

***An Update on the Planned Clinical
Workflow Integration of pCT and pRad at
the Chicago Proton Center***

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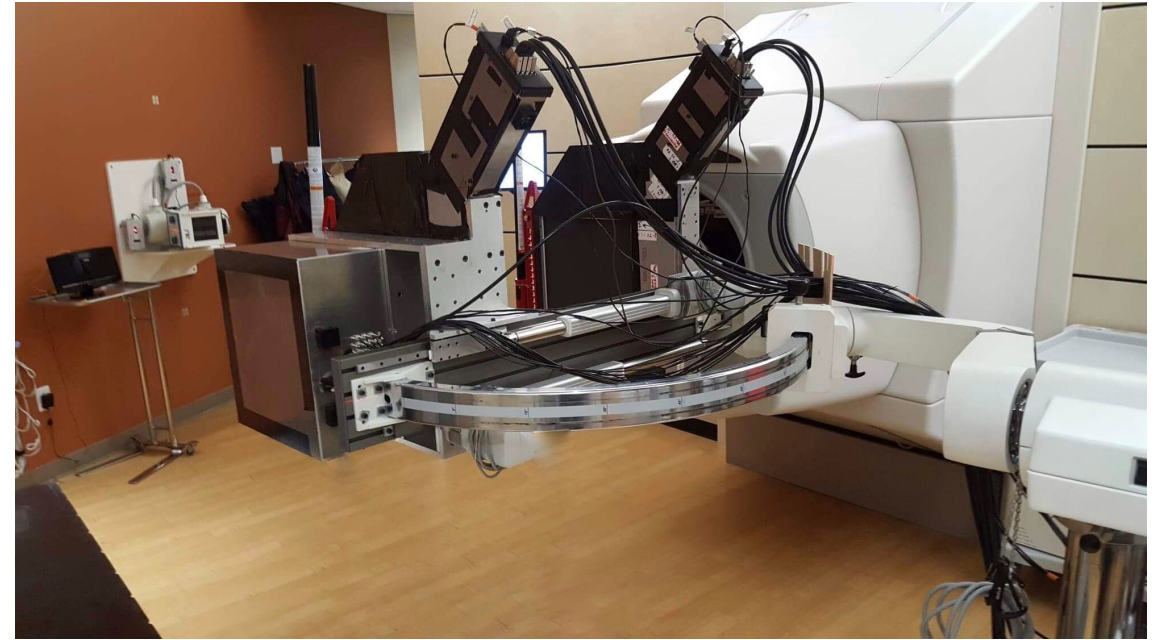
Loma Linda University

Clinical Transition: Goals

- ❖ 2D pRads in under 1 minute and 3DpCT for planning in 10 minutes or less (later for online adaptive planning in 3 minutes or less)
- ❖ WEPL and RSP resolution better than 1%
- ❖ No artifacts even in the presence of metal objects
- ❖ Ultra-low dose to the patient: pRad $< 10\mu\text{Sv}$, pCT $< 1.5\text{ mSv}$)
- ❖ Integration into clinical workflow

Hardware & Beam Delivery Concepts

- ❖ Large area detectors (40cm x 40 cm)
- ❖ Compact energy detector
- ❖ Low-dose imaging scheme utilizing pencil beam scanning with diffuse spot
- ❖ Adaptable to existing cyclotrons or synchrotrons
- ❖ Rotating chair, horizontal beam line

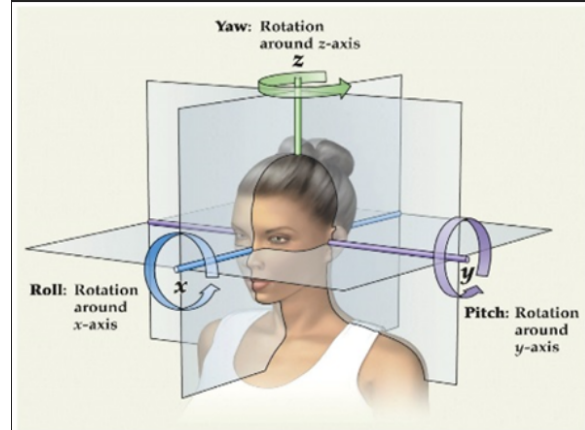


Clinical prototype of a proton radiography (later proton CT) system, undergoing testing at the NMCPCT. Currently, there is no chair in the setup.

