New fashion for an old paradigm: efficient, no moving part, ingot-like WFSs for LGS

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INAF
Astronomical Observatory of Padova
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LABORATORIO NAZIONALE
ADONI
OTTICA ADATTIVA

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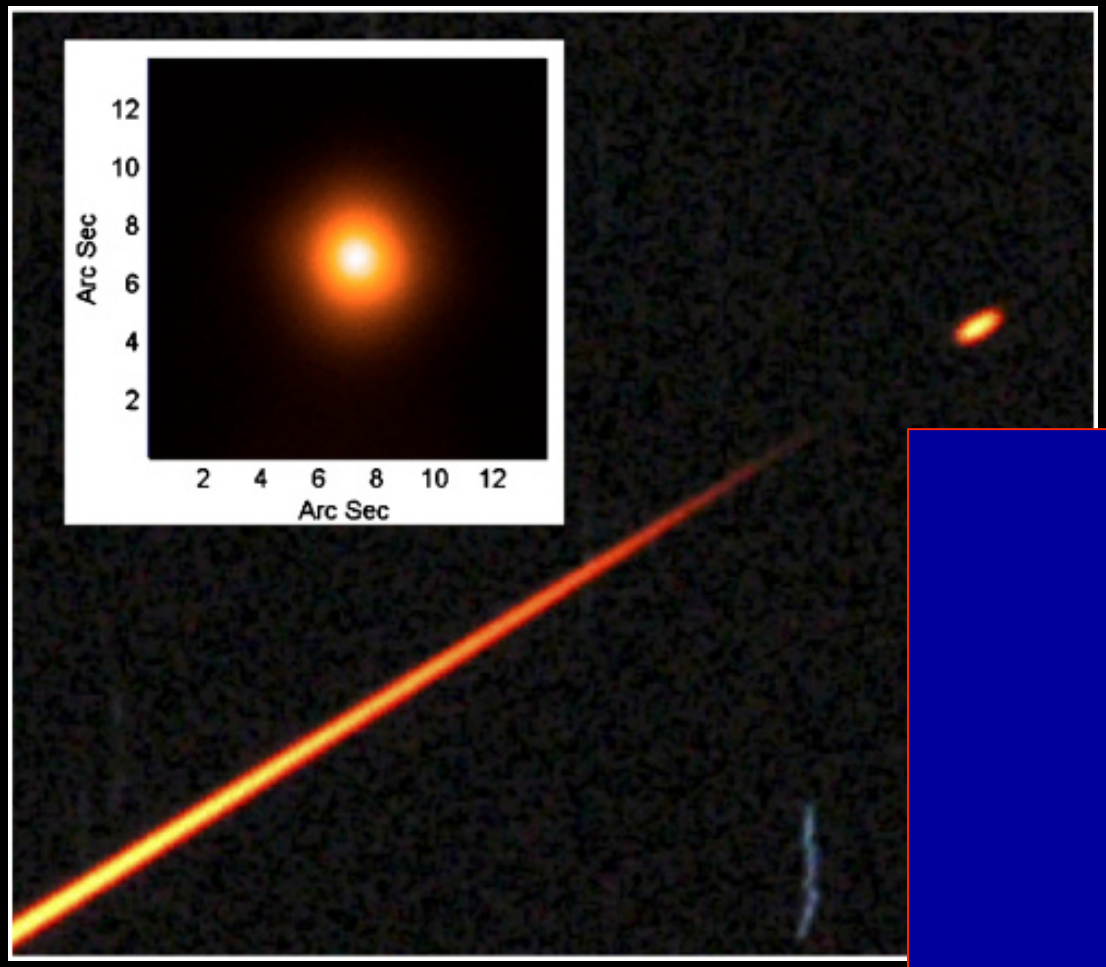
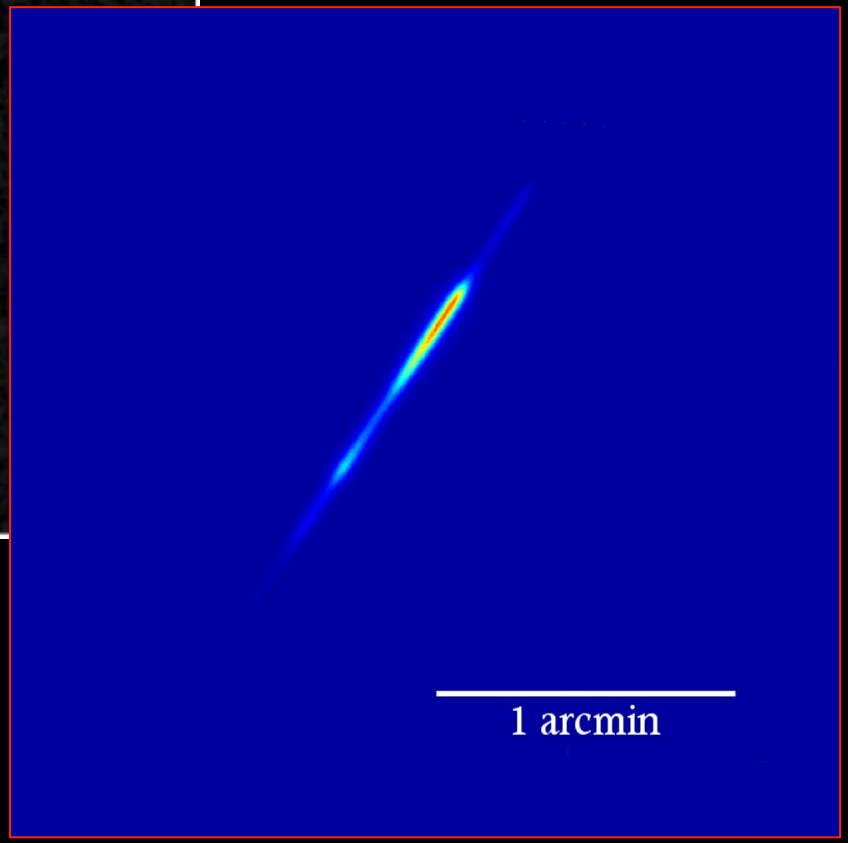
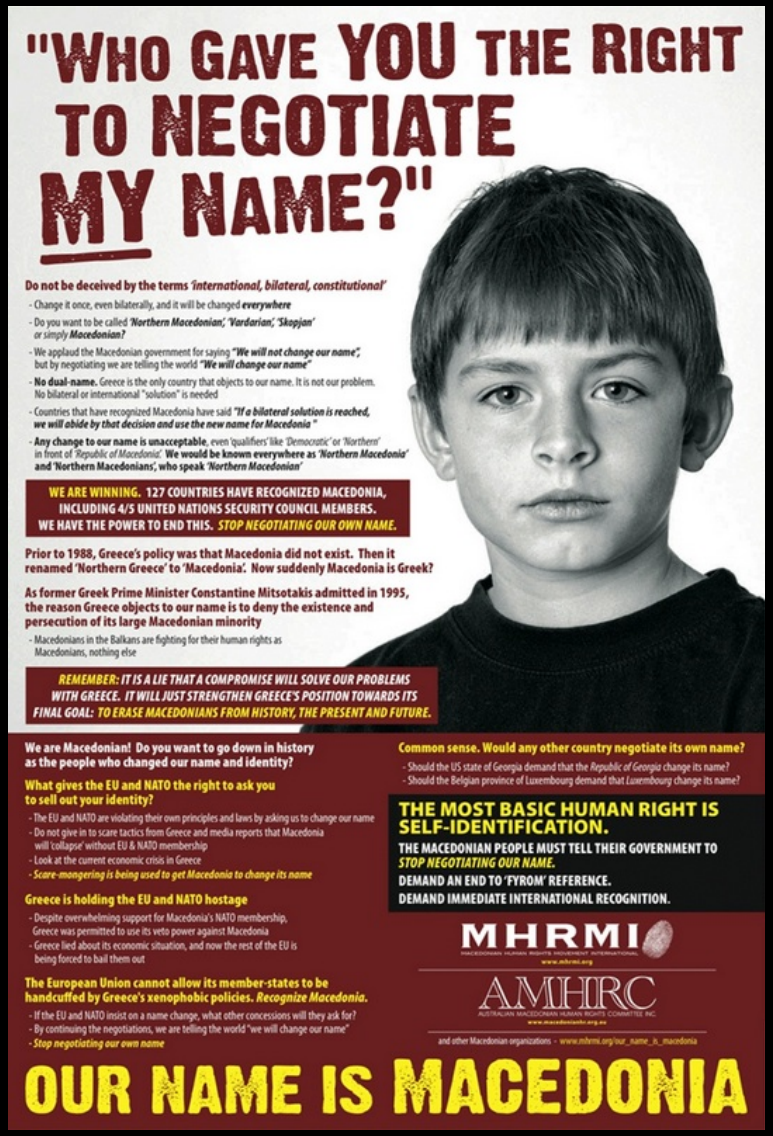




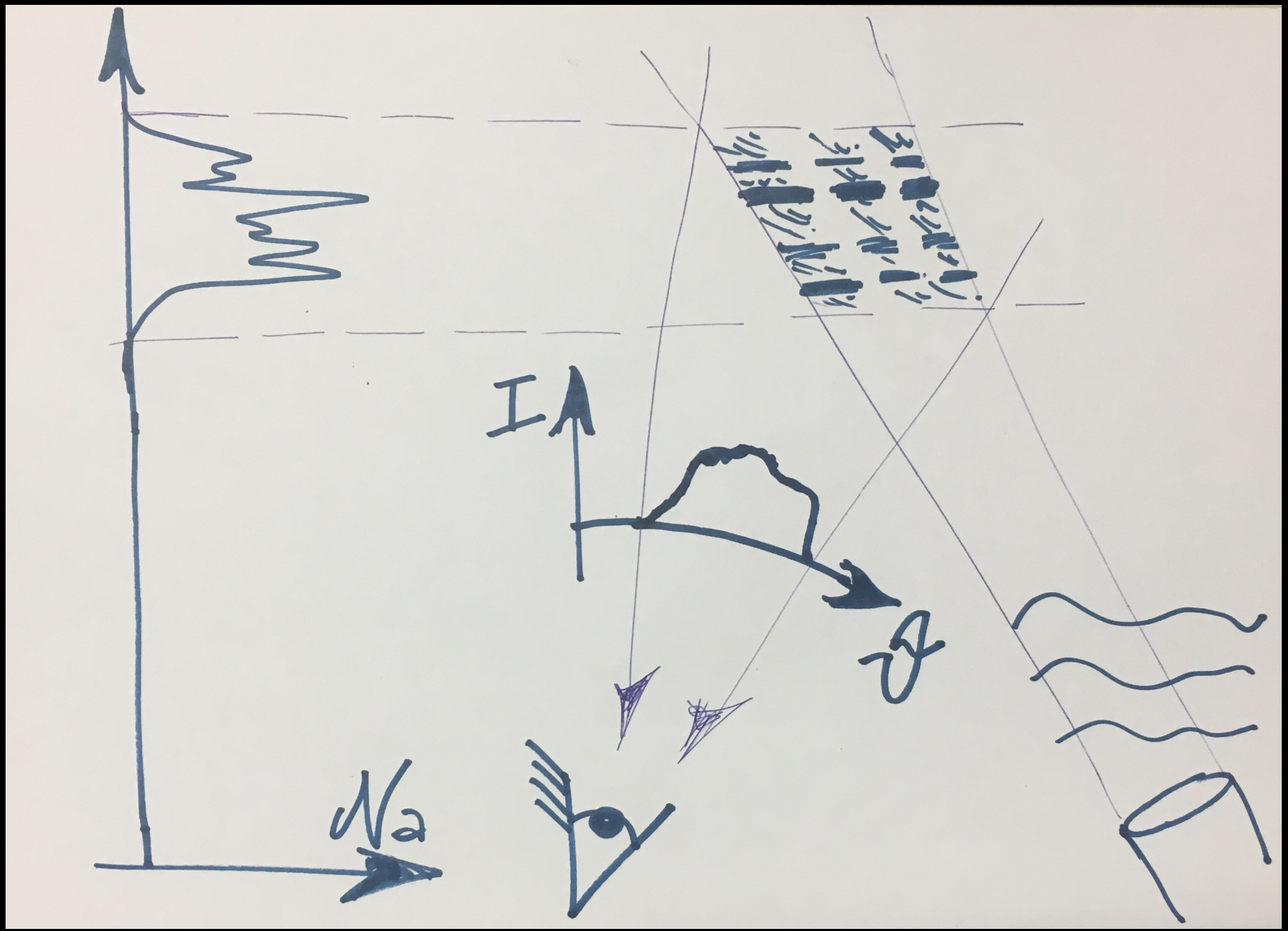
Laser Guide Stars are not “stars”

Names ***are*** important…!!!



