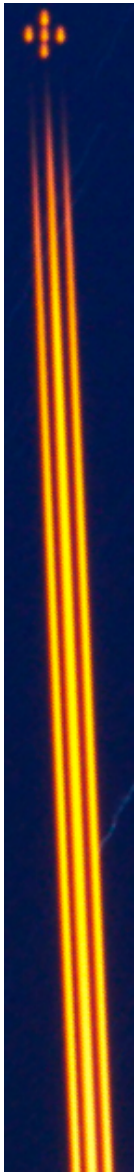


Sodium Photon Return, spot elongation and Fratricide effect:

First on-sky results with GeMS

AO4ELT2 - Victoria - September 26th-30th

B. Neichel, F. Rigaut, M. Bec*, M. Boccas, V. Fesquet, C. d'Orgeville, G. Trancho*

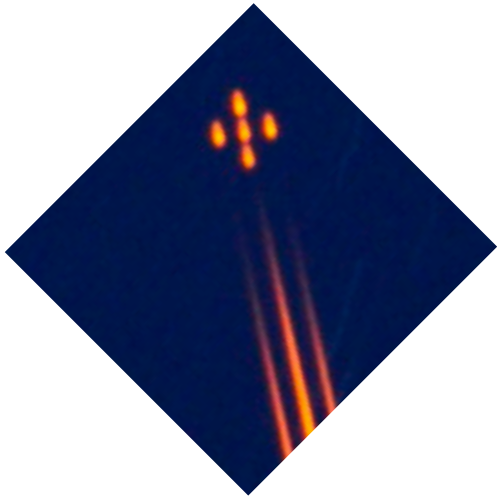
Gemini Observatory
(*) GMTO

Outline of the presentation

Photon Return & Spot Elongation

Rayleigh Diffusion & Fratricide Effect

Sodium Photon return

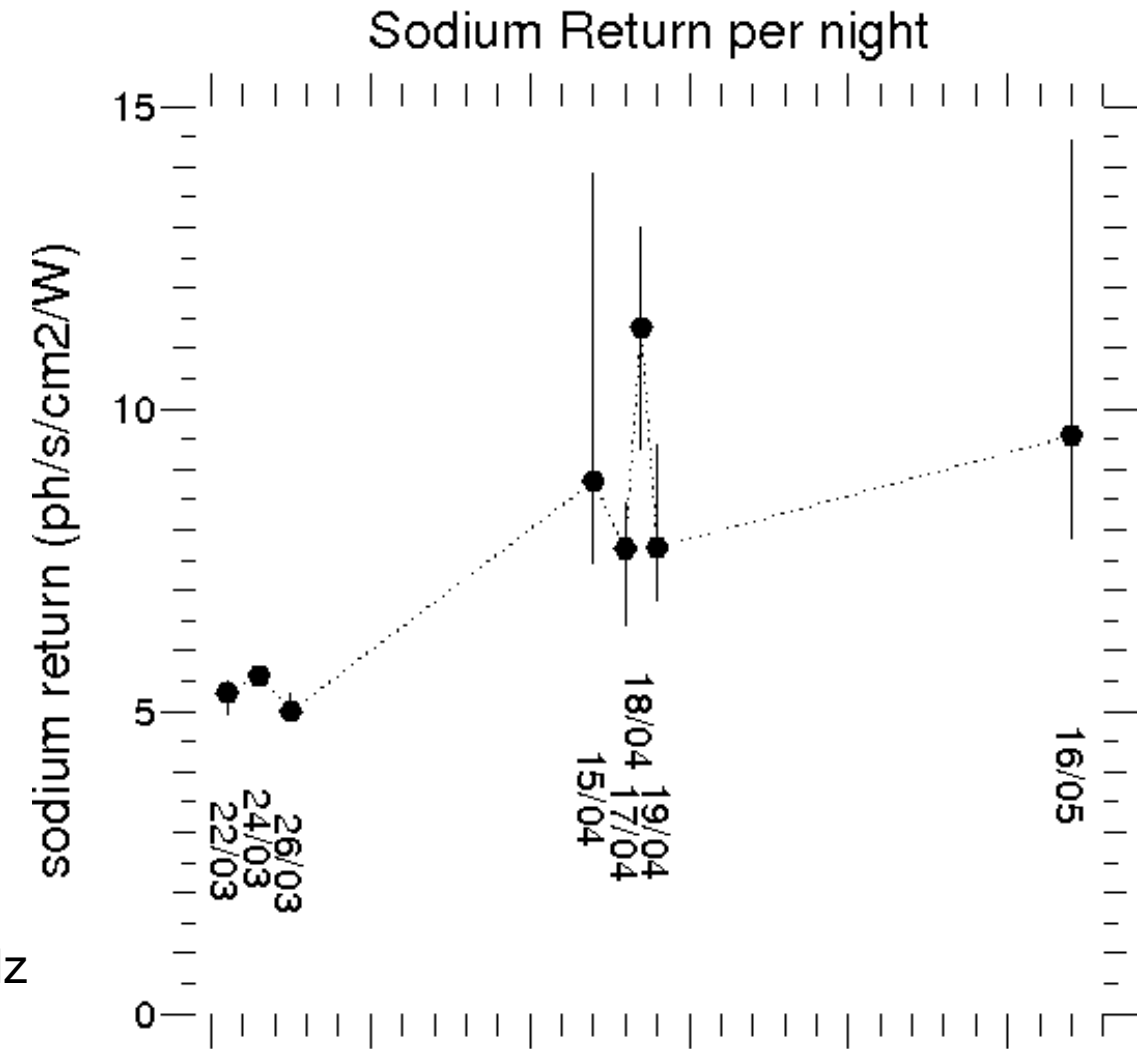


Large flux variation within few months.

March	5.4 ph/s/cm2/W
April	8.7 ph/s/cm2/W
May	9.5 ph/s/cm2/W

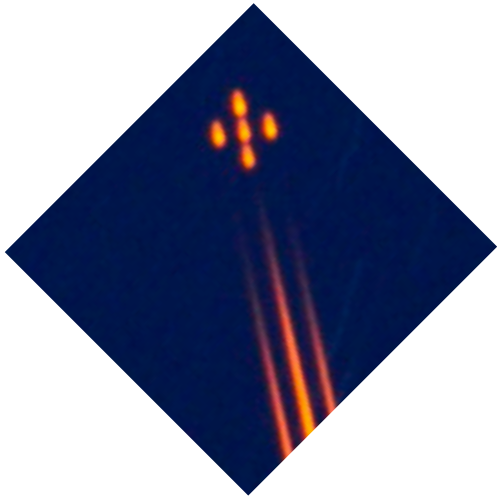
W == Watts propagated on-sky

10 ph/s/cm2/W
=> 35 ph/frame/pix @ 800Hz



Sodium photon return computed at the LGSWFS

Sodium Photon return



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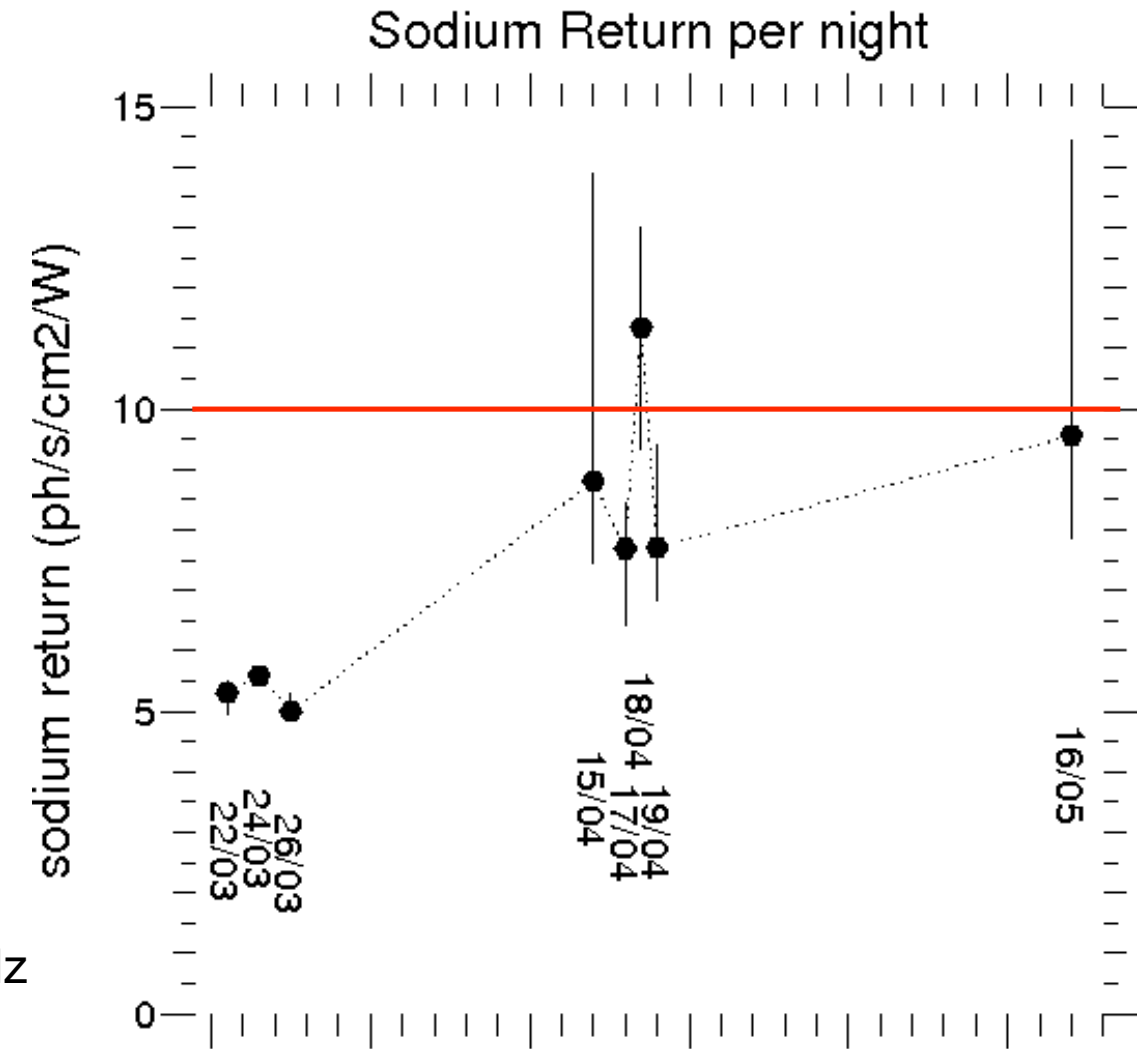

Sodium photon return computed at the LGSWFS

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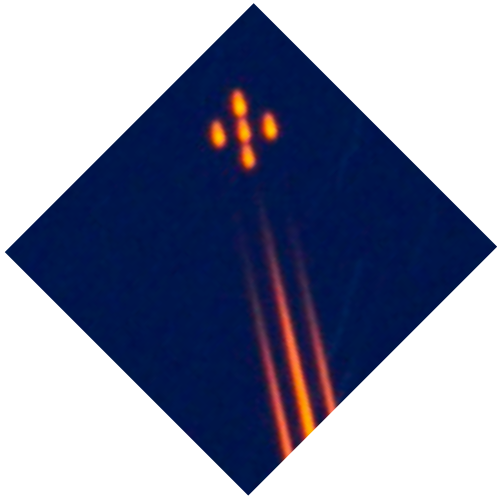

