



Stereo Vision Based Distance Estimation in G6

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Algorithm Team



Outline

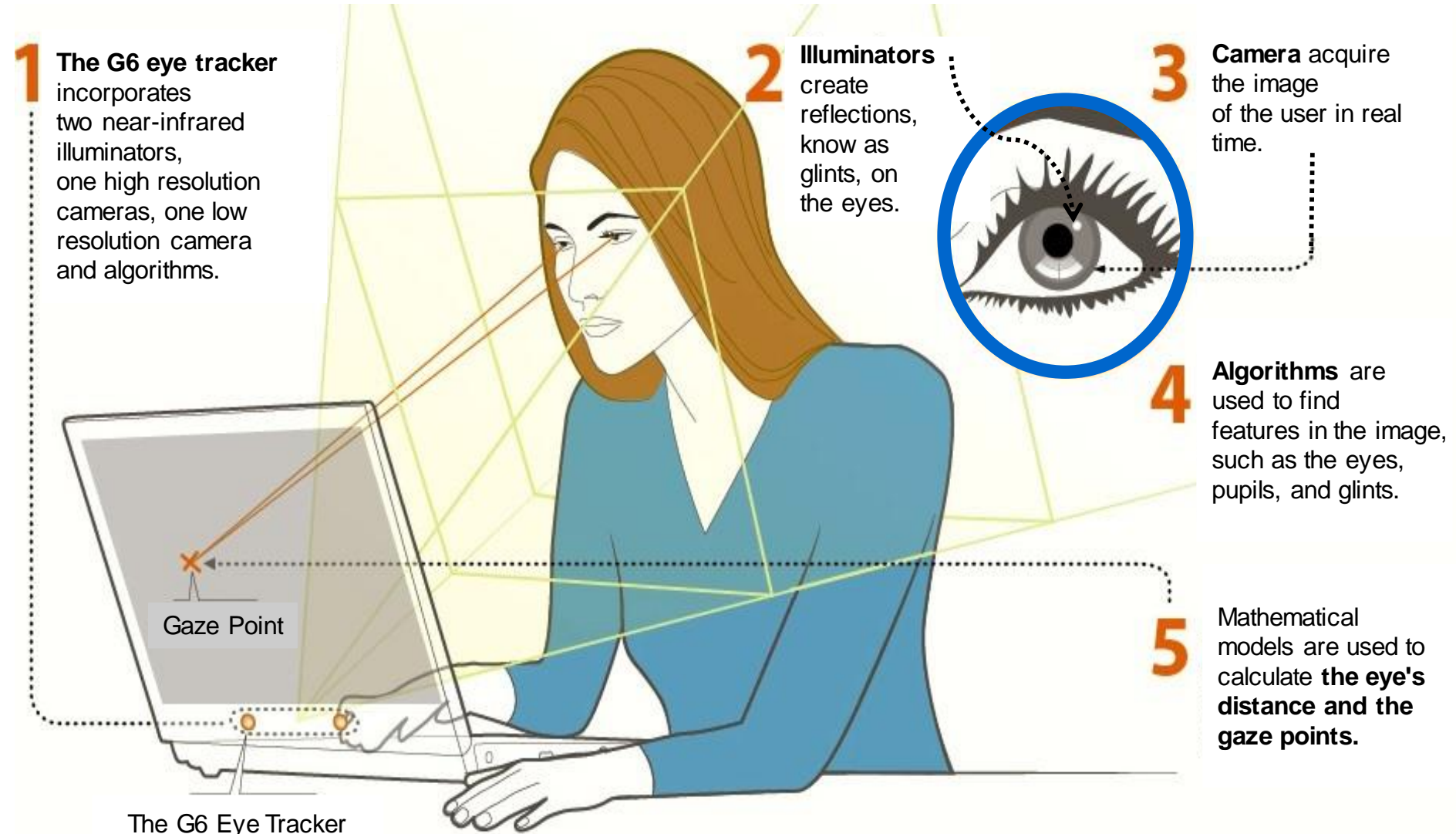
- Importance of Distance Information
- Stereo Glint Based Distance Estimation
- Benefits, Challenges, and Beyond 15



