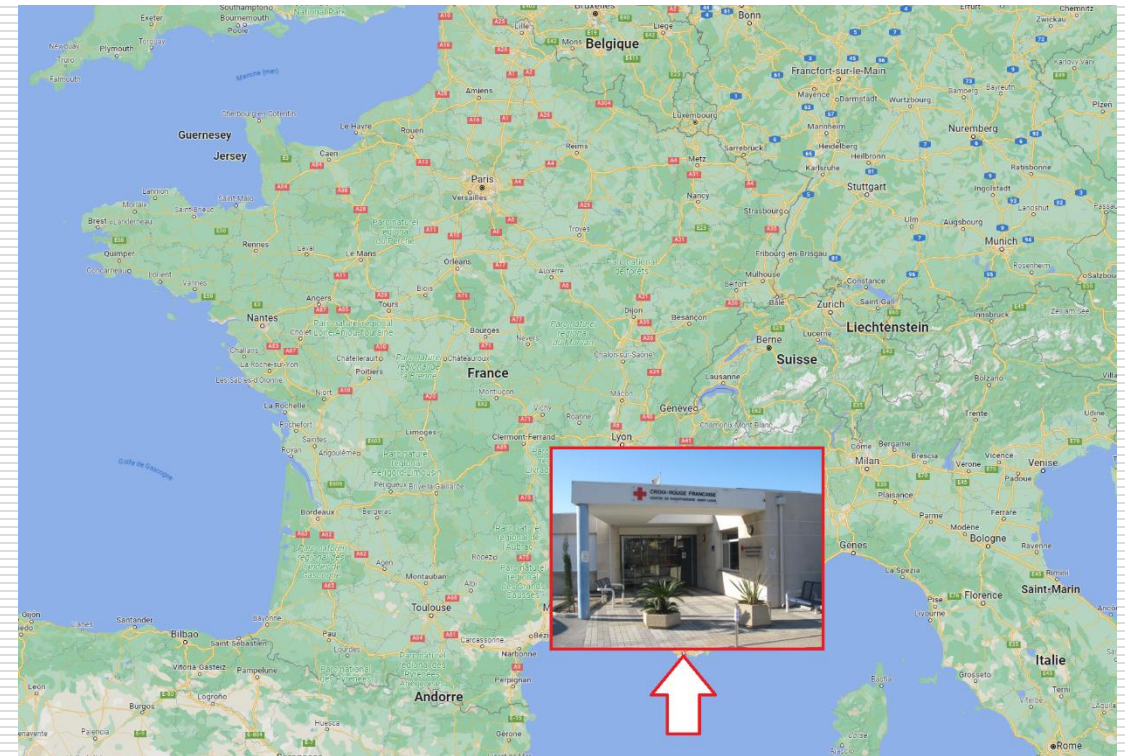# Surface Imaging for SRS: Insights from St Louis Radiotherapy Center

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Introduction

- Centre de radiothérapie St Louis, Croix rouge française, Toulon
- Technical platform:
  - CT scan system : GE optima580
  - LINACs : 3 Synergy et 1 Versa HD (Elekta)
 - TPS : Monaco

Introduction

- ☐ VisionRT since March 2021
  - ■ 4 equipped LINACs
  - ■ CT scan System
- ☐ SRS since April 20, 2022
  - ■ Exclusively on VersaHD
  - ■ 82 patients treated
- ☐ Benchmarking :
  - ■ Thanks to the Swiss onco-radiotherapy team at Sion hospital (Dr Orzoy et Pr Castella)
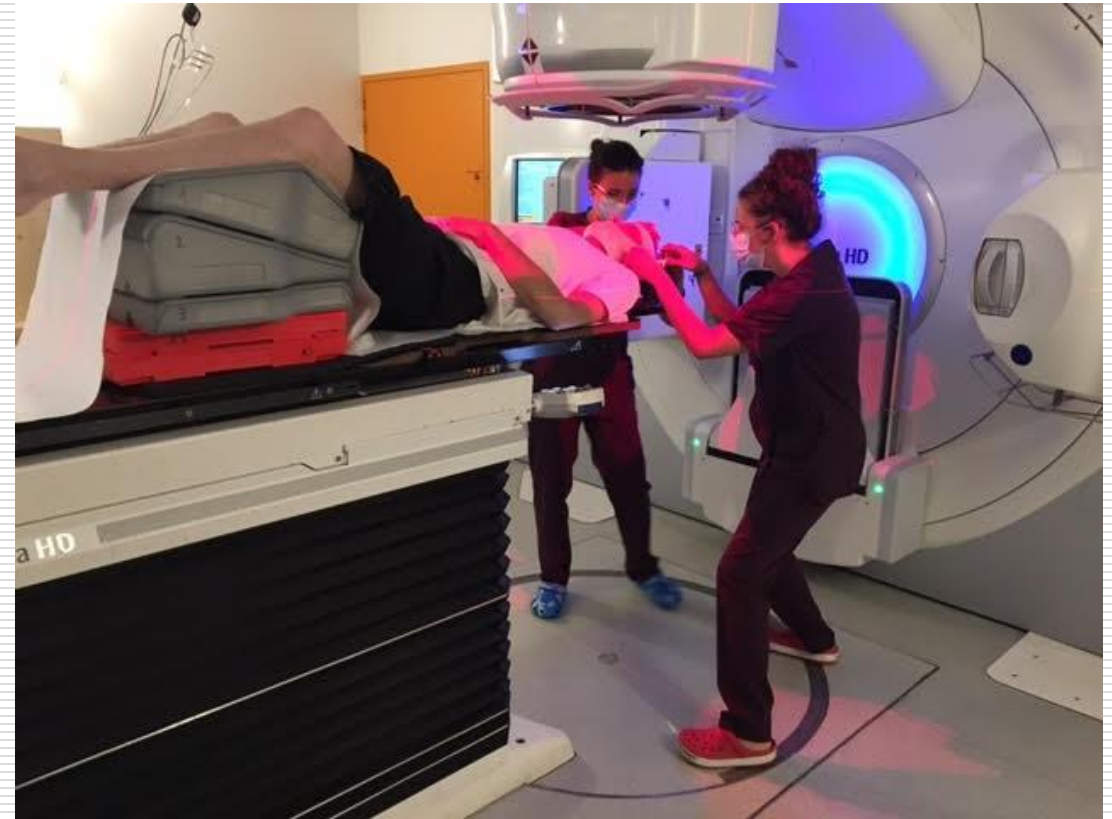
Material

