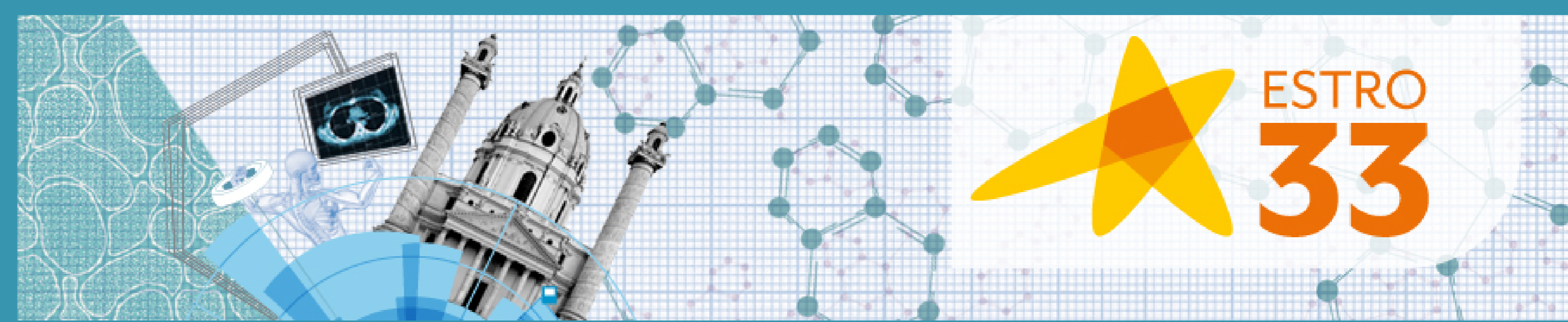


Reproducibility of bladder volume in prostate RapidArc radiotherapy treatment



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INTRODUCTION

There is evidence that dose escalation improves local control in prostate tumors, thereby increasing toxicity risk in normal tissues, such as the bladder. In order to minimize this risk, filling bladder protocols (consisting of water ingestion) can be adopted to increase its volume, resulting in a smaller irradiated bladder volume, also keeping the small intestine away from the radiation field. Thus, the reproducibility of bladder's volume during treatment period is crucial.

Objective: Assess the effectiveness of three different filling bladder protocols, evaluating the respective variations in bladder filling throughout treatment period.

MATERIALS AND METHODS

The bladder volume was measured in **60 patients** undergoing prostate RapidArc radiotherapy treatment (38-40 fractions). Before performing the planning CT scan and prior daily treatment, patients were instructed to **fill the bladder** according to one of **three protocols** (Table 1).

| Protocol | Ingested water volume (ml) | Time to treatment (min) |
|------------|----------------------------|-------------------------|
| Protocol 1 | 500 | 30 |
| Protocol 2 | 667 | 30 |
| Protocol 3 | 667 | 40 |

Table 1 – Details of the filling bladder protocols.

The **bladder was contoured** and its volume was measured in the **planning CT scan** and in **seven Cone Beam CT (CBCT) scans** weekly acquired during treatment.