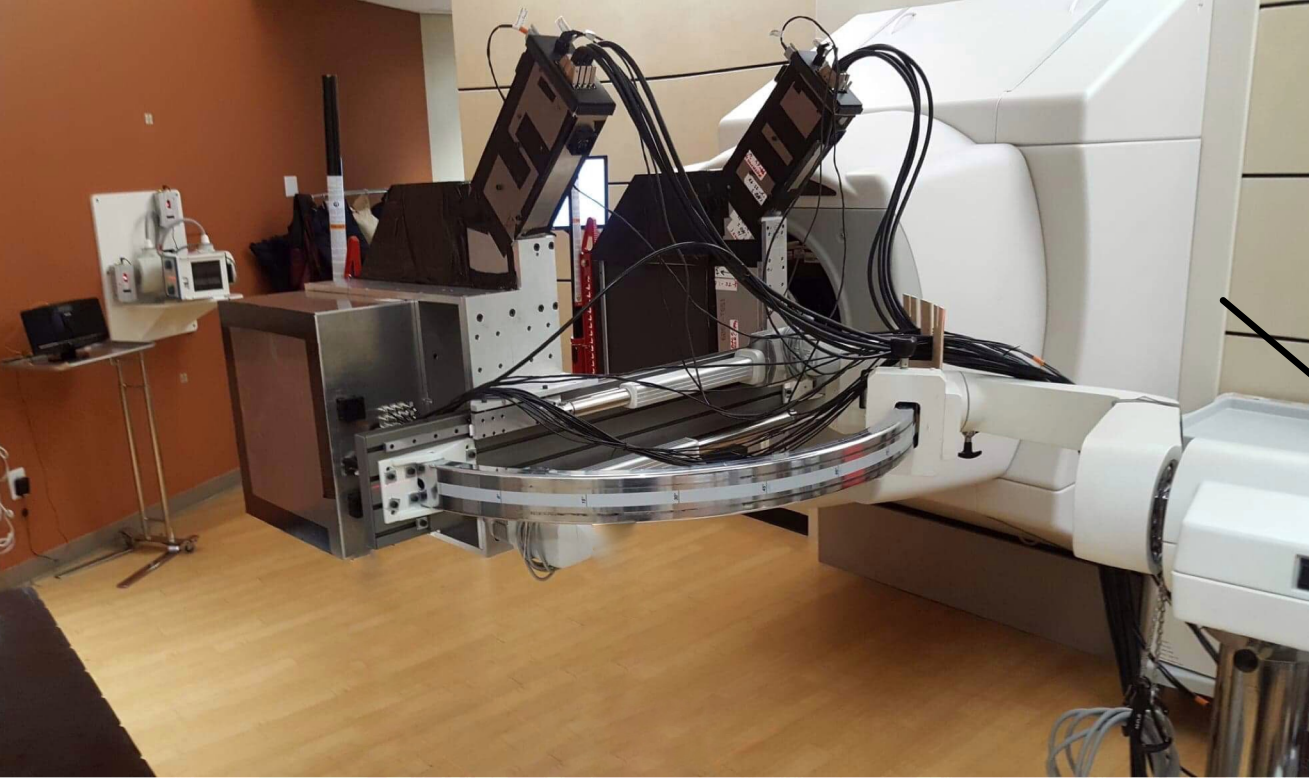
Vertical Chair

- ❖ A custom chair with a vertical back will allow complete rotation of the patient between the detector planes; it will be mounted on a sturdy rotational platform
- ❖ Additional fine control with 6 degrees of freedom will be implemented for patient positioning
- ❖ This will allow acquisition of data from all projection angles for pCT and pRad
- ❖ It will also enable head and neck cancer treatments from any direction for head and neck cancer patients

IUPESM 2018



The former patient positioning chair used at the Fermilab Neutron Therapy Facility is shown here to demonstrate the concept of a chair for treatment and imaging at the NMCPC