- ☐ **Head Adjuster**
- ☐ **Open masks macromedics** : dsps® double shell positioning system +/- bite block.
- ☐ Hexapod since October, 2023 (not discussed today)
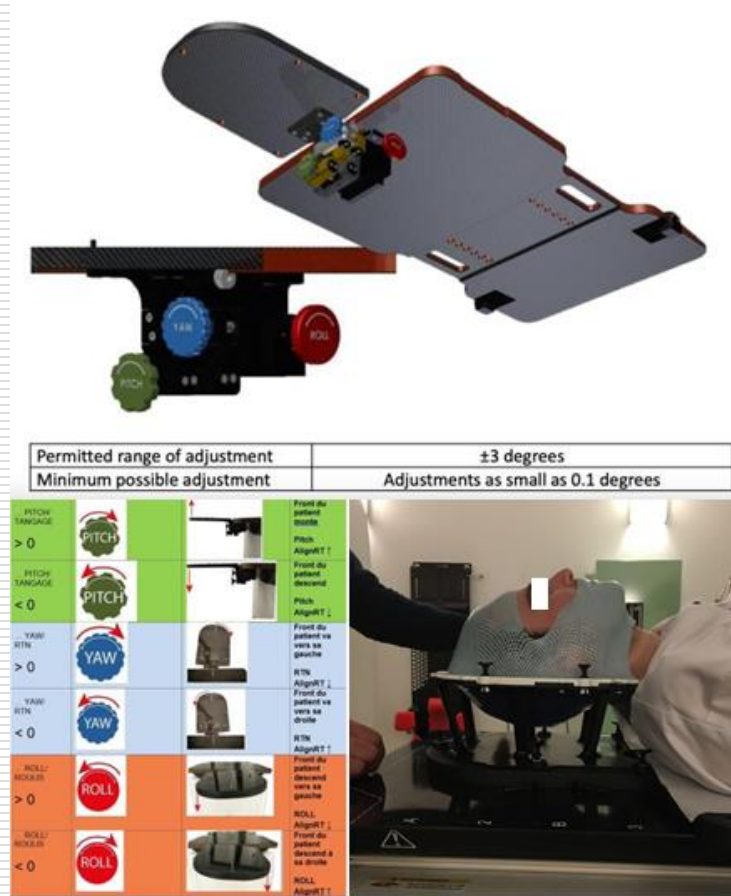
Methods

