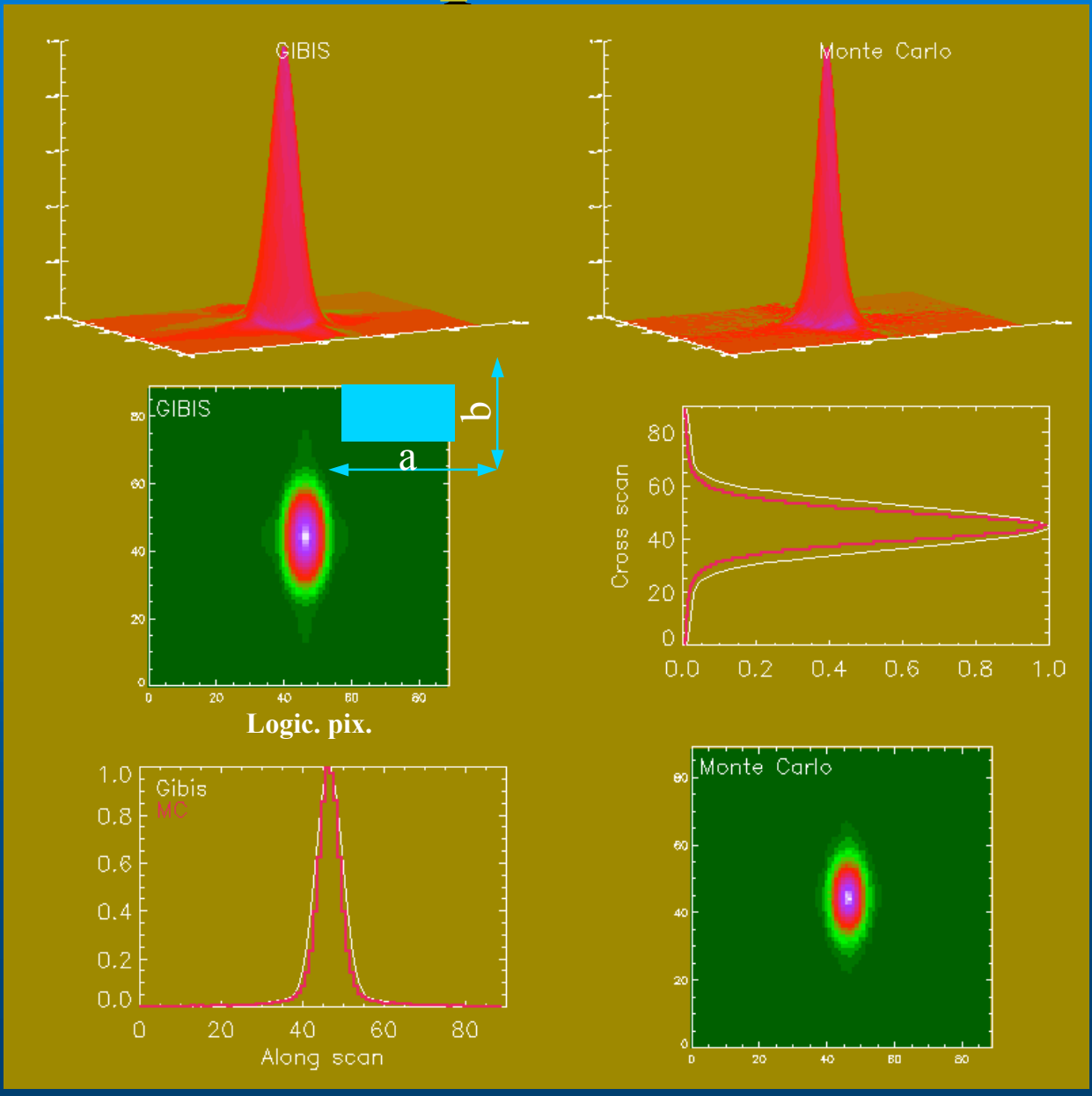
Asteroids - Focal Plane Simulation

- Inputs
  - diameter, size
  - velocity (cross- & along-scan)
    - shape (sphere, ellipsoid, binary, topographic model)
    - aspect (phase, orientation, POS view)
    - centre-to-limb darkening
  - position wrt pixel
  - V Magnitude

Simulated PSF

- **Star from GIBIS**
  (http://www.ast.cam.ac.uk:8080/gibis)
  G type; colour V-I = +1.0
- **Over-sampling: x4** (logical pixel)
- **Size [517x517]**
- **With or without optical aberration**
- **Smearing of 1 pixel is assumed**