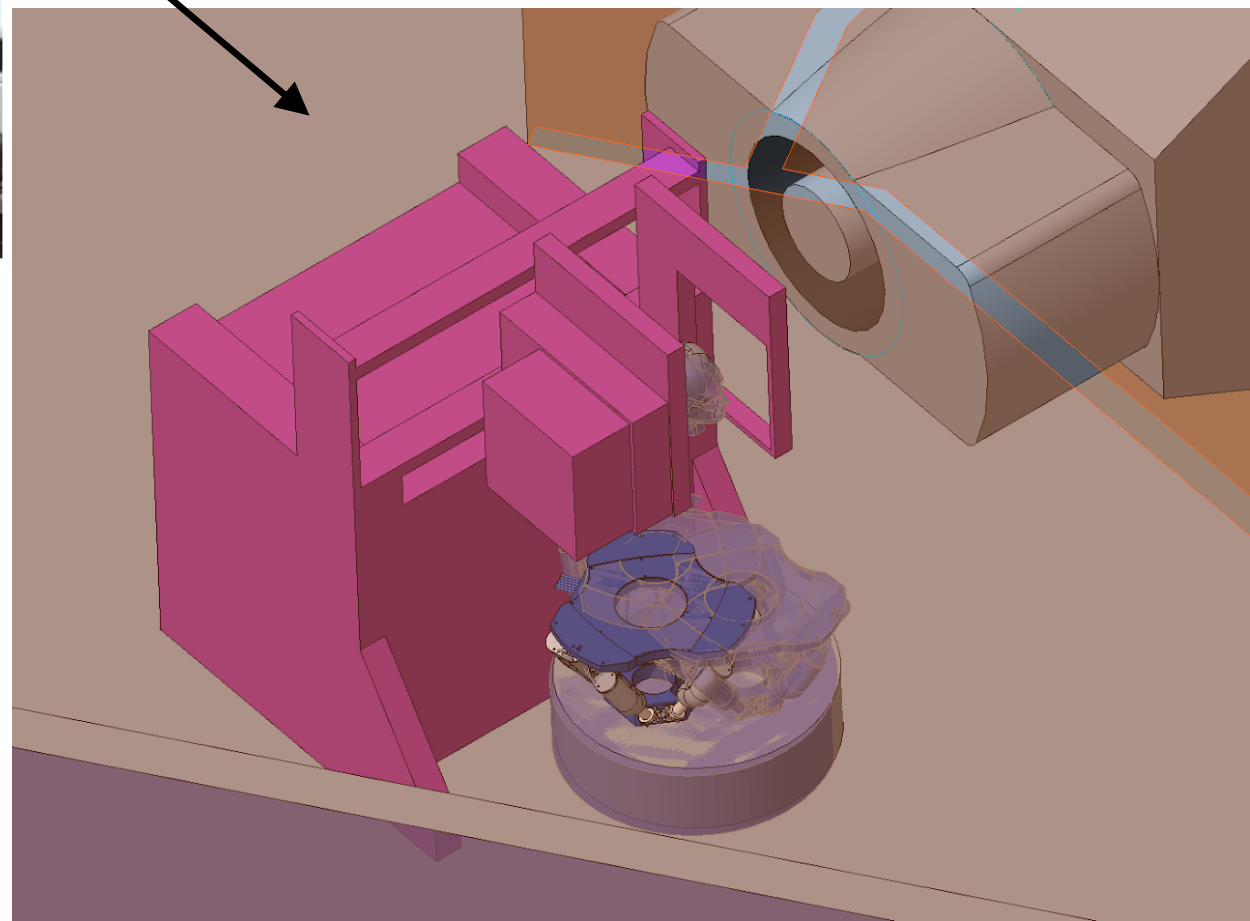


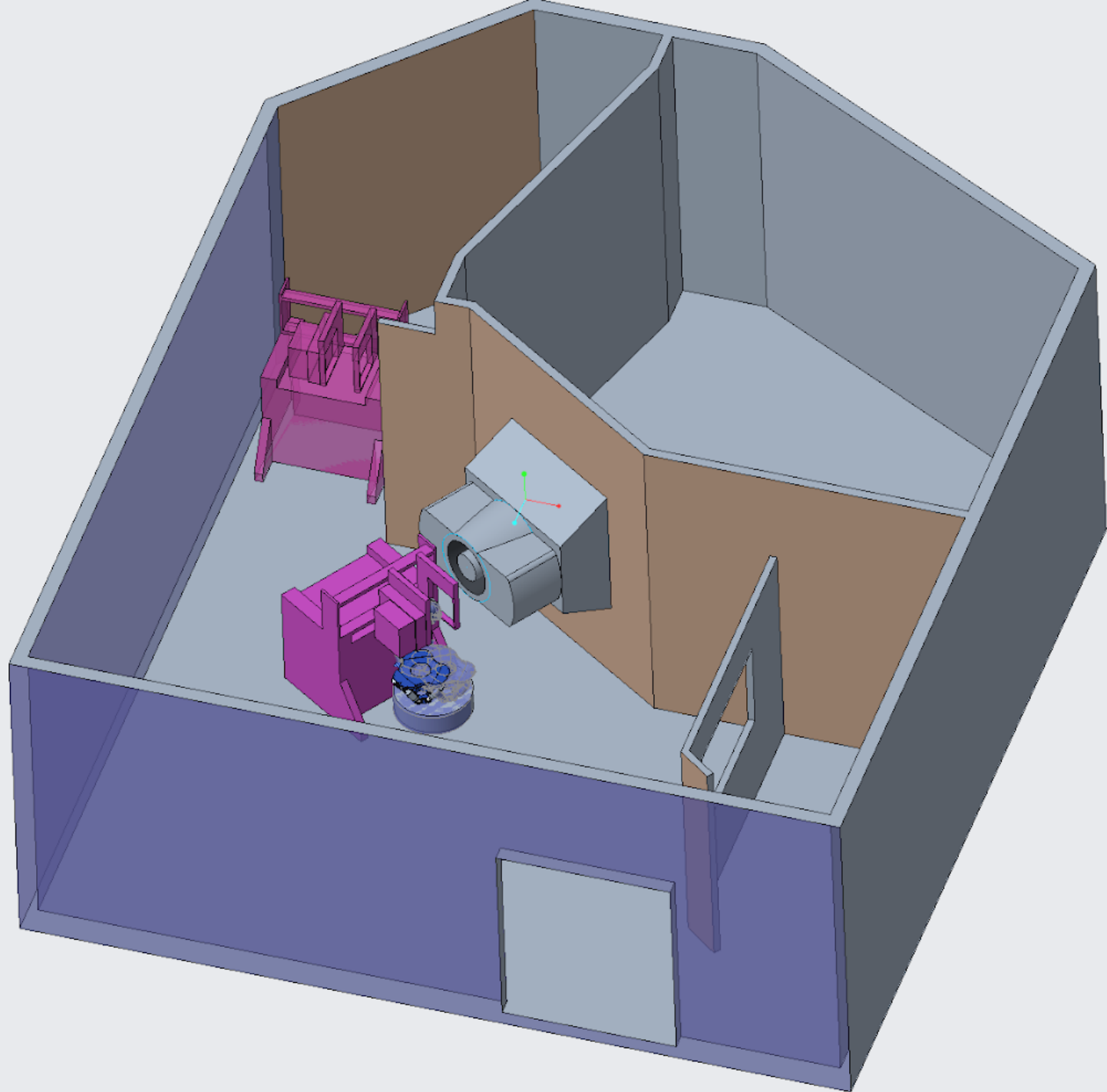
Goal:
From this

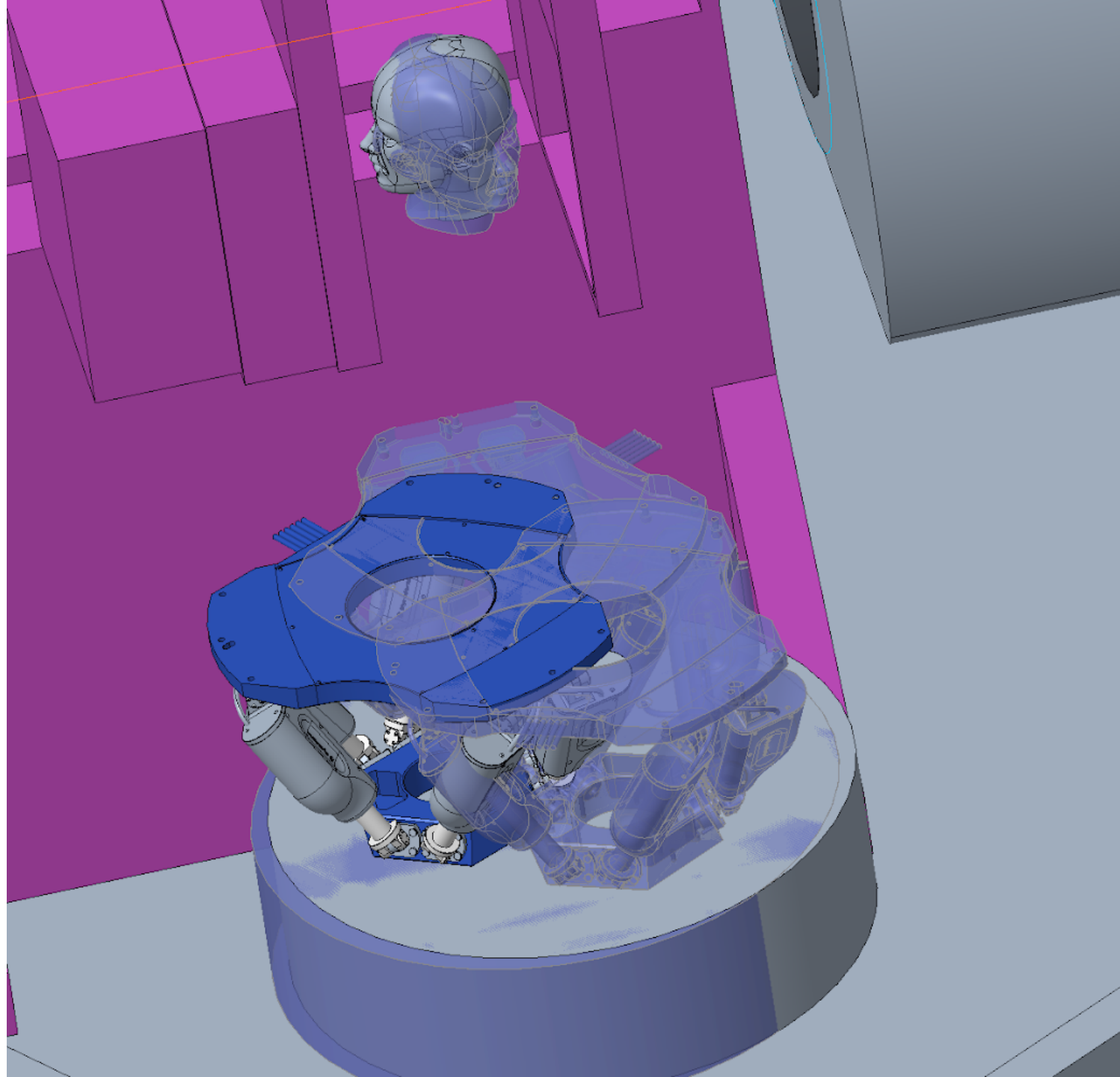
This year!

To this (Igor Polnyi)

Last year!







Software Concepts for pCT integrated with the Treatment Planning System

- ❖ pRad and pCT software programs need to interface to existing clinical patient management systems.
 - ❖ Software for design of a scanning beam imaging plan based on prior knowledge of patient anatomy and integration with the chair control system for rotation during image acquisition