- External structures :
  - For SGRT :
    - A threshold close to 0 allows for visualizing the rubber thread used to delimit the boundary between the skin and the mask
    - Provides great assistance to therapists in determining the region of interest
  - For TPS :
    - A higher threshold, used to consider only the patient for dose calculations
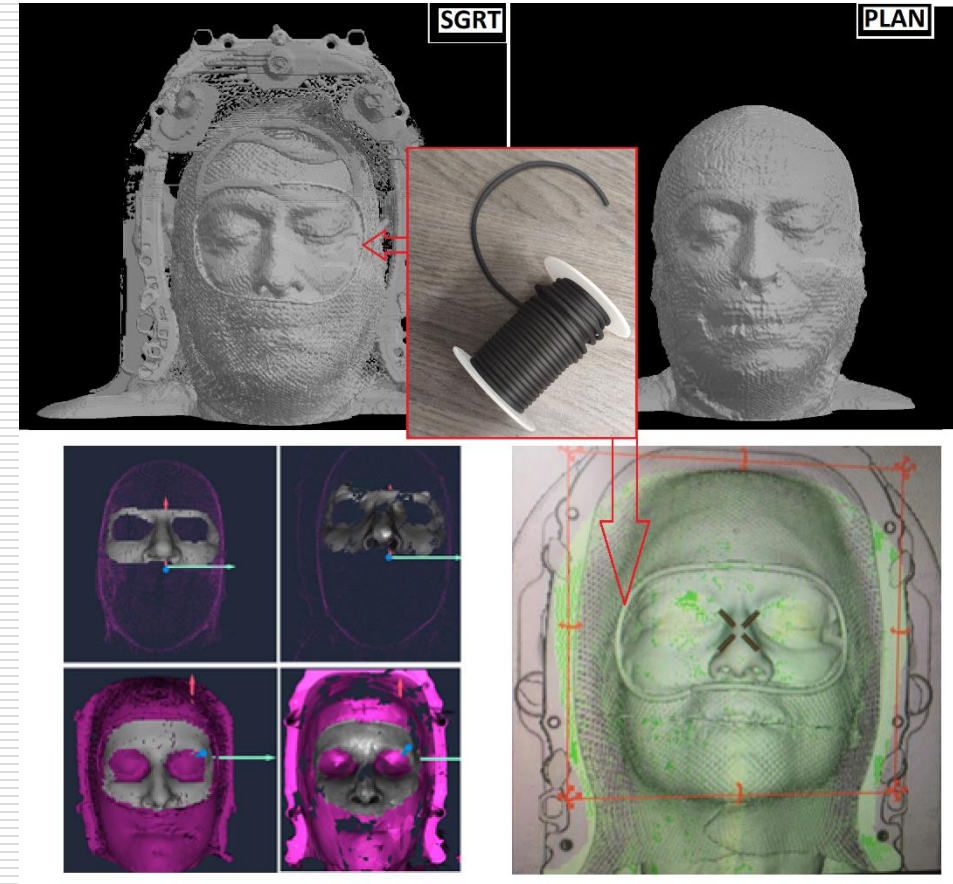
Methods

- CT scan for treatment planning :
  - Making the mask during the patient's installation
  - Slice thickness=1.25mm, FOV 40, pitch 0.56:1 (+/- MAR)
- MRI timing :
  - MRI exam conducted the day before the CT
- VERSA HD, FFF (flattening filter-free) 6MV, TPS Monaco
  - **A. *Prescription modalities*:**
    - At least 98% of the PTV volume has to be covered by the prescription dose
  - **B. *Treatment plan:***
    - DCA (Dynamic Conformal Arc) or VMAT
    - 1 full arc (360°) at couch 0°, along with 5 half arcs at non-zero couch angles (60°, 30°, 330°, 300°, 270°
    - Calculation of dose deposition to medium using the Monte Carlo algorithm
    - Grid spacing = 1mm
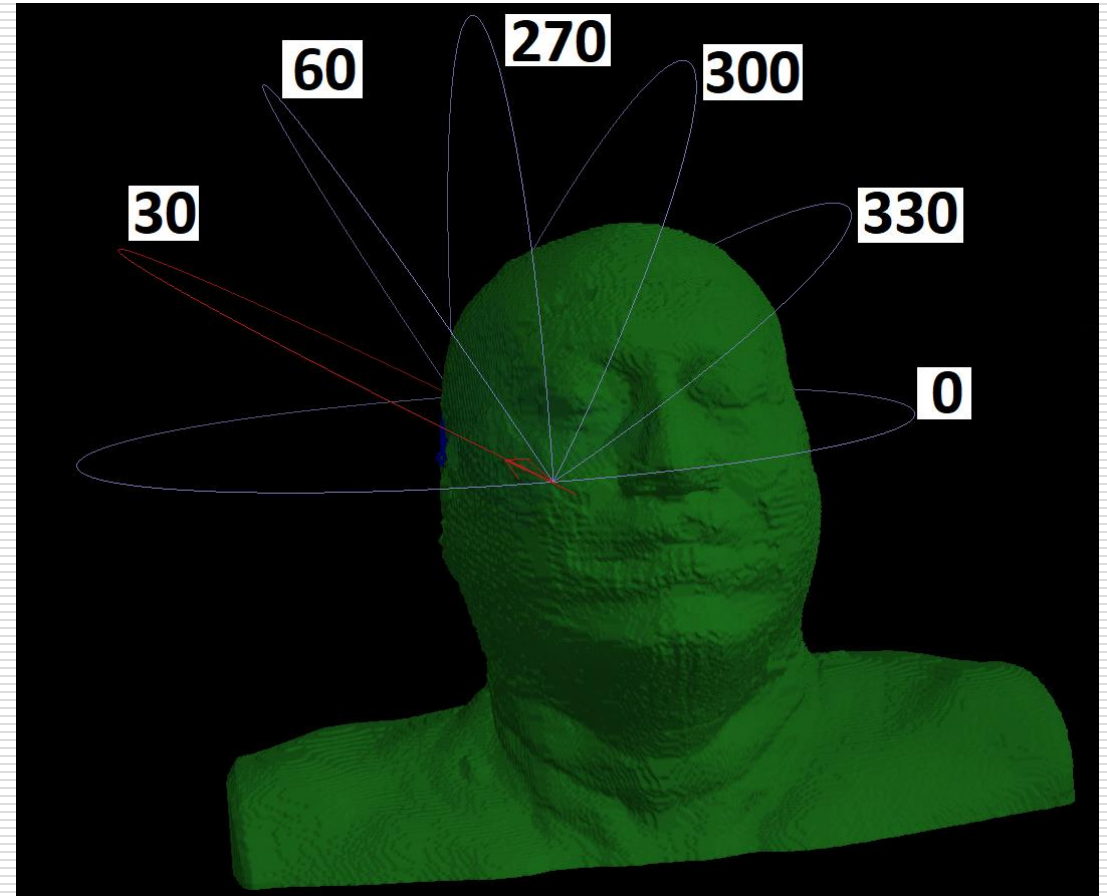
LINAC constraint
## What about submillimeter precision?