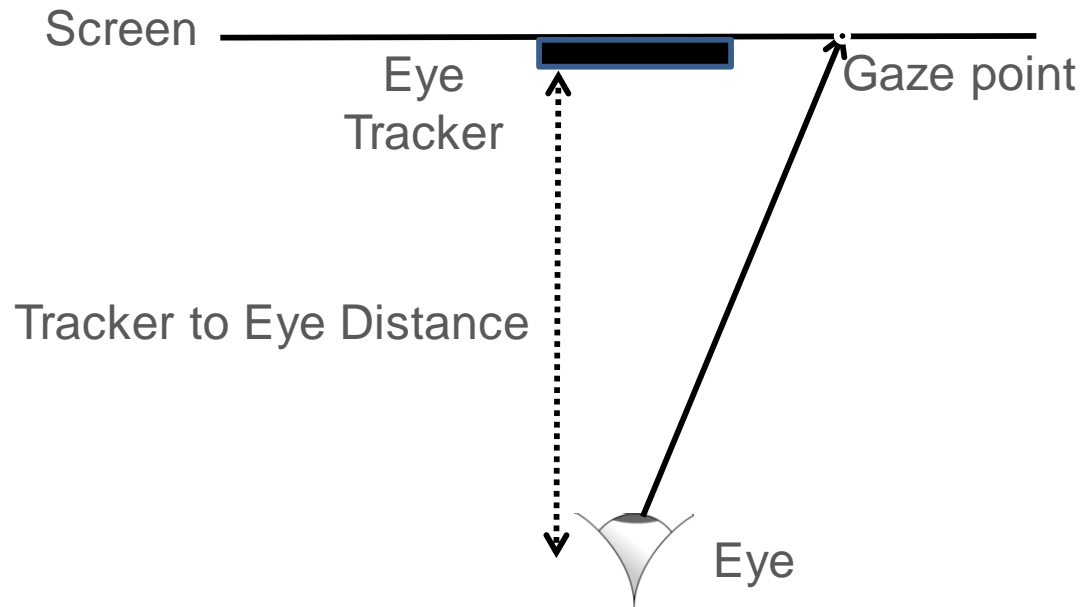
Brief Overview of Eye Tracking

Importance of Distance Information

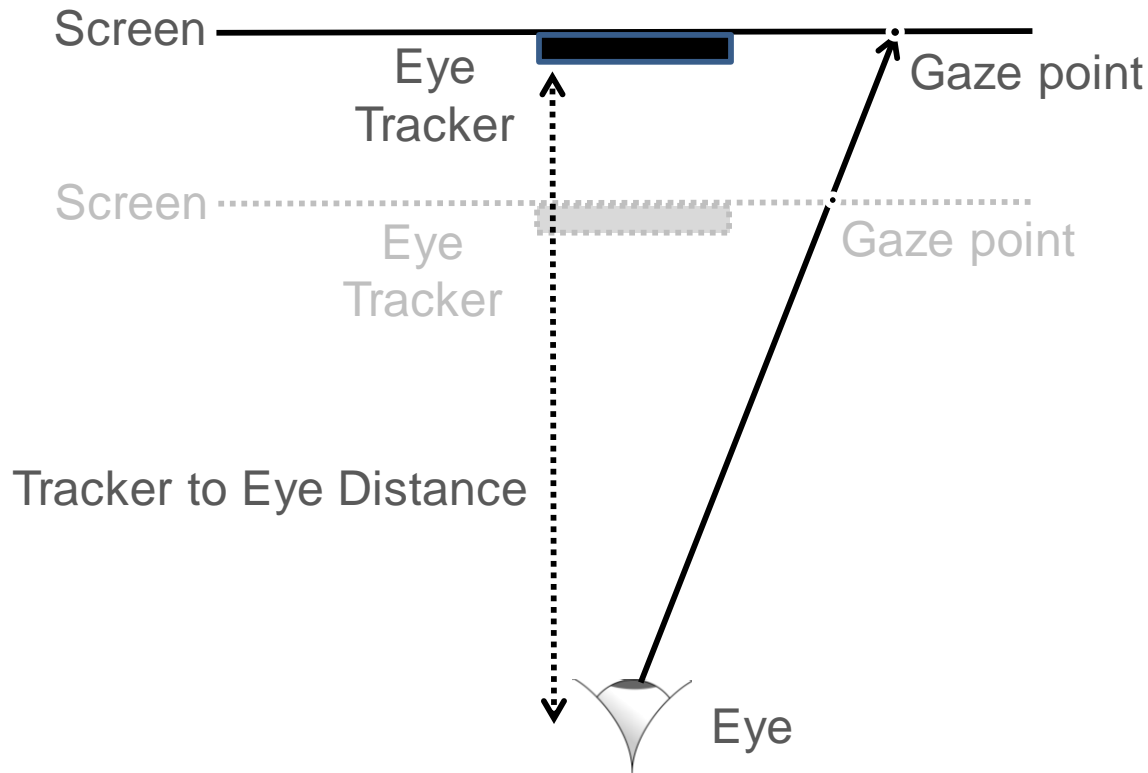
Brief Overview of Eye Tracking



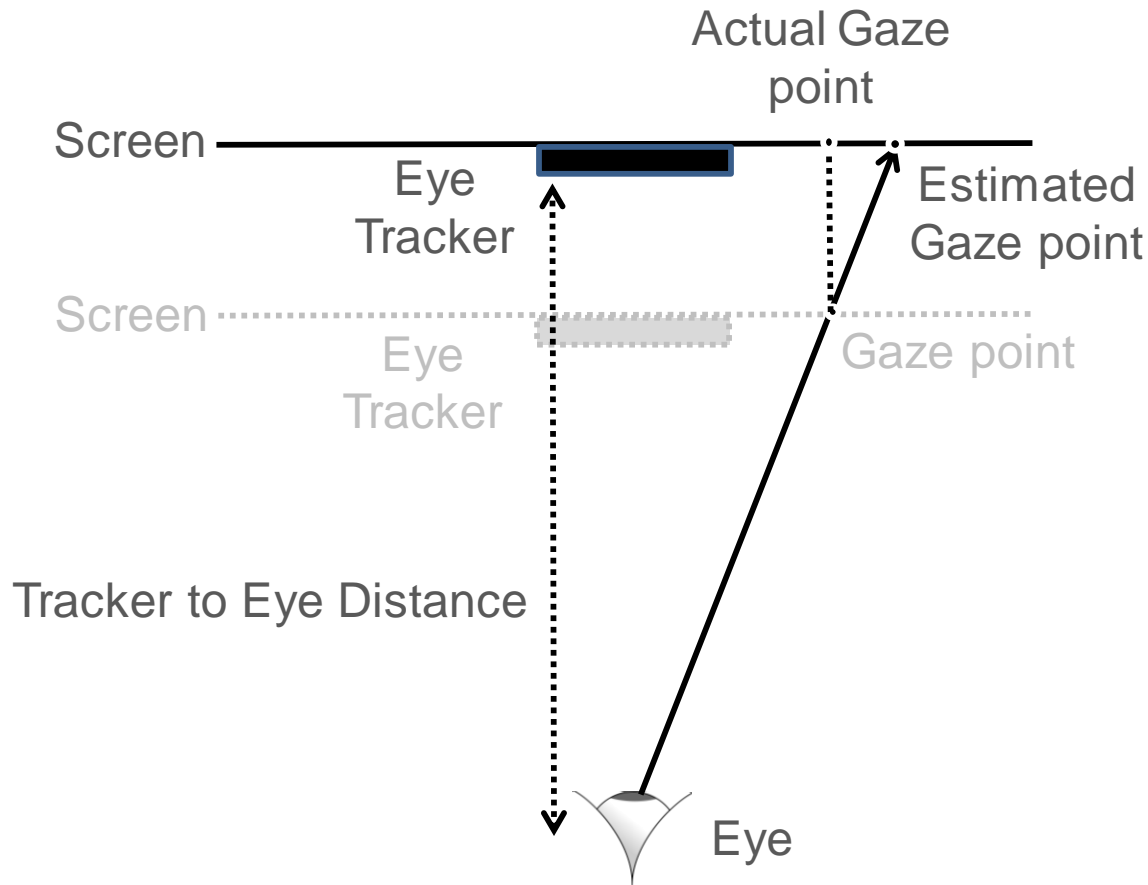
Importance of Distance Information



Importance of Distance Information



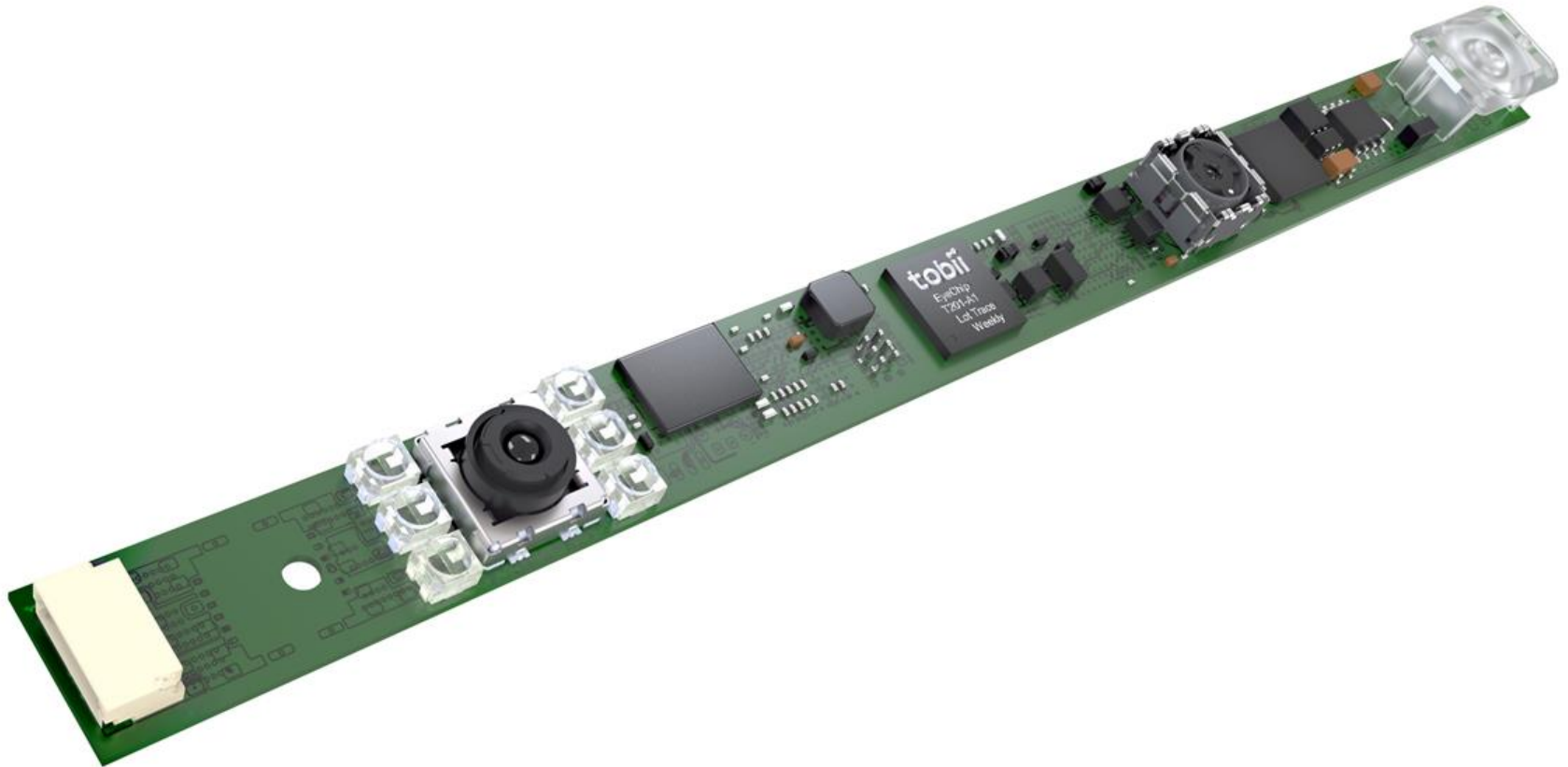
Importance of Distance Information





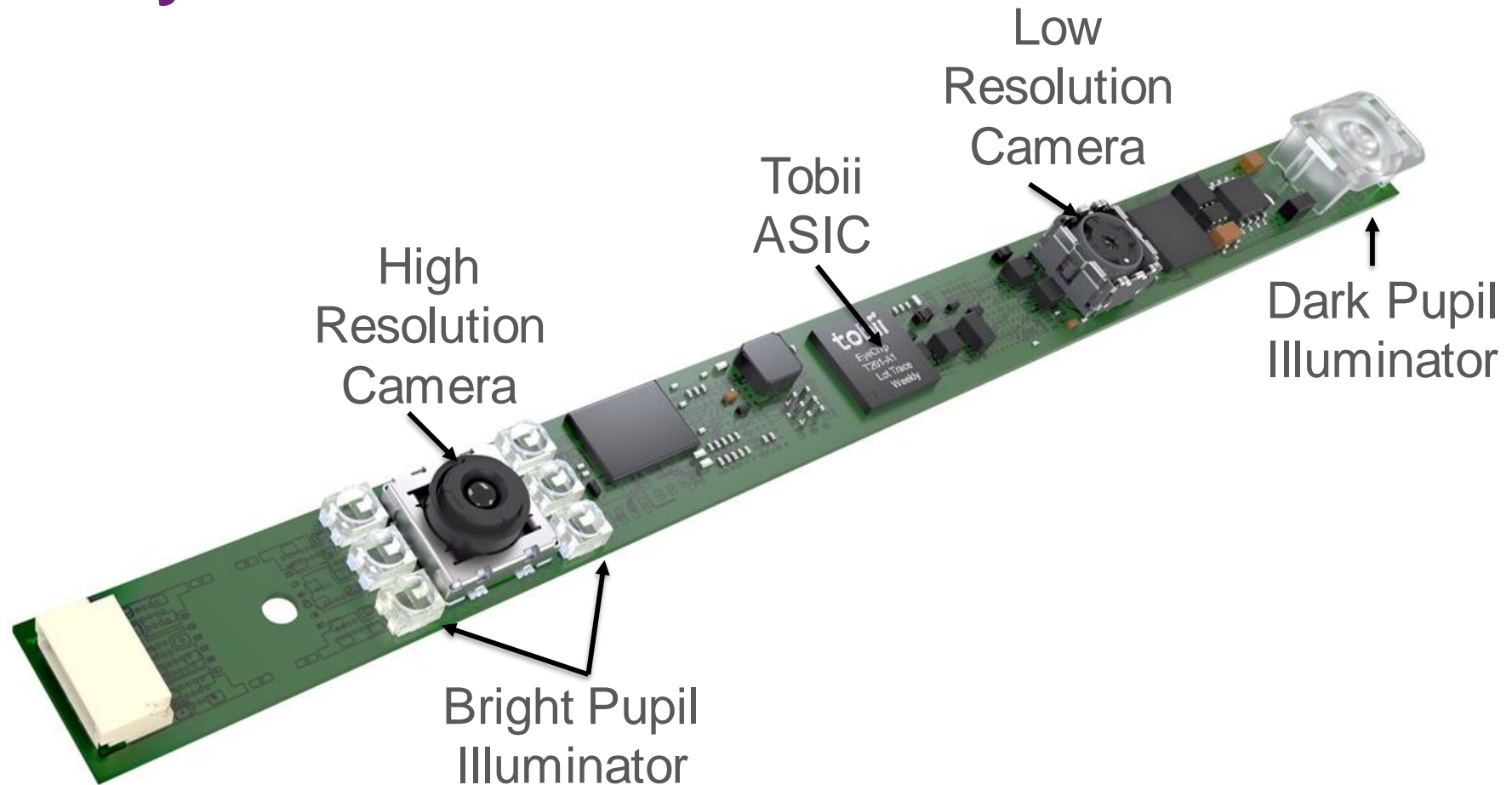
Stereo Glints Based Eye Position Estimation in G6

G6 Eye Tracker



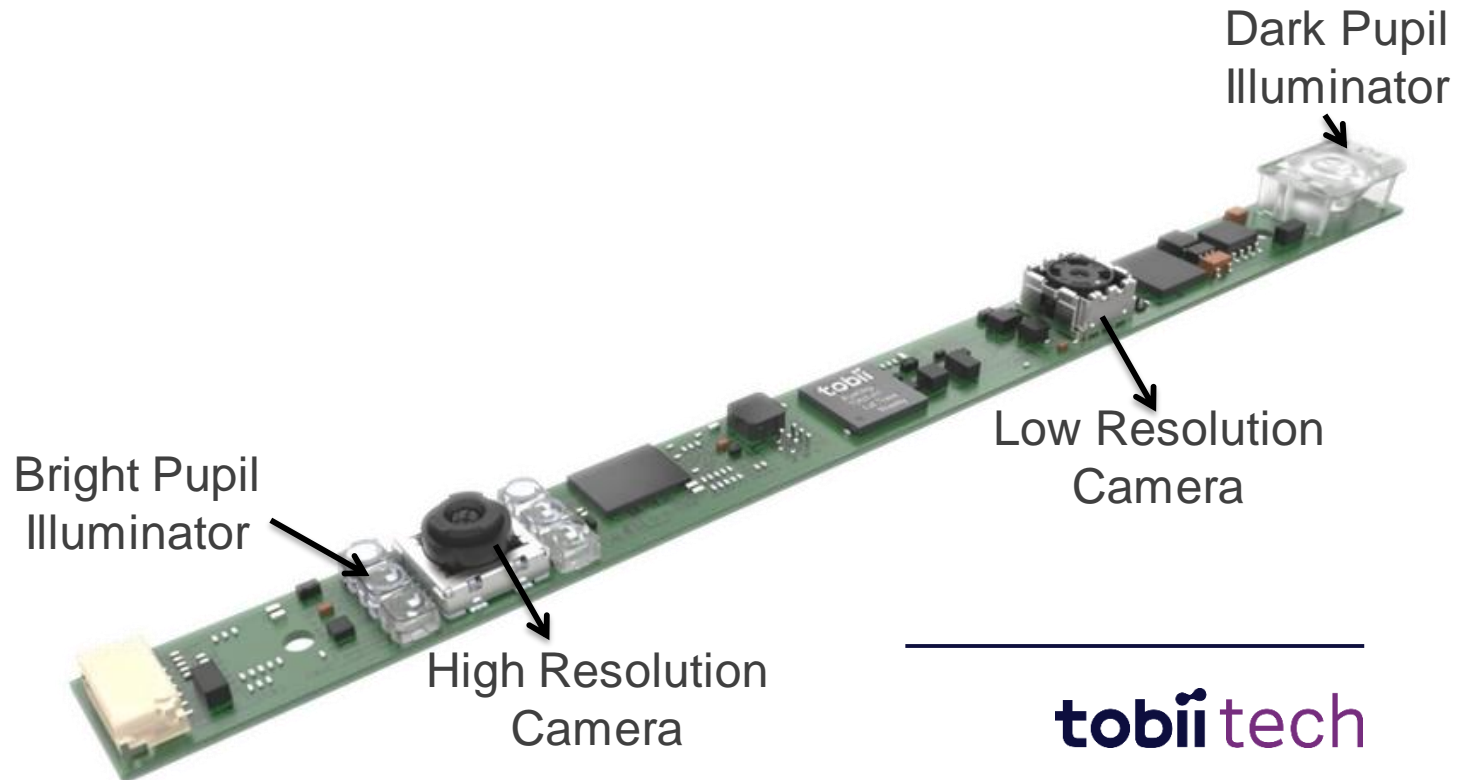
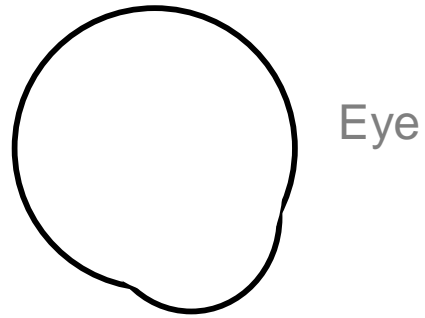
G6 Base Geometry

