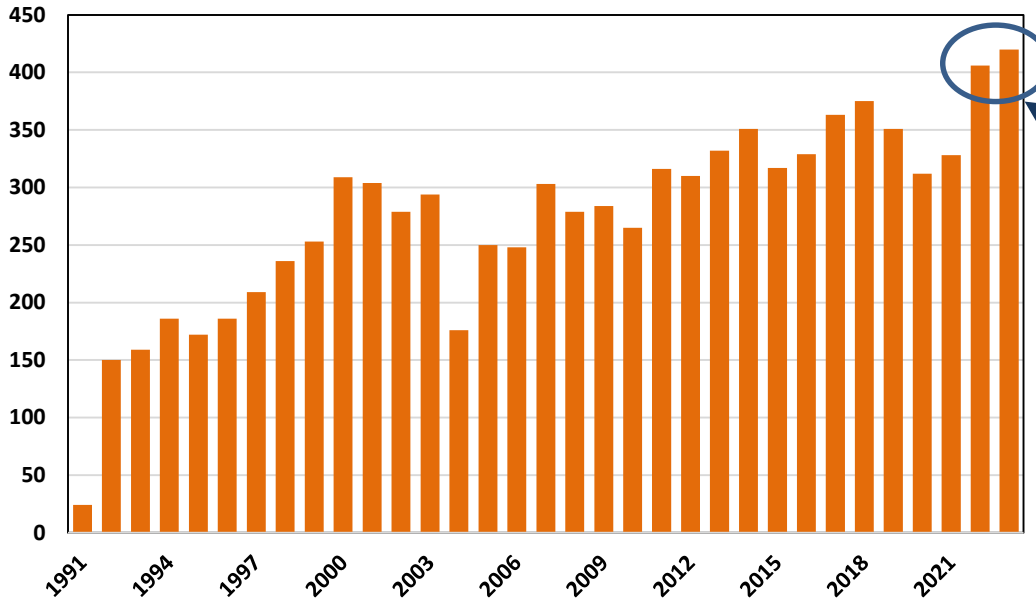
Ocular protontherapy at Institut Curie : Clipless positioning

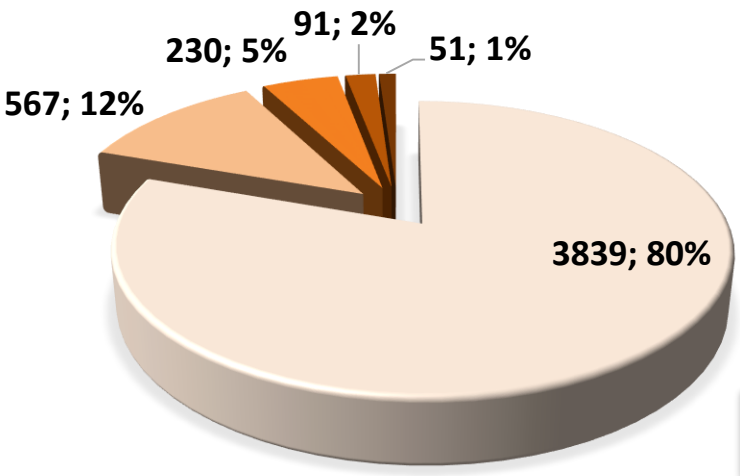
Statistical data for ocular treatments



> 8600 ocular treatments

> 400 patients per year

~ 8-12 treatments per day

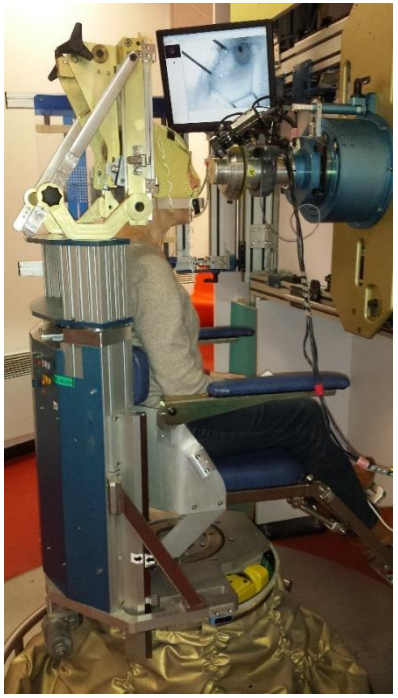


- Choroïdal and cilary body melanoma
- Conjonctival melanoma
- Hemangiomia
- Iris melanoma
- Others