LGSs…

- LGS is not a point source
- It is a “cigar in the sky” (LGC…???)
- Speckles pattern can develop if projector larger than Fried parameter
- Different point of the LGS focus at different planes
- Basically speckles pattern get smeared
- Structure in the LGS because of (unpredictable) density variations of the Sodium column is smeared out as well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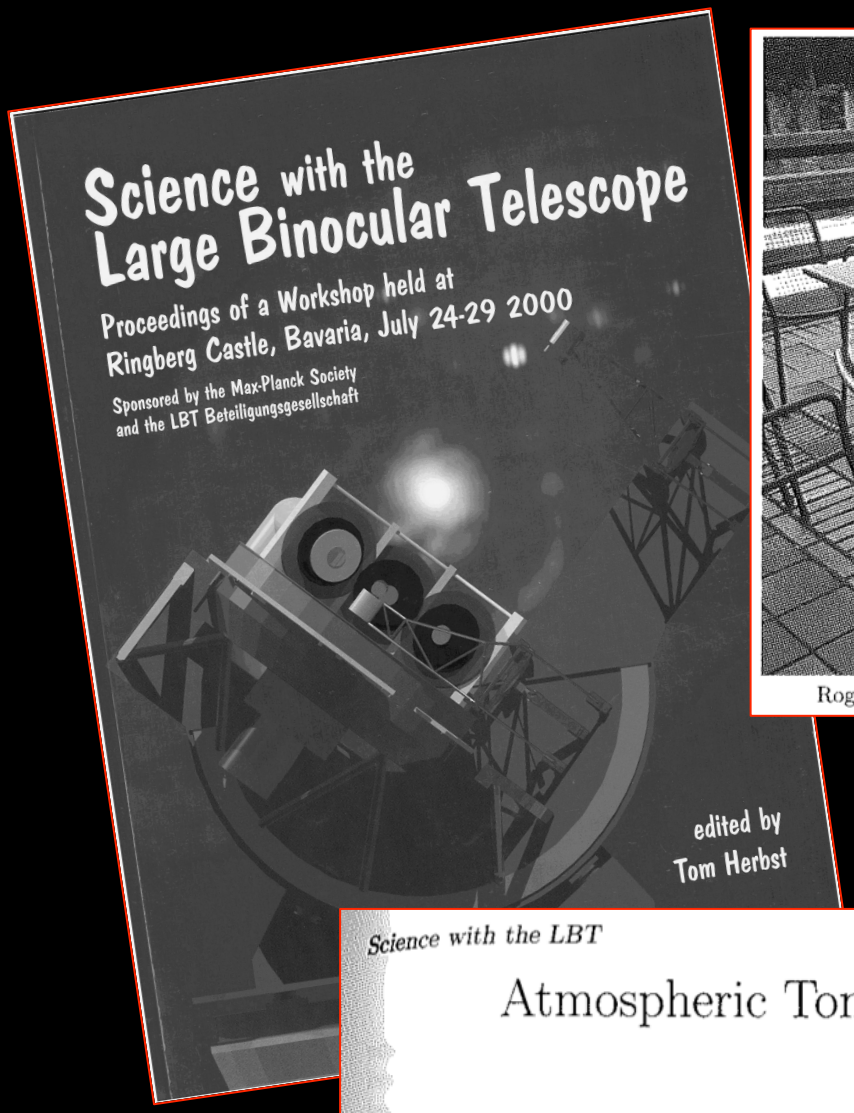
Are we looking to the future or to the past…???

NGS

NGS

LGS

BLAST FROM THE PAST



Roger Angel, Roberto Ragazzoni, and Piero Salinari hatching new ideas on the sun deck

Atmospheric Tomography with Multiple Lasers

R. Ragazzoni[a]

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Further author information: (Send correspondence to R. Ragazzoni)
E-mail: ragazzoni@pd.astro.it

LGS WFSensing…

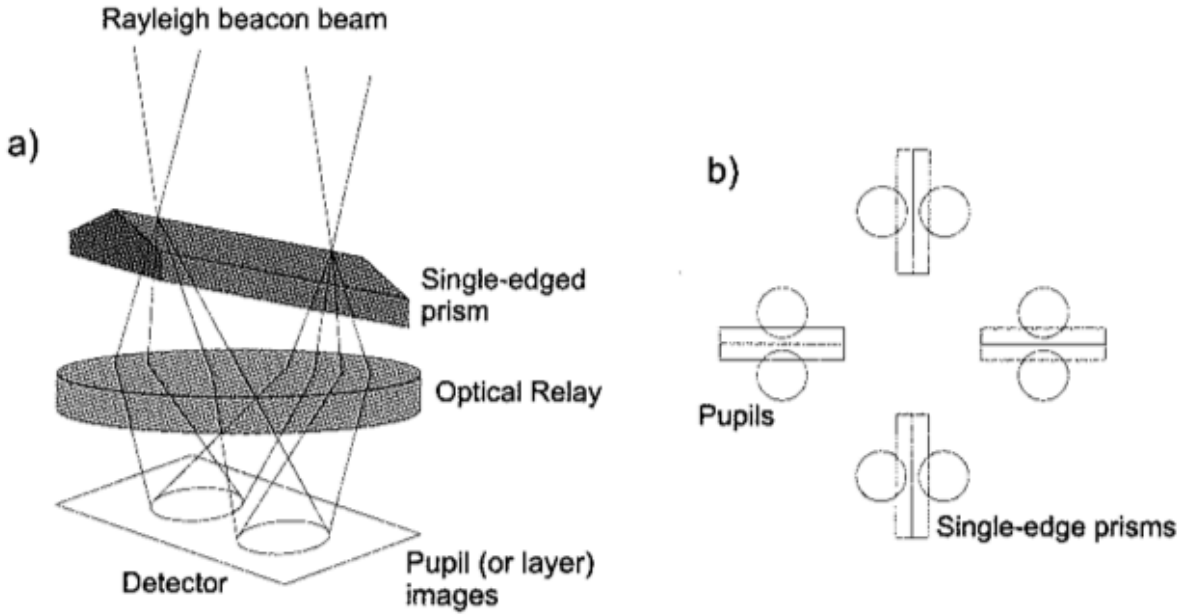

Figure 1. If a LGS is launched aside of the main mirror its apparent position on the focal plane will change and, simultaneously the minimum waist position will move. *a)*: One can place a roof–prism whose edge is aligned with such a continuous line. Provided the optical relay re–image the pupil of the telescope in this way one can, by the normalized difference of illumination on the two pupils images, retrieve the wavefront derivative along a given direction. *b)*: Using four LGSs fired by four equidistant positions around the main telescope and using the proper arrangement of such roof prism one can determine the derivative of the wavefront along two orthogonal direction.

Mon. Not. R. Astron. Soc. **368,** 1796–1802 (2006) doi:10.1111/j.1365-2966.2006.10254.x

Pseudo-infinite guide stars for multi-conjugated adaptive optics on extremely large telescopes

Roberto Ragazzoni,[1]★ Stephan Kellner,[2]★ Wolfgang Gaessler,[2] Emiliano Diolaiti[3] and Jacopo Farinato[1]

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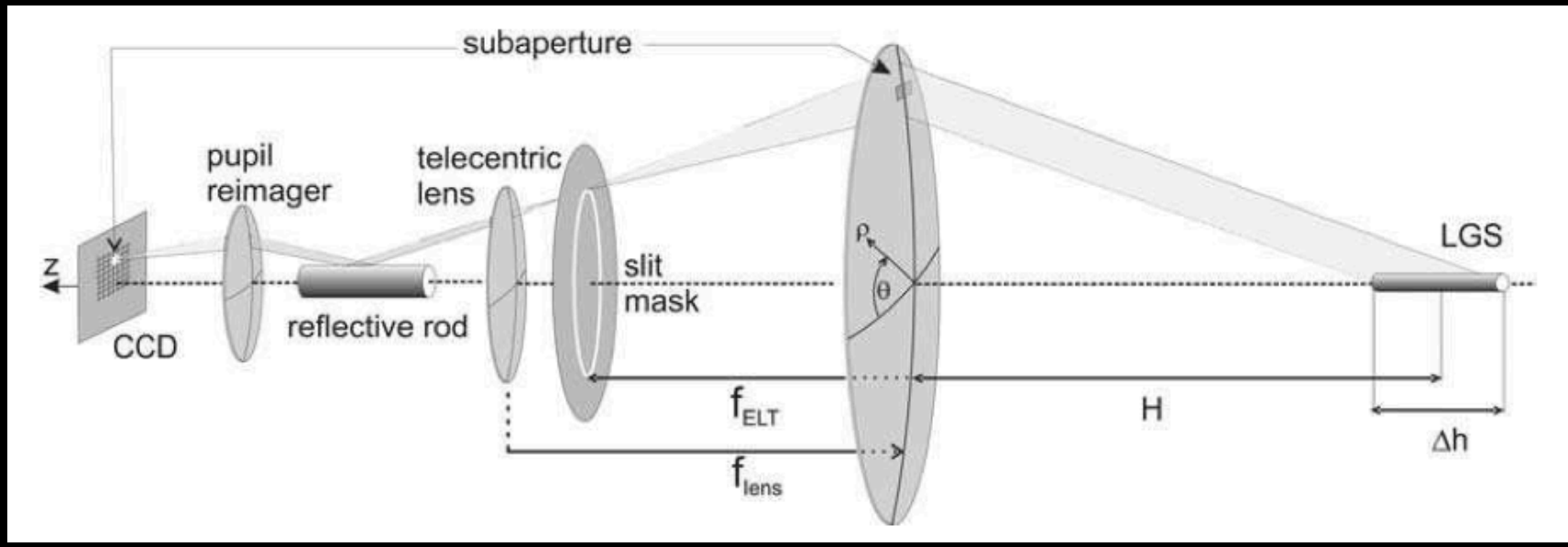
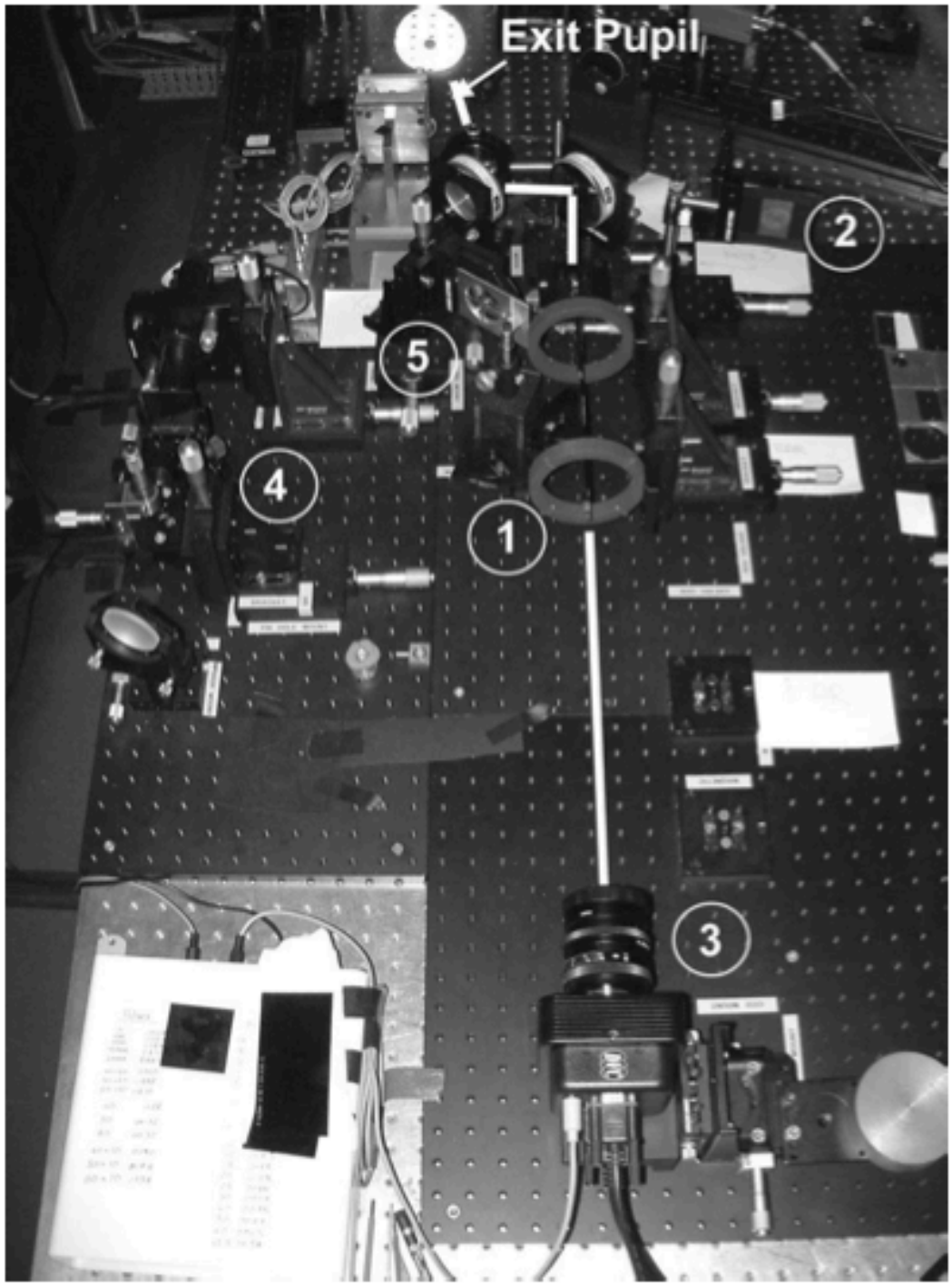
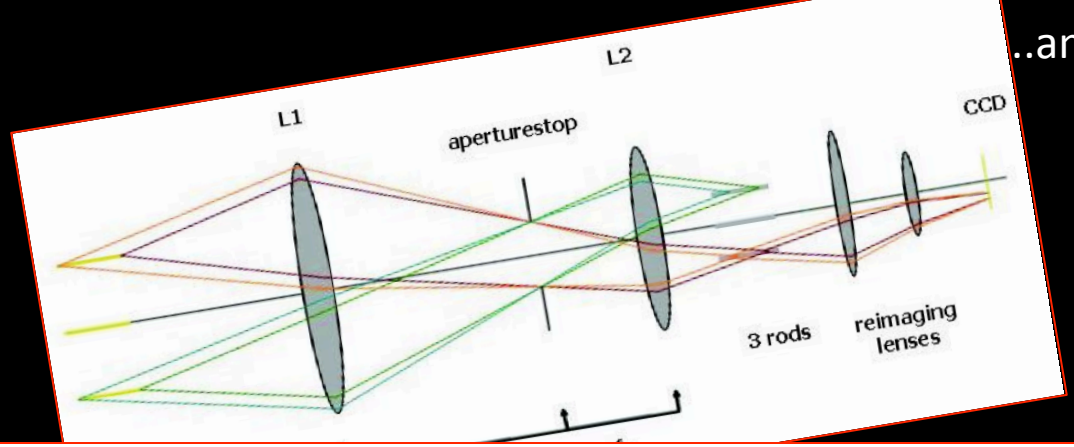
[2]*Max-Planck-Institut für Astronomie, Koenigstuhl 17, D-69117 Heidelberg, Germany*
[3]*INAF – Osservatorio Astronomico di Bologna, via Ranzani 1, I-40127 Bologna, Italy*