G6 Eye Tracker

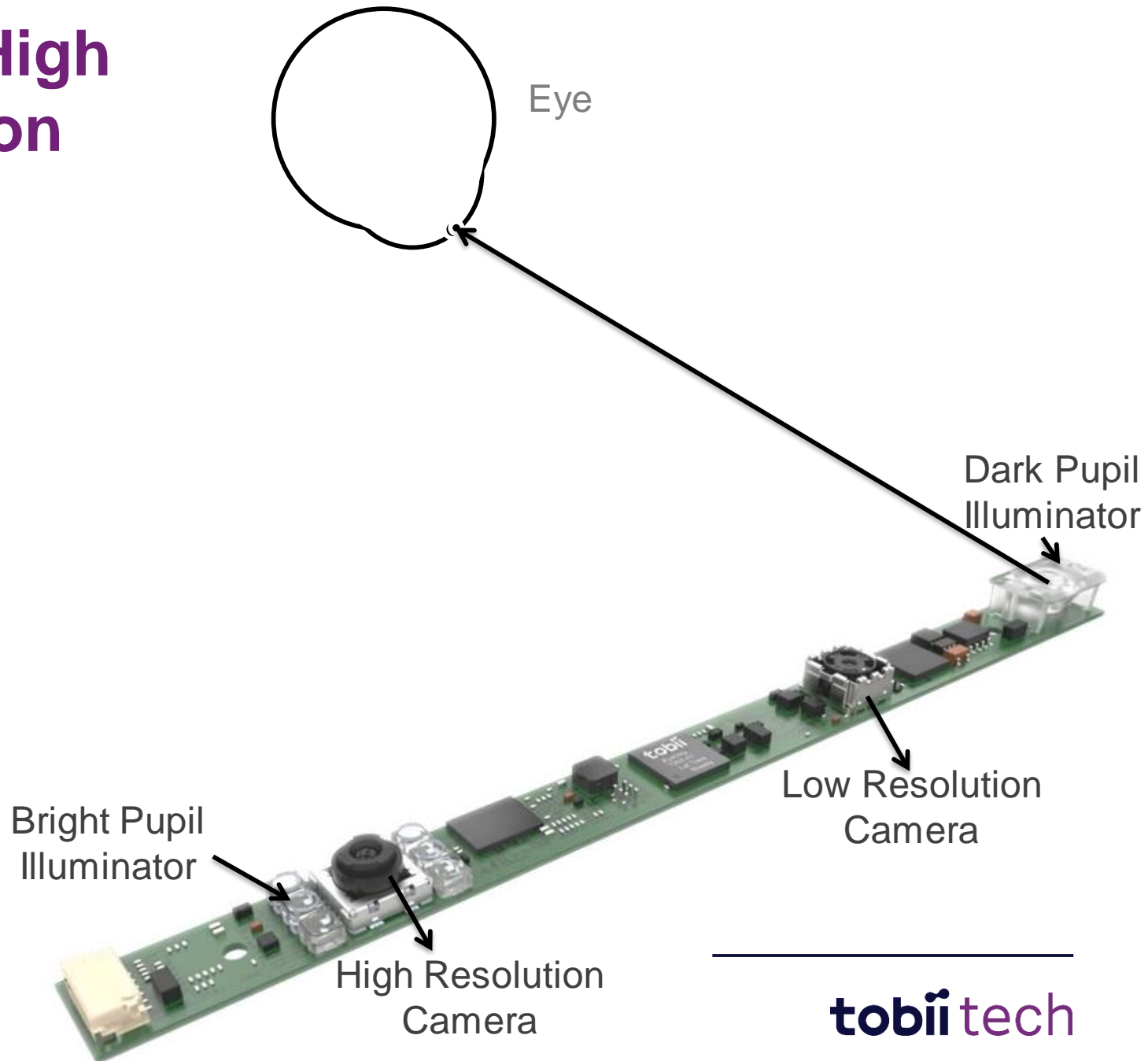


G6 Base Geometry

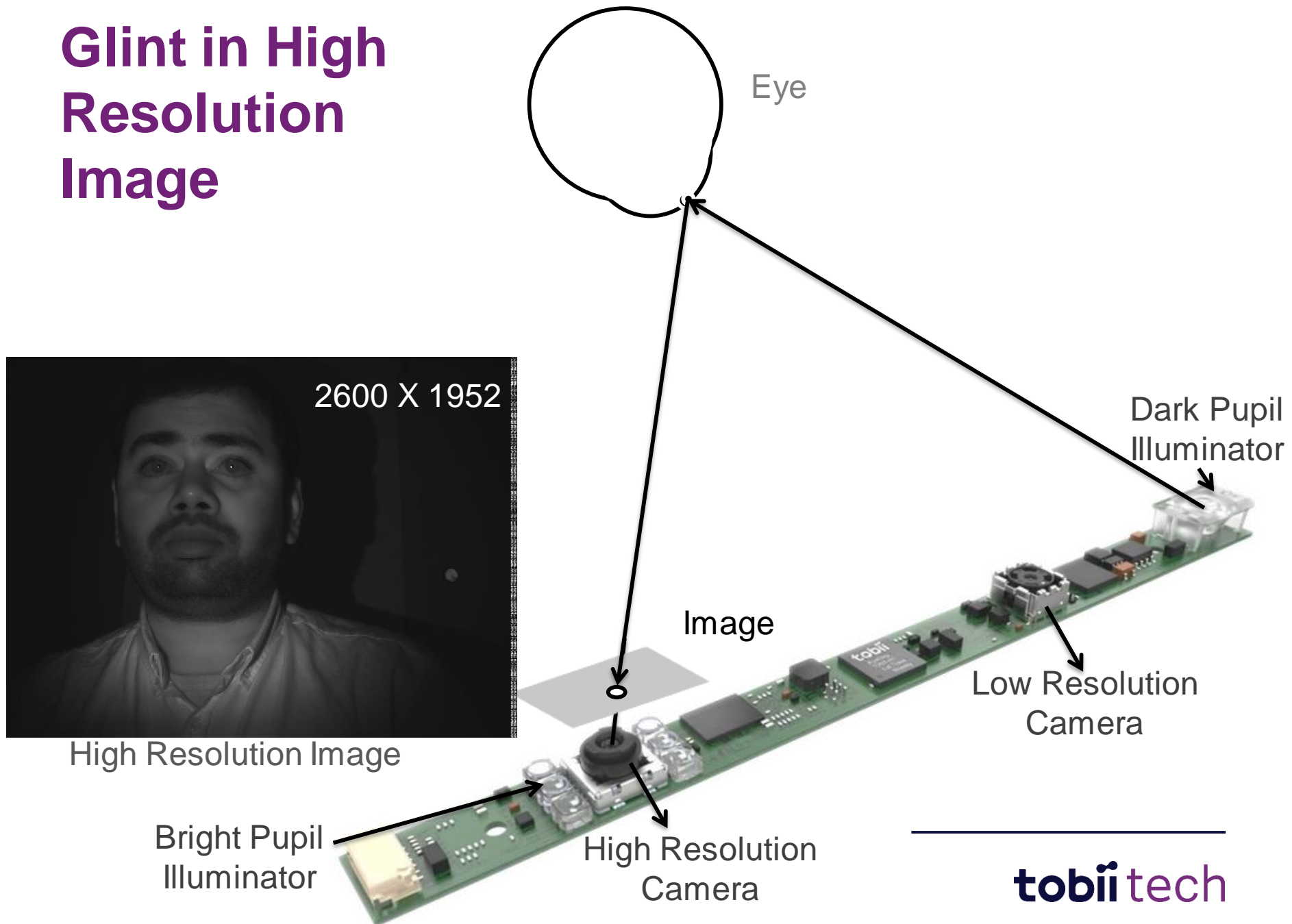
Glint in High Resolution Image



Glint in High Resolution Image



Glint in High Resolution Image



Glint in High Resolution Image

Eye Classification and Detection



High Resolution Image

Bright Pupil Illuminator

High Resolution Camera

Image

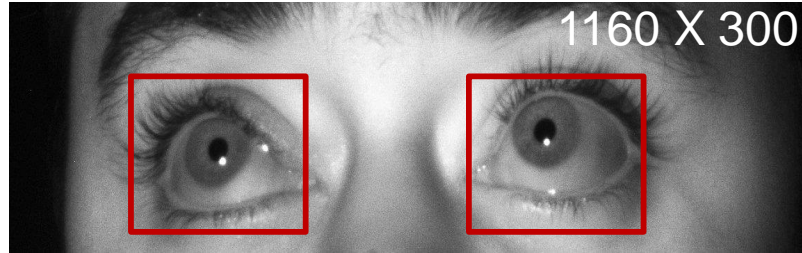
Dark Pupil Illuminator

Low Resolution Camera

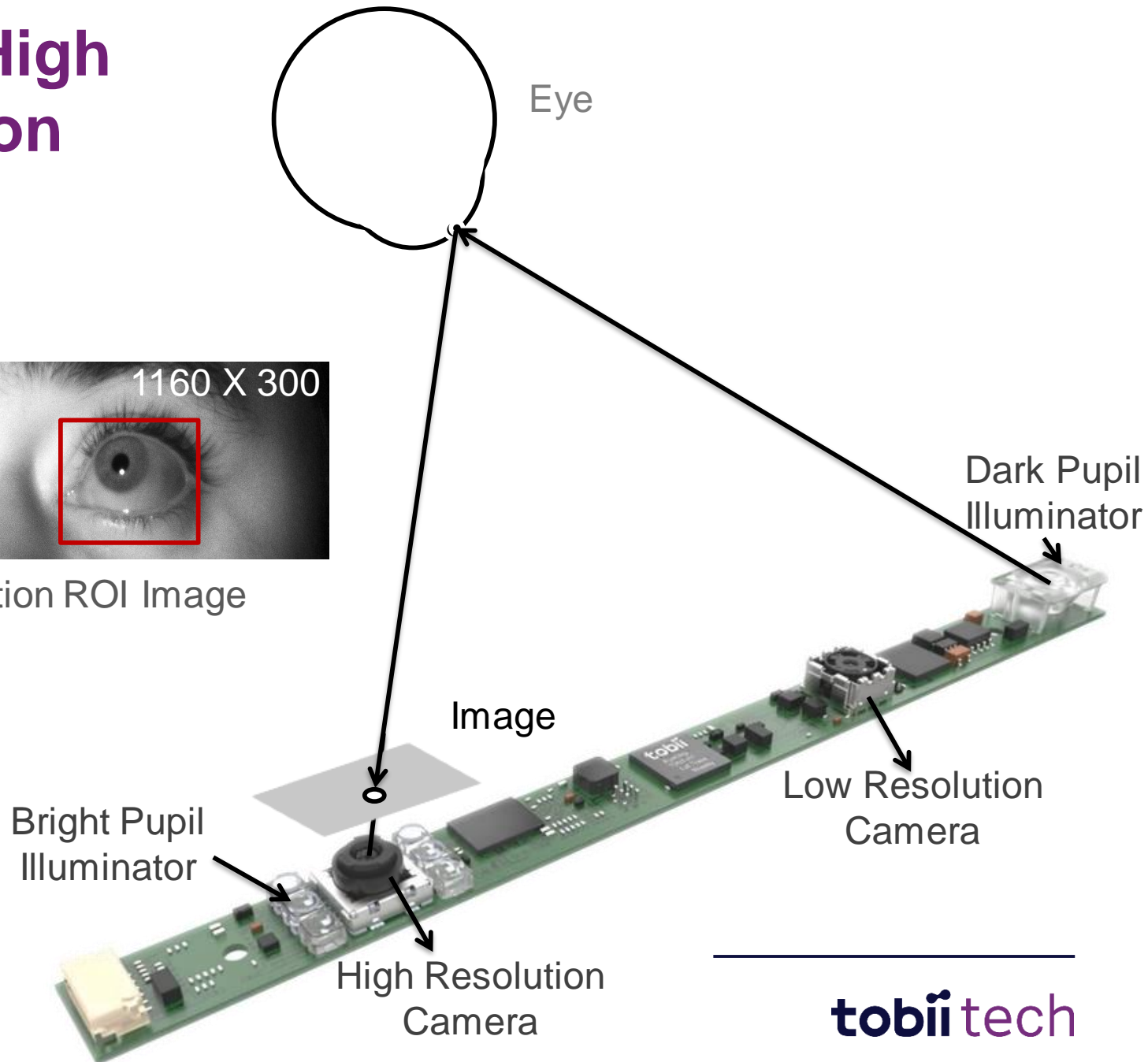
Eye

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Glint in High Resolution Image



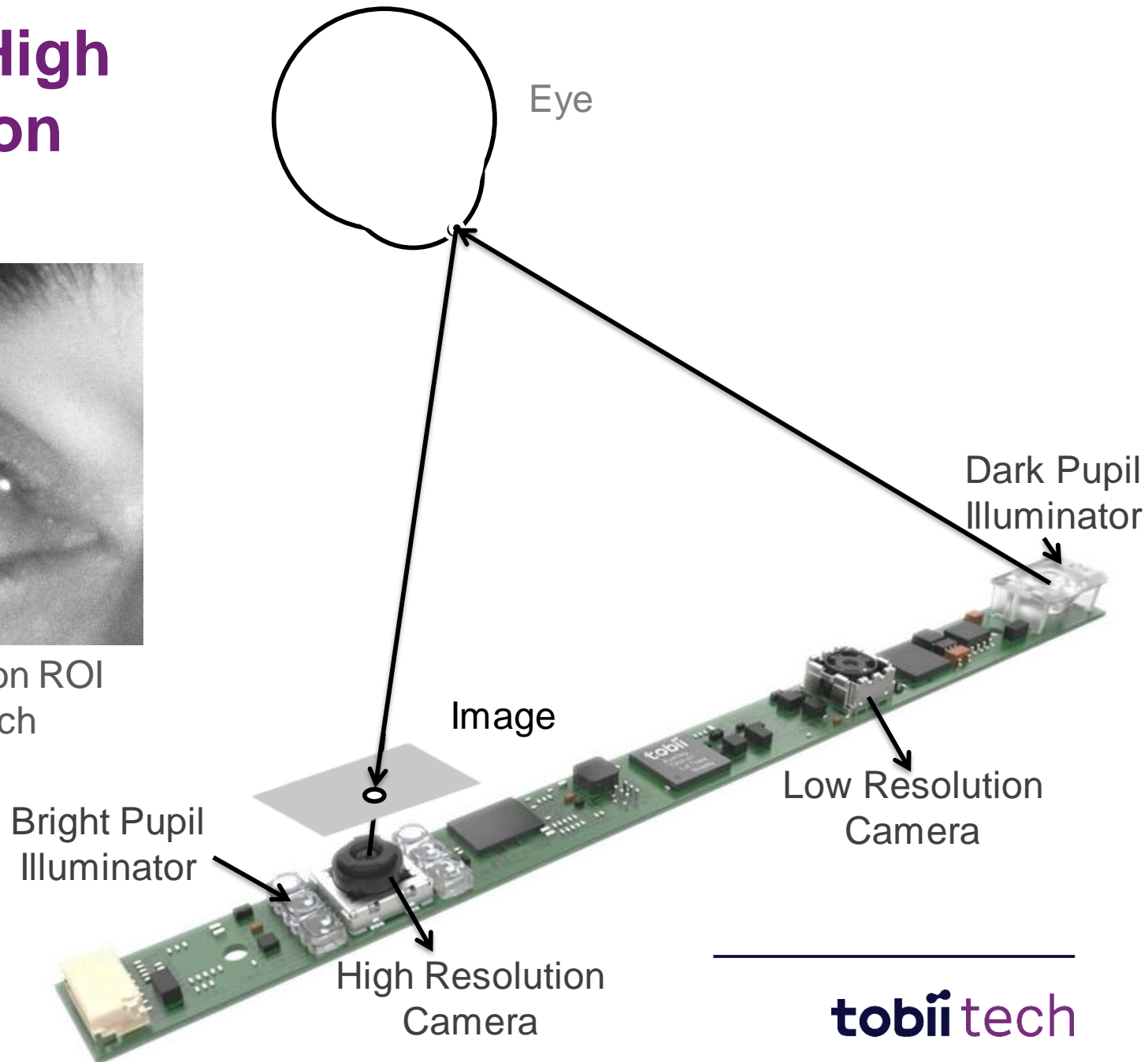
High Resolution ROI Image



Glint in High Resolution Image



High Resolution ROI
Image Patch

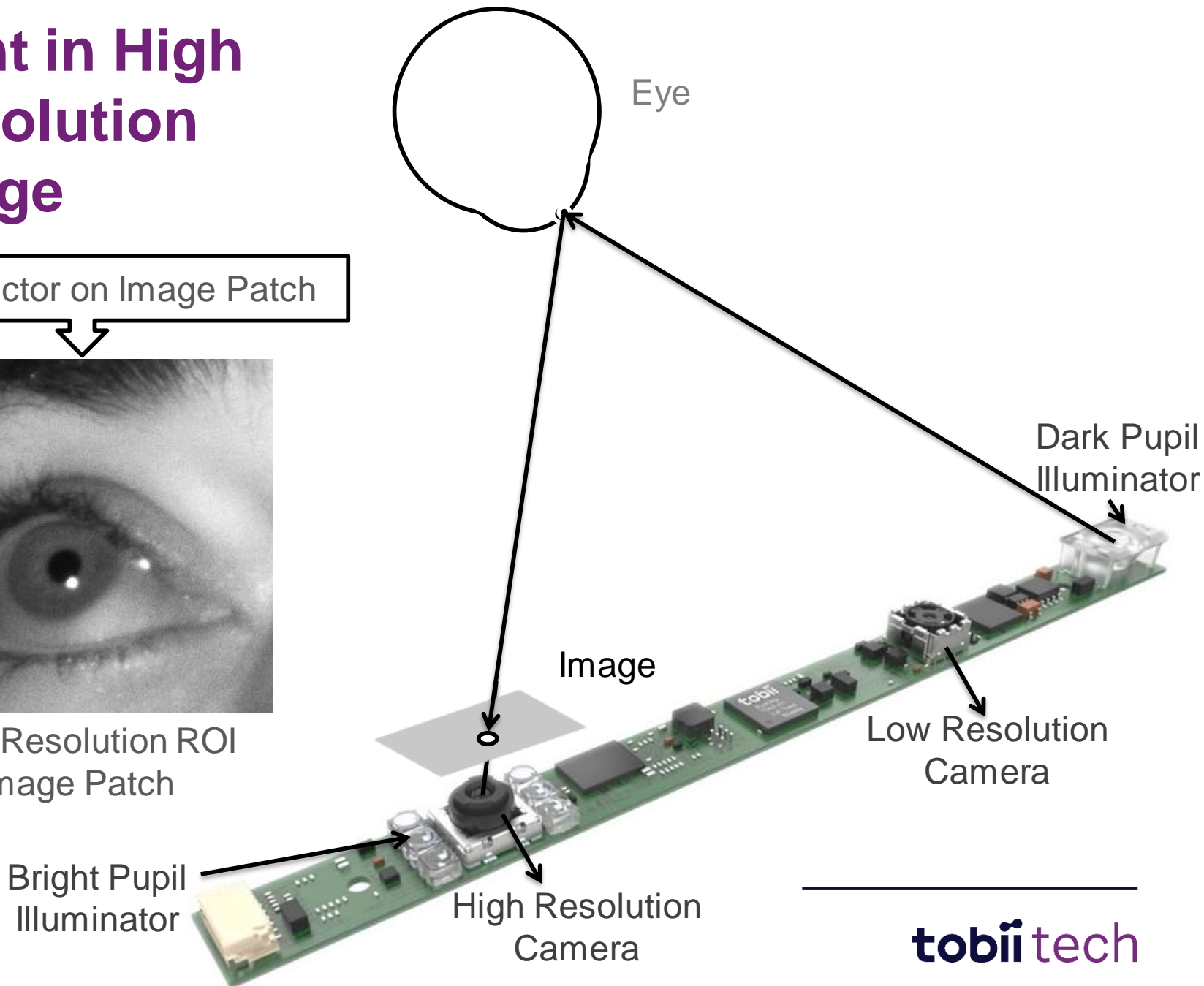


Glint in High Resolution Image

Glint Detector on Image Patch

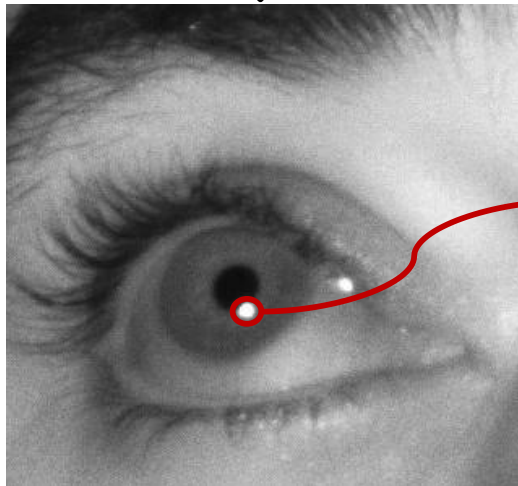


High Resolution ROI Image Patch



Glint in High Resolution Image

Glint Detector on Image Patch



Glint

High Resolution ROI
Image Patch

Bright Pupil
Illuminator

High Resolution
Camera

Image

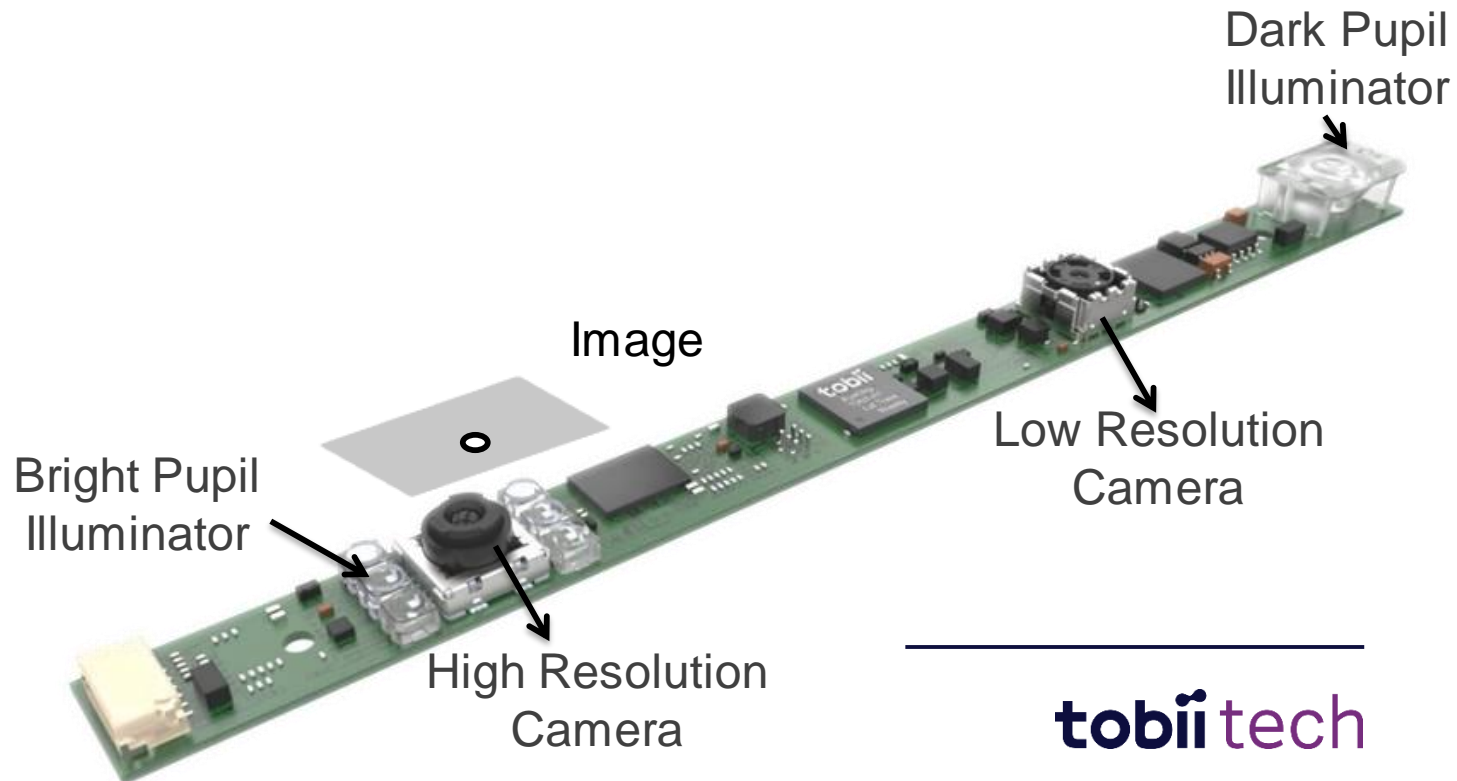
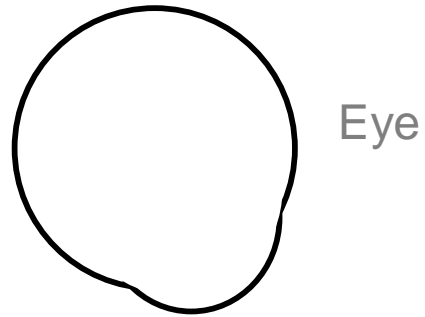
Low Resolution
Camera