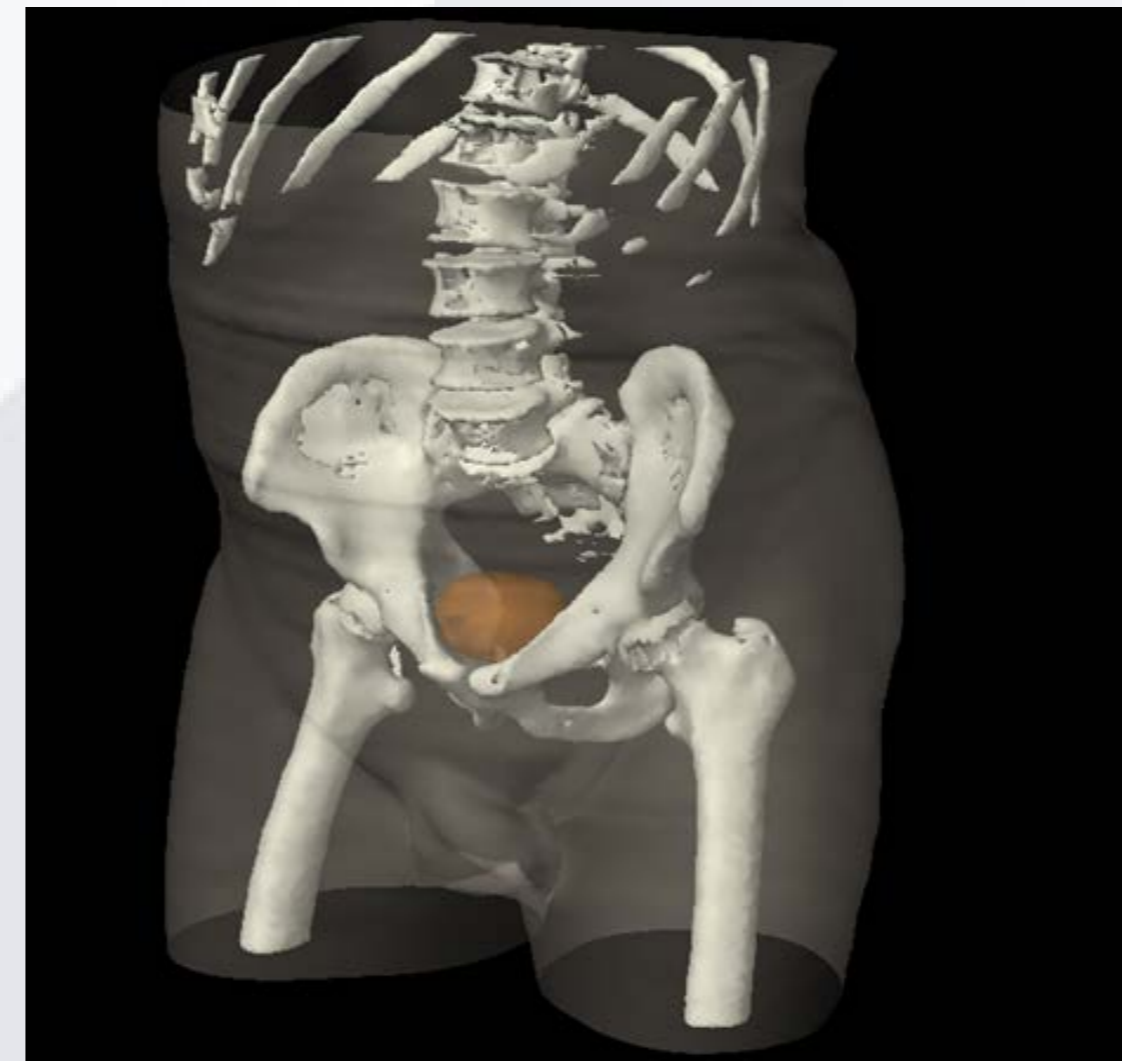


Figure 1 – 3D-reconstruction of bladder contouring.

Data analysis:

- Calculation of **mean value** of bladder volume in CT planning scan and in CBCT scans and their **relative deviation**.

- Application of **Pearson correlation test** to evaluate the correlation between bladder volume in CT planning scan and its variation during treatment period.

RESULTS

There was a decrease between mean bladder volume in the **planning CT** (**199.5±112.4 ml**) and in the **treatment period** (**150.5±69.7 ml**).

