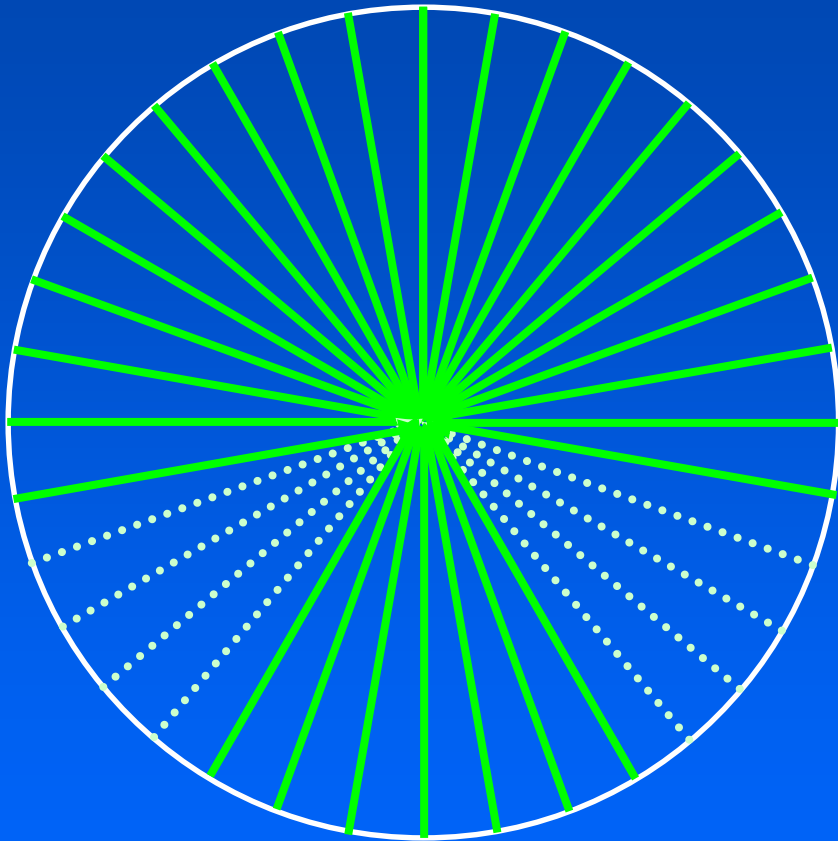
Gantry / Beam tuning



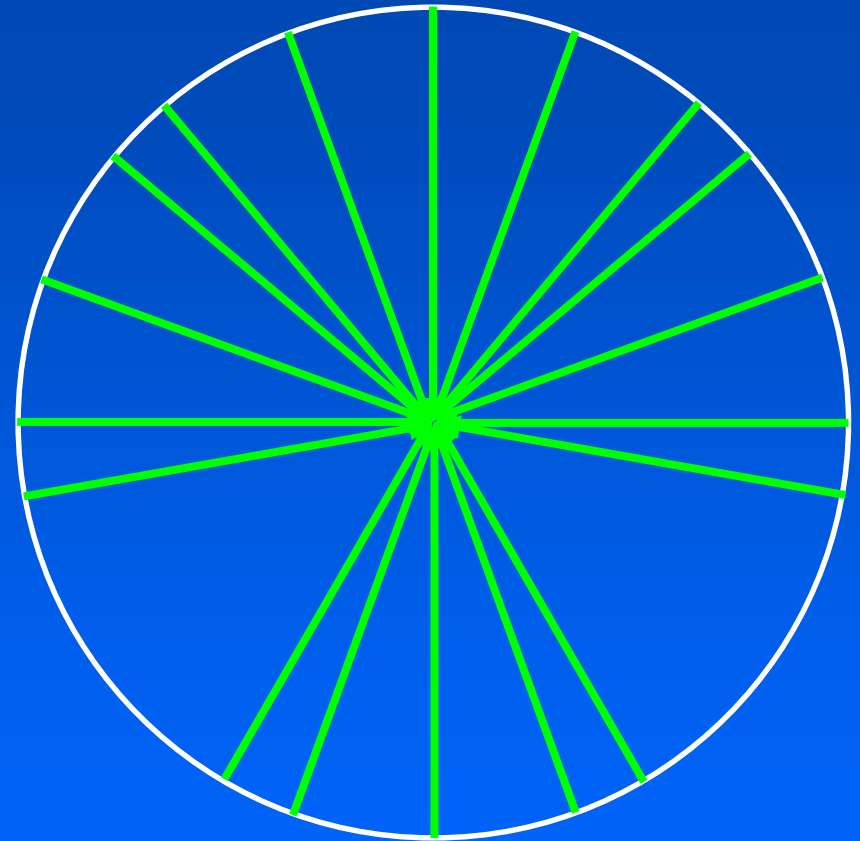
=> 18 accelerators to set up!

