



## Reproducibility of facial landmarks and dosage measurements for EOS®- a low dosage X-ray

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## As Low As Reasonably Achievable

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EOS<sup>®</sup>: The 1992 Nobel Prize for Physics was awarded to : Professor **Georges Charpak**, France, École Supérieure de Physique et Chimie, Paris and CERN, Geneva, Switzerland, for a high energy particle detector.

Digital cephalometric imaging device: CS 9300, Carestream- (CBCT and panoramic) with additional Cephalometric feature.

The digital cephalometric imaging feature:

Part of the CS 9300, Carestream, Rochester New York, USA

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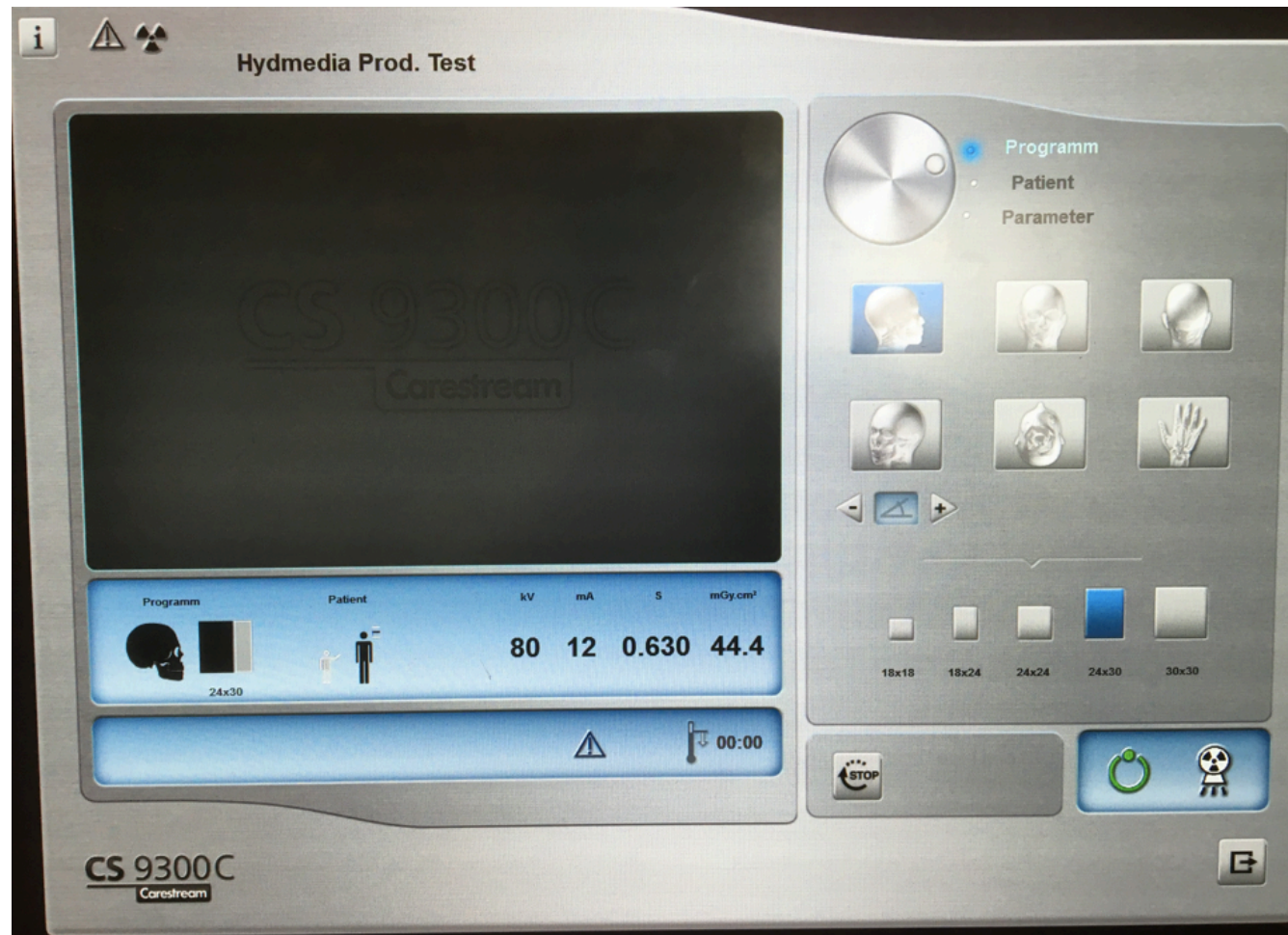
## Protocol CS 9300

