

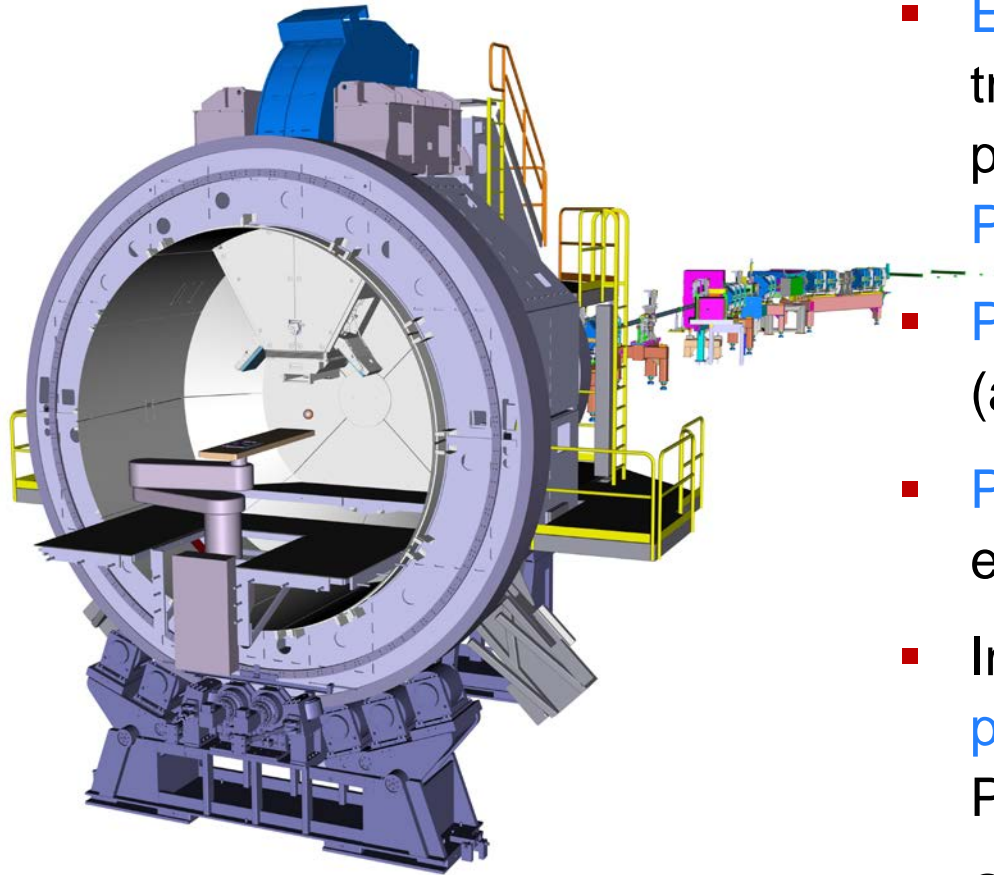


# Project Gantry 3

A.Koschik , J.Duppich on behalf of the Gantry 3 project team

EuCARD<sup>2</sup> Workshop on Superconductivity and other new Developments in Gantry Design for Particle Therapy  
17.9. – 19.9.2015, Parkhotel Bad Zurzach & PSI, Villigen, Switzerland

# Project Gantry 3 – Goals & Vision



- Expansion of research and treatment capacity for proton therapy at the PROSCAN facility at PSI
- Precise spot scanning (active scanning technology)
- Performance comparable to existing PSI Gantry 2
- Installation and commissioning in parallel to clinical operation of PROSCAN facility (no shutdown)
- Short realization time ~3 years

# Gantry 3 and the PSI PROSCAN facility

1984

2006

2013

Evolution

## Optis 1

- Passive scattering
- Eye treatments



## Gantry 1

- 1<sup>st</sup> pencil beam scanning Gantry in the world
- Compact eccentric layout
- $d = 4\text{m}$



## Optis 2

- New setup after installation of COMET

1996

## COMET

- 250 MeV sc cyclotron
- 80% extraction efficiency
- $1\mu\text{A}$  max. beam intensity



2010

## Gantry 2

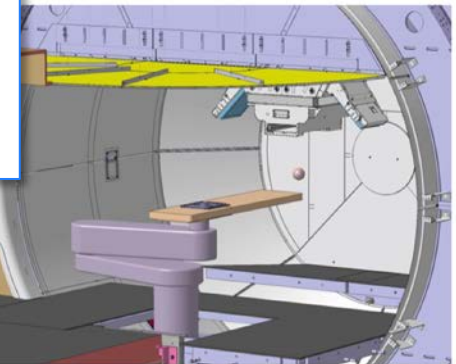
- Iso-centric layout ( $d=8.4\text{m}$ )
- Fast energy changes 100ms
- Parallel beam scanning
- X-ray in beam direction
- For volumetric repainting (treatment of moving targets)