PSF Comparison GIBIS/Aldo



Convolutions

- **Convolution for size & shape**
  - **S(x,y) = $\cap\cap$ PSF(x,y) I(x-u,y-v) $du\,dv$**
- **Convolution for velocity (d=t .V_x)**
  - **S(x,y) = $\cap\cap$ PSF(x,y) (x-u,y-v) $du\,dv$**
- **Smaller size, e.g. [96x96]**
- **Code in IDL, relatively fast**
- **Large variety of inputs (size, shape, velocity, binary, LD, physical ephem.)**

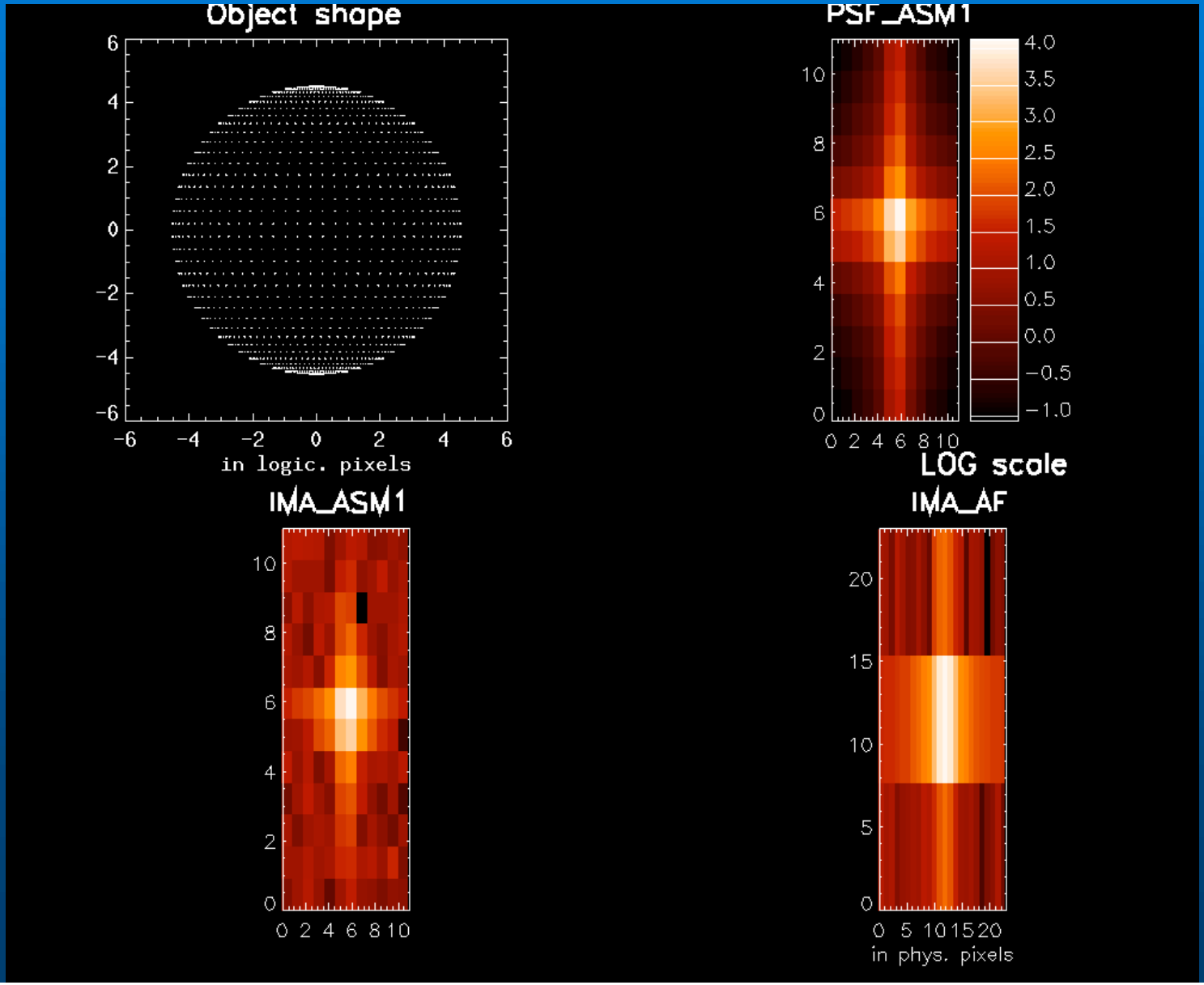
Output / Implementation

- Files: FITS or data matrix
  - logical (oversampled) or physical pixels
  - ASM, AF, BBP, SSM
- IDL code short version (Uniform Disk) can be run locally
- Implementing on the WEB (ION);
  - longer version for varying shape and physical ephemerides