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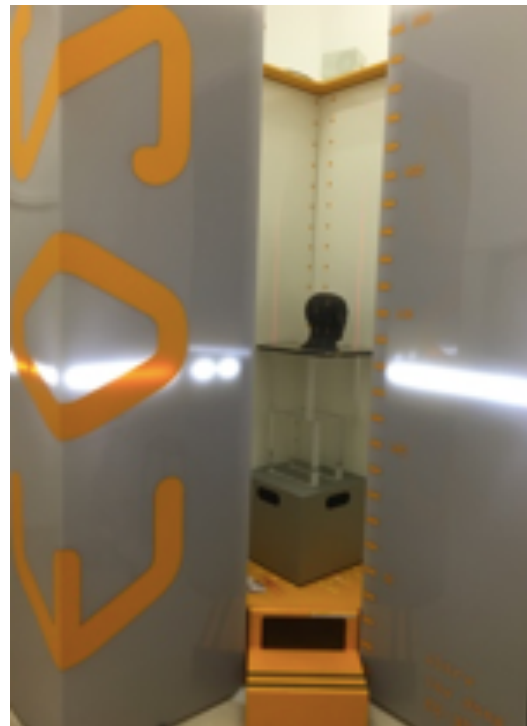
# EOS®

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EOS<sup>®</sup> captures simultaneous frontal and lateral head-to-toe images of patients in the upright, weight-bearing position.

EOS<sup>®</sup> uses two perpendicular X-ray beams collimated in two very thin, horizontal, fan-shaped beams along with two detectors.





## Study: part A

### Retrospective

48 biplanar radiographs intended previously for the study of scoliosis with different positions of the upper extremities.

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- To two observers identified 38 landmarks two times with at least a time interval of two weeks. (2-2-2)
- The landmarks were placed digitally in a 2D reference system.
- Intraoperator repeatability and interoperator reproducibility were evaluated for each landmark. Furthermore, intraclass correlation coefficients (ICC) were calculated for each landmark.





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### Posteroanterior view

- (SF): where the smaller wing of the sphenoid bone crosses the medial orbital ridge
- (ANS) Anterior nasal spine: the centre point at the base of the nose
- (J) Jugulare: the most superior and medial point of the zygomatic buttress
- (M) Mastoid: the most inferior point of the mastoid point
- (A): the contact area between the maxillary incisors
- (B): the contact area between the mandibular incisor
- (Go) Gonion: the most inferior posterior point at the angle of the mandible
- (Me) Menton: the most inferior point at the anterior mandibular area
- (CH): the most inferior lateral point on the anterior inferior border of the mandible
- (C2): upper border of the odontoid process

### Lateral view

- (G) Glabella: the most anterior point of the frontal bone
- (N) Nasion: the most anterior point on the frontal nasal suture in the midsagittal plane
- (Or) Orbitale: the lowest point on the inferior orbital rim
- (S) Sella: the centre of the sella turcica, as on the lateral cephalogram, which is located by inspection
- (Ptm) Pterygomaxillare: the apex of the teardrop-shaped pterygomaxillary fissure (lowest point of opening)
- (ANS) Anterior nasal spine: anterior tip of the nasal spine
- (PNS) Posterior nasal spine: the most posterior aspect of the palate bone
- (A)-point or subspinale: the most posterior midline point in the concavity where the lower anterior adage of the anterior nasal spine meets the alveolar bone overlying the maxillary incisor
- (B)-point, or supramentale: the most posterior midline point in the concavity of the mandible between the alveolar bone overlying the mandible incisors (infradentale) and the pogonion
- Pogonion (Pog): the most anterior point of the chin
- (Go) Gonion: the point defined by using two lines, one tangent to the inferior border of the ramus; found by bisecting the angle formed by the two lines and extending the bisectors through the curvature of the mandible
- (Gn) Ganthion: the lowest, most anterior midline point on the symphysis of the mandible (midway between the menton and the pogonion)
- (Me) Menton: the most inferior point on the symphysis of the mandible in the midline
- (Po) Porion: the most superior point of the external auditory meatus; the machine porion is the uppermost point on the outline of the rods of the cephalometer
- (Co) Condylion: the most posterosuperior point on the head of the condyle
- (C2): upper border of the odontoid process