2016

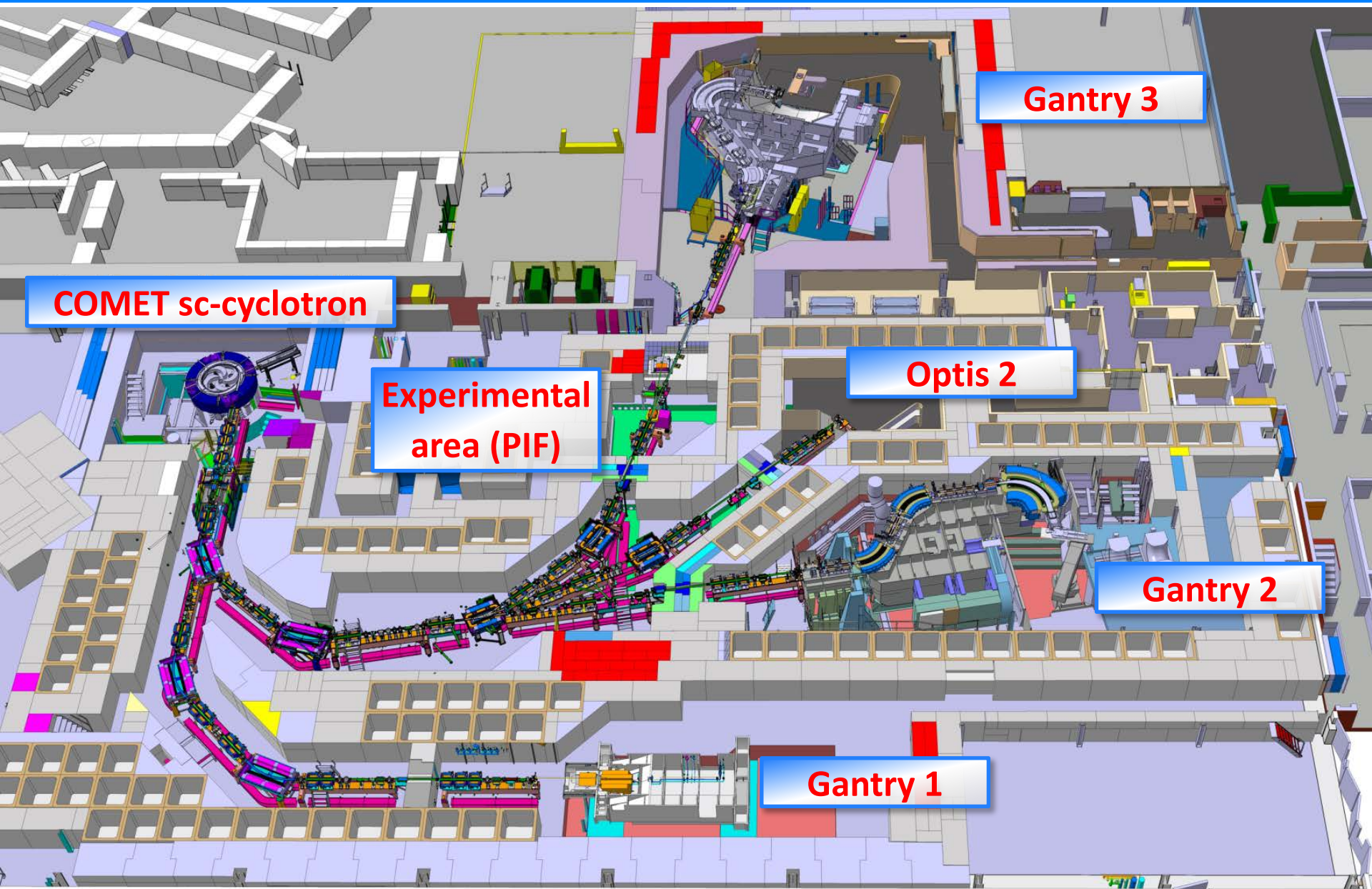
## Gantry 3

- Performance comparable to Gantry 2
- Cone Beam CT





# PSI PROSCAN facility layout





- Funded by the Swiss Canton of Zürich
- Investment sum: 20 Mio CHF
- Schedule: 54 months realization time (4.5 years) defined
- Collaboration agreement with University of Zürich (UZH) and University Hospital of Zürich (USZ)



Universität  
Zürich<sup>UZH</sup>



UniversityHospital  
Zurich

- Tight timeline for realization
- Technology Transfer  
➔ industry partner

## Press Releases

[<< \[Back to Press Releases\]](#)

### **Paul Scherrer Institute (PSI) Extends R&D Collaboration with Varian Medical Systems and Expands Capacity for Clinical Research and Patient Treatments**

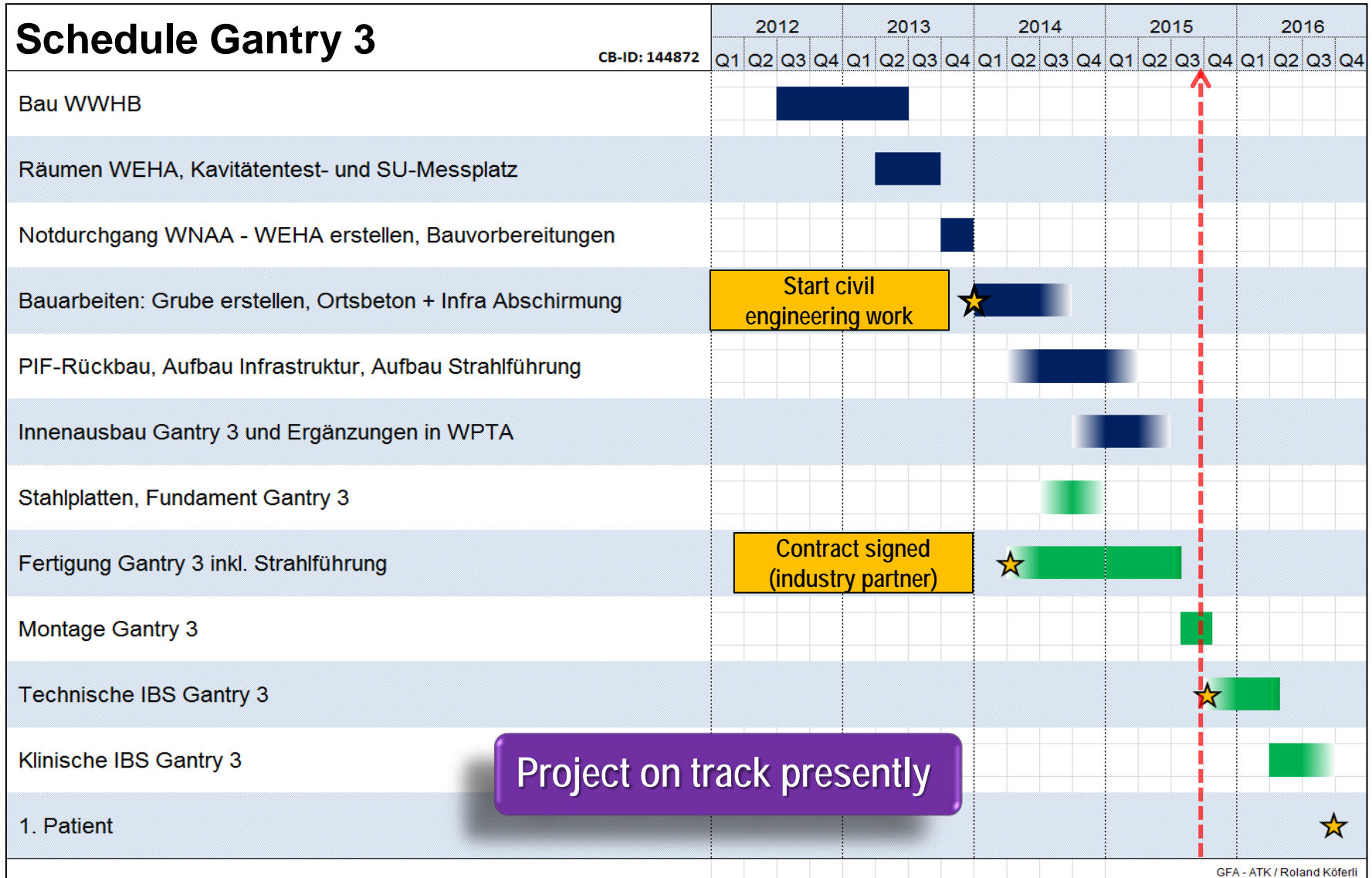
Mar 31, 2014

BERGISCH GLADBACH, Germany, March 31, 2014 /PRNewswire/ -- Varian Medical Systems (NYSE: VAR) and the [Paul Scherrer Institute \(PSI\)](#) are announcing an extension of their existing collaboration in the field of proton therapy to offer patients more precise cancer treatments using intensity modulated proton therapy (IMPT). Under the agreement, Varian will also supply technology and equipment to help meet a growing demand for clinical research and treatments at PSI.