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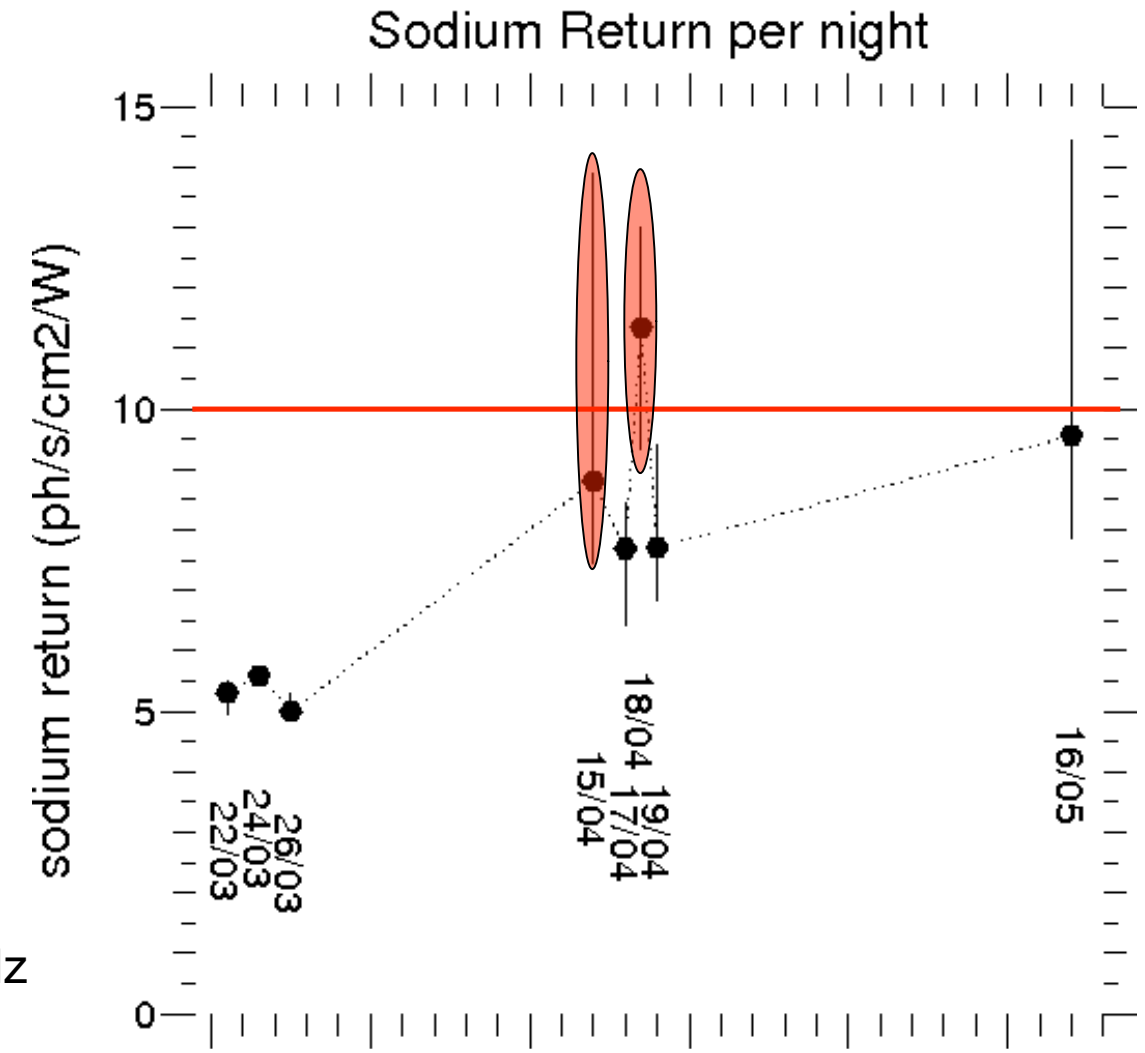
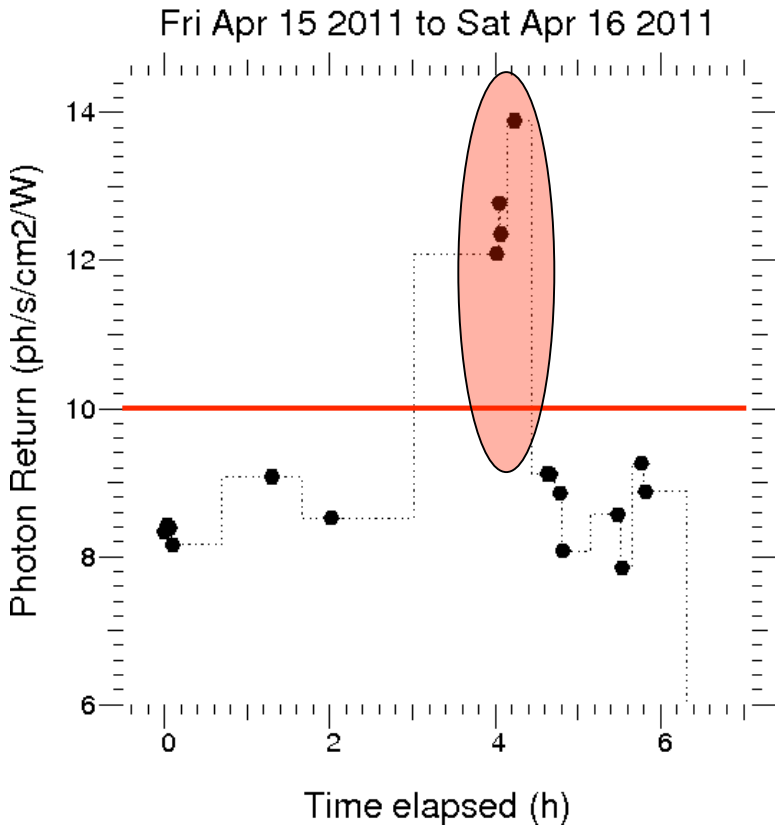
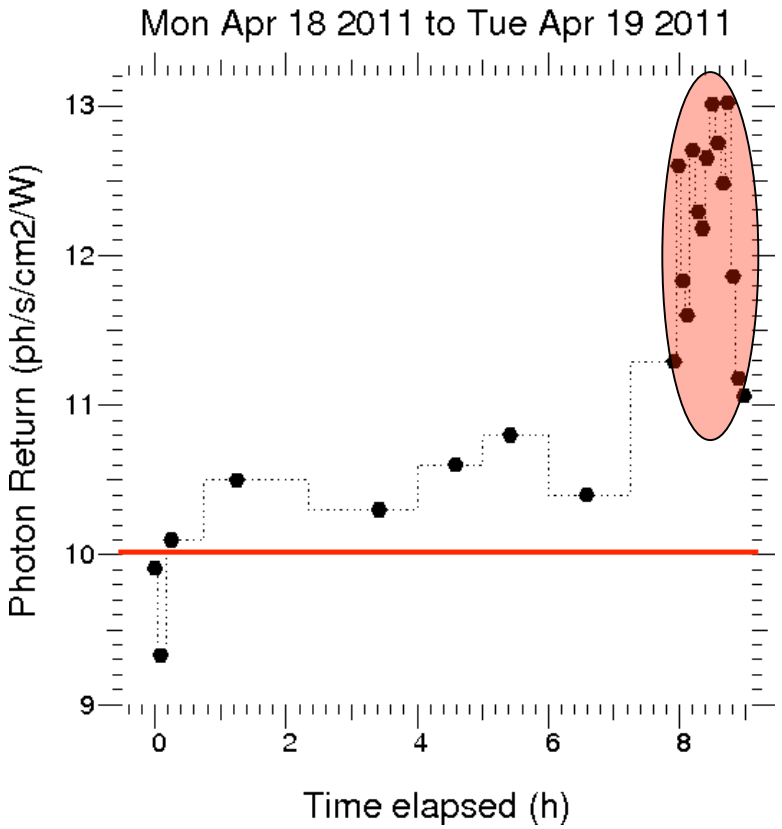


Sodium photon return computed at the LGSWFS

Sodium Photon return

Sporadic increased the flux by up to 50% !