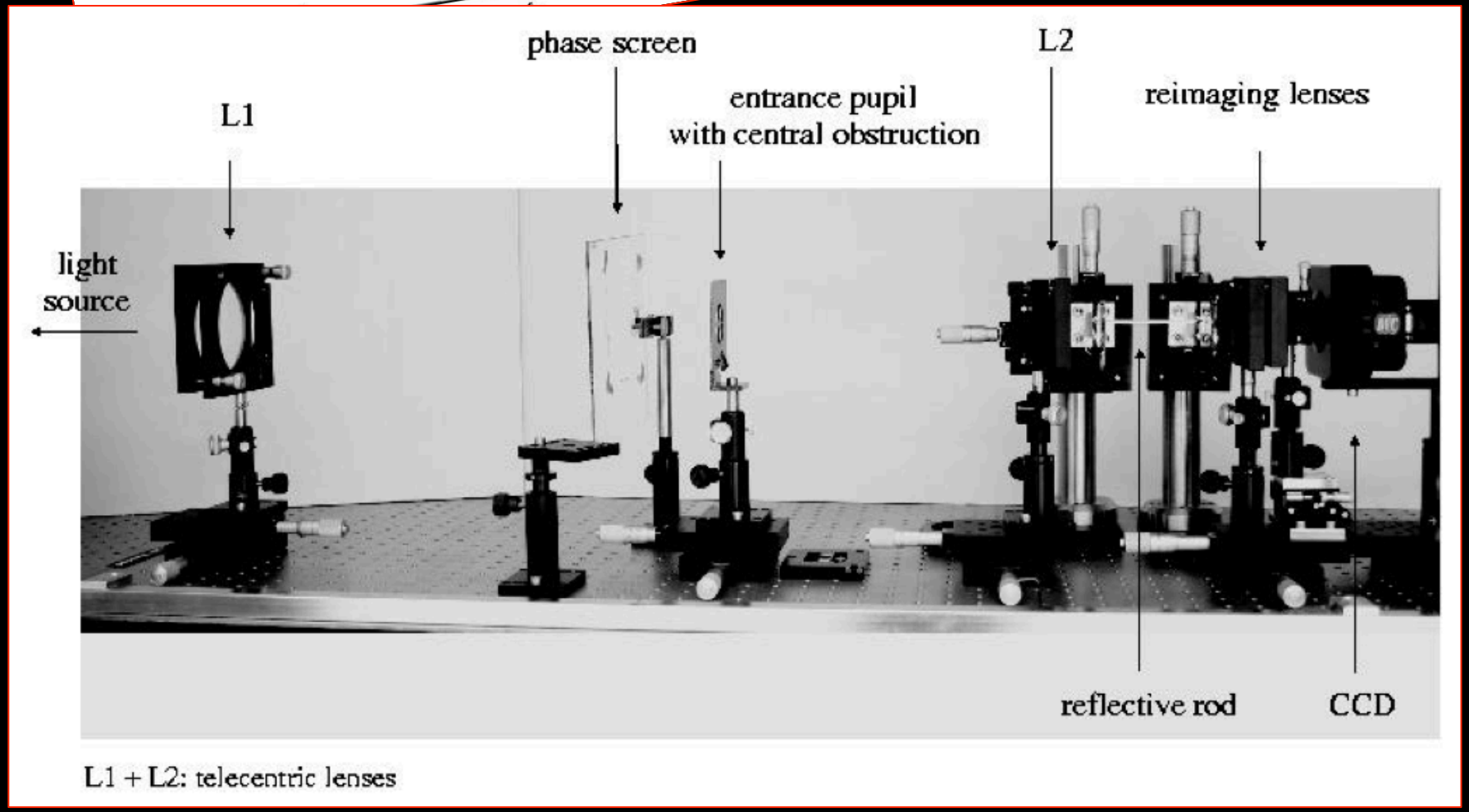


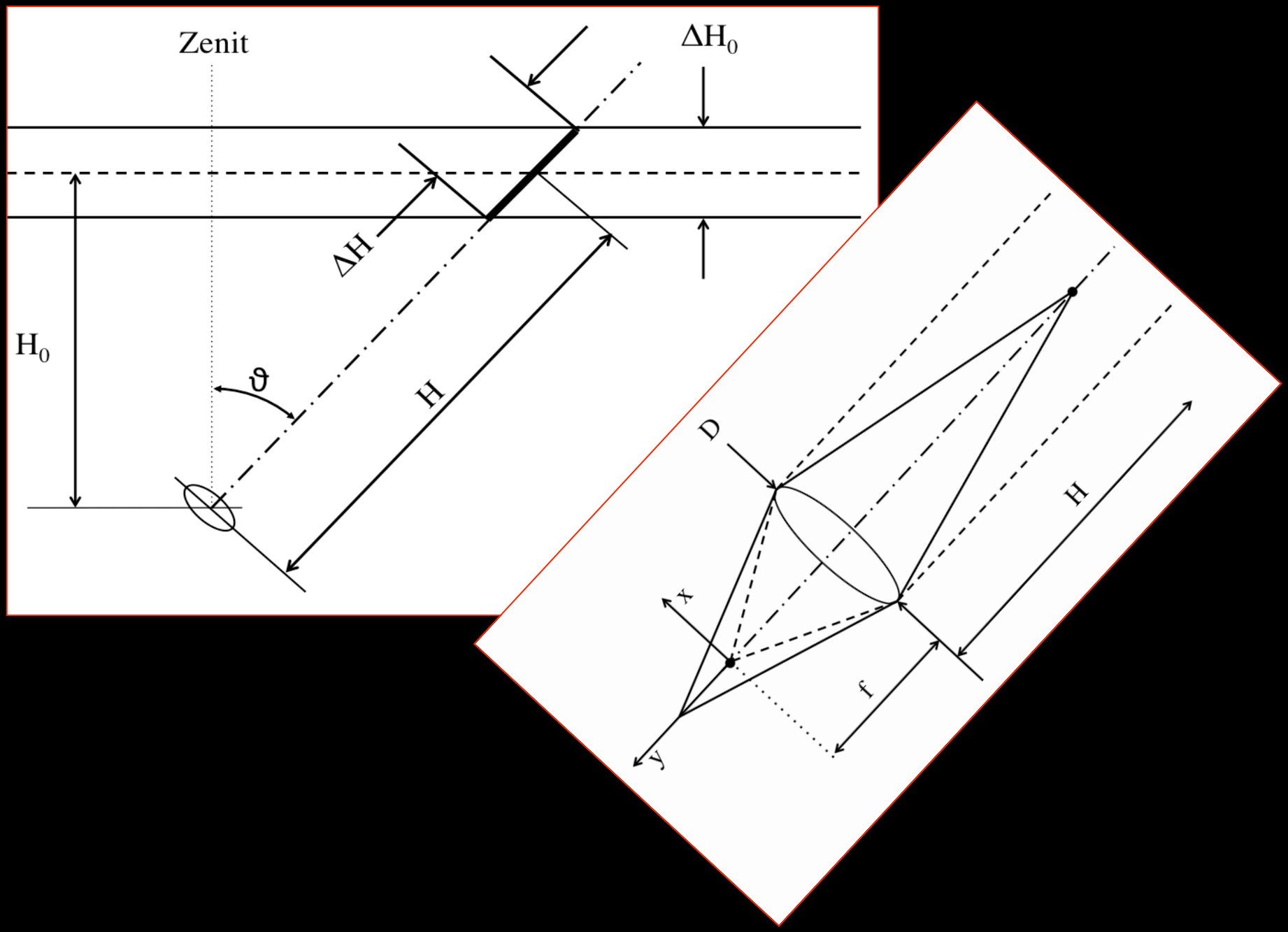


Even tested on the sky at WHT…

..and in the lab in their MCAO versions






Zenit
ΔH_0
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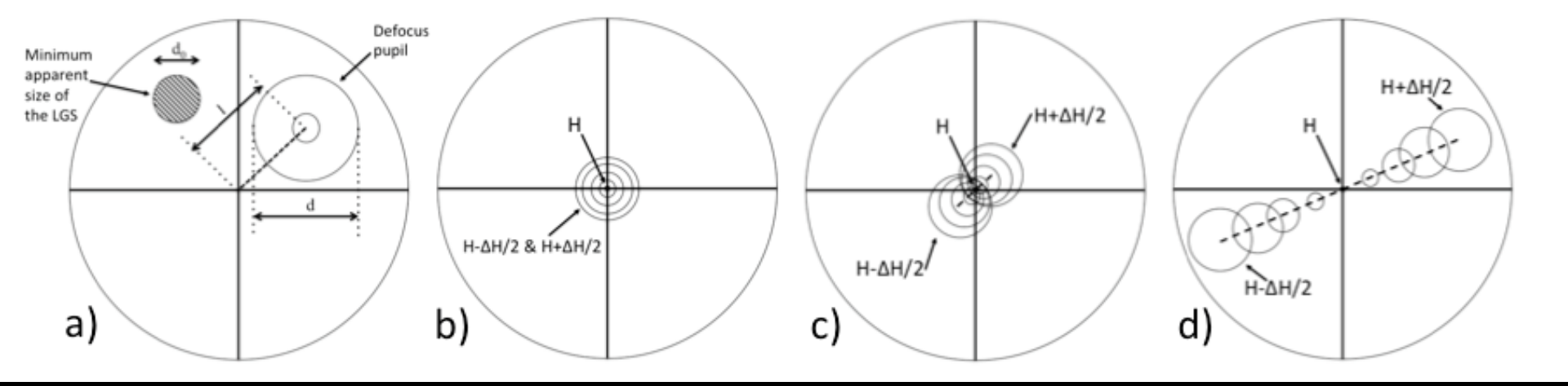
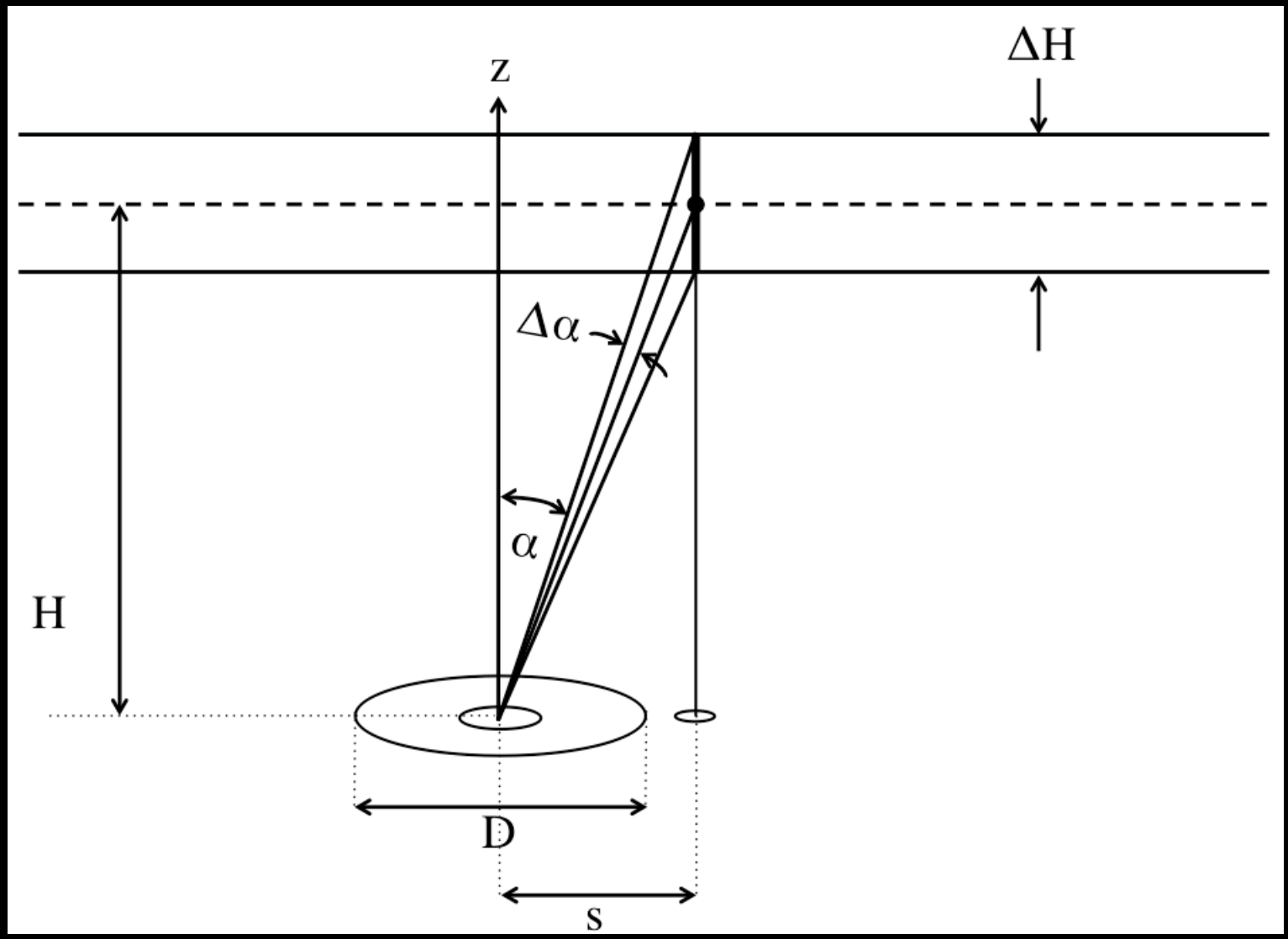
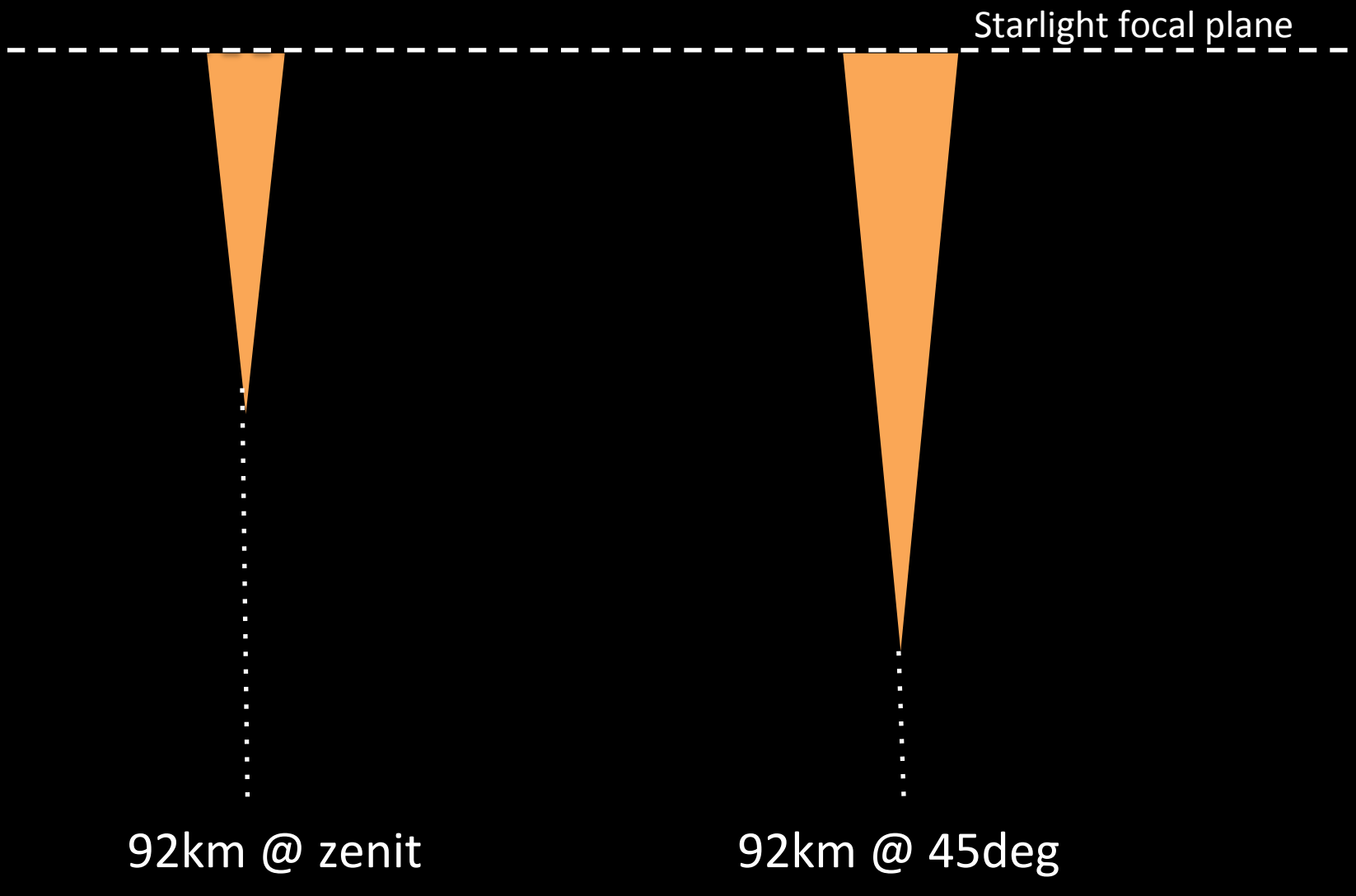
Elongation is not the whole story…



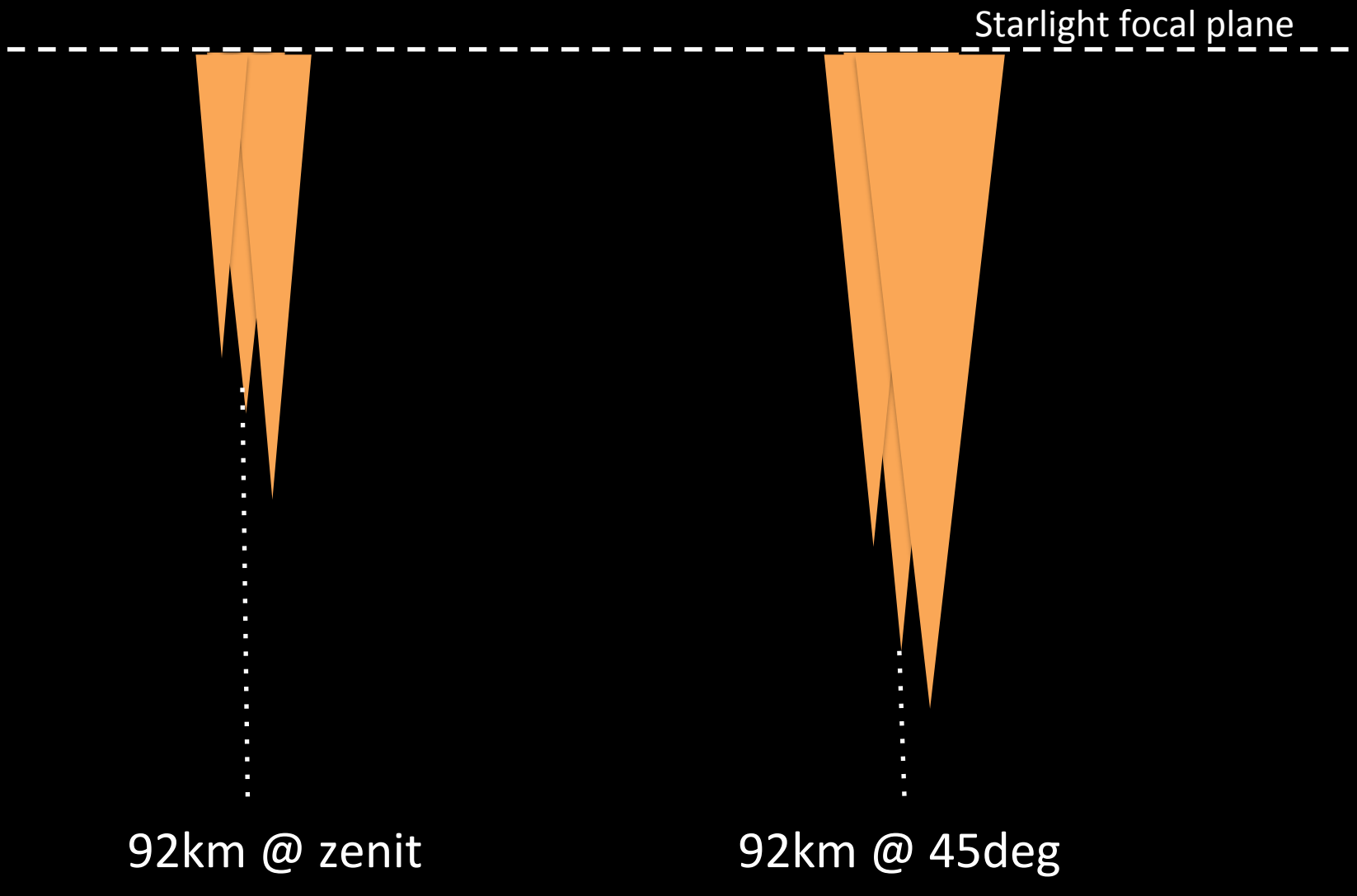
And, as soon as the LGS is fired from outside the pupil…



LGS WFSensing…