- Realization in research collaboration  
with industry partner **Varian Medical Systems**



# Gantry 3 Schedule & Timeline (defined 2012!)



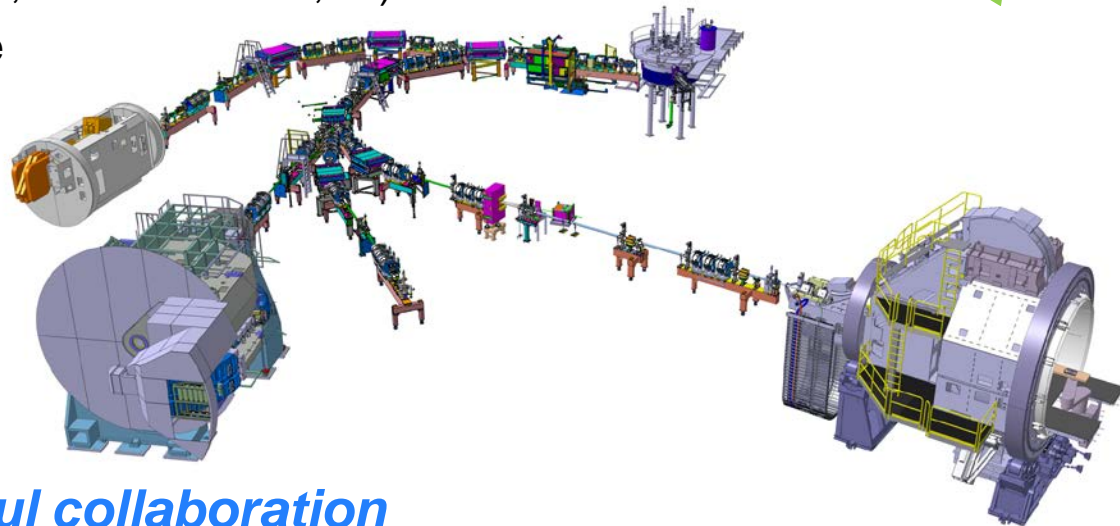


## Challenges

- Cooperation industry and institutional partner
- Integration in existing facility
- Realization in parallel to clinical operation (no shut down)
- Realization in parallel with other large & high priority project SwissFEL
- For Varian in particular:  
deviation from standard product, adaptations necessary

## Benefits

- Use established industry processes  
(procurement, fabrication, logistics, documentation, ...)
- Expertise and know-how available  
at PSI in many technical and  
scientific areas
- Realization within the  
allocated time frame
- High quality product



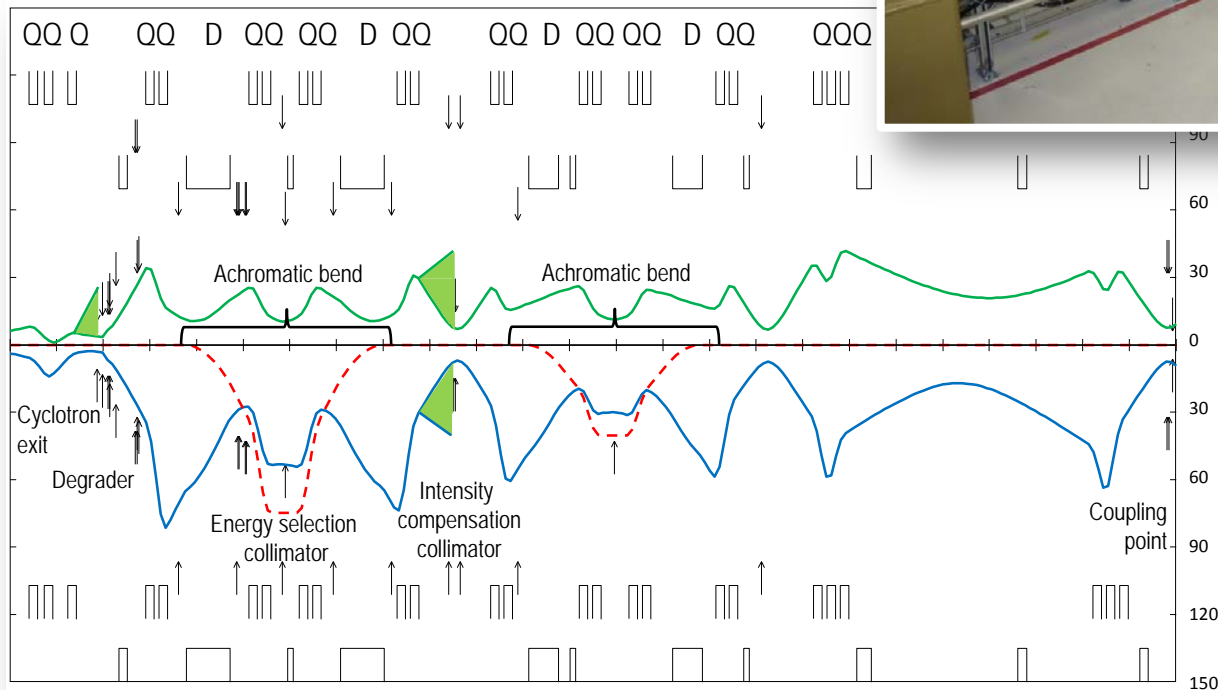
*Mutually inspiring and fruitful collaboration*