Landmarks according to the description provided in Reyneke JP (2003) Essentials of Orthognathic Surgery, Quintessence Publishing Co, pp 43-60; for both views, the landmark 'C2' was added to represent the odontoid process.





## Full spine Protocol:

Frontal tube voltage 90 kV  
Frontal tube current 250 mA  
Frontal DAP 716 mGy cm<sup>2</sup>  
Lateral tube voltage 105 kV  
Lateral tube current 320 mA  
Lateral DAP 1082 mGy cm<sup>2</sup>  
Morphology Adult  
Scanned length 76 cm  
Scanning speed 5  
Acquisition time 12.5 s

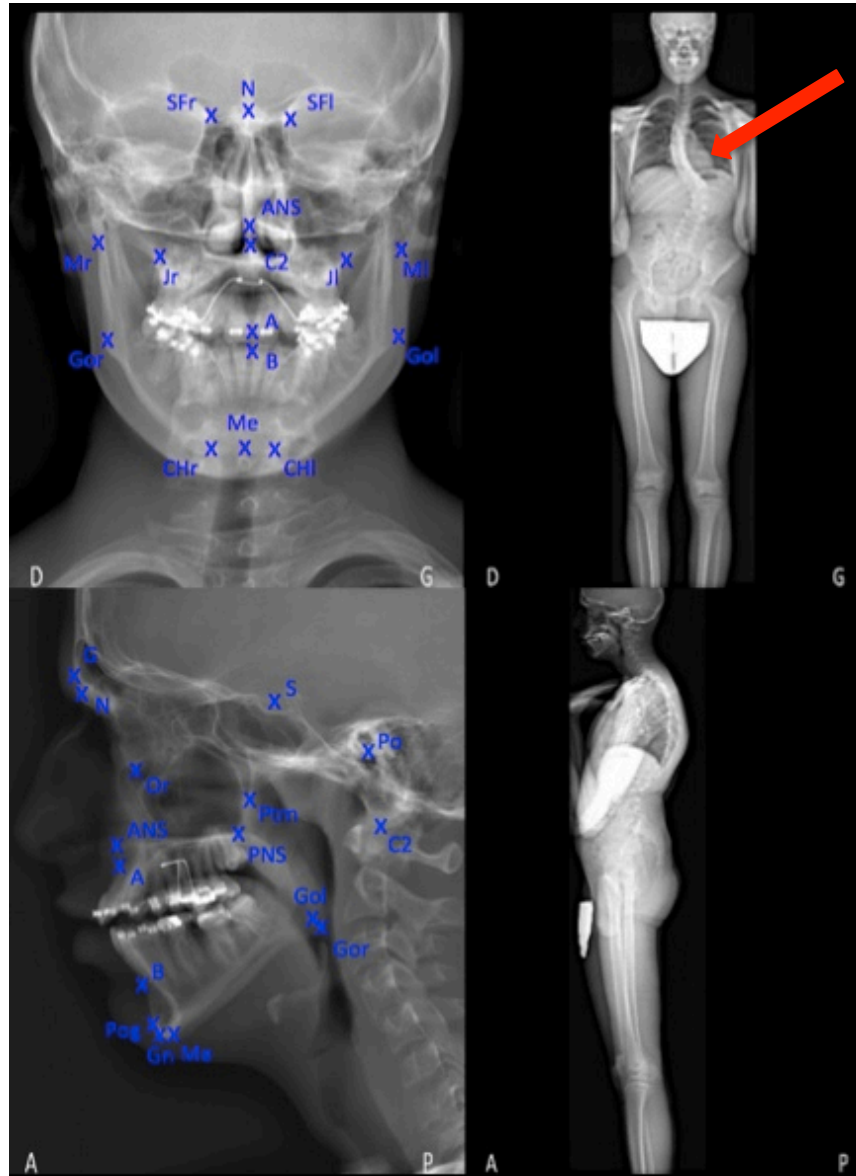
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Scoliosis, reason why the images were acquired