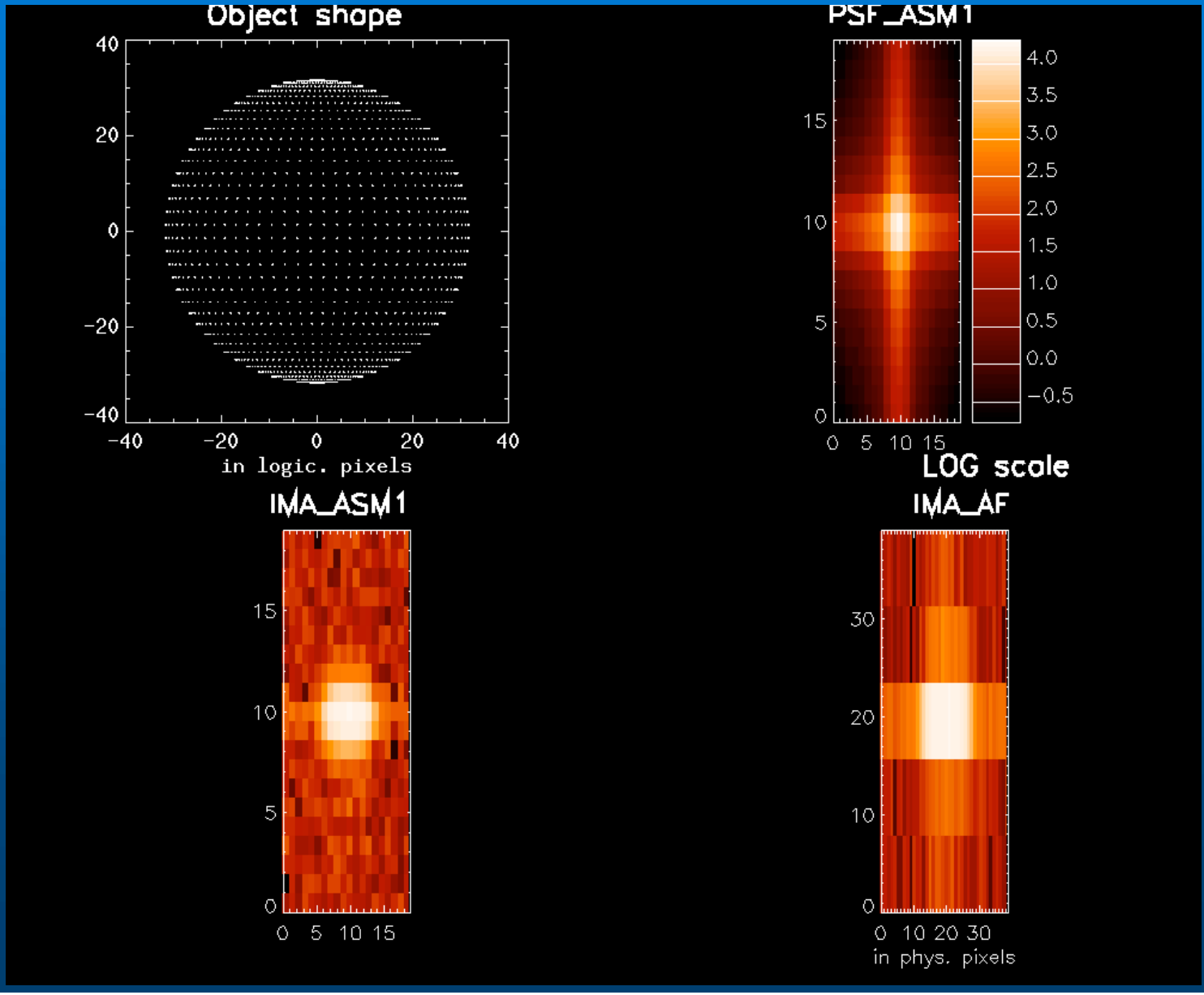
Examples

- **Sphere (UD)**
  Diameter Φ, Vmag = 10
  - **Φ = 100 mas** no motion Vx = Vy = 0
  - **Φ = 700 mas** no motion
  - **Φ = 10 mas (Vx; Vy) = (100; 10) mas/s**
- **Binary**
- **Topographic model**
- **1 logical pixel ~ 10 mas**