# Gantry 3 – Main Parameters & Features

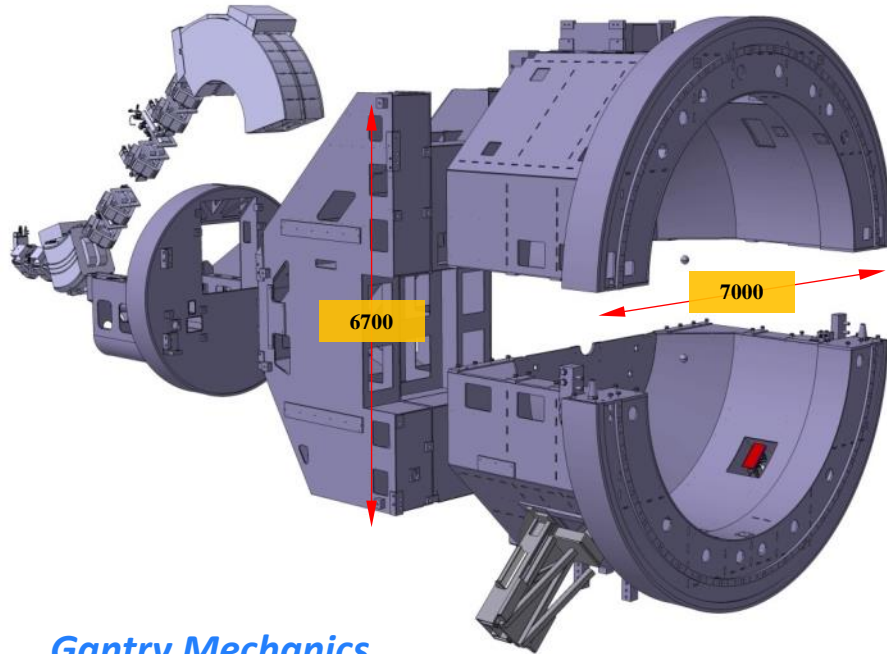
Parameter	Value
Layout type	iso-centric, full 360° rotation, 45°-135° dipoles, achromatic downstream (divergent) PBS
Beam delivery type	downstream (divergent) PBS
Diameter	10.5 m
Length	9.5 m
Weight	270 t
Energy range	70 - 230 MeV
Energy precision	< 0.1 MeV
Beam momentum spread	< 1%
Layer switching time	200 ms
Beam FWHM at IC (in air)	8.5 mm
Lateral beam position precision (IC)	1 mm
Field size	300 × 400 mm <sup>2</sup>
Dose delivery	2 Gy/Liter/min
Imaging	co-rotating CBCT integrated



- Extension of existing beamline for exp.
- Beam emittance max.  $30\pi$  mm.mrad
- Beam momentum spread  $\pm 1.0\%$
- Achromatic bending sections
- Circular collimator at coupling point to Gantry
- Intensity compensation scheme:  
Defocussing + collimation to reduce  
energy-dependent intensity variation



**TRANSPORT Beam Optics Calculations**  
 $2\sigma_y$  vertical,  
 $2\sigma_x$  horizontal beam size;  
 dispersion trajectory



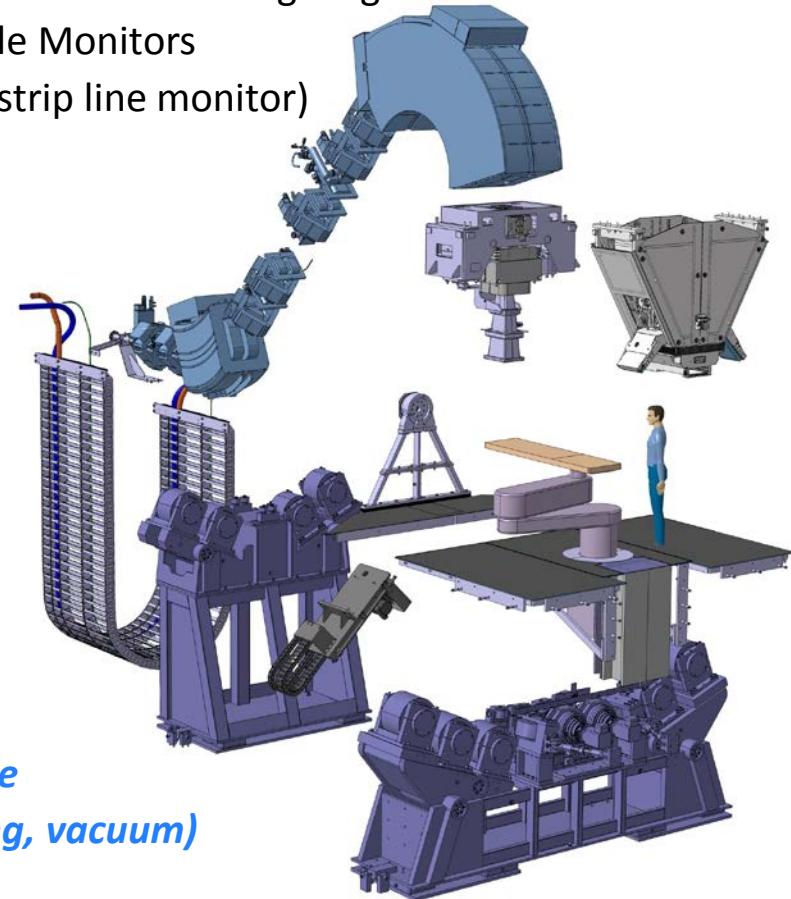
## *Gantry Mechanics consisting of 6 major parts*

- Upper front ring
- Lower front ring
- Intermediate body
- Cable drum
- Front roller
- Rear roller
- + Counterweights

+ *Robotic table*  
+ *Technical Infrastructure*  
(power, cabling, cooling, vacuum)

## *Gantry beamline:*

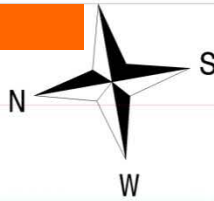
- 45, 135 dipole magnets
- 7 quadrupoles
- 3 diagnostic monitors
- 2 dual plane trajectory correction magnets
- Downstream scanning magnets
- Nozzle Monitors  
(ICs, strip line monitor)