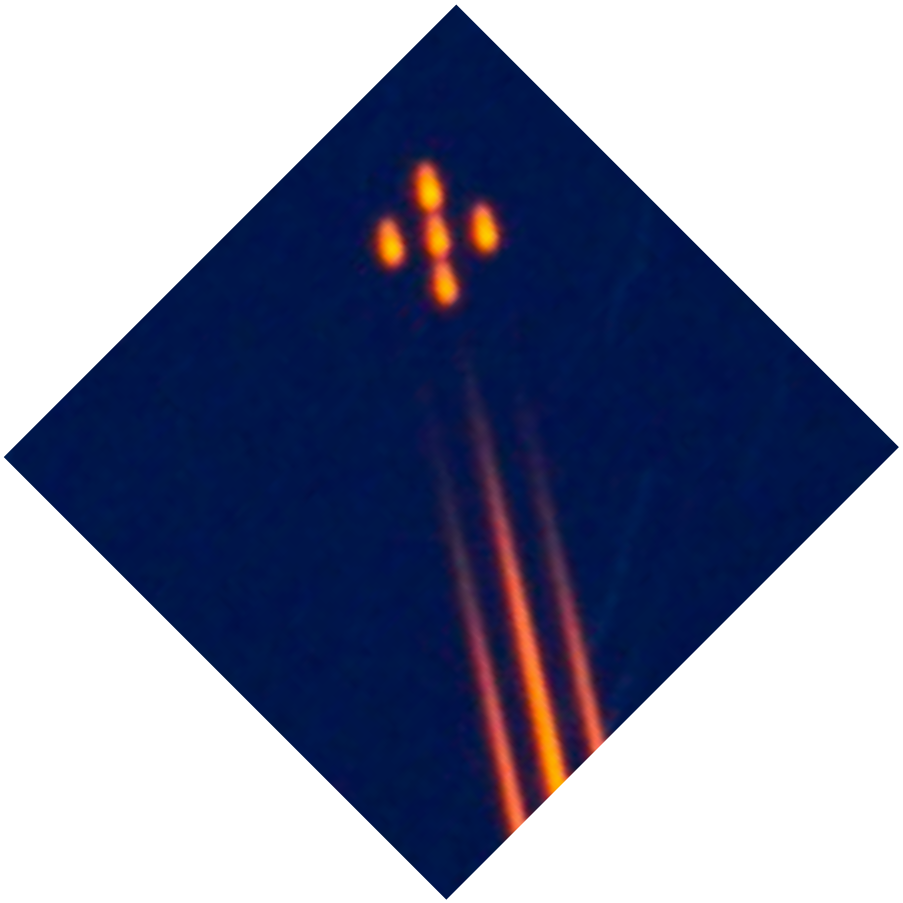




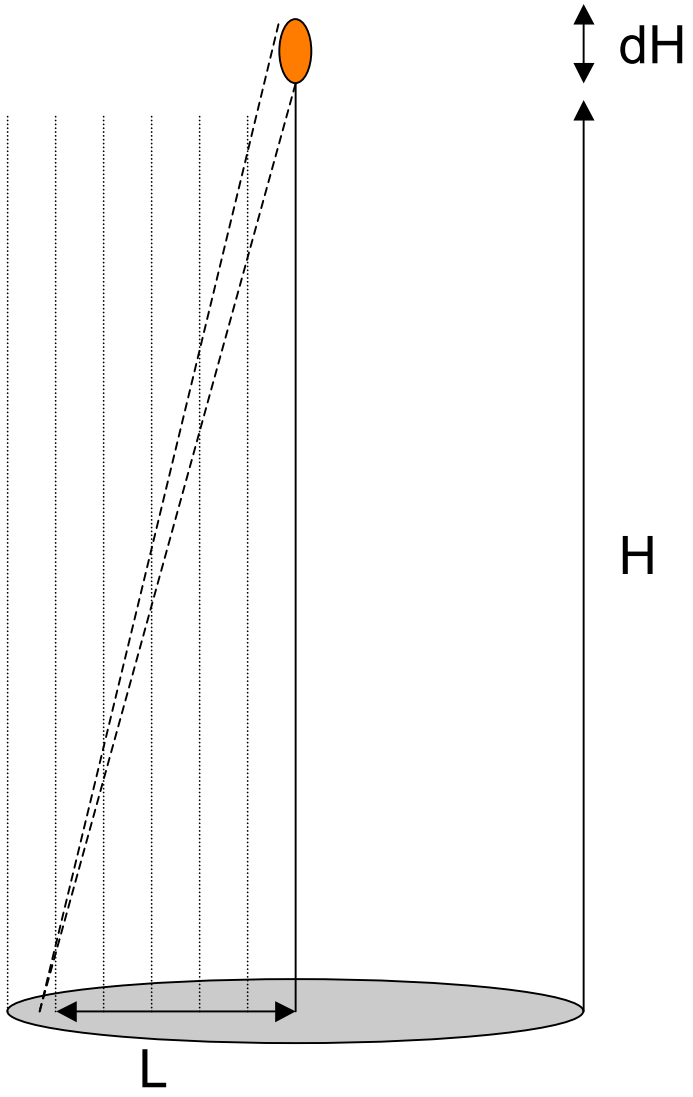
=> Sodium return can change

=> Should be included in the reconstructors / optimization procedures

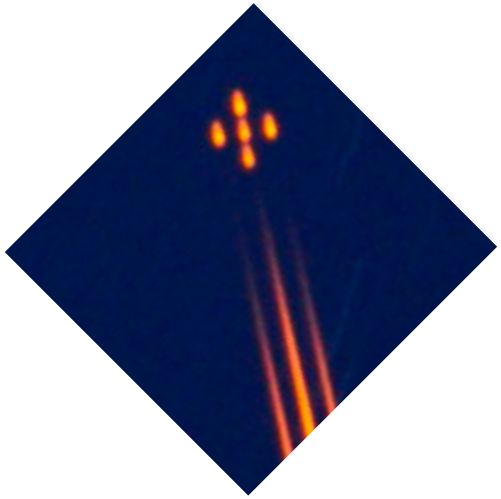
Spot elongation



$$\alpha \simeq \frac{L.\Delta H}{H^2 + H.\Delta H}$$

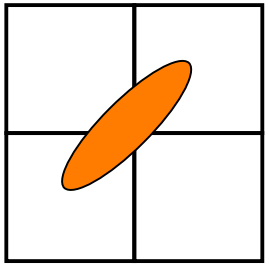


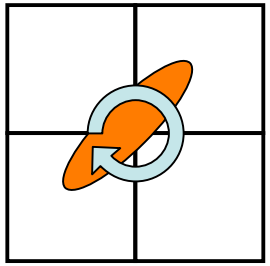
Spot elongation



LGSWFS are using Quad-cells
Spot size is measured with a Dithering method

Gratadour, Rigaut, OSA 2003

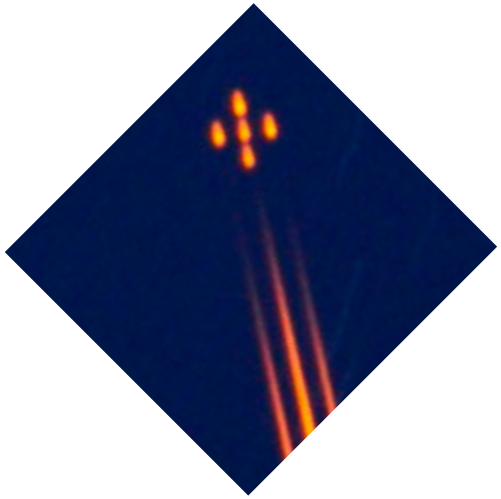




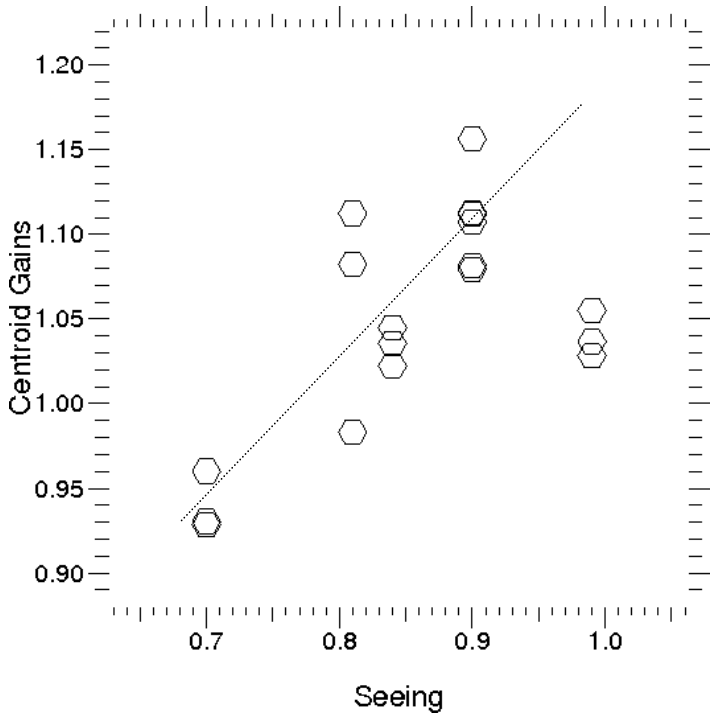
Projection onto (X,Y,R) => Elongation => Na layer thickness

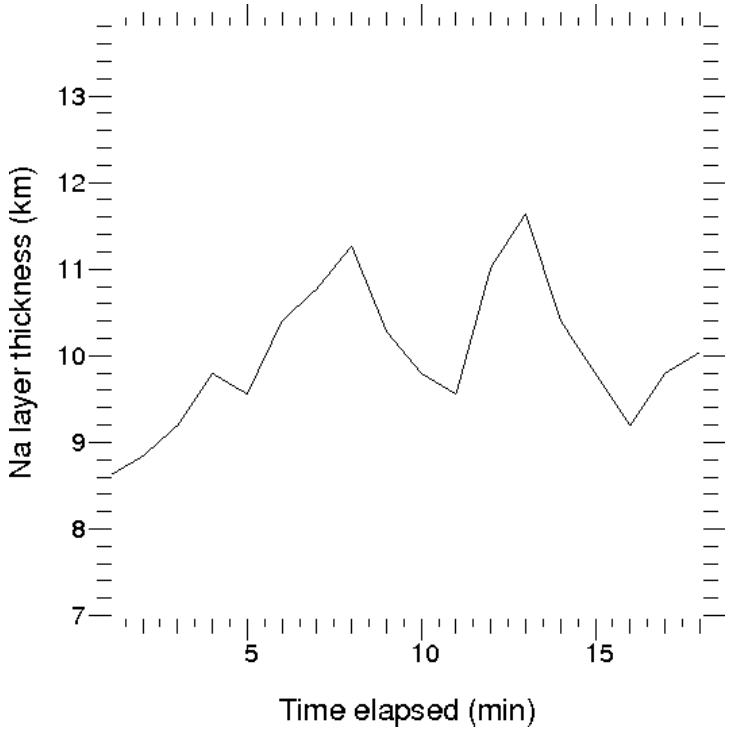
$$\alpha \simeq \frac{L.\Delta H}{H^2 + H.\Delta H} \quad \Rightarrow \quad \Delta H \simeq \frac{\alpha H^2}{L - \alpha H}$$

Spot elongation



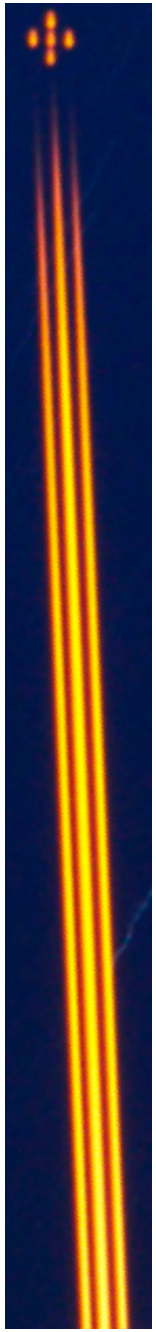
First ***preliminary*** results

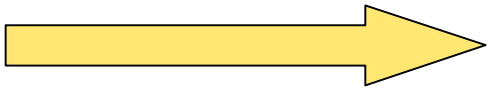


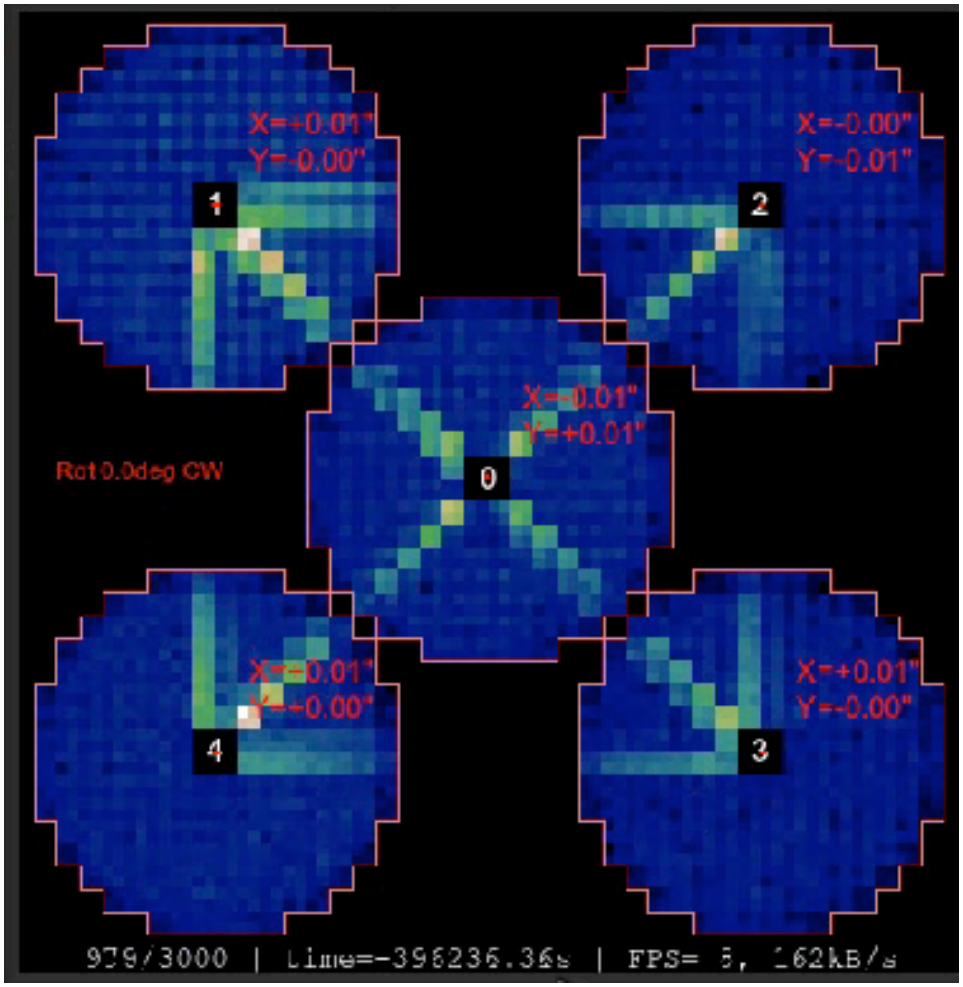


=> Monitoring of Sodium layer thickness every ~10s.