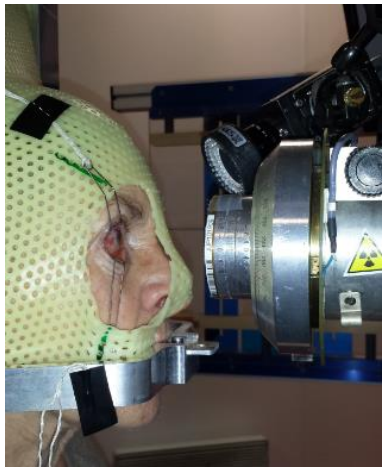
Since 2010

14 % patients without clips

Clipless positioning setup



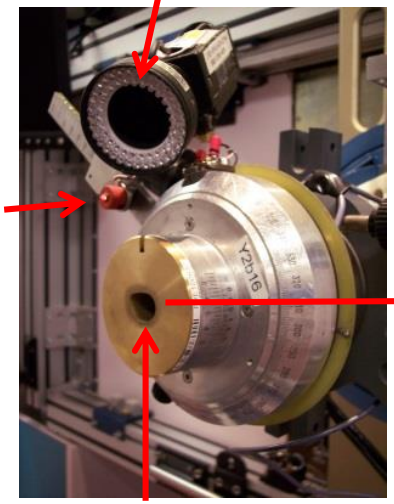
Robot chair



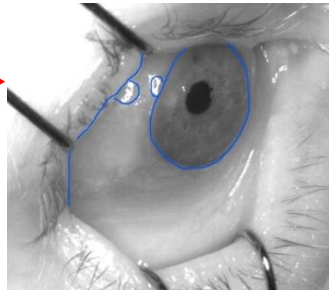
Thermoplastic face mask
+ Bite block
+ 2 eyelids retractors

Infrared side camera

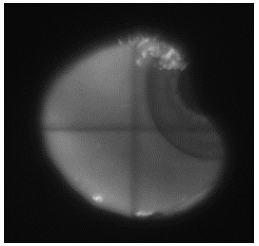
Gazing angle LED



Personalized collimator



Medusa software
Developped by CPO



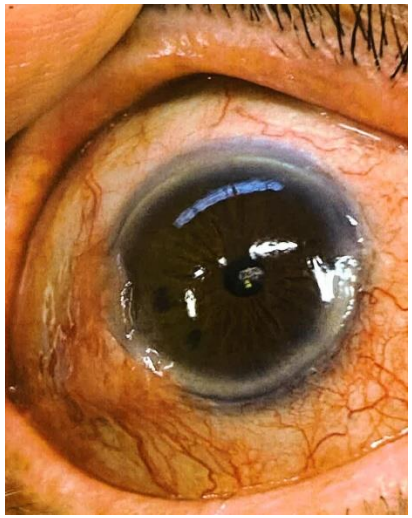
BEV camera
or
Light field

- **Patient seated facing the proton beam**
- **Distance from collimator with lasers**
- **LED in front of him to keep the gazing angle (polar, azimuth)**
- **Use of 2 retractors for removing the eyelids out of the radiation field**

