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JOINT AAPM | COMP MEETING

HyperSight CBCT–Based Simulation on Ethos: Workflow Development and Dosimetric Assessment

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ABSTRACT

Purpose: To evaluate the feasibility of **HyperSight CBCT–based RT planning** on the **Varian Ethos v2.0** platform and to develop a clinically deployable simulation workflow that overcomes current system limitations.

Methods: The Ethos v2.0 platform requires an existing treatment plan to access a patient record. To address this, we developed ***EthosSimHelper***, a custom application that generates placeholder images, structures and plans and automates their export to Eclipse, enabling a streamlined and reproducible simulation workflow. The SNC Advanced Electron Density and QUART phantoms were scanned using HyperSight CBCT on Ethos and conventional CT on a Siemens X.ceed simulator and HU values were compared. A VMAT plan was generated on the planning CT in Eclipse (v15) using the Acuros XB algorithm and recalculated without re-optimization on HyperSight CBCT for both phantoms and two pelvic patient cases. Relative and absolute dose differences were assessed.

Results: EthosSimHelper successfully enabled a smooth Ethos simulation workflow with a clear and easily implemented procedure for clinical staff. HyperSight CBCT showed **HU agreement within 50 HU** for soft tissue, with maximum deviations below 120 HU in high-density regions. Phantom studies demonstrated **mean dose differences below 1.8% for PTVs and 2.5% for OARs**. In patient cases, target and OAR dose differences were under 1.5% and 3.5%, respectively. DVH and isodose comparisons demonstrated strong dosimetric agreement between CT- and CBCT-based plans.

Conclusion: HyperSight CBCT–based planning on **Ethos produces dosimetric accuracy within clinically acceptable tolerances**. By enabling direct simulation and planning on the Ethos platform, this workflow **expands clinical flexibility** and **reduces time to treatment**, particularly in high-throughput or resource-constrained settings.

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INTRODUCTION

CT simulation is the gold standard for RT planning, providing the density information needed for accurate dose calculation.

CBCT is widely used for daily image guidance, but image noise, artifacts, and HU inaccuracies have limited its use for treatment planning.

Recent advances in CBCT hardware and reconstruction have improved image quality and HU accuracy, enabling applications such as adaptive RT, dose recalculation, and CBCT-based treatment planning.

Varian HyperSight CBCT offers improved HU stability, soft-tissue contrast, larger field-of-view coverage, and faster image acquisition than conventional CBCT systems.

This work describes the implementation and dosimetric validation of a HyperSight CBCT simulation workflow on the Varian Ethos platform. We evaluate its suitability for pelvic treatment planning and outline a practical clinical workflow.

HU CALIBRATION

HyperSight CBCT was configured in the Eclipse treatment planning system with electron and physical density **HU calibration curves** obtained using an **electron density phantom**.

(Mean HU measured in cylindrical ROIs in each plug of the phantom, 6mm long, 1.5cm diameter.)

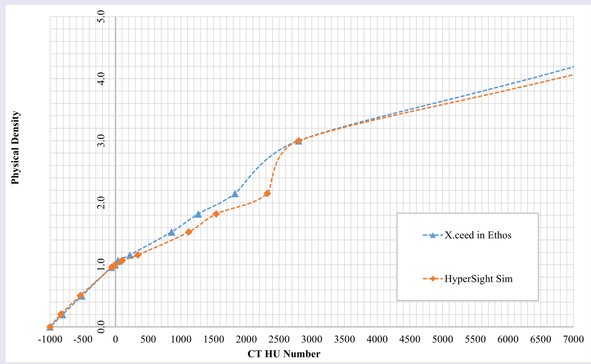


Figure 1: HU to physical density calibration curve.

PATIENT STUDY

Pelvic RT plans for two patients were **retrospectively recalculated** with pre-set MUs on HyperSight CBCT images acquired during treatment setup.

Rigid registration between planning CT and HyperSight CBCT was used to transfer structures. The difference in the Body (external) contour between the HyperSight CBCT and the planning CT, which existed due to small soft tissue changes at the timepoints of the two scans, was added as a support structure to the HyperSight CBCT and assigned to water.