Dark Pupil
Illuminator

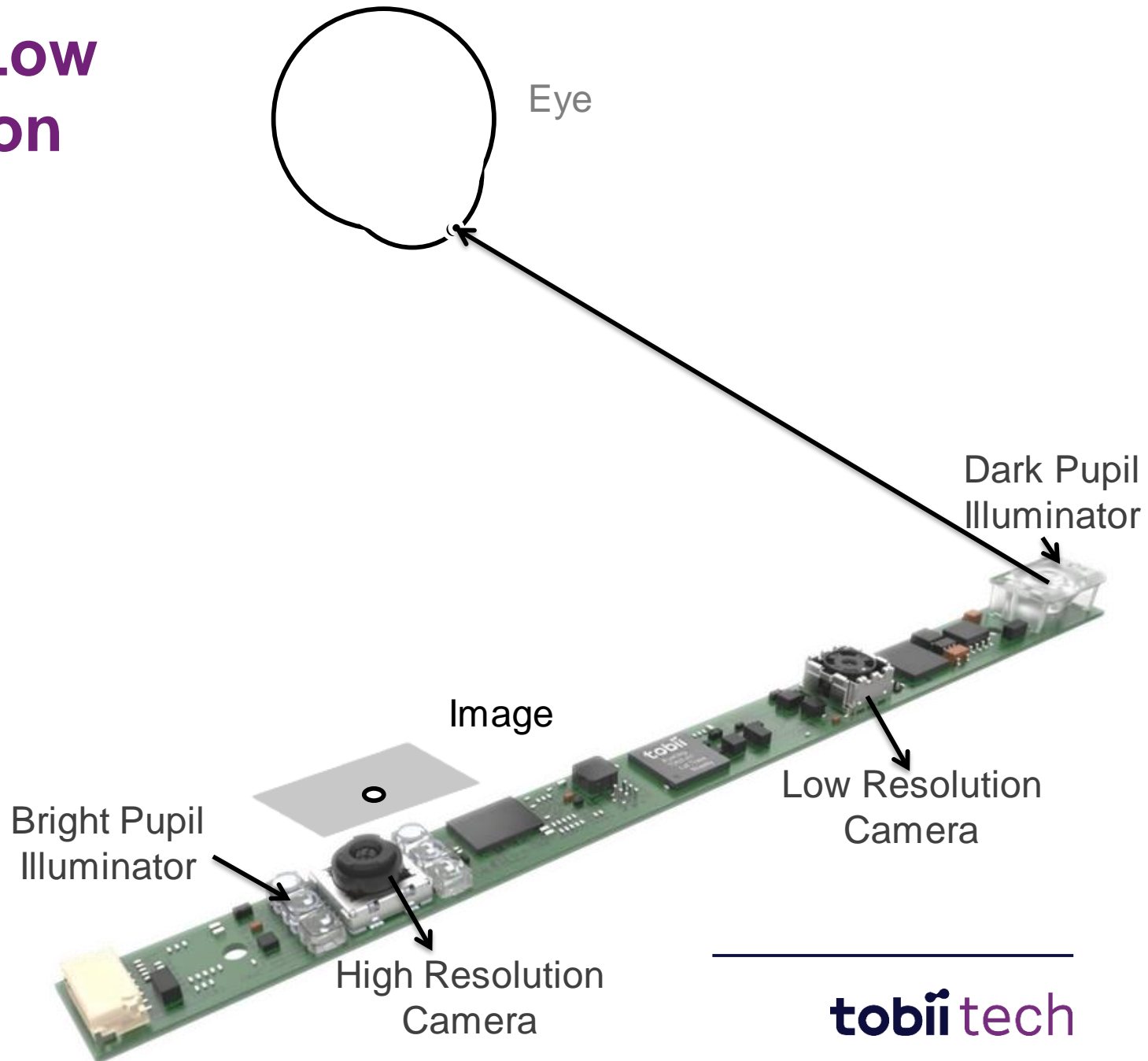
Eye

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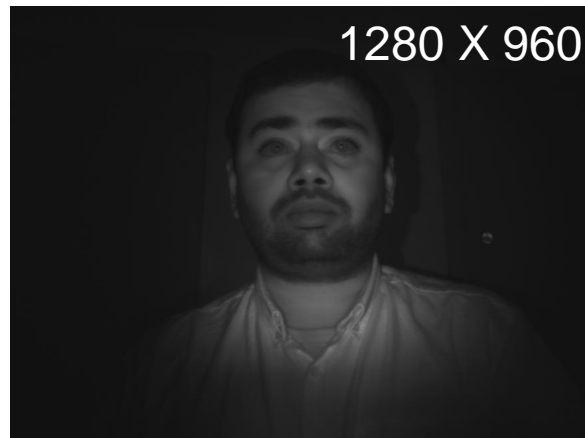
Glint in Low Resolution Image



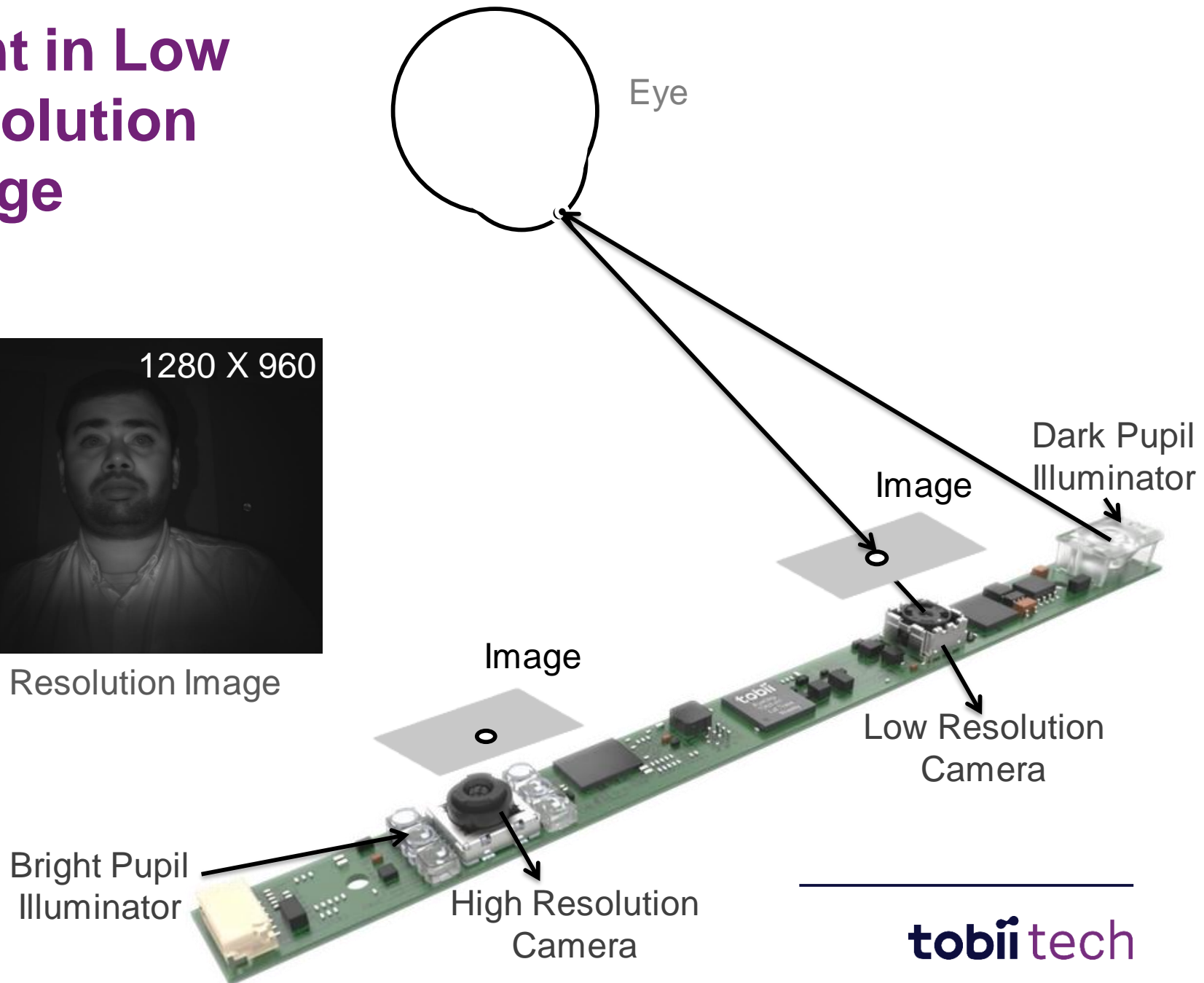
Glint in Low Resolution Image



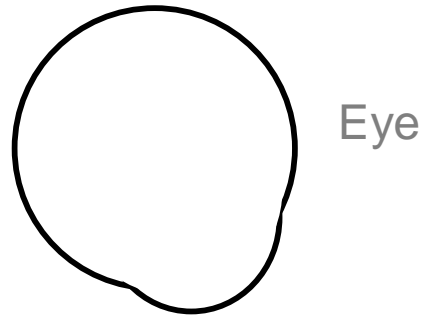
Glint in Low Resolution Image



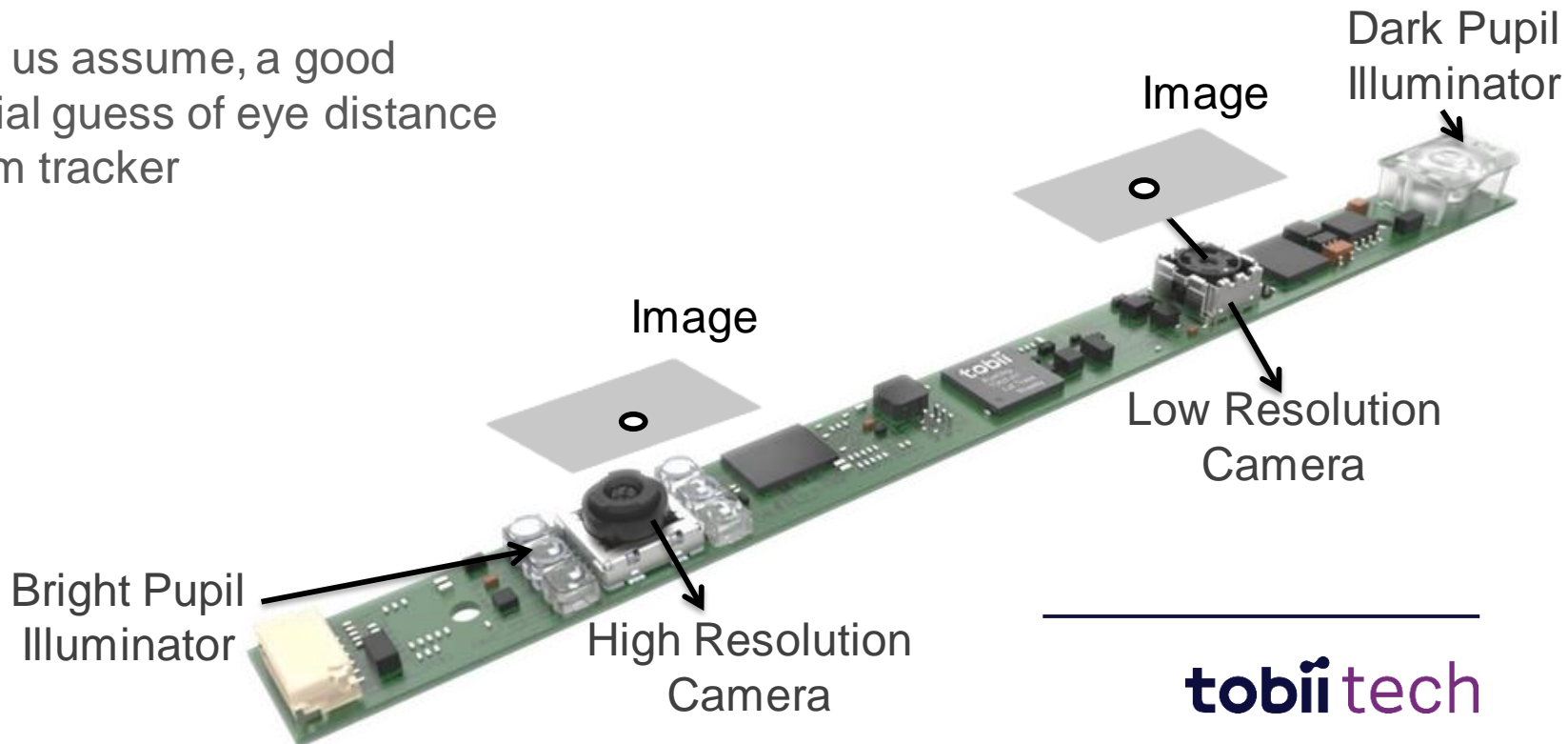
Low Resolution Image



Glint in Low Resolution Image

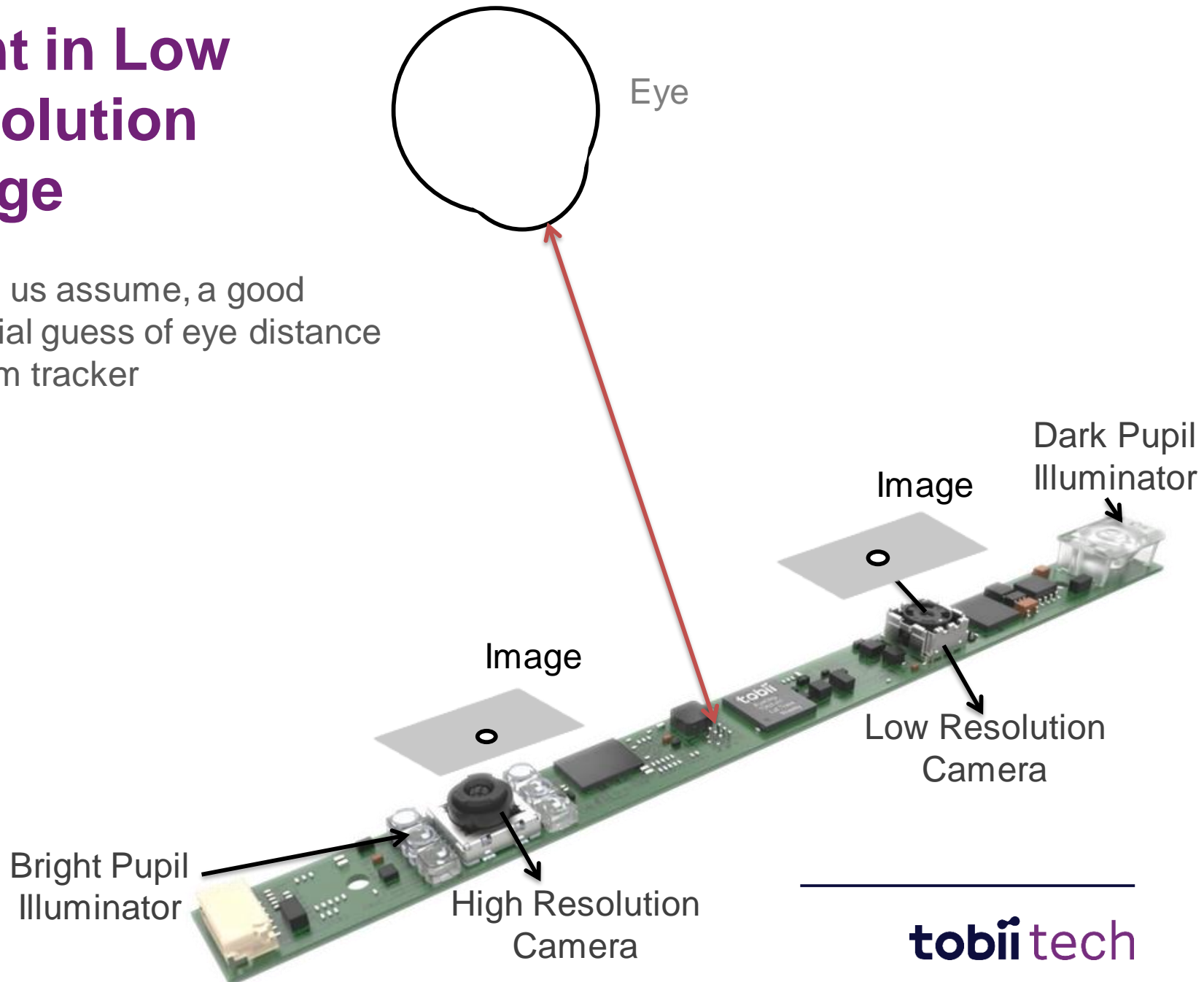


- No eye classification, detection, and tracking in low resolution image
- Let us assume, a good initial guess of eye distance from tracker