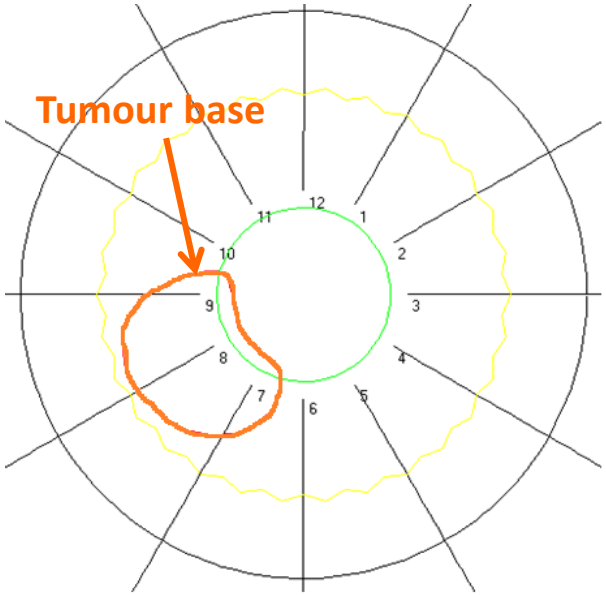
Treatment modelling with EYEPLAN

Conjonctival melanoma → **Patient without clips**

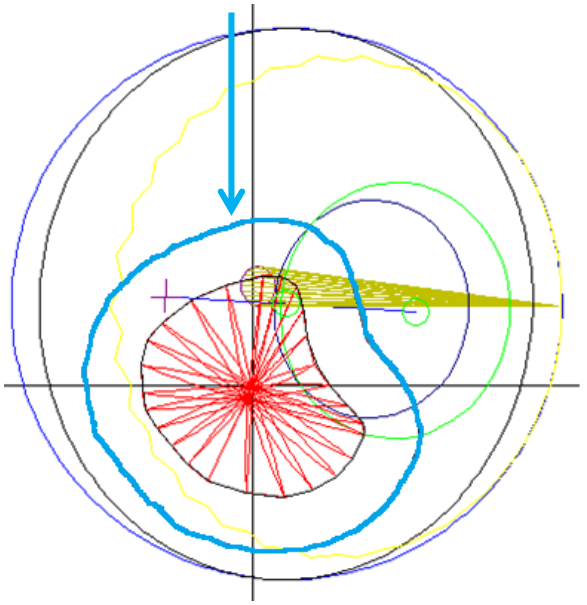
- Protontherapy following surgery to remove the tumor
- One step preparation, one day before treatment
- 7.5 CGE-Gy * 8 fractions



Pre-op localisation
Front eye view



Drawing tumor base
Pre-op localisation
Front eye surface
(polar view)



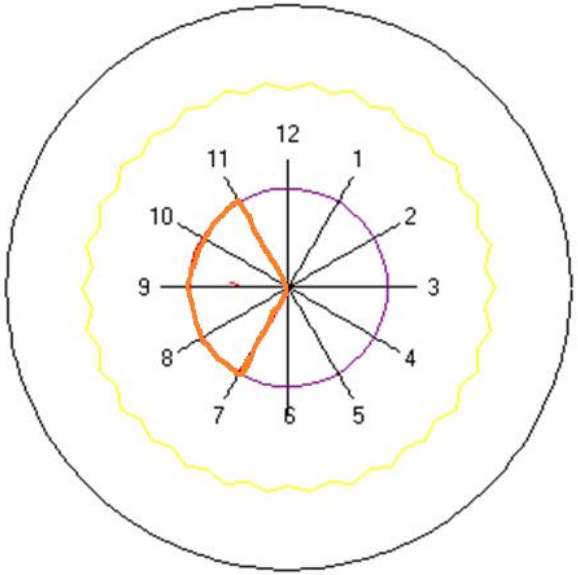
Beam's eye view
Treatment position

Treatment modelling with EYEPLAN

Iris melanoma → **Patient without clips**

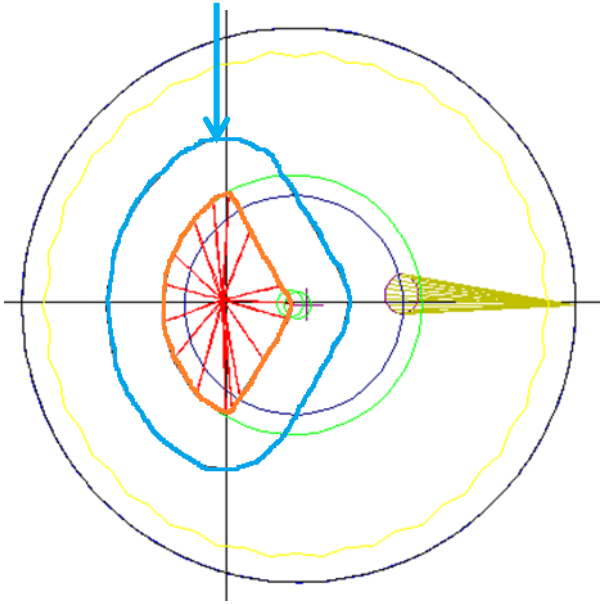
- One step preparation, one day before treatment
- 15 CGE-Gy * 4 fractions

Front eye view



Drawing tumor base
Front eye surface
(polar view)

