Masking bright objects with LSST

Journées de Rencontres Jeunes Chercheur.se.s
25/11/2024

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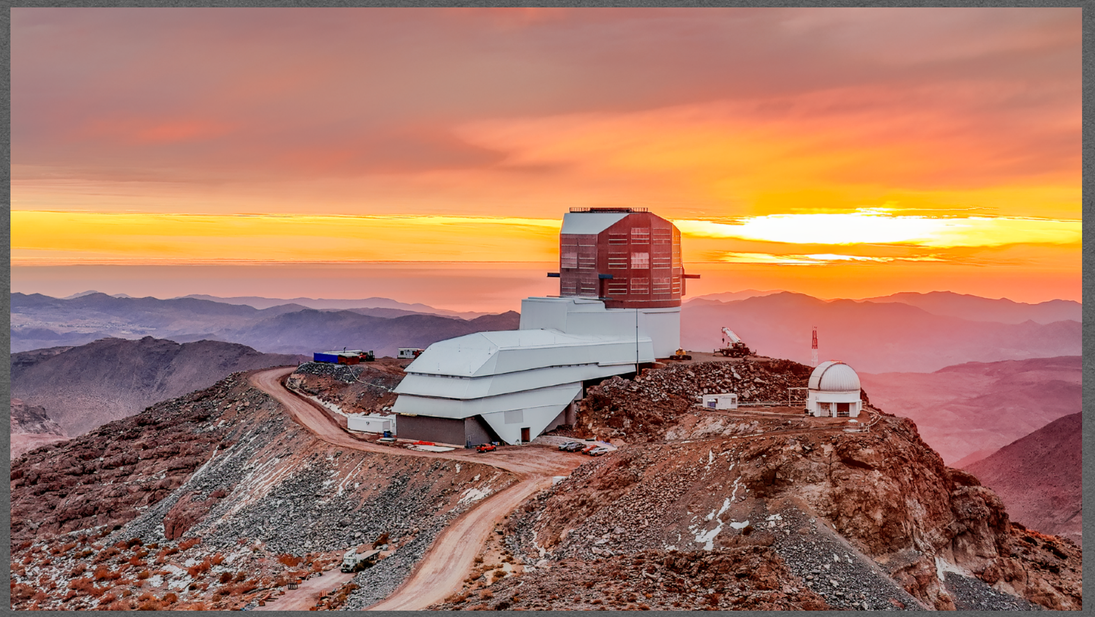
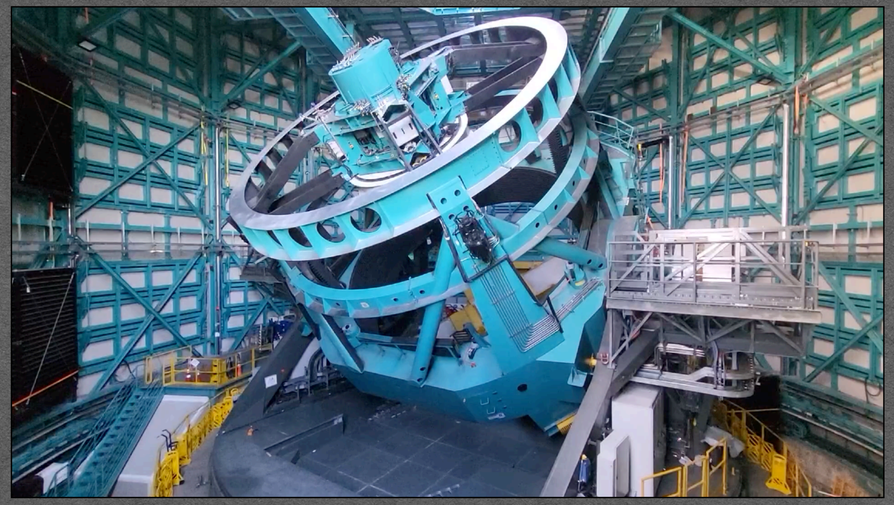
VERA C. RUBIN OBSERVATORY
LSST Legacy Survey of Space and Time
LSST DESC Dark Energy Science Collaboration

General context

Vera Rubin Observatory - LSST

- 10 year photometric survey
- 6 bands from near IR to near UV





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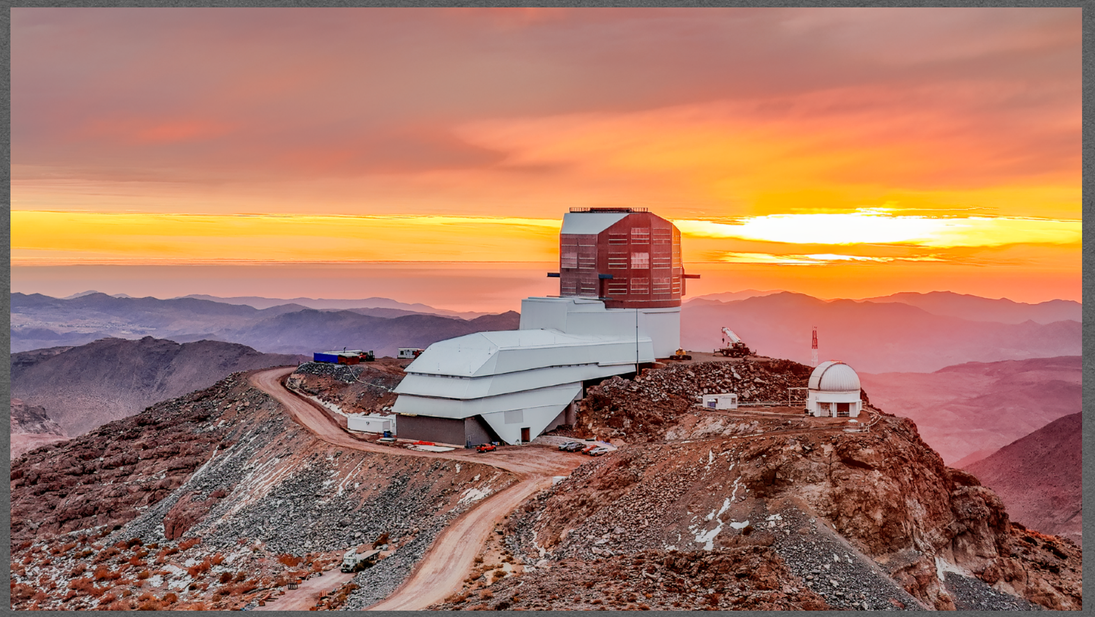

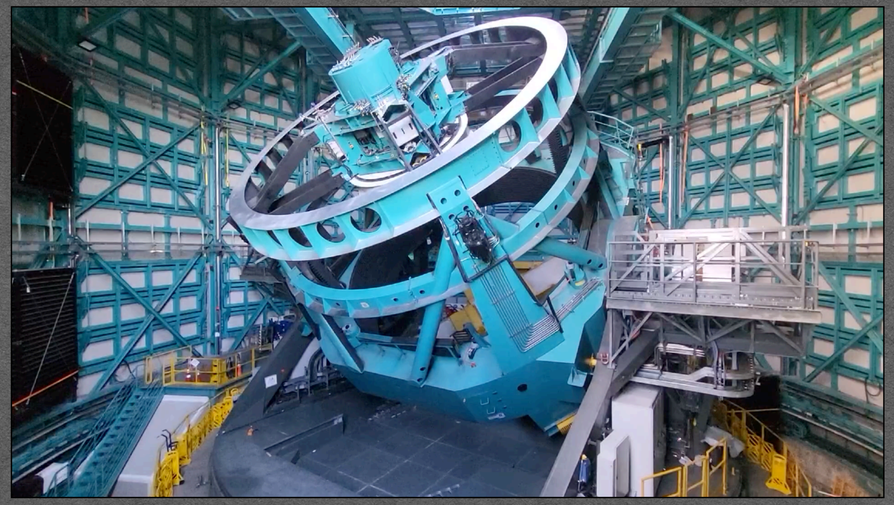

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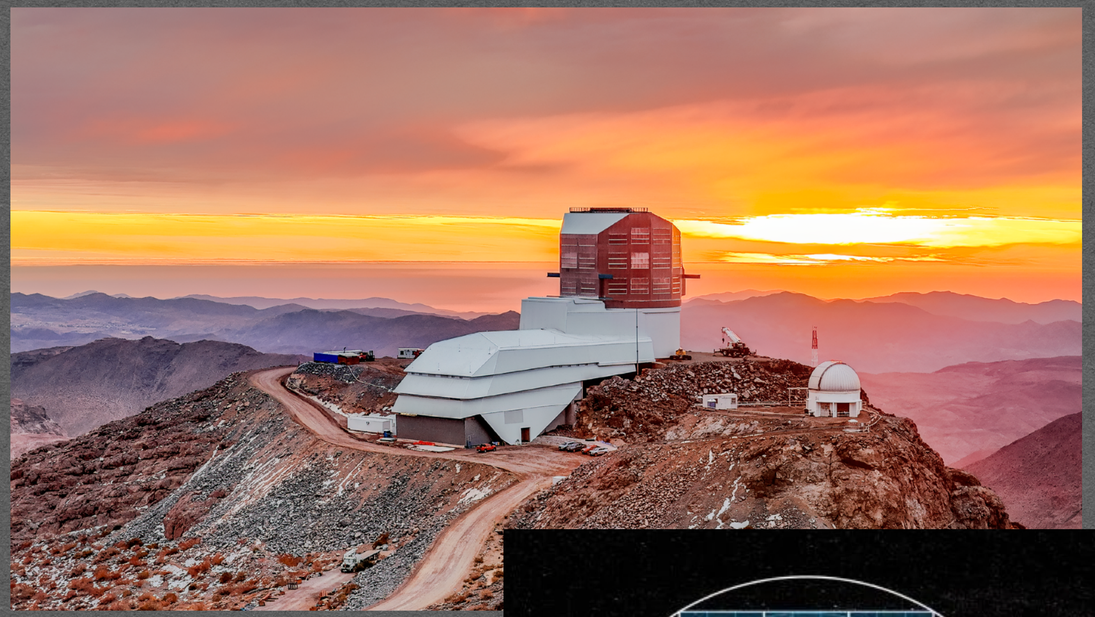

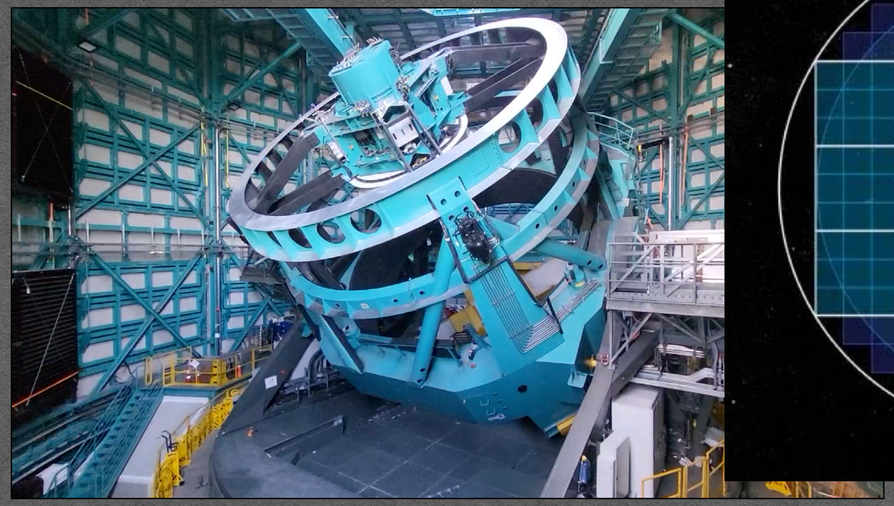

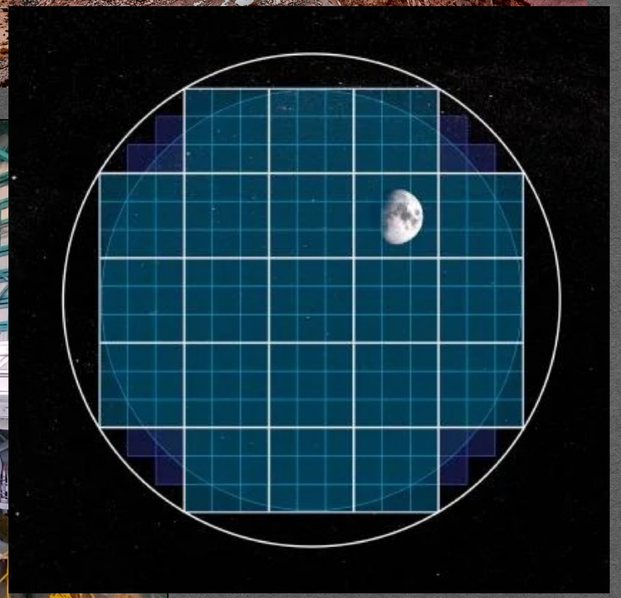

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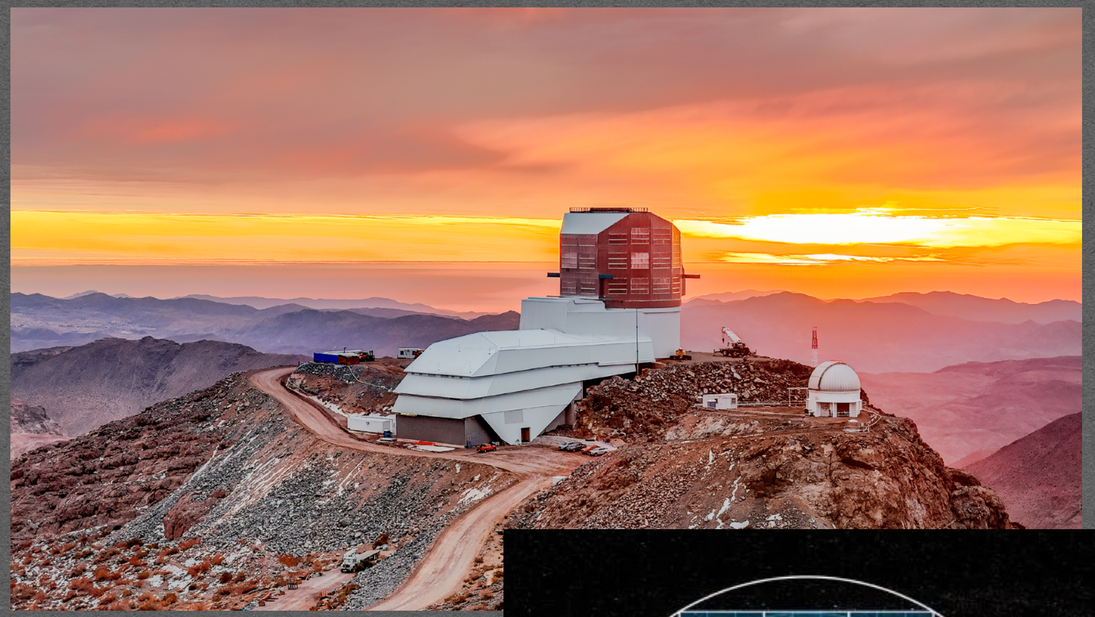

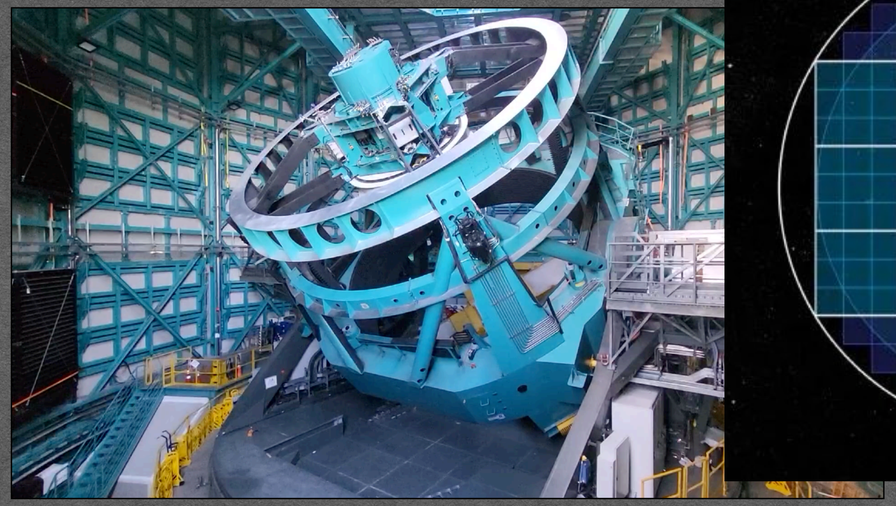

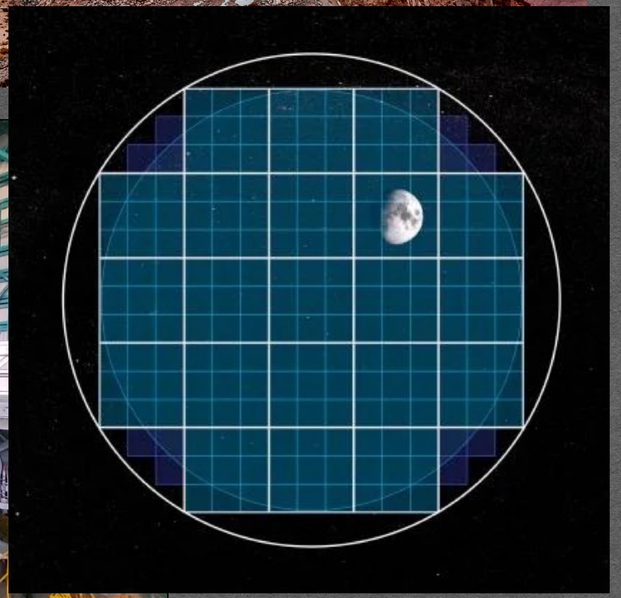

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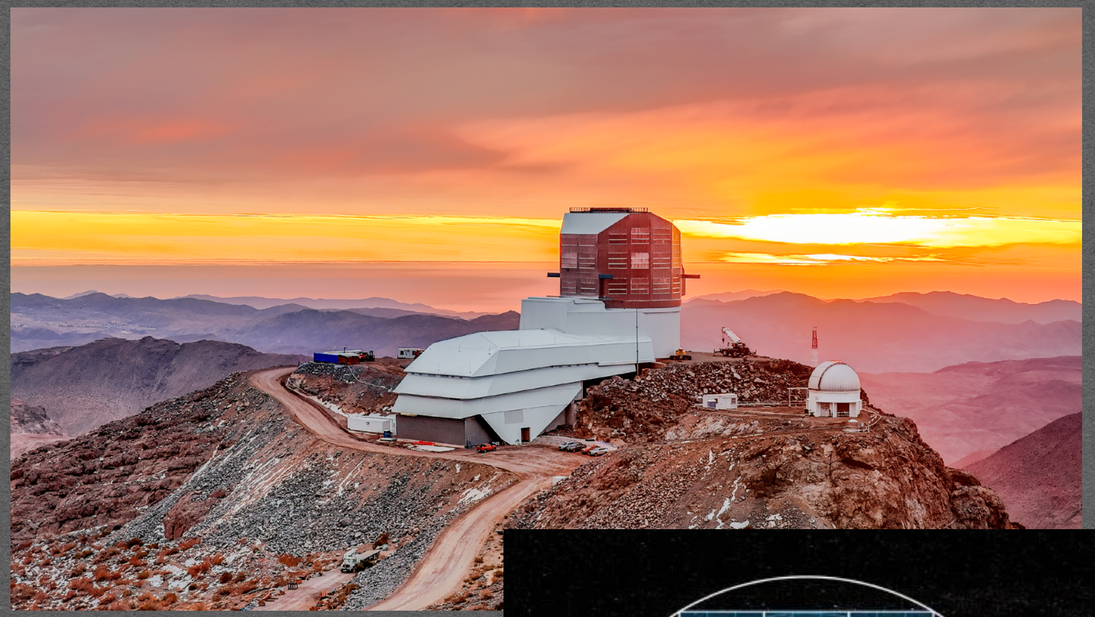