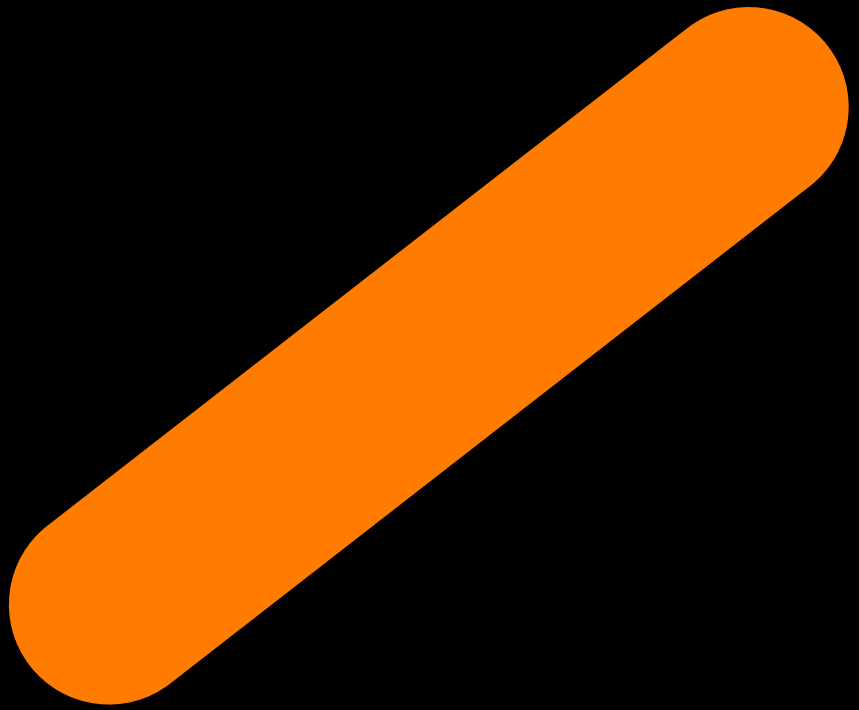
LGS WFSensing…



LGS WFSensing

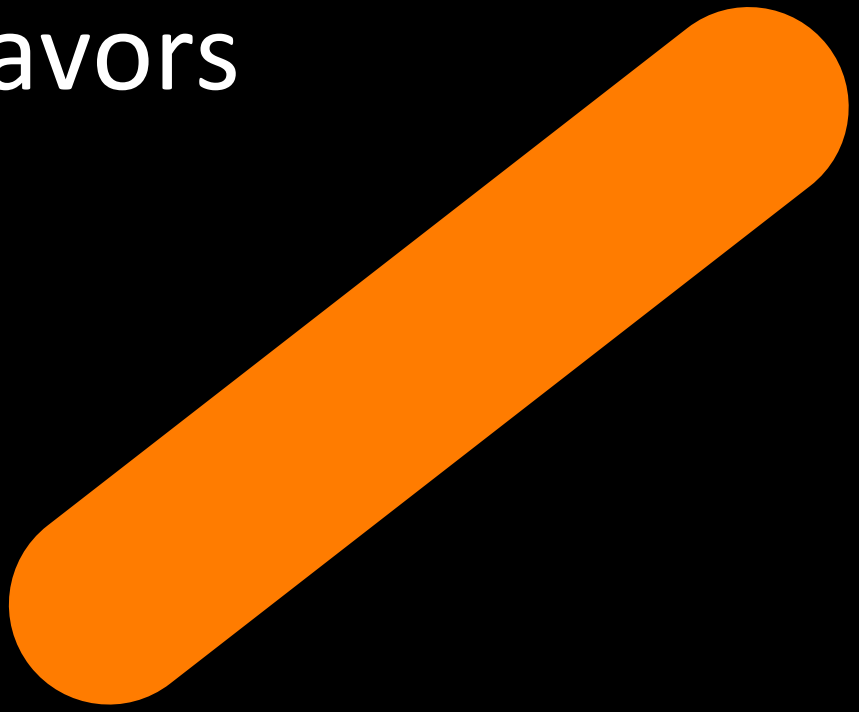
- Most (if not all) of proposed LGSs WFS are basically measuring local tilt into a subaperture
- If the LGS is an elongated stuff measurement along the elongation is inherently inefficient
- If the LGS has a structure one can use that but at the expense of a lot of pixels and with little gain
- The edges contribute to most of the signal
- If one edge is much sharper than the other that will contibute mostly