Radiation field
Lateral margin 2.5mm

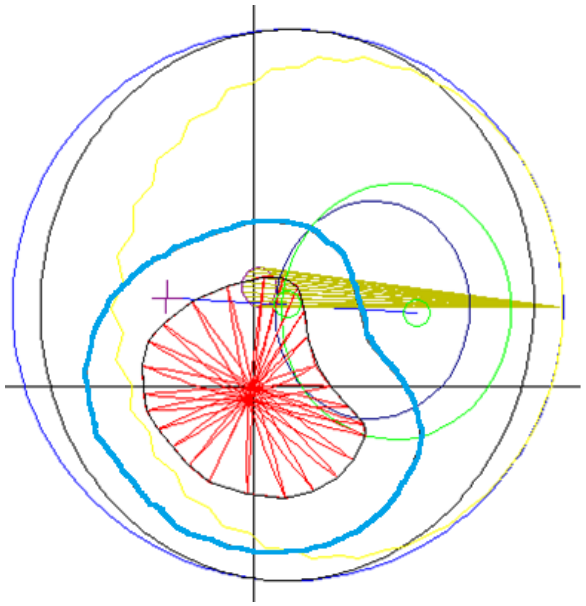


Beam's eye view
Treatment position

Treatment modelling with EYEPLAN

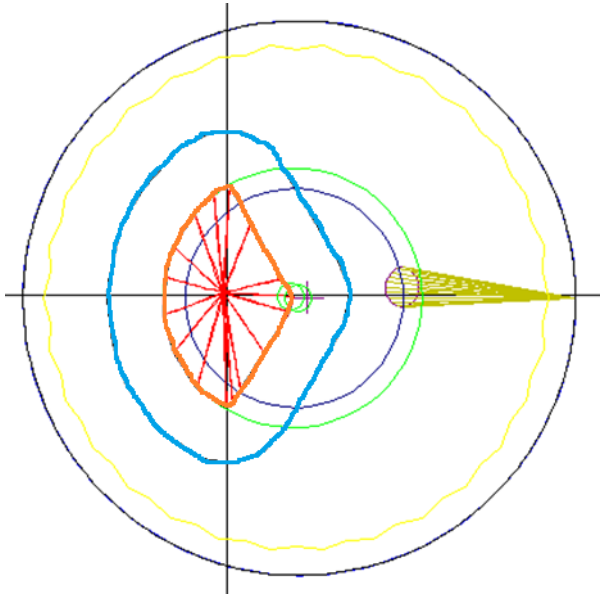
Beam's eye view - Treatment position

Conjonctival melanoma



Gazing angle chosen to minimize the eyelids in the radiation field

Iris melanoma



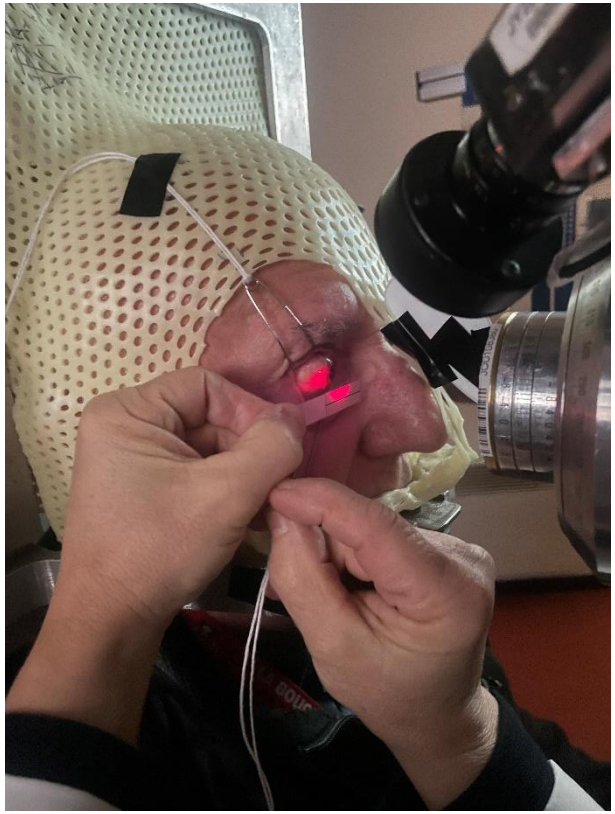
Always look straight ahead

Clipless positioning process – Light field

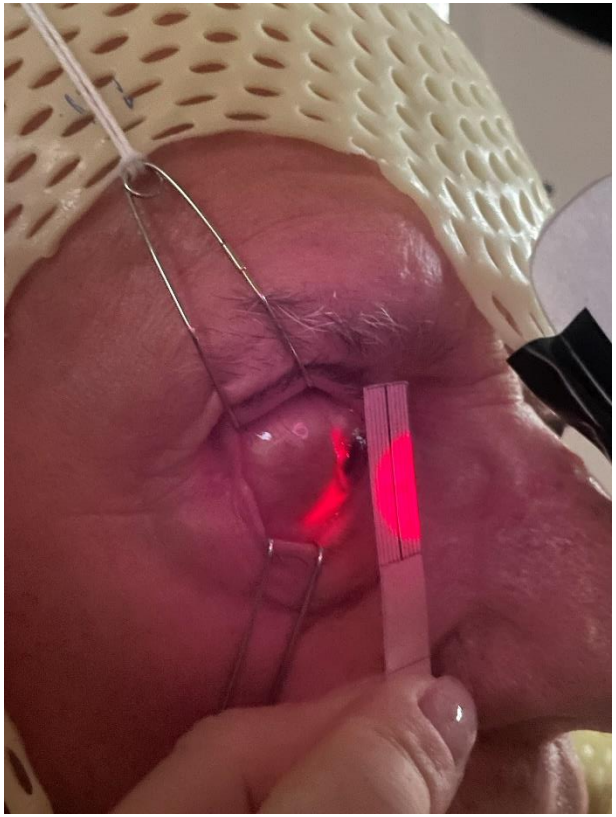
Historical process for positioning without clips

Daily set-up control

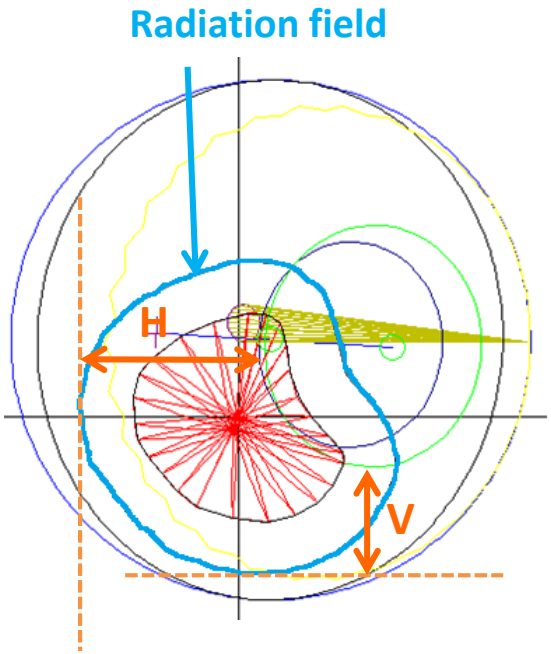
- Measurements with a small graph paper
- Horizontal and vertical distance from iris to edge of field