## GANTRY 3 room concept

M 1:100

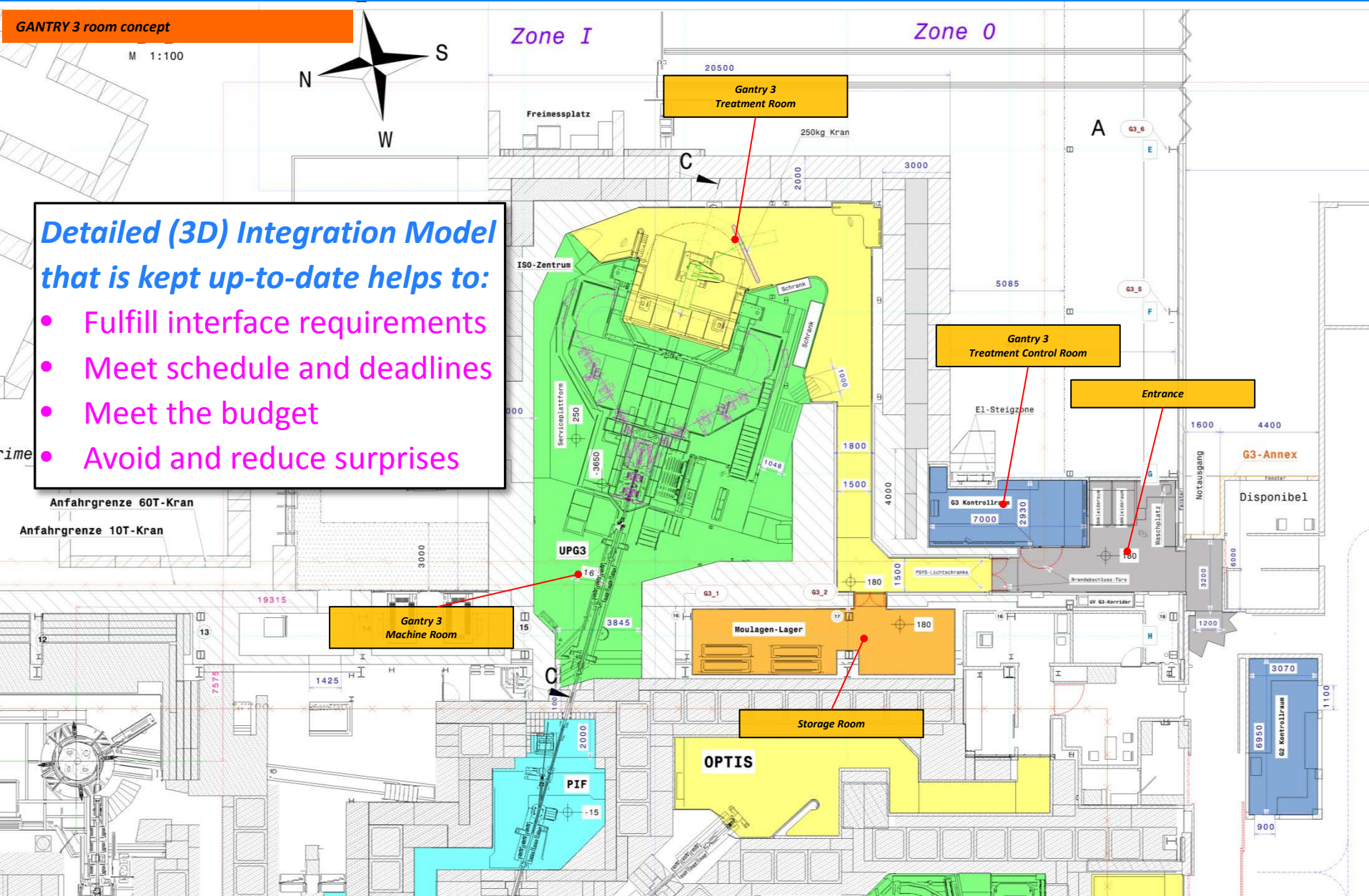


*Detailed (3D) Integration Model that is kept up-to-date helps to:*

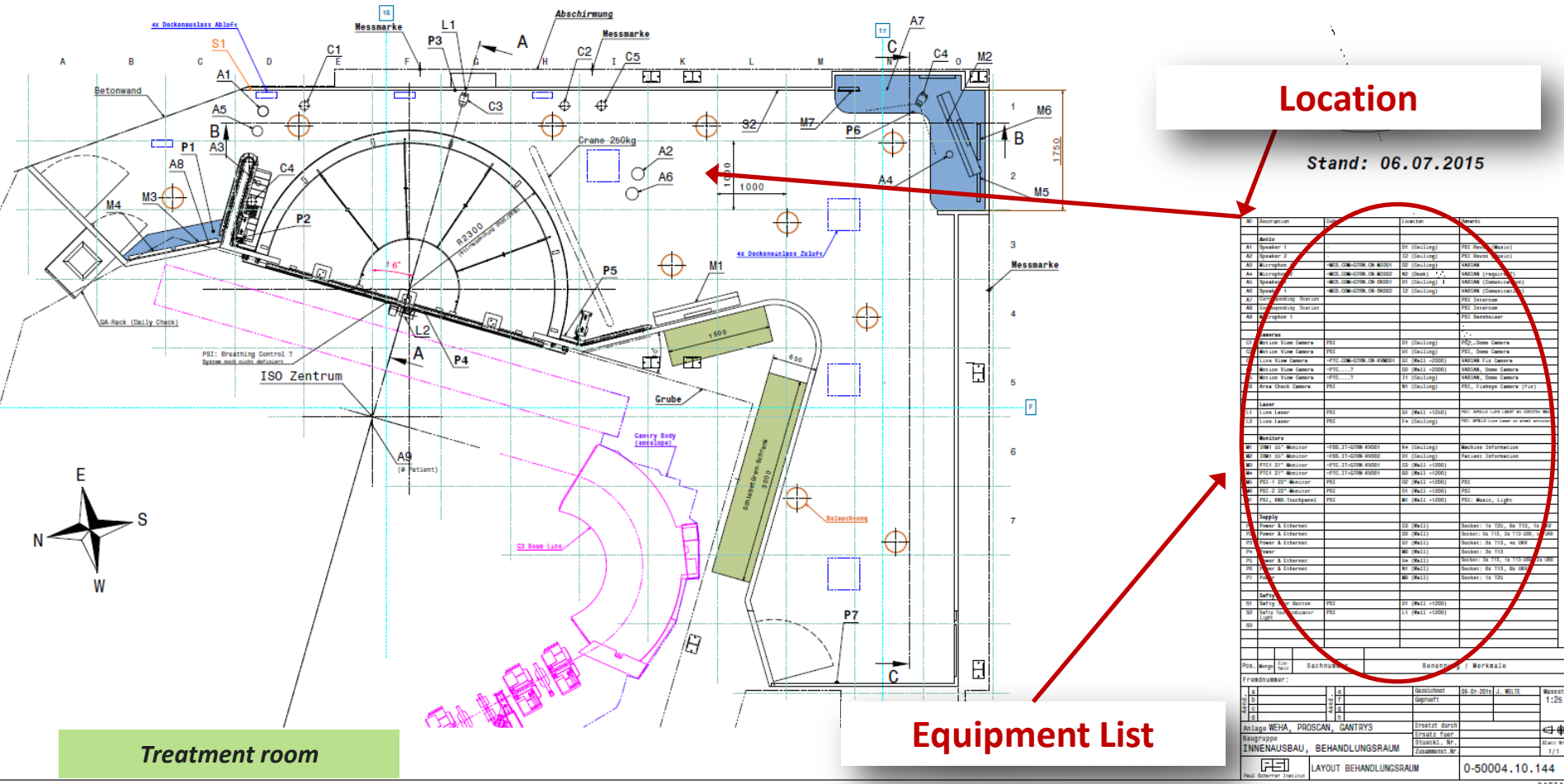
- Fulfill interface requirements
- Meet schedule and deadlines
- Meet the budget
- Avoid and reduce surprises