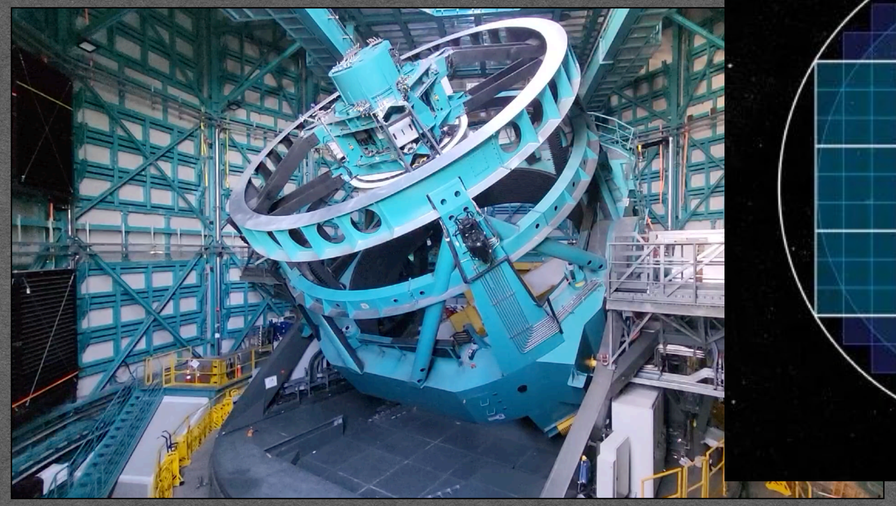

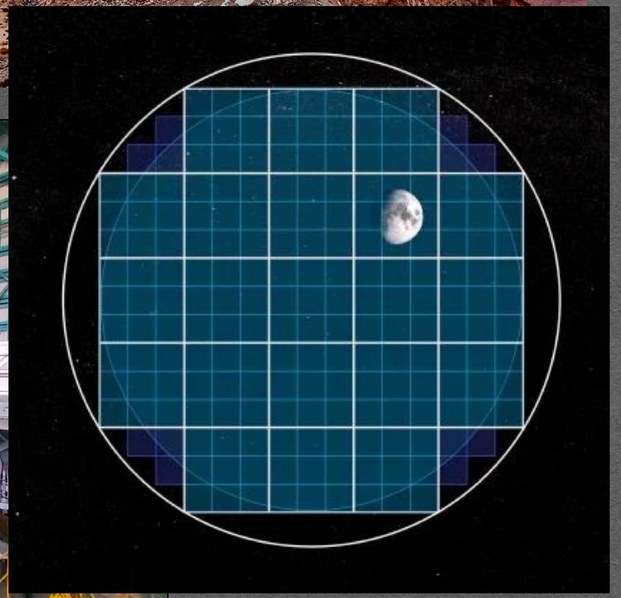

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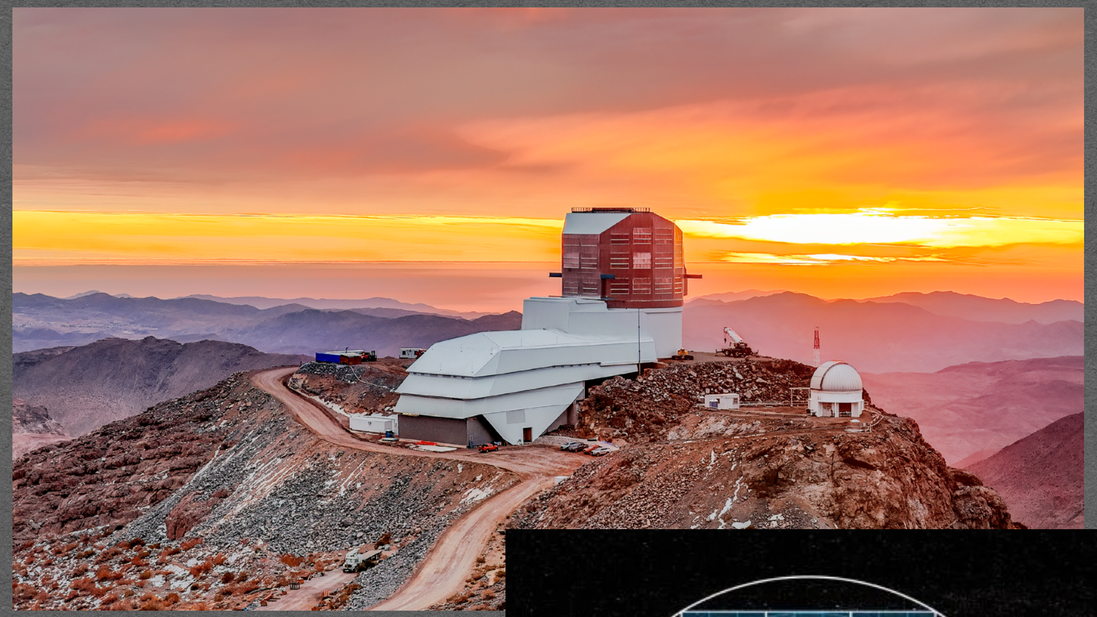

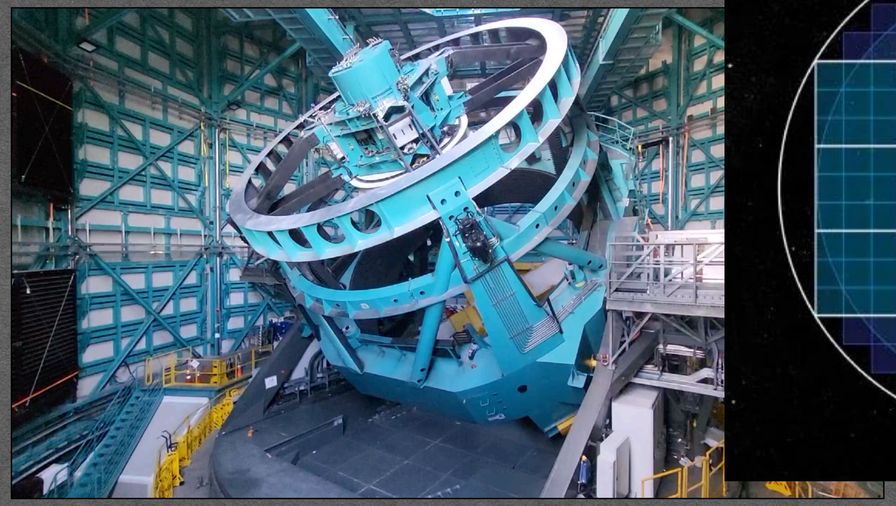

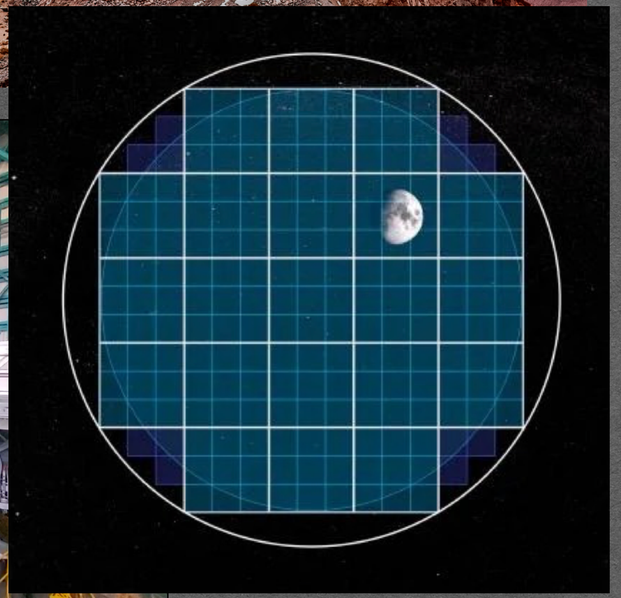

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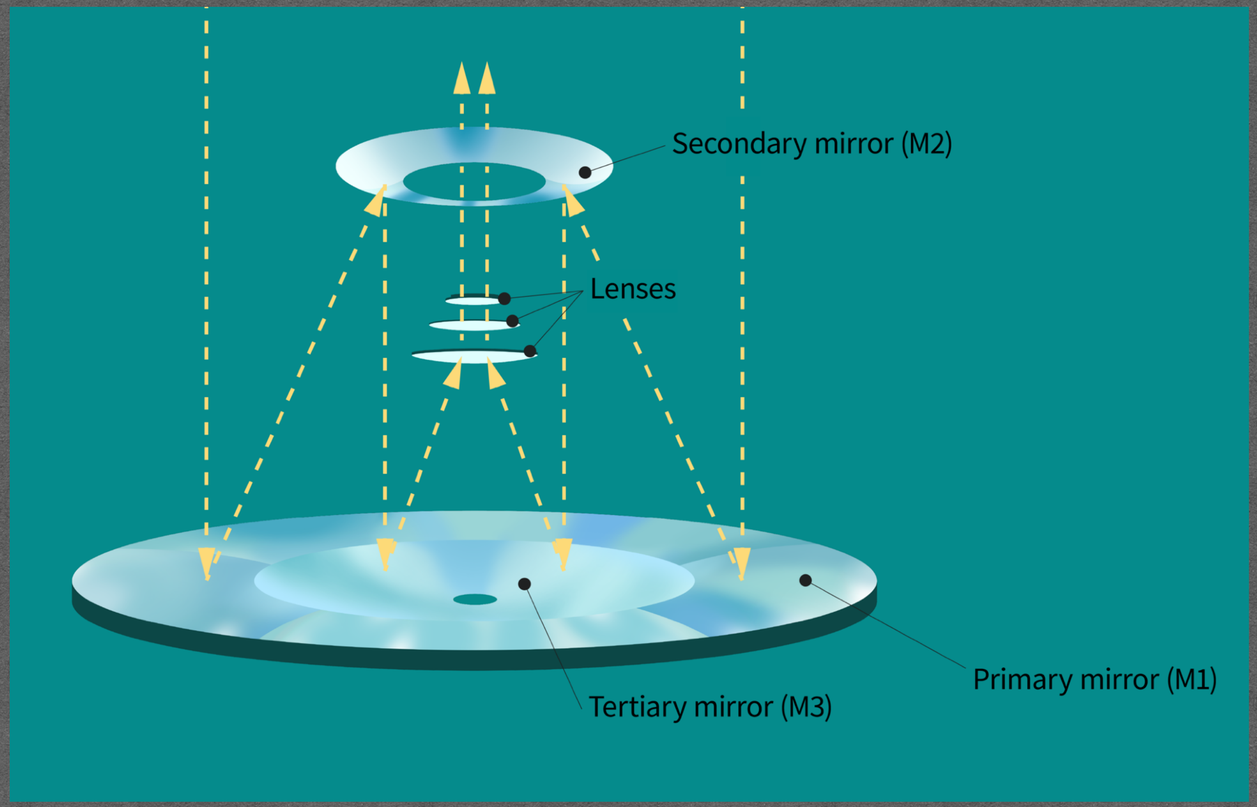

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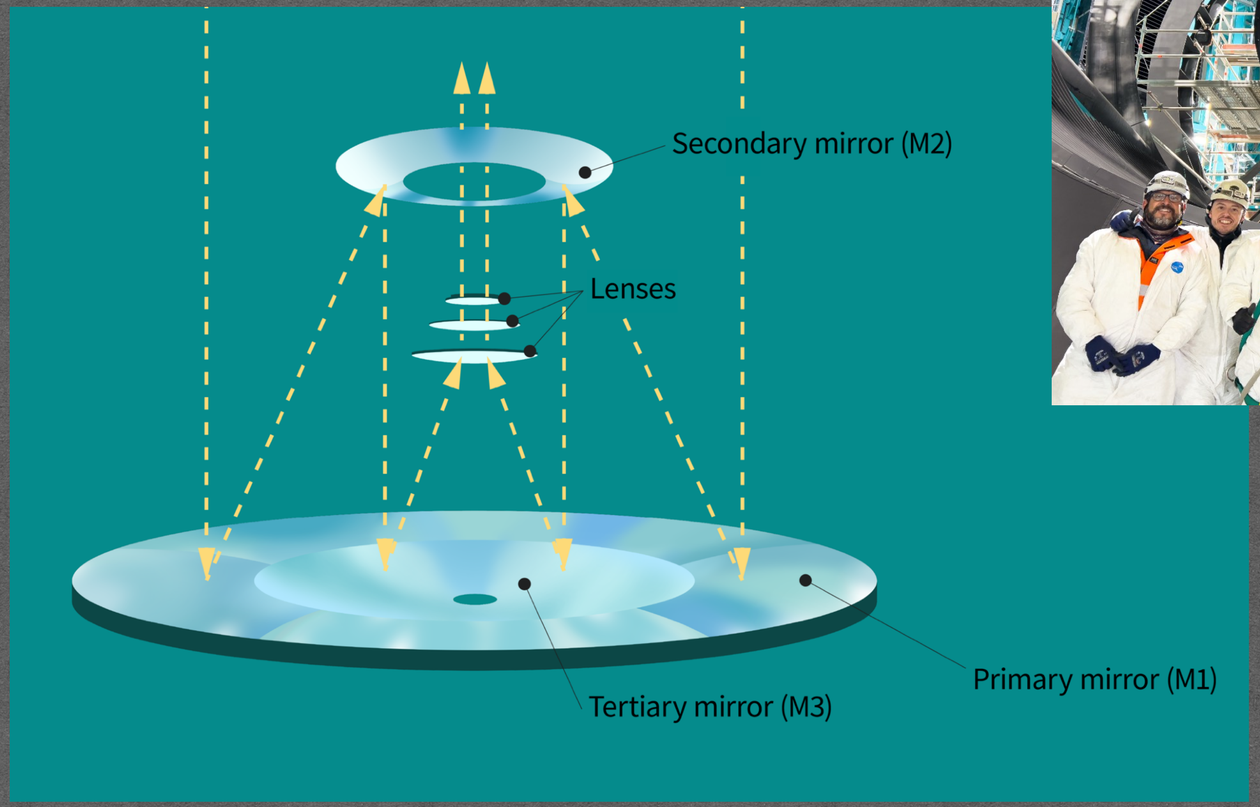

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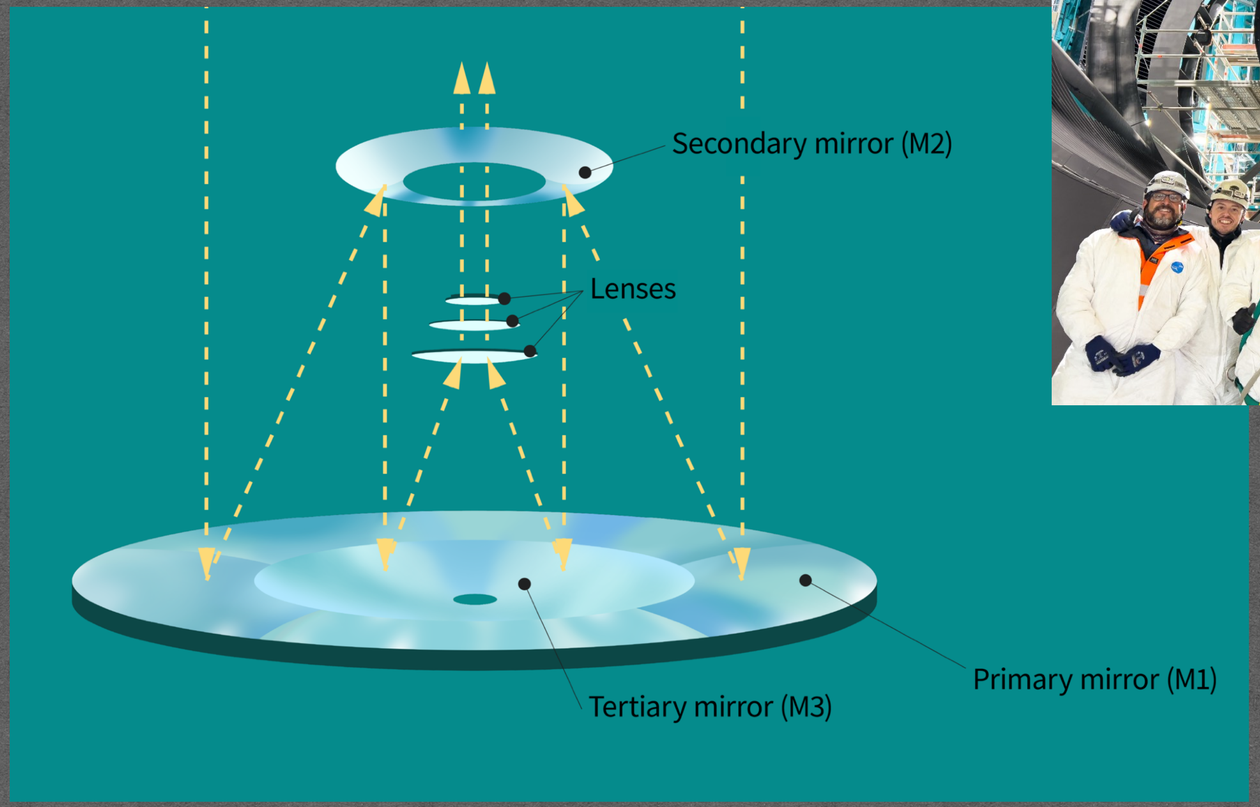