- Double checking: physicist – radiation oncologist



Vertical



Horizontal



Treatment position

Clipless positioning process – Light field

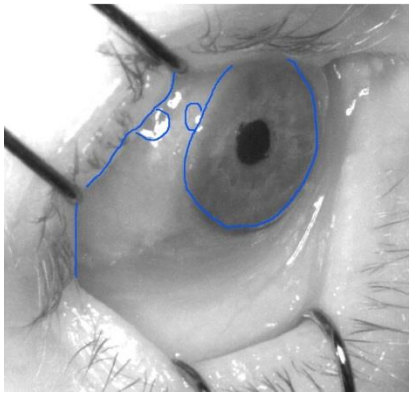
Historical process for positioning without clips

After light field's checking, patient's eye in treatment position

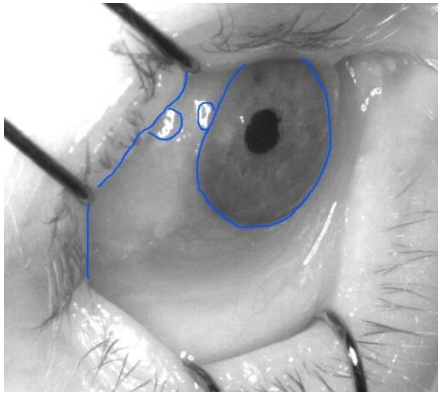
→ reflections and iris contouring on the image camera (light field off)

Checking position at the control desk

Drift, oscillation, voluntary movement



Beam off



Beam On

Side camera (size *10)

+ Manual gating

Accuracy positioning depends on:

- ***the way to measure (users variability)***
- ***the side camera position***
- ***the reliability of contoured reflections***