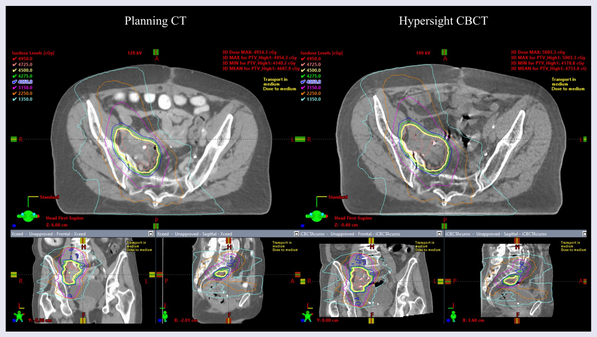


Figure 2: Isodose line comparison for plan calculated on planning CT and HyperSight CBCT on axial view for one clinical case.

RESULTS AND DISCUSSION

- A clinical HyperSight CBCT simulation workflow was successfully implemented on Varian Ethos 2.0.
- An in-house tool (***EthosSimHelper***) streamlined simulation plan creation, reducing workflow time from ~10 minutes (15 steps) to <1 minute (2 steps).
- HyperSight CBCT showed excellent agreement with planning CT:
  - HU differences were <50 HU in soft tissue
  - OAR DVH dose differences were <2%
  - Target DVH dose differences were <1.5%
  - Spatial dose distributions were equivalent
- Results support the **use of HyperSight CBCT for treatment planning** in the pelvis.
- Some bowel–soft tissue interface artifacts were observed, highlighting the need for continued optimization of acquisition and motion-management strategies.
- Further validation across larger patient cohorts and additional treatment sites is ongoing.

Table 1. HU comparison between patient planning CT and Hypersight CBCT for two pelvis patients P1 and P2.

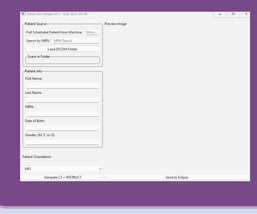
HU	Planning CT		Hypersight CBCT		
Organ	mean	std dev	mean	std dev	**diff**
P1 PTV	64.8	134.7	24.5	153.3	**40.3**
P1 Rectum	2.8	133.5	-36.4	58.1	**39.2**
P1 Bladder	11.0	12.5	-5.9	47.0	**16.9**
P1 Pelvic Bones	252.1	208.8	196.9	228.7	**55.2**
P2 PTV	27.4	46.5	14.5	35.9	**12.9**
P2 Rectum	-120.3	301.6	-24.1	101.8	**-96.2**
P2 Bladder	18.6	11.6	13.4	20.7	**5.2**
P2 Femurs	304.3	267.3	265.8	268.1	**38.5**

EthosSimHelper application

The Ethos v2.0 platform requires an **existing treatment plan** to access a patient record.

We developed ***EthosSimHelper***, a custom application that generates placeholder images, structures and plans and automates their export to Eclipse, enabling a streamlined and reproducible simulation workflow.

1) *EthosSimHelper* GUI



1. Pull up patient
2. Choose patient orientation e.g. HFS
3. Select “Generate CT + RTSTRUCT”
4. Select “Send to Eclipse”

2) Ethos

1. Create new plan in Ethos using a SIMULATION template (1cGy, 1 fraction plan with a placeholder PTV goal).
2. RT Intent and Planning Directive are automatically generated.
3. Use placeholder CT from Eclipse as the Planning Image.
4. Approve plan.

3) Treatment console

1. Patient record can now be opened for simulation.
2. Use “Pelvis Large” CBCT imaging mode with Extended CBCT and iCBCT-Acuros reconstruction.
3. HyperSight acquisition is limited to 125 kVp or 140 kVp. 140 kVp is recommended for simulation workflow.

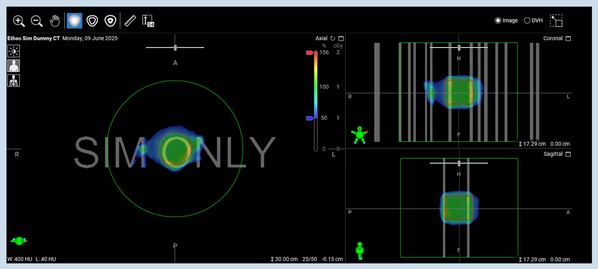


Figure 3: Ethos SimHelper GUI and the placeholder CT generated with a placeholder 1cGy adaptive pla n for the simulation process on the Ethos system.

CONCLUSIONS

We established a **HyperSight CBCT simulation workflow compatible with Varian Ethos 2.0**, and confirmed the feasibility of using HyperSight CBCT images for RT treatment planning in the pelvic region.