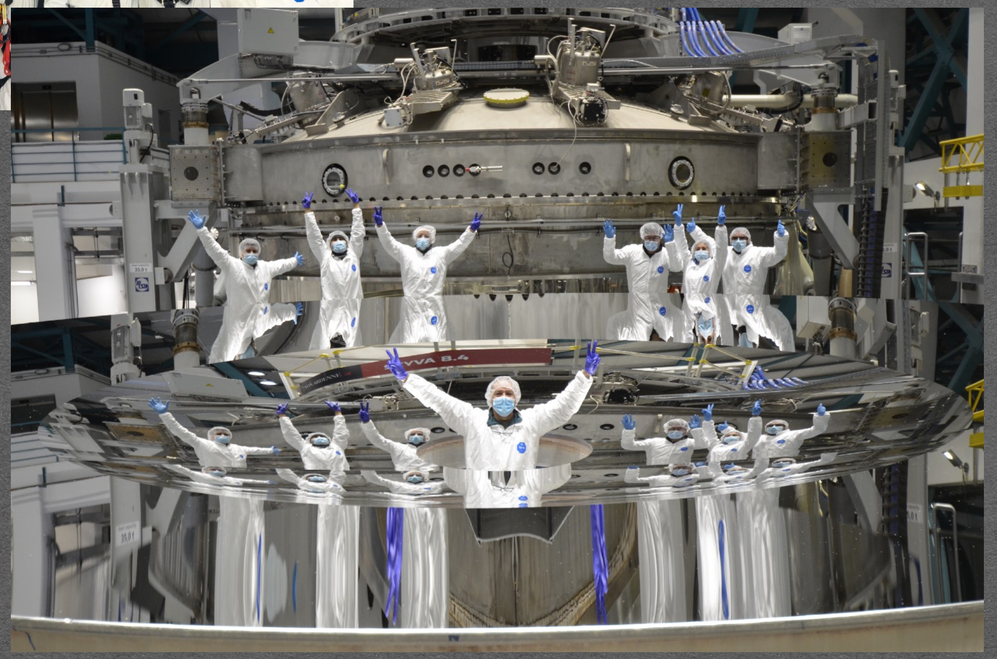

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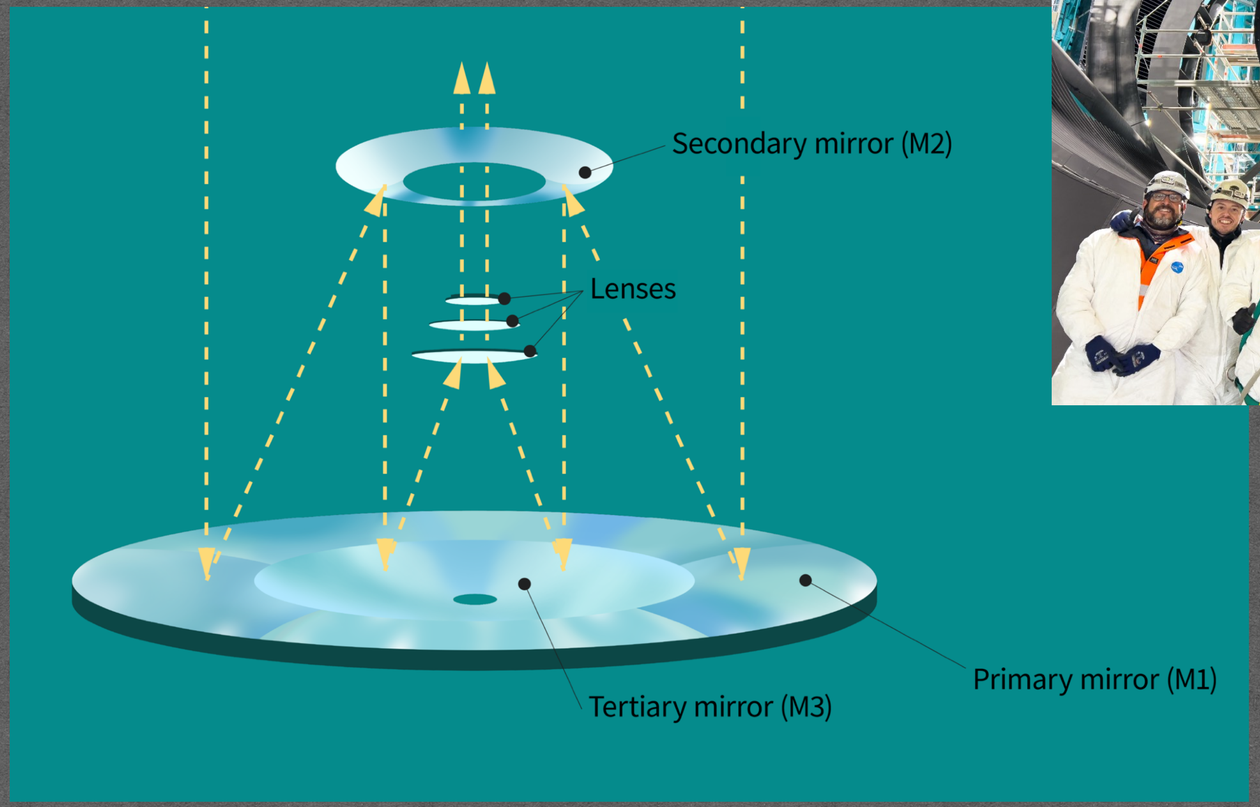

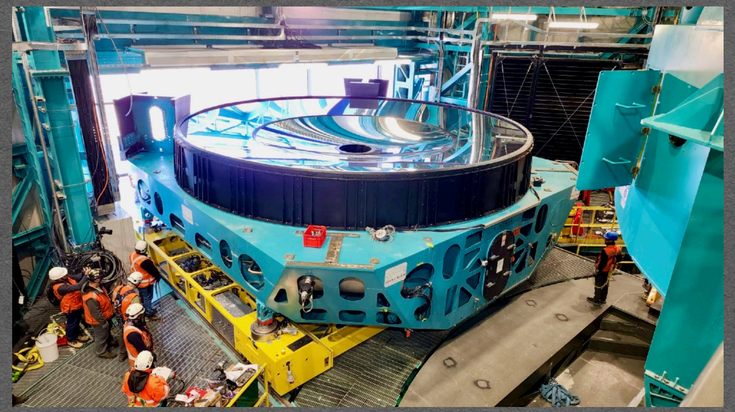

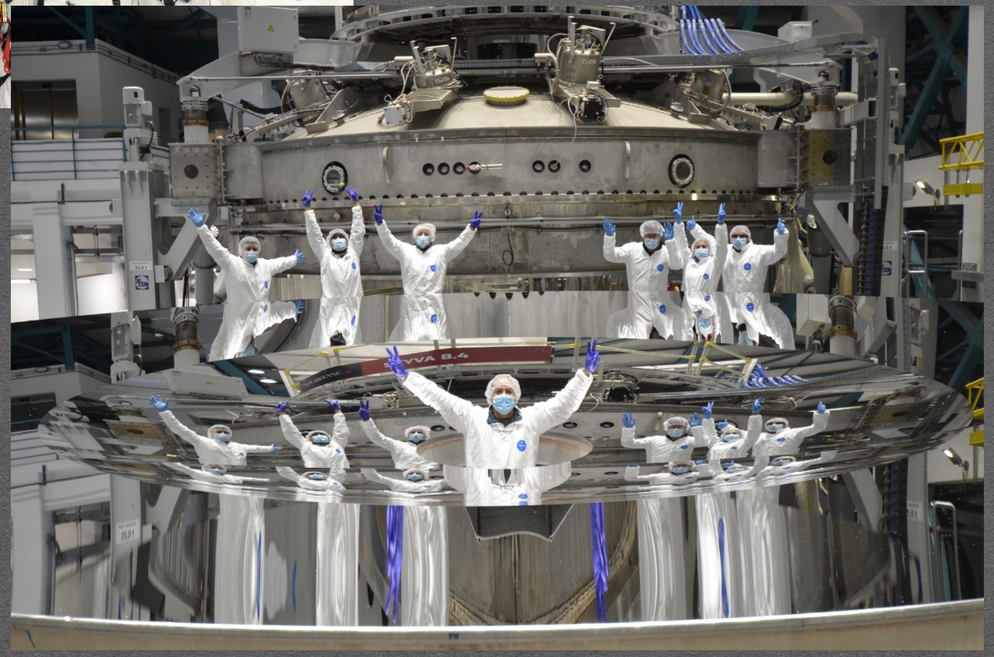

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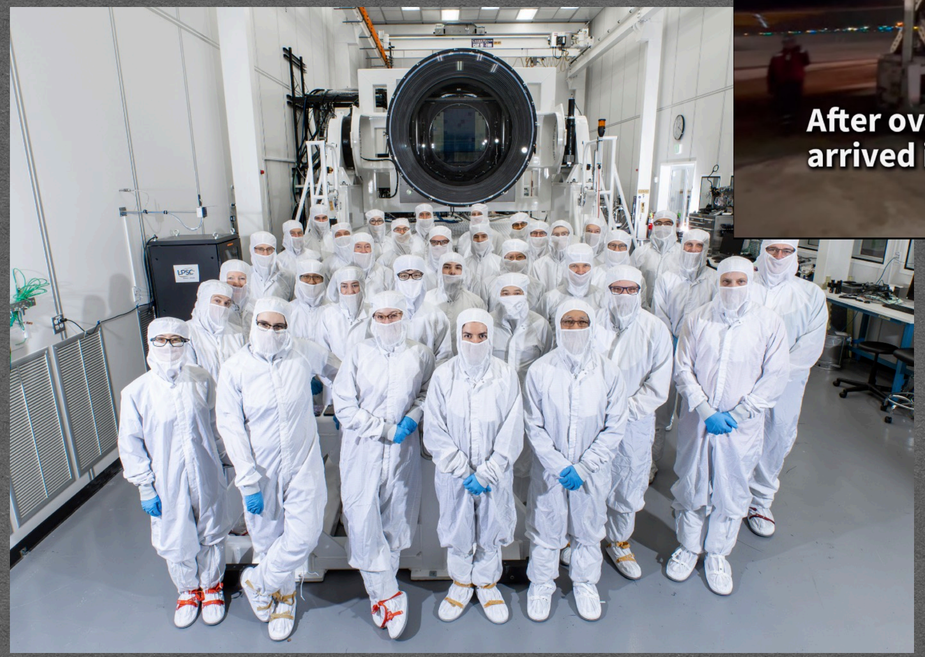

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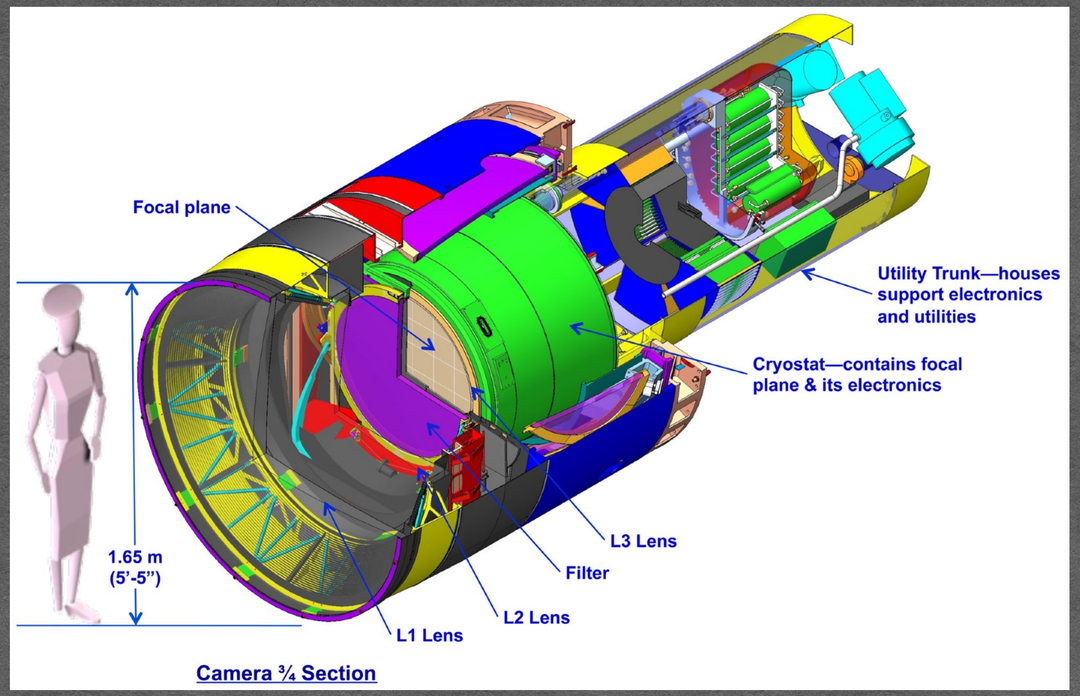

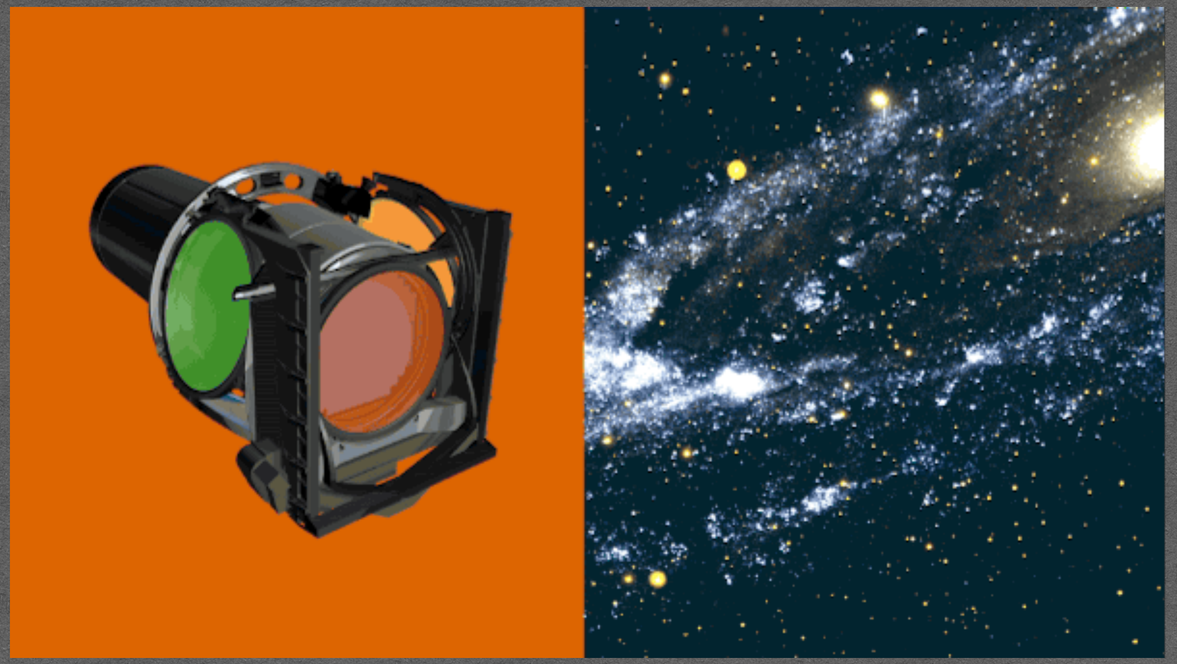

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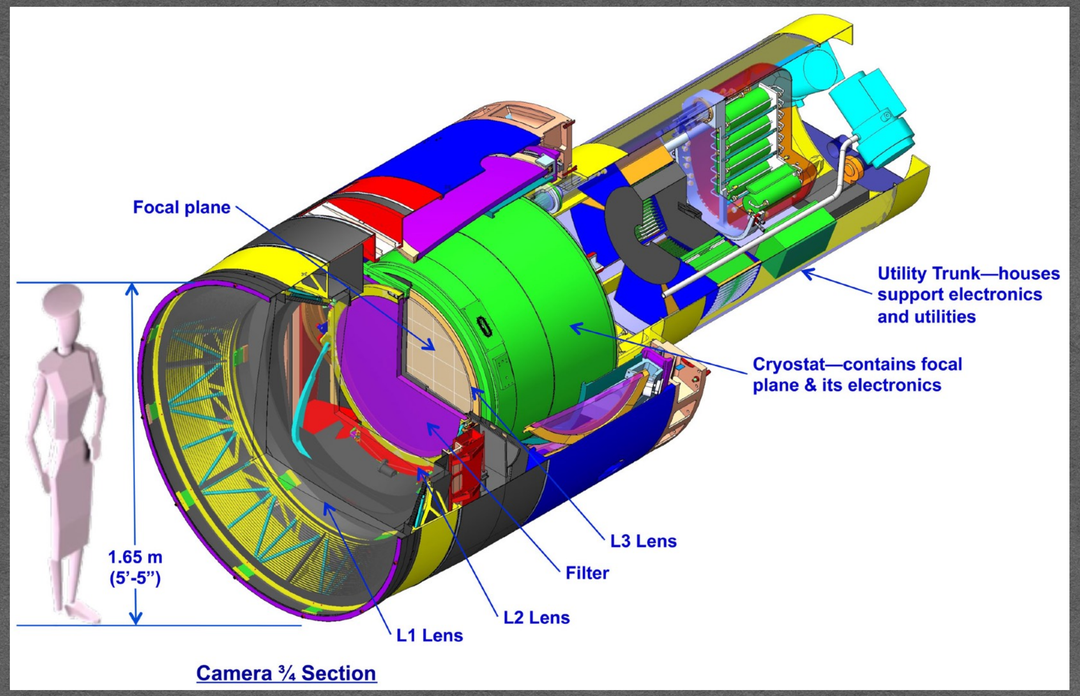