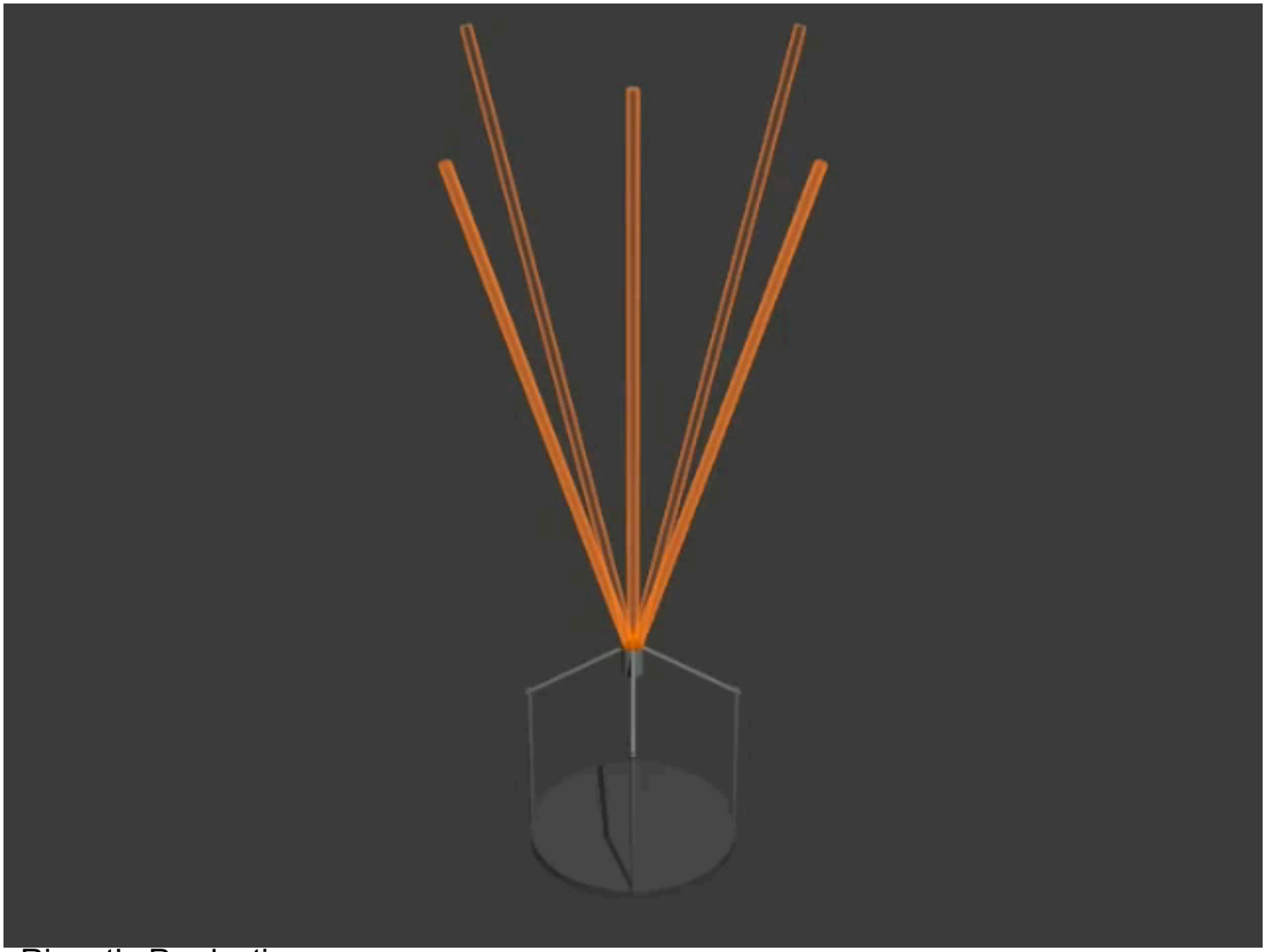
Laser “Fratricide” effect

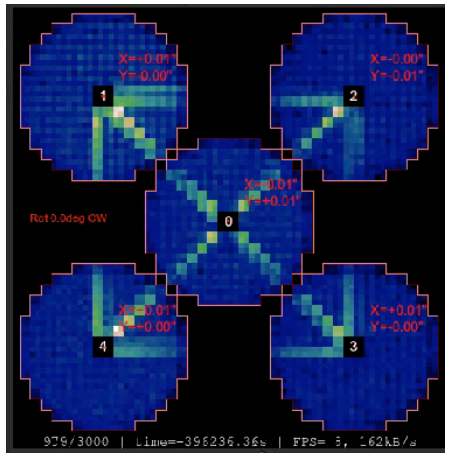






Laser “Fratricide” effect

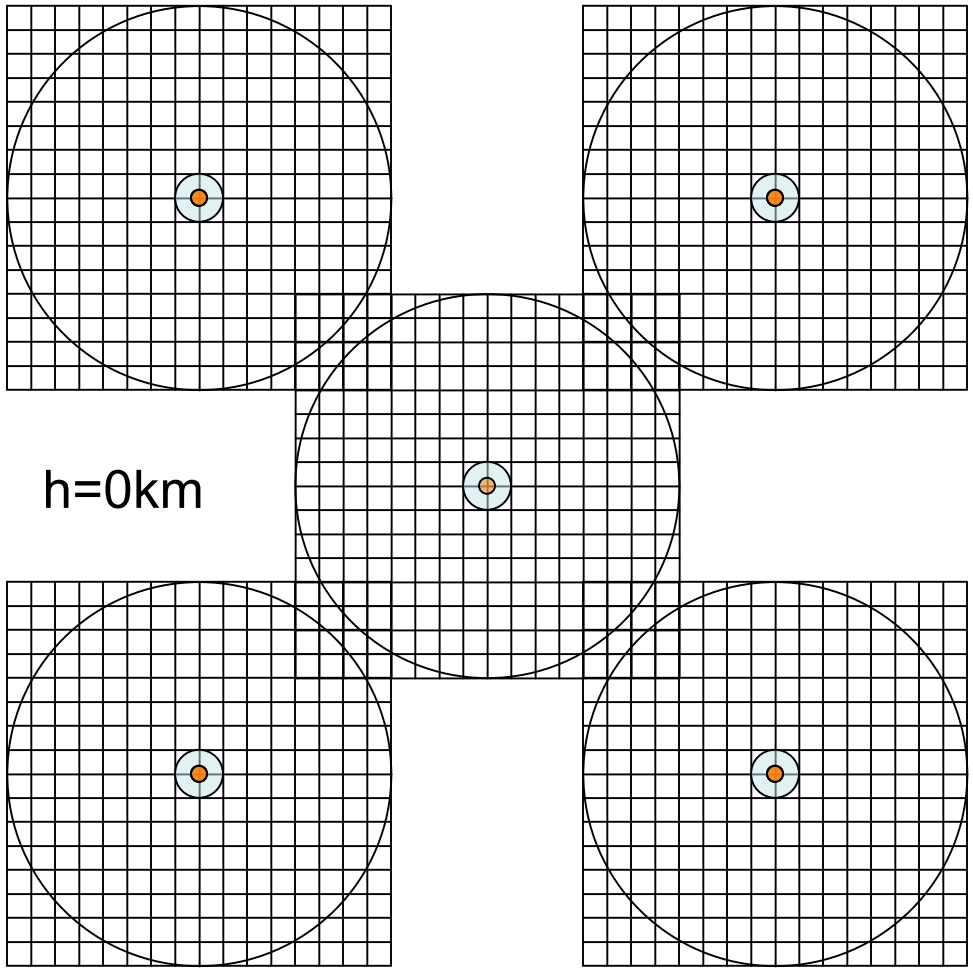


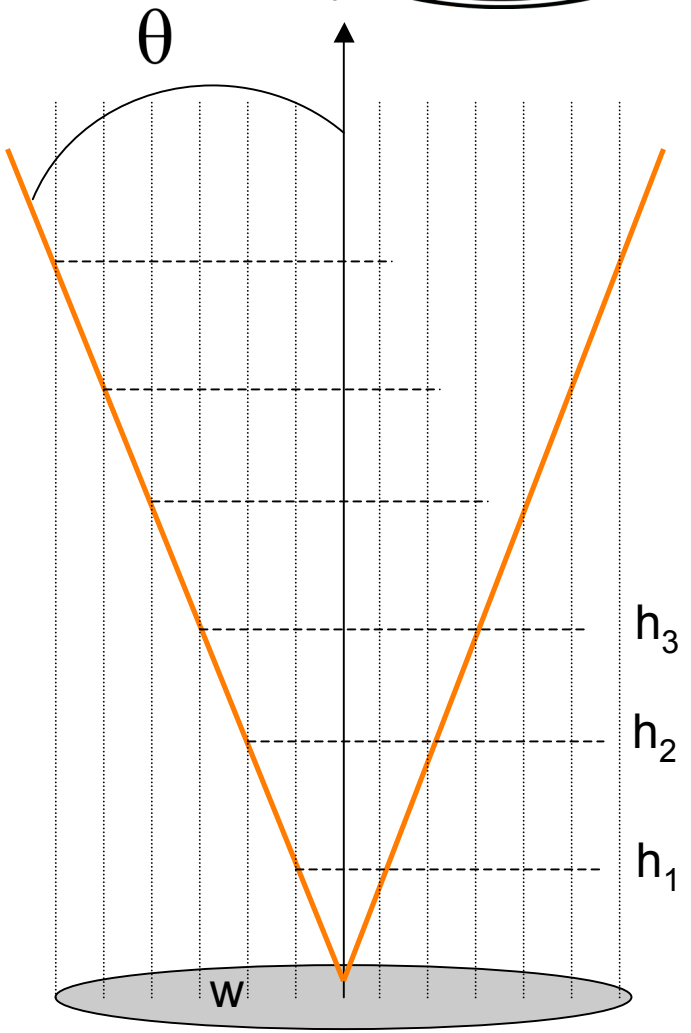


Rigaut’s Production

Laser “Fratricide” effect

Modeling of the Fratricide:





$I(h) = k \cdot \exp(-h / \text{ScaleHeight})$

h_1 { 3.4km / 6.9km } h_{max} { 27.5km / 41.2km }

Laser “Fratricide” effect

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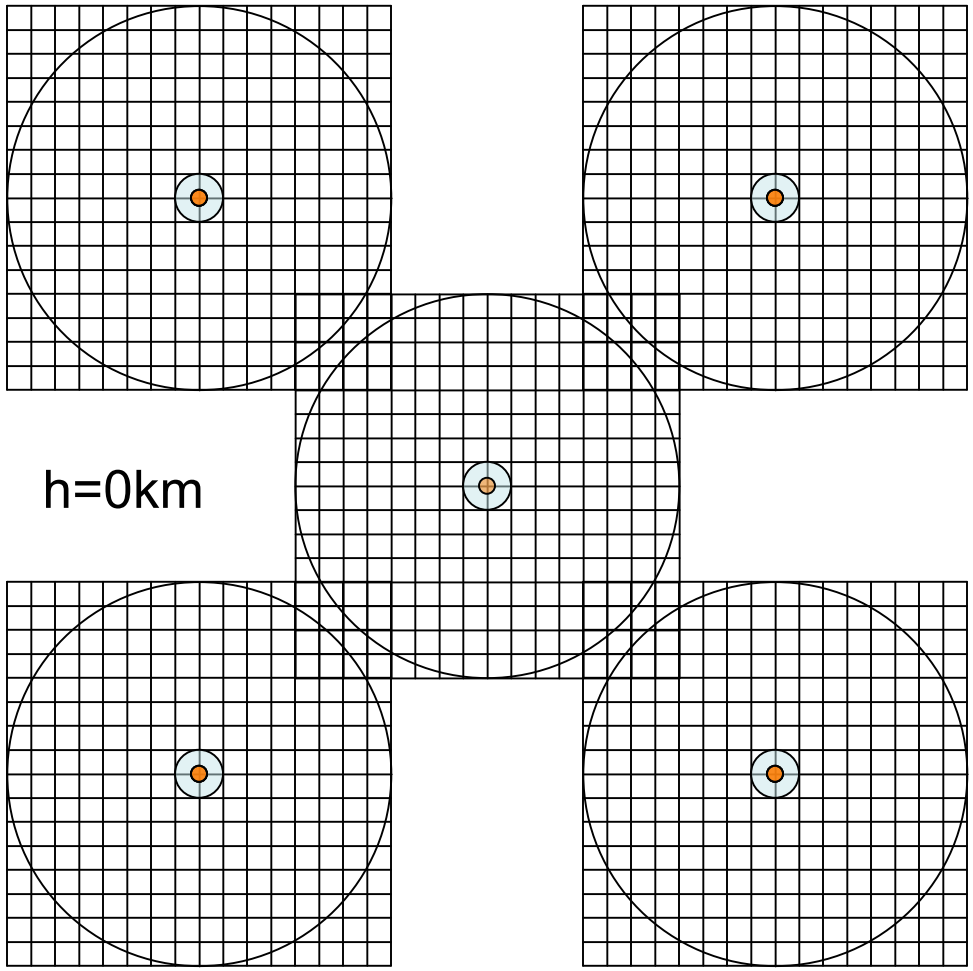

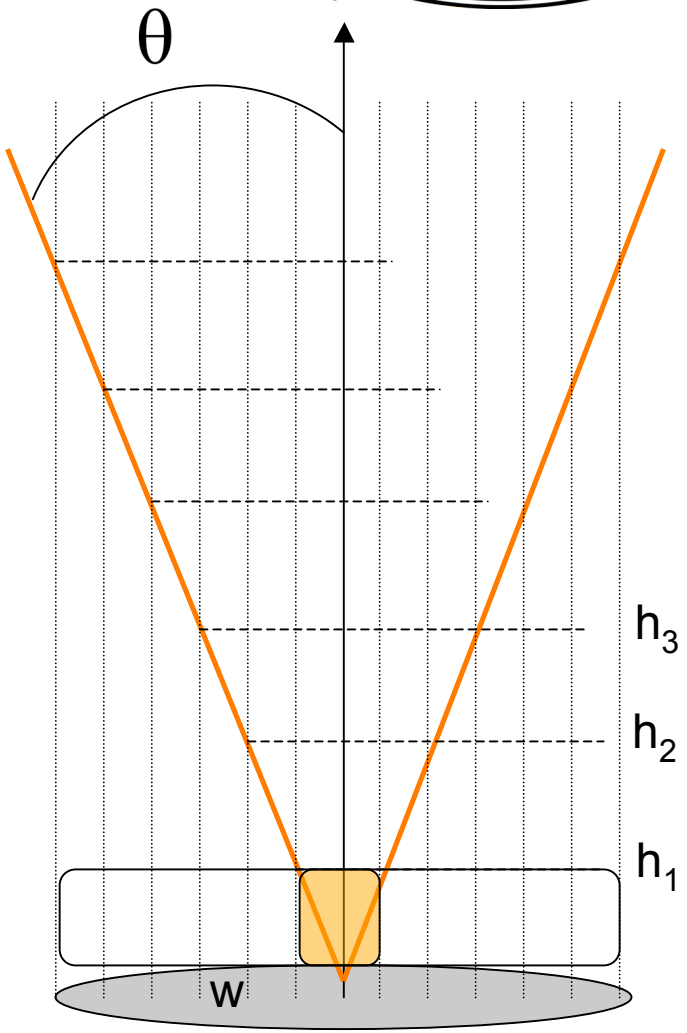

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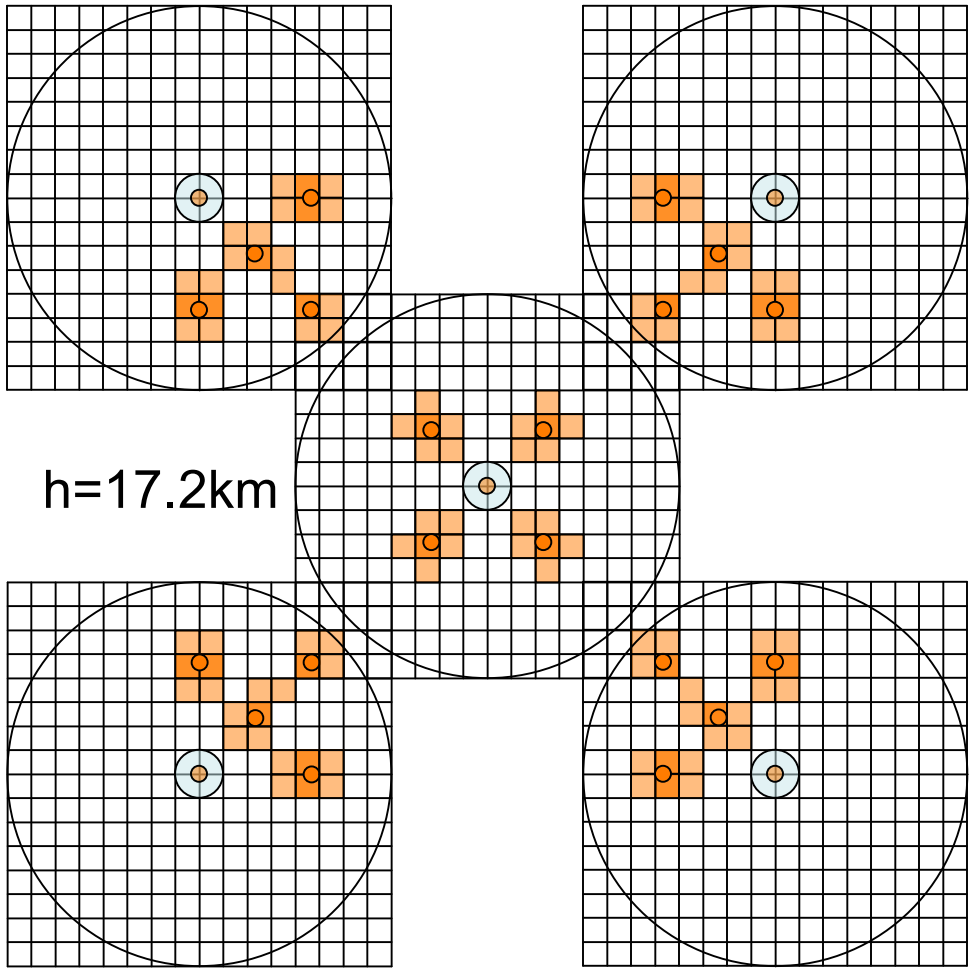