Gantry / Status

p

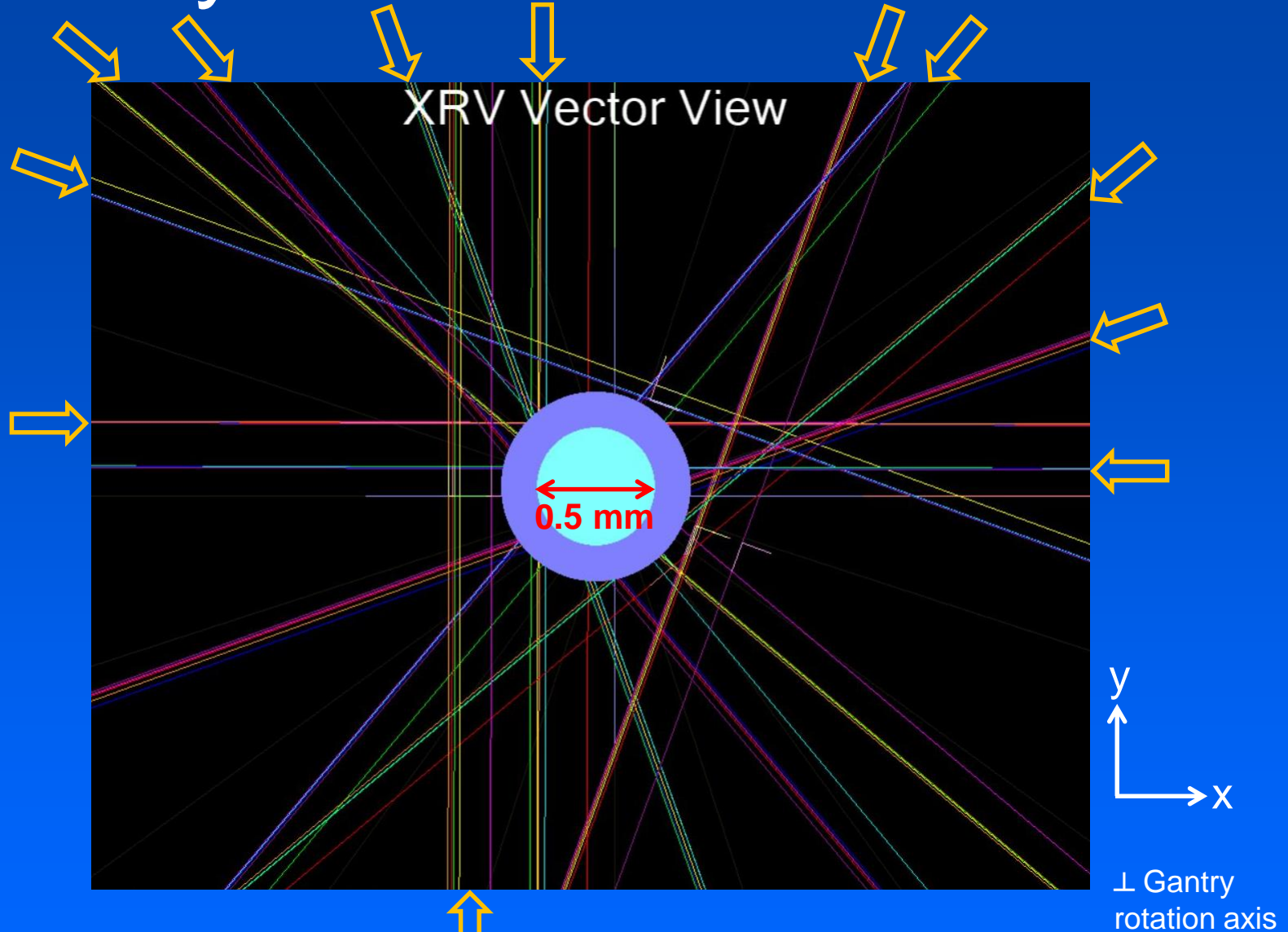


¹²C

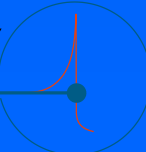


Set up by accelerator
Released for therapy

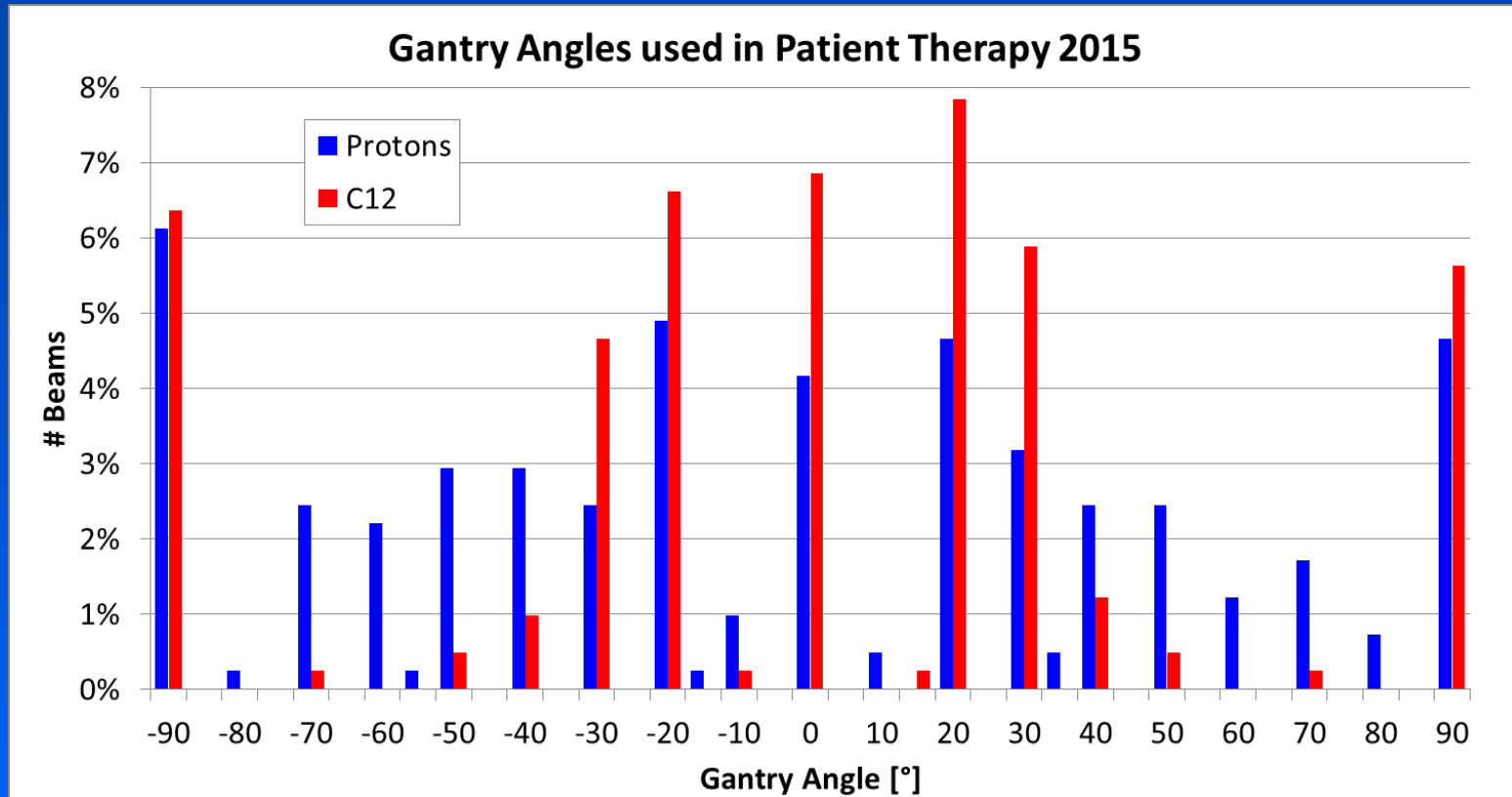
Gantry / Achieved Precision