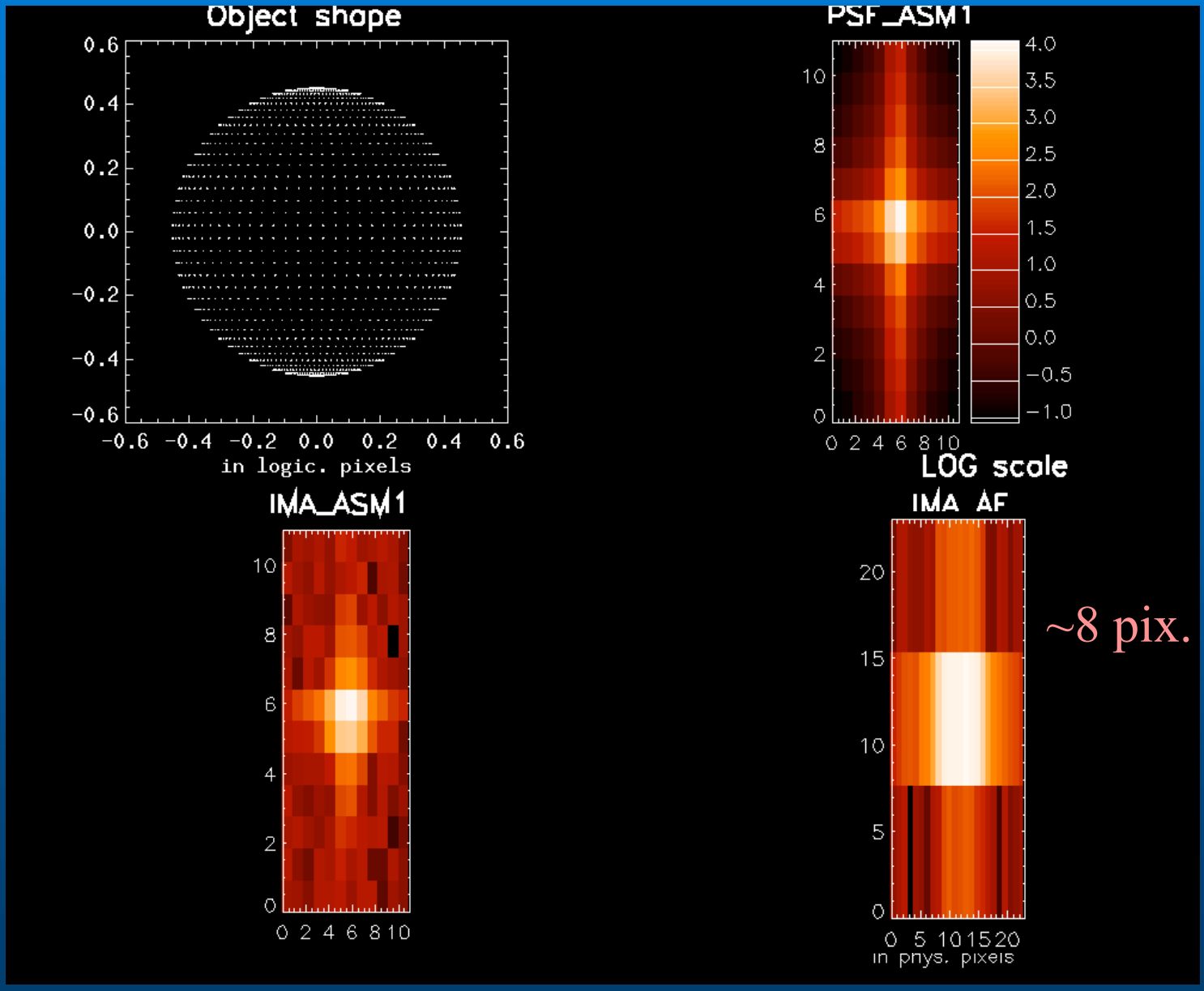
Φ = 100 mas ; No velocity



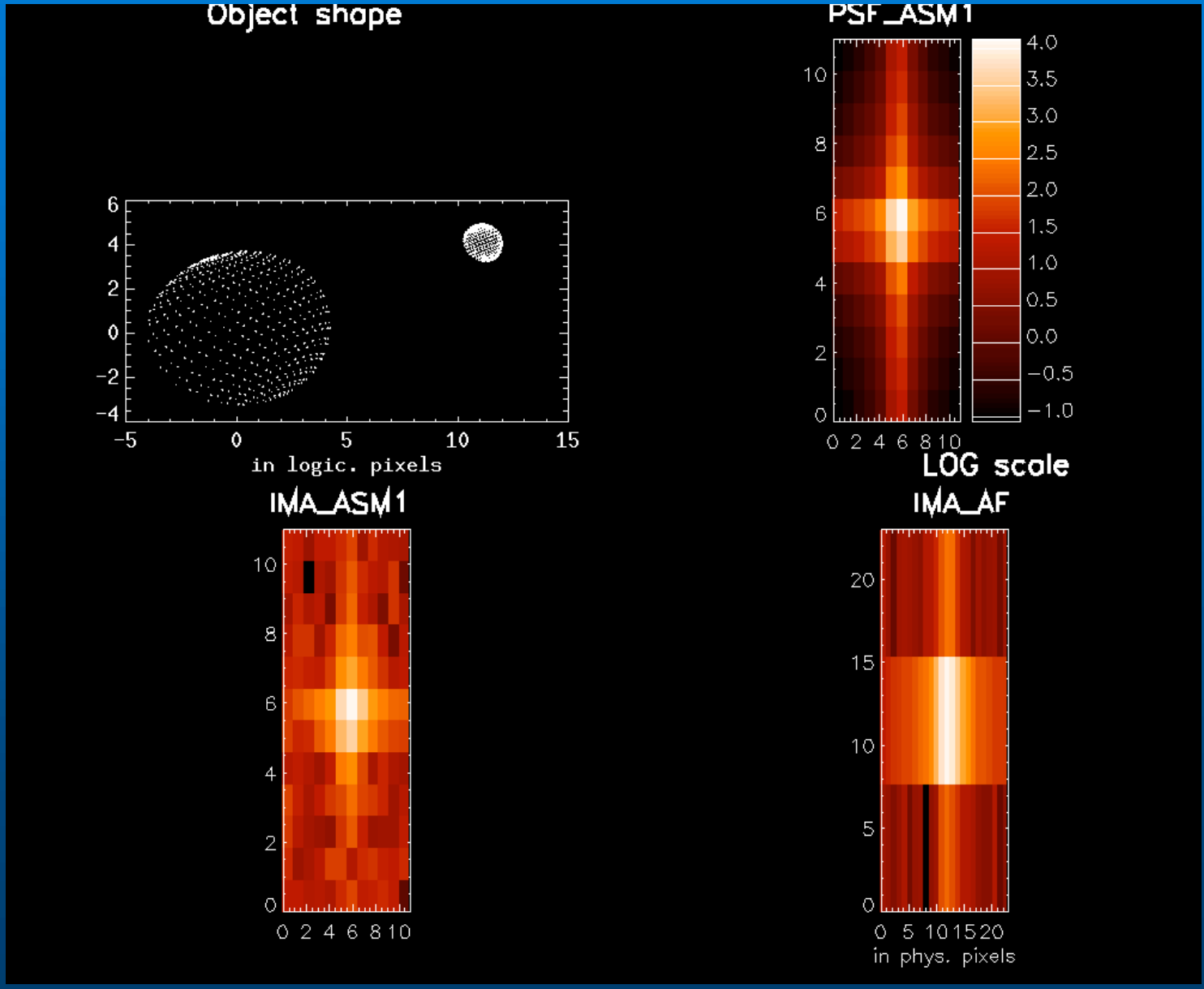