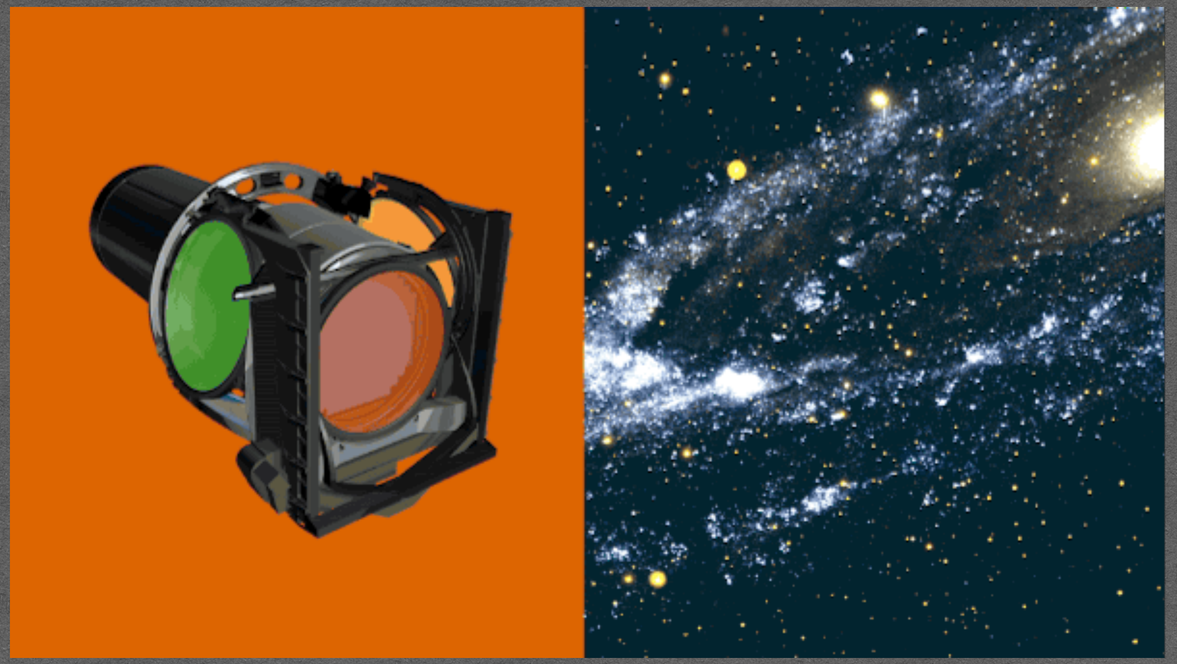

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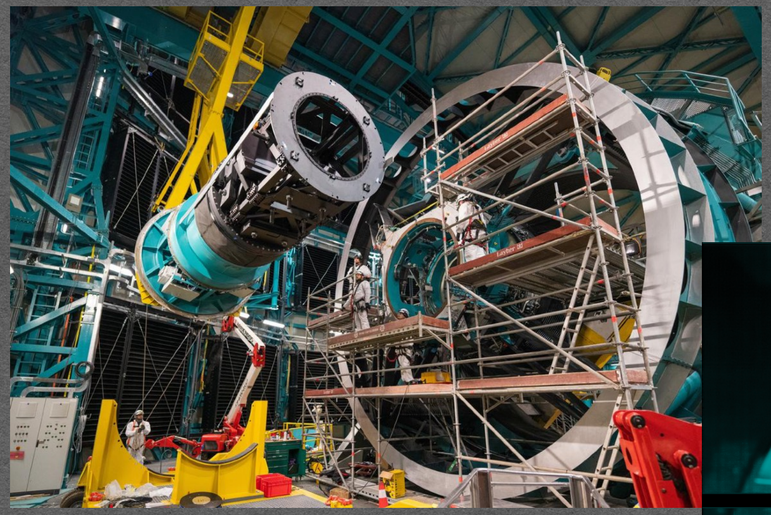

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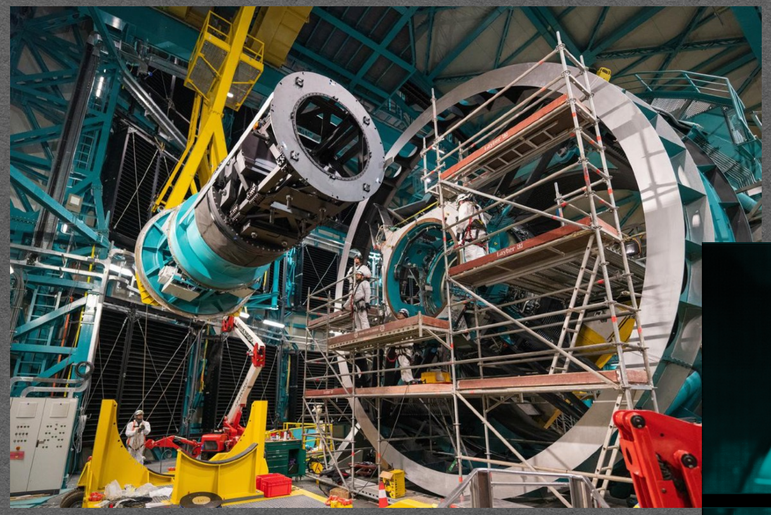

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Next things to come :

- LSSTCam on the TMA - January 2025
- First light - June 2025
- Begining of the survey - September 2025
    - DR1 end 2026
    - Analysis on first data

Cosmology with LSST

- 4 main probes for testing ΛCDM and its extensions :
  - Weak Lensing
  - BAO
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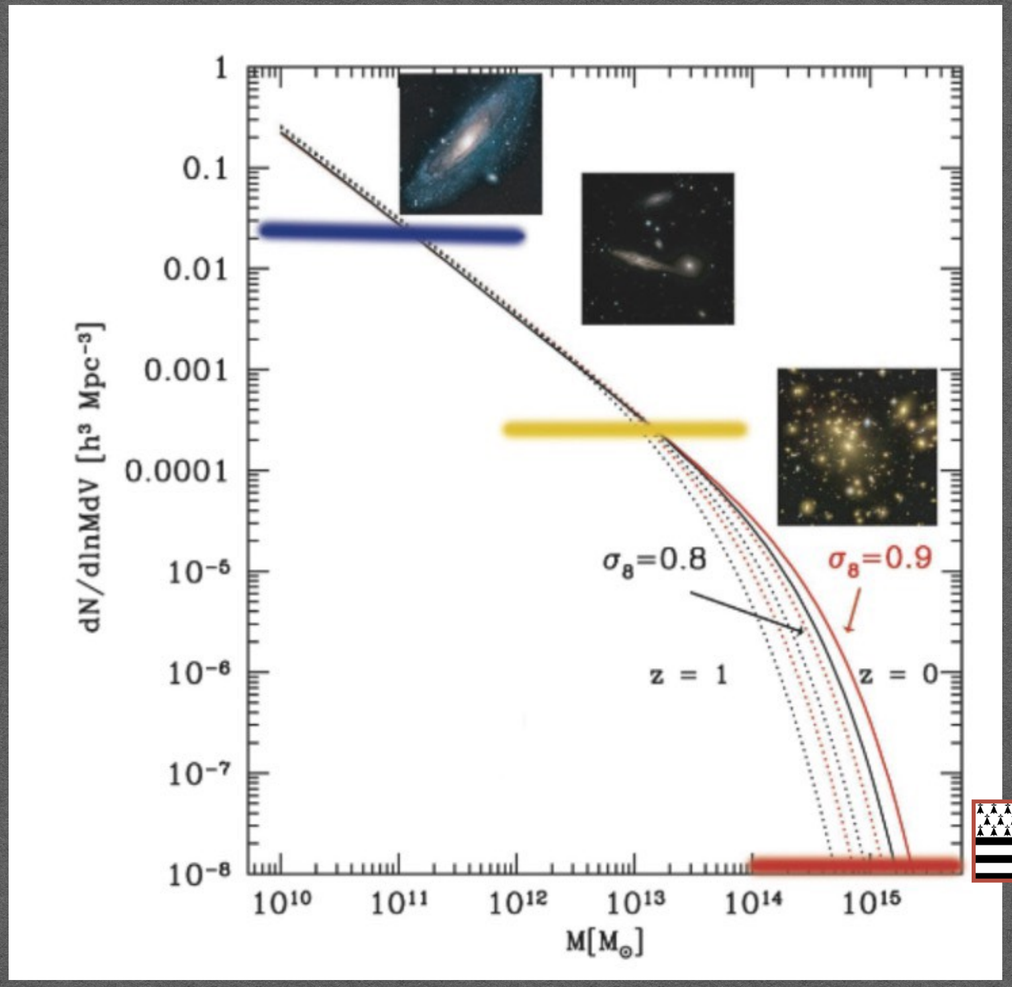

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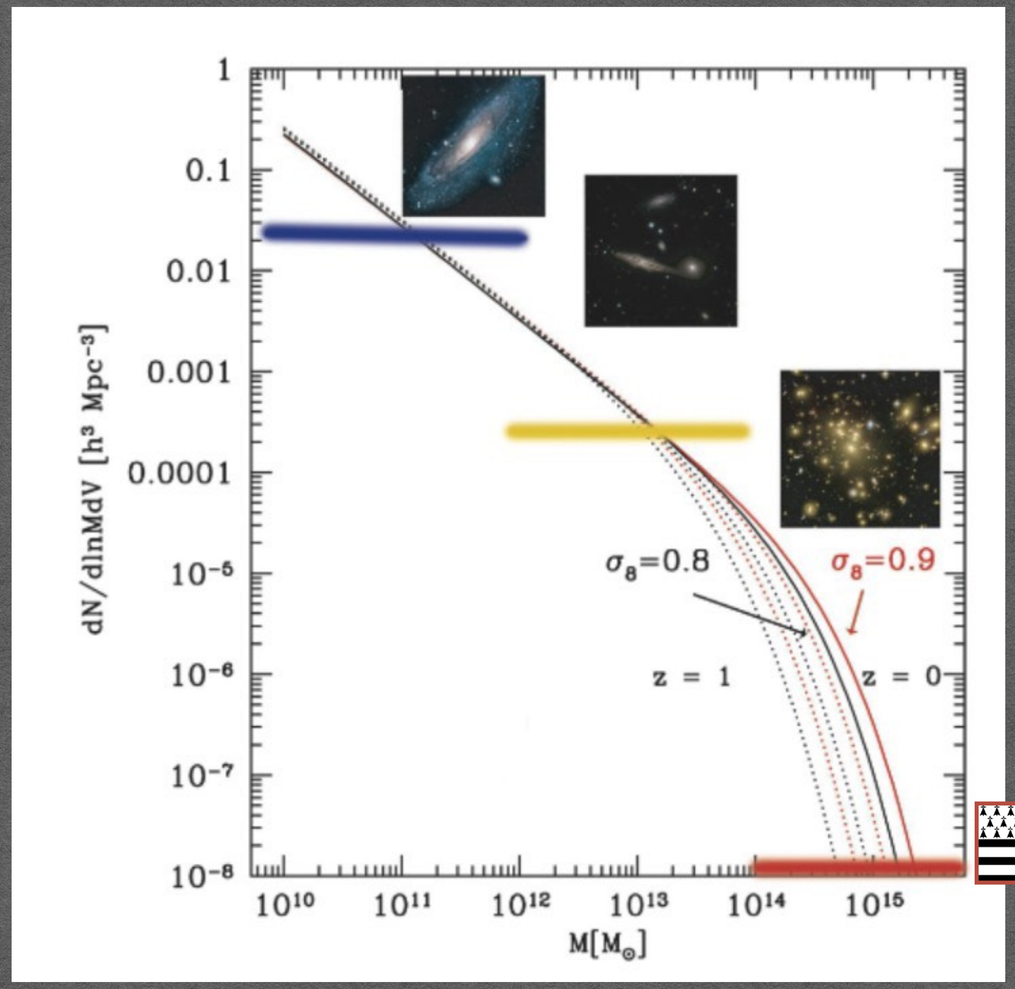

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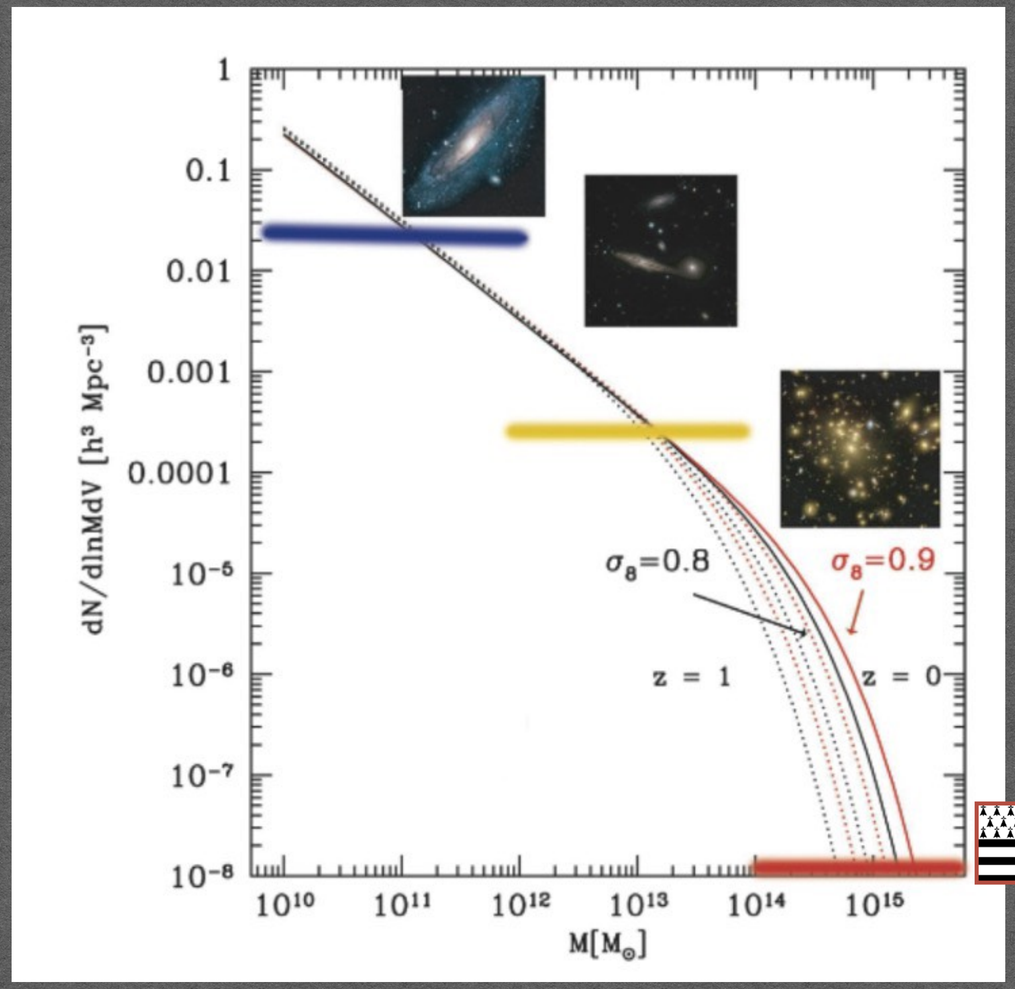

Bright object masks

The bright stars issue

Bright stars reduce image quality by introducing optical / electronical effects

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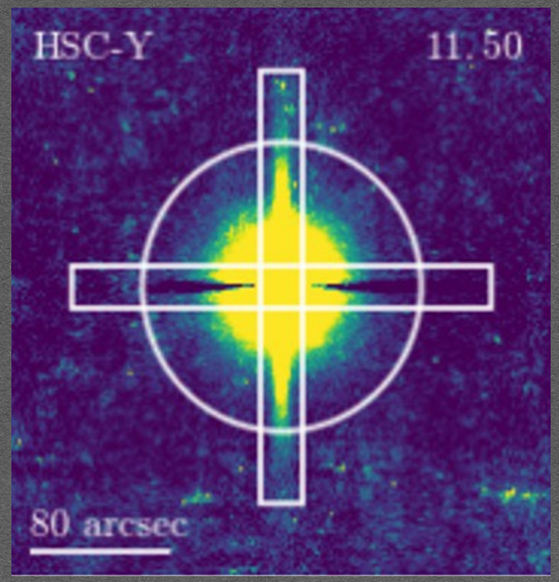

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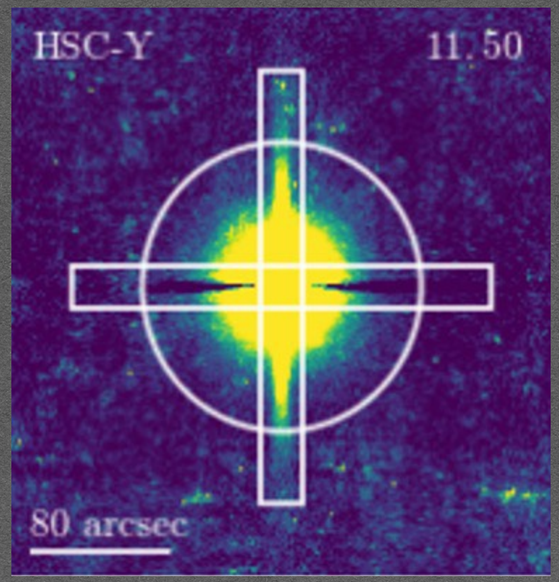