S. Brons, Heidelberg Ion Beam Therapy Center

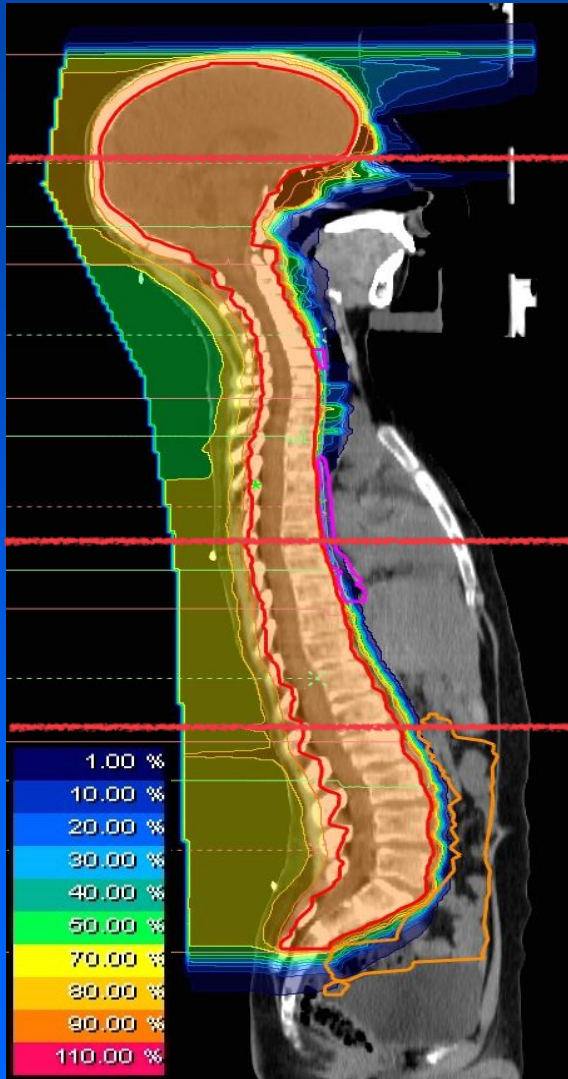


Gantry angles used in therapy

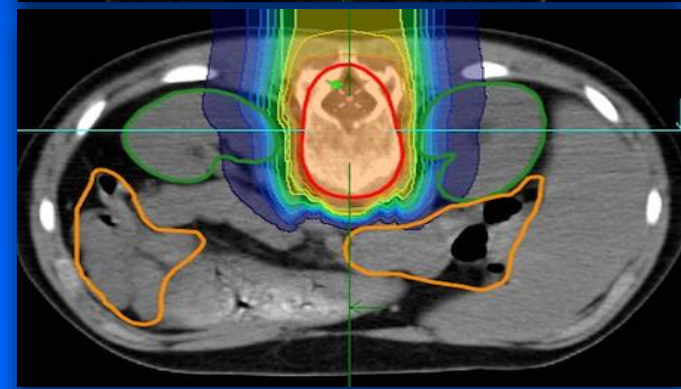
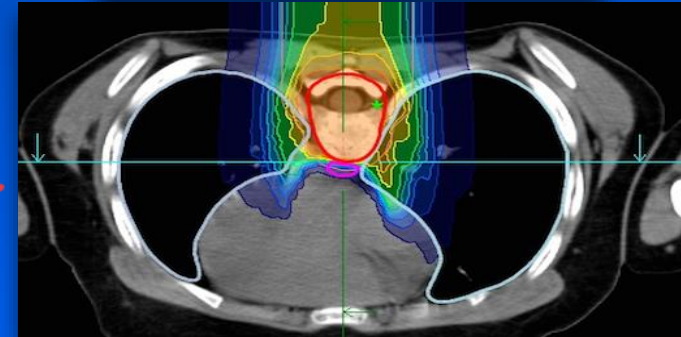
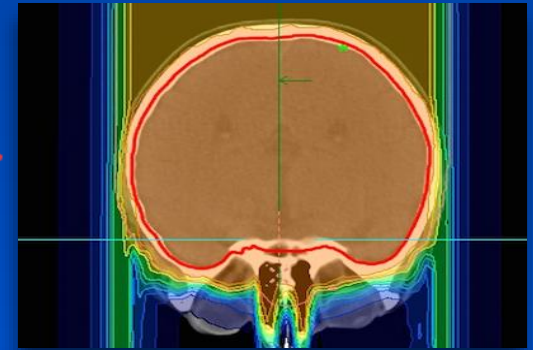