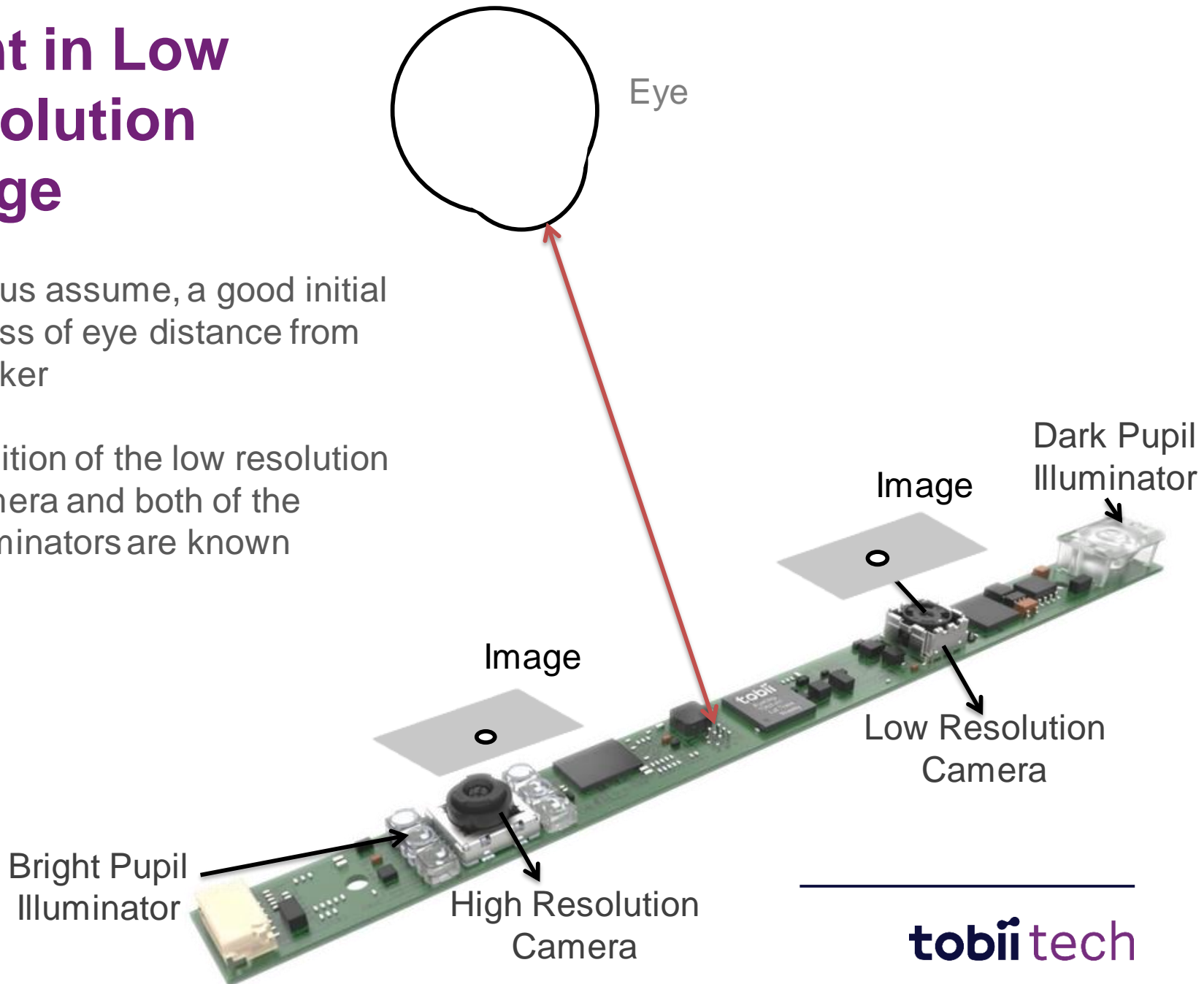
Glint in Low Resolution Image

- Let us assume, a good initial guess of eye distance from tracker



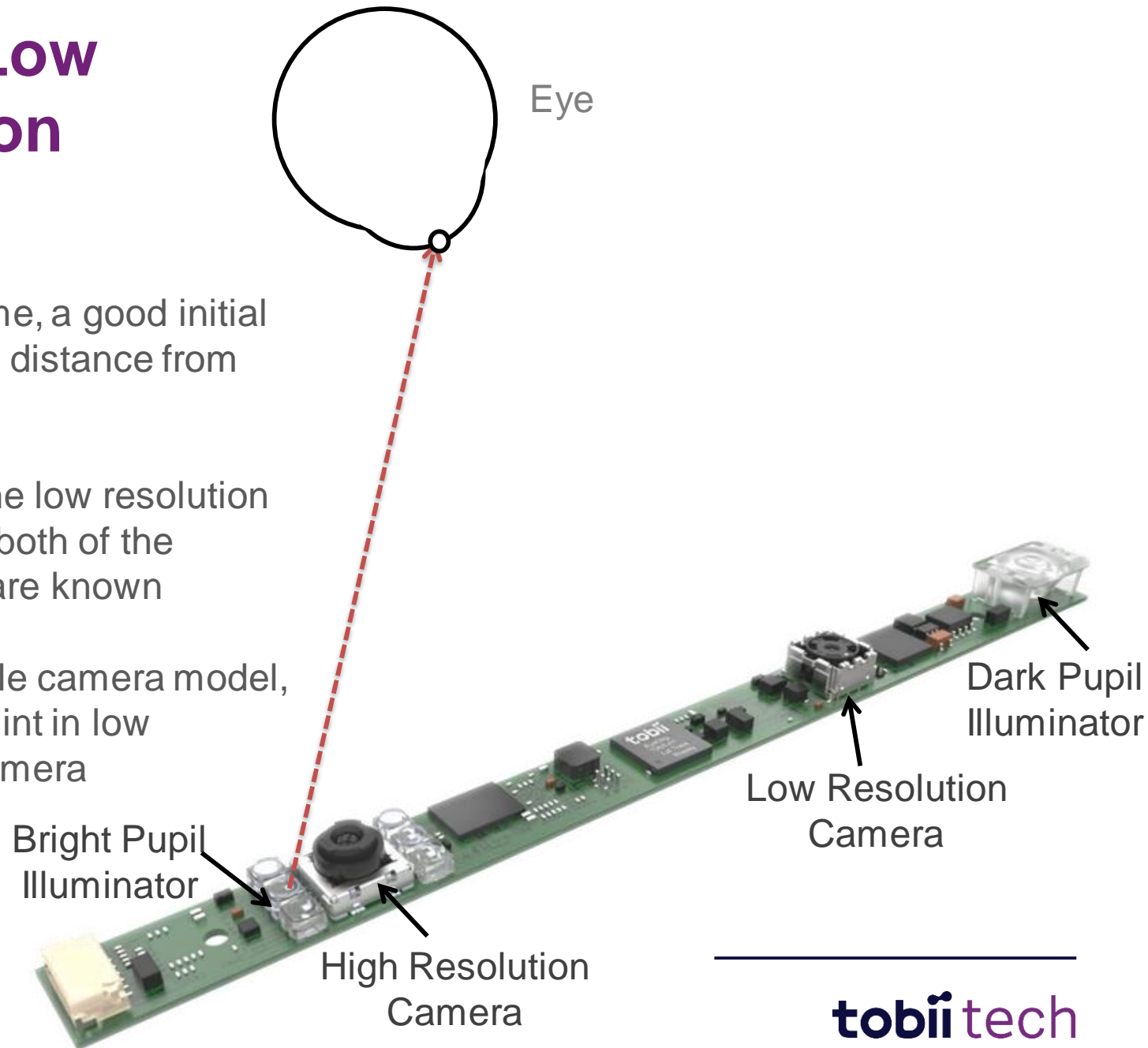
Glint in Low Resolution Image

- Let us assume, a good initial guess of eye distance from tracker
- Position of the low resolution camera and both of the illuminators are known



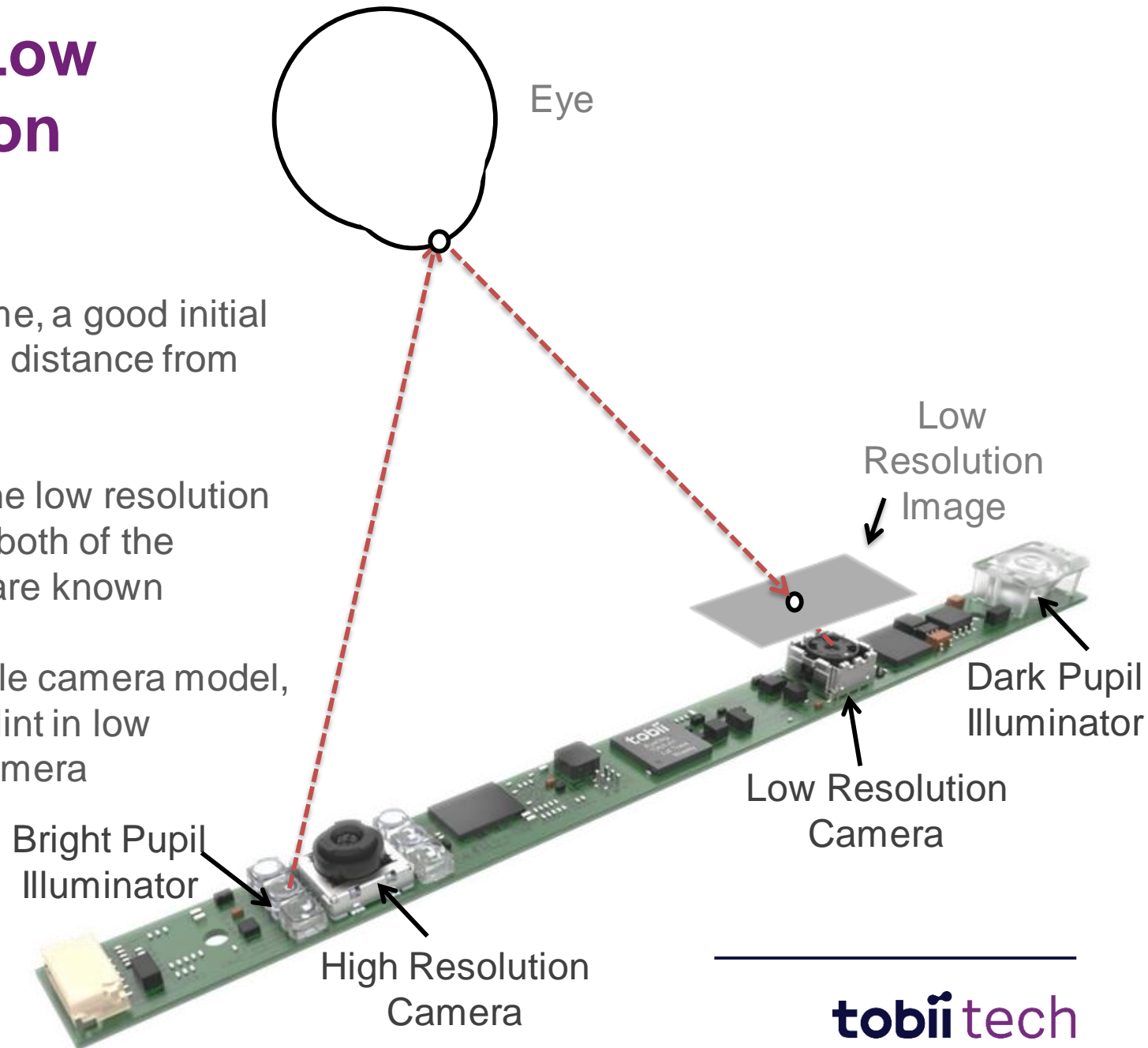
Glint in Low Resolution Image

- Let us assume, a good initial guess of eye distance from tracker
- Position of the low resolution camera and both of the illuminators are known
- Using pin-hole camera model, project the glint in low resolution camera