Anfahrsgrenze 60T-Kran

Anfahrsgrenze 10T-Kran



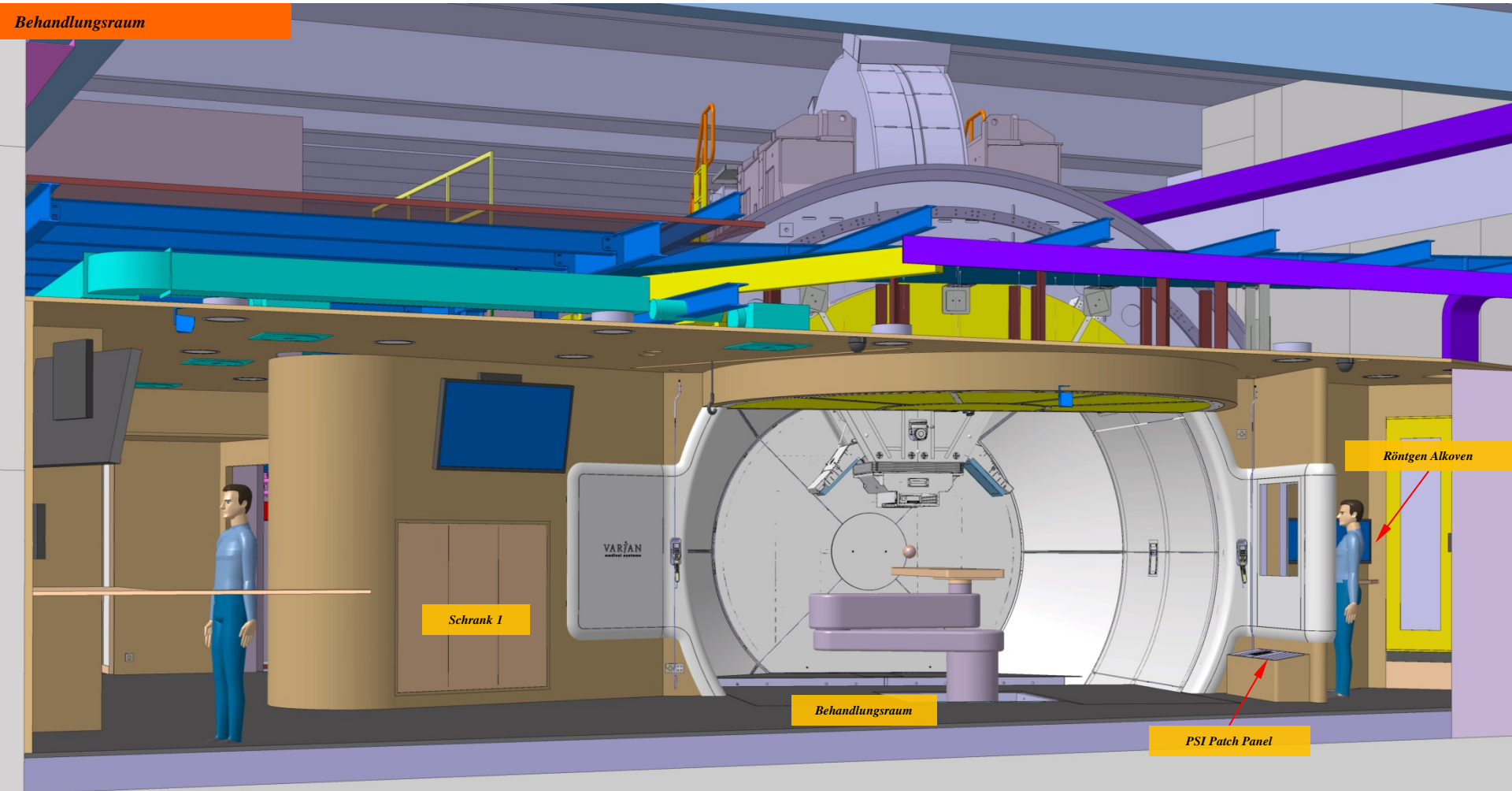
- **Very detailed planning down to the equipment level**
  - Switches, plugs, light, defined workspaces, camera systems, loudspeakers, lasers, displays, survey network points, crane, cabinets, shelves, ...