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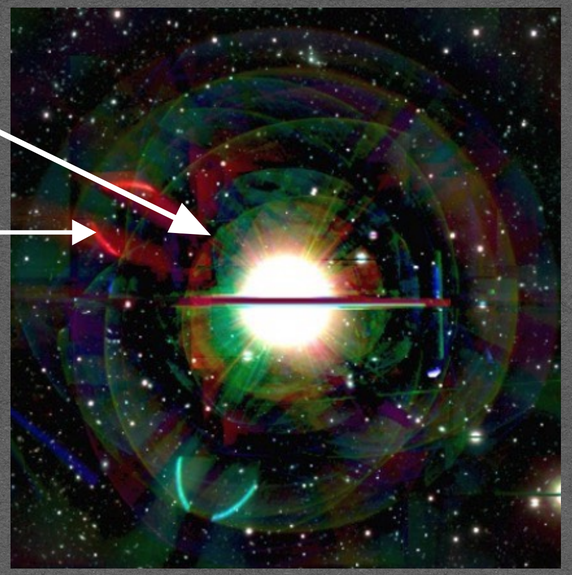

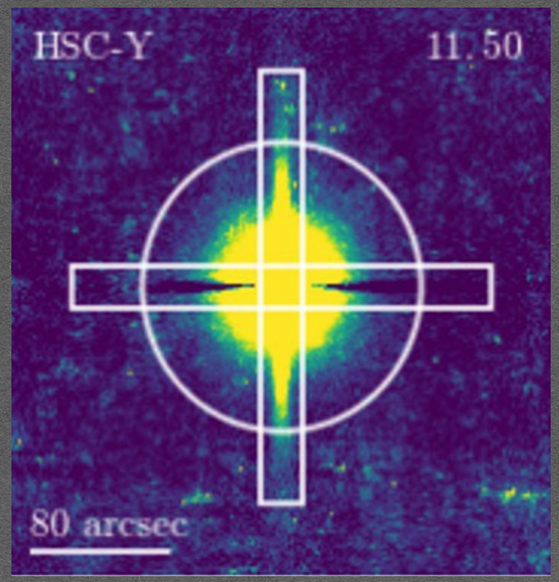

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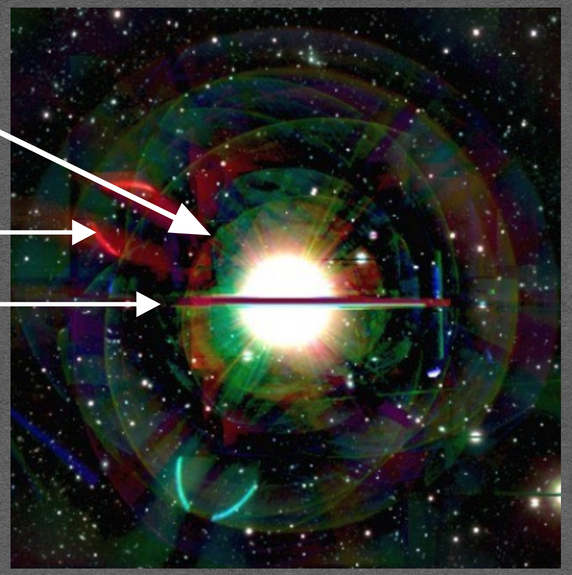

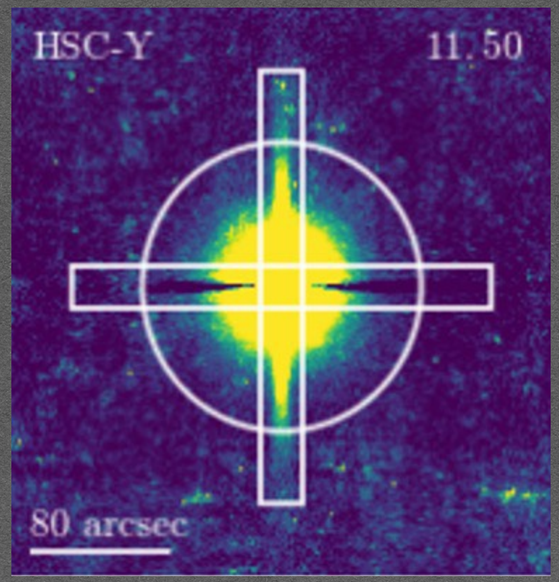

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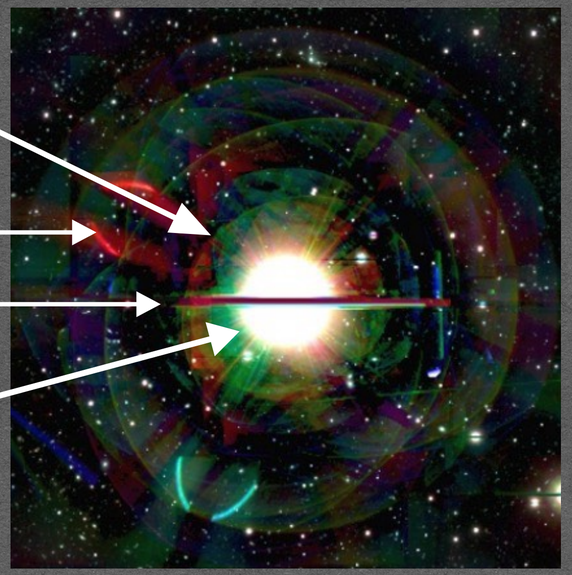

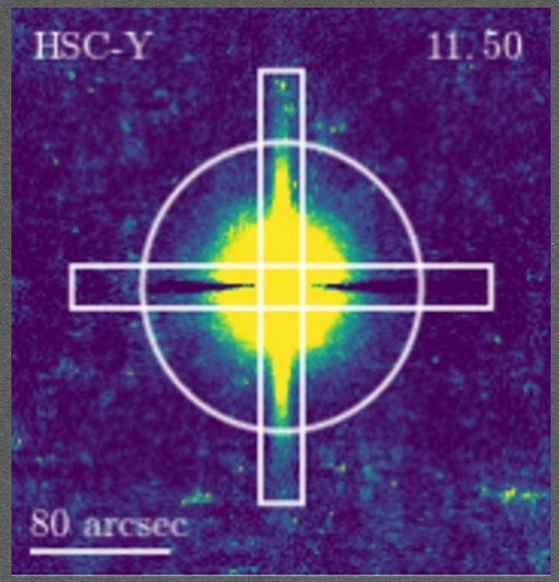

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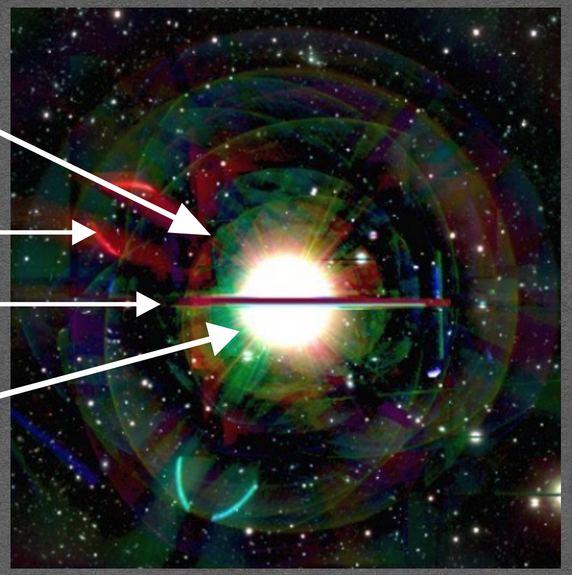

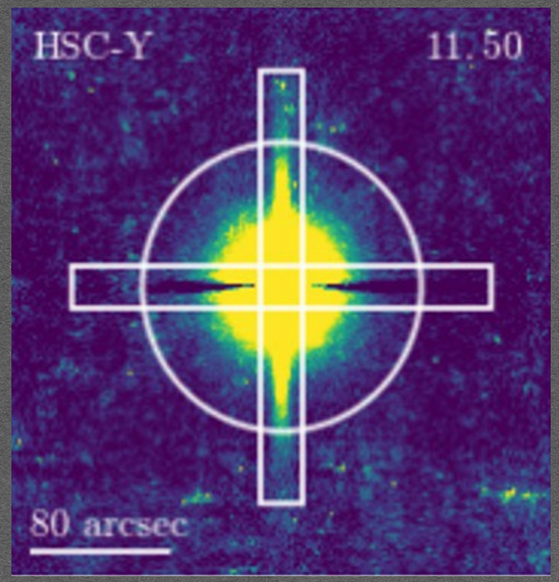

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→ Concerns different working groups with different needs for masks

DC2 simulation

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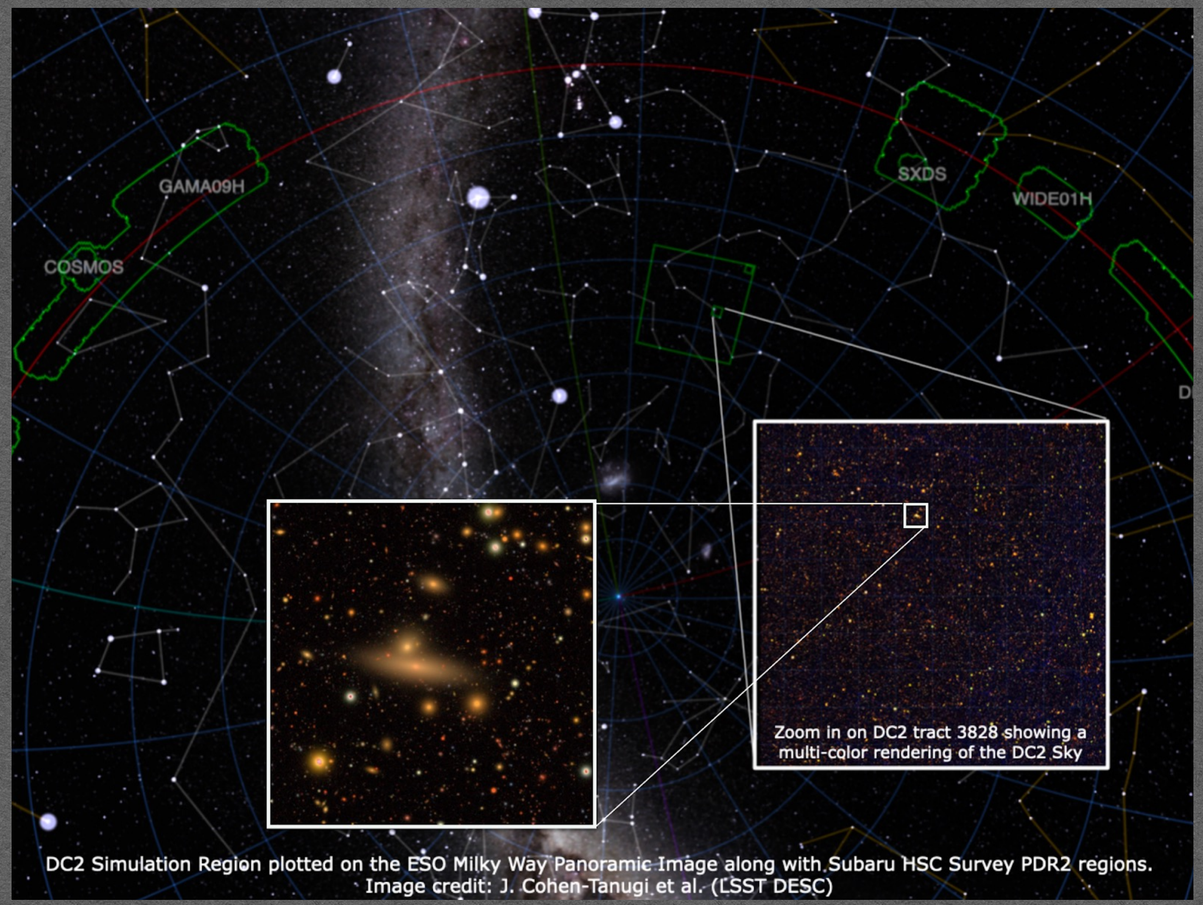

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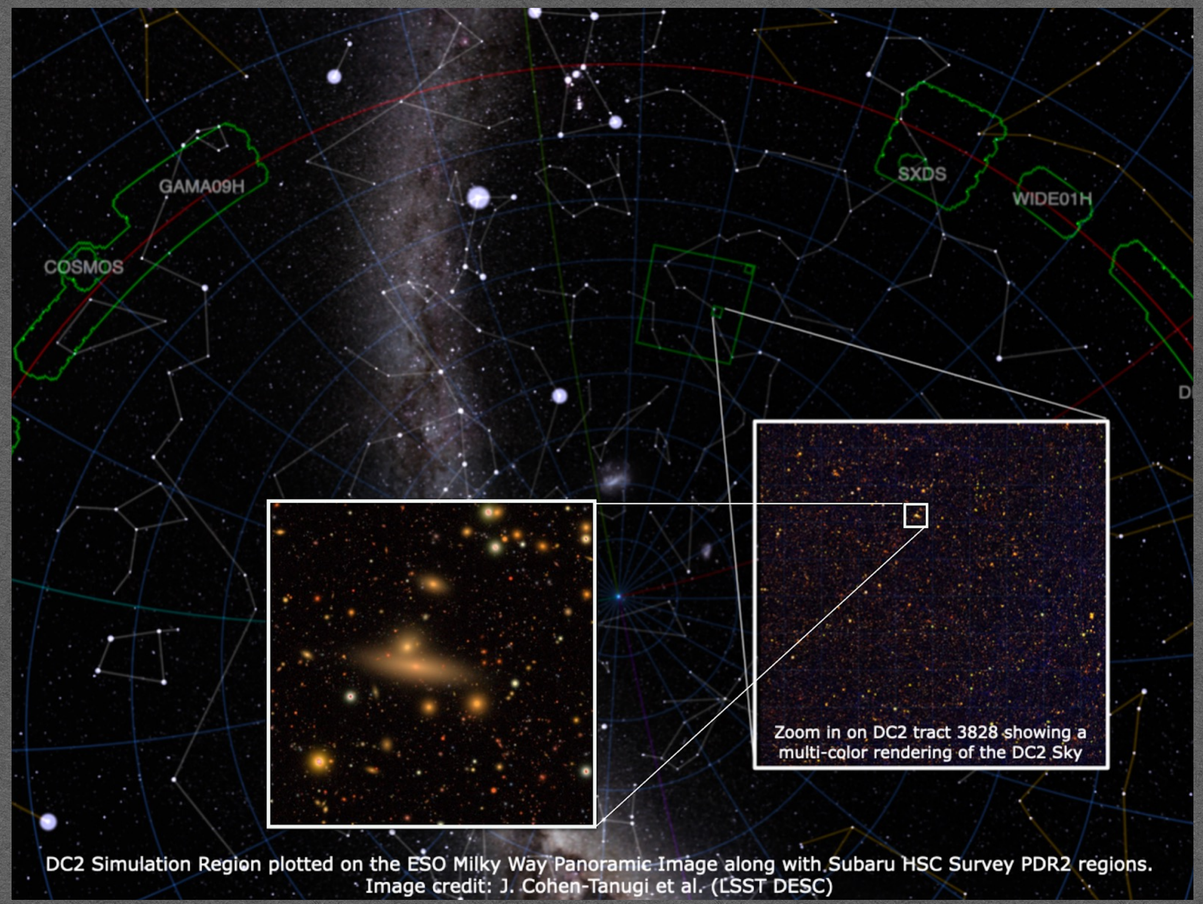

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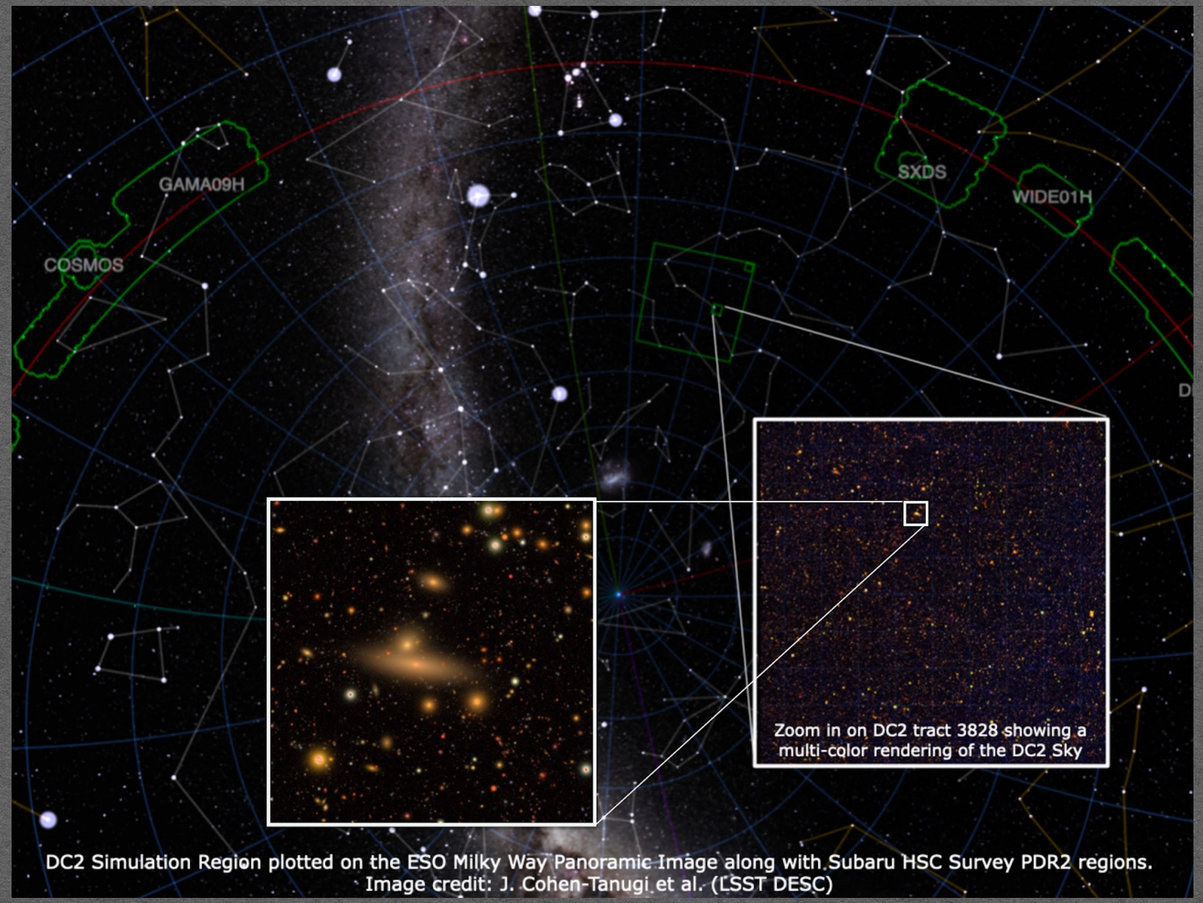