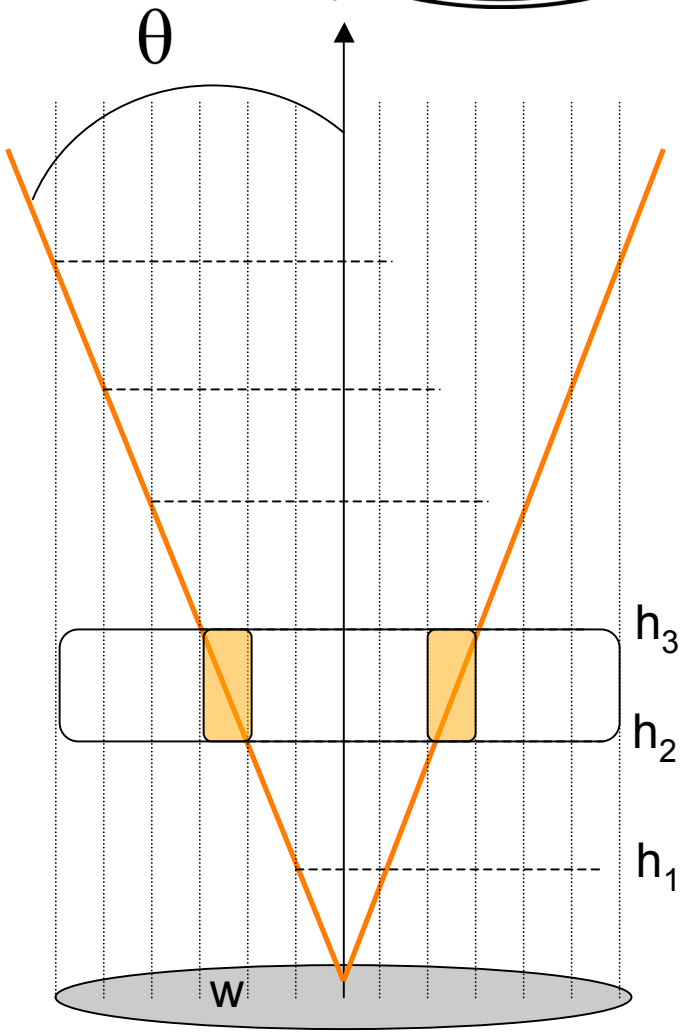

$I(h) = k \cdot \exp(-h / \text{ScaleHeight})$

$h_1 \begin{cases} 3.4\text{km} \\ 6.9\text{km} \end{cases}$ $h_{max} \begin{cases} 27.5\text{km} \\ 41.2\text{km} \end{cases}$

Laser “Fratricide” effect

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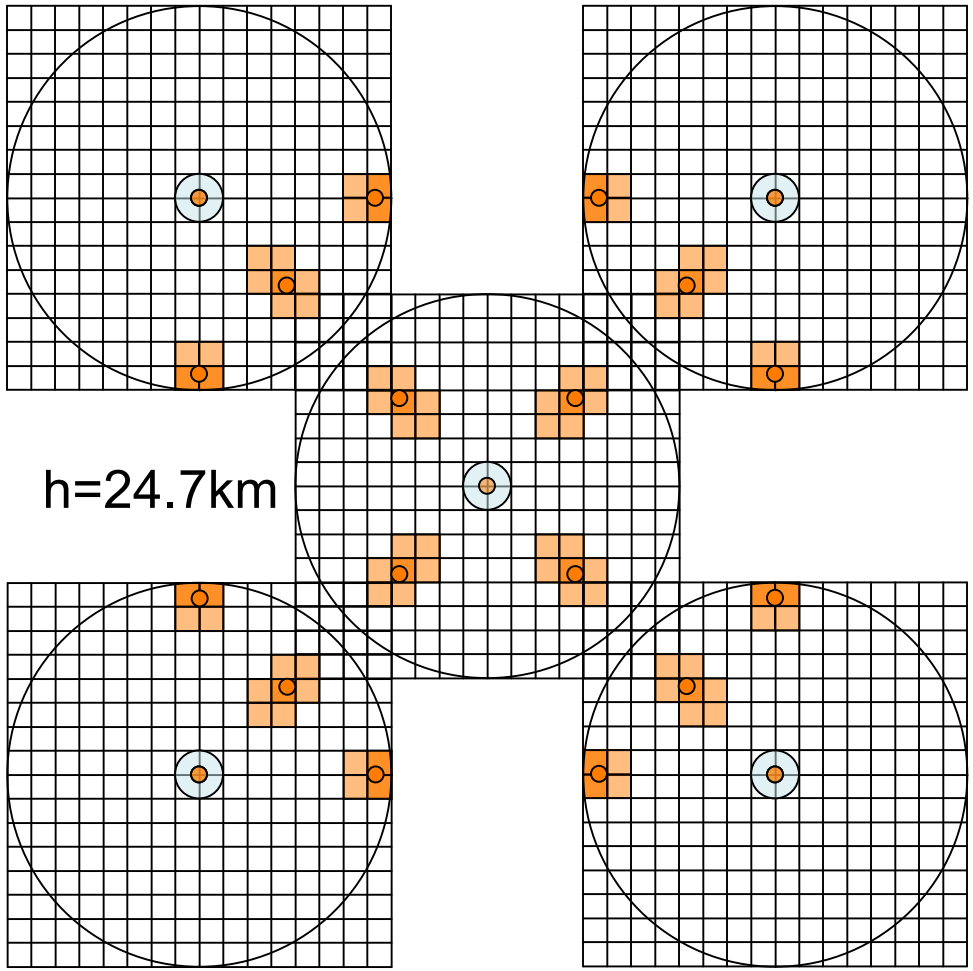

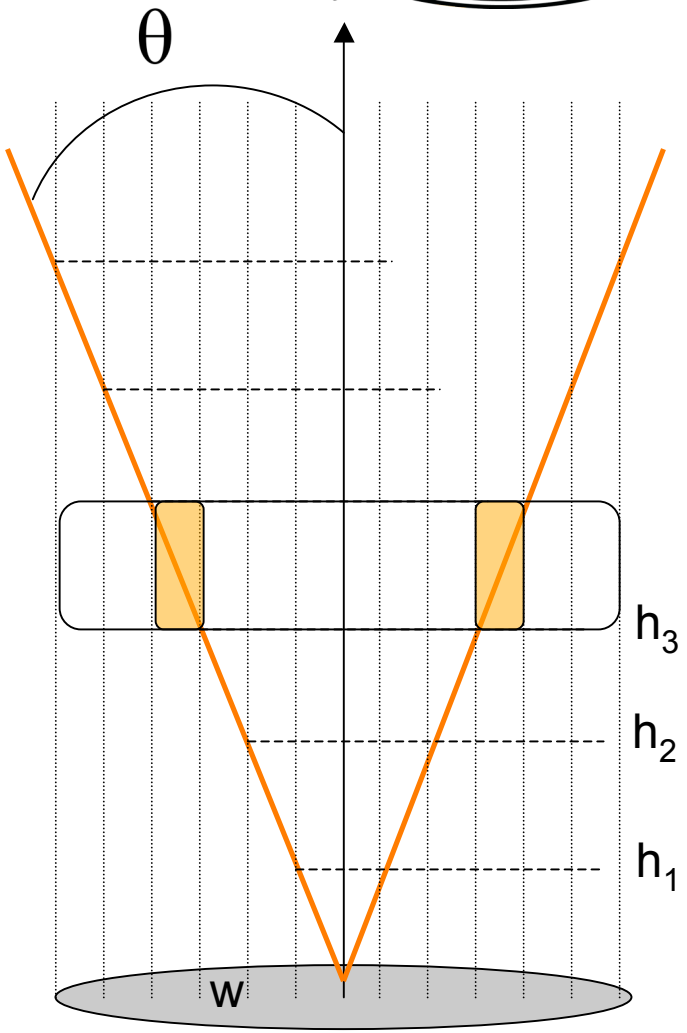

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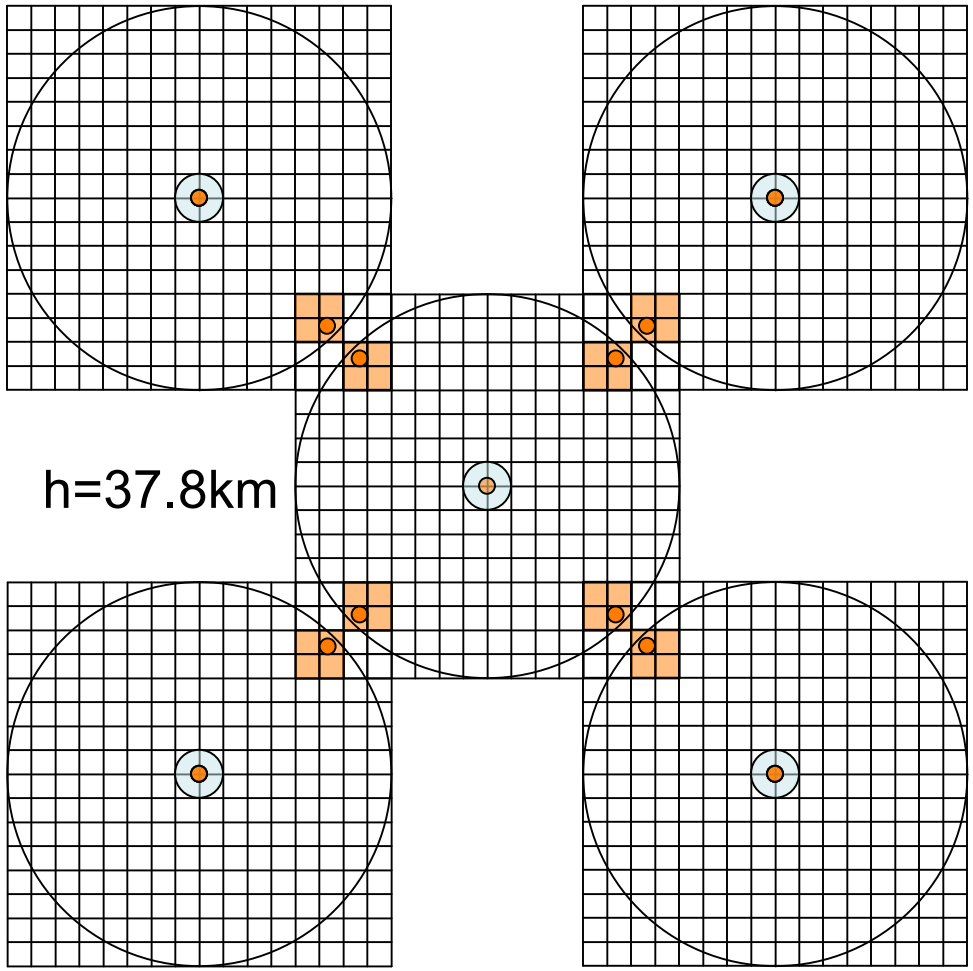