EOS® image. Posteroanterior and lateral images with landmarks of a patient. The orthodontic device is clearly visible without artefacts.

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- Interoperator and intraoperator test-retest reliability was overall greater than 0.91, except for the lateral orbital which was 0.86.
- Other landmarks showed slightly lower but still very good repeatability.
- Assessment of the facial skeleton's anatomical landmarks using the EOS<sup>®</sup> system is precise and radiological diagnostics of the facial skeleton is well possible.



## Conclusion part A

EOS imaging system can be considered a valuable option for the assessment of facial skeletal deformities or trauma.

EOS<sup>®</sup> Aim für the future: 3D

→ Today → low dosage 3D → CBCT

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- The EOS<sup>®</sup> imaging for the spine can also be used for assessing the facial skeleton.
- Reduction of radiation is essential since the radiation dosage accumulates through a lifetime. Especially children with scoliosis accumulate high dosages. Children who need continuous follow-ups with imaging (e.g. idiopathic scoliosis) show more often asymmetric features of malocclusion.

## Part B

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- Dosage measurements: performed with the Alderson Phantom

- Alderson Phantom: molded of tissue-equivalent material





Small thin-layer thermoluminescence dosimeter pills which were embedded in available openings and on the facial surface.



The analysis of the dosimeter was performed by the SUVA (Swiss National Accident Insurance).

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Dosage measurements of the EOS<sup>®</sup> showed higher dosage measurements in comparison to the CS 9300 cephalometric imaging.