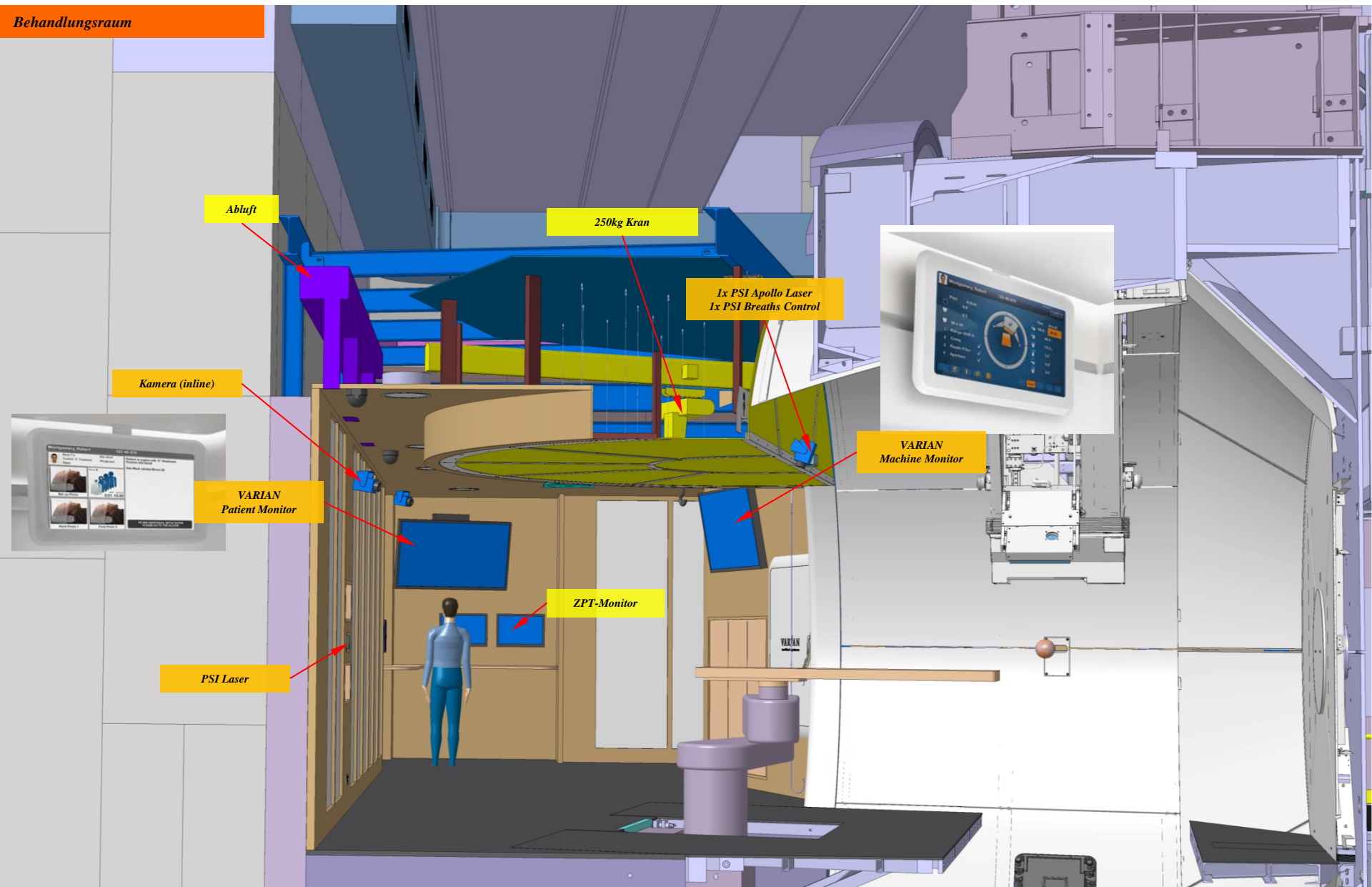




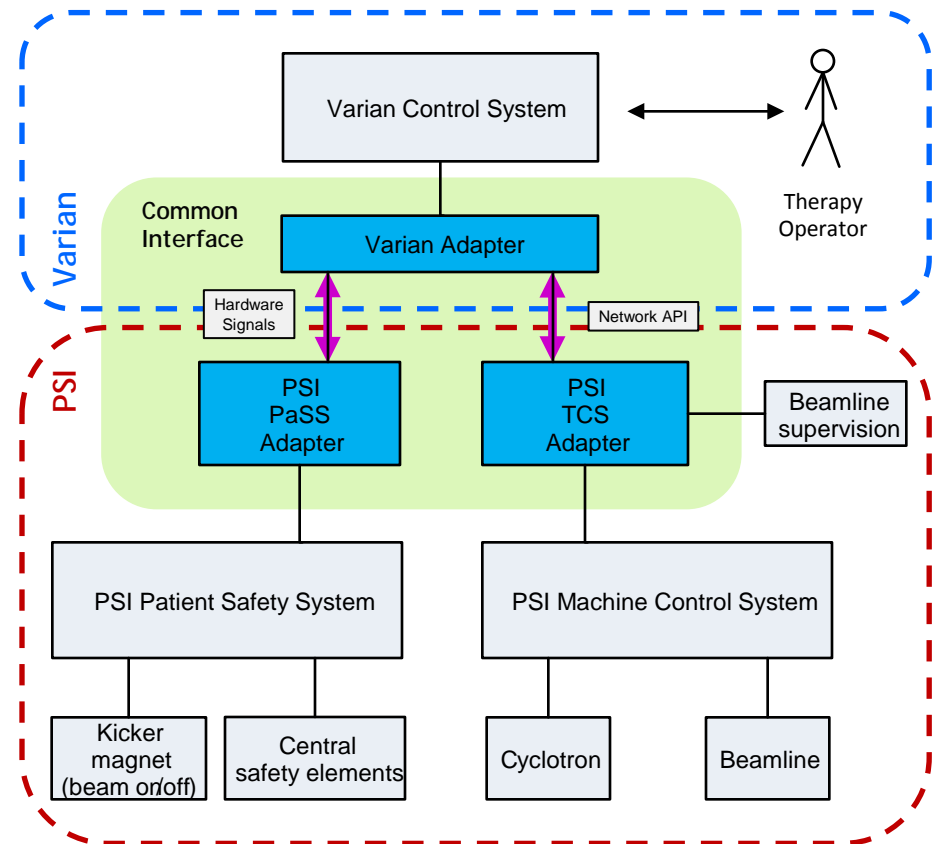






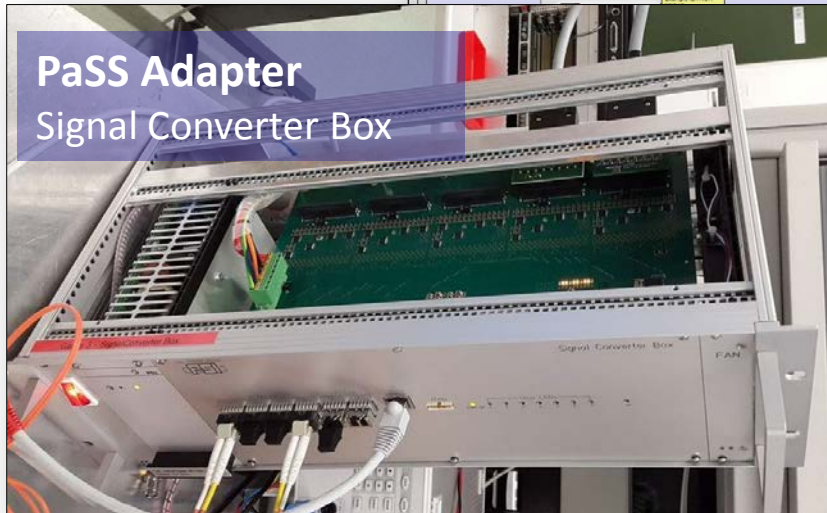
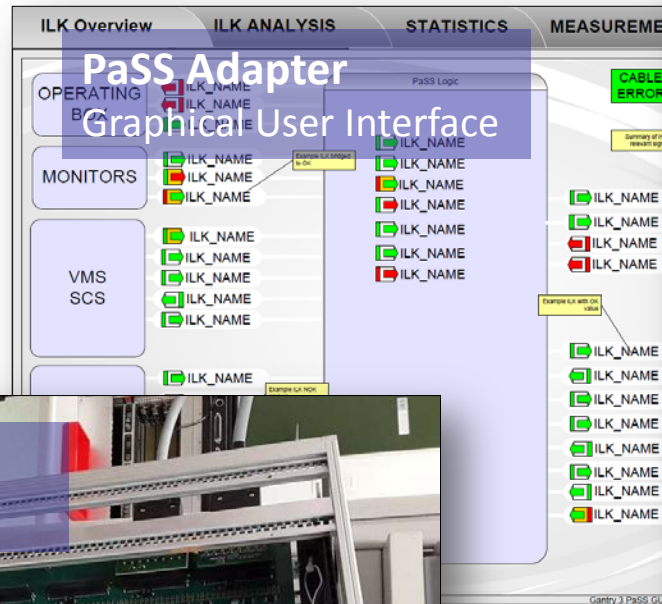