- ☐ Beam deviation >1.2mm
  - ■ due to gantry sagging
- ☐ XVI accuracy = 0.5mm
- ☐ Coincidence between the two MV and kV isocenters
  - ■ Checked daily
- ☐ Couch runout >0.7mm
  - ■ checked every week
- ☐ Agility MLC
  - ■ checked every month
  - ■ on average one calibration per quarter, depends on the 3ABUT
- ☐ VisionRT cameras accuracy
  - ■ <0.1mm ; 0.1°
  - ■ <0.3mm ; 0.2° for non-zero couch angles
  - ■ Coincidence between the two MV and cameras isocenters <0.3mm ; 0.3° Checked daily
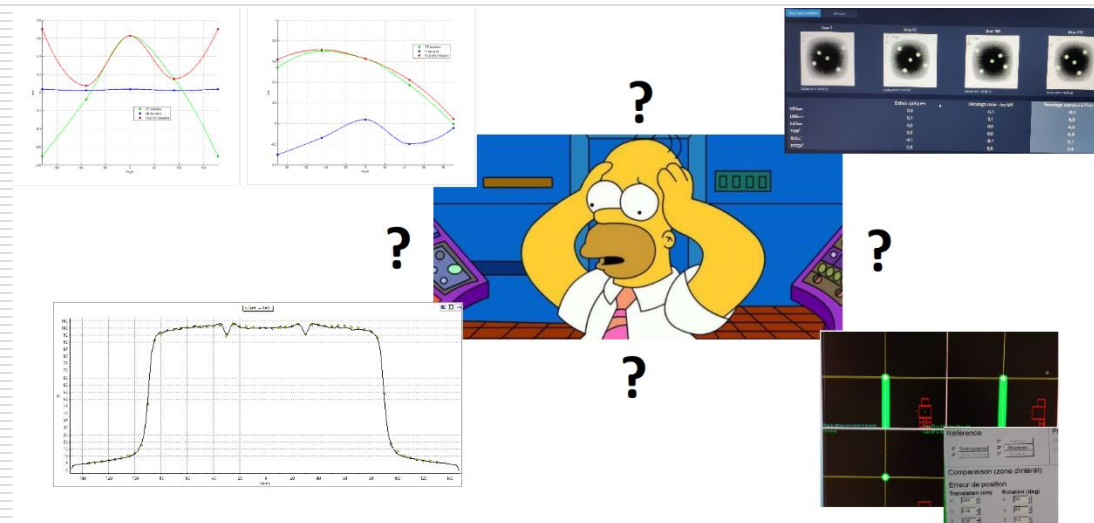
LINAC constraint
What about submillimeter precision?

- ☐ End-To-End :
  - ■ MaxHD Antropomorphic phantom
  - ■ Orthochromic Film solution
  - ■ Accuracy < 1mm/1° close to LINAC isocenter

- ☐ Winston-Lutz :
  - ■ SunNuclear Multimet Cube solution
  - ■ Accuracy not guaranteed outside a 5cm radius from the isocenter.

