EIC Simulations

Thomas Kitching

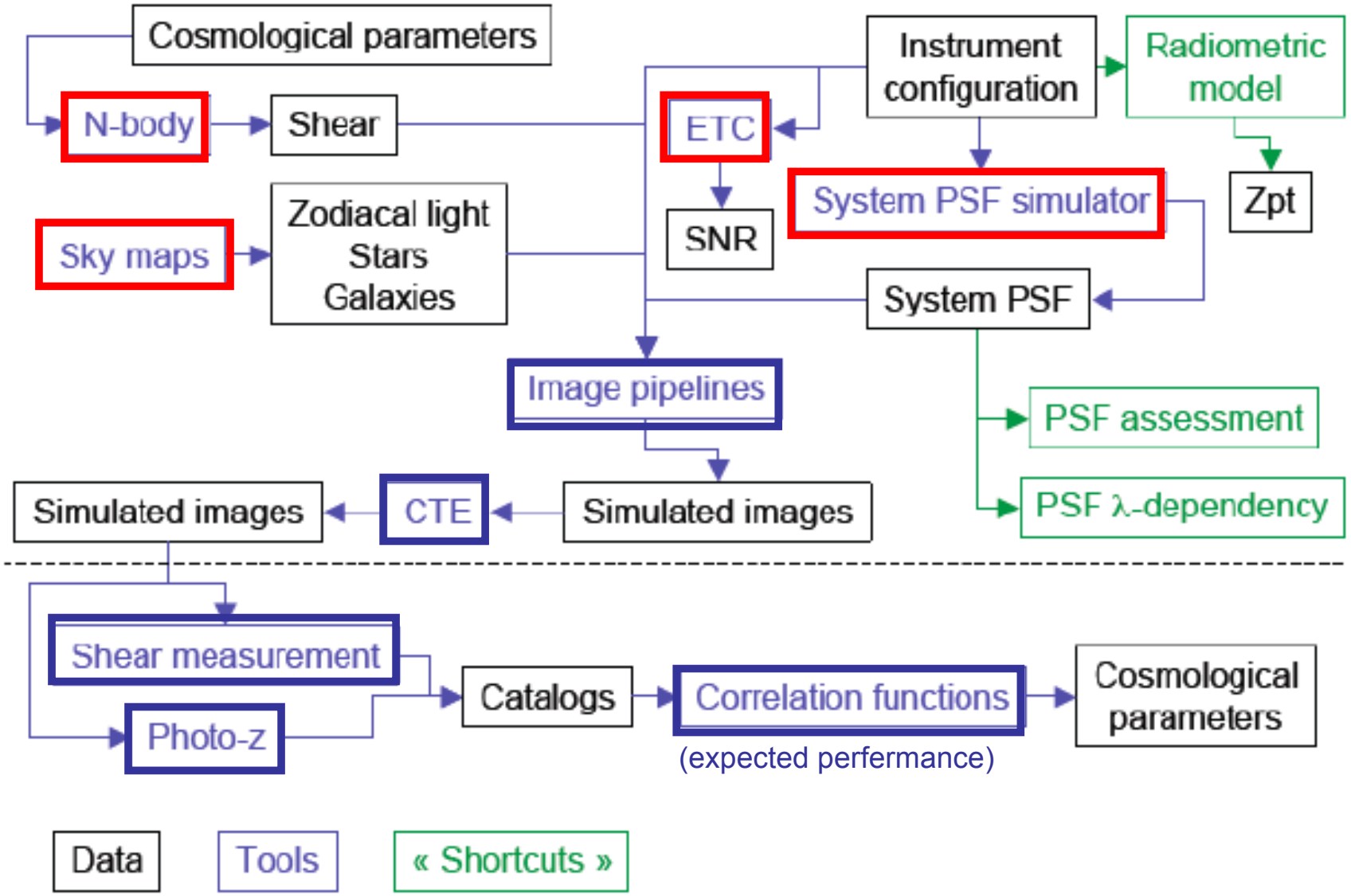
A. Amara, S. Bridle, O. Boulade, B. Dobke,
A. Fontana, A. Grazian, A. Heavens,
A. Kiessling, M. Meneghetti, S. Paulin-Henriksson,
J. Rhodes, A. Refregier, A. Taylor, R. Teyssier, L. Voigt

EIC Weak Lensing & Simulation Working Groups

EIC Simulations

- Simulating aspects of
  - Hardware
  - Software
  - Image Reconstruction
- Weak Lensing
- Linking
  - Science Requirements to Mission and Survey Design
- EIC Simulations and Weak Lensing Groups

End-to-End Simulation Infrastructure



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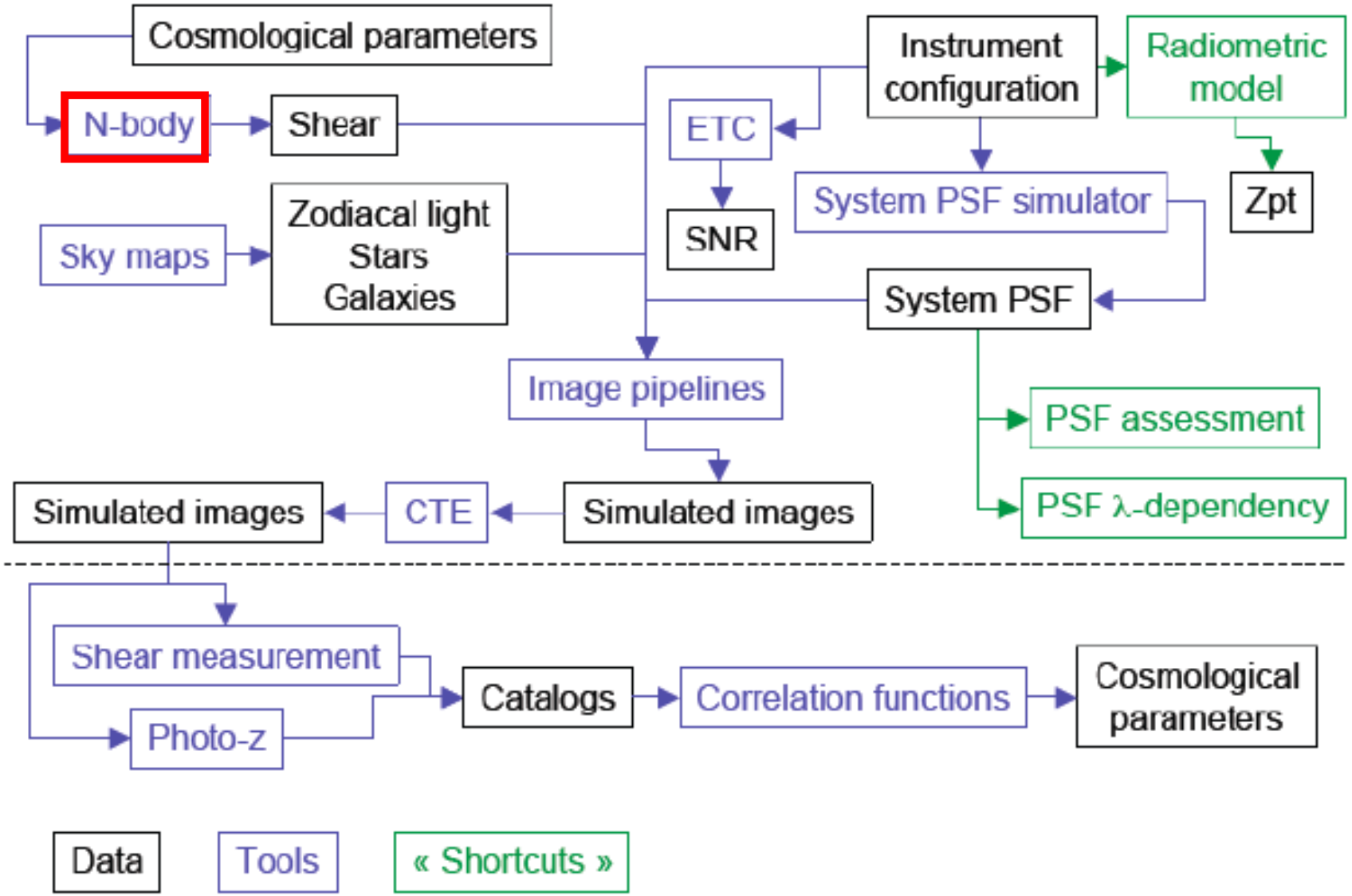