➤ Majority of beams have gantry angles $\neq 0^\circ/90^\circ/270^\circ$

Neuraxis beam setup

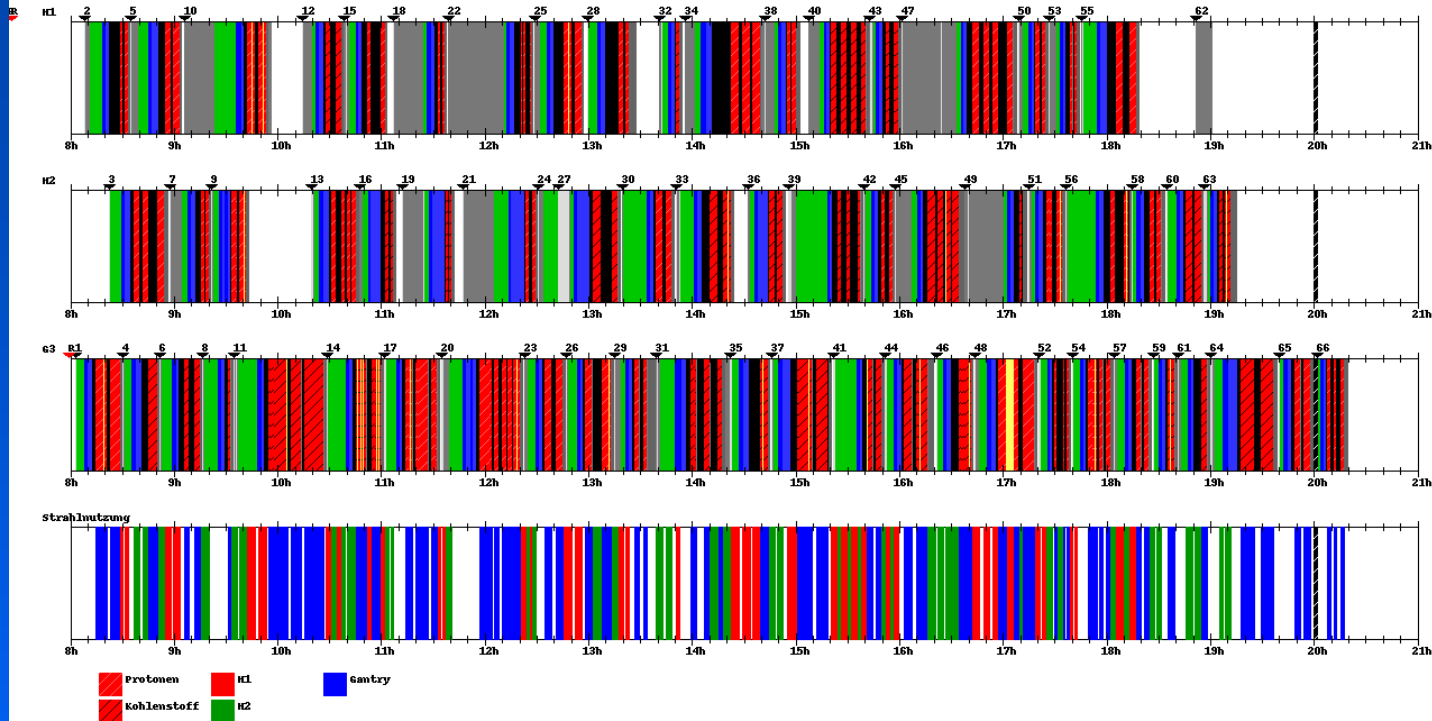


Courtesy of K. Herfarth



HIT Workload

Übersicht Raumaktivitäten
Wednesday, 01.02.2017

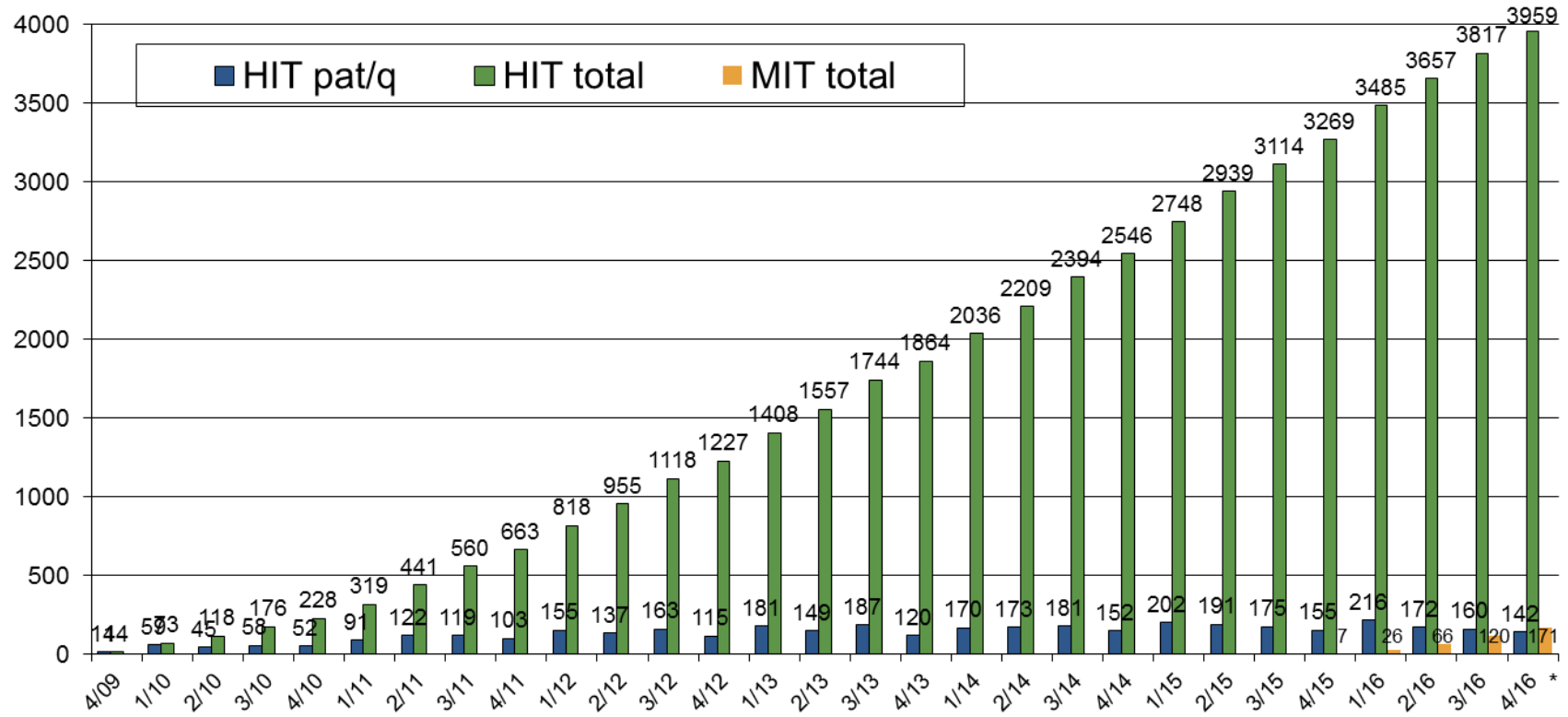


	Alle	Room1	Room2	Room3
Anfang	08:02	08:08	08:22	08:02
Ende	20:19	19:00	19:15	20:19
Dauer	12h 16m	10h 52m	10h 52m	12h 16m
#Sitzungen	66	19	21	26
#PV	104	36	42	26
#Felder	227	92	98	55
#interl.	49	4	8	37
Summen	31h 01m	09h 23m	09h 46m	11h 52m
Laden	00h 57m	00h 14m	00h 21m	00h 20m
Leerlauf	04h 02m	02h 18m	01h 21m	00h 21m
Warten	06h 25m	01h 58m	01h 48m	02h 38m
Vorbereit.	05h 03m	01h 08m	01h 47m	02h 12m
PV	02h 15m	00h 36m	00h 39m	00h 59m
Regist.	02h 18m	00h 28m	01h 00m	00h 50m
Strahl	07h 38m	01h 54m	02h 01m	03h 42m
Interlocks	00h 04m	00h 00m	00h 00m	00h 03m
Doku.	01h 42m	00h 30m	00h 36m	00h 35m

Neueinstellung
Umstellung
Unterbrechung
Restfall/Vx
R - RTTPT Neustart

TreatmentTraacer v4.2, HIT Betriebs Gesellschaft mbH, 2017-02-15 10:59:58, plotted by: wintermarcus

Patients @HIT/MIT



2009
14

2010
214

2011
435

2012
570

2013
637

2014
676

2015
723 (HIT)
7 (MIT)

2016
690 (HIT)
164 (MIT)

Development & Updates

- ^4He Therapy
- Accelerator improvements
- BAMS upgrade
- TPS upgrade,
Cone beam CT, PT-MR-system...