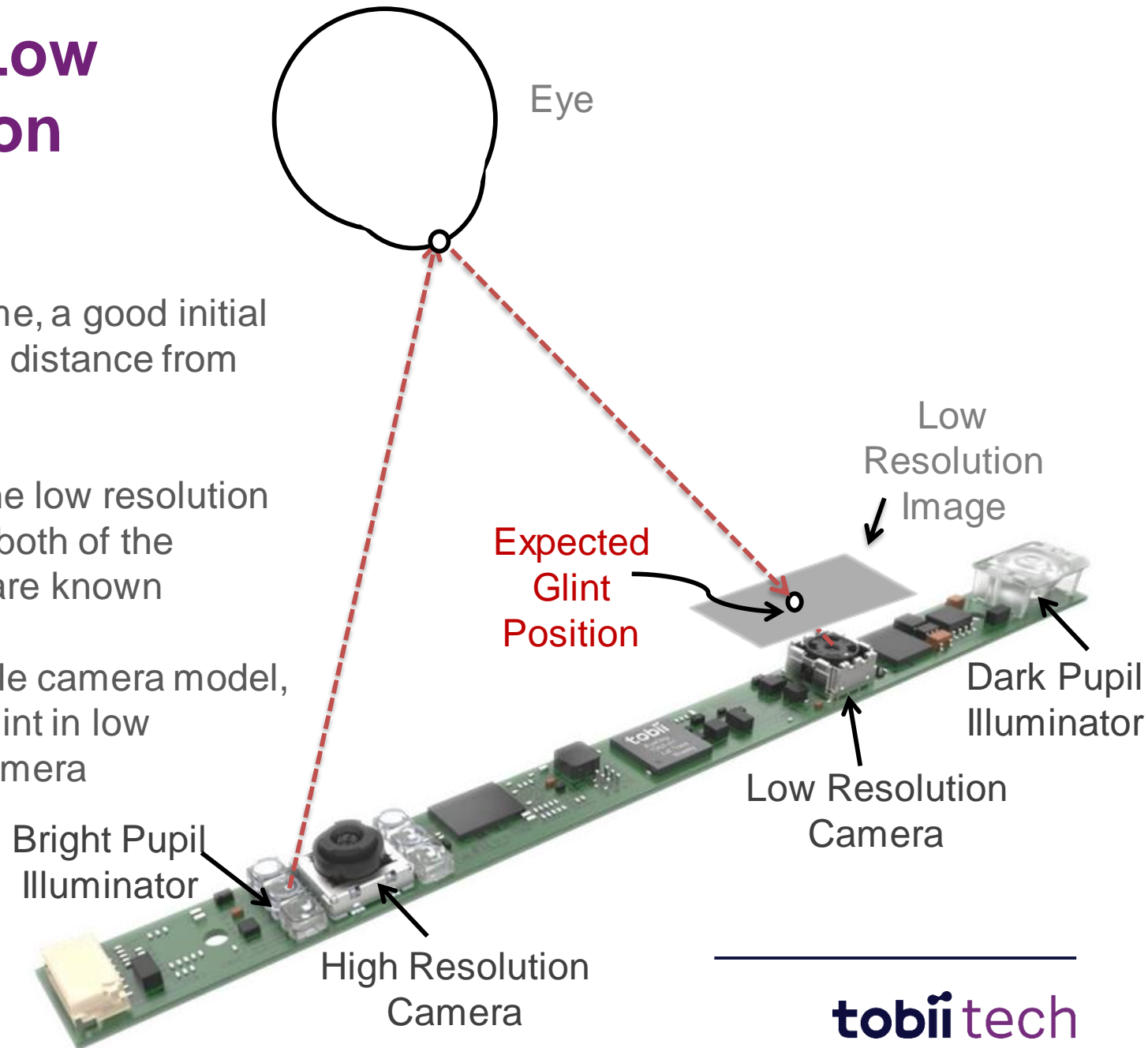
Glint in Low Resolution Image

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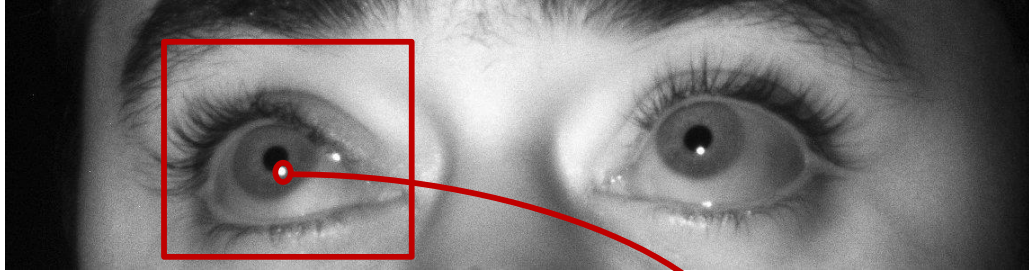
Glint in Low Resolution Image

- Let us assume, a good initial guess of eye distance from tracker
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- Using pin-hole camera model, project the glint in low resolution camera



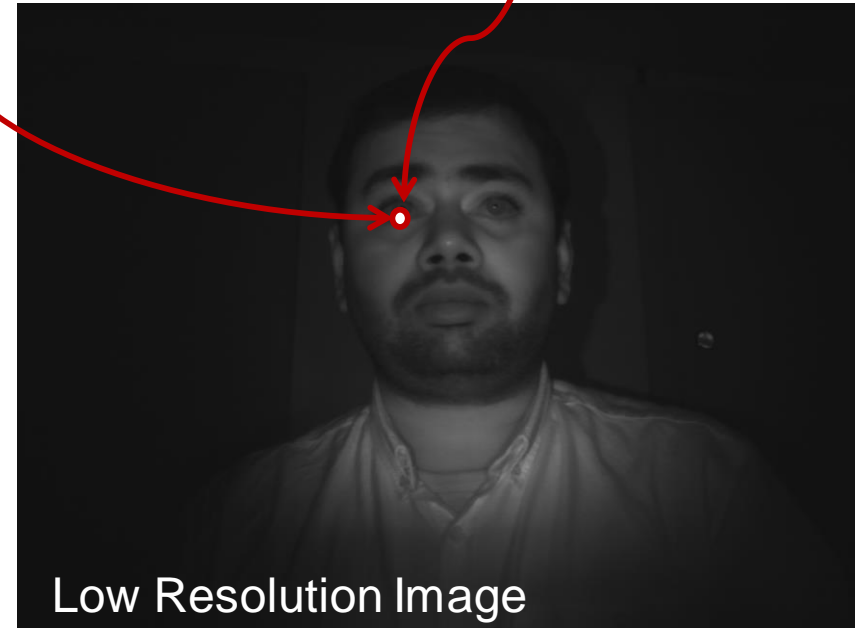
Glint Mapping and Detection

High Resolution ROI Image



- Expected glint position in low resolution image

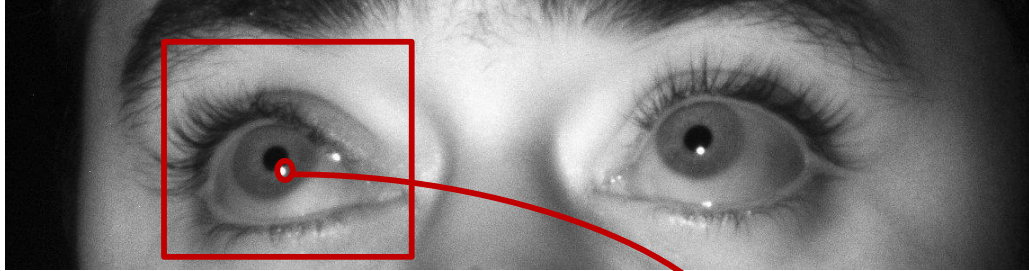
- No eye classification and detection is required in low resolution image