- ☐ Decisions :
  - ■ Set of 2mm GTV-PTV margin
  - ■ Isocenter always positioned at the center of the target
  - ■ Multi-target case: Single isocenter only if the dose distribution can be entirely measured during the DQA session with the SRS MapCheck solution
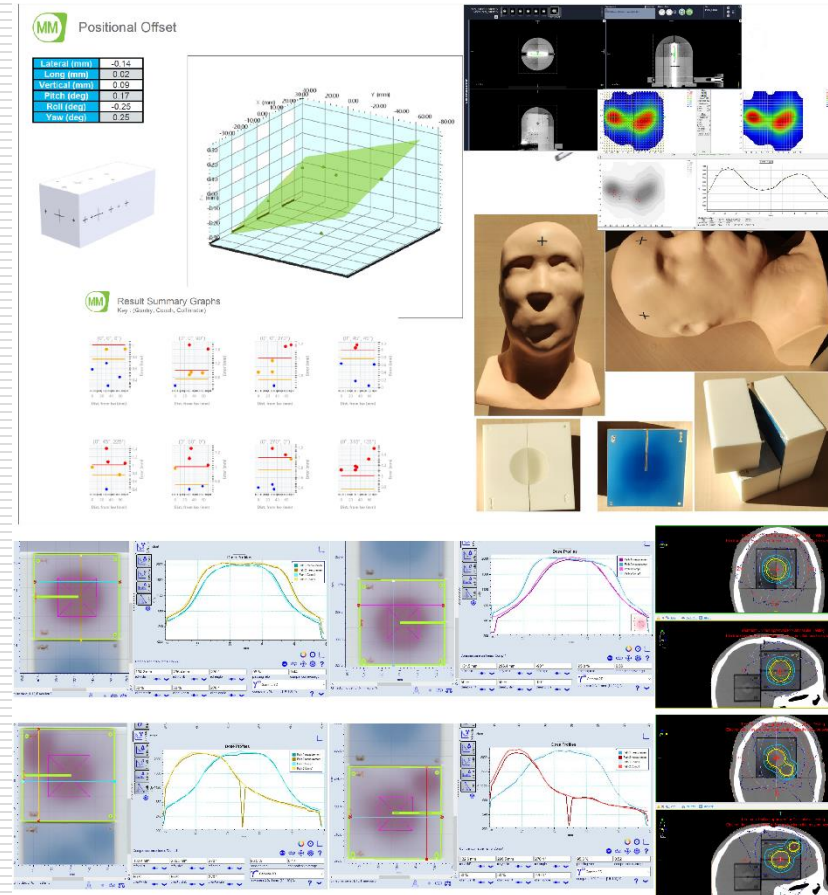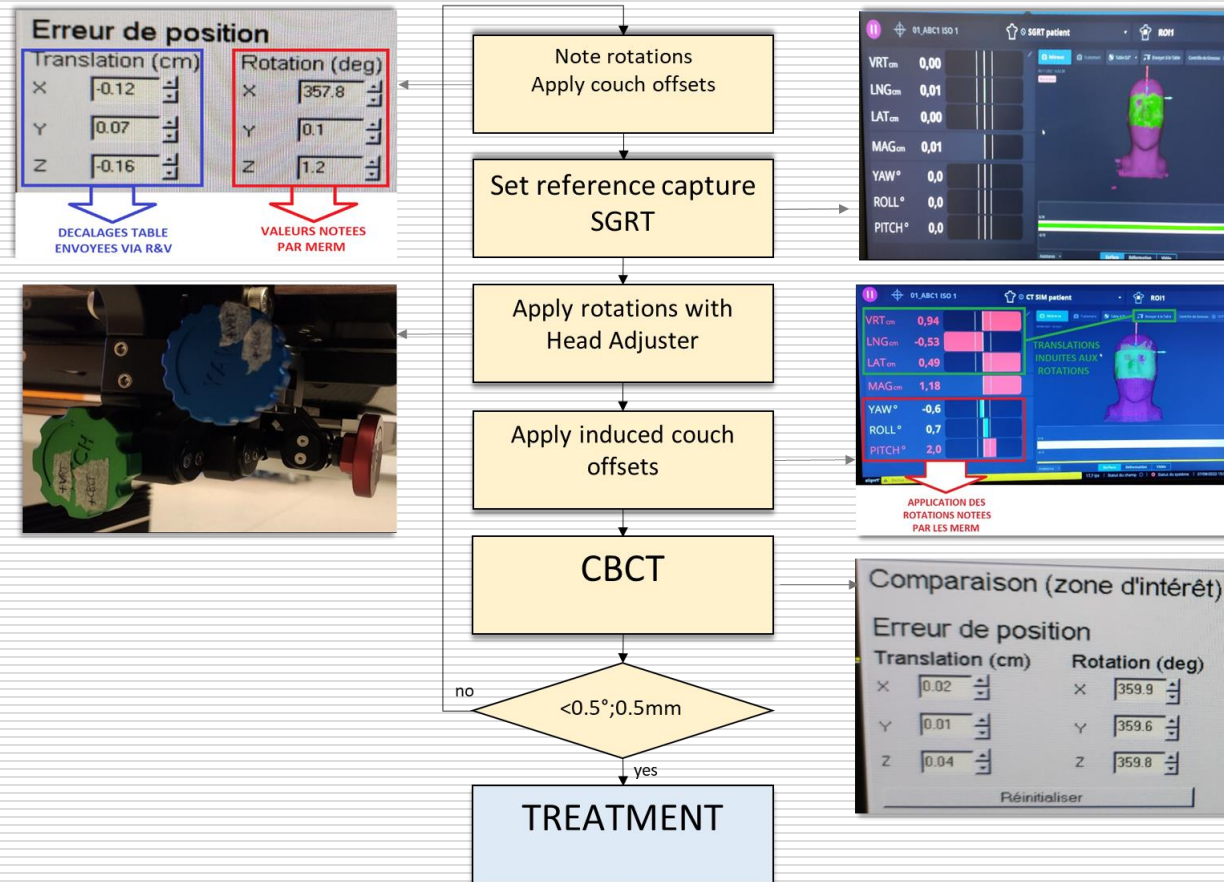
Tests on phantom
Positioning : Elekta CBCT (XVI) vs VisionRT data