Φ = 700 mas ; No velocity



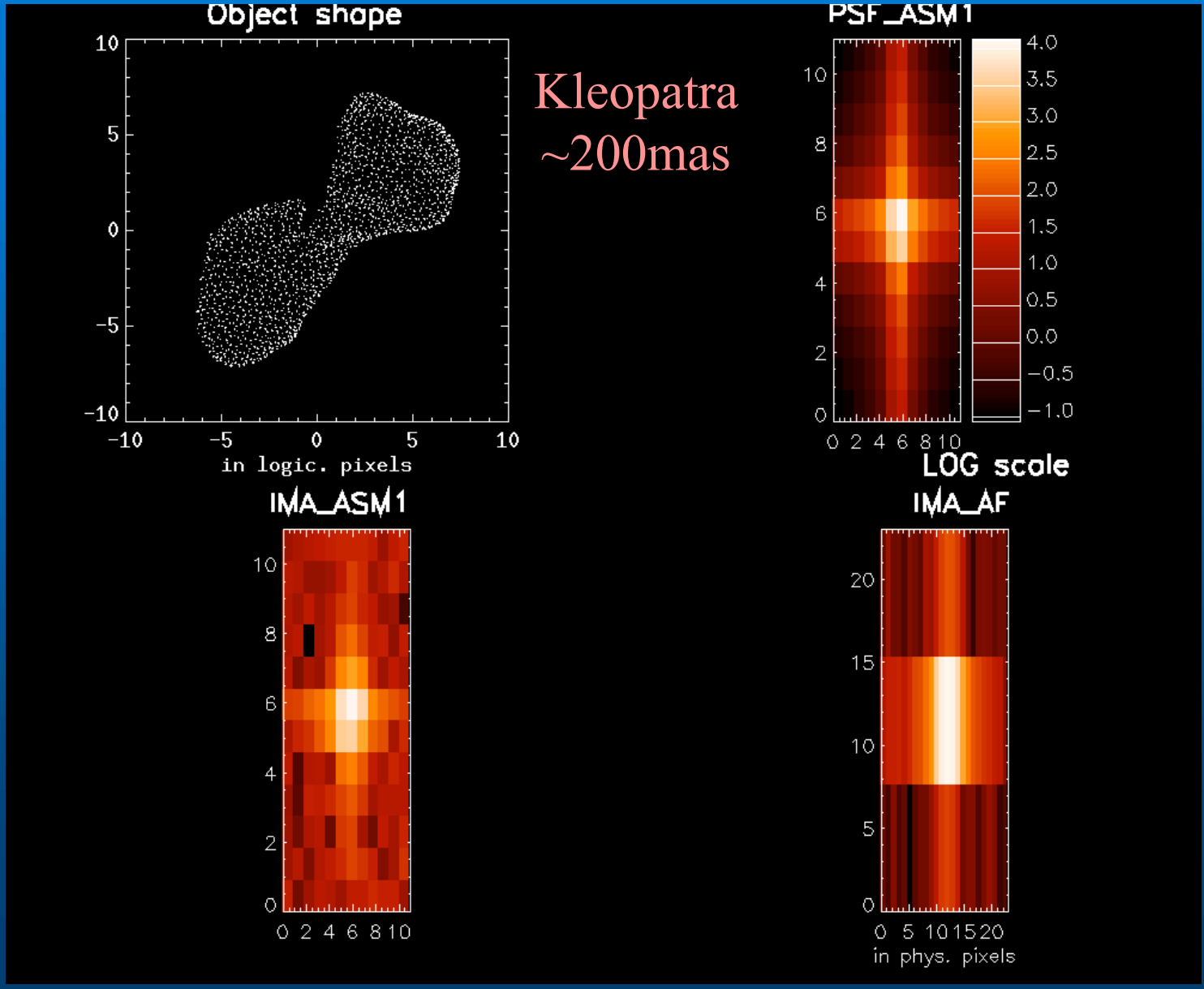
Φ = 10 mas ; Vx=100; Vy=10



Binary+phase+limb darken.