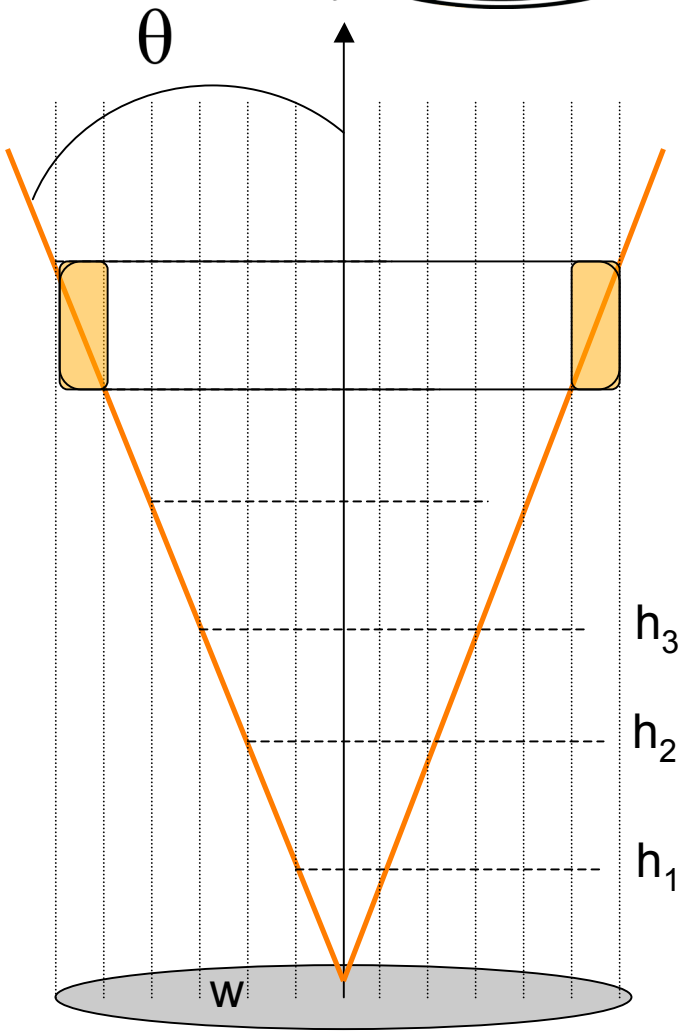

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Laser “Fratricide” effect

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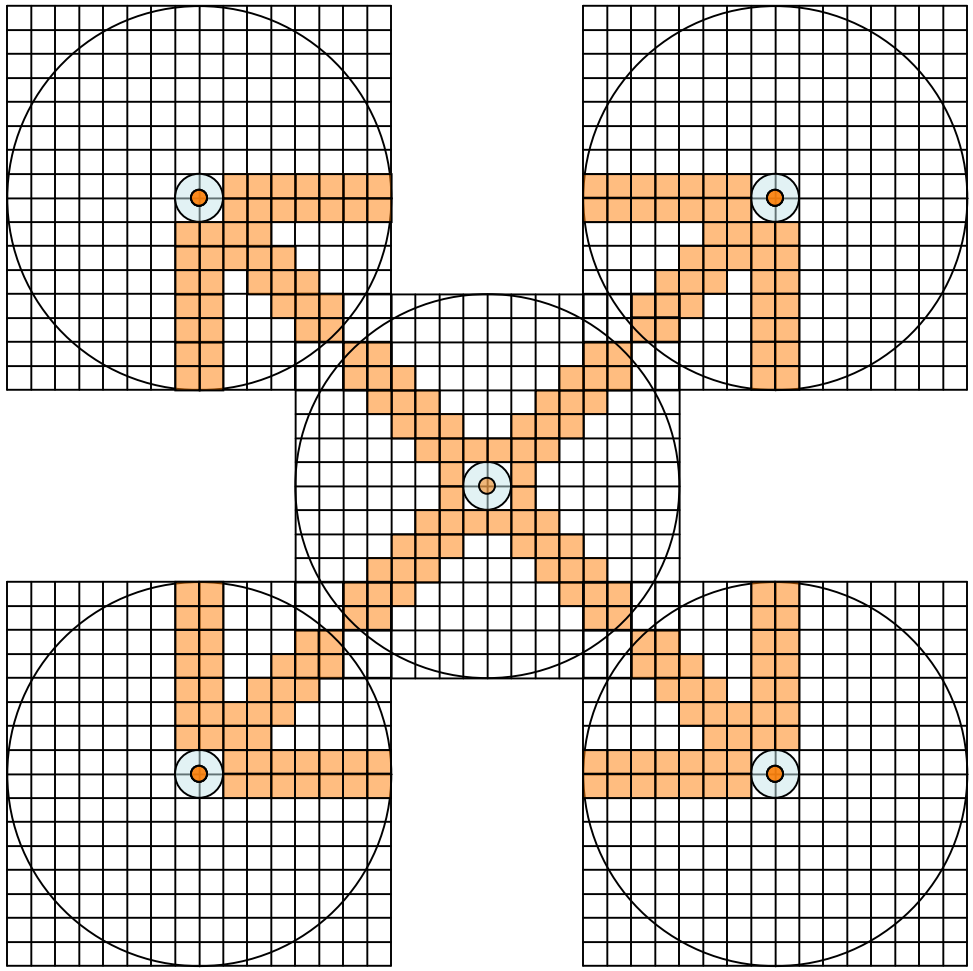
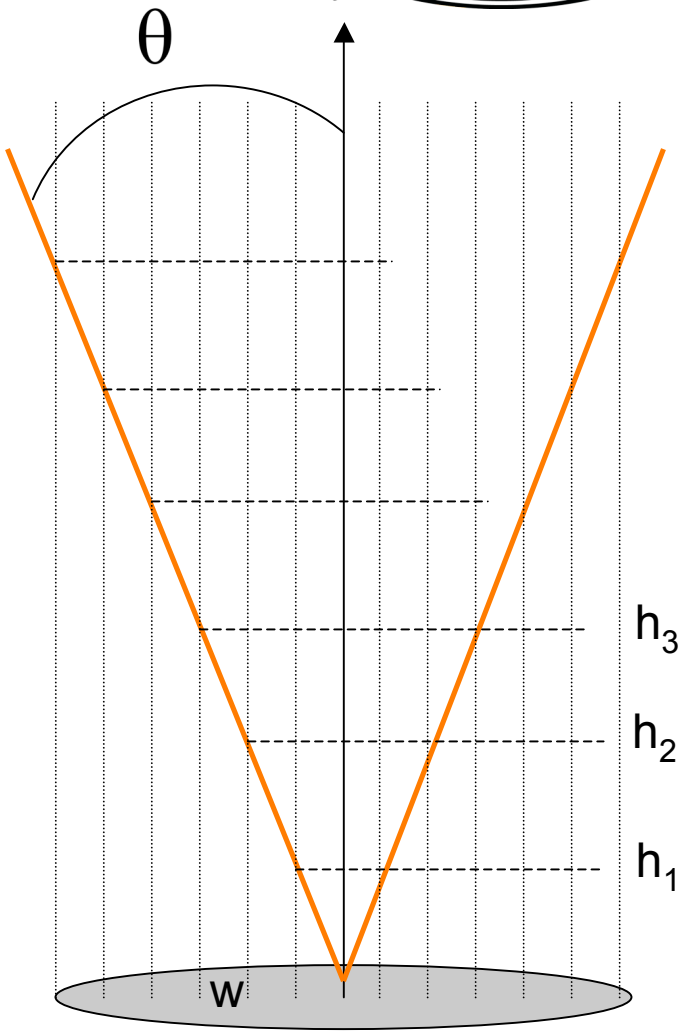




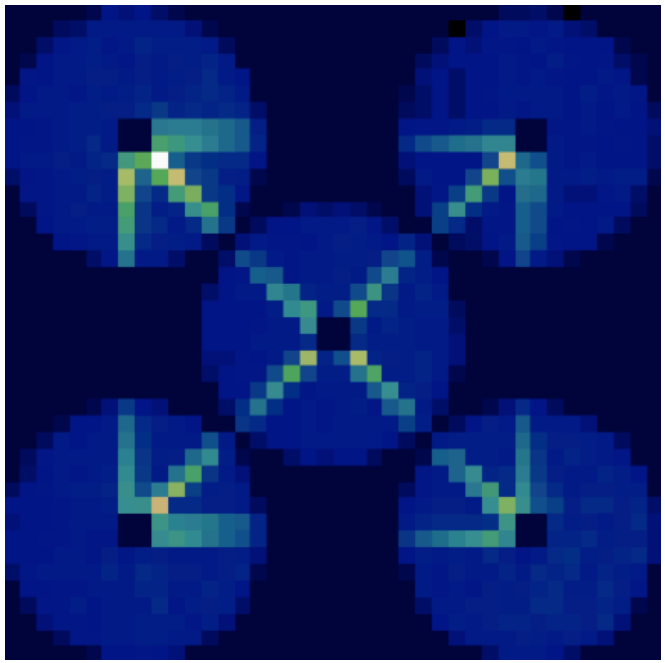
I(h) = k . Exp(-h / ScaleHeight)
+ Rotation + Offsets + LLT beam position

h_1 { 3.4km / 6.9km

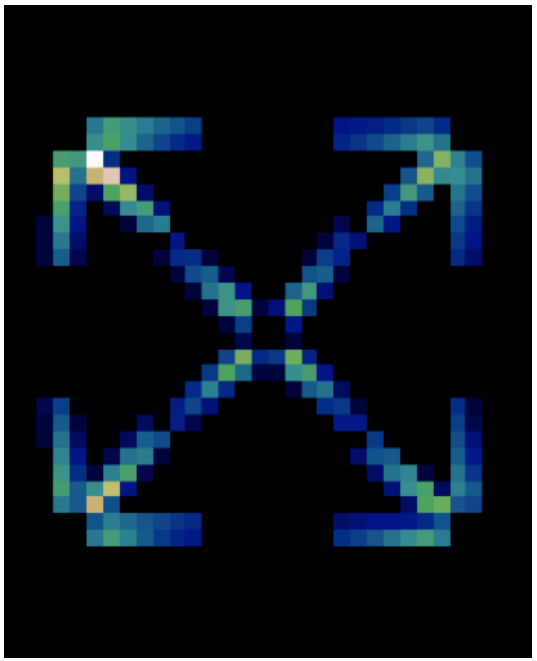
h_{max} { 27.5km / 41.2km

Laser “Fratricide” effect

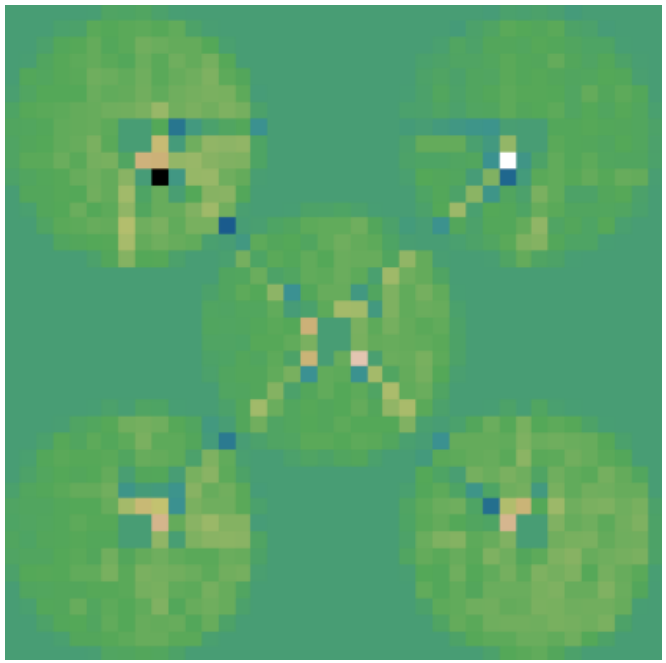
Modeling of the Fratricide: Fitting data



Data



Model



Residual

Offsets = -1.8, -0.1 arcsec

Flux = +3.3, Angle +0.8 degree

Scale height = +5.1km

LLT offsets, beam 0: +1.7, -8.6 cm

LLT offsets, beam 1: -7.0, -12.5 cm

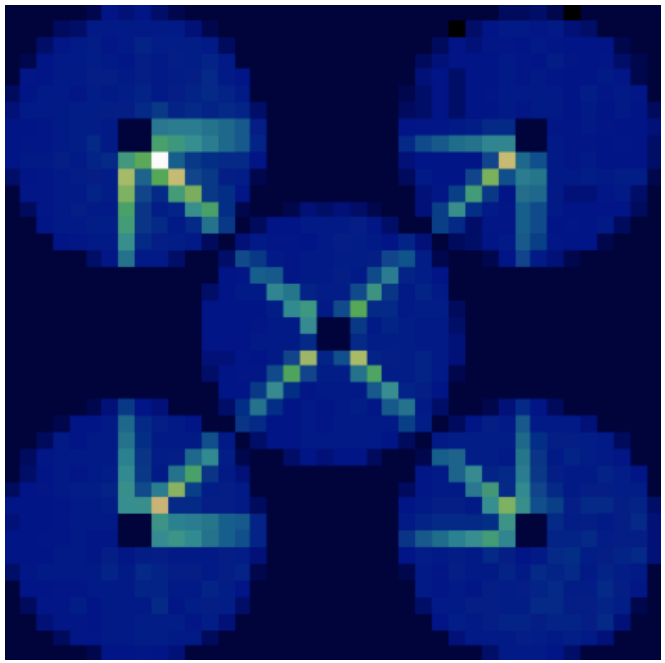
LLT offsets, beam 2: +7.1, -14.2 cm

LLT offsets, beam 3: +2.2, -8.4 cm

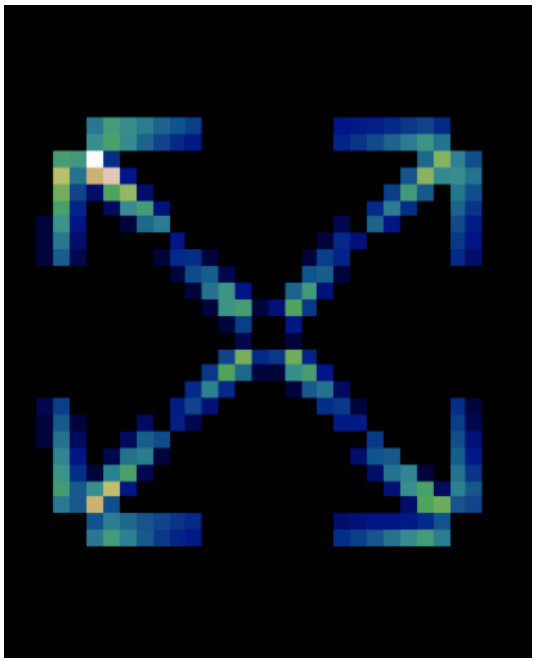
LLT offsets, beam 4: +3.2, -15.0 cm

Laser “Fratricide” effect

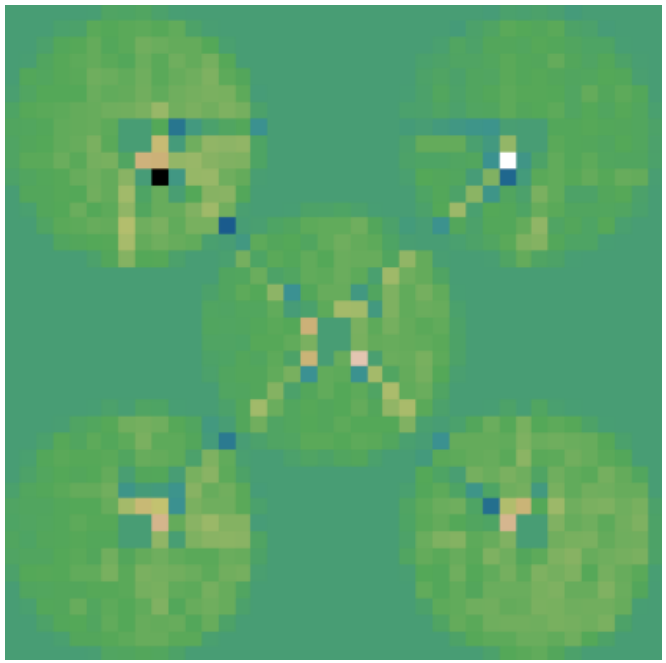
Modeling of the Fratricide: Fitting data