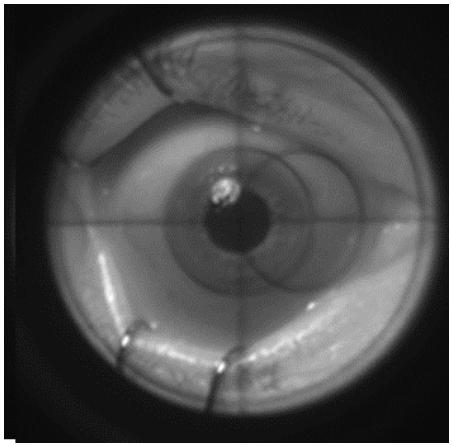
- ***difficulties to evaluate the motion***
- ***need for measurements training / lack of self-confidence for therapist***
- ***For some patients, gazing angle may change because of light field***

Clipless positioning process – BEV camera

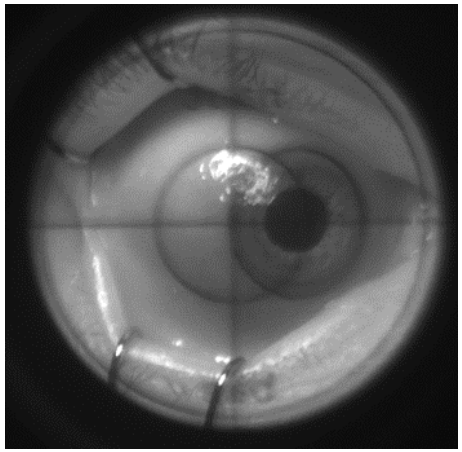
New process adding a BEV camera (since 2014)