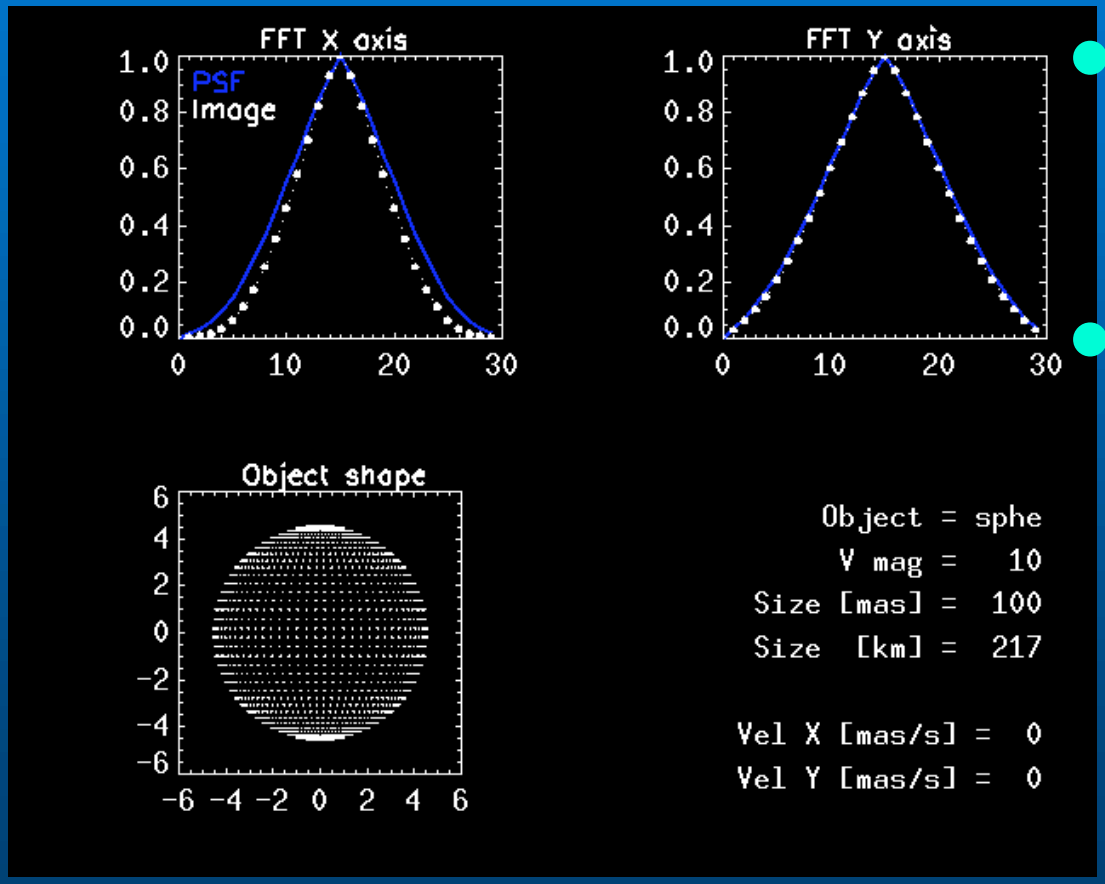
Topographic model



Future work

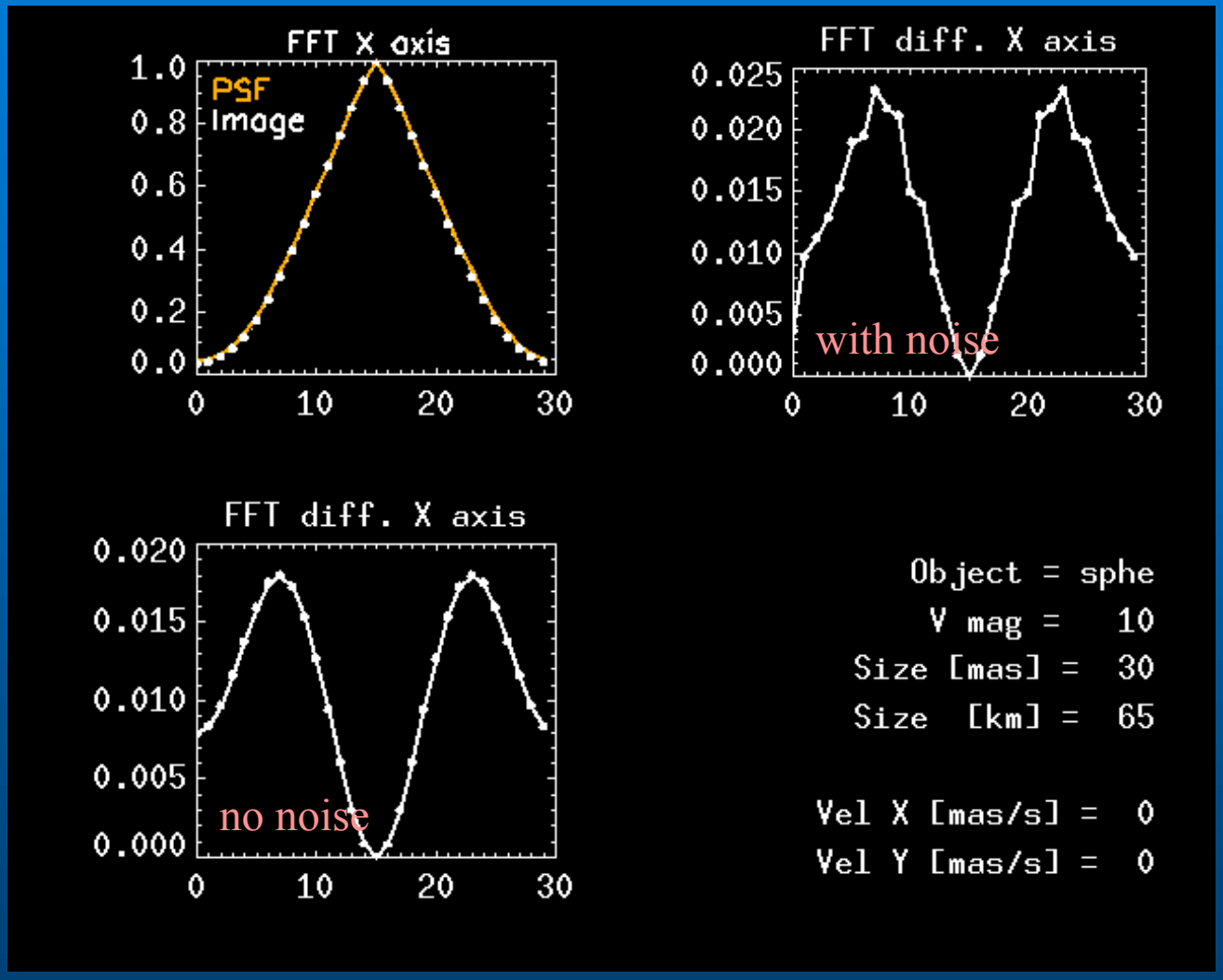
- **Implement ION (IDL On the Net) and WEB interface in connection with GIBIS**
- **Testing the detection procedures** (SimWG)
- **Testing the astrometry precision & the bias due to the solar phase**
- **Complete simulation in connection with the transits log** (F. Mignard)
- **Testing “imaging” capabilities of transmitted samples**