N Body Simulations

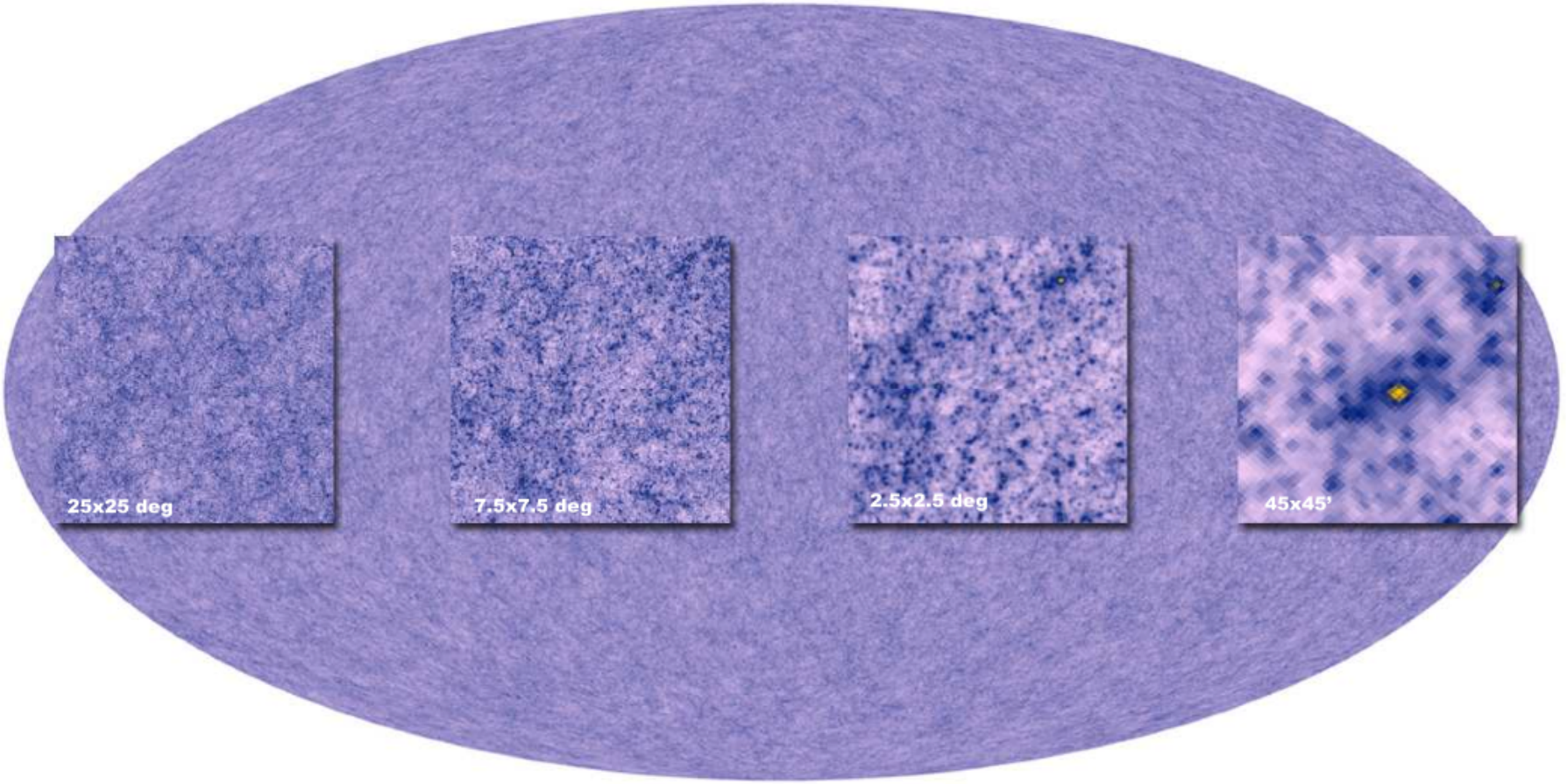
- Need Cosmological N-body Simulations
- Including full ray tracing through dark matter
- Multi-scale Multi-resolution approach

