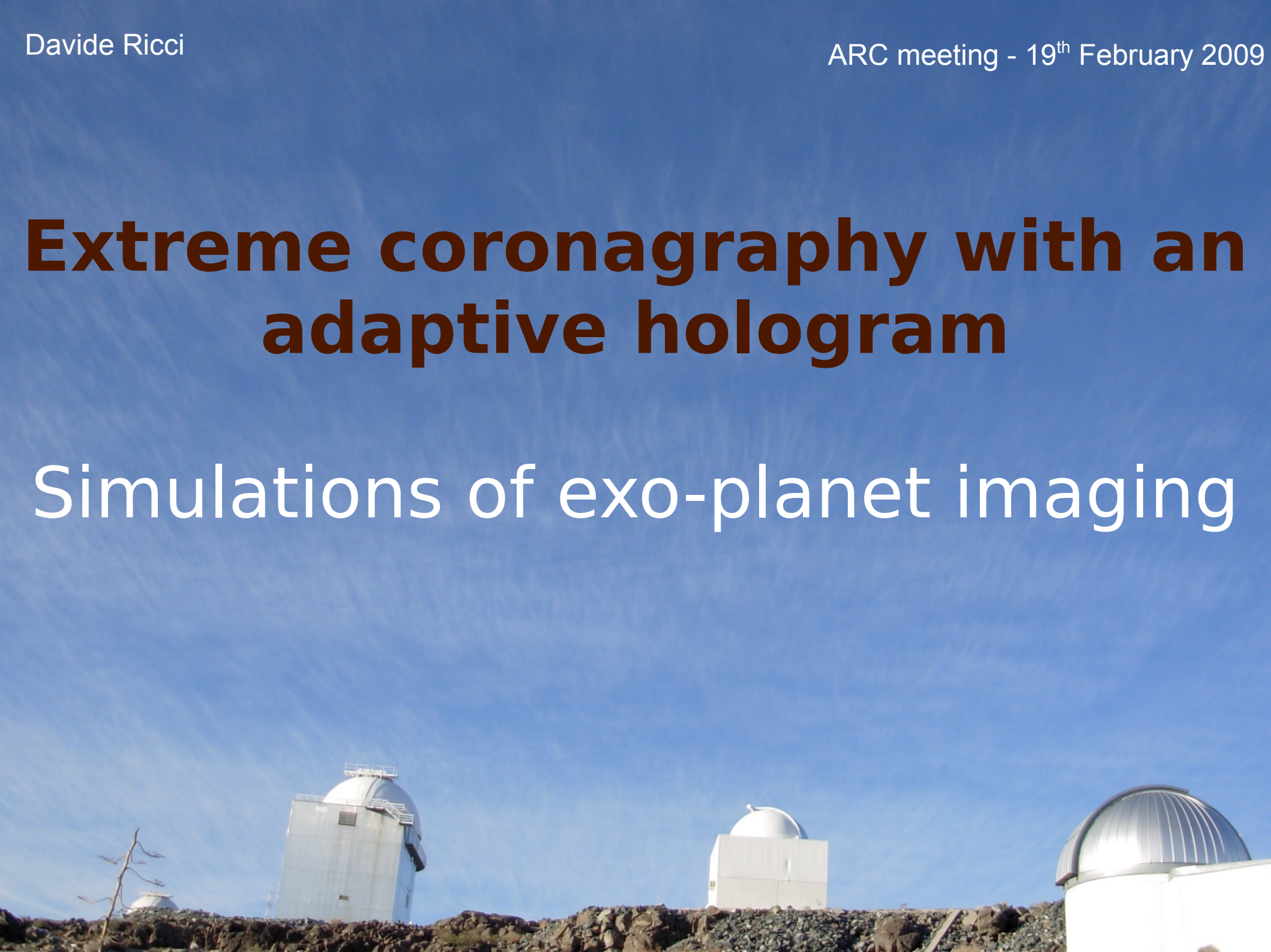
Davide Ricci

ARC meeting - 19th February 2009

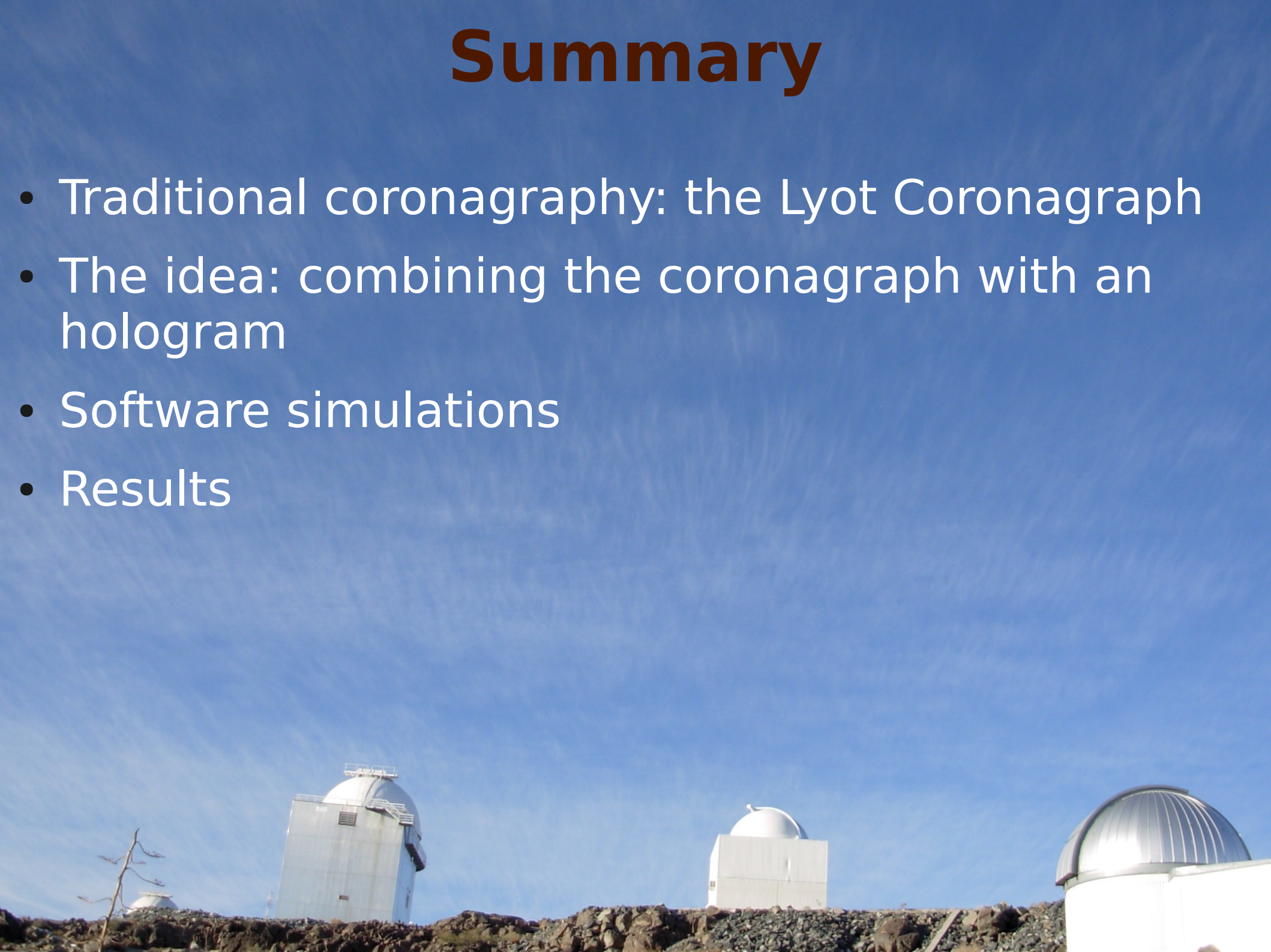
Extreme coronagraphy with an adaptive hologram