LGS WFSensing…



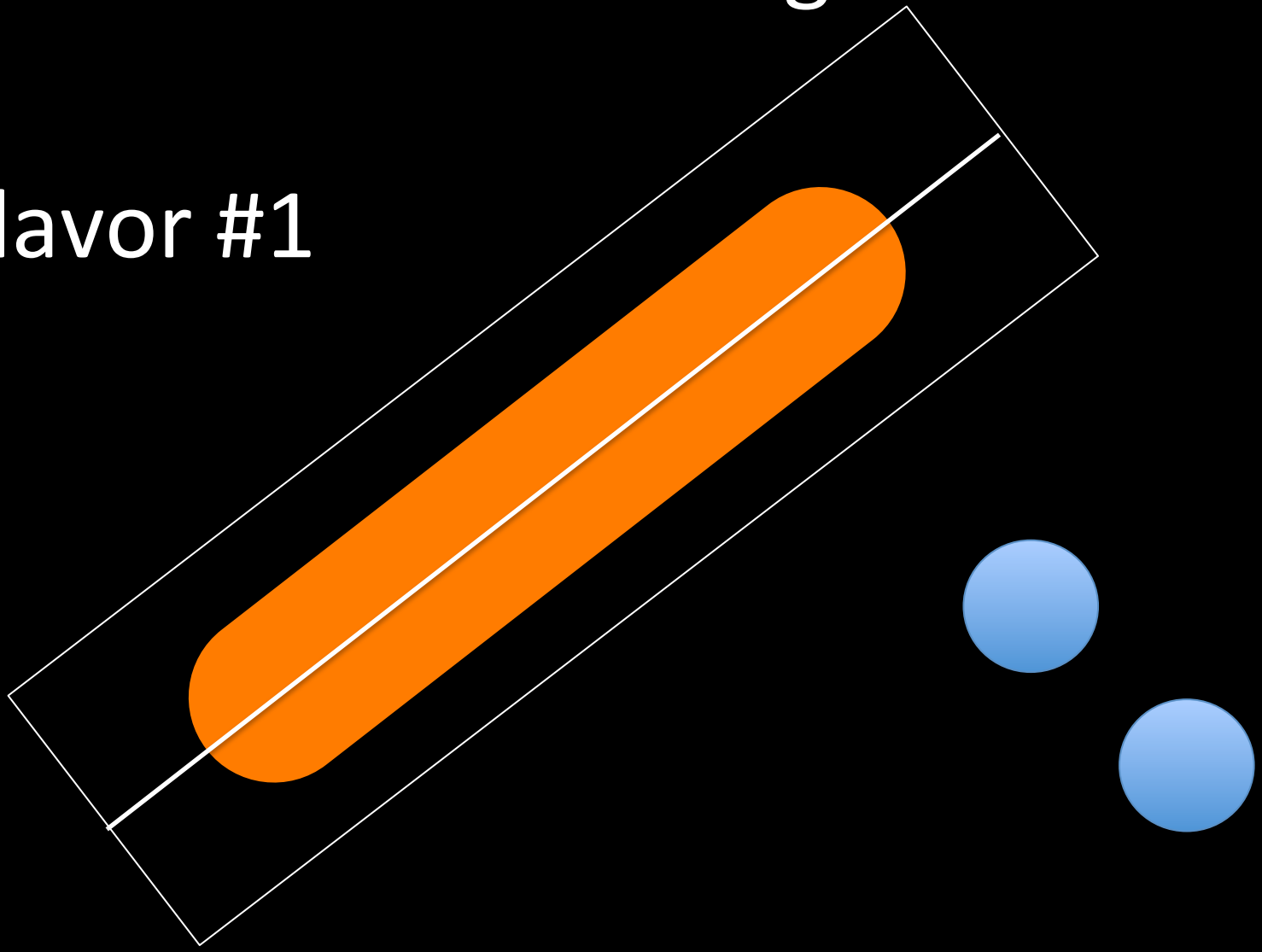
LGS WFSensing…

…in 5 flavors



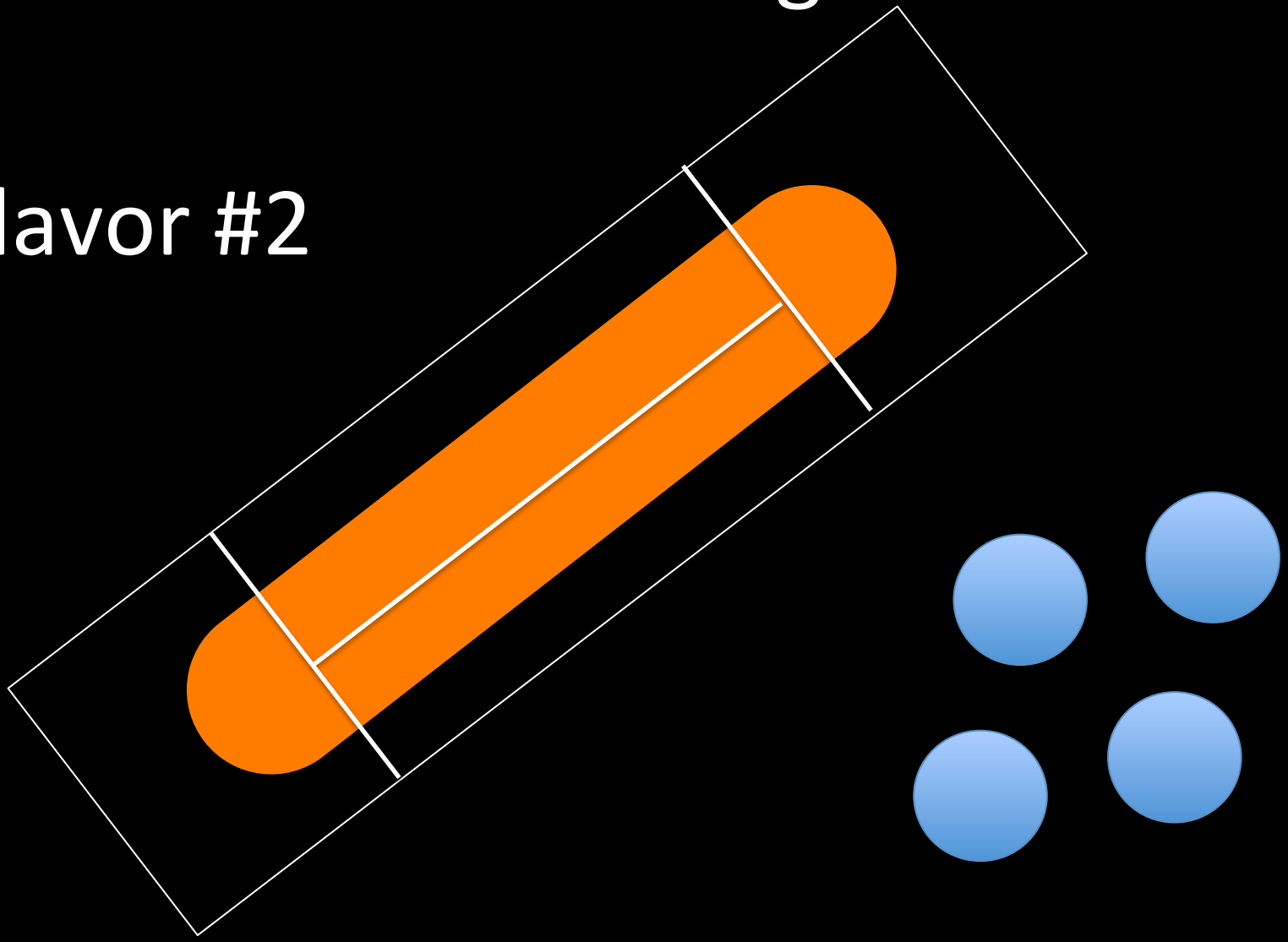
LGS WFSensing…

Flavor #1



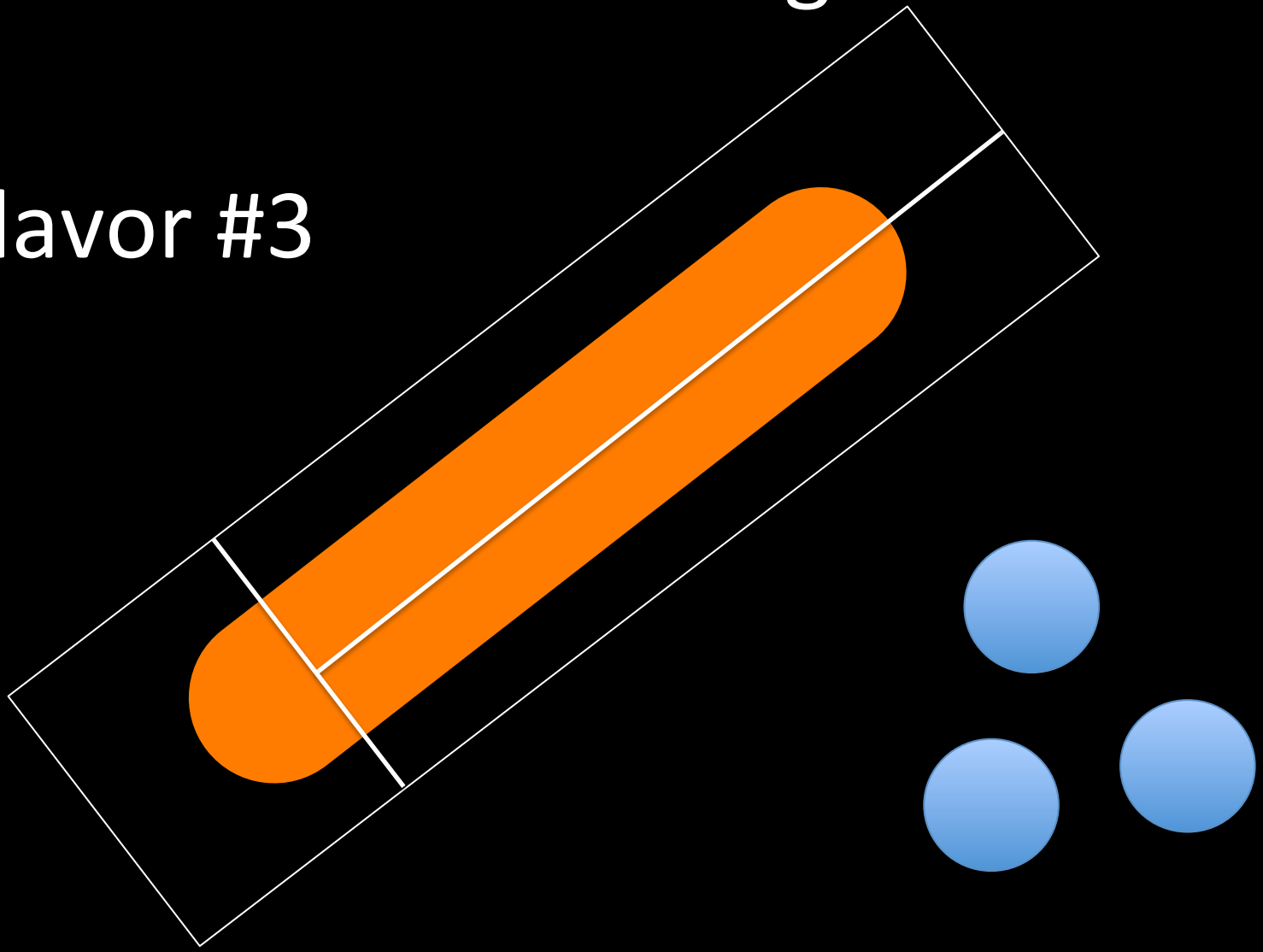
LGS WFSensing…

Flavor #2



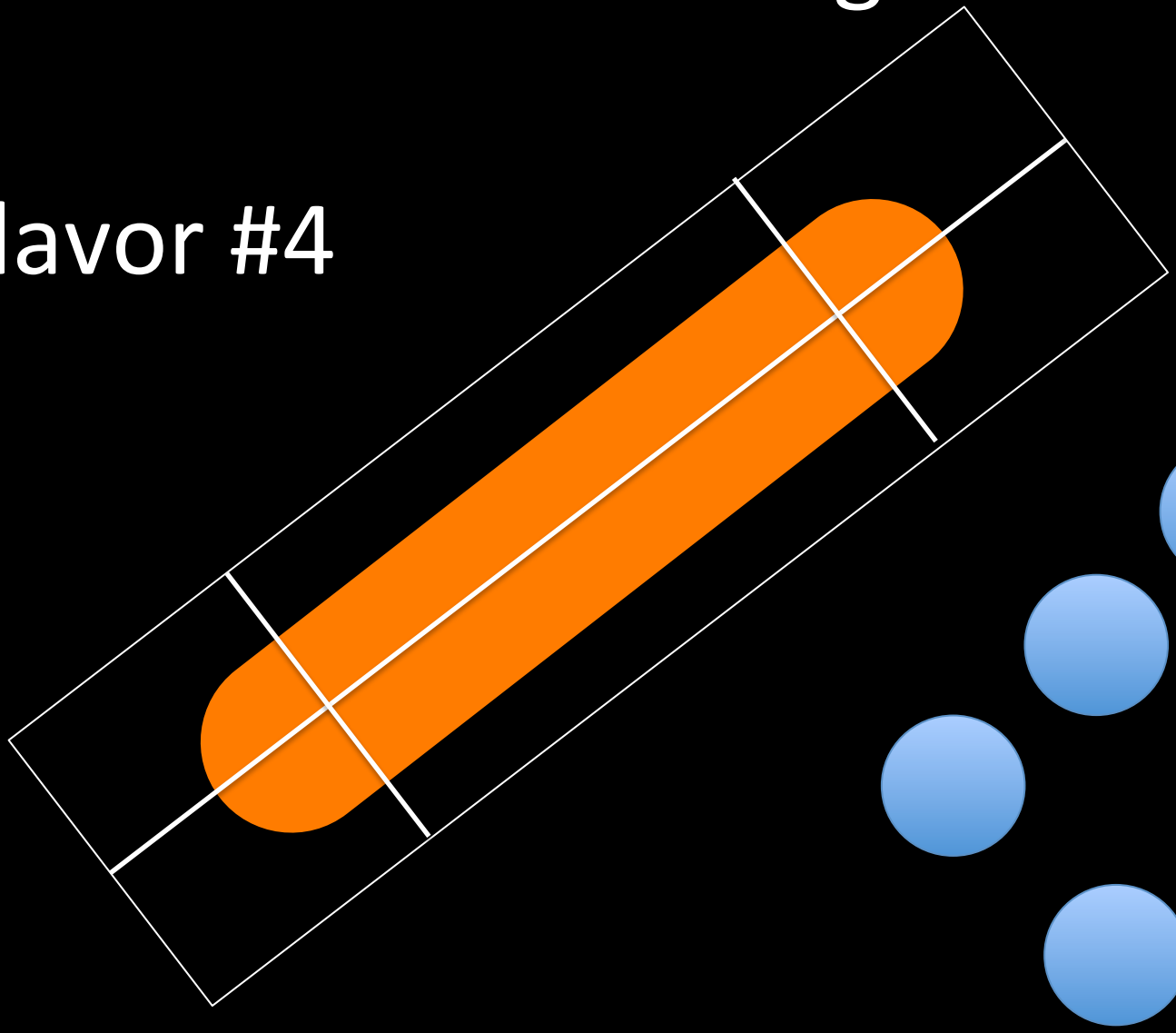