Low Resolution Image

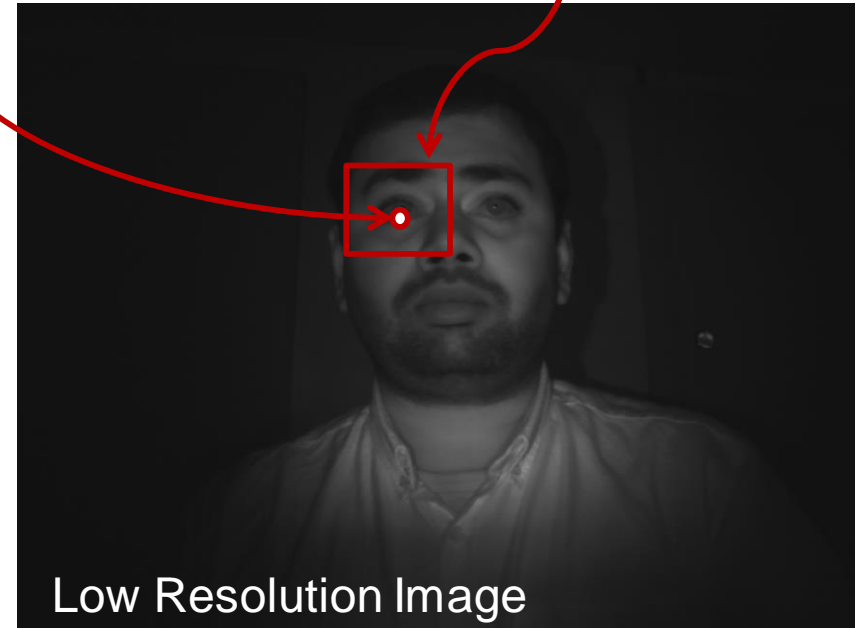
Glint Mapping and Detection

High Resolution ROI Image



- Crop image patch around the expected glint position in low resolution image

- No eye classification and detection is required in low resolution image



Low Resolution Image

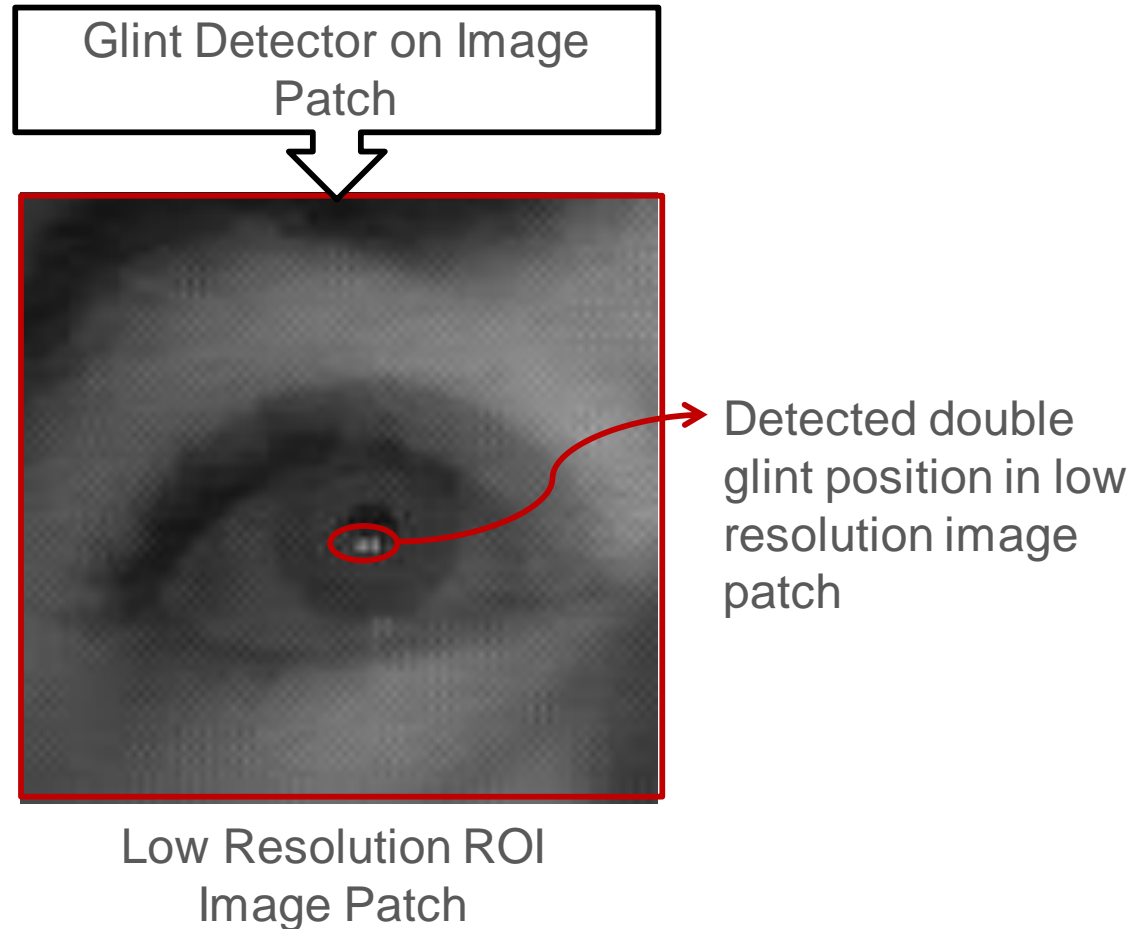
Glint Mapping and Detection

Glint Detector on Image
Patch

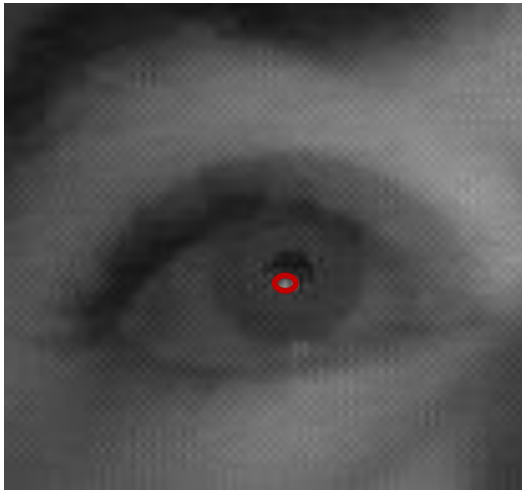


Low Resolution ROI
Image Patch

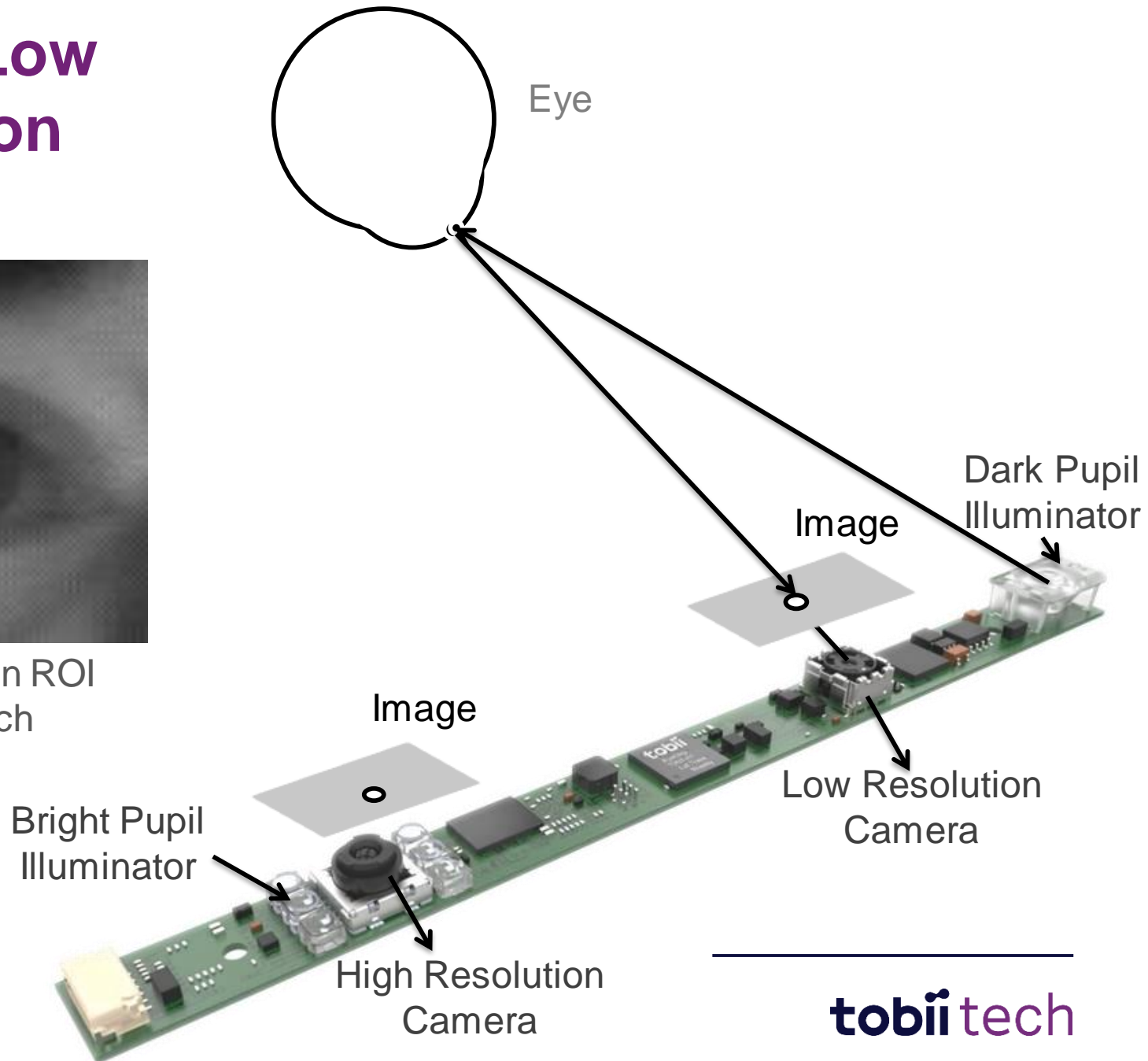
Glint Mapping and Detection



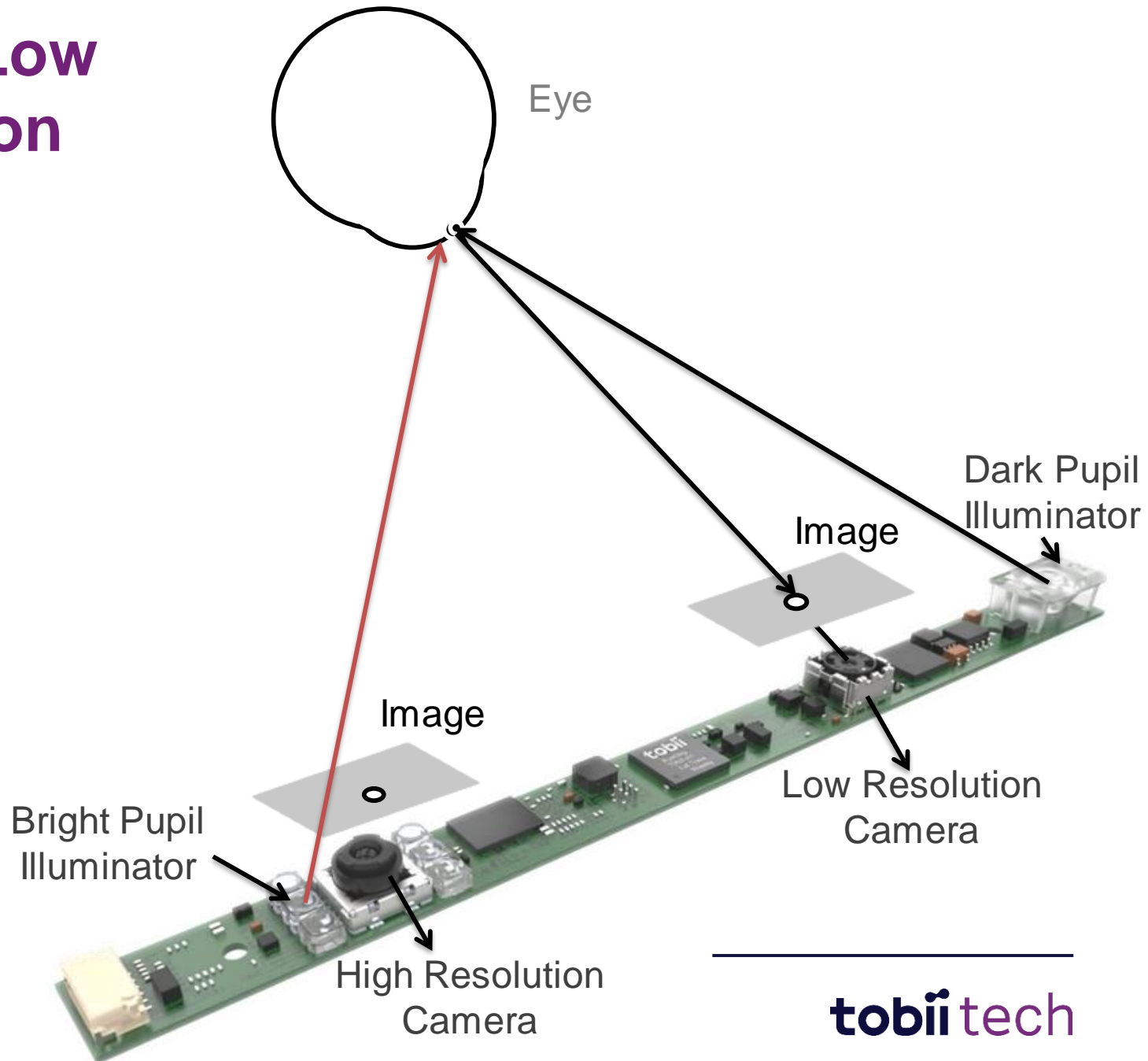
Glint in Low Resolution Image



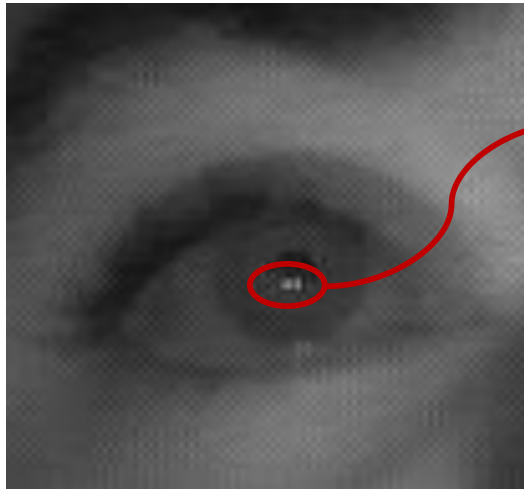
Low Resolution ROI
Image Patch



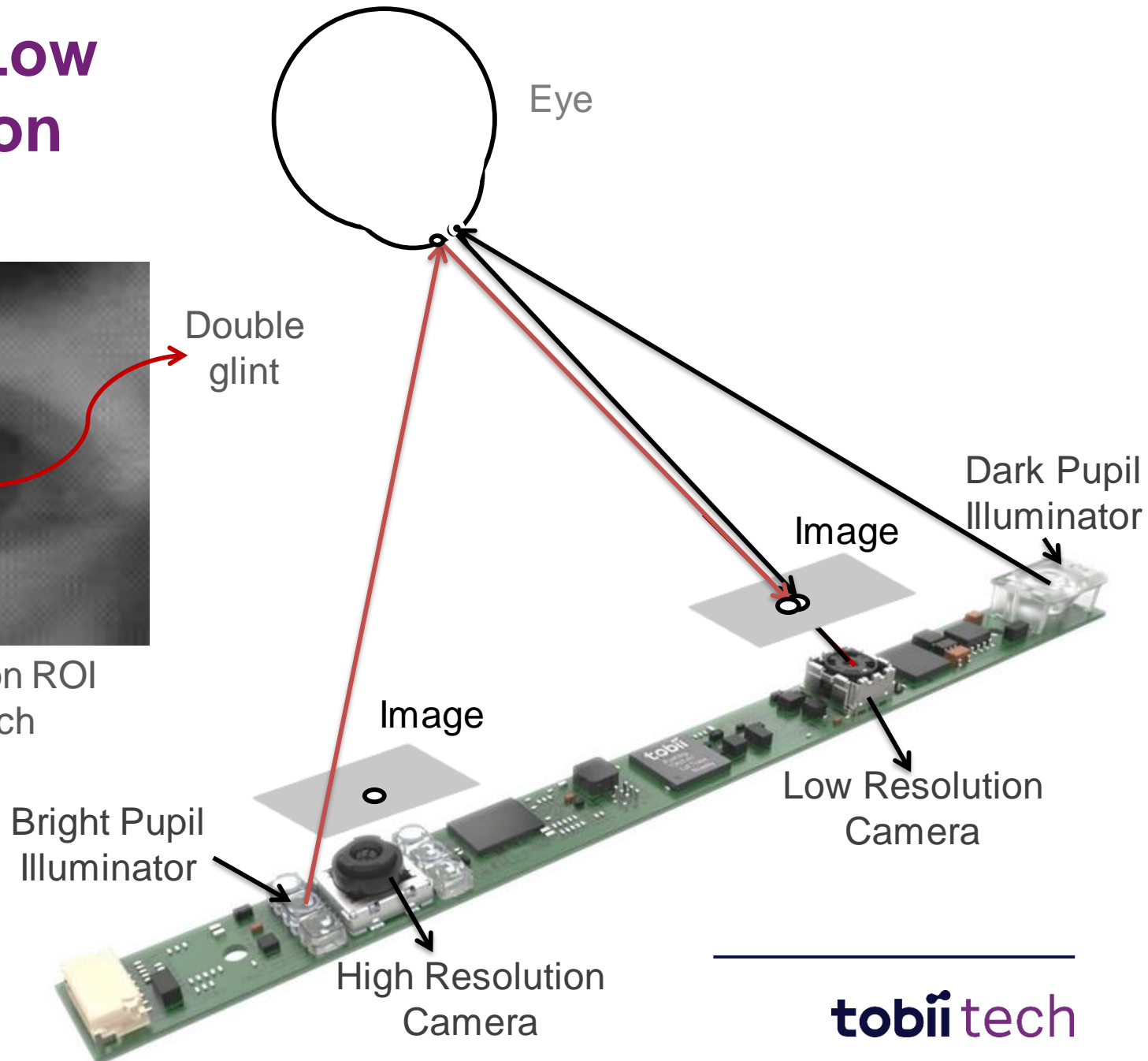
Glint in Low Resolution Image



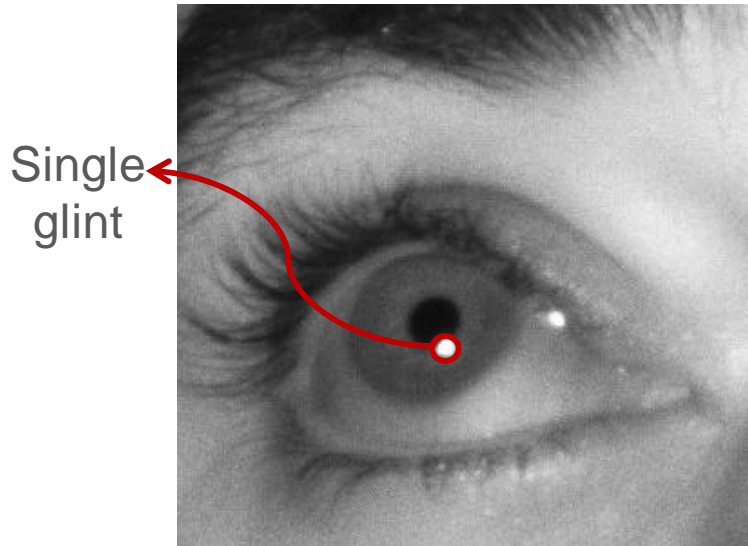
Glint in Low Resolution Image



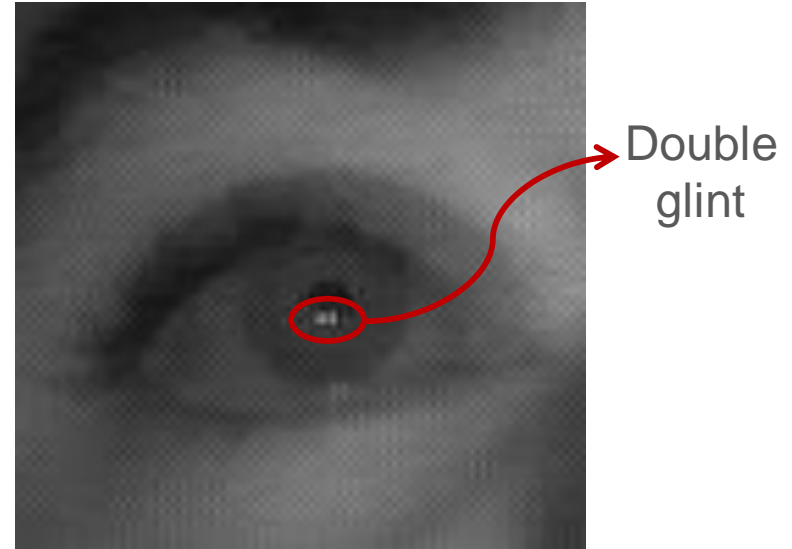
Low Resolution ROI Image Patch



Stereo Glint Pair

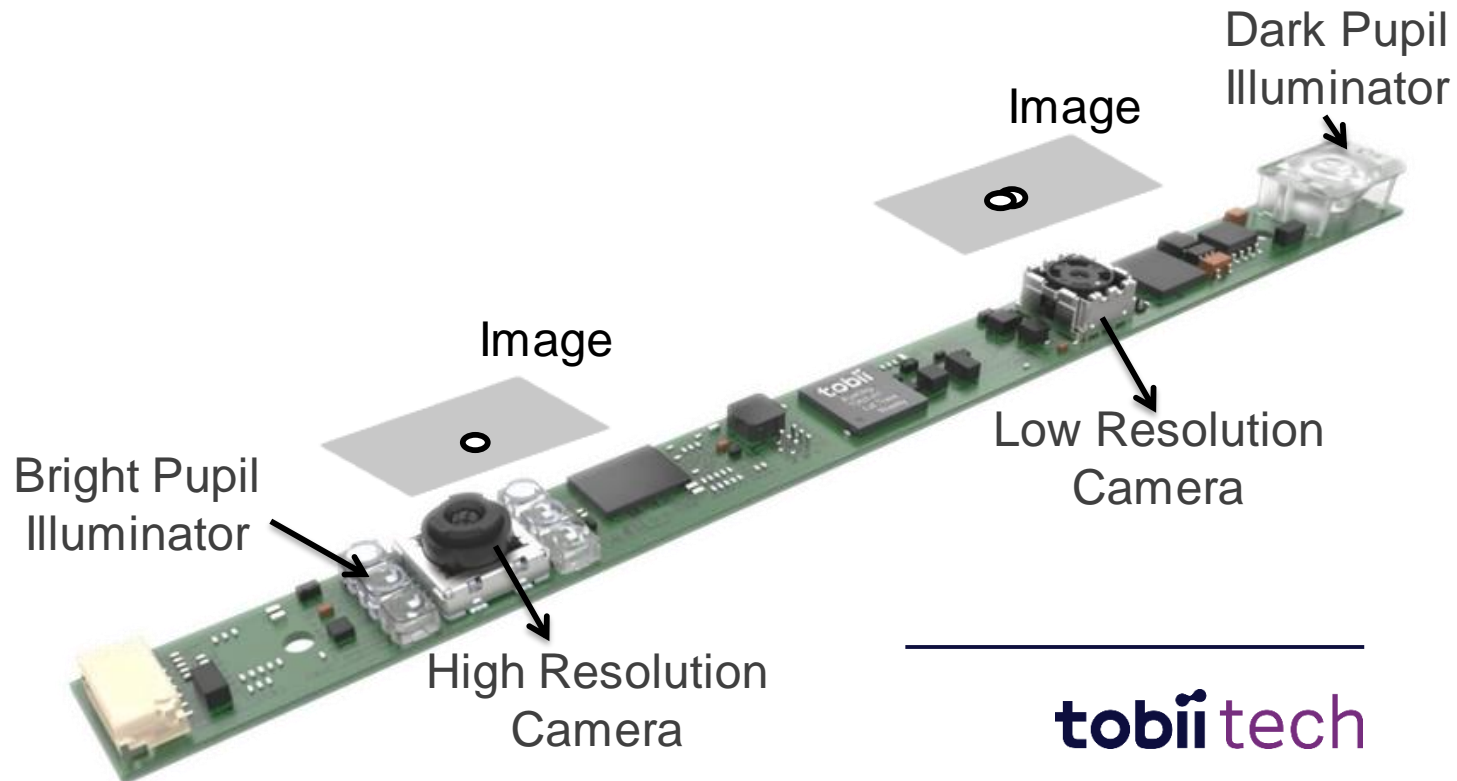
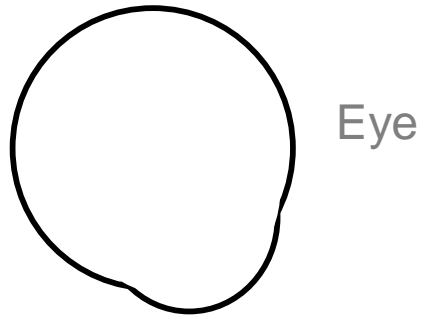