- For the mission
  - Needed for covariances and theoretical predictions

- So far
  - Need to create realistic mock surveys

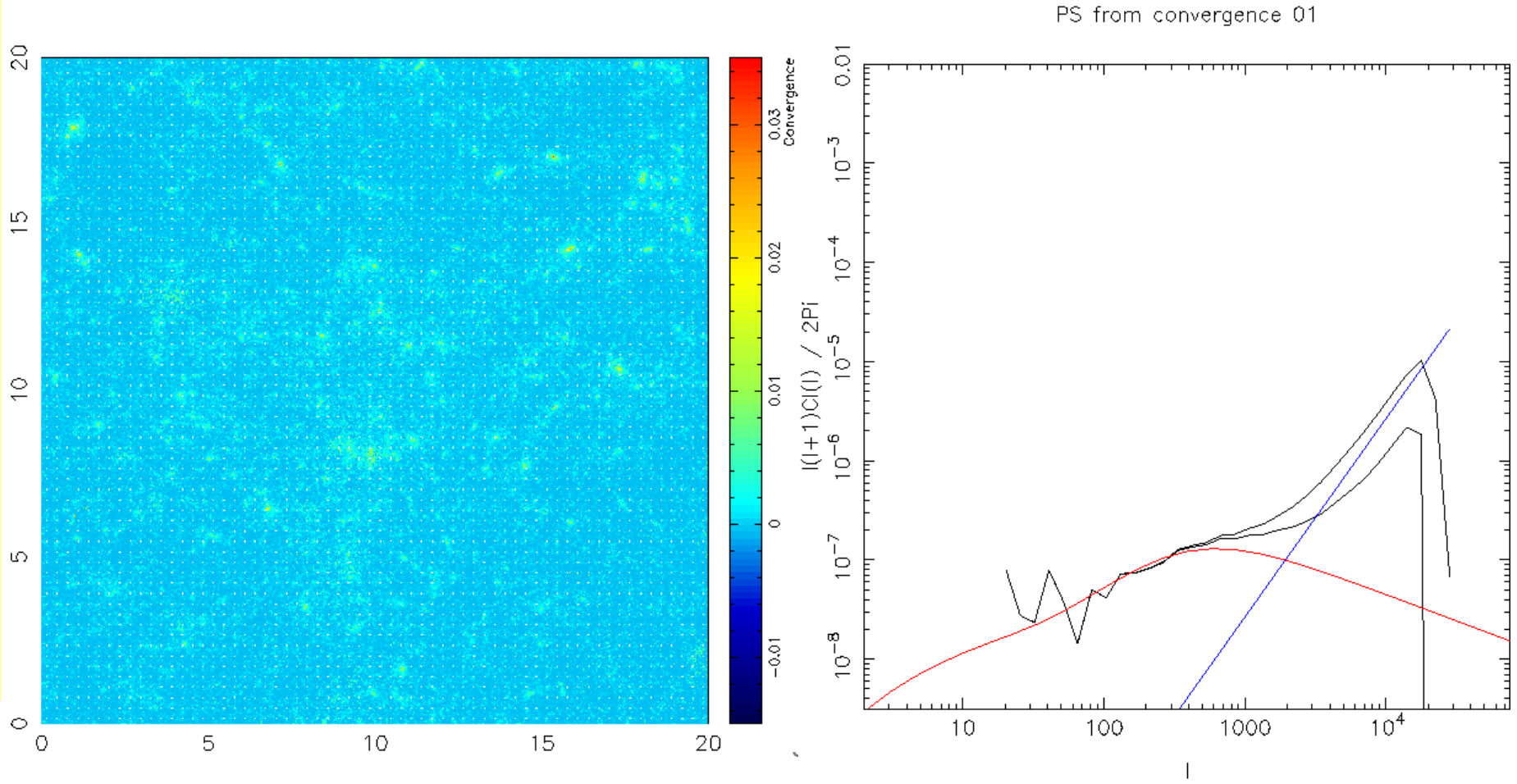
N-body Simulations

- R. Teyssier (2007)
- Largest N-body simulation to date

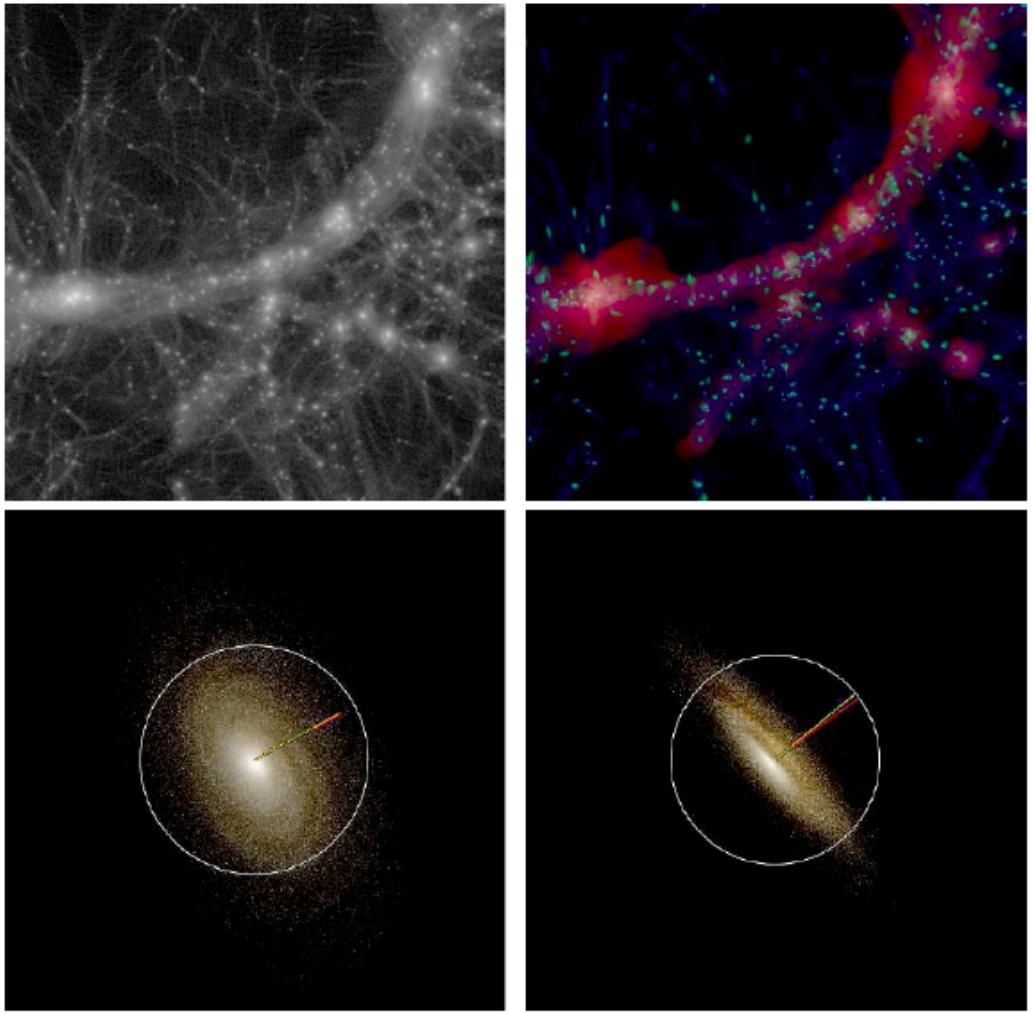


N-body Simulations

- Smaller scale - higher resolution (A Kiessling, A. Heavens, A. Taylor)
- Evolution as a function of redshift
- 20 sq deg z=0.1-1.5 Recover l=100 - 10,000