- A 0.8mm systematic offset on the longitudinal axis occurs when positioning the phantom using the external structure from the TPS

  - Consequences on use:
    - Application of the couch shift proposed by XVI
    - 2nd CBCT completed, with a tolerance of < 0.5mm and 0.5°
    - Reference capture done after 2nd CBCT validation

- Perfect reproducibility observed with 10 CBCTs performed after different handlings, all using the same reference SGRT capture
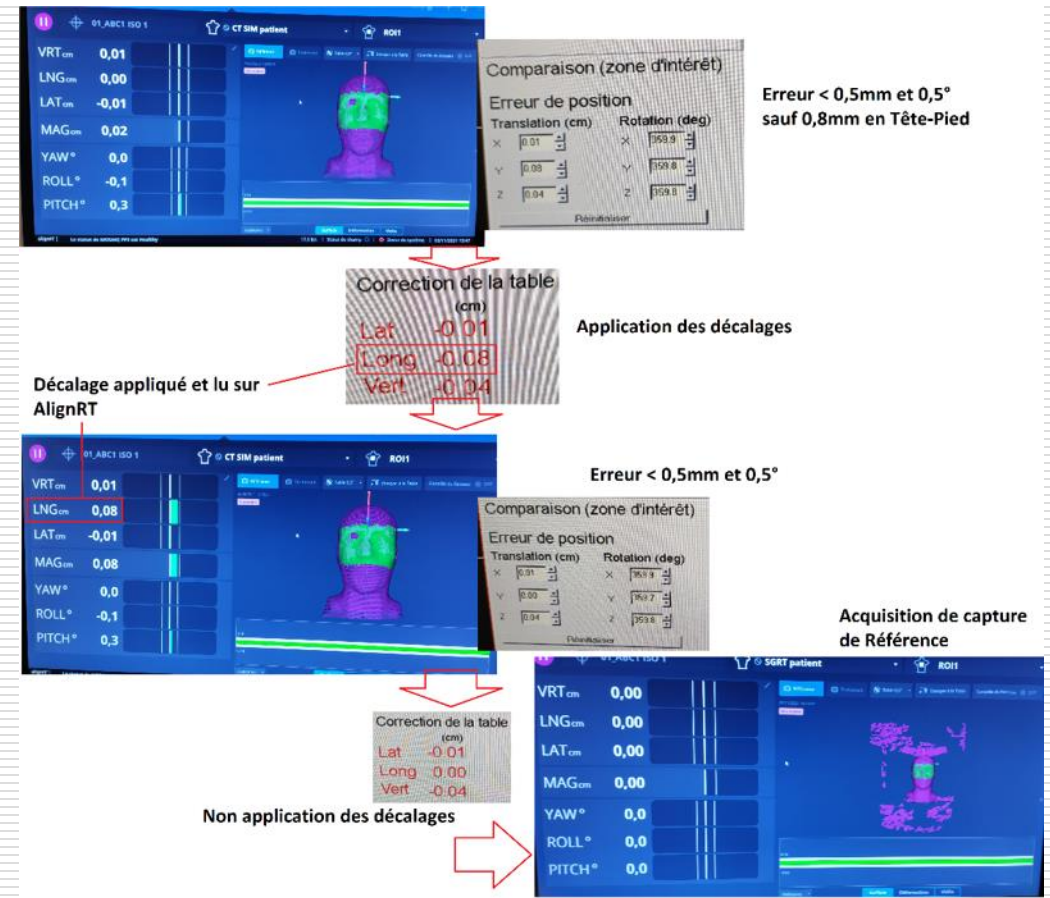
Tests on phantom
Positioning : goal to achieve a CBCT results≤ 0.5mm ; 0.5°