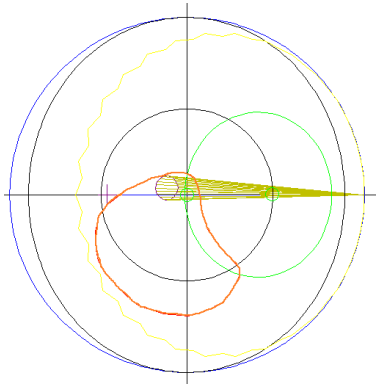
Position on the eye center

Straight ahead position

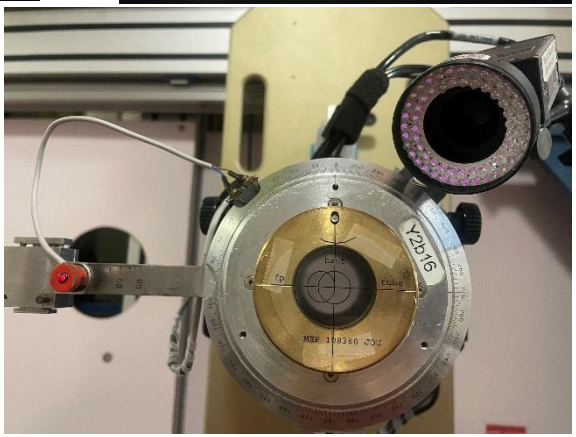


Treatment gazing angle





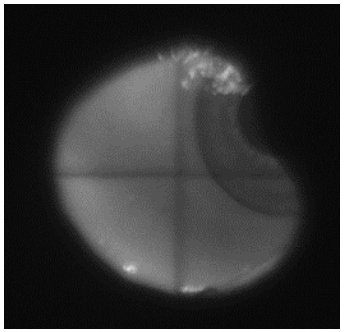
Eyeplan

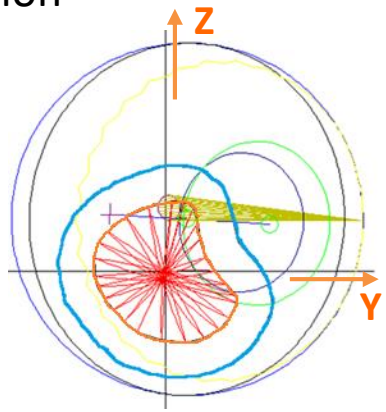


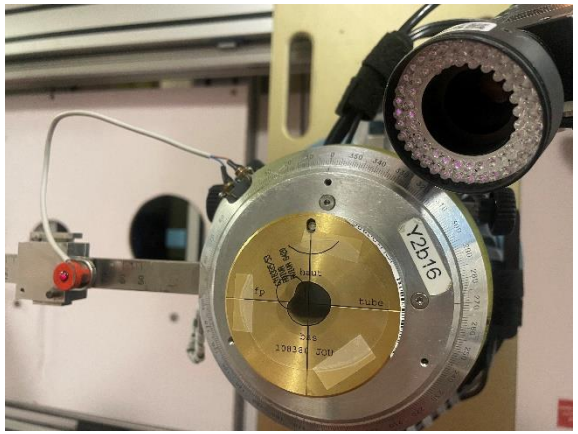
Ref. collimator
with transparent sheet

Position on the tumor center

Treatment position

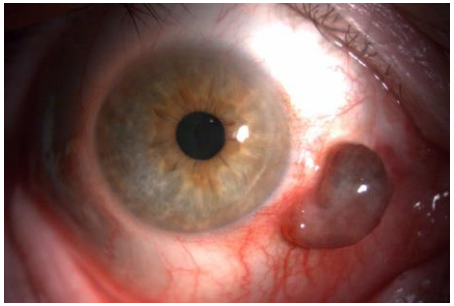






Patient's collimator
with transparent sheet

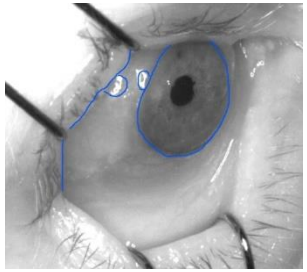
Clipless positioning process – BEV camera

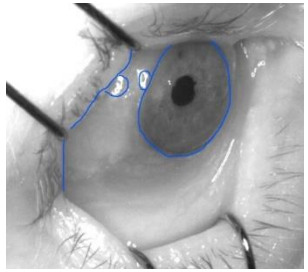


When iris is « not » present in the radiation field

Position on the tumor's center

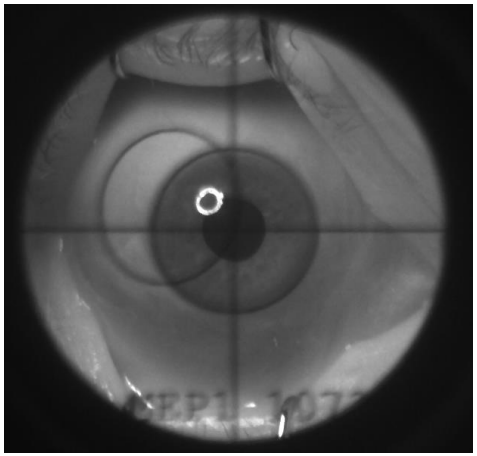
Treatment position



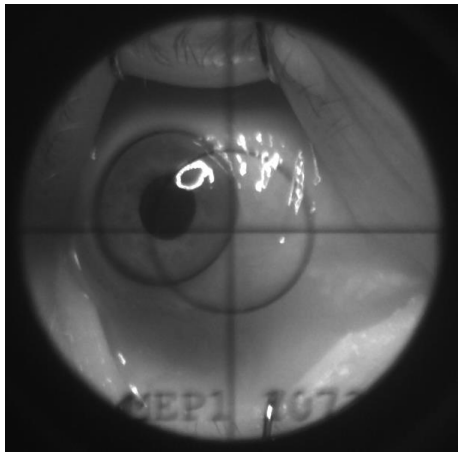


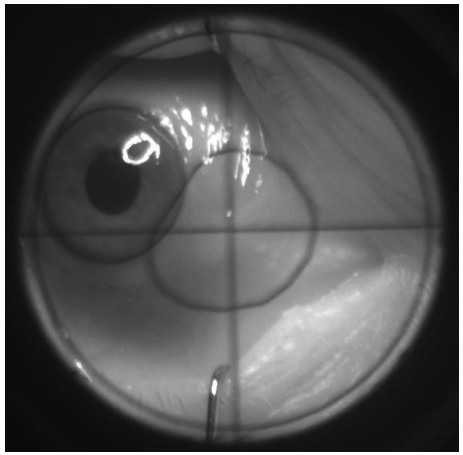
Position on the eye's center

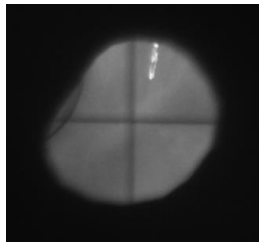
Straight ahead position



Treatment gazing angle







Step 1

Neutral position

Step 2

Checking gazing angle

Step 3

Checking robot motion

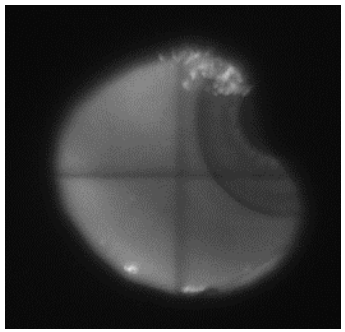
Step 4

Treatment condition

Clipless positioning process

Daily set-up control

- **Positioning with BEV camera**
- **Checking measures on the patient with light field**
- **Double checking : physicist – radiation oncologist (D1) after physicist - therapist**