Simulations of exo-planet imaging

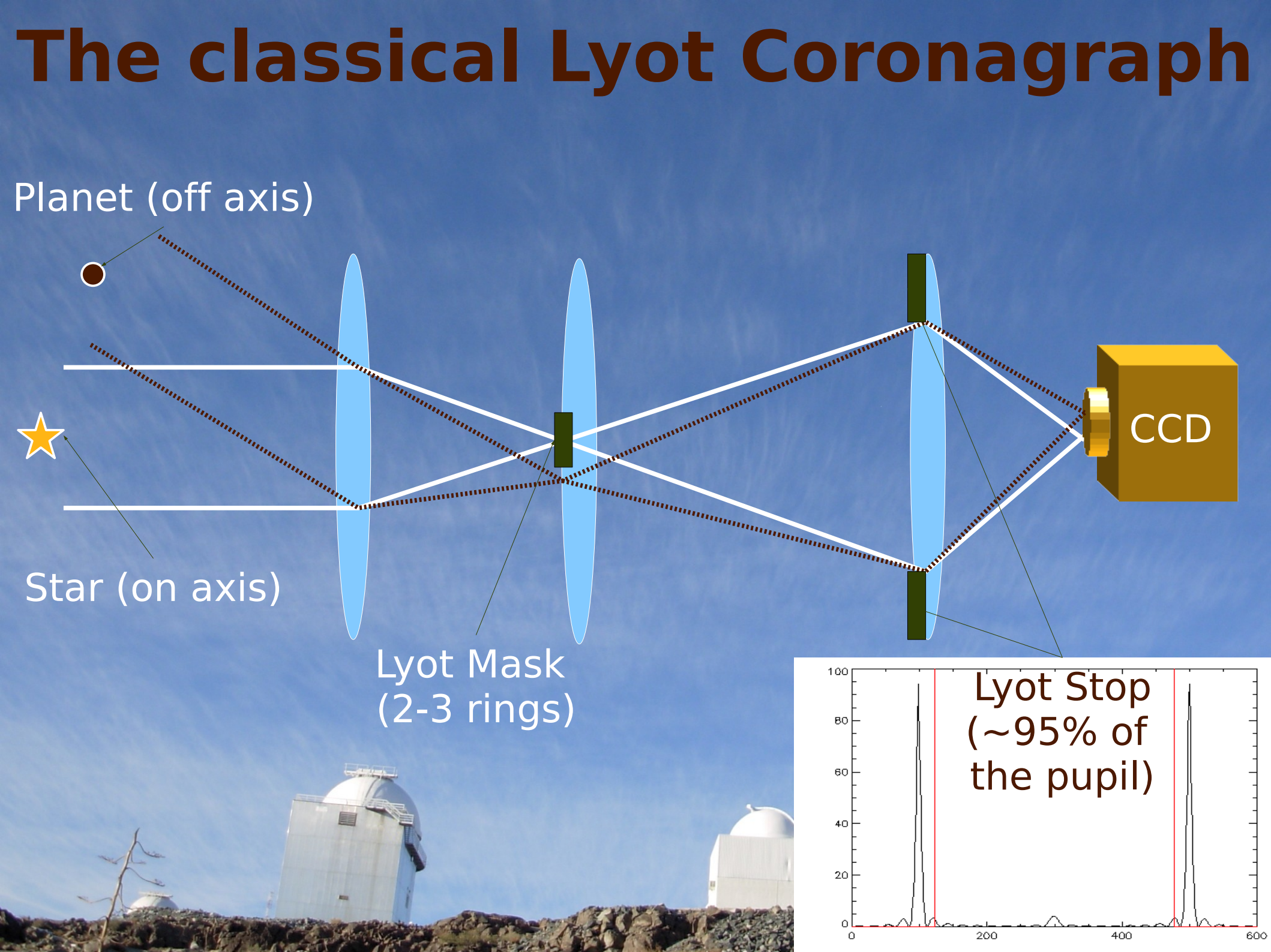


Summary

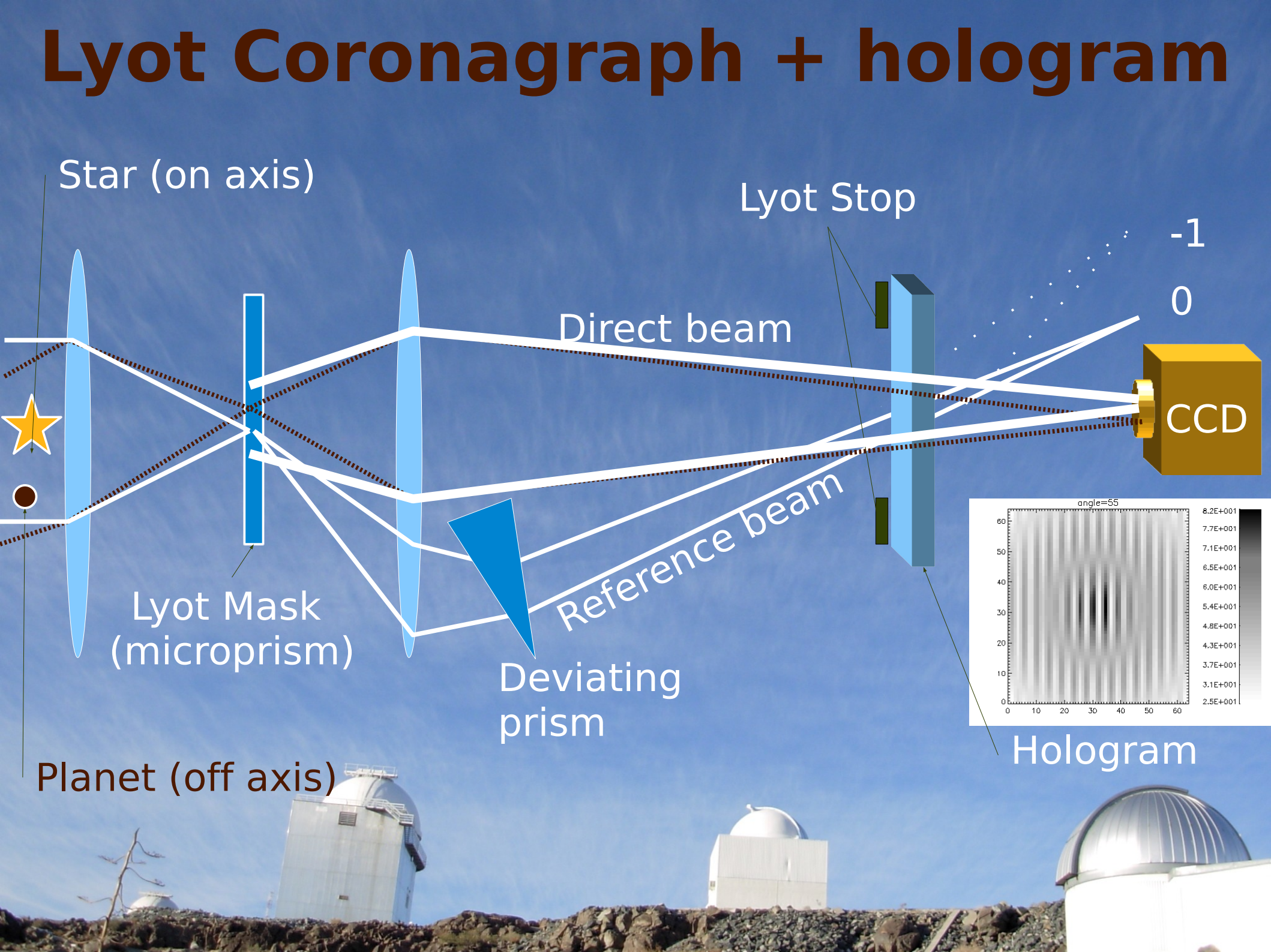
- Traditional coronagraphy: the Lyot Coronagraph
- The idea: combining the coronagraph with an hologram
- Software simulations
- Results