Tests on phantom
Treatment : VisionRT data vs gantry / couch angles

- ☐ 2 causes of discrepancies :
  - ■ Couch runout involves a signal deviation for non-coplanars arcs
  - ■ Cameras obstruction
- ☐ Affected data :
  - ■ Especially LNG and LAT
  - ■ VERT, YAW, ROLL and PITCH undisturbed
- ☐ Decisions :
  - ■ Reference capture done at Couch0° without cameras obstruction soon as CBCT ≤0.5mm ; 0.5°
  - ■ SGRT data tolerance set at 1mm/1°
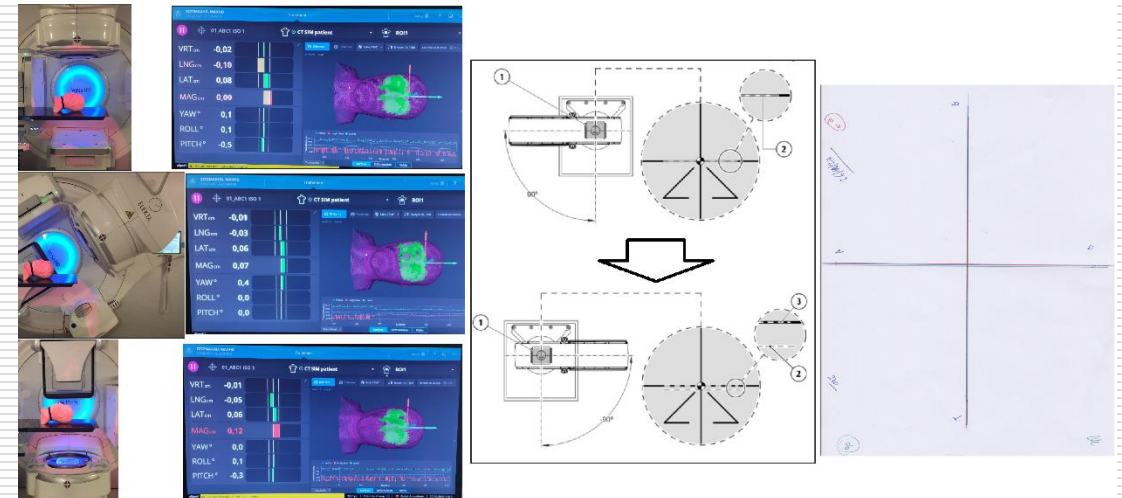
Decision tree and treatment
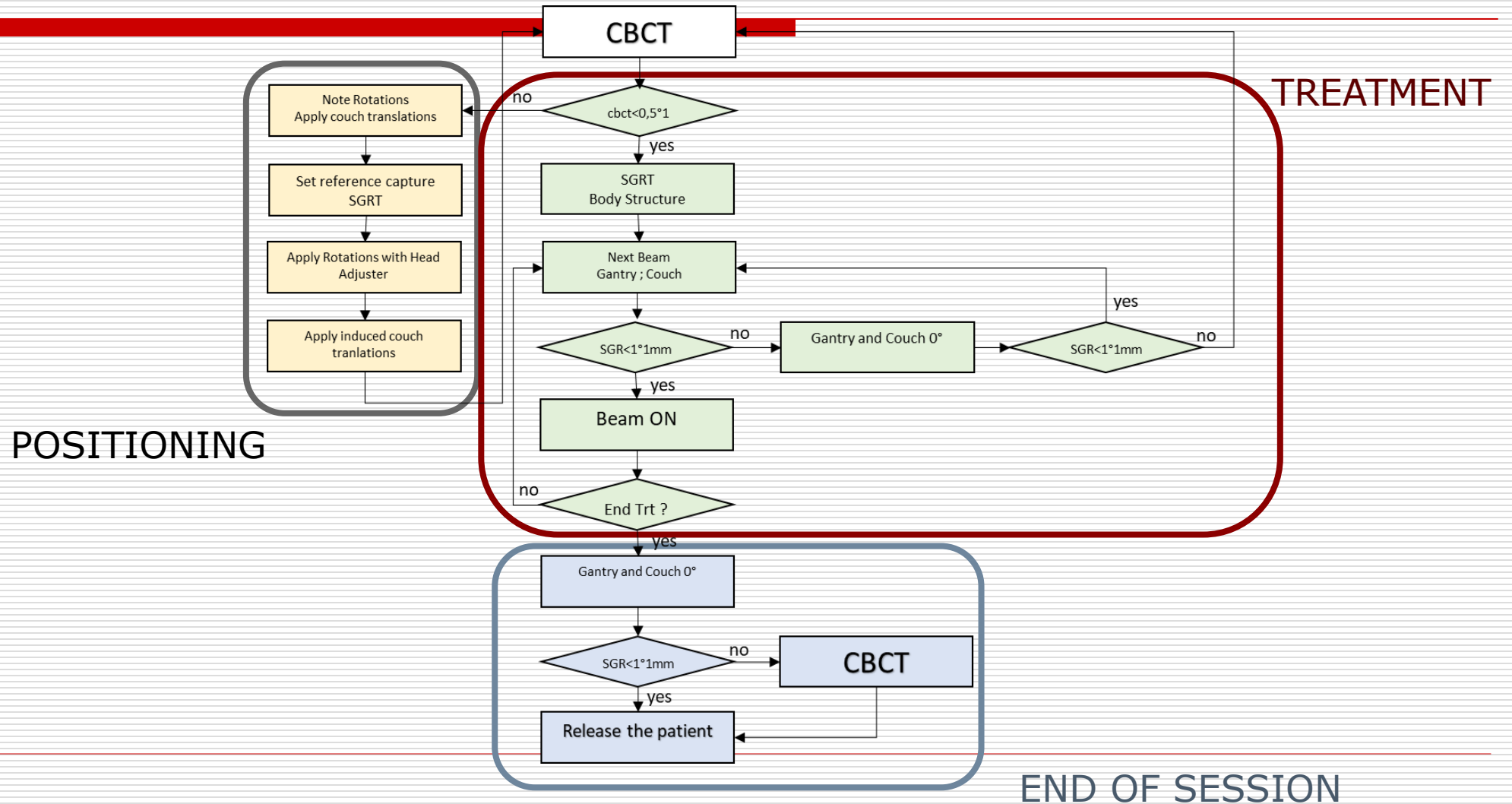
Positioning
Feedback on the patients