LGS WFSensing…

Flavor #3



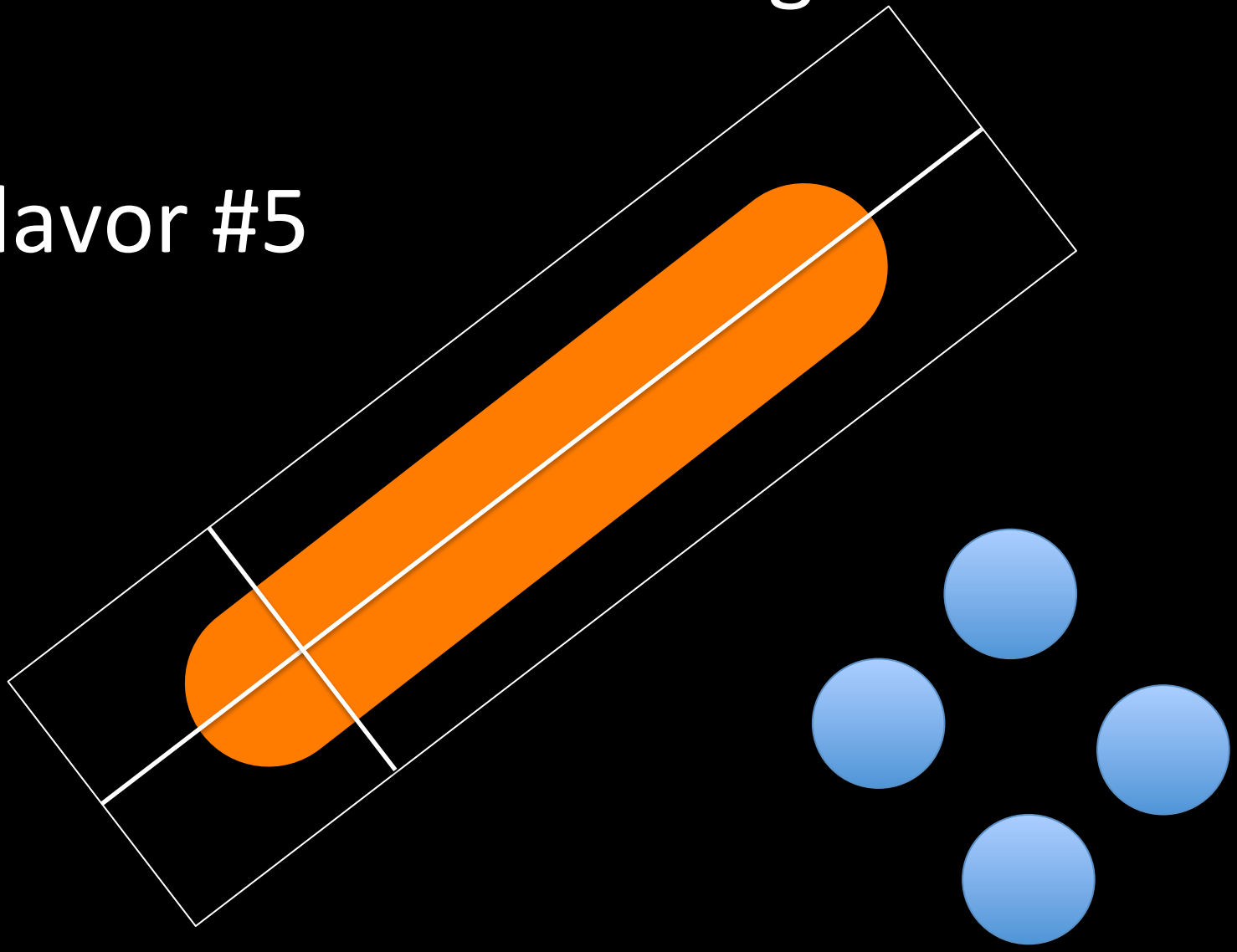
LGS WFSensing…

Flavor #4

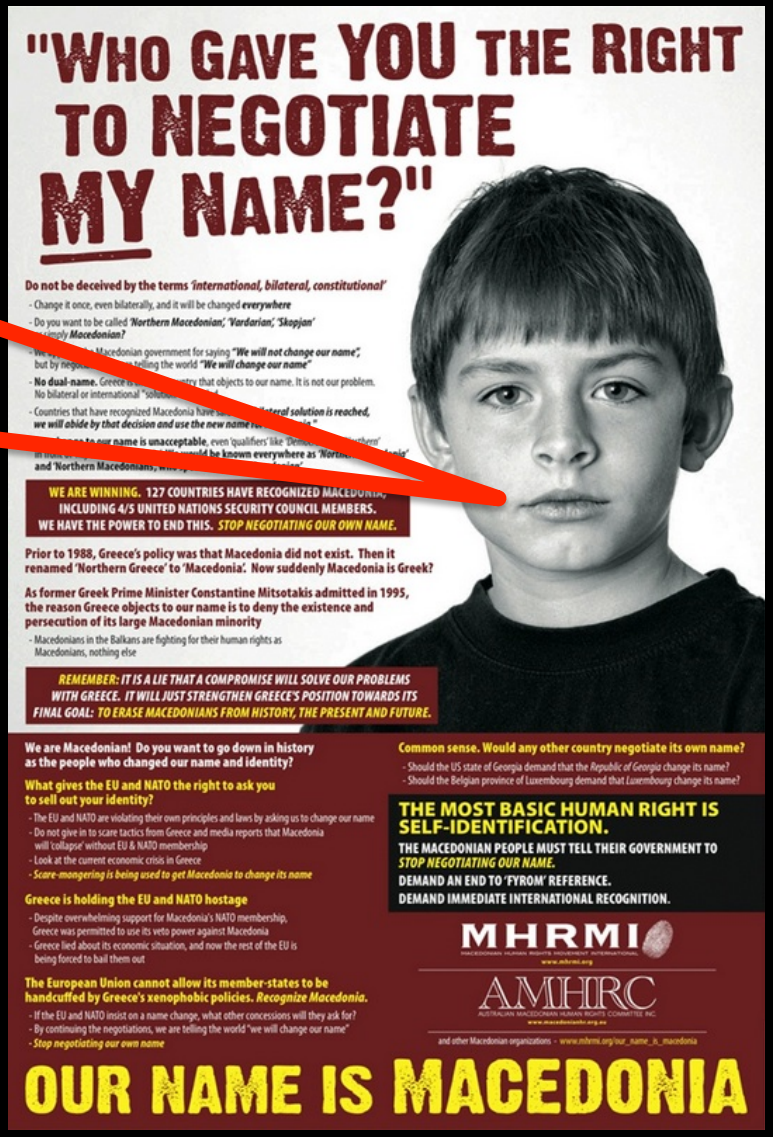


LGS WFSensing…

Flavor #5



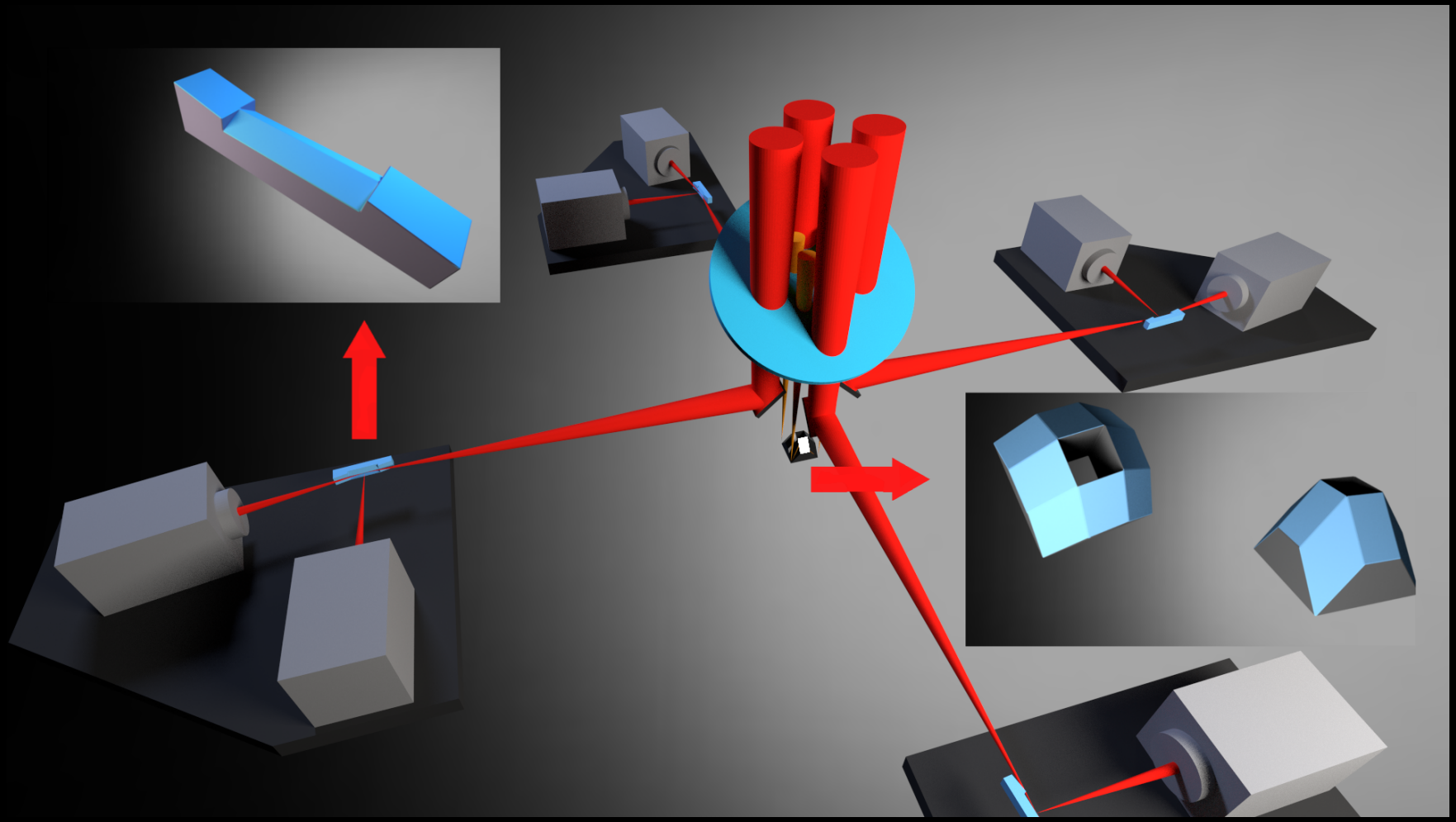
Ehi, remember, names **are** important..!!