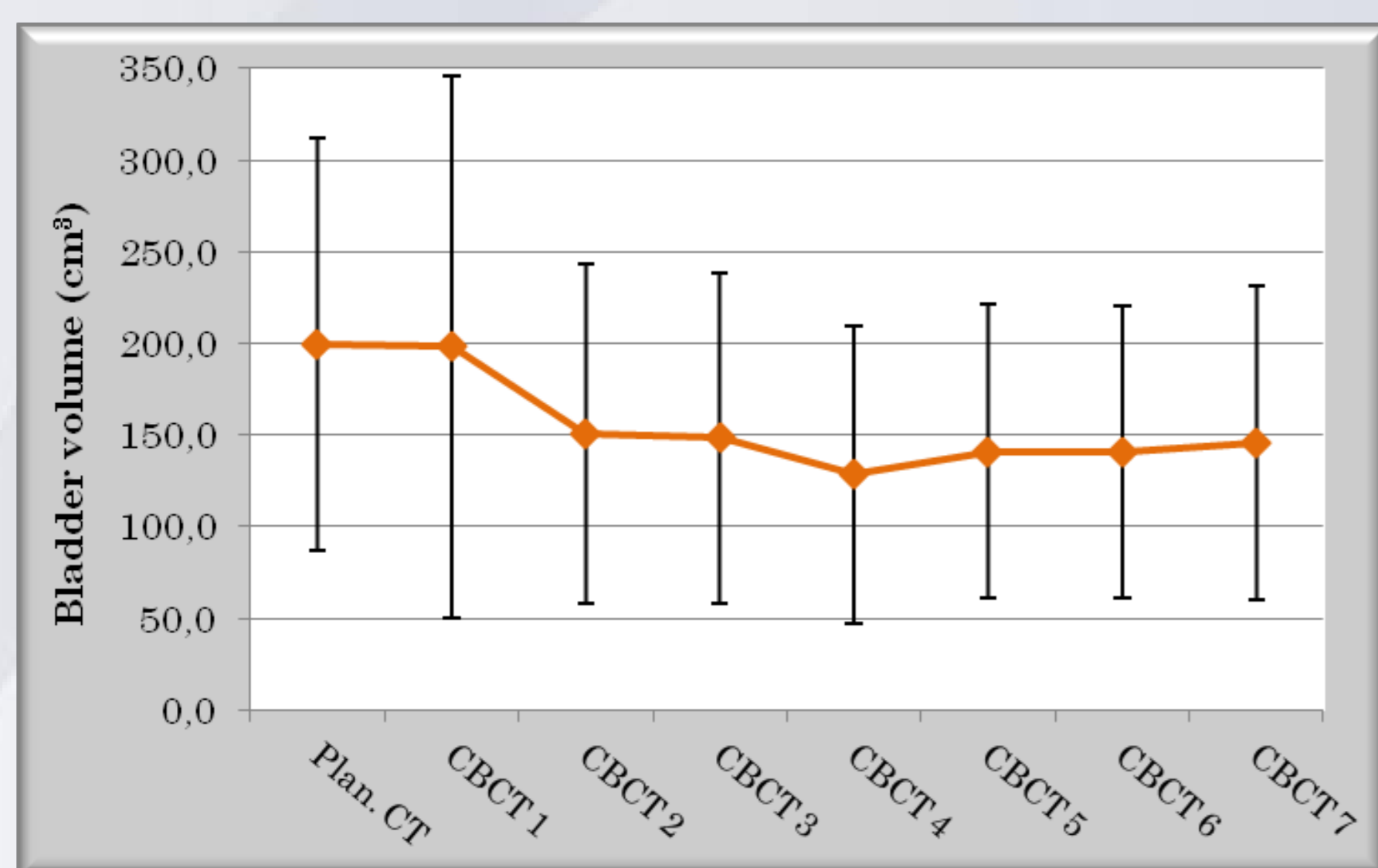


Figure 2 – Mean bladder volume in planning CT and weekly acquired CBCT scans throughout treatment period.

The relative deviation between planning CT and weekly CBCT scans suggests that **protocol 1 is more reproducible**; the mean square relative deviation indicates that protocol 1 has lowest bladder volume variation during treatment.