“Imaging” capabilities



- FFT(PSF)-FFT(Image) over 30 pixels could be calibrated
- Example Φ=100mas no noise

FFT(PSF) - FFT(Image)



- Φ=30mas no noise
- +noise; V=15 (albedo 0.05 @ 3AU)
- => partially resolved
- limit V<15
- smaller for p_v=0.2, or stars

Photocentre offset

$$\begin{pmatrix} \Delta\alpha\cos\delta \\ \Delta\delta \end{pmatrix} = \begin{pmatrix} \sin\theta_s \\ \cos\theta_s \end{pmatrix} C(i)\,\sin(i/2)\,\phi/2$$

Planet	Ceres	Pallas	Vesta	Iris
Diameter [km]	913	523	501	203
ϕ_{max} [arcsec]	0.67	0.41	0.40	0.25
A priori values				
rms [mas]	9.6	9.7	7.2	9.7
ratio (%)	23	21	48	7
Least squares				
$\langle i \rangle$	17°4	18°2	21°4	22°9
$\langle C(i) \rangle$	0.63	0.62	0.75	0.68
$\pm 1\sigma$	0.06	0.06	0.04	0.15

- Largest bodies
- Not correlated to Osculatg Elemts
- 1st approximation
- Diameter
  - Φ
- LD parameter
  - C(i)

Hipparcos (1998 A&A 336, 776)

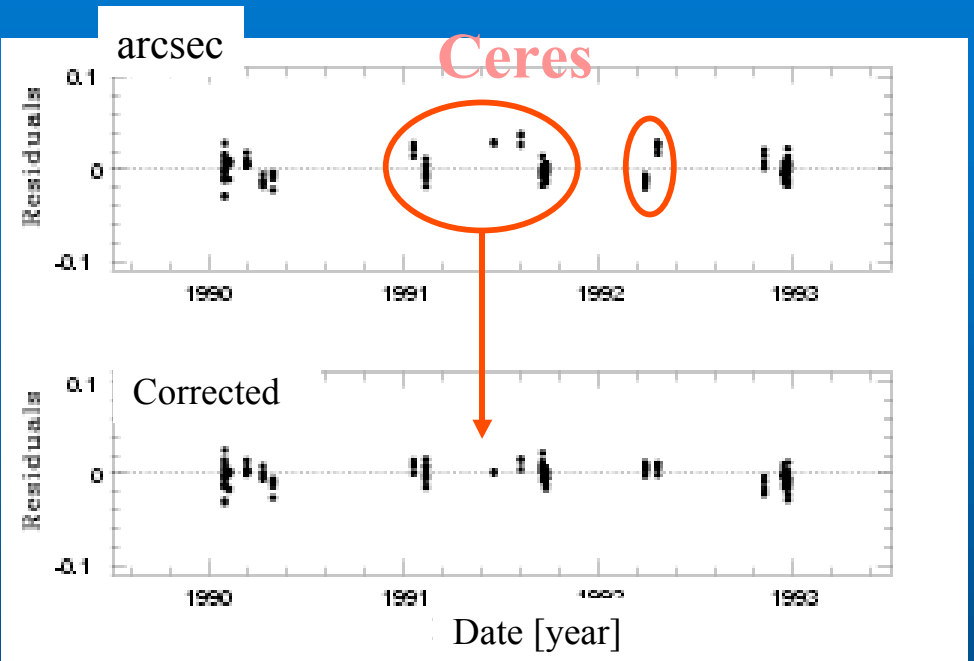


Fig. 2. Improvement of the residuals for (1) Ceres when the correction for the photocentre offset is applied. Upper panel: initial O-Cs where the ephemerides are calculated from the osculating elements for the year 1996 (Batrakov 1995). The photocentre offset Δv calculated from Eqs. (2) and (11) is shown as open squares, values are given on the right-hand label. Middle panel: residuals obtained after compensation for the correction to the 6 osculating elements, without taking the phase effect into account. Lower panel: same as before, but the O-Cs were corrected for the phase effect