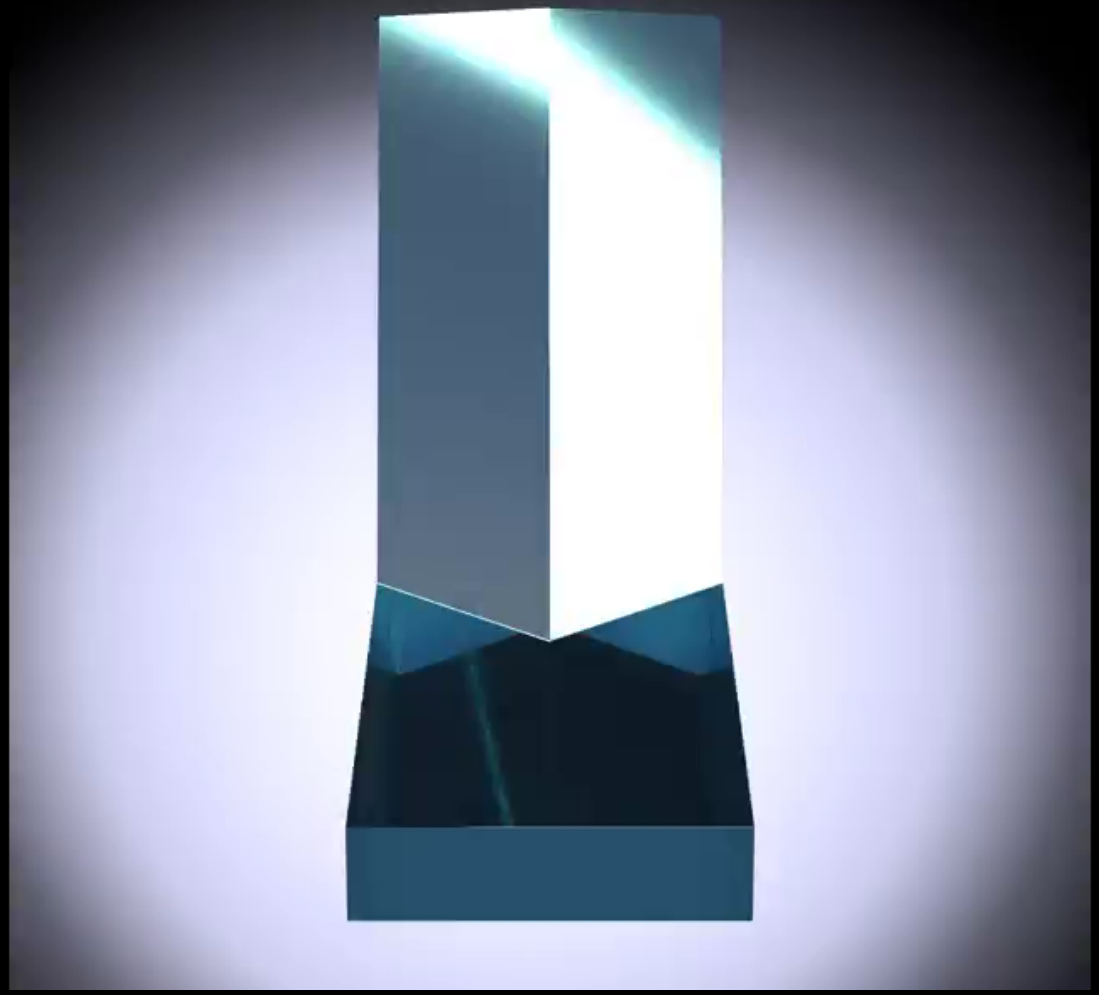


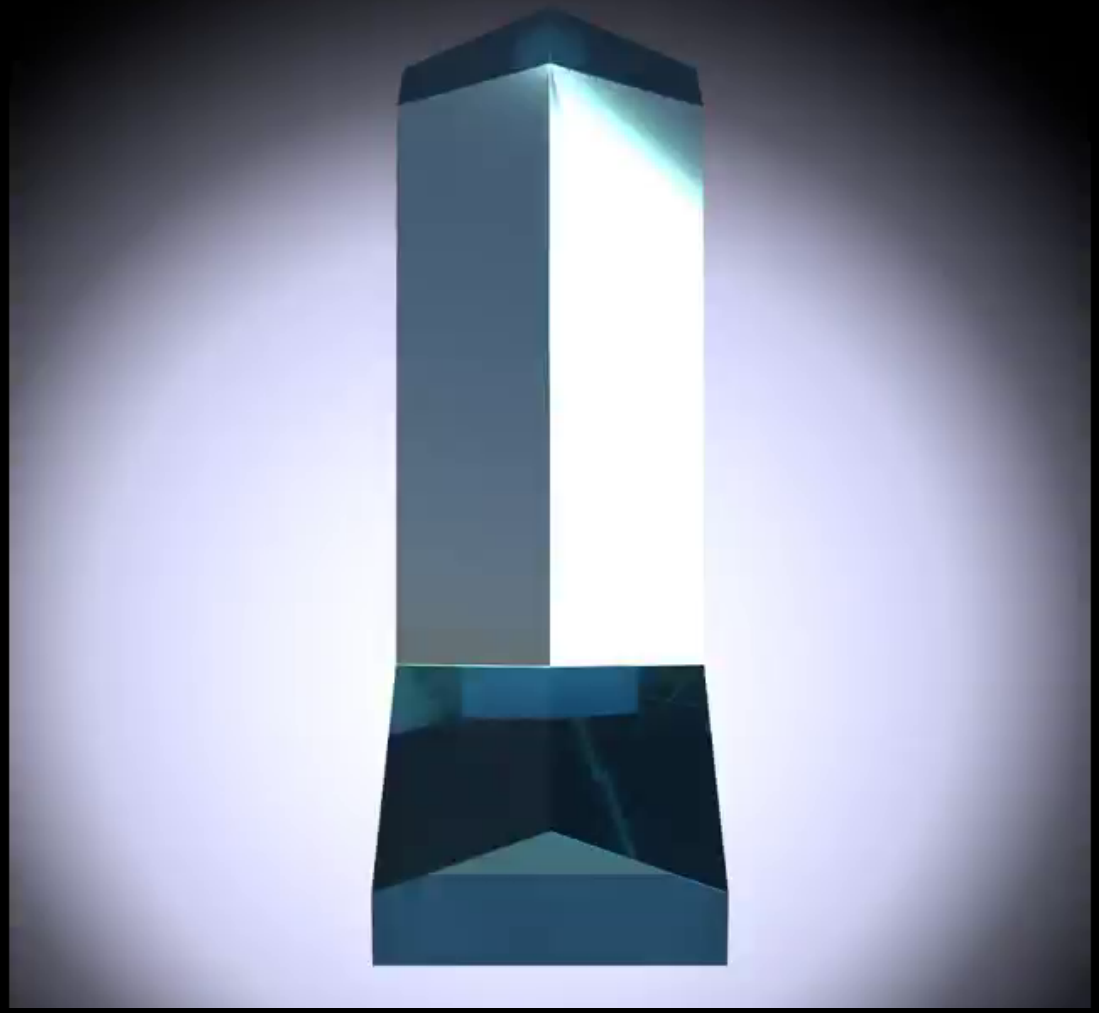
LGS WFSensing…

LGS WFSensing…

A bit more than conceptual…

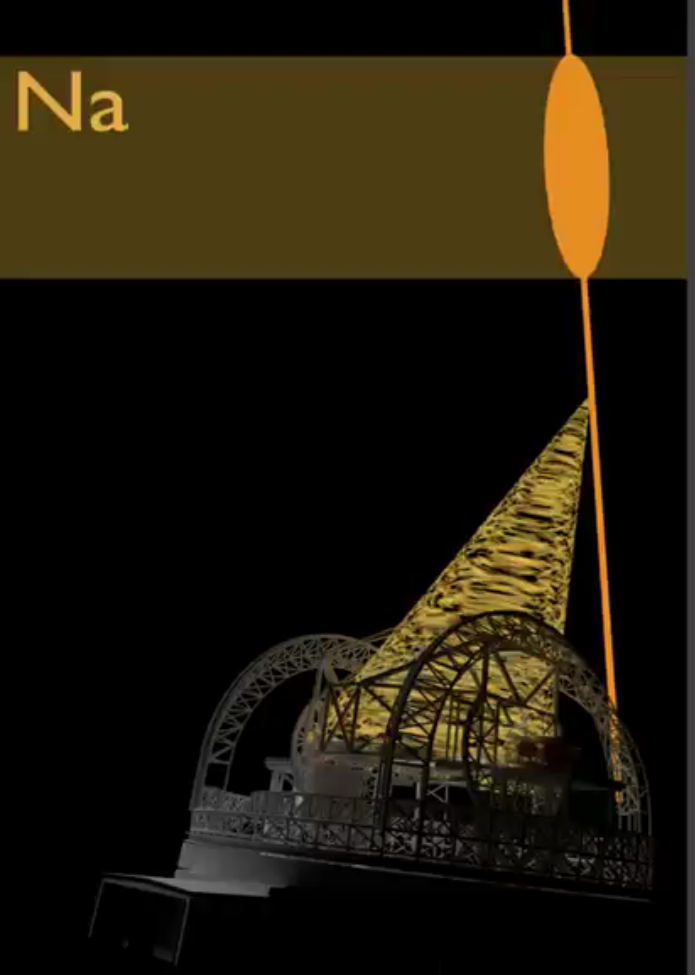


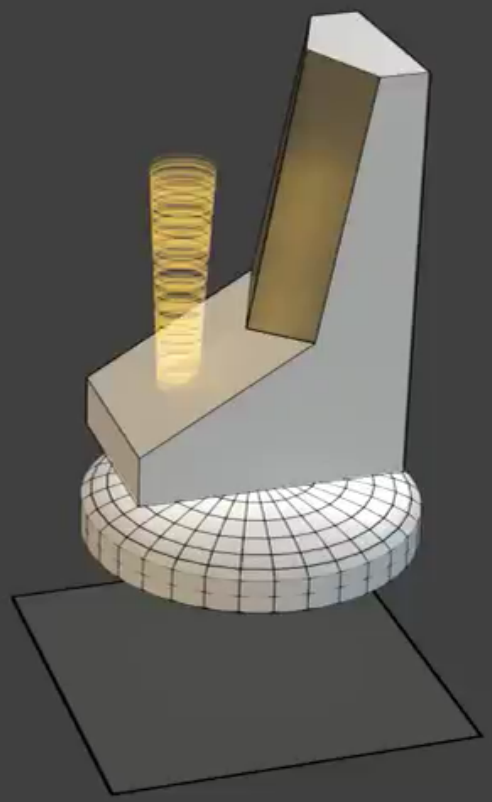




In the following LGS light is propagated for display purposes but a pulsed laser is ***not*** required…!

Na





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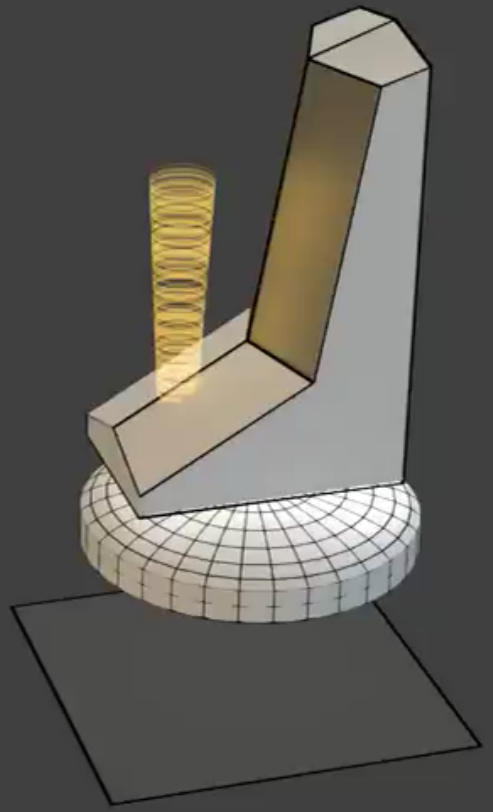
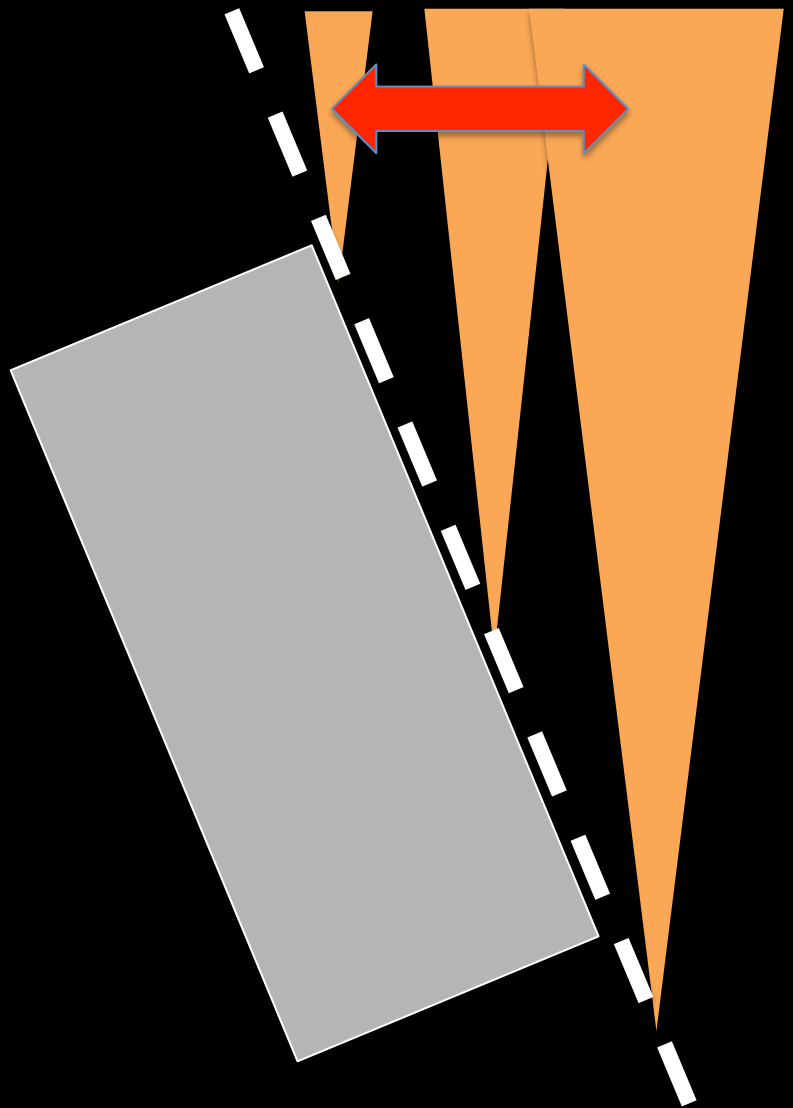


How to adapt to different apparent Sodium column lengths…??