- ☐ Day 1 :
  - ◼ No cases were observed where CBCT deviations were ≤ 1mm/0.5° when using the external structure from TPS
  - ◼ At least 2 CBCTs are required
  - ◼ Time ≈20min
- ☐ From day 2 :
  - ◼ Time is less than 10 minutes for around 50% of cases where a single CBCT is sufficient to access the treatment step by using the reference capture of day 1
  - ◼ The other 50% is similar to day 1

Treatment

Feedback on the patients

- ☐ « Perfect case » :
  - ■ Around 20% of cases
  - ■ The patient who does not move at all
  - ■ Case where the isocenter is closed to the Region Of Interest (ROI) used for the monitoring
  - ■ No signal deviation
  - ■ Treatment time ≈ 10min
- ☐ Majority of cases :
  - ■ The patient doesn't move but needs to be coached on day1
  - ■ No signal deviation for the three rotations and the vertical axis, regardless of the couch and gantry position
  - ■ Fixed shift observed on the longitudinal and/or lateral axis for an average of 2 non-zero couch position
  - ■ "'Jumping delta' is observed as soon as the gantry obstructs one of the cameras on the longitudinal and lateral axes, which can either degrade a good result or improve a bad one
  - ■ Treatment time ≈ 10min

Treatment

Feedback on the patients

- □ « Tricky case » :
  - ■ Around 10% of cases
  - ■ Fixed shift > 1mm on the longitudinal and/or lateral axes for non-zero couch position which get worst during the treatment
  - ■ Needs to interrupt the treatment and check on zero couch position
  - ■ Often cerebellums
  - ■ Treatment time ≈ 15min
- □ « Difficult case » :
  - ■ Patient's moving in his mask
  - ■ Stressed patient
  - ■ Involves a « no yes test » before CBCT
  - ■ Needs to be coached
  - ■ Treatment time until 40min

The benefits of SGRT
with Head Adjuster

- ☐ Allows for guiding patient positioning to achieve satisfactory CBCT results (0.5mm / 0.5°) before starting treatment without a 6D couch.
- ☐ Leads to an accurate (≈0.1°) couch position using the YAW axis when Elekta's tolerance is 1°
- ☐ Enables continuous monitoring during the treatment and alerts the therapist promptly in case of patient movement
- ☐ Allows for treating six non-coplanar arcs with full confidence in less than 15 minutes while limiting exposure to kV imaging

D.YAW(deg)
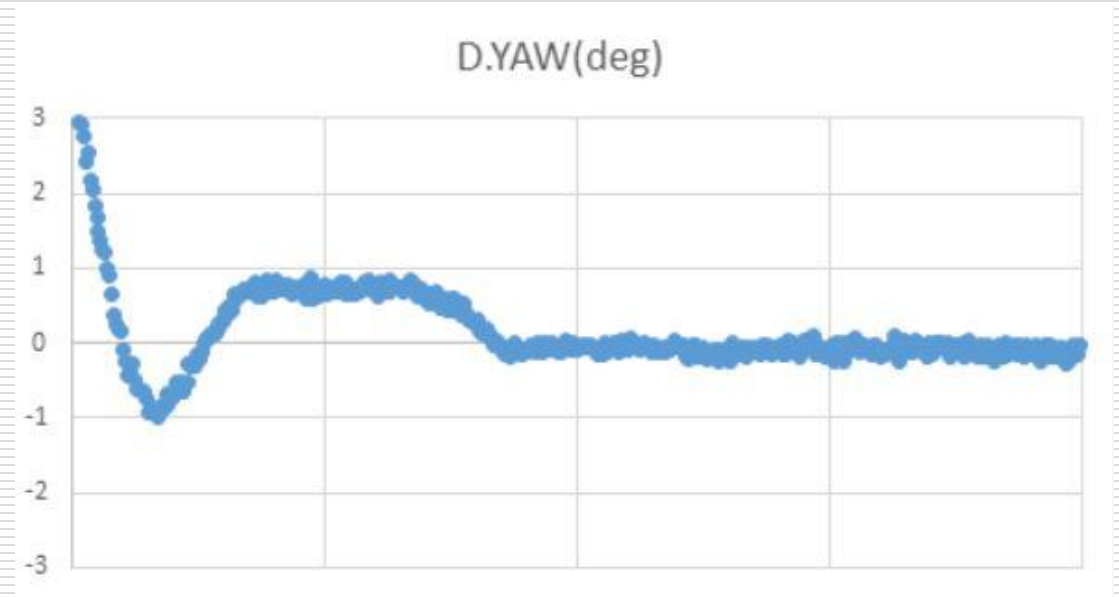
Reflections following two years of utilization
Considerations for future application

- ❑ Important usefulness of tests carried out on anthropomorphic phantoms, although they are not sufficient to anticipate the issues encountered in a clinical setting
- ❑ Requires experienced staff capable of interpreting the data
- ❑ Initiative to streamline patient repositioning at a 0° couch angle using VisionRT in case of treatment interruption, thereby eliminating the need for additional CBCT scans
- ❑ The Head Adjuster serves as an excellent backup solution in the event of a Hexapod couch malfunction

Thank you for your attention