DC2 Simulation Region plotted on the ESO Milky Way Panoramic Image along with Subaru HSC Survey PDR2 regions.
Image credit: J. Cohen-Tanugi et al. (LSST DESC)

DC2 simulation

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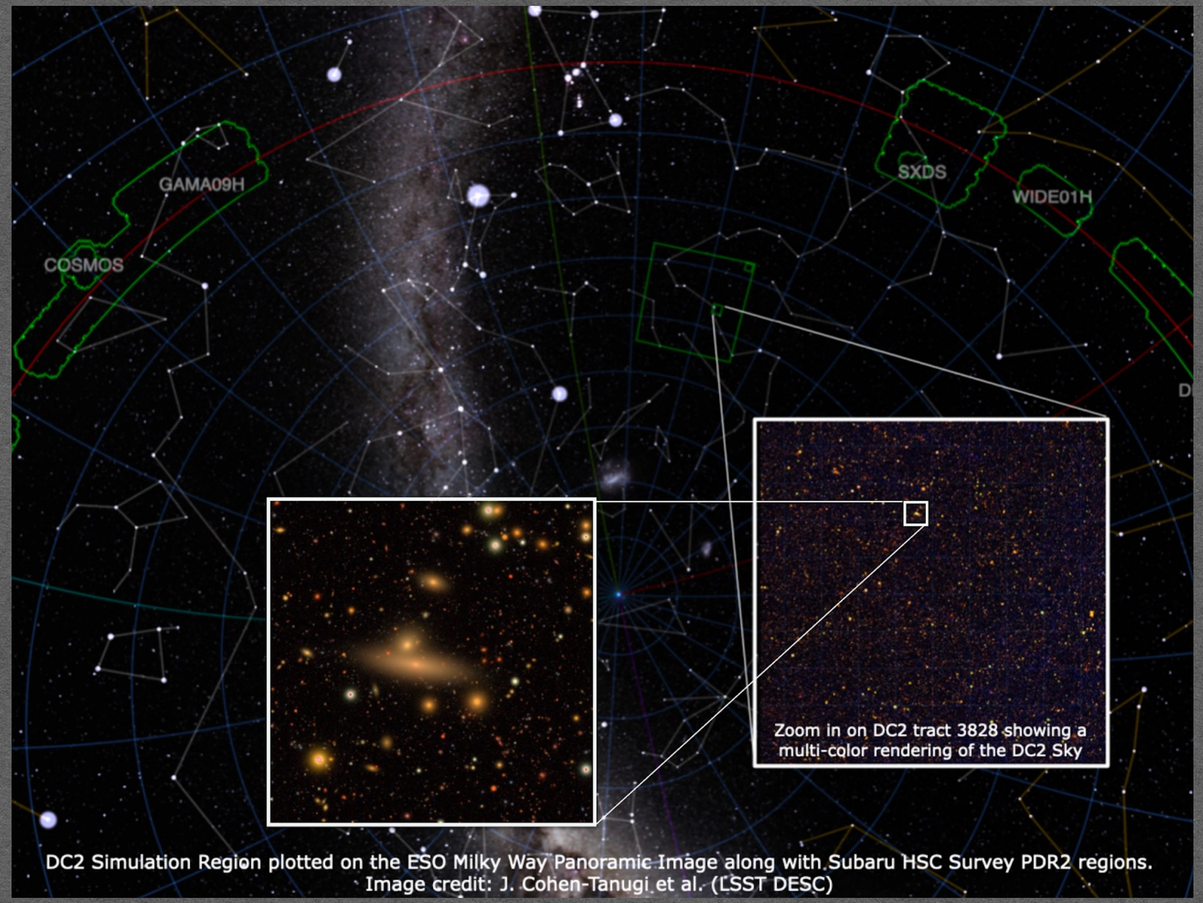

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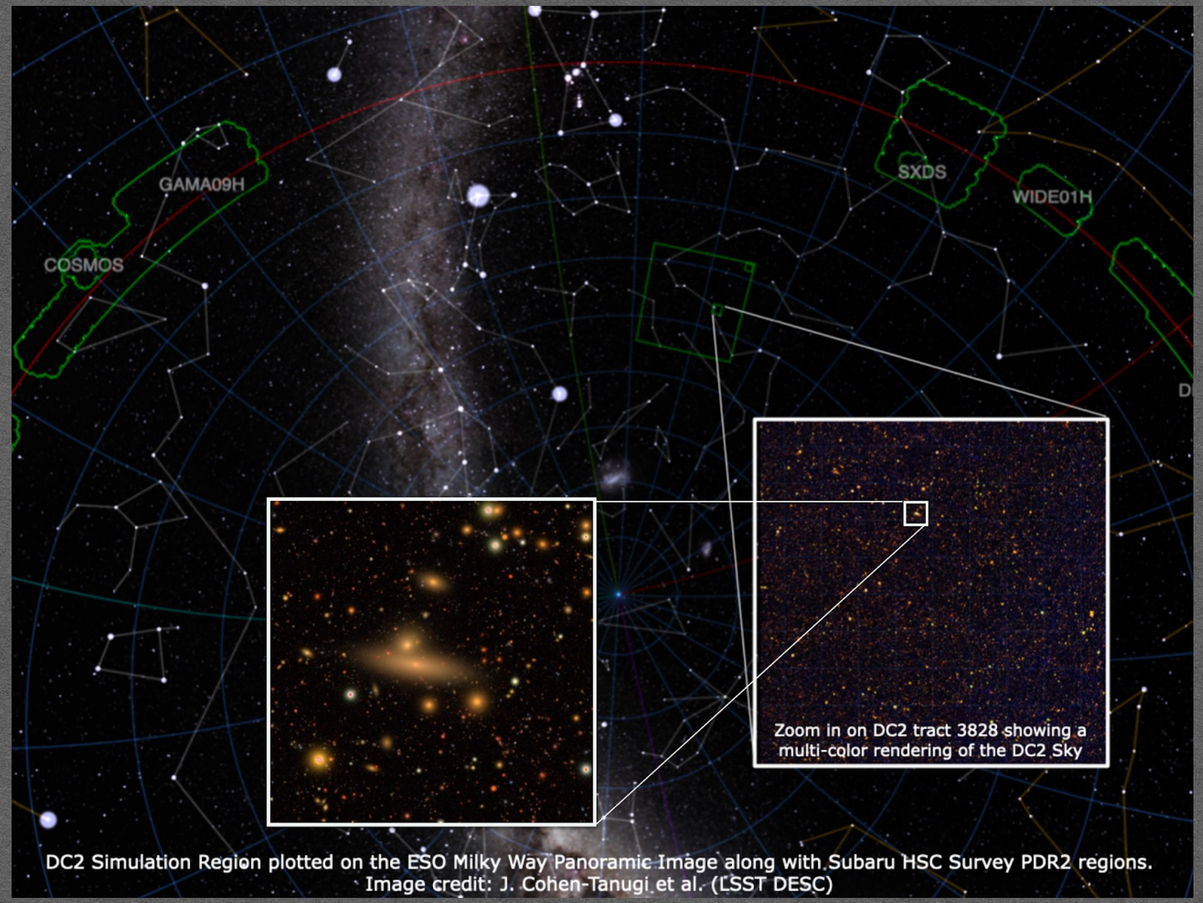

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→ DC2 object catalog

We use this dataset in this presentation

Bright object masks

Masking methodology

Bright object sample

+

Galaxy sample

Step one

Bright object masks

Masking methodology - Samples

Build samples :

Bright star sample

1. Select stars using object truth type
2. Pick stars with truth magnitude < 17
3. Bin them with respect to their truth magnitude

Bright object masks

Masking methodology - Samples

Build samples :

Bright star sample

1. Select stars using object truth type
2. Pick stars with truth magnitude < 17
3. Bin them with respect to their truth magnitude

Galaxy sample

1. « Basic quality cuts » using flags (bad PSF shape, SNR, flagged flux, …)
2. 17 < mag_i < 25.3 → keep object selection efficiency around 95%
3. Use flag « extendedness » == 1

Bright object masks

Masking methodology

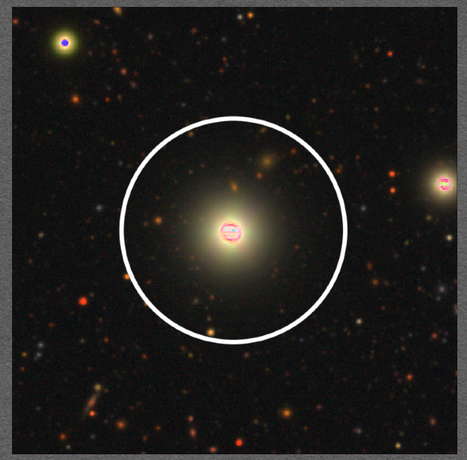
Bright object sample

+

Galaxy sample

Step one

Determine disk radii



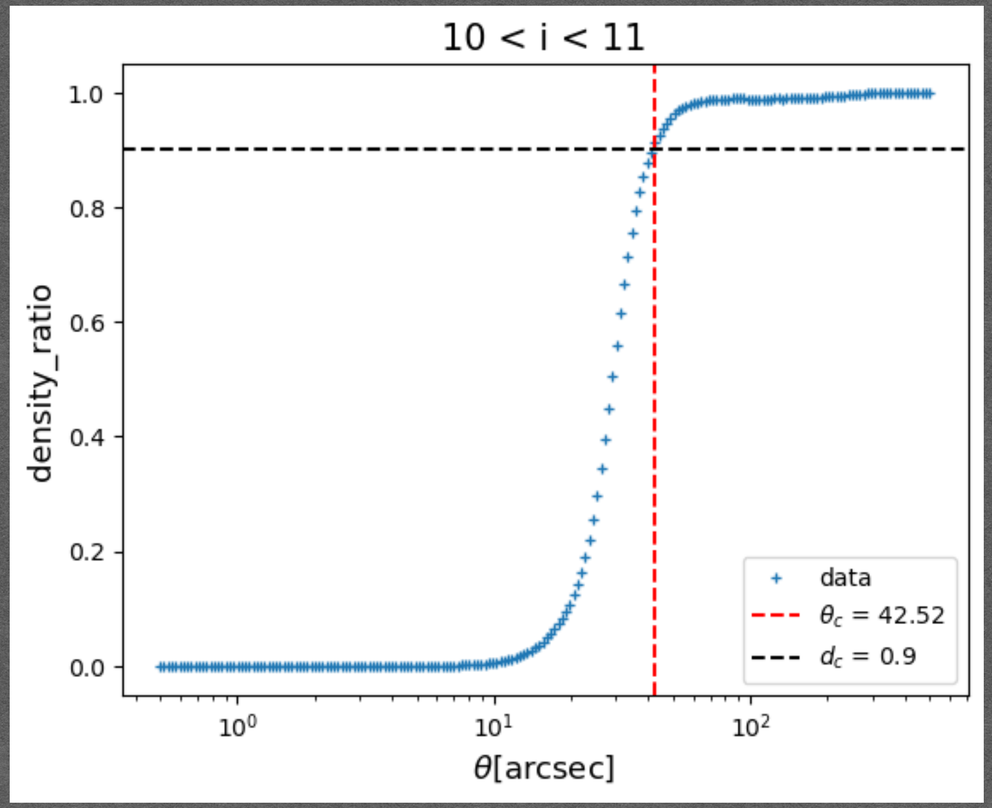
Step two

Bright object masks

Masking methodology - Density profiles

Determine disk radius :

1. Sort bright stars in bins of magnitude
2. Calculate object density within several radiuses around each star
3. Normalize with full survey density



Bright object masks

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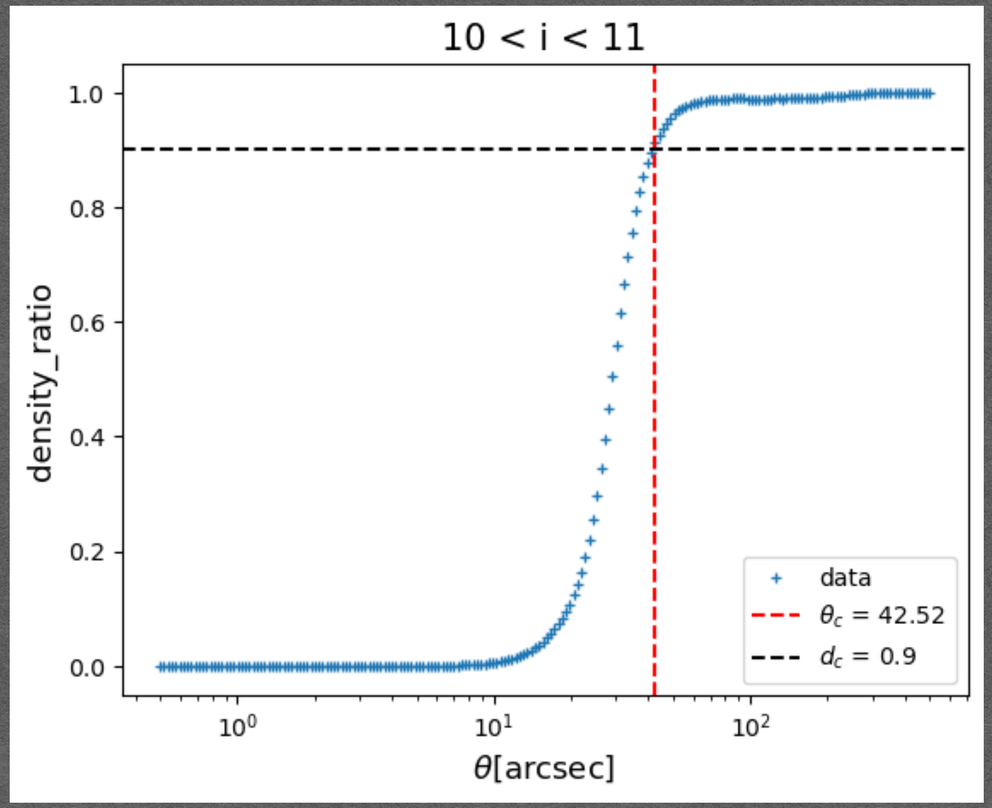

$$5” < \theta_c < 50”$$

Bright object masks

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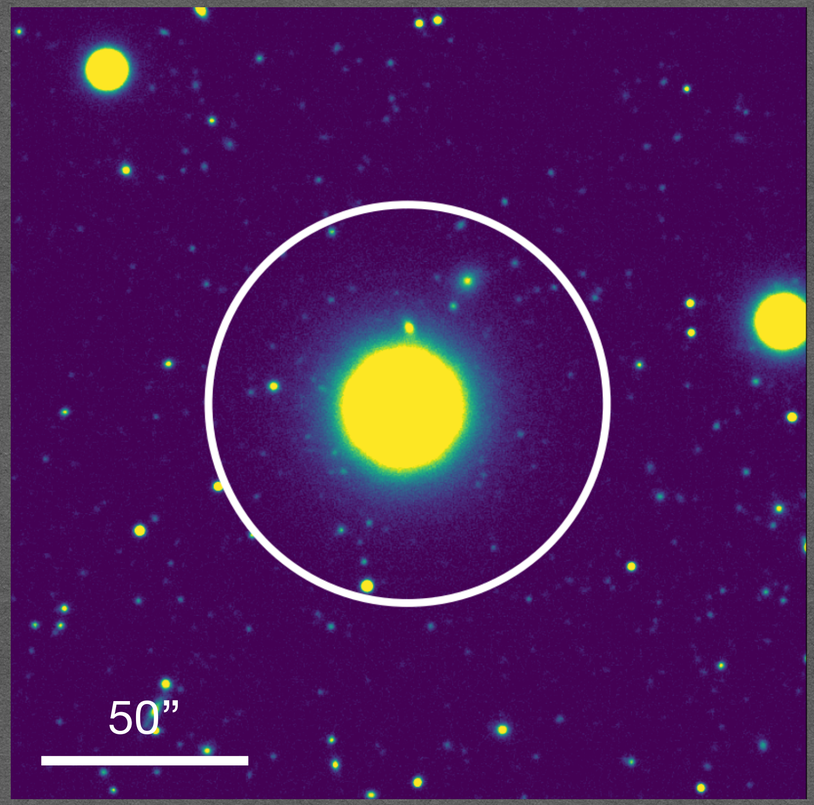

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Bright object masks

Masking methodology

Bright object sample

+

Galaxy sample

Step one

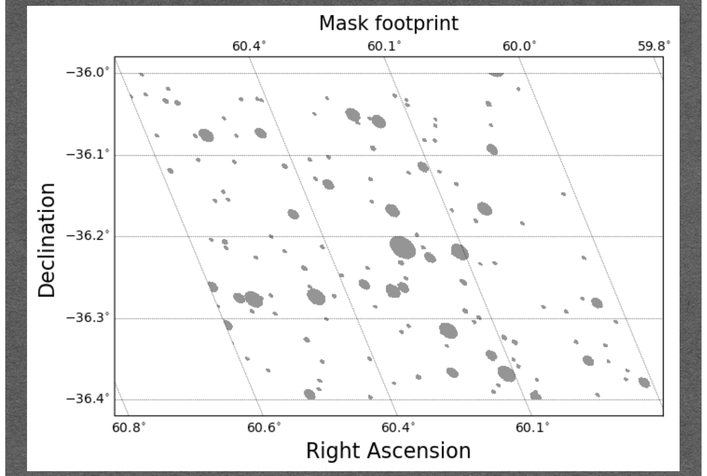
Disk radii

+

Bright object sample

Step two

Mask map



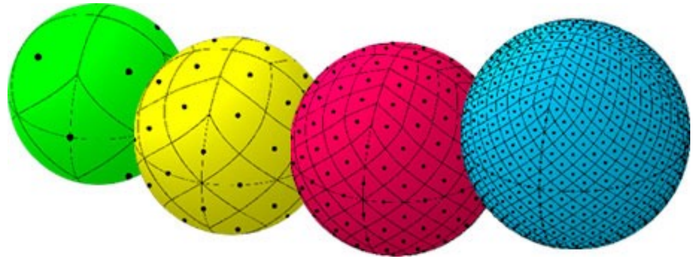
Step three

Bright object masks

Masking methodology - Generate a mask map

Healsparse : tool to generate high resolution HEALPix pixel map

Empty high resolution map (resolution ~0.5”)