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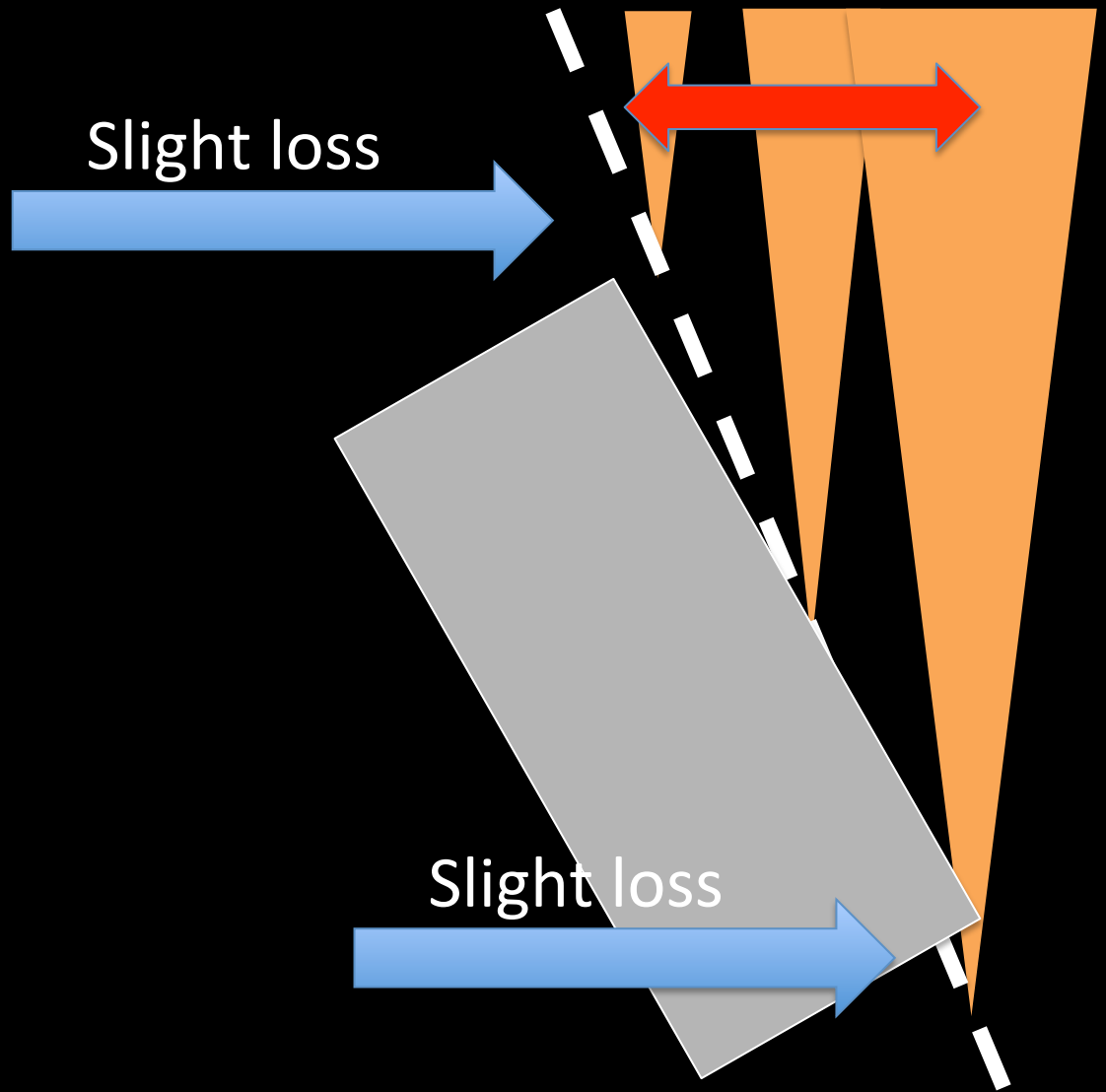


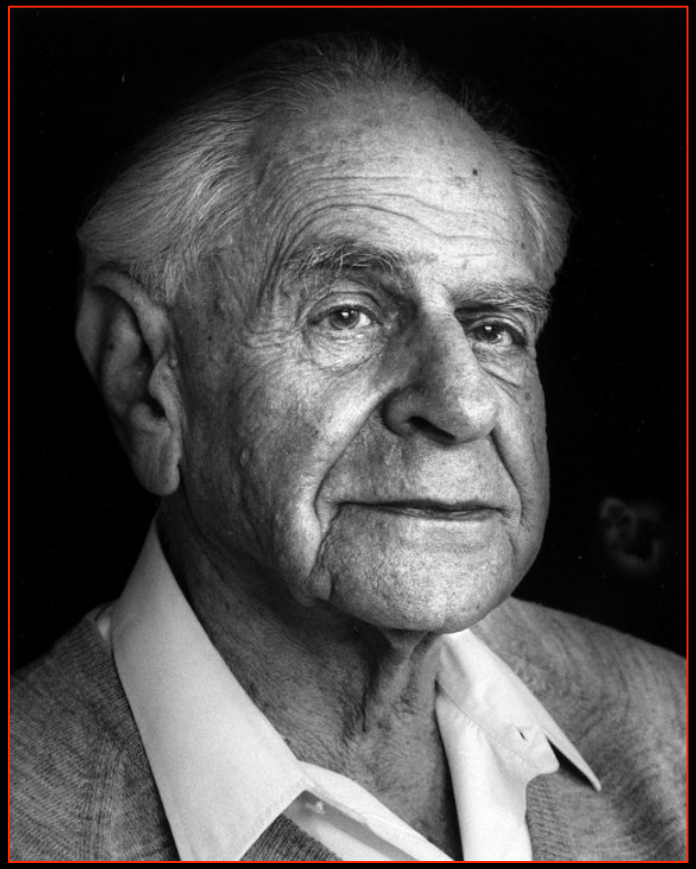
Summarizing… (1 of 2)

- Ingot-like WFS does not require pulsed LSG and do not require moving parts
- Are extremely efficient in terms of pixel occupations (pyramid-style)
- Sense LGSs with proper elongation and defocus effects taken inherently into account
- Using the profile structure of the LGS is given up
- The less complex flavors progressively give up part of the edges signal and one edge, eventually, presumably a small contribution to the overall signal.

Summarizing… (2 of 2)

- They are doable in a compact manner with a combination of refractive and reflective surfaces
- Chromatism in refraction is not an issue at all as monochromatic
- The one edge flavor can match any apparent column elongation with no loss
- The two edges flavor can match apparent column elongation with little loss by tilt of the device (or with no loss by changing the EFL, but it would become rather complex)

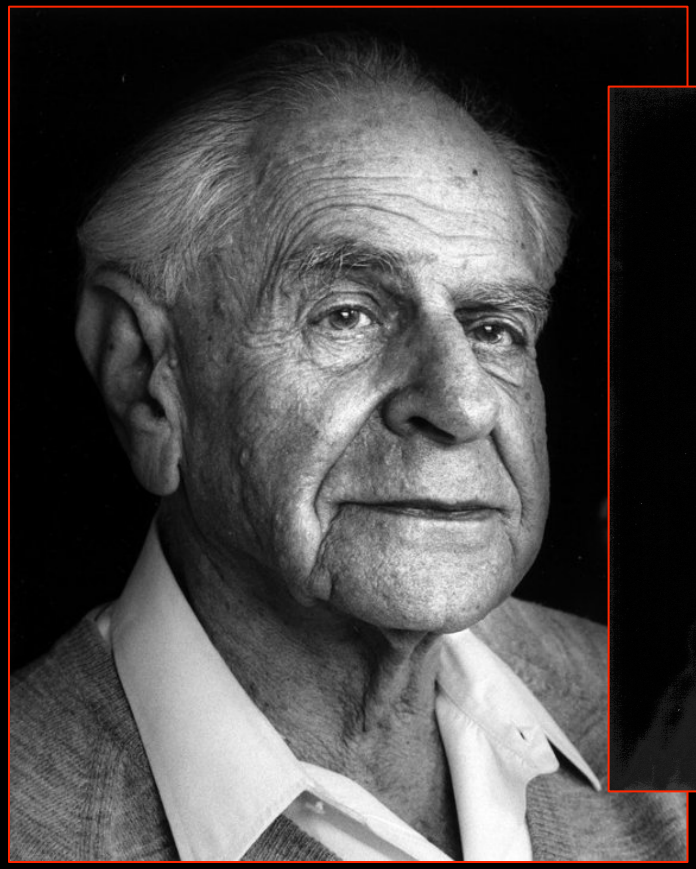
Epistemology of Adaptive Optics



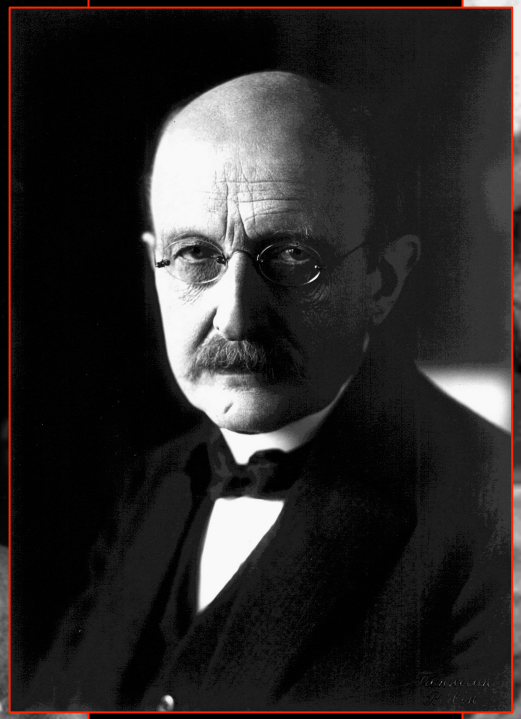
Karl Raimund Popper

Thomas Samuel Kuhn

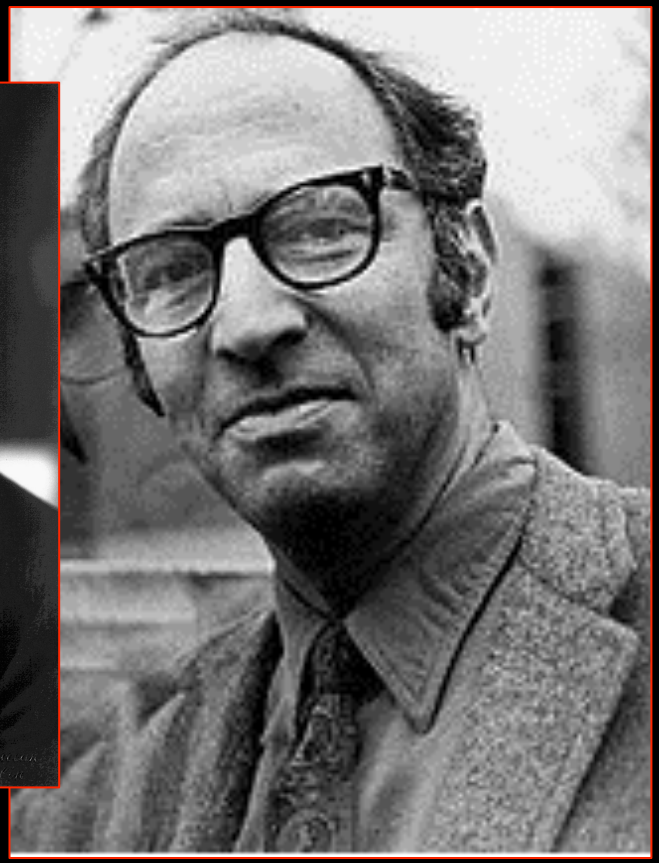
Epistemology of Adaptive Optics



Karl Raimund Popper



Max Planck



Thomas Samuel Kuhn

Epistemology of Adaptive Optics

Science advances for new paradigms
but common people would call this

“fashion”

Thomas Samuel Kuhn

So, I Googled for fashion show…

The stylist
The rude version
Politically incorrect version

At the coffee break…

- Everyone can become a WFS-fashionist…

- *THANKS A LOT….!!!*