Data



Model



Residual

Offsets = -1.8, -0.1 arcsec

Flux = +3.3, Angle +0.8 degree

Scale height = +5.1km

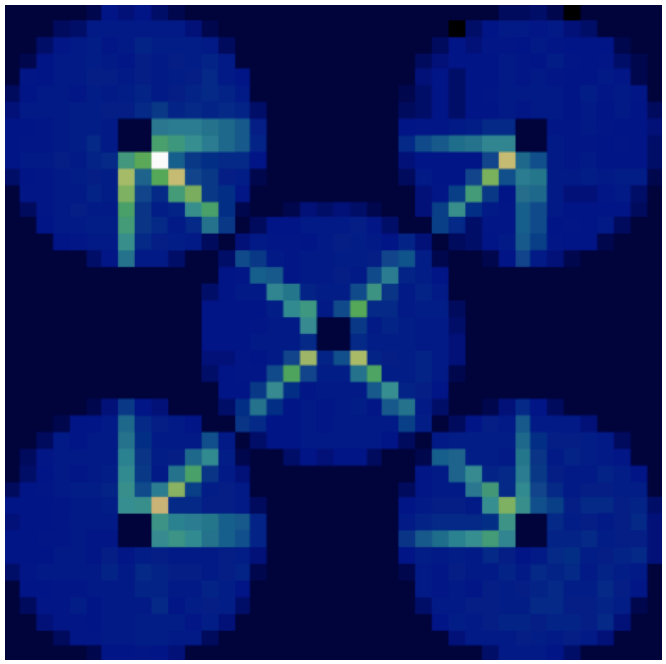
Average scale height of earth = 7.64 km

US Naval Research Laboratory
www.nrl.navy.mil/research/nrl-review/2003/atmospheric-science/picone/

Cerro Pachon = 2.6km

Laser “Fratricide” effect

Impact of Fratricide on the slopes: Can we calibrate it ?



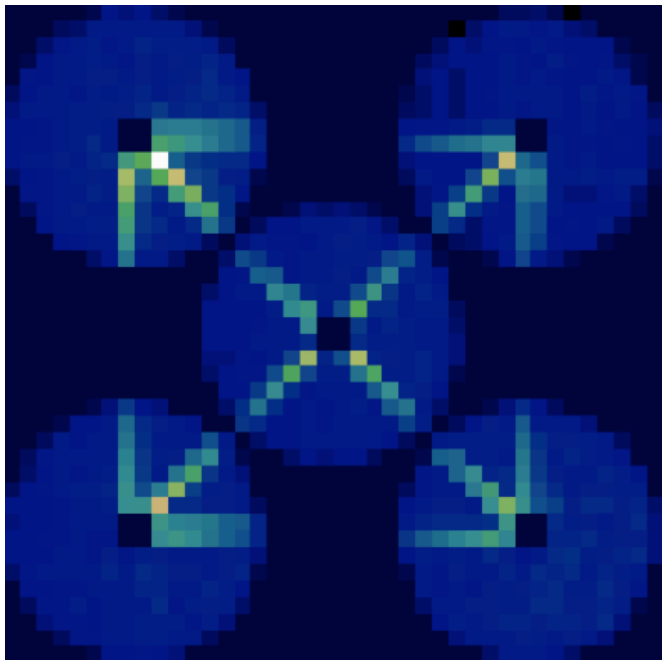
WFS subapertures flux

Initial strategy was:

1. Detune the Laser
2. Acquire a dark
3. Subtract dark

Laser “Fratricide” effect

Impact of Fratricide on the slopes: Can we calibrate it ?

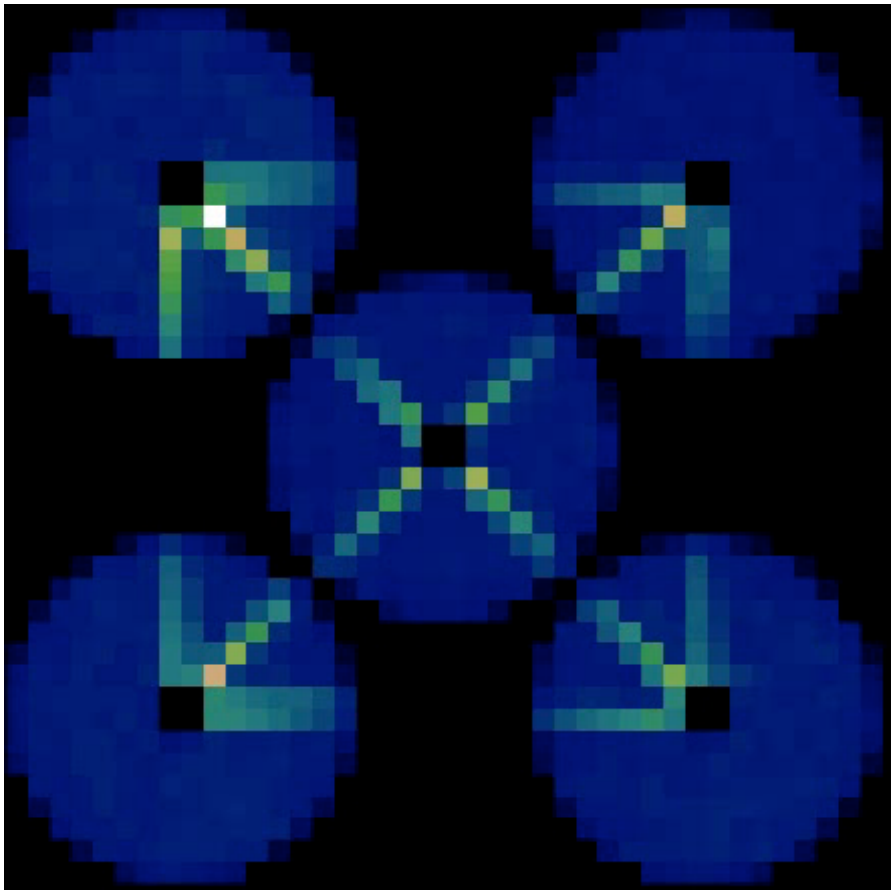


WFS subapertures flux

Initial strategy was:

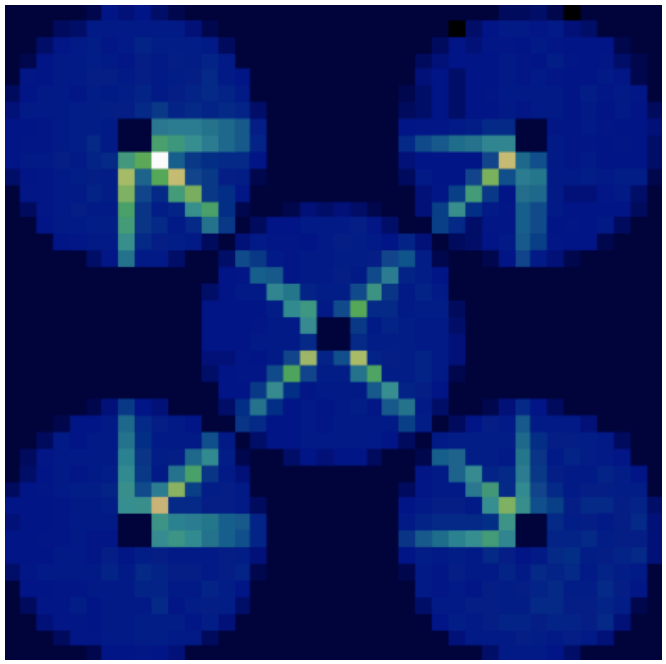
1. Detune the Laser
2. Acquire a dark
3. Subtract dark

But…



Laser “Fratricide” effect

Impact of Fratricide on the slopes: Can we calibrate it ?



WFS subapertures flux

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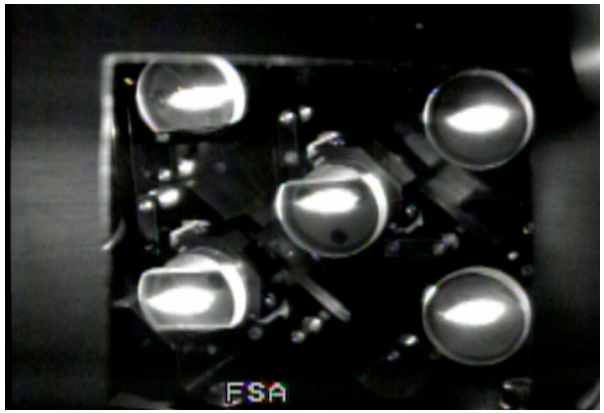
Rayleigh modulation due to Fast Steering Mirrors

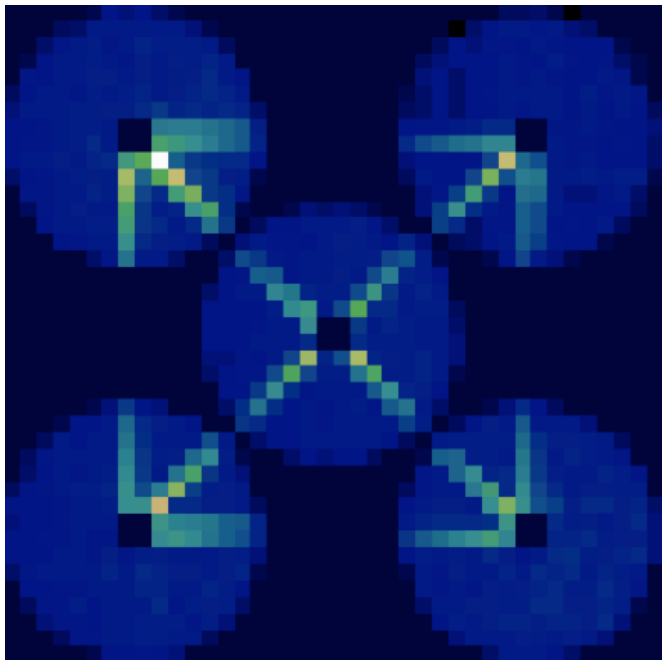


=> Not in pupil plane

=> Jitter of the beams on the LLT

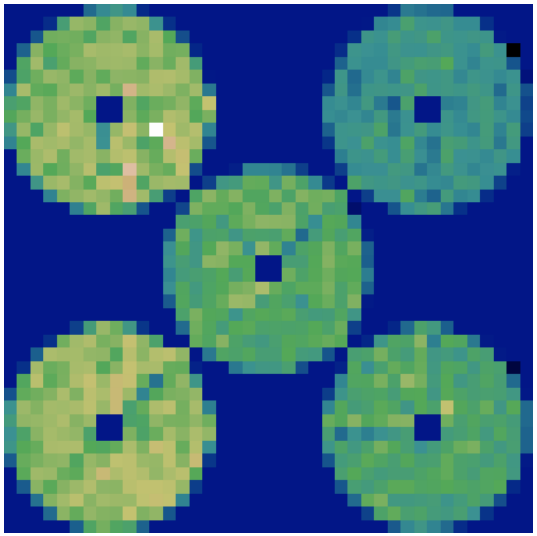
Laser “Fratricide” effect

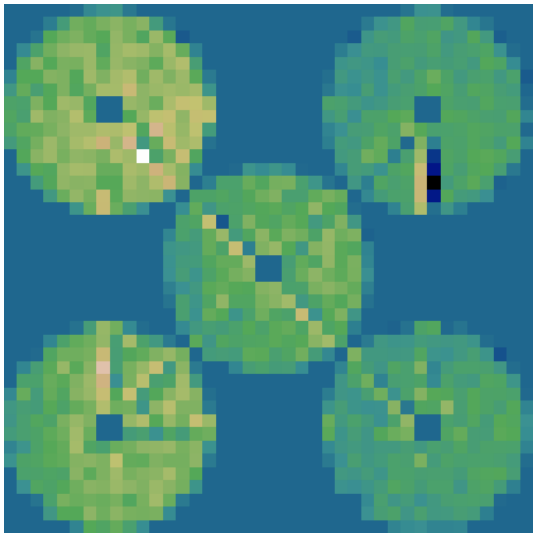
Impact of Fratricide on the slopes: Can we calibrate it ?