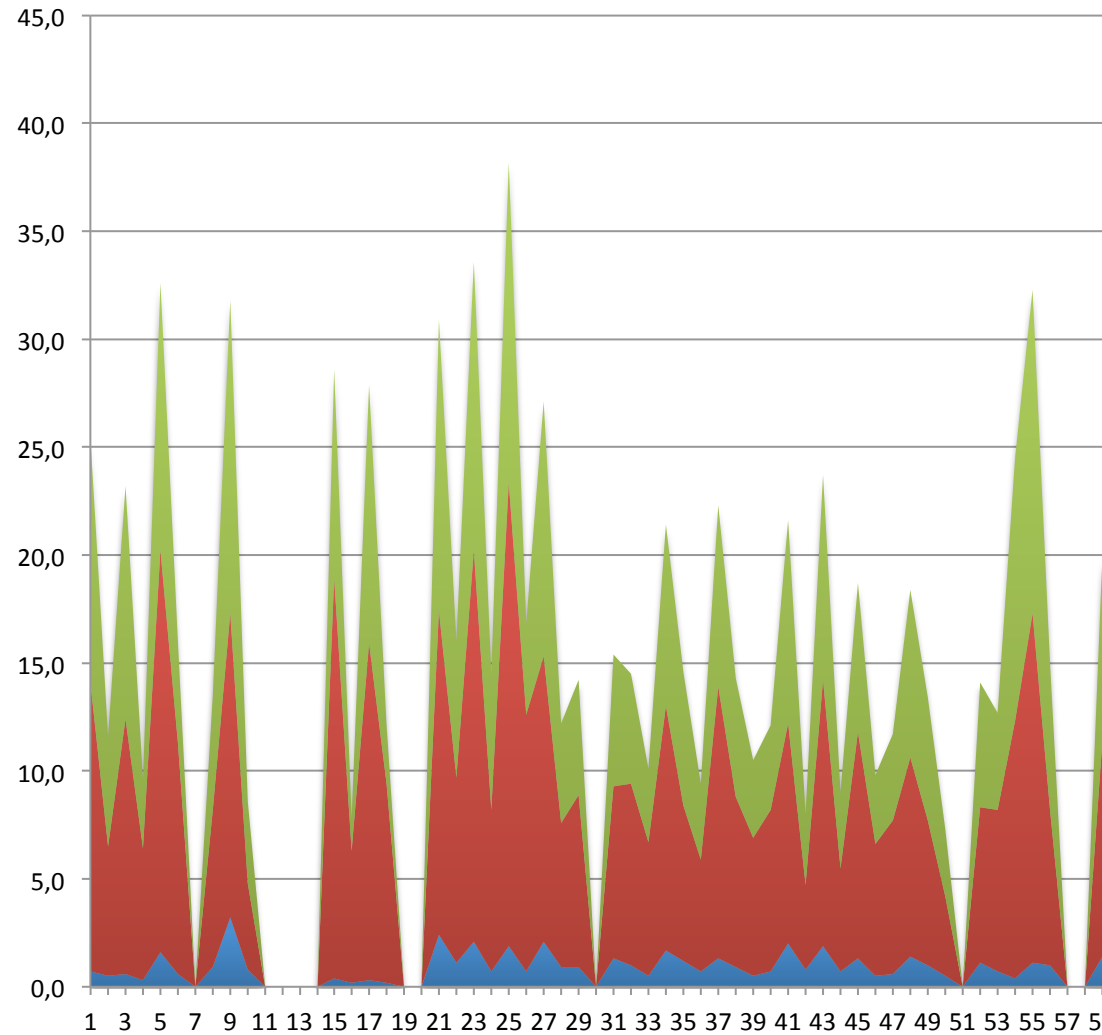


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EOS sag&cor  
EOS sag  
FRS

30 acquisitions

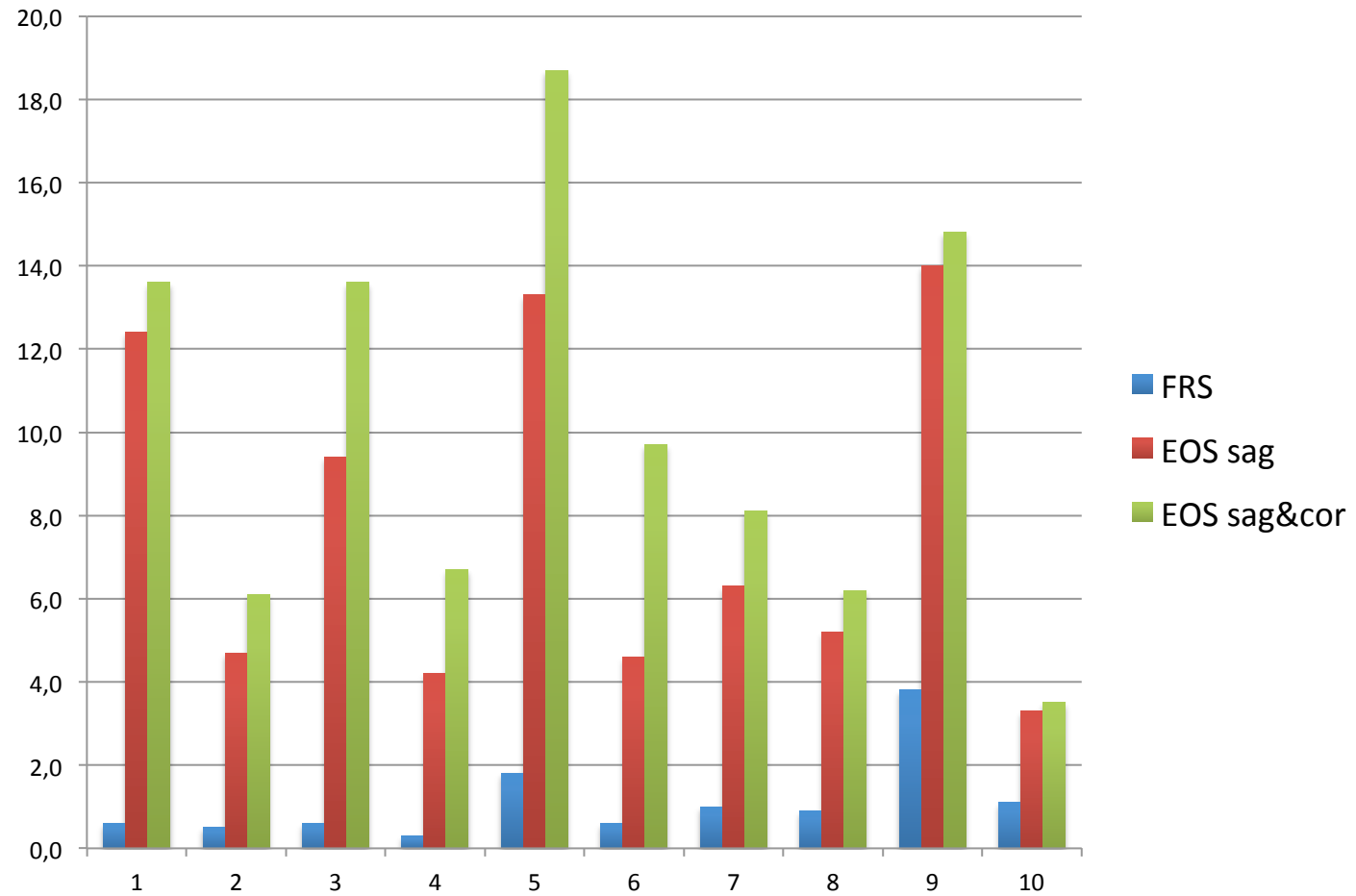