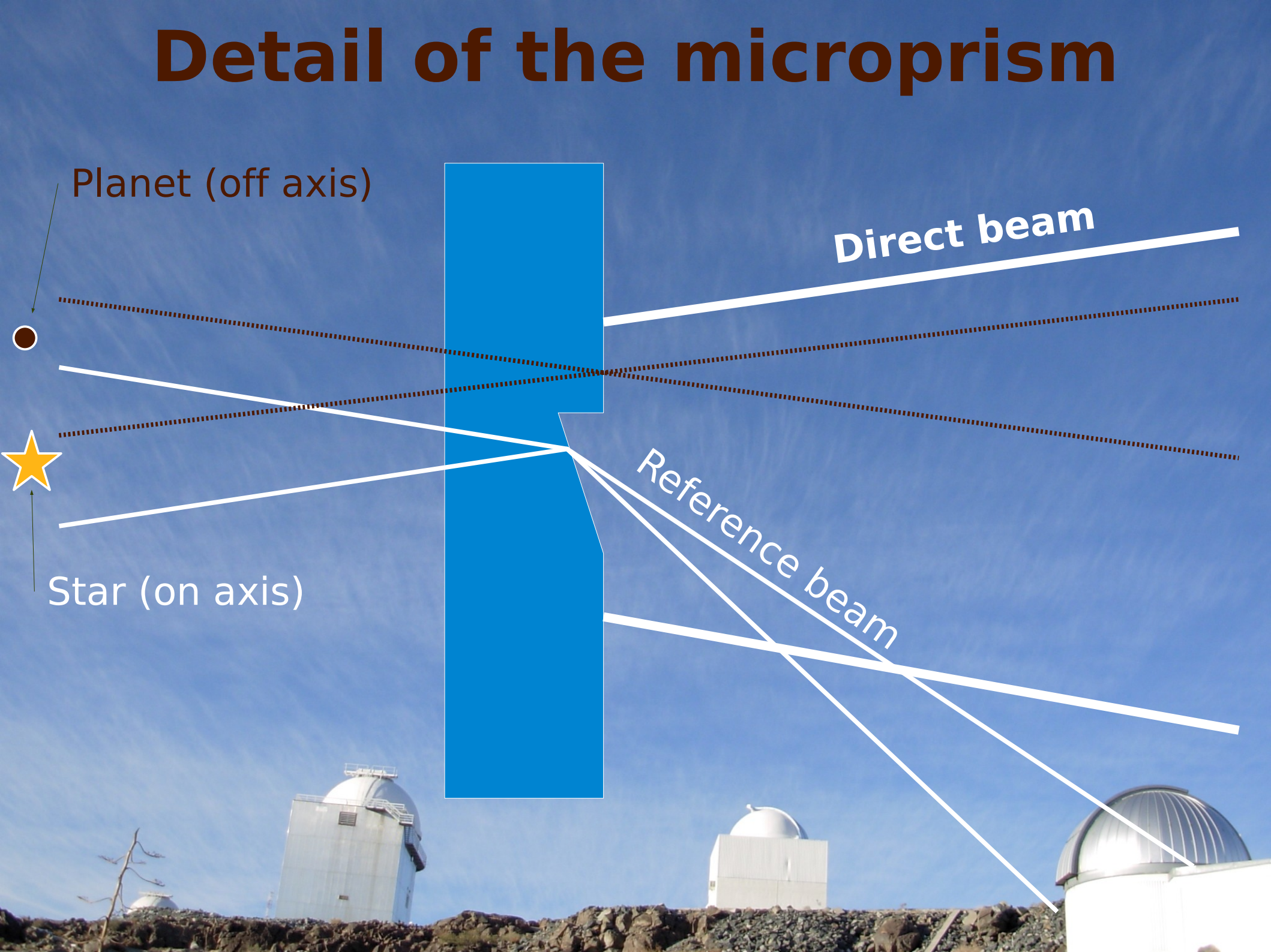
The classical Lyot Coronagraph

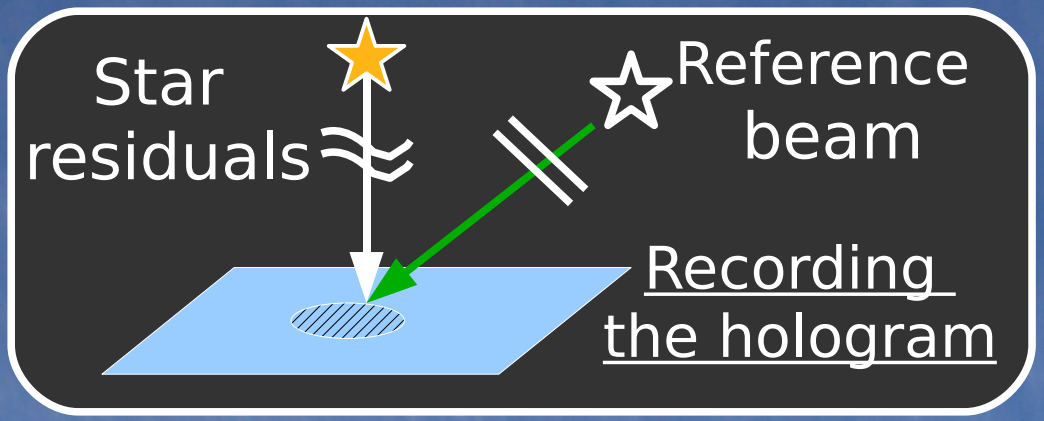


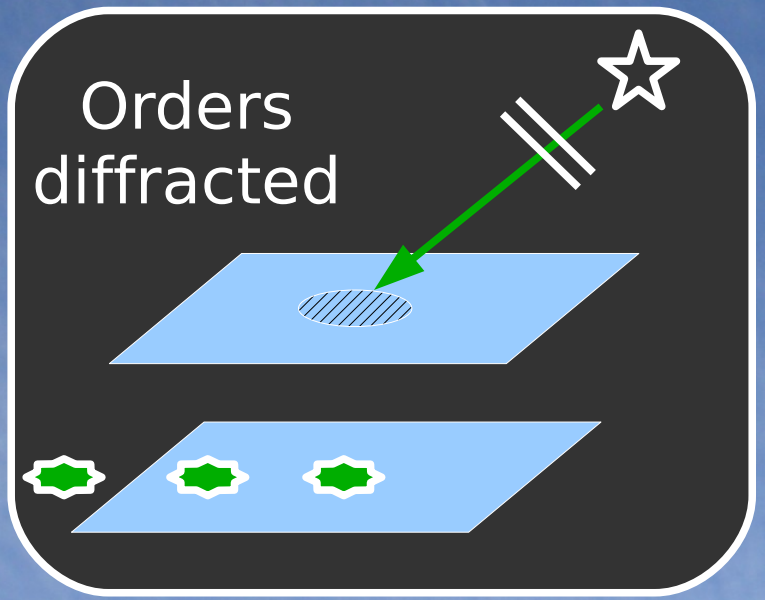
Lyot Coronagraph + hologram