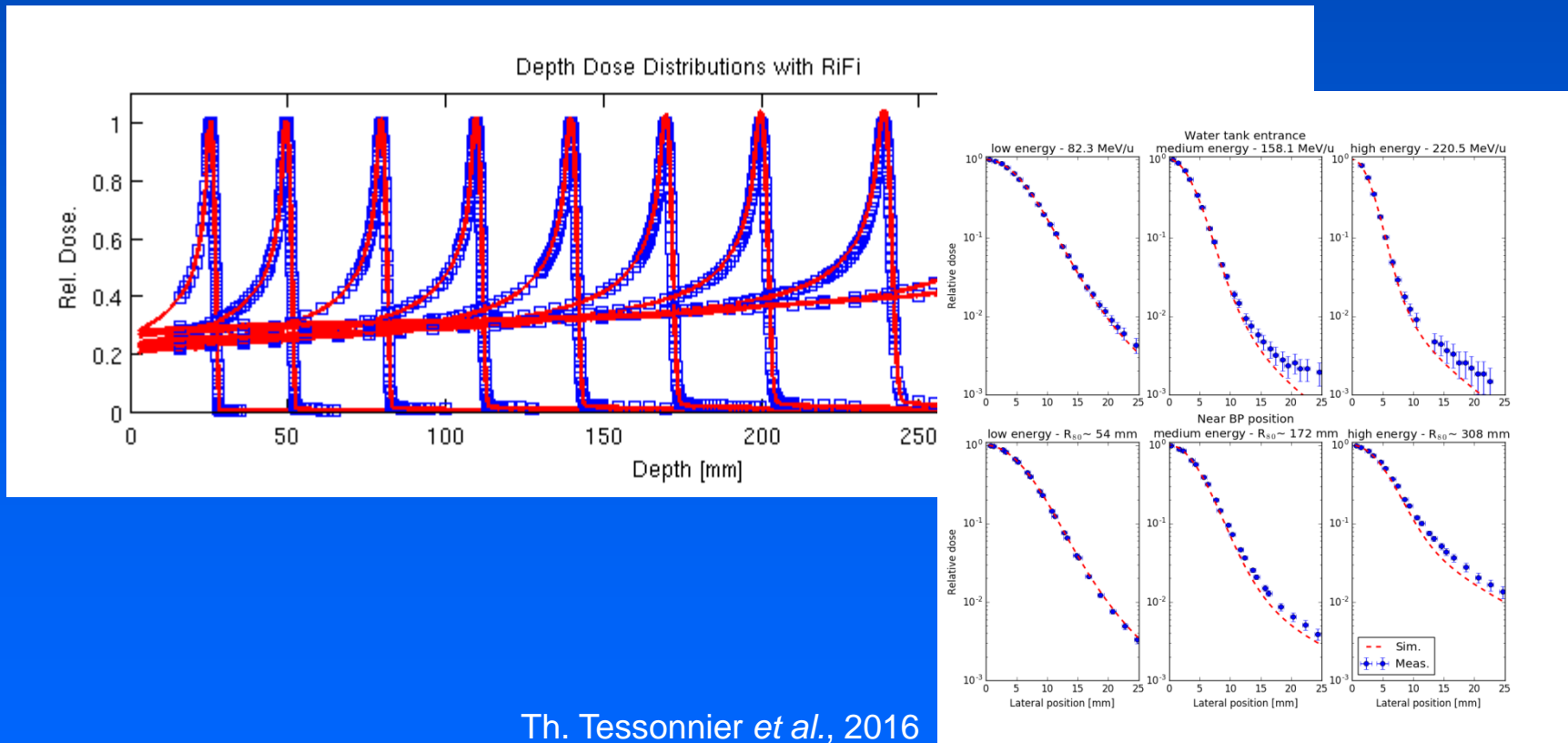
^4He status

➤ Beam tuning

✓ Done

➤ Base data

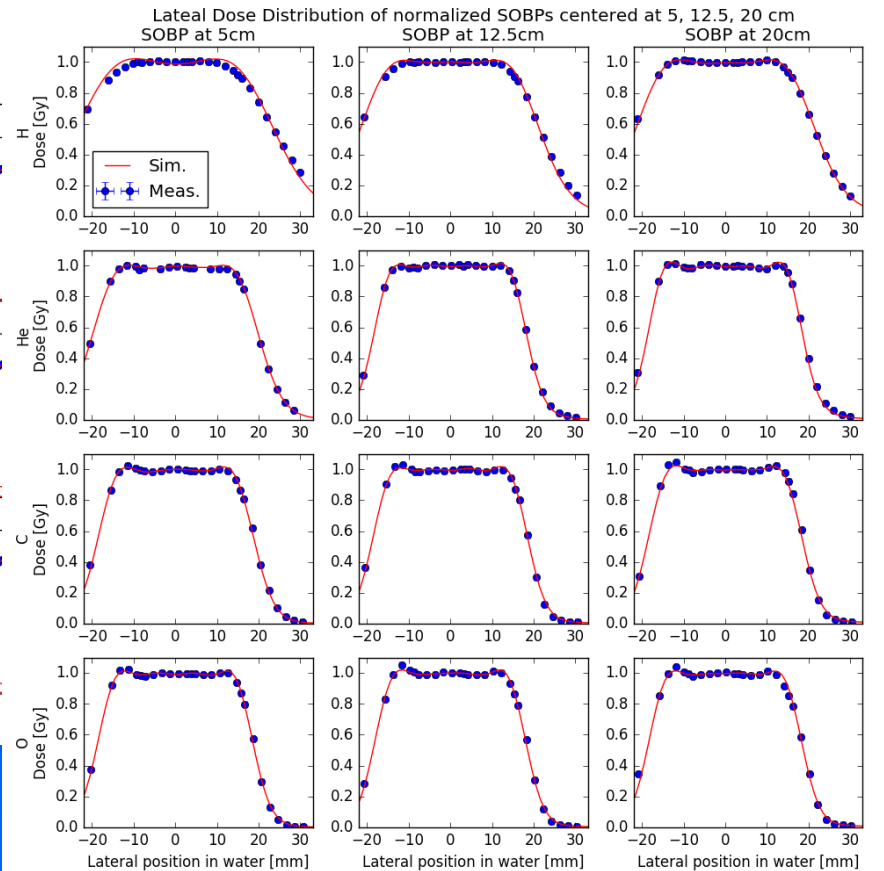
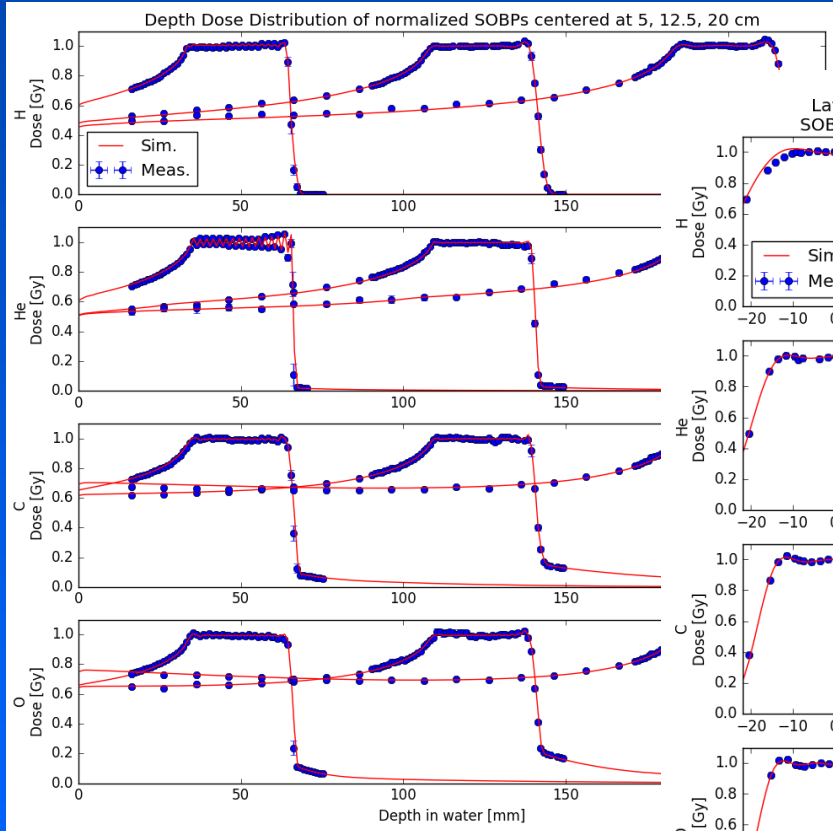
✓ Done



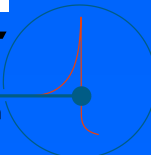
^4He status (cont'd)

➤ Planning studies (MC-TPS)

✓ Done



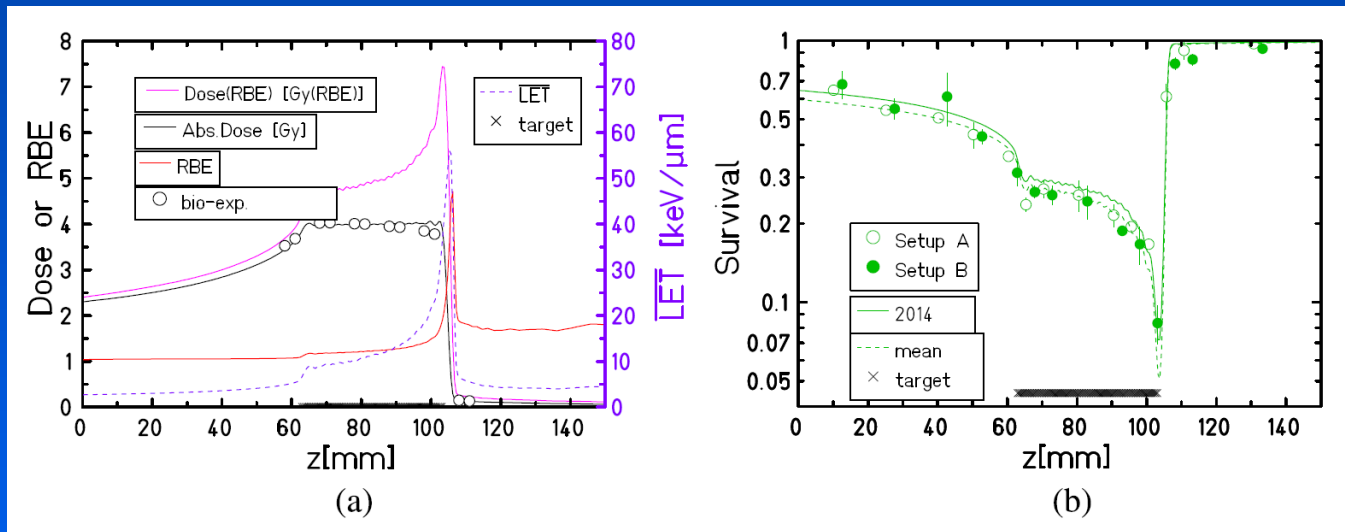
Th. Tessonier *et al.*, 2017



^4He status (cont'd)

➤ Biological validation

Underway...