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30 acquisitions

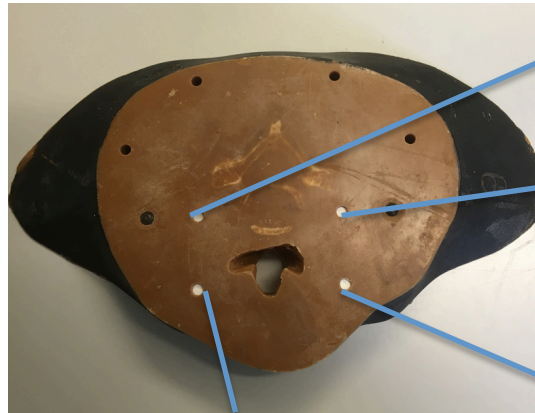


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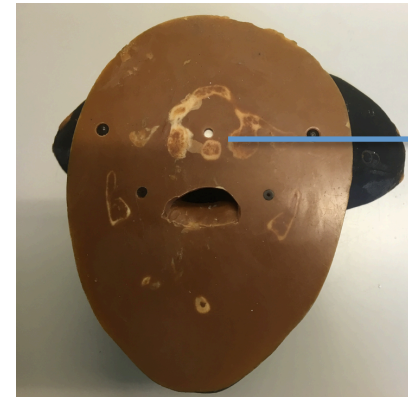