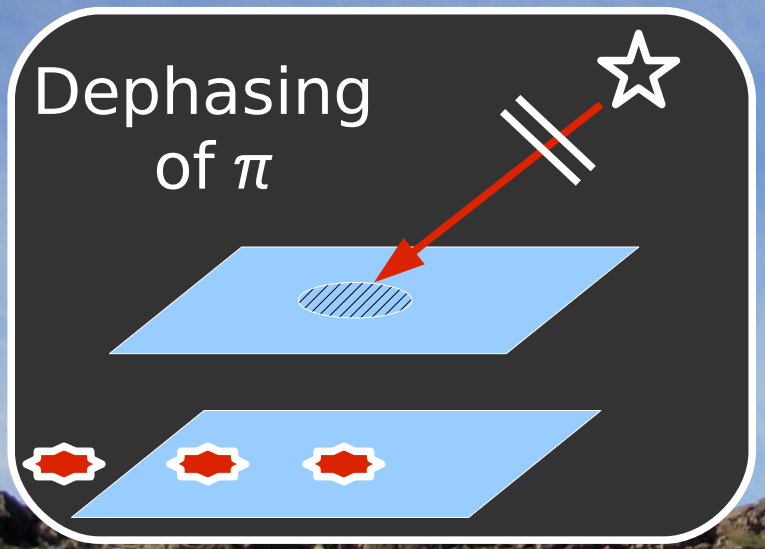


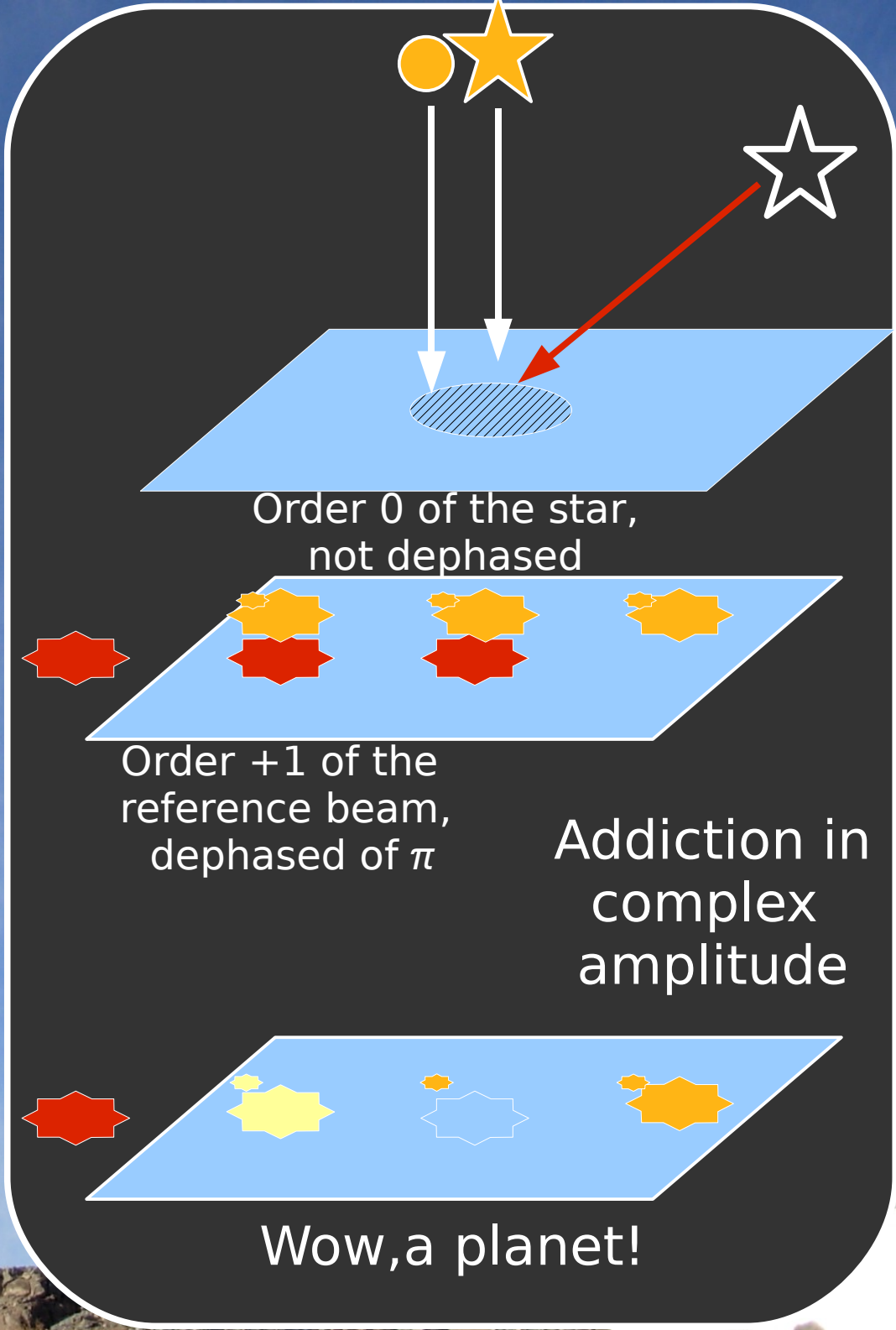
Detail of the microprism

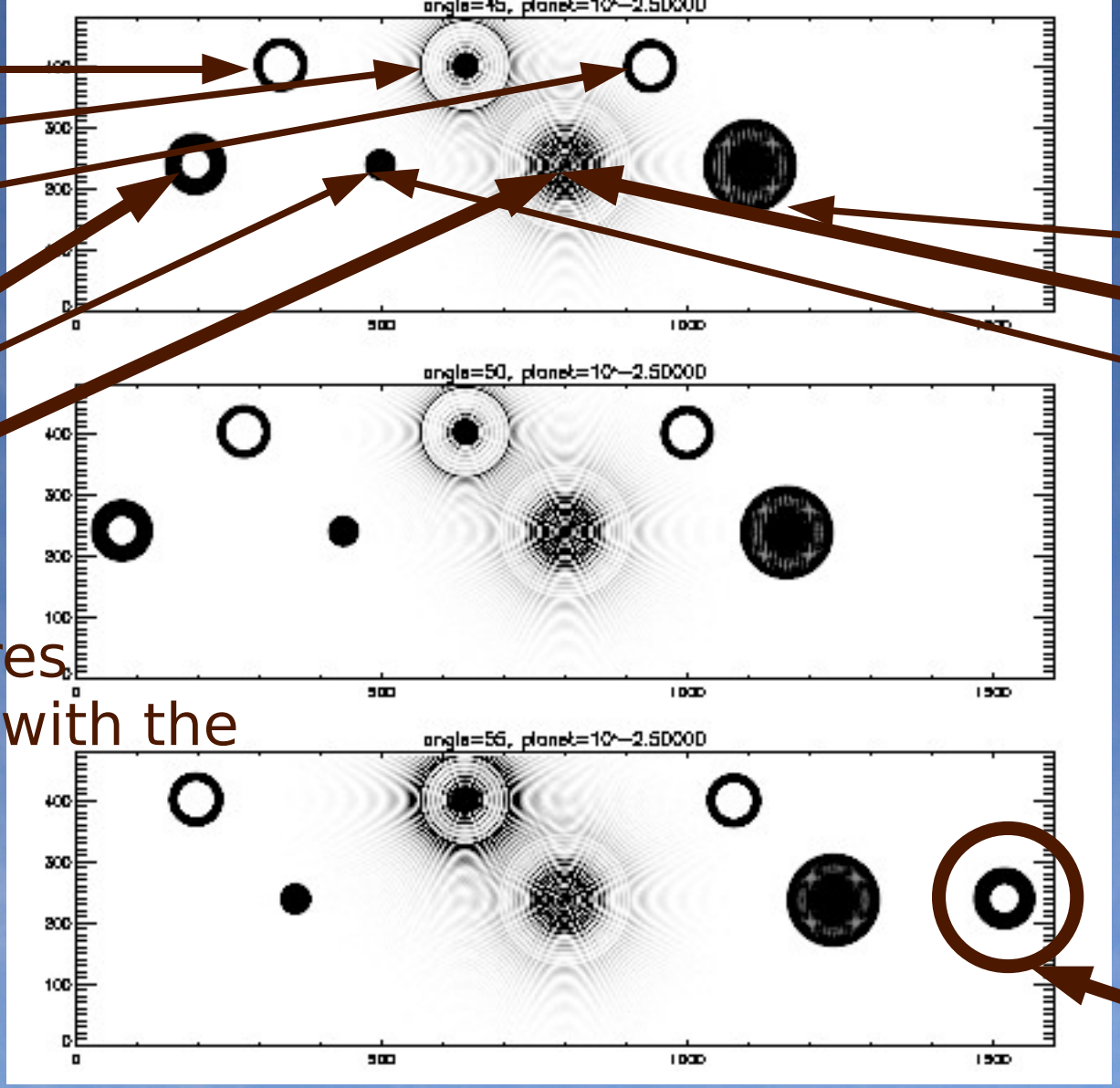



Star residuals
Reference beam
Recording the hologram


Orders diffracted


Dephasing of π


Order 0 of the star, not dephased
Order +1 of the reference beam, dephased of π
Addiction in complex amplitude
Wow,a planet!