Bright object masks

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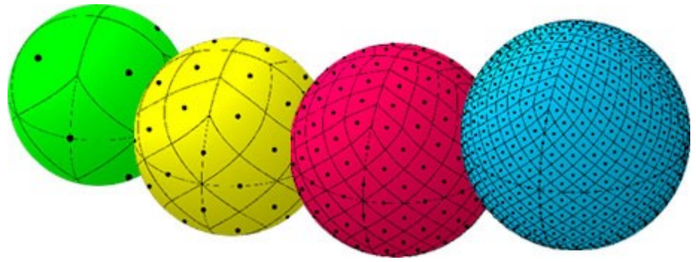

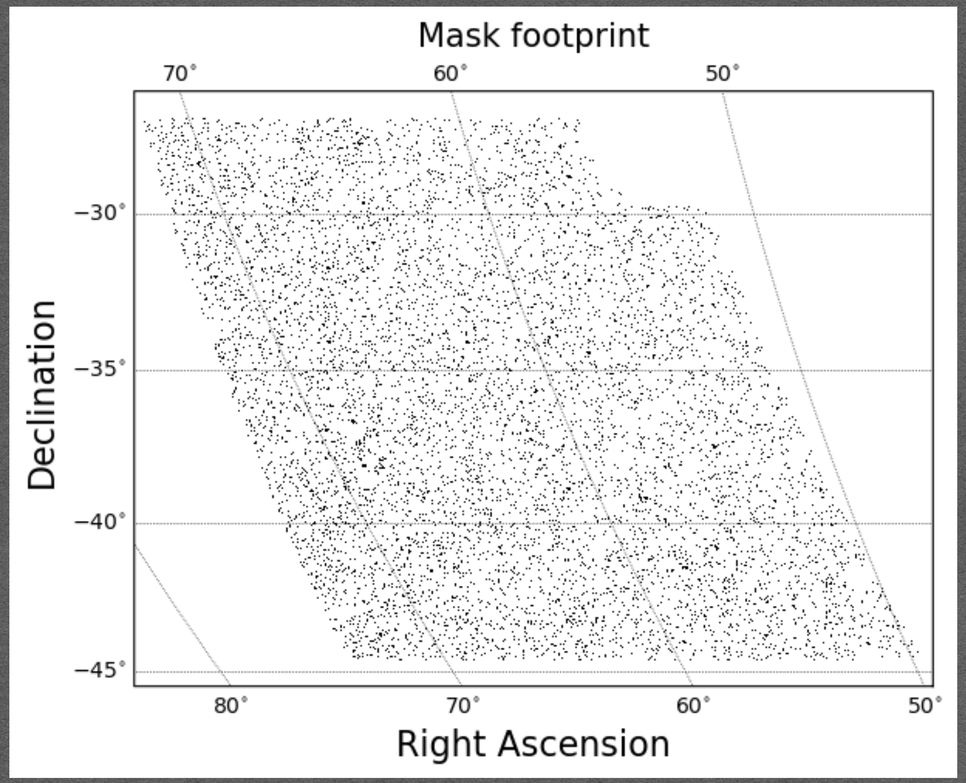

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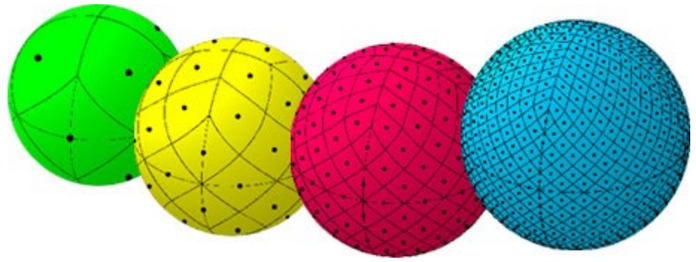
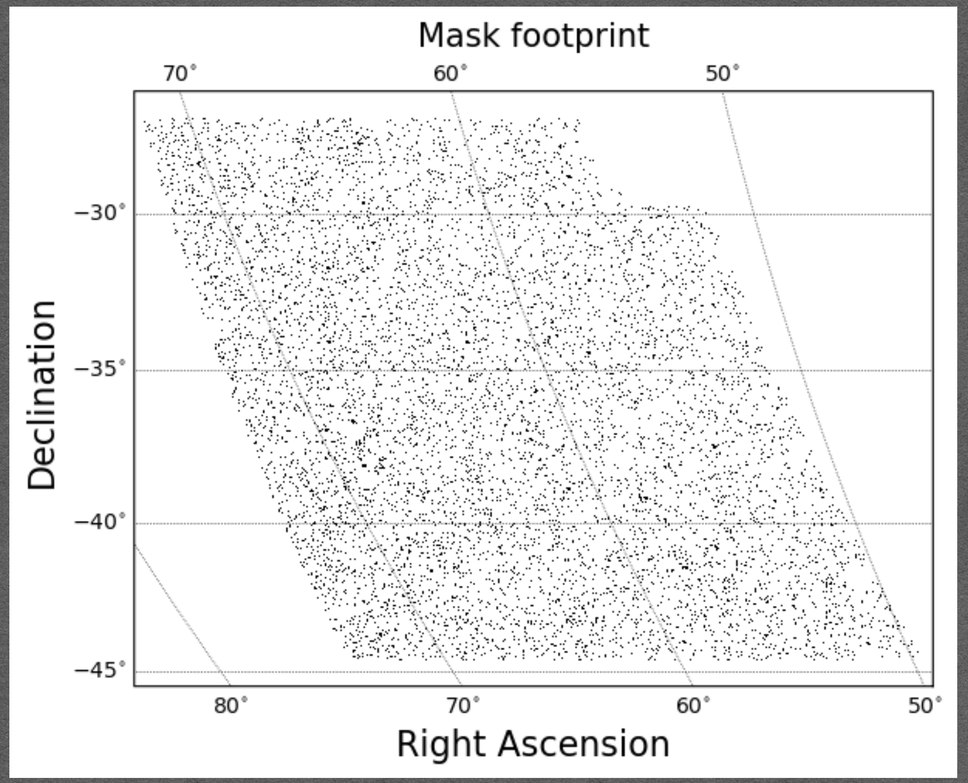
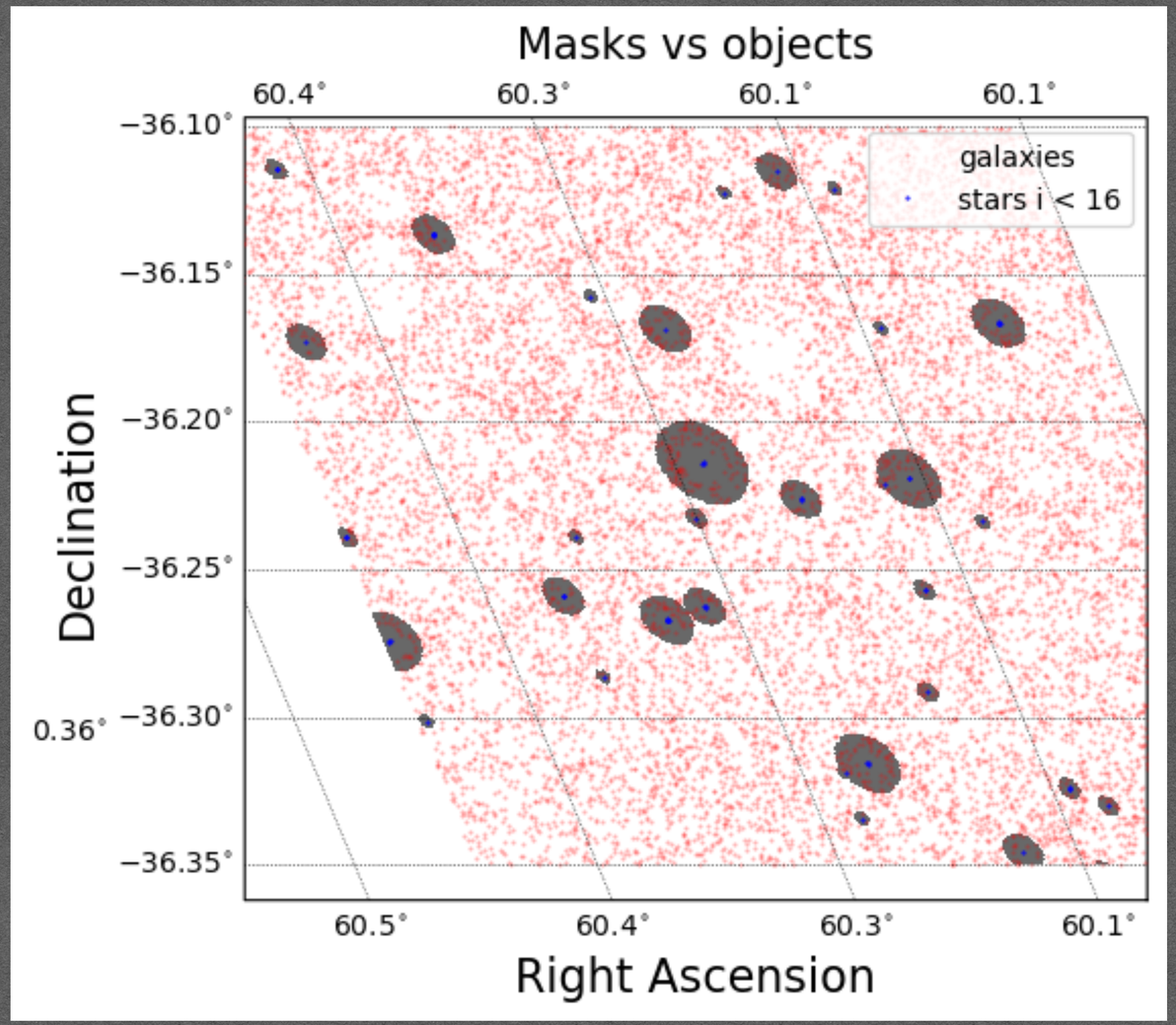




Remove objects contained in masked pixels

Bright object masks

Masking methodology - Results



Bright object masks

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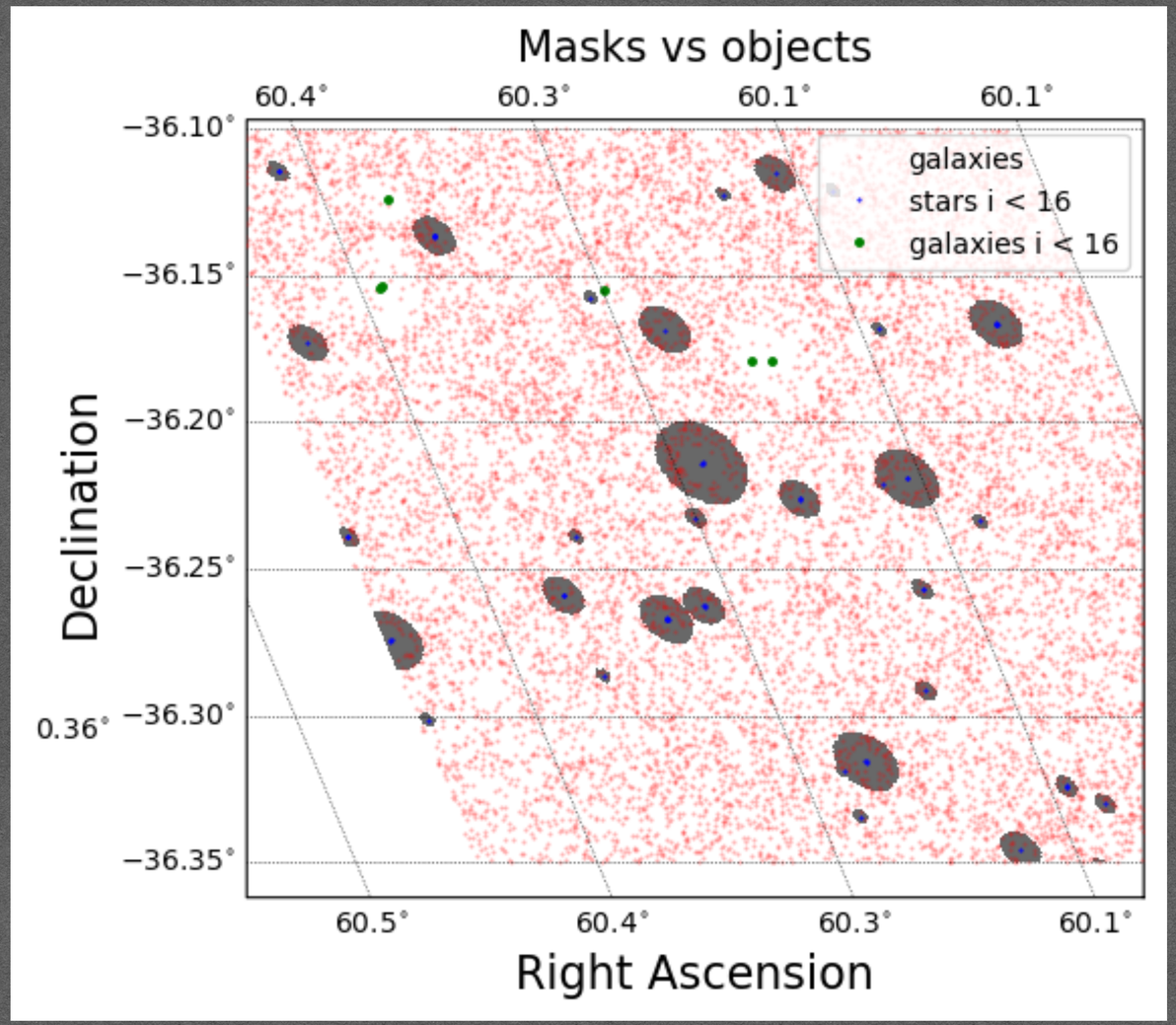

Bright object masks

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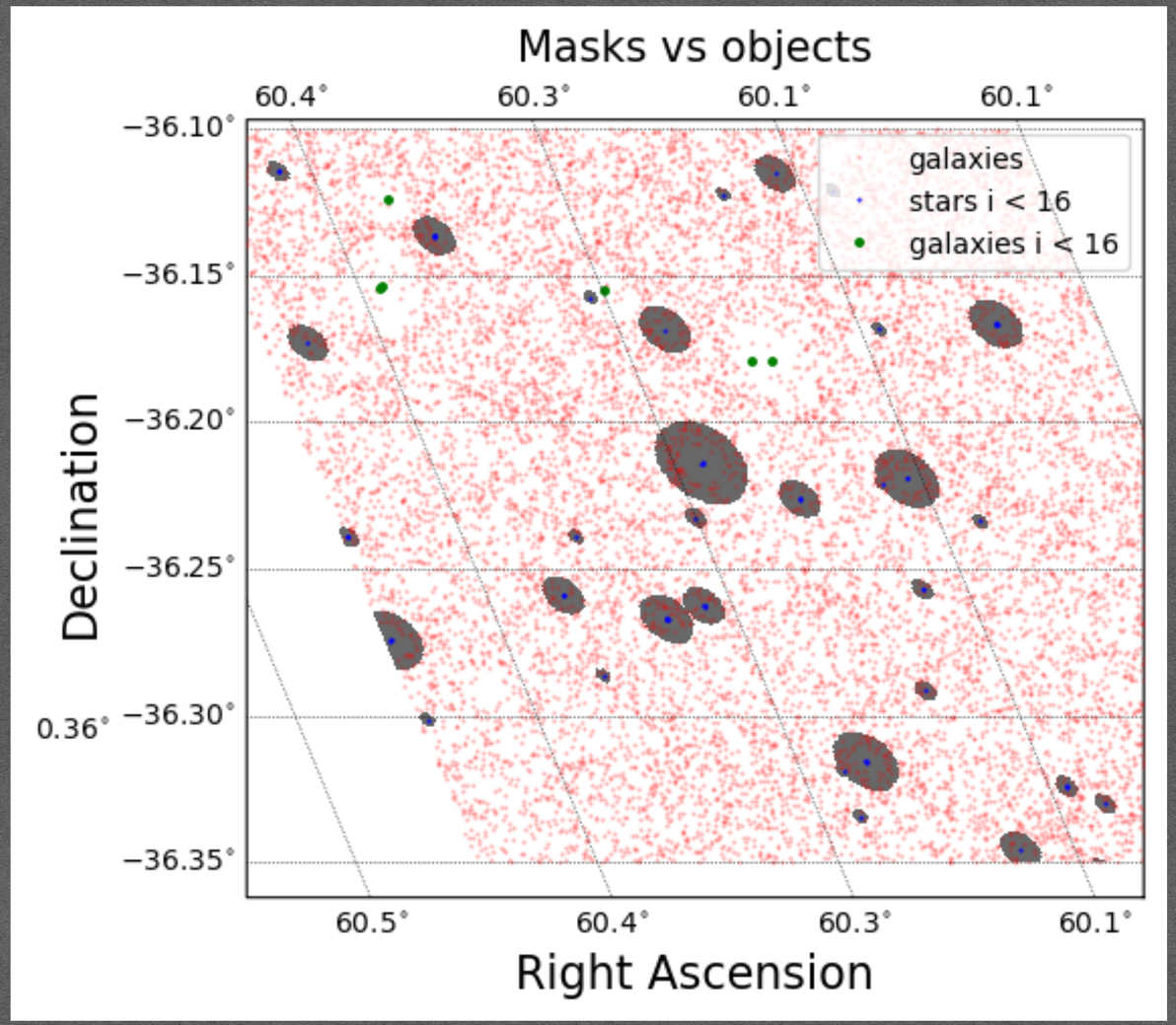