WFS subapertures flux

With Rayleigh background subtracted





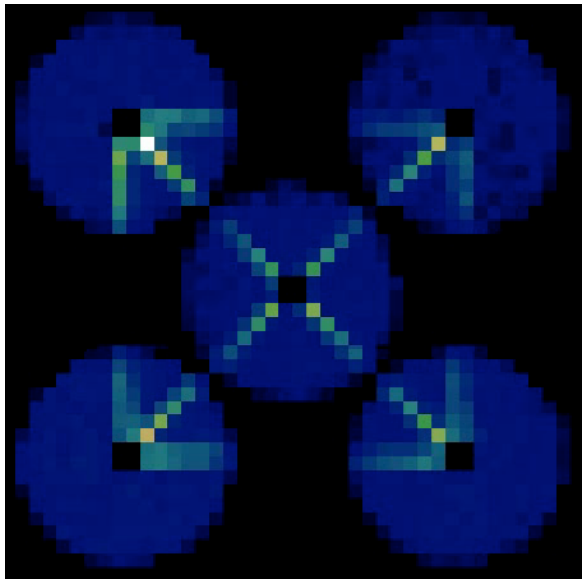
Can we calibrate it ?
=> Maybe, but would need dedicated (& real-time ?) procedure.
=> Not implemented in current GeMS real-time software.

Laser “Fratricide” effect

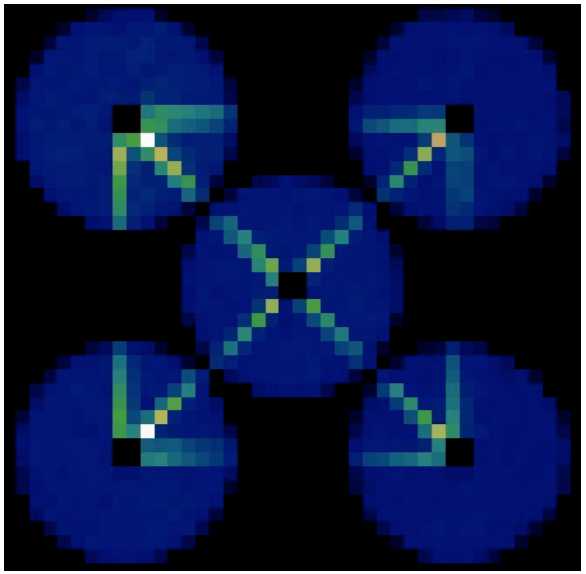
Impact of Fratricide on the slopes: Can we calibrate it ?

Some more (not too much) exotic issues:

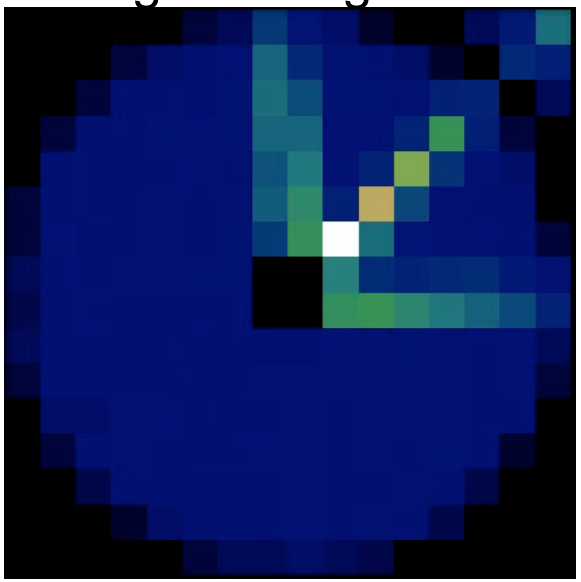
Clouds



Motor control issue ?



Large misalignment



Can we calibrate it ?
=> Maybe, but would need dedicated (& real-time ?) procedure.
=> Not implemented in current GeMS real-time software.

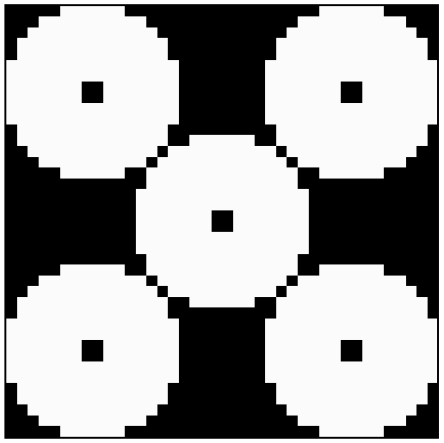
Laser “Fratricide” effect

Impact of Fratricide on the slopes: Can we calibrate it ?

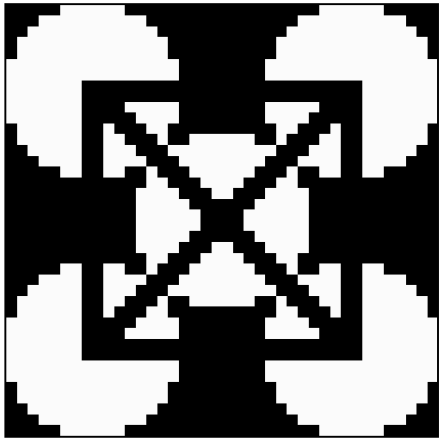
=> Remove contaminated subapertures = 224 subap lost

=> New extrapolated actuators on DM4.5

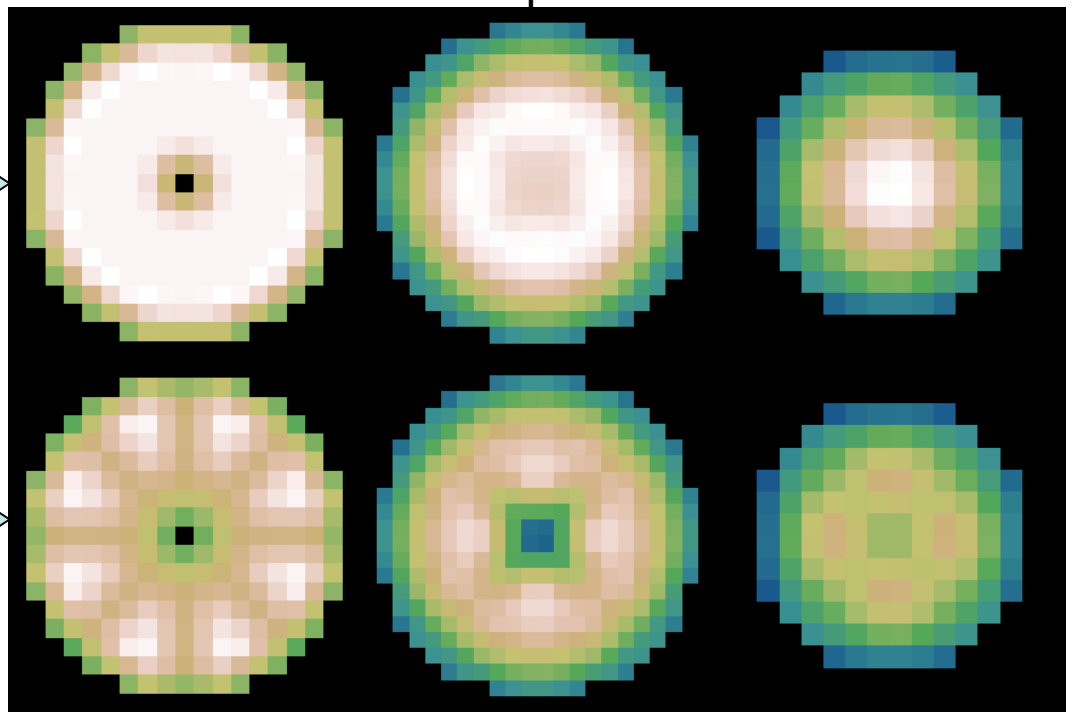
With all subap



Remove Rayleigh subap

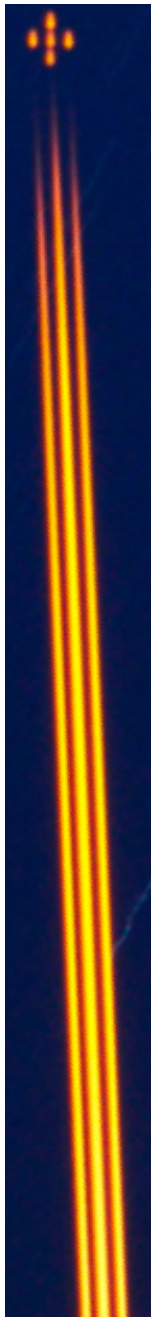


RMS of iMat per actuators



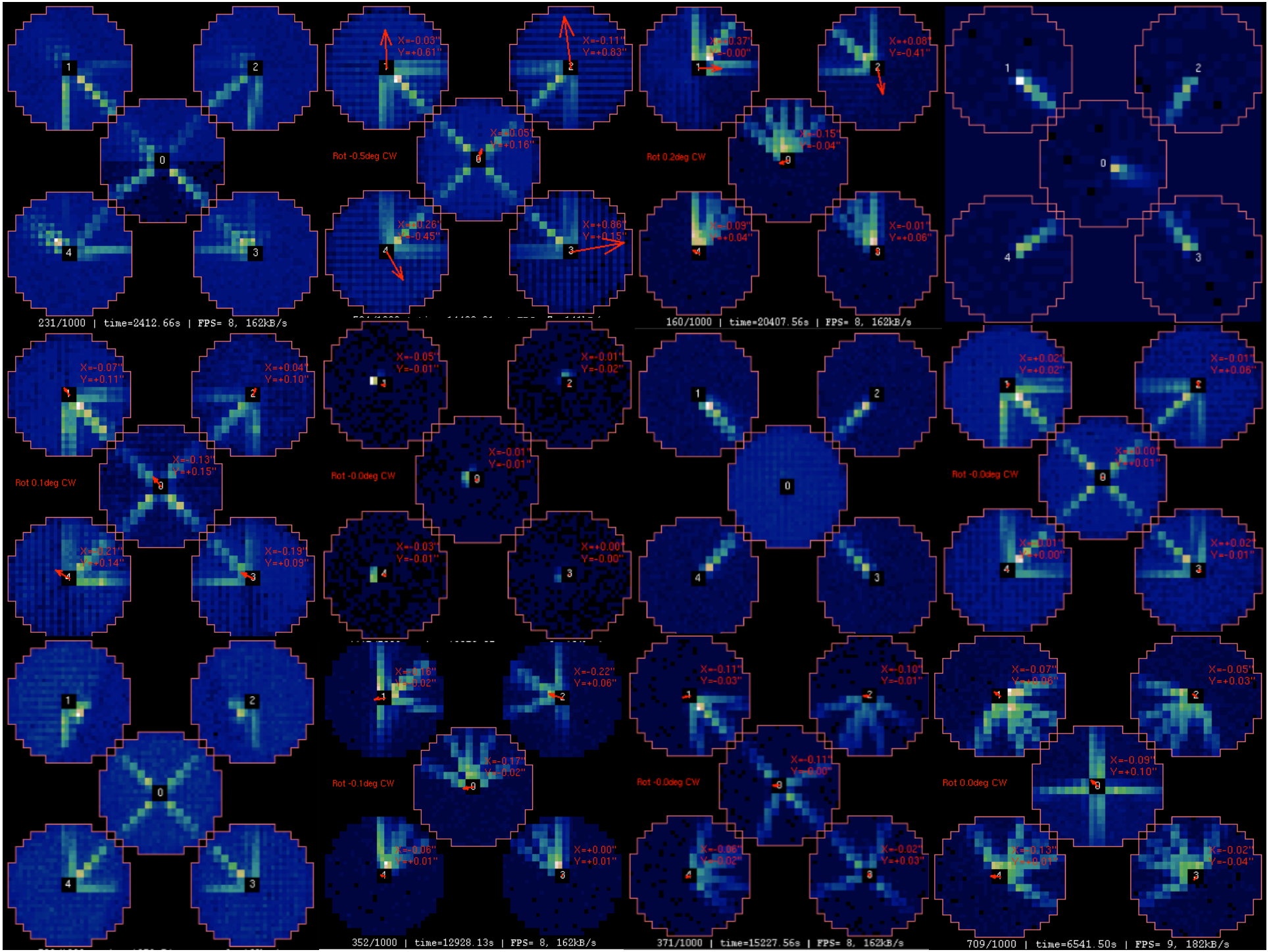
DM0 DM4.5 DM9

Conclusions



- LGSWFS flux variation could be included in reconstructors / optimization procedures

- Fratricide calibration is challenging
  - More characterization of the beams jitter
  - Implement new (real-time ?) background estimation procedures
  - Propagate the slope errors in the reconstructed phase, test different reconstructor
  - Better control of the static alignment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Rot 0.0deg CW
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709/1000 | time=6541.50s | FPS= 9, 182kB/s