Planet { -1, 0, +1

Ref. beam { **-1**, 0, **+1**

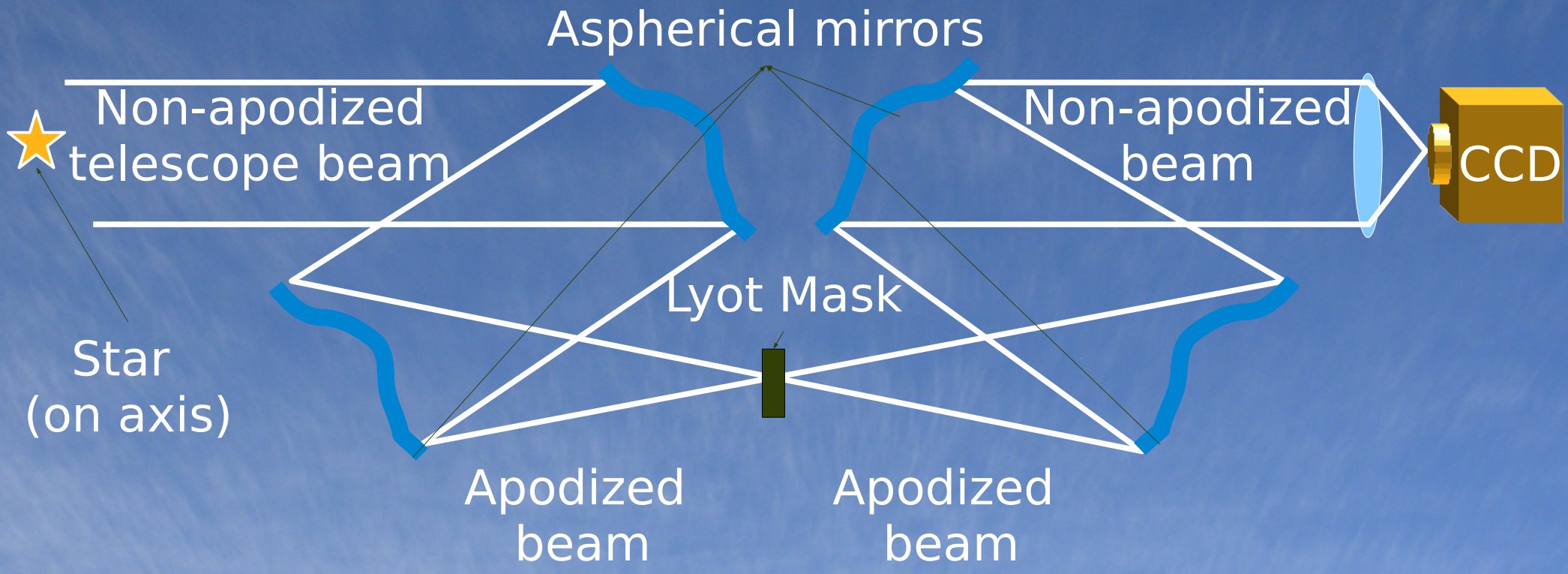
{ -1, **0**, +1 } Star

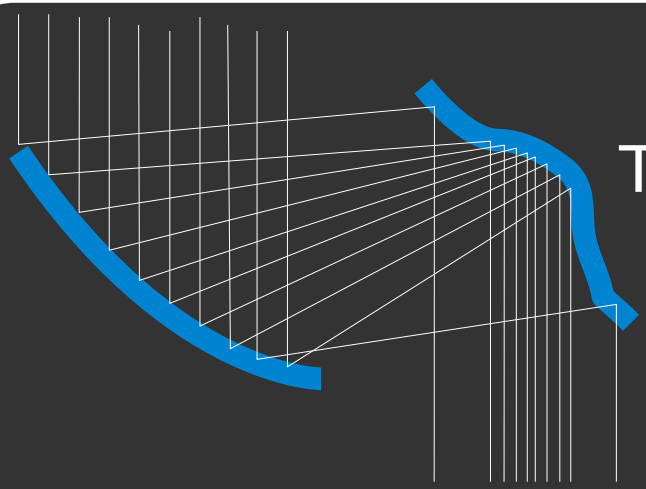
The order **+1** of the ref. beam interferes destructively with the order **0** of the star

The order -1 of the ref. beam is said the “twin wave”

Aliasing effect (numerical, can be analytically subtracted) twin wave appears on the other side