High Resolution ROI
Image Patch

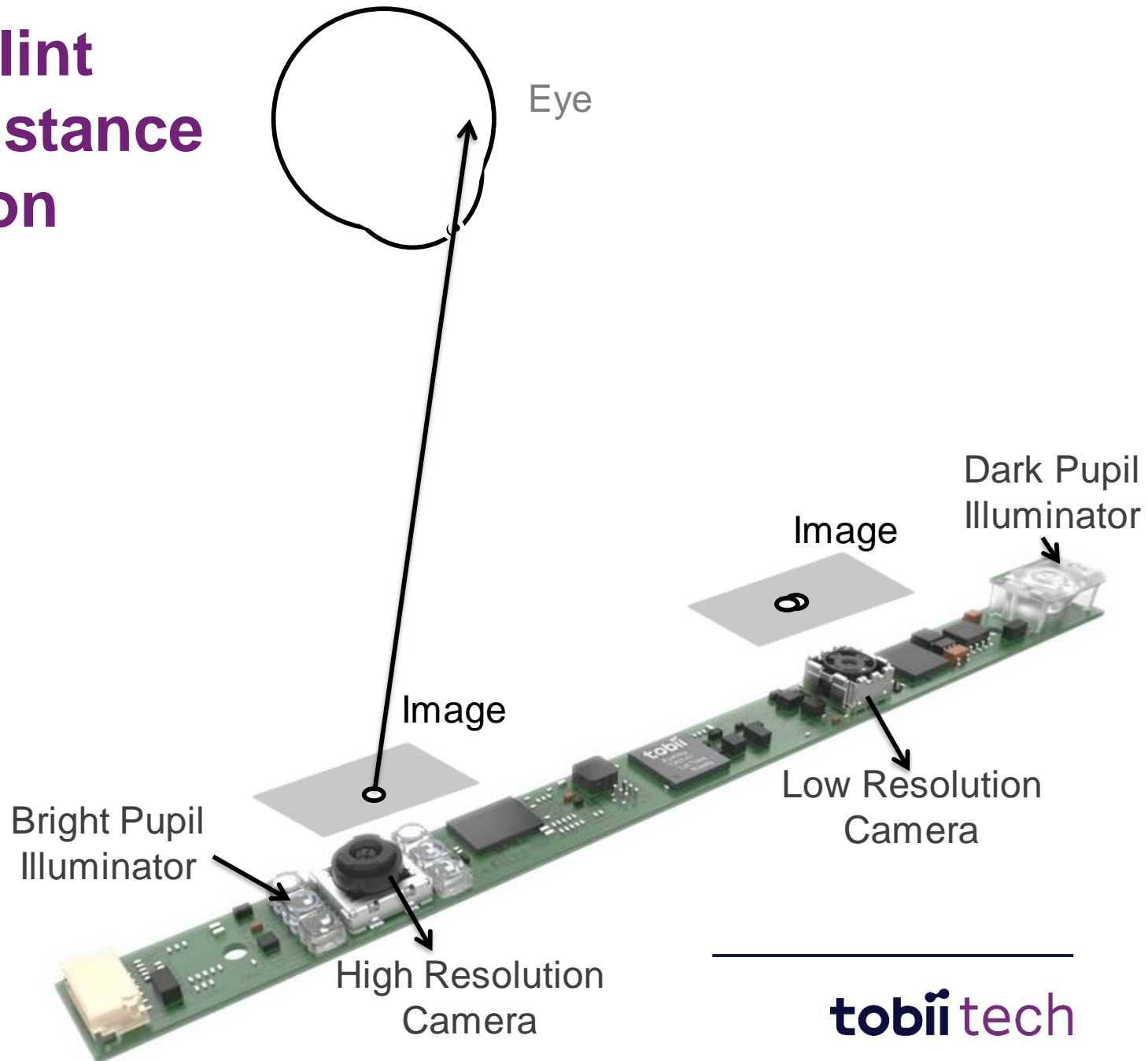


Low Resolution ROI
Image Patch

Stereo Glint Based Distance Estimation

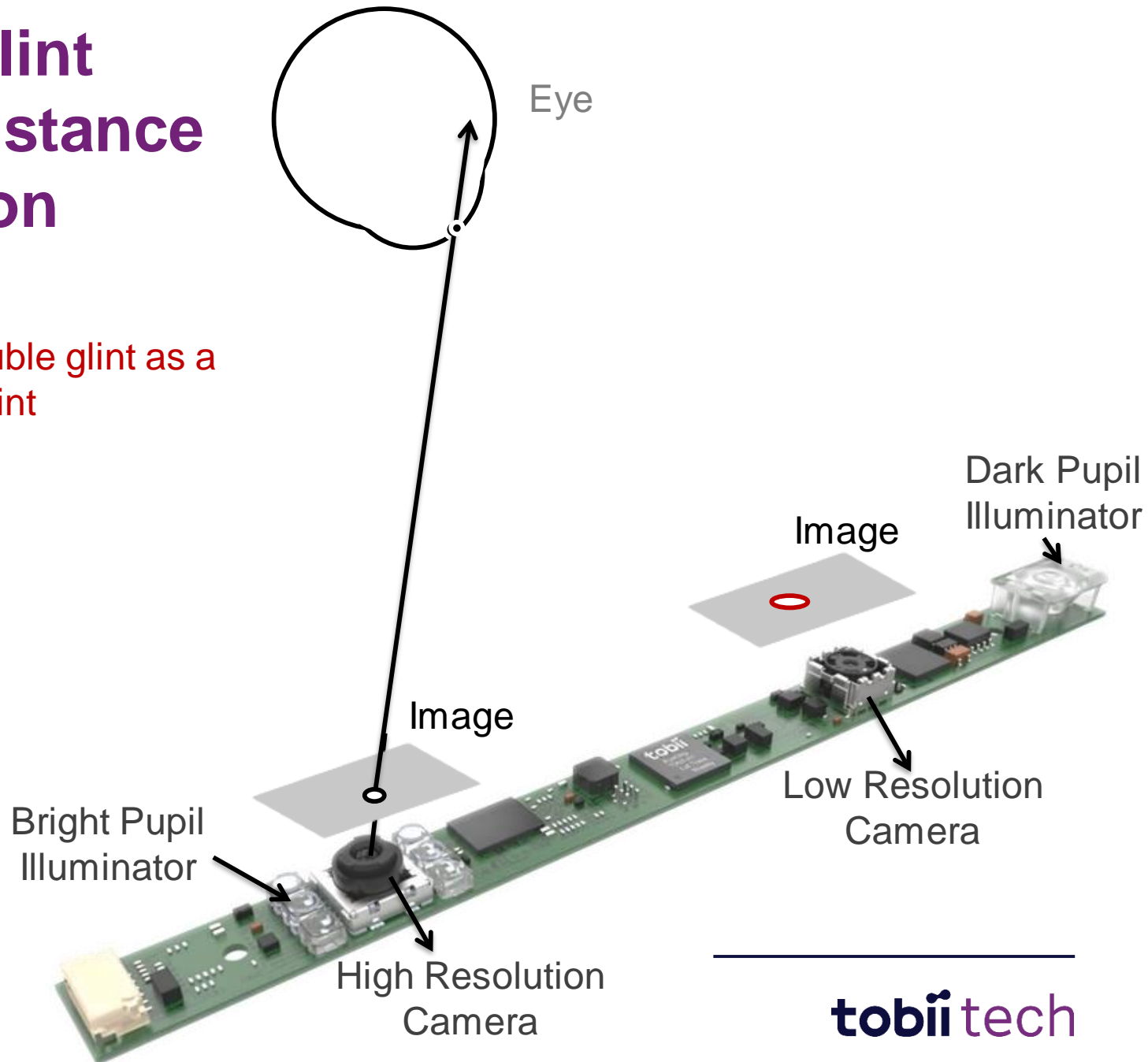


Stereo Glint Based Distance Estimation

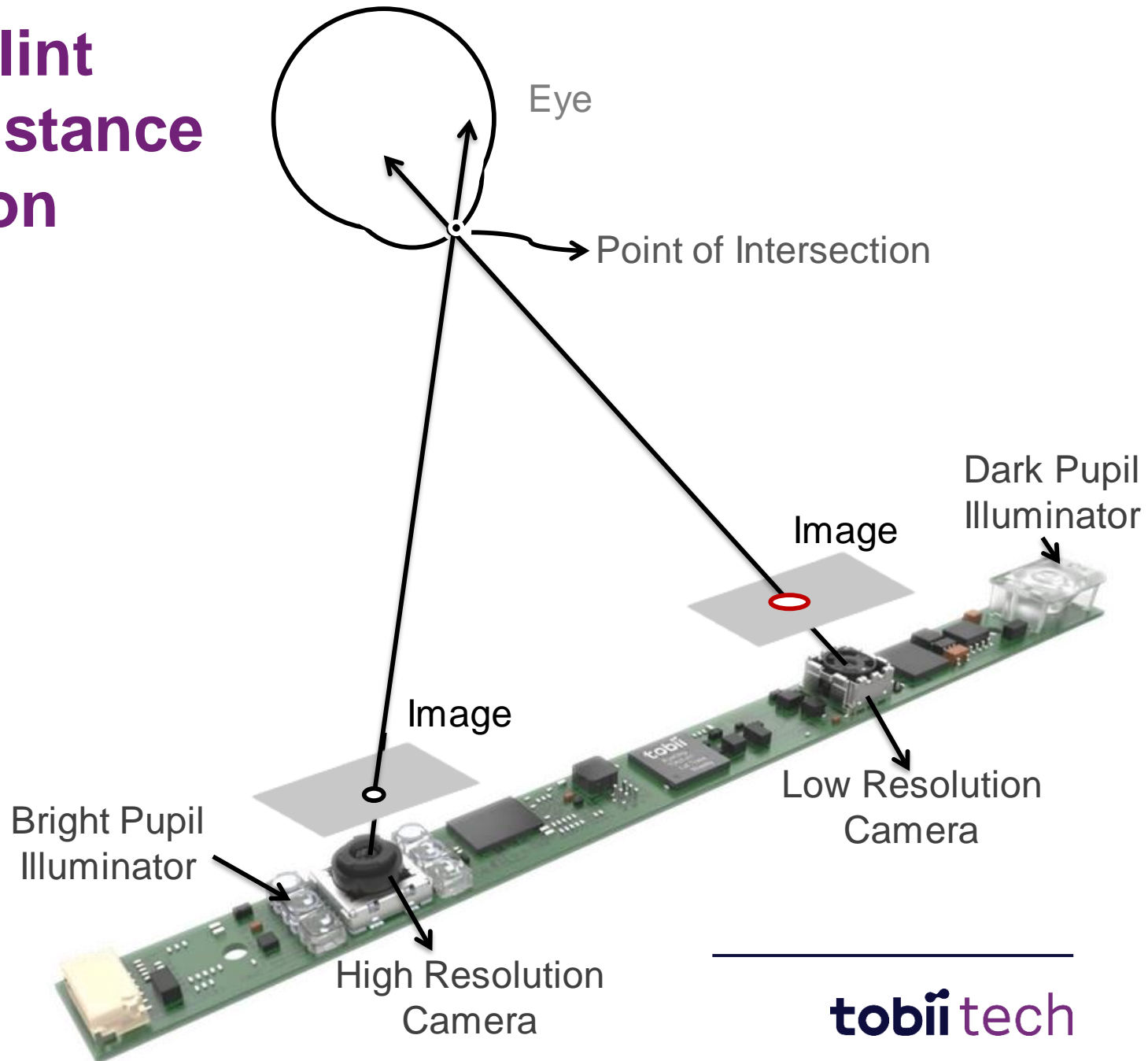


Stereo Glint Based Distance Estimation

- Assume double glint as a big single glint

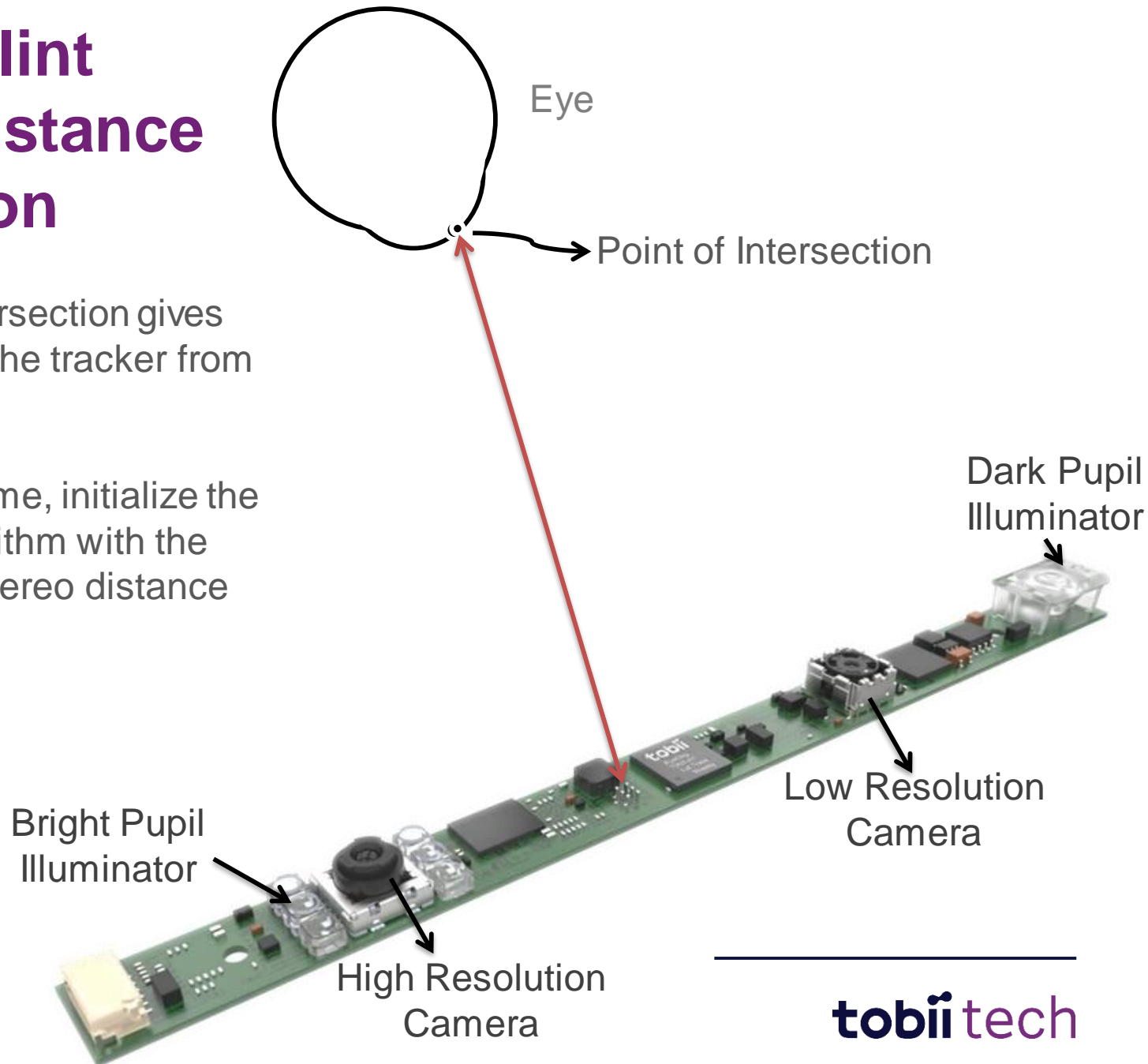


Stereo Glint Based Distance Estimation



Stereo Glint Based Distance Estimation

- Point of intersection gives distance of the tracker from the eye
- For next frame, initialize the stereo algorithm with the estimated stereo distance





Benefits, Challenges, and Beyond 15

Benefits

- Stable distance estimation when compare to temporal glints based position information
- Only one glint is required to estimate distance information
 - Improve gaze at large gaze angles
 - Distance information is even when temporal glint based distance estimation fails
 - Help to improve temporal glints based distance estimates
- Improves gaze accuracy and precision with estimated cornea radius, instead of a fixed default value

Challenges

- Unsynchronized stereo system
 - Acquisition time will be different for the low and high resolution images
 - Double glints in low resolution images
- Asymmetric stereo system
 - Detected glint position in low resolution will have limited accuracy and precision
- Highly sensitive to camera calibration parameters

Develop Beyond 15

- Online self-calibration for the stereo camera rig



Thank You