M. Krämer *et al.*,
2016

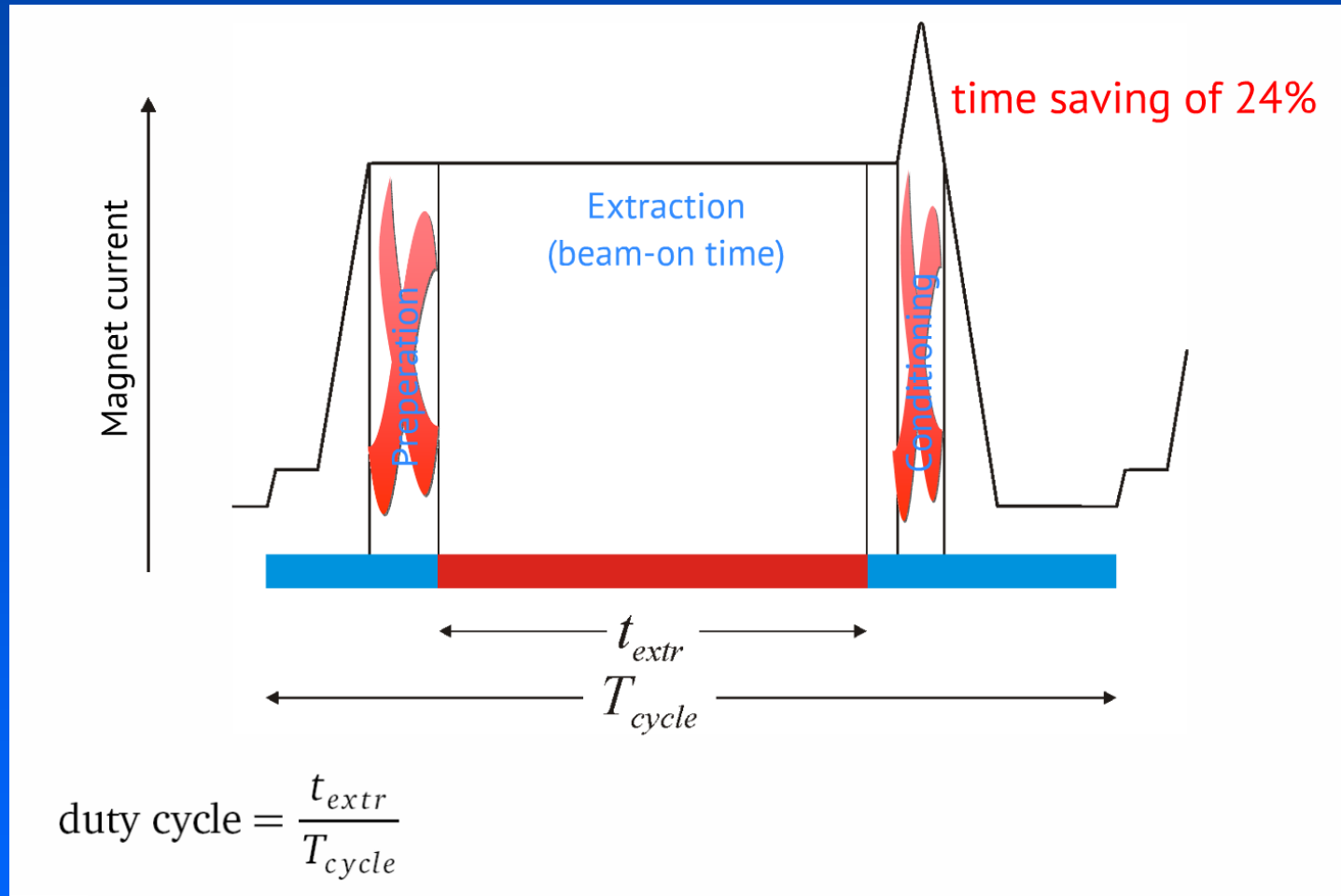
➤ Integration into Medical Product

To be done

➤ Legal admission

To be done

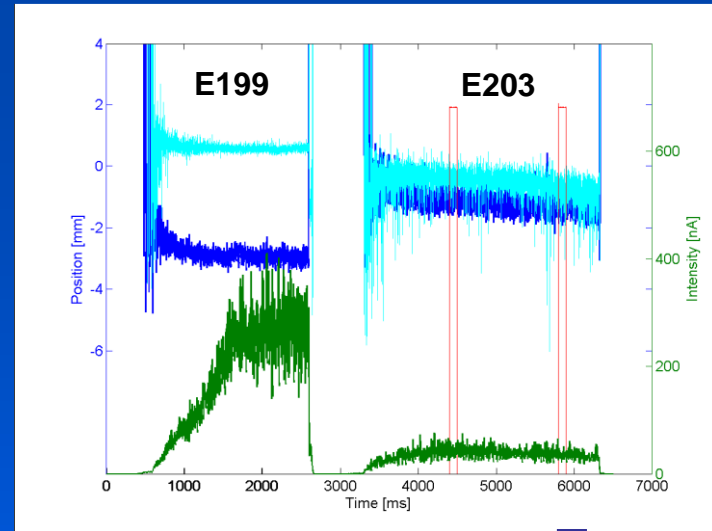
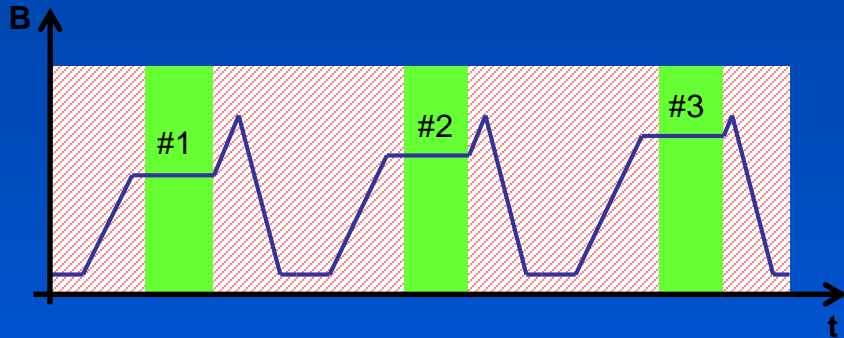
Magnetic field control



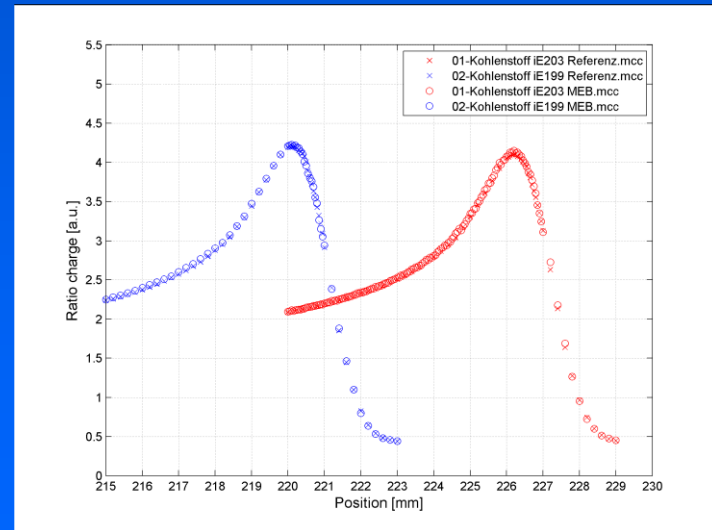
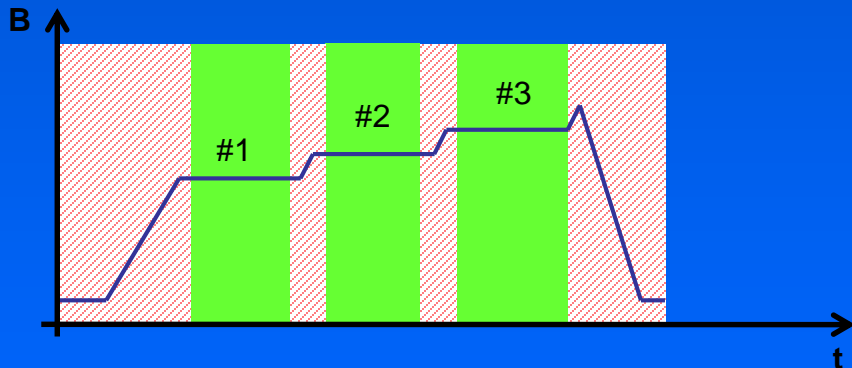
Courtesy of E. Feldmeier

Multi energy operation

Conventional beam cycle:

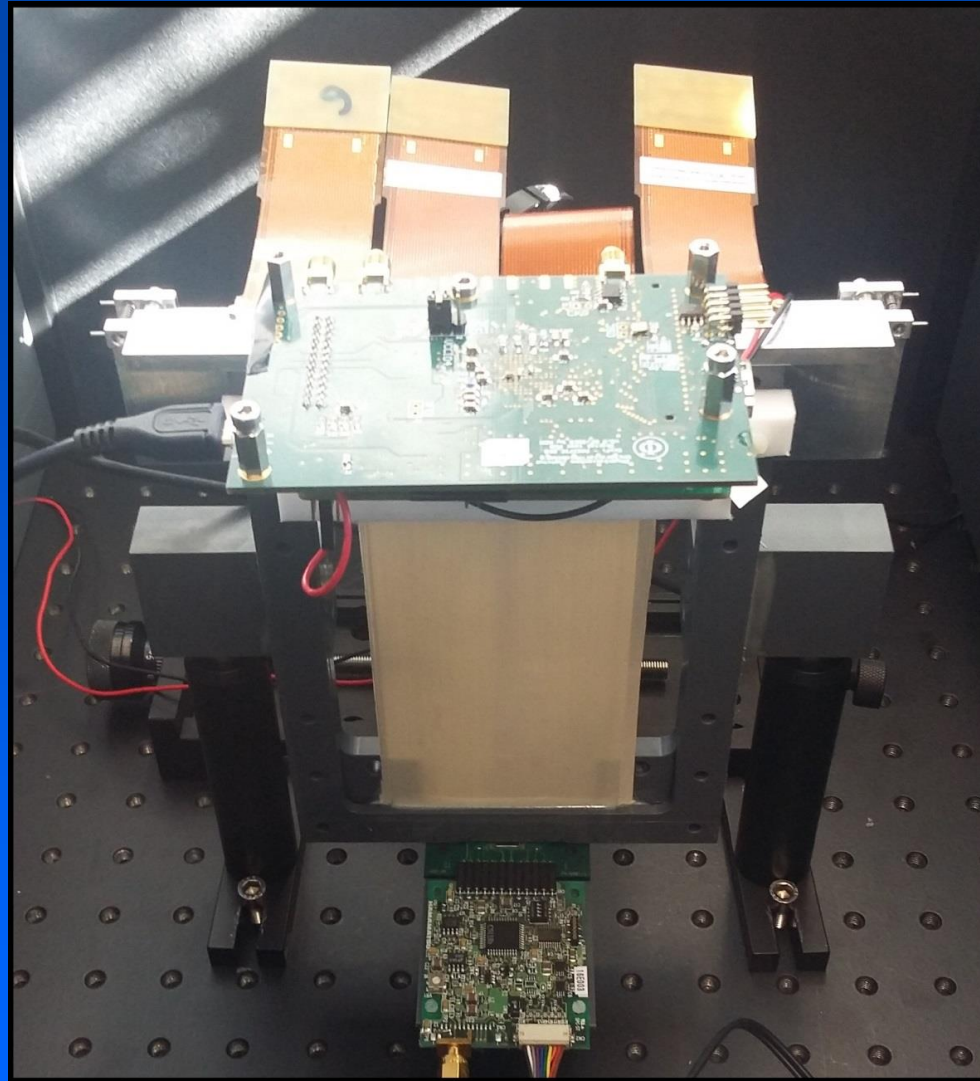


Multi energy cycle:



Courtesy of Chr. Schömers

SciFi BAMS



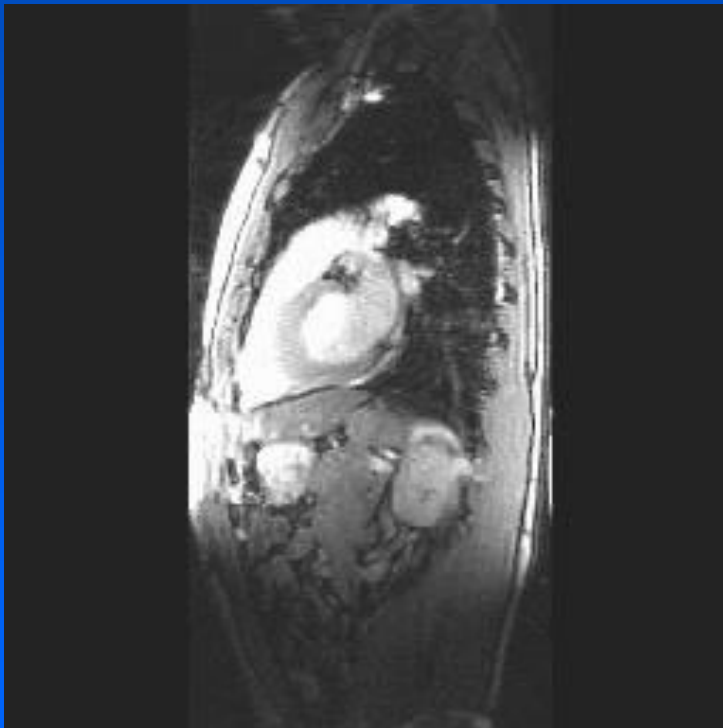
Courtesy of L. Renner

S. Brons, Heidelberg Ion Beam Therapy Center

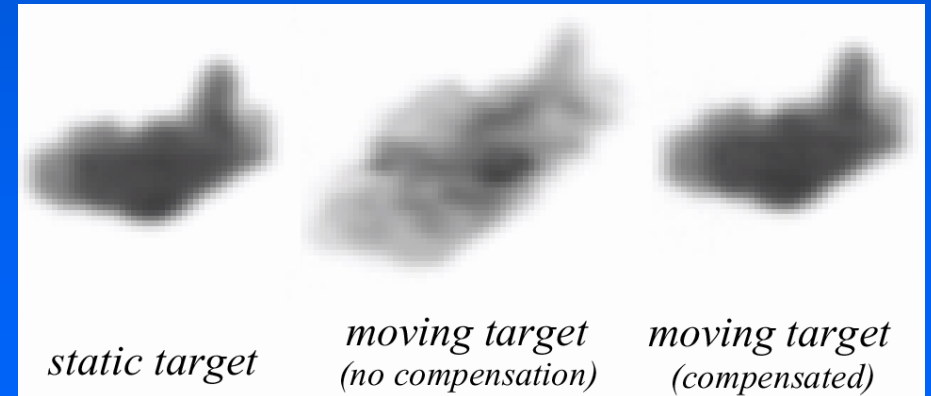
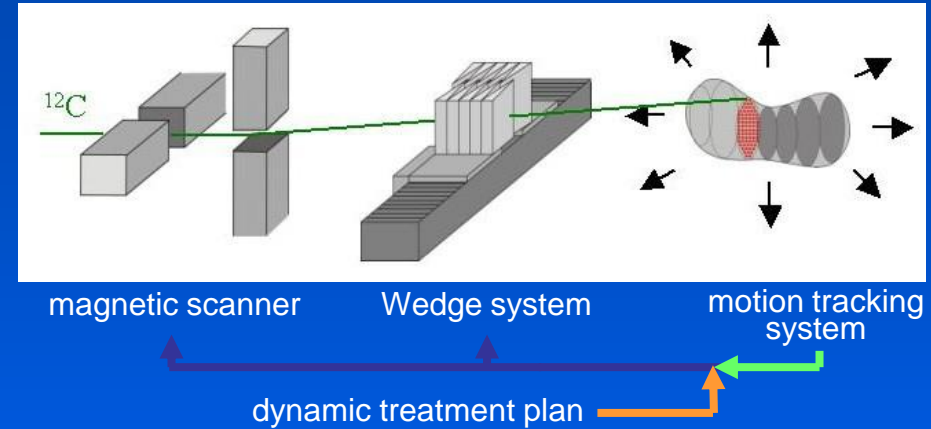
BAMS upgrade / Perspectives