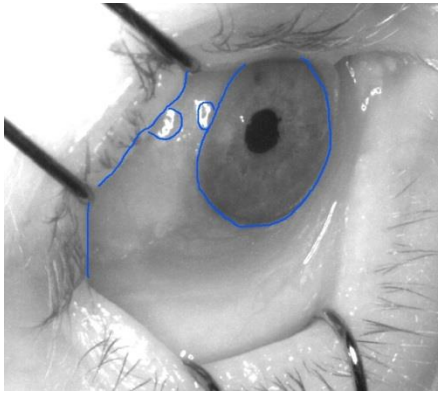


BEV camera

Recording in data base

traceability of treatment

Light field

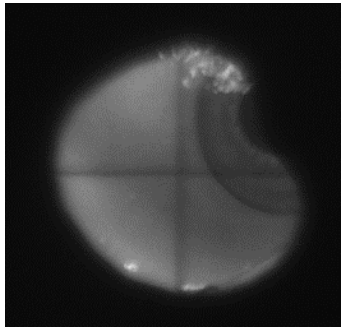


Side camera

Clipless positioning process

Daily set-up control

- Positioning with the BEV camera
- Checking measures on the patient with light field
- Double checking: physicist - physician (D1) after physicist - therapist

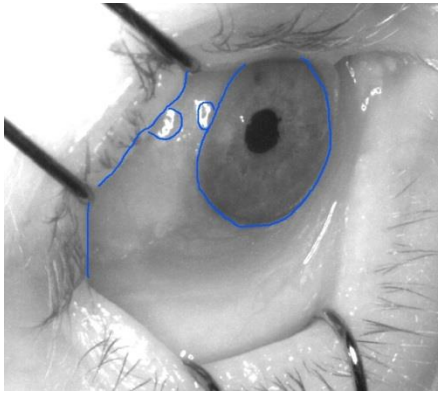


BEV camera

Recording in data base

traceability of treatment

Red light simulation

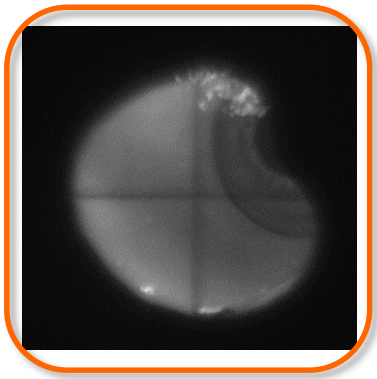


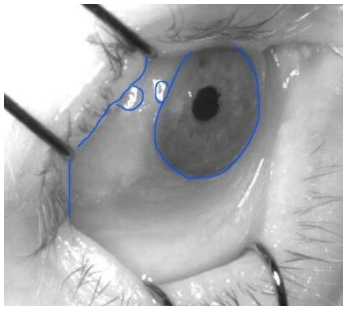
Side camera

Essential step ?

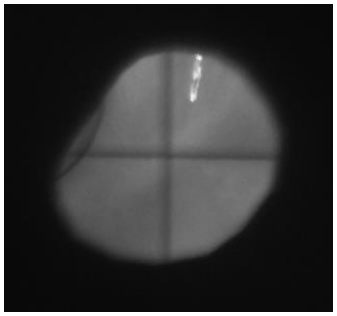
Clipless positioning process

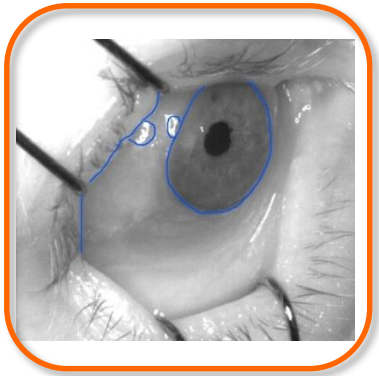
Expected accuracy





Easily quantifiable motion
Accuracy ± 0.5mm





User-dependent method
Accuracy ± 1mm

BEV camera

Side camera

Limits : **Lack of assessment of eye torsion**
Evaluation of the motion

Prospects : **Accurate automatic motion detection and quantification**


PARIS 2024
Thank you
for your attention
institutCurie