- Gantry 3 plugs in existing PSI facility like treatment areas Gantry 1 and Gantry 2
- PSI (safety and control) systems foresaw additional areas by design, no changes to system but only addition of further area
- Simple and Minimized Interfaces
  - Building and technical infrastructure (mechanical & electrical) interfaces
  - Control System Interface (P4P – ProBeam for PROSCAN)
- P4P architecture strategy
  - Leave systems mostly untouched
  - Communicate via newly developed adapters
- TCS (Treatment Control System) adapter
  - System communication to cyclotron/beamline
- PaSS (Patient Safety System) adapter
  - Connection of central components of safety systems





- **PaSS & TCS system almost ready**
  - Assembled in CPT lab, currently being tested
  - Installation of productive systems within next weeks



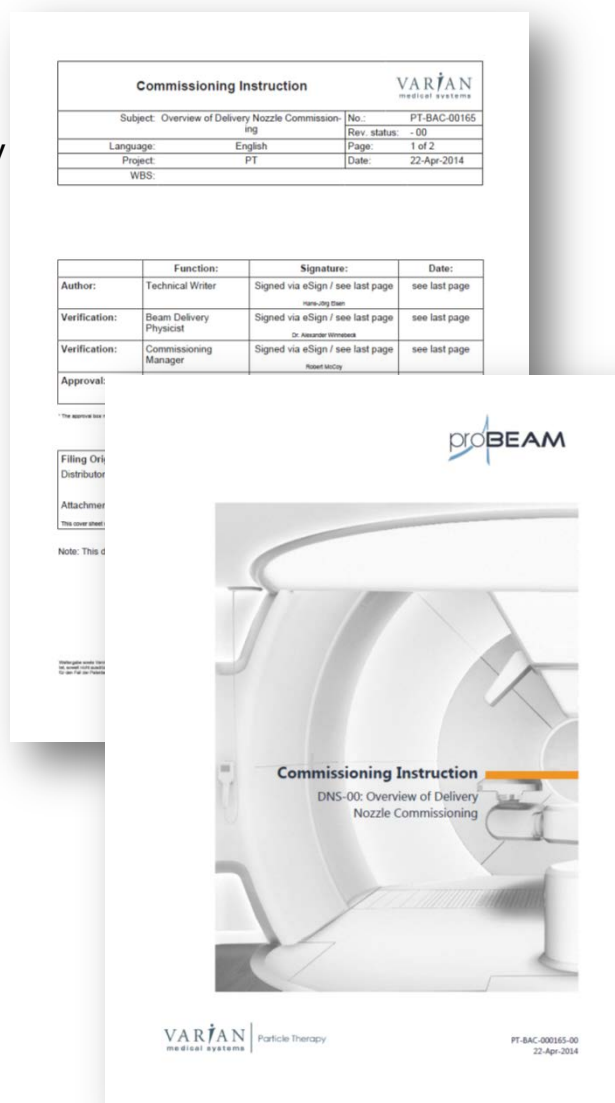
## ■ Constraints

- Operation & Maintenance PROSCAN (G1/G2/Optis2) has priority
- Integration and beam tests that require Gantry 3 Mastership:  
**night shifts 21:00 – 05:00 (Sa-We)**

## ■ Planning & Coordination

- Definition of tasks and activities, milestones:  
**Component tests, integration, control system integration, beam tests, acceptance tests, ...**
- Manpower Varian / Manpower PSI

	Montag	Dienstag	Mittwoch	Donnerstag	Freitag	Samstag	Sonntag
05:00-06:30	Hochfahren	Hochfahren	Hochfahren	Hochfahren	Hochfahren	Hochfahren	Hochfahren
06:30-08:00	Daily Check	Daily Check	Daily Check	Daily Check	Daily Check	(PIF)	(PIF)
08:00-13:00 Vormittag	Patienten G1 / G2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	(Patienten / PIF / R&D)	(PIF / R&D)
13:00-18:00 Nachmittag	Patienten G1 / G2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	Patienten G1 / G2 / O2	(Patienten / PIF / R&D)	(PIF / R&D)
18:00-21:00 Abend	Verifikation G1	QA	Verifikation G2	Unterhalt COMET	R & D (Gantry 2)	(PIF)	(PIF)
21:00-05:00	VARIAN	VARIAN	VARIAN	Unterhalt COMET	(PIF)	VARIAN	VARIAN



## Achieved milestones:

- Civil engineering work completed, infrastructure prepared for final connections
- PSI beamline up to coupling point fully installed, commissioned and operational
- Control system modified to include Gantry 3 treatment room/beamline
- Varian Gantry delivered and mechanically installed (incl. nozzle, beamline, robot)



## Next steps:

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>■ Electrical connections<br/>(Gantry beamline, Nozzle, Robot)</li> <li>■ Final alignment</li> <li>■ Hardware/component testing</li> <li>■ Control system integration (P4P adapter)</li> </ul> | <ul style="list-style-type: none"> <li>■ Commissioning w/o beam</li> <li>■ Technical commissioning (Q2/2016)</li> <li>■ Clinical commissioning</li> <li>■ 1<sup>st</sup> patient (end 2016)</li> </ul> |
|--|--|



# Impressions from civil engineering works and installation

*WEHA Experimental Hall prepared for Gantry 3 construction work, Jan 2014*









# Gantry 3 – Impressions from civil eng. works



*Gantry 3 Areal Jan 2015*



# Gantry 3 – Impressions from Installation





# Gantry 3 – Impressions from Installation





Thanks for your attention and see you at the tour!