➤ Faster scanning

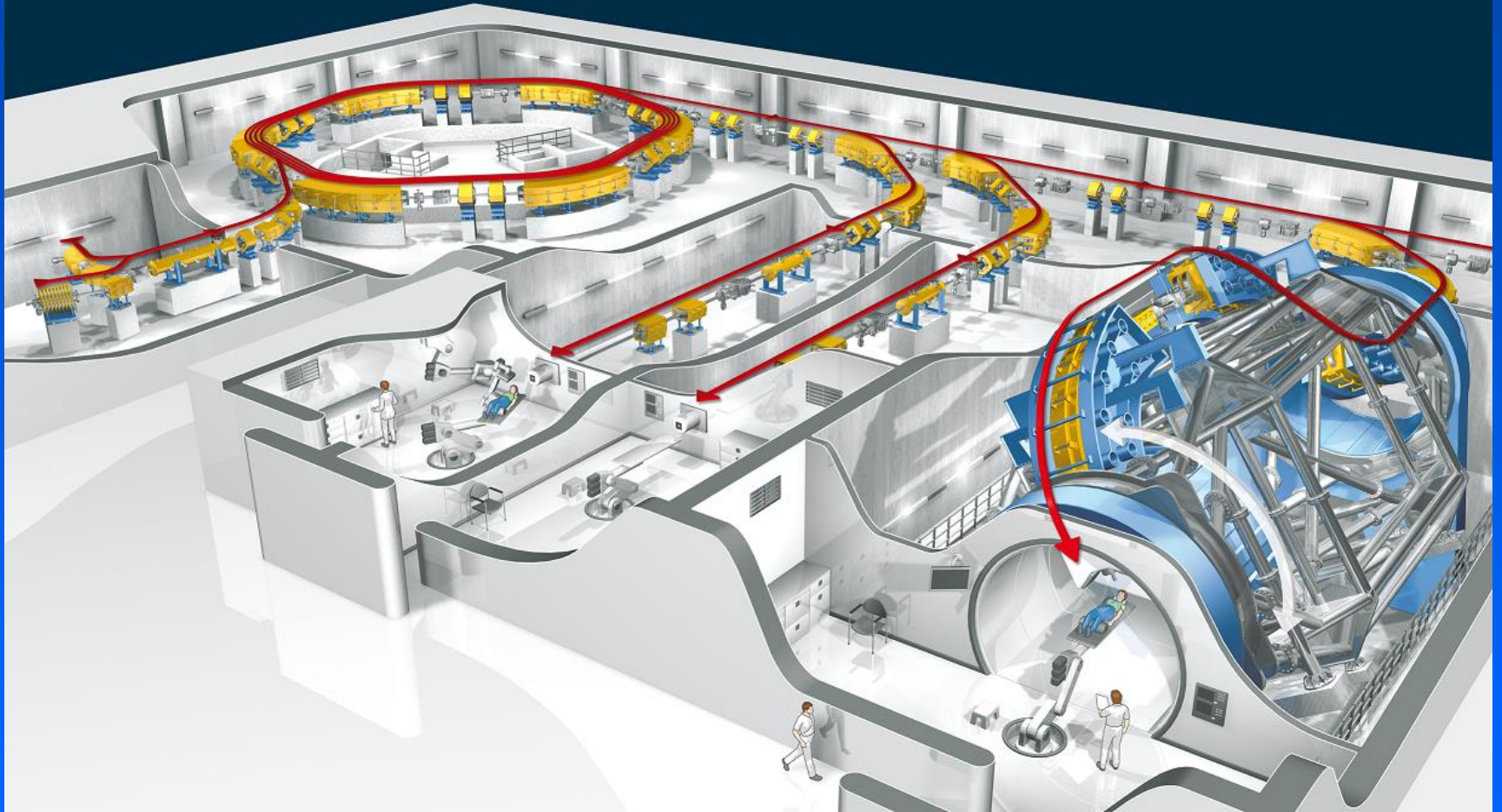
➤ Rescanning...



➤ Tracking?

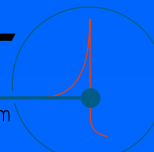
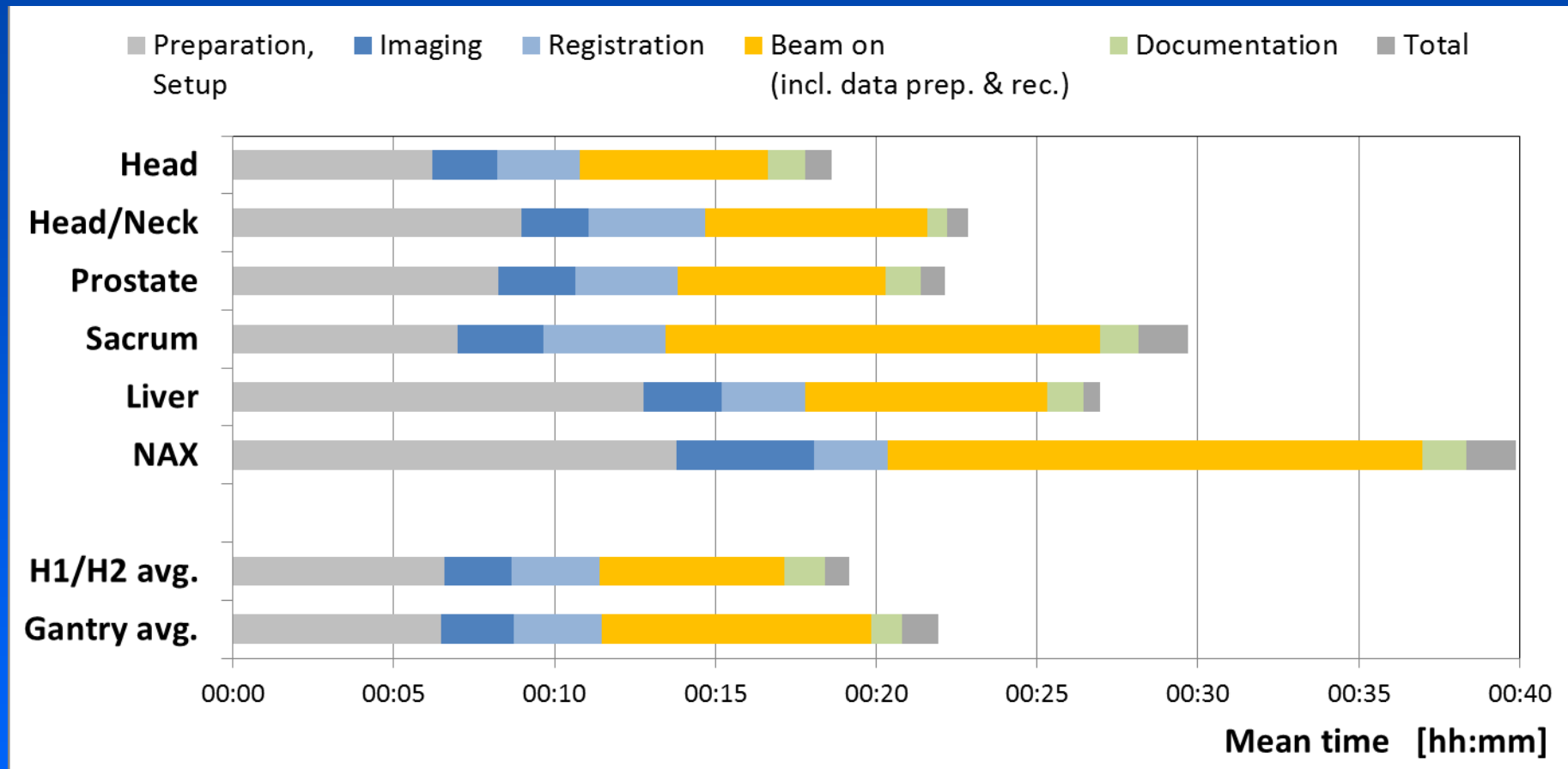


Thanks for your attention!



Workflow Performance

Mean time per workflow step (2015)



HIT Indications 2015

HIT Operation
MIND 2015 | 20