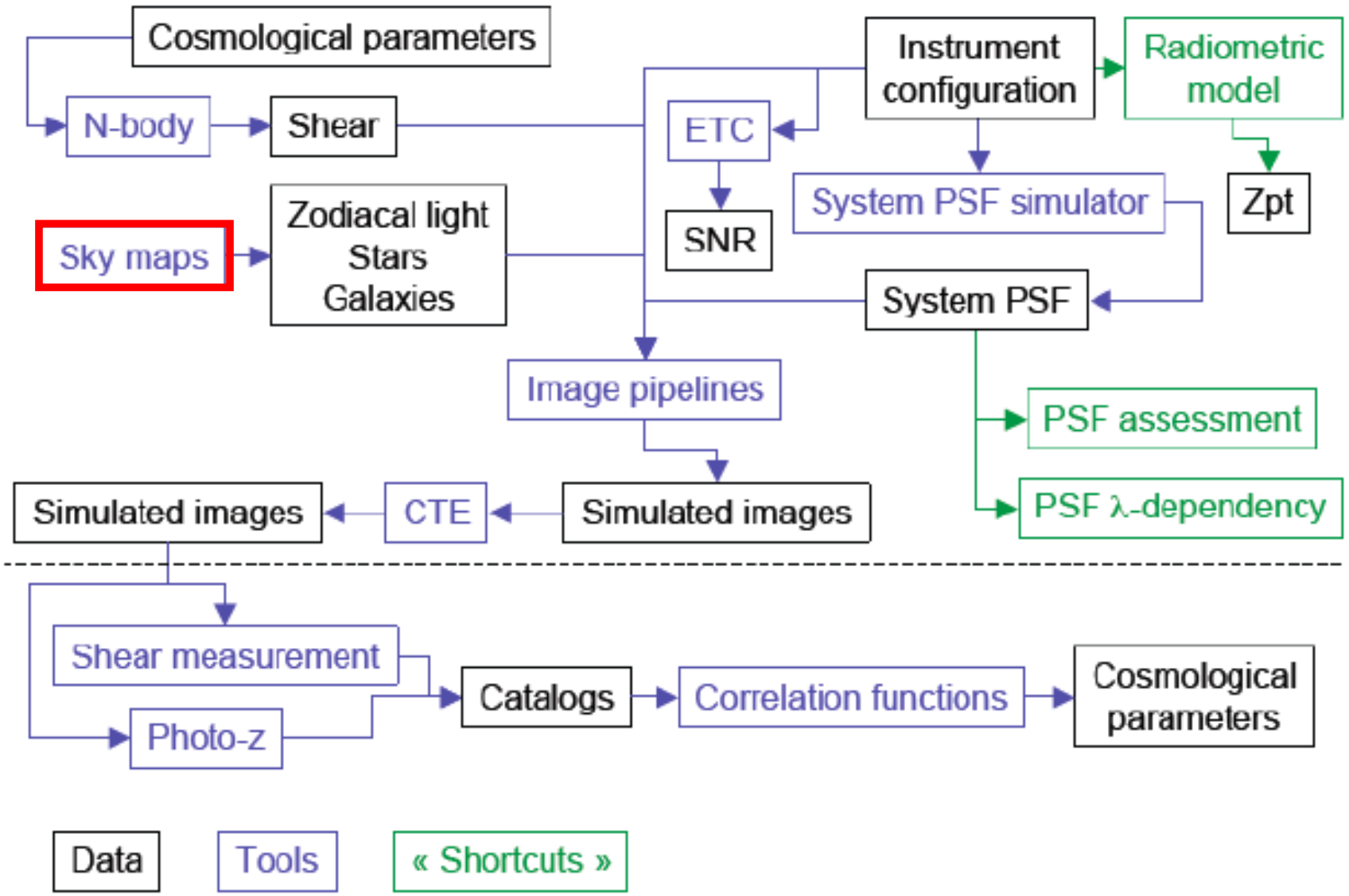


N-body Simulations



- O. Hahn et al.
- Full hydrodynamic
  - Baryonic effects
  - Ram pressure striping
- Disk intrinsic Alignments
  - Depend on orientations
- Advancing understanding of intrinsic alignments
  - N-body
  - Halo Model (M. Schnieder & Bridle)
  - Nulling (Joachimi & P. Schnieder)

End-to-End Simulation Infrastructure

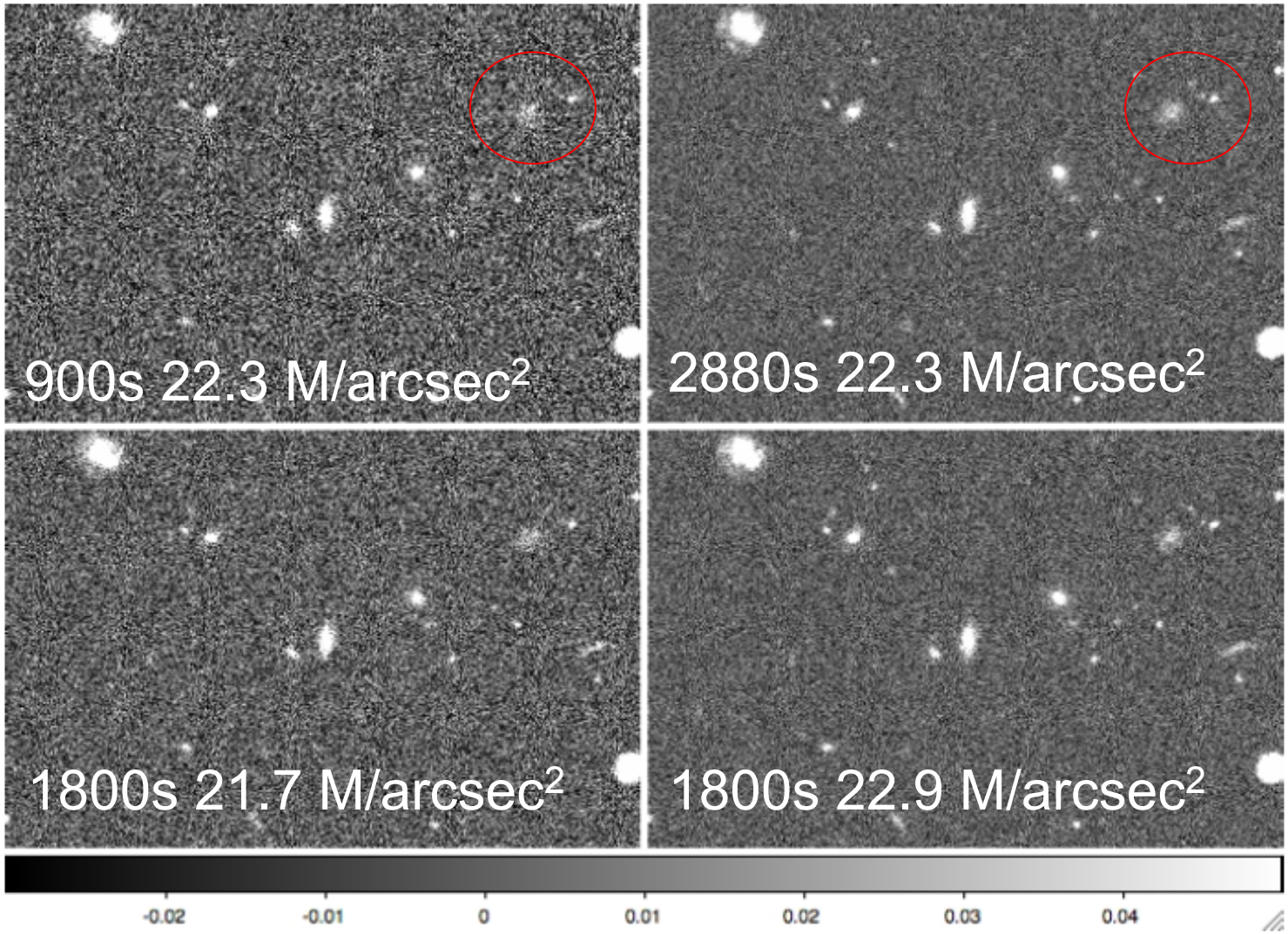


Sky Maps

- Two independent pipelines
  - `skylens` : M. Meneghetti
  - `simage` : J. Rhodes, R. Massey
  - Convergence tested and confirmed
- Aim of producing mock Euclid images
- Use 10,000 HUDF galaxies in B,V,i,z,J,H decompose into shapelets
- Telescope diameter, field of view, CCD gain, readout noise, pixel scale, QE
- (constant) shear added to simulations