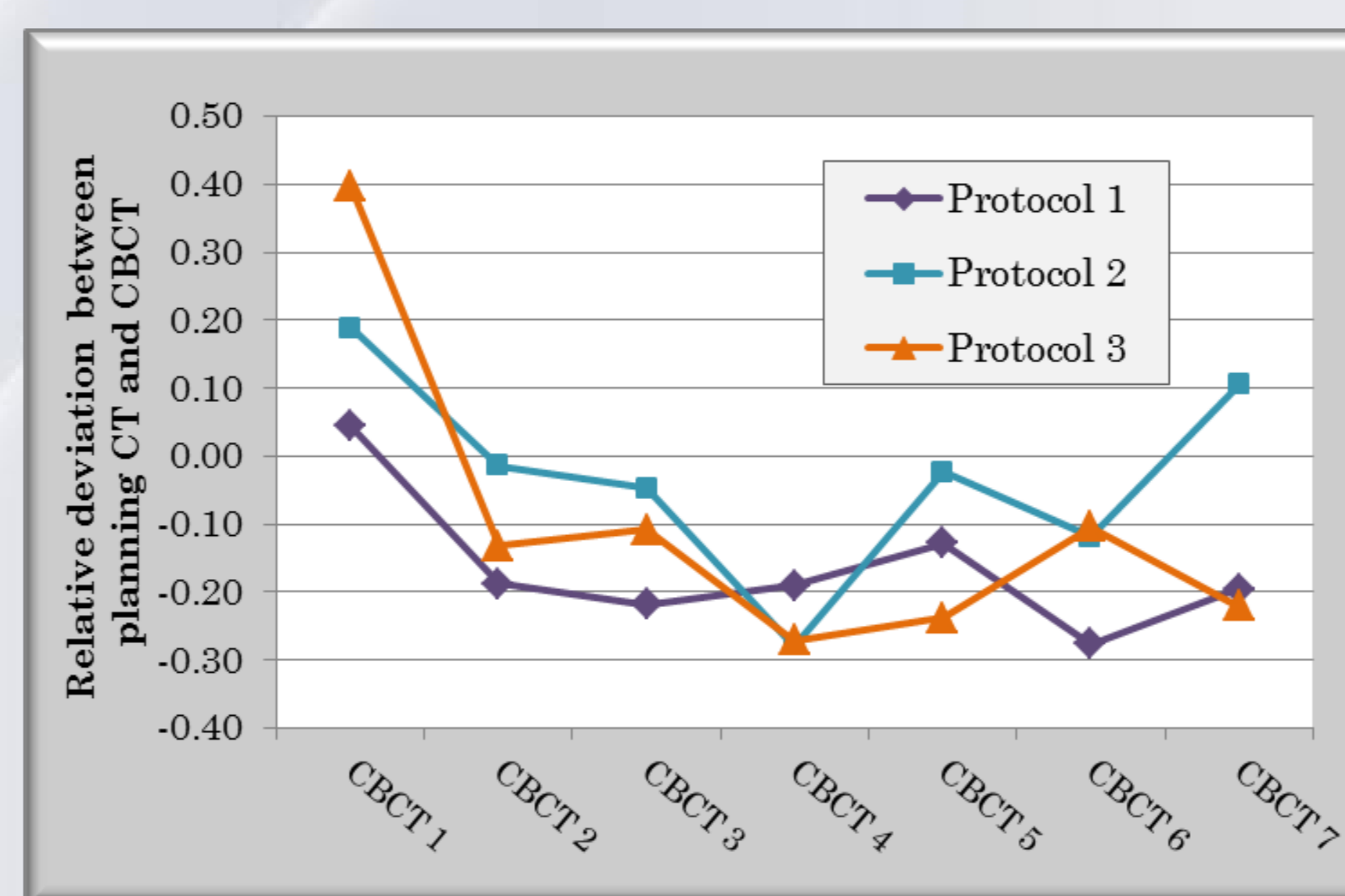


Figure 3 – Relative deviation of bladder volume between planning CT and weekly acquired CBCT scans.

| Protocol | Mean square relative deviation |
|------------|--------------------------------|
| Protocol 1 | 0.35 |
| Protocol 2 | 0.53 |
| Protocol 3 | 0.45 |

Table 2 – Mean squared relative deviation of bladder volume between planning CT and weekly acquired CBCT scans.

There is a weak correlation ($r=0.47$) between the bladder volume in the planning CT and its variation throughout treatment, indicating that **patients with higher bladder volumes in the planning CT tend to have greater bladder filling variation throughout treatment period**.

CONCLUSIONS

Generally, the **reproducibility of bladder filling during treatment is low**, since the estimated mean bladder volume is smaller when compared with the value at the planning CT scan. Still, **protocol 1 seems to be more reproducible**; as this protocol involves less water amount and less time to treatment, these results are in agreement with the correlation test that indicates the higher bladder volume in the planning CT, the larger variations throughout treatment period.

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