Using an apodized pupil



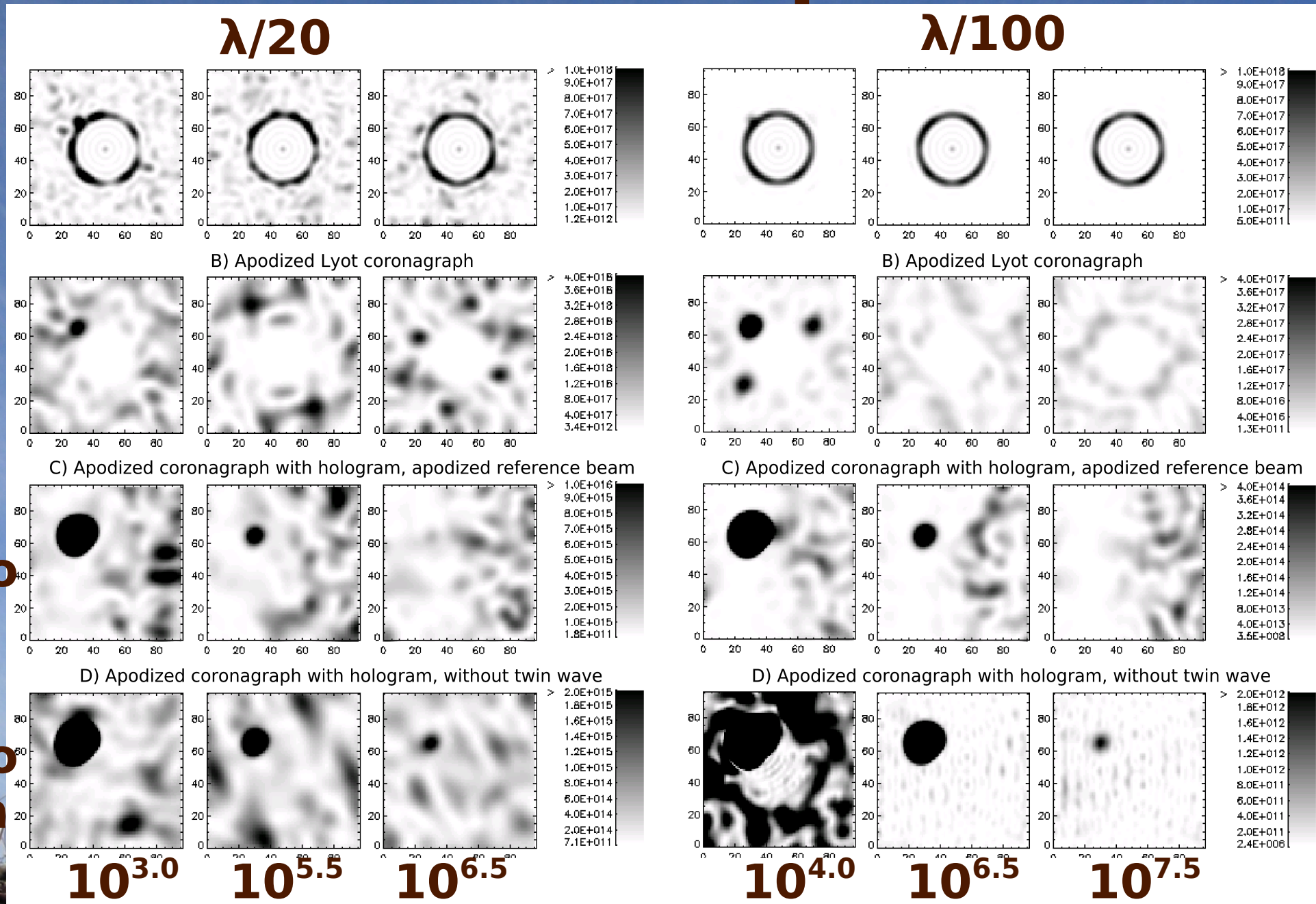


The flux is concentrated within the peak, increasing the effect of the Lyot mask

Testing the performances of...

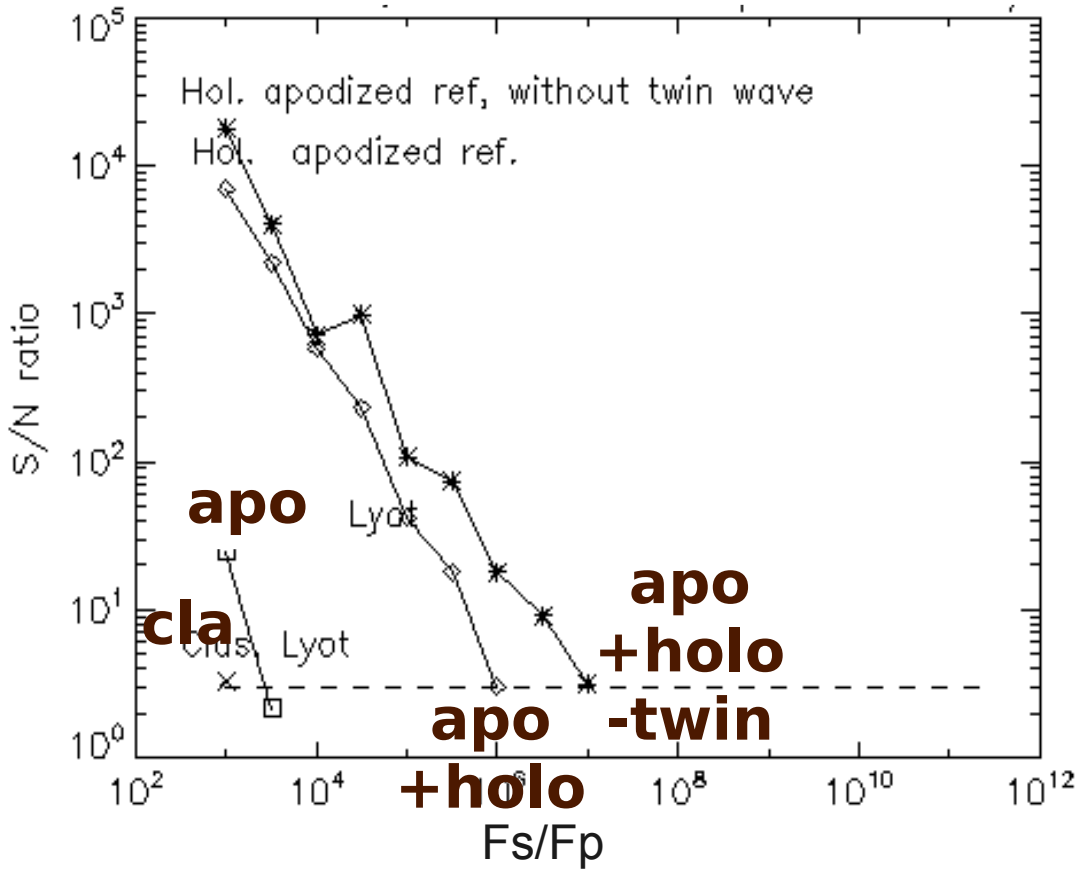
- Classical Lyot coronagraph
- Apodized Lyot coronagraph
- Apodized Lyot coronagraph + adaptive hologram
- Apodized Lyot coronagraph + adaptive hologram and after the subtraction of the twin wave
  - Perfect conditions
  - λ/20 and λ/100 mirror imperfections
  - λ/20 and λ/100 imperfections + photon noise