FRS: 0,02  
E s&c: 0,453  
E s: 0,413

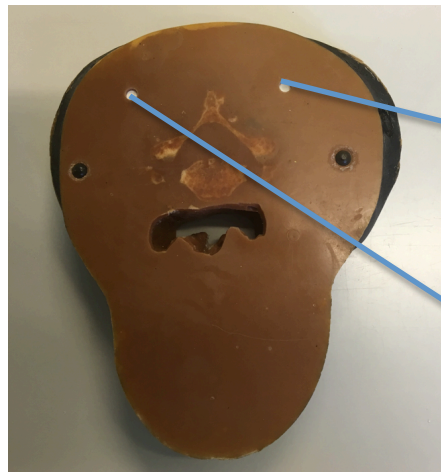
FRS: 0,01  
E s&c: 0,223  
E s: 0,140

FRS: 0,02, E s&c: 0,453  
E s: 0,413

FRS: 0,017  
E s&c: 0,203  
E s: 0,157

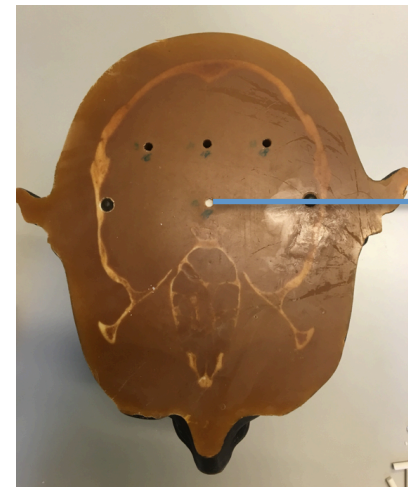


FRS: 0,017  
E s&c: 0,203  
E s: 0,157



FRS: 0,017  
E s&c: 0,203  
E s: 0,157

FRS: 0,017  
E s&c: 0,203  
E s: 0,157



FRS: 0,017  
E s&c: 0,203  
E s: 0,157



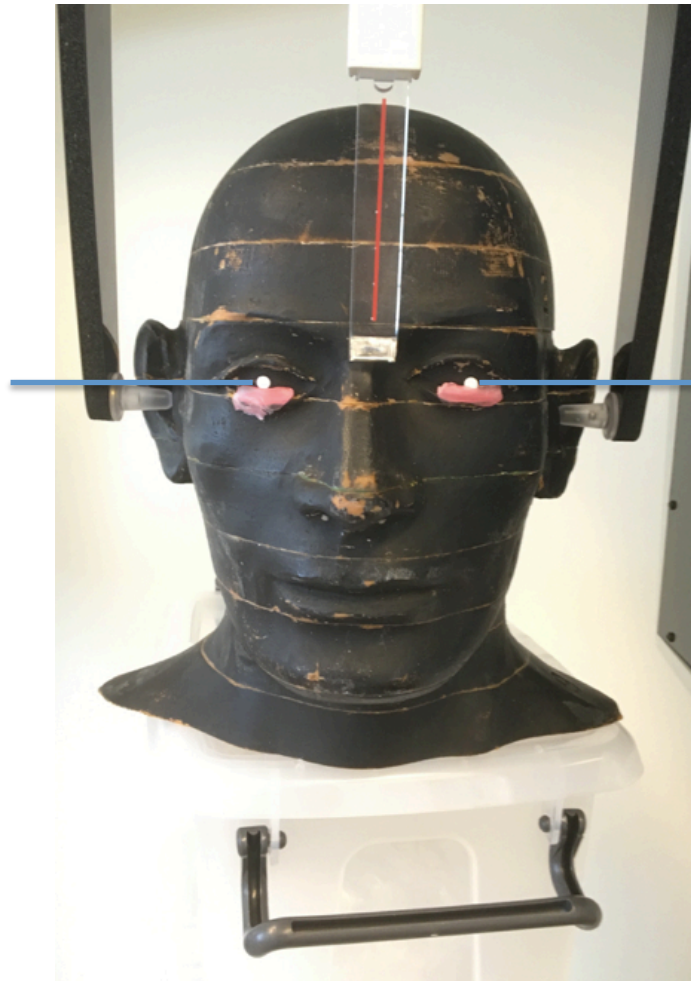
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FRS: 0,127  
EOS s& c: 0,493  
EOS s: 0,467



FRS: 0,037  
EOS s& c: 0,117  
EOS s: 0,110

Measurements in  
msV





## Conclusion part A & B

- The EOS® proved to be precise for the assessment of facial anatomical landmarks.
- Available scans of the captured face (e.g. due to orthopaedic imaging of the spine) should be forwarded to the treating dentist, orthodontist or maxillofacial surgeon.
- Due to the higher dosage, it shouldn't be first choice for lateral cephalometric imaging.

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Thank you very much for your attention!

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I would like to thank the SGDMFR for their financial support of Part B: the dosage measurements.

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"Judging by your X-rays, I'd say you've been exposed to too much radiation."