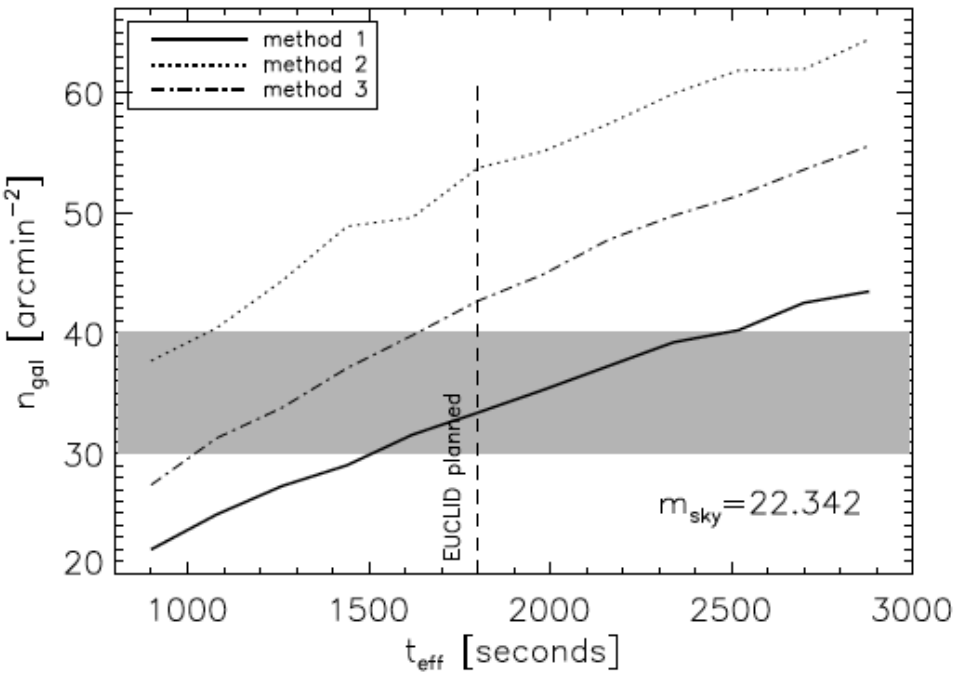
Sky Maps

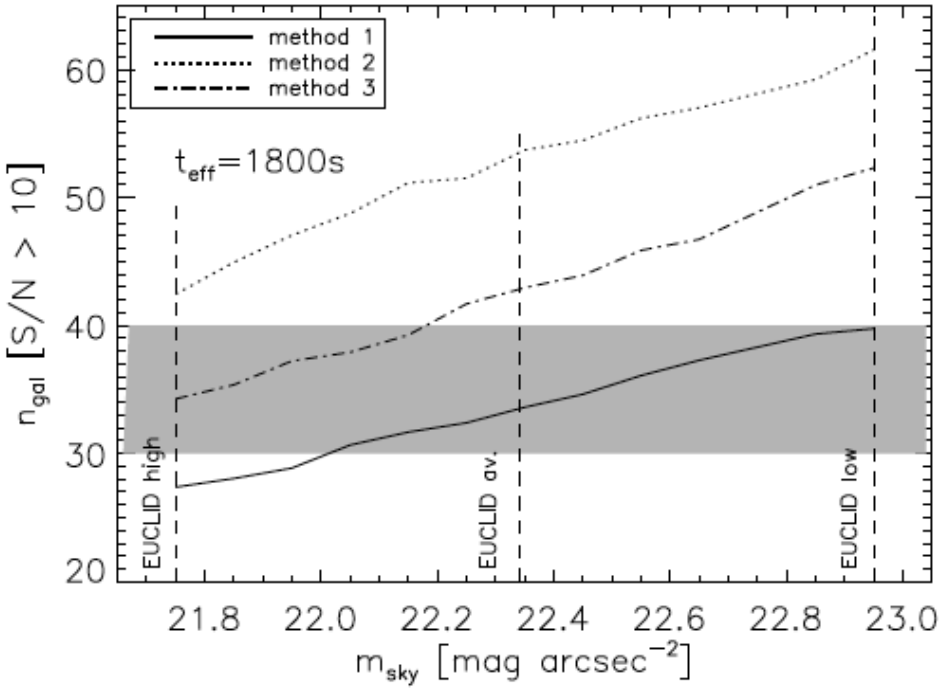
- 33''x22'' ~ $(1/3x10^9)^{th}$ of Euclid
- 1800s
- 22.3 M/''2