Performances with wavefront bumpiness

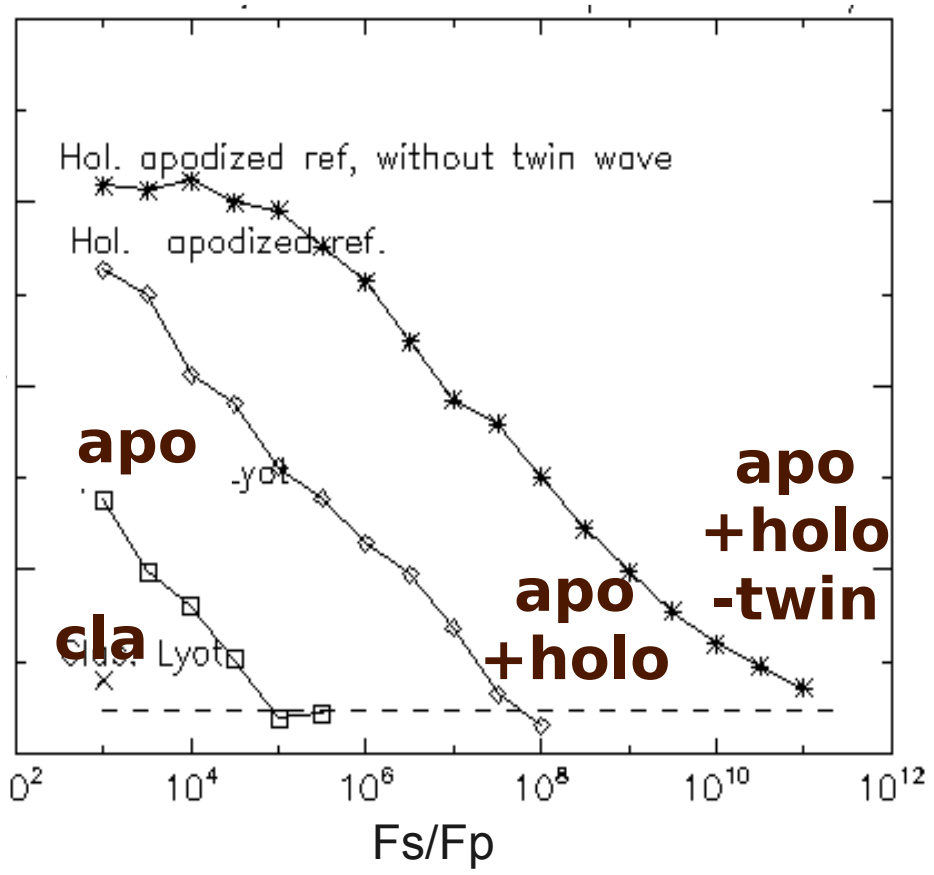


Performances with wavefront bumpiness

λ/20

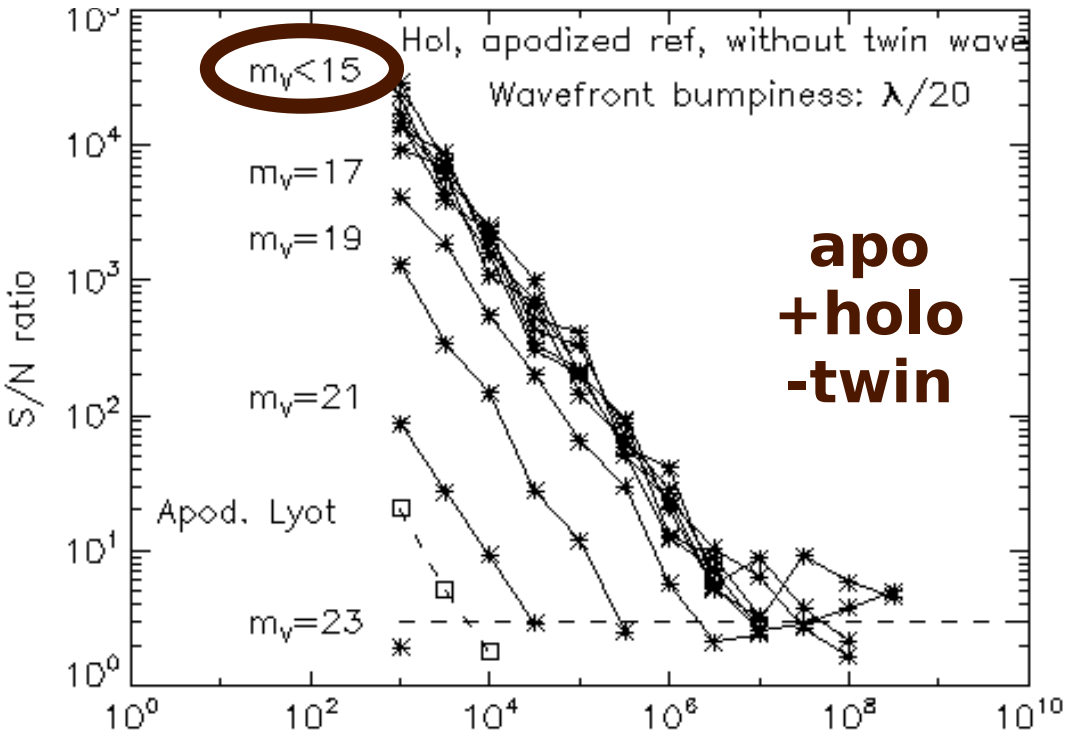


λ/100

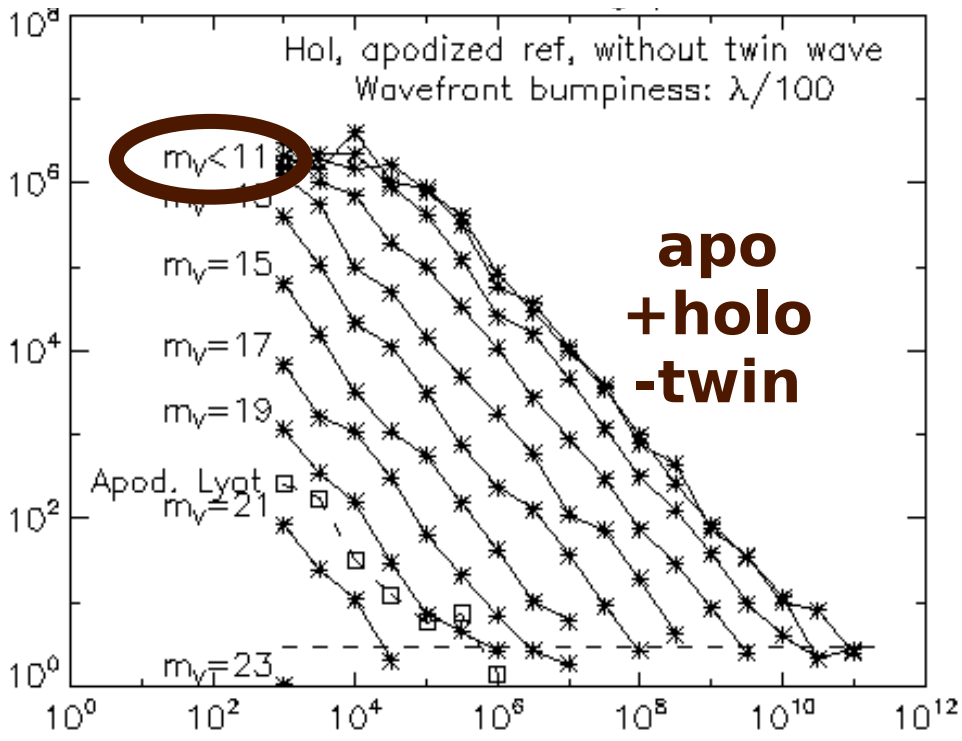


Performances with wavefront bumpiness and photon noise

λ/20



λ/100



Results

	Ideal	λ/100	λ/20
• Classical coronagraph:	$10^{3.2}$	$10^{3.2}$	$10^{3.1}$
• Apodized coronagraph:	$10^{9.5}$	$10^{5.0}$	$10^{3.4}$
• Apodized coron. + hologram:	$10^{10.0}$	$10^{7.8}$	$10^{6.0}$
• Apodized coron. + hologram – twin wave:	$10^{11.0}$	$10^{11.0}$	$10^{7.0}$

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Simulations of exo-planet imaging

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...submitted...