 - ❖ Automatic delivery of pCT images to outside reconstruction through an anonymizing gateway to a local computer cluster of the cloud and reconstruction and delivery of pCT planning images to the TPS.
 - ❖ Direct use of RSP values important with the MC-based planning algorithm of a commercial TPS
 - ❖ Creation of alignment and WET check DRRs for pre-treatment verification
 - ❖ Integration of data with Electronic Medical Record system

Software for pRad and pCT Pretreatment Imaging

- ❖ Automatic delivery orthogonal and BEV pRads through gateway for reconstruction and return of reconstructed images within 1 minute.
- ❖ Alignment and WET check with console display of results and required action suggestion
 - ❖ If WET error over treatment field (after best possible alignment correction) exceeds added treatment planning margins, a repeat pCT will be performed
 - ❖ Based on the results of the analysis the adapted plan will be adapted to the new WET distribution and verified on the new pCT scan

Clinical Workflow including pmaging

- ❖ Patient selection for pmaging protocol
- ❖ Creation of imaging plan from prior anatomical knowledge
- ❖ pCT treatment planning scan in treatment room
- ❖ pCT-based plan optimization (with reduced margins) and pDRRs
- ❖ Daily pRad-based and patient alignment and WET checks, repeat pCT if triggered
- ❖ Adapt plan to new pCT scan