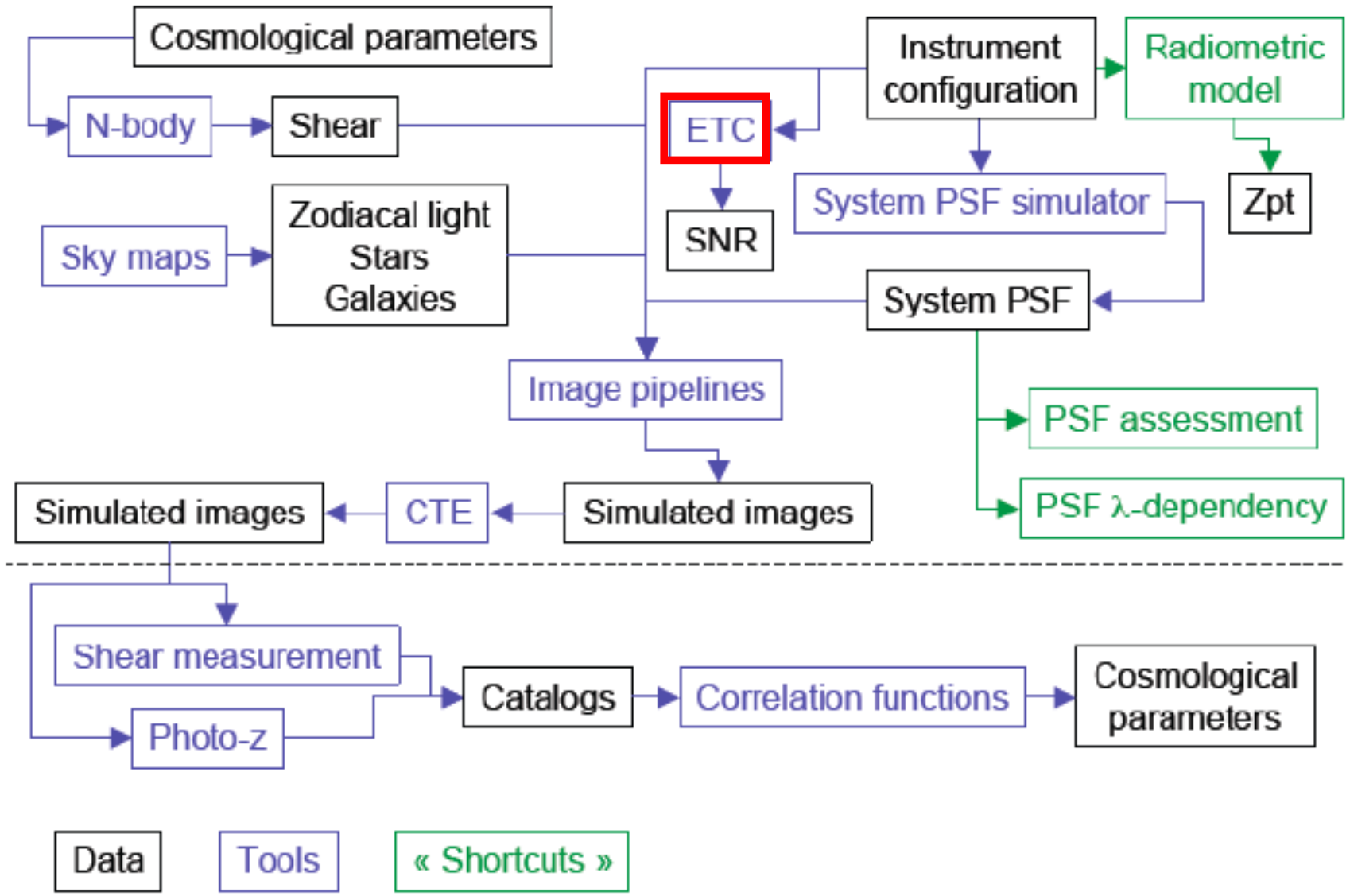
Sky Maps

- Using 3 independent shape measurement techniques
  - Also made a SourceExtractor S/N detection
  - *lens*fit : T. Kitching, L. Miller
  - im2shape : S. Bridle, L. Voigt





End-to-End Simulation Infrastructure



Exposure Time Calculator

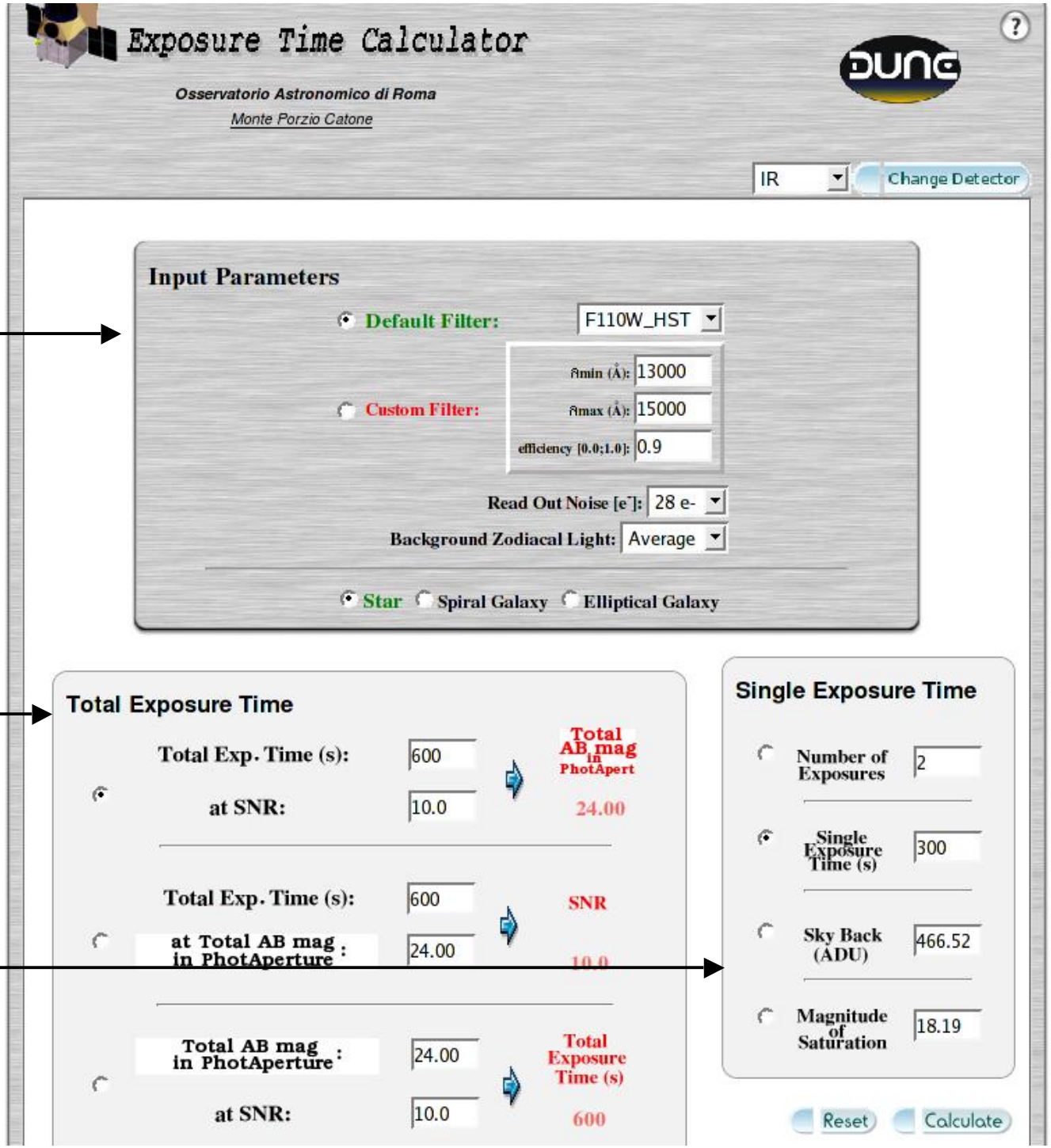
- Andrea Grazian & Adriano Fontana
- Based upon LBT exposure time calculator
  - Grazian et al. (2004)
- `http://lbc-oa.roma.inaf.it/cgi-bin/calcuateETCDUNE.pl`
- Allows user to specify a flexible combination of
  - S/N, magnitude limit and exposure time
- Can also change several instrument parameters
  - e.g. on-the-fly filters of arbitrary bandwidth and efficiency

ETC

Instrument Inputs inc. VIS/NIP, Object type

Specify S/N, Magnitude, Exposure Time

Details of Exposure, Number, time, background



ETC

- Output
  - Simulated image of object
  - Parameters e.g. flux, S/N, PSF size
- Instrument development
- Link to Science requirements (area, mag nitude, size) to survey optimisation

Simulation PARAMETERS

DUNE ETC Version v.1.0 (2008-12-03)

Instrumental Parameters:

- DUNE Device = **InfraRed**
- Filter = **F110W_HST.ecf** (Total Efficiency)
- ƛpeak =**11249.62** (Å)
- Read Out Noise = **28** (e^-)
- Dark Current = **0.02** (e^-/s)
- Flat Field Accuracy = **0.0025**
- Pixel Scale = **0.3** ($arcsec^{-1}$)
- AB to Vega Factor = **-0.726**

Object Parameters:

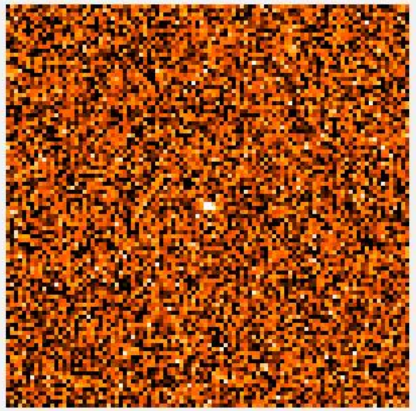
- Object Type = **star**
- PSF at Selected ƛ = **0.40** (arcsec)
- Photometric Aperure = **1.0** (arcsec)
- Aperture Correction = **0.25** (mag)
- Total AB Magnitude = **24.00** (AB mag)
- Signal to Noise Ratio = **10.0** (in 2.5 x PSF)
- Flux of the Source = **1405.14** (ADU)
- Mag/$arcsec^2$ = **23.84** (AB mag)

Observational Parameters:

- Number of Exposures = **2**
- Single Exposure Time = **300** (s)
- Total Exposure Time = **600** (s)
- Background Zodiacal Light = **A** [(L)ow/(A)ve/(H)igh]
- Sky AB mag = **22.10**(AB mag/$arcsec^2$) airmass=0

Image Parameters:

- Magnitude of Saturation = **18.19** (AB mag)
- Zeropoint = **32.13** (AB mag)



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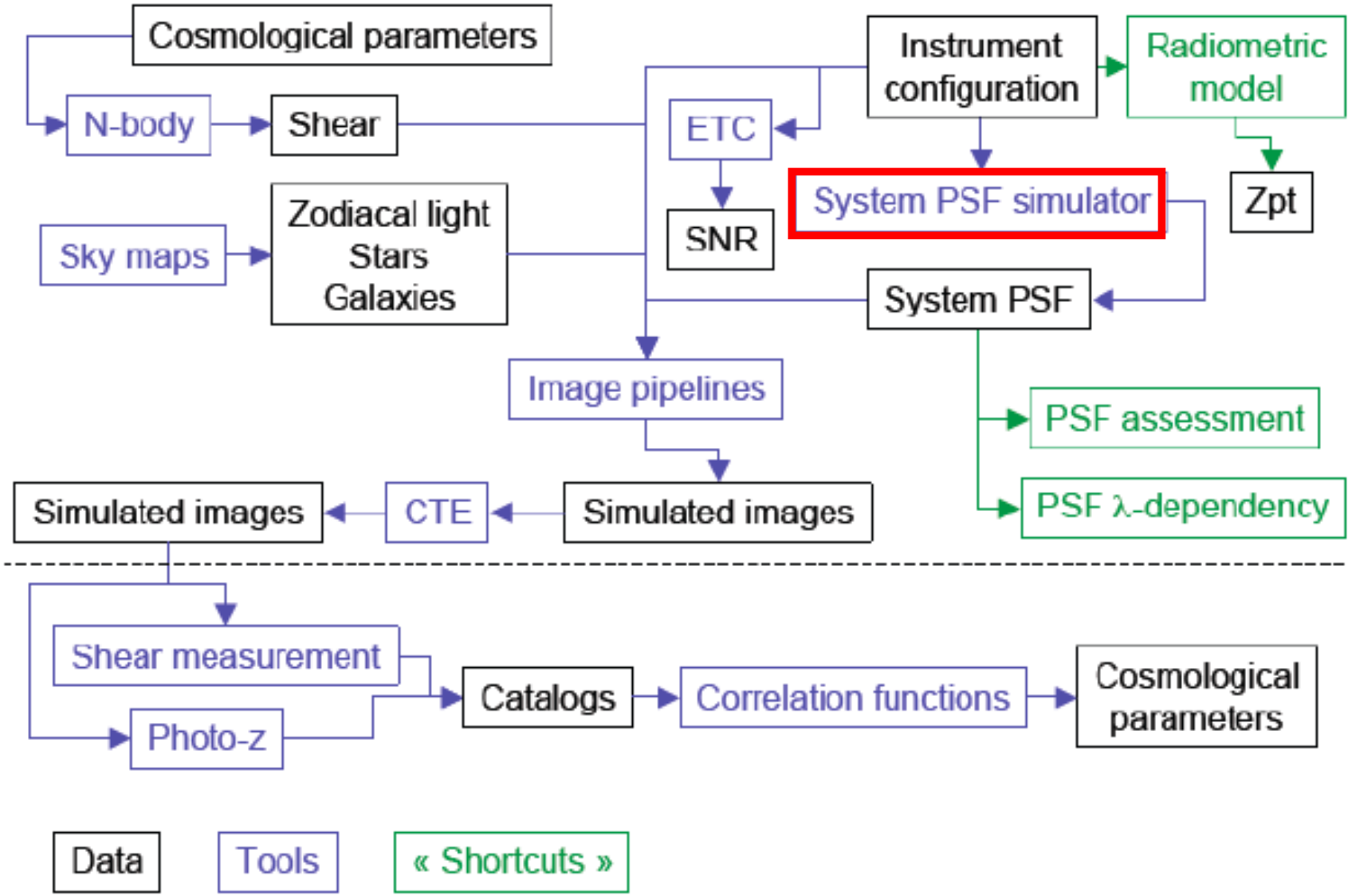
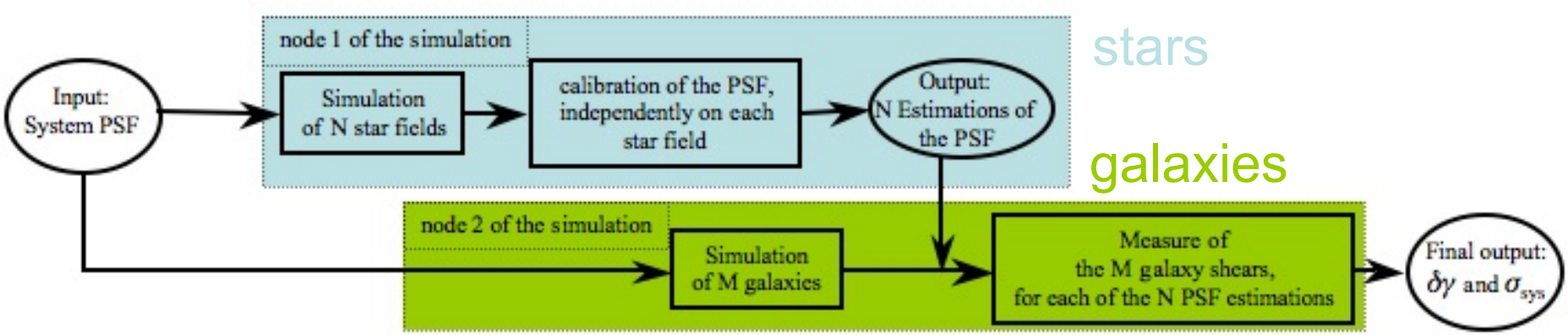
End-to-End Simulation Infrastructure



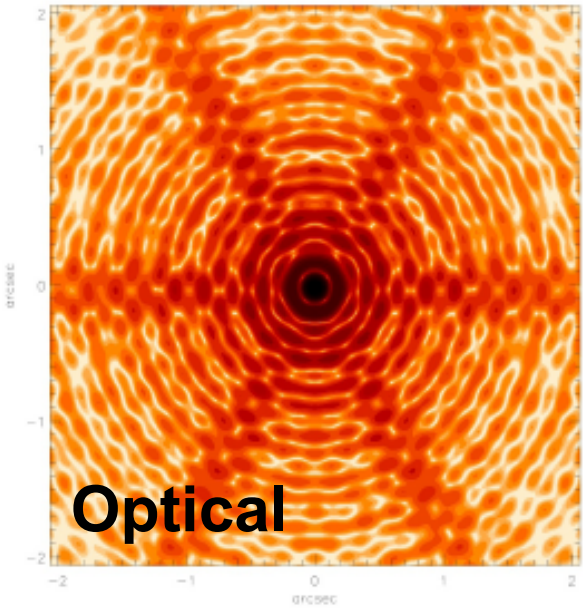
PSF Simulator

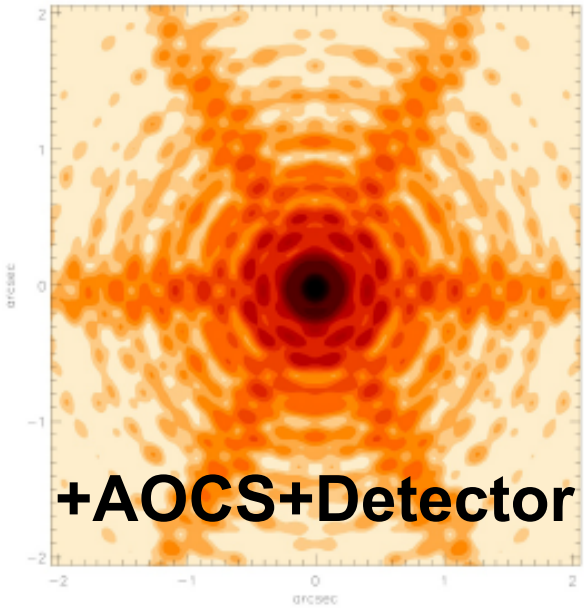


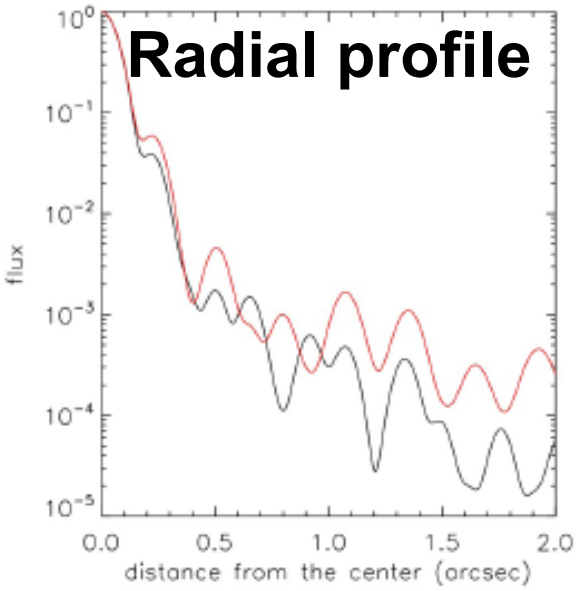
- S. Paulin-Henriksson et al.
- Links the system PSF to the science requirements
- Simulate stars and galaxies, measures shears
- Comparison made between the measured shear variance and requirement of $\sigma_{sys} \leq 10^{-7}$ (Amara & Refregier, 07)

PSF Simulator

- PSF components
  - Optical PSF, includes diffraction effects
  - AOCS contribution, due to movement during exposure
  - Detector PSF e.g. due to diffusion (adopt a Gaussian)

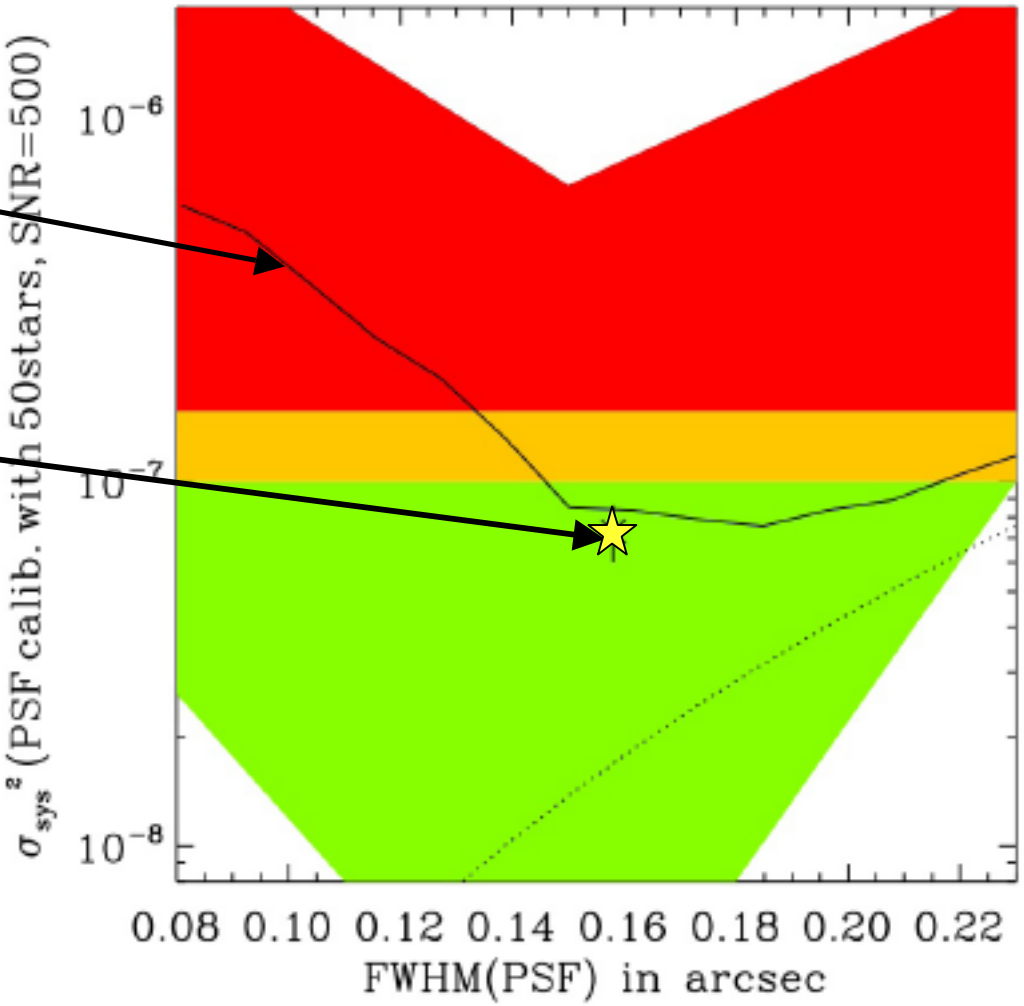






PSF Simulator

- Example : Pixel scale / PSF FWHM optimisation
- Fixed pixel scale 0.1"
- Analytic approximation
  - Gaussian PSF
- Nominal System PSF



Conclusion

- Cosmological to System-Level simulations
  - Links Science Requirements to Hardware & Survey Design

- N-body - multi-scale multi-resolution approach
- Sky Maps - realistic Euclid performance; n_{eff} req. met
- Exposure-Time Calculator - flexible & multi-purpose
- PSF Simulator - throughput from harware to science

End