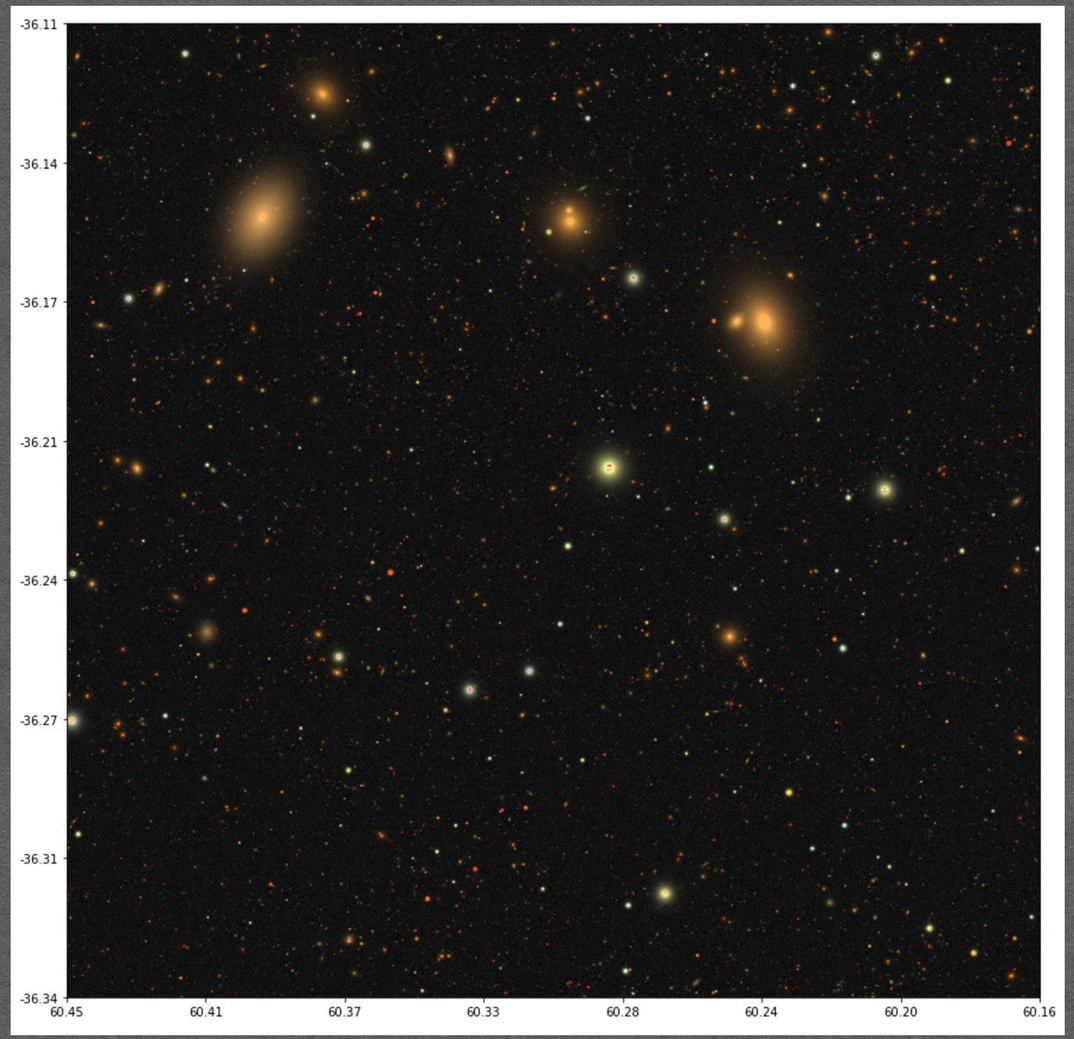

Bright object masks

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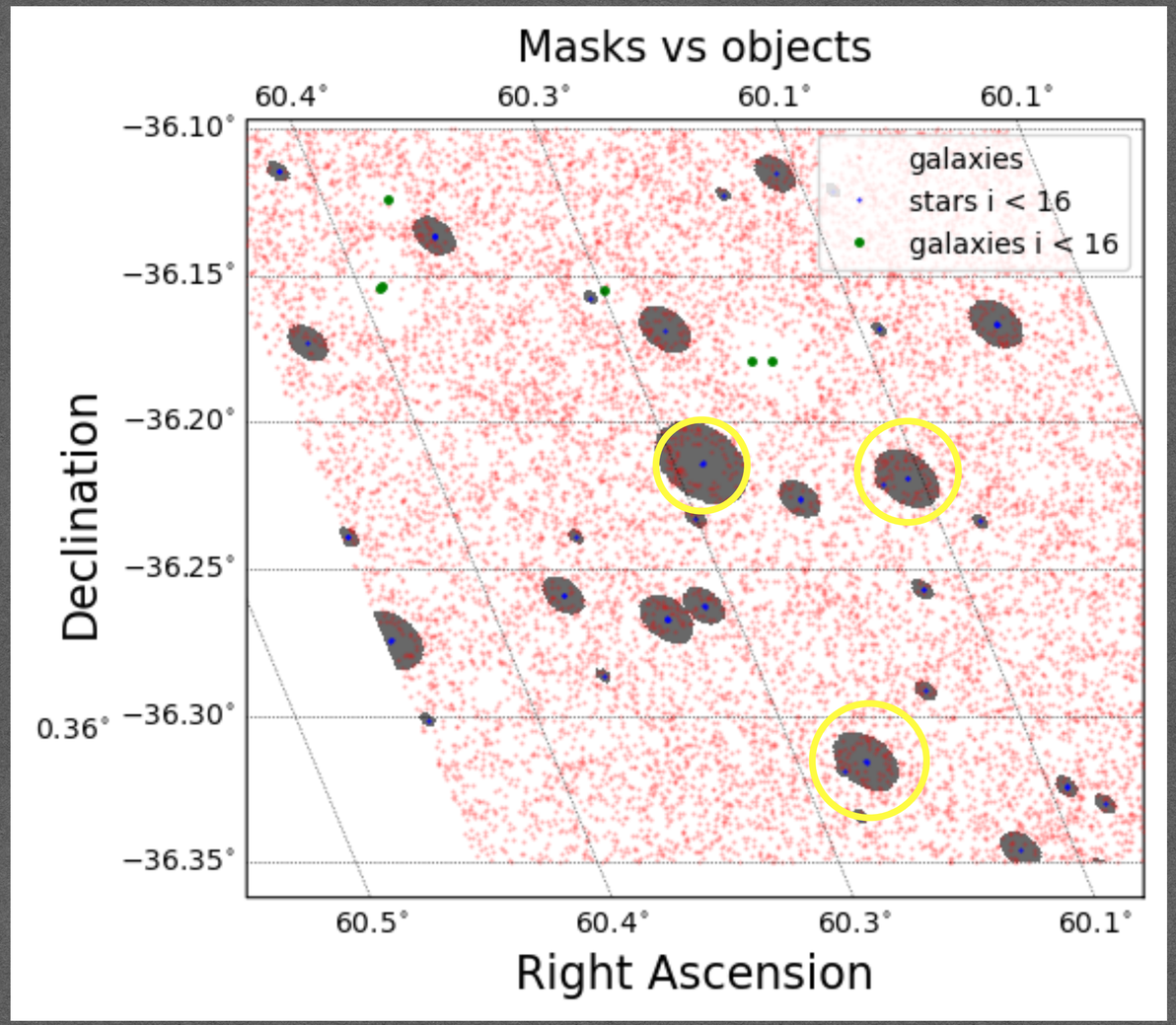

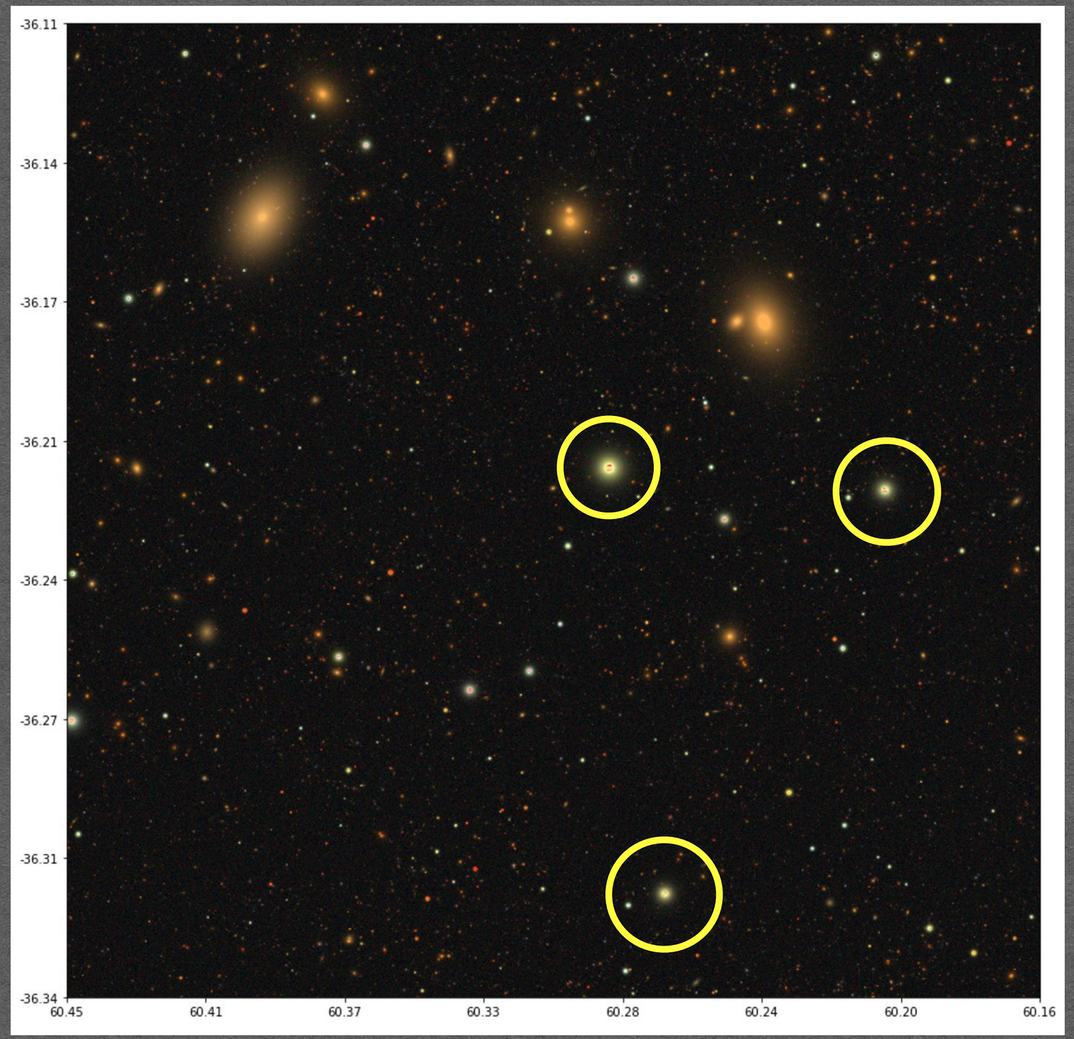

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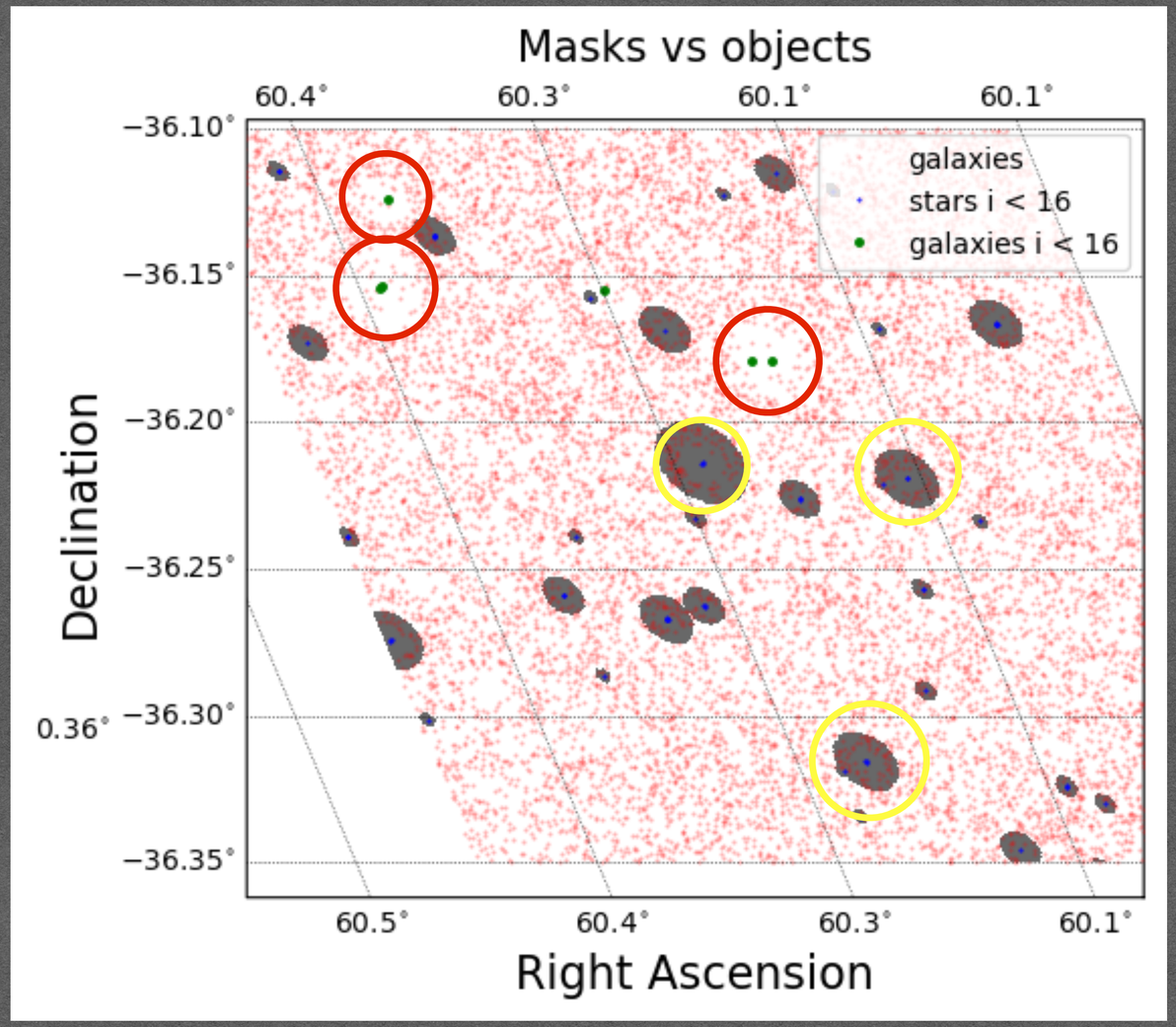

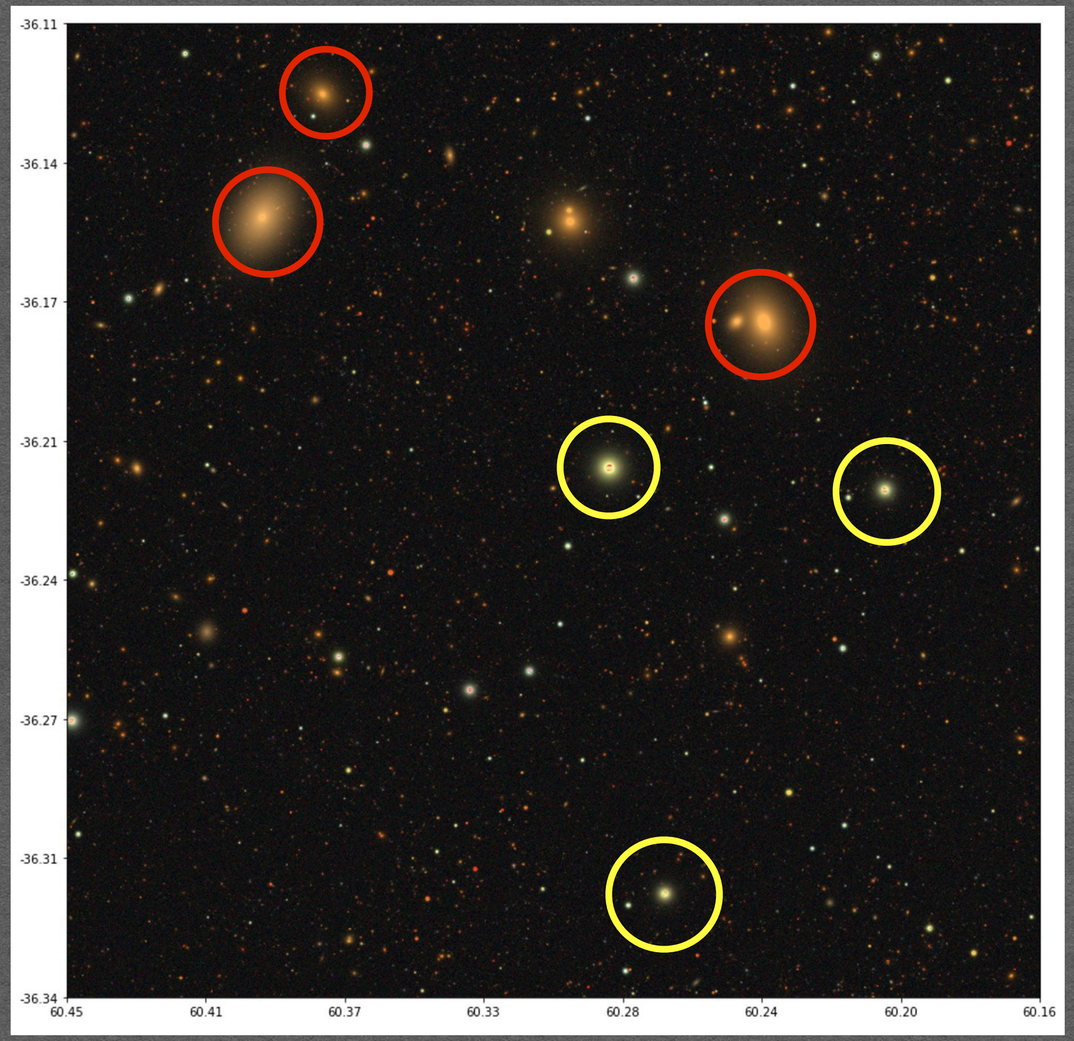

Bright object masks

Bright galaxies

Credits : NASA, ESA, Hubble Space Telescope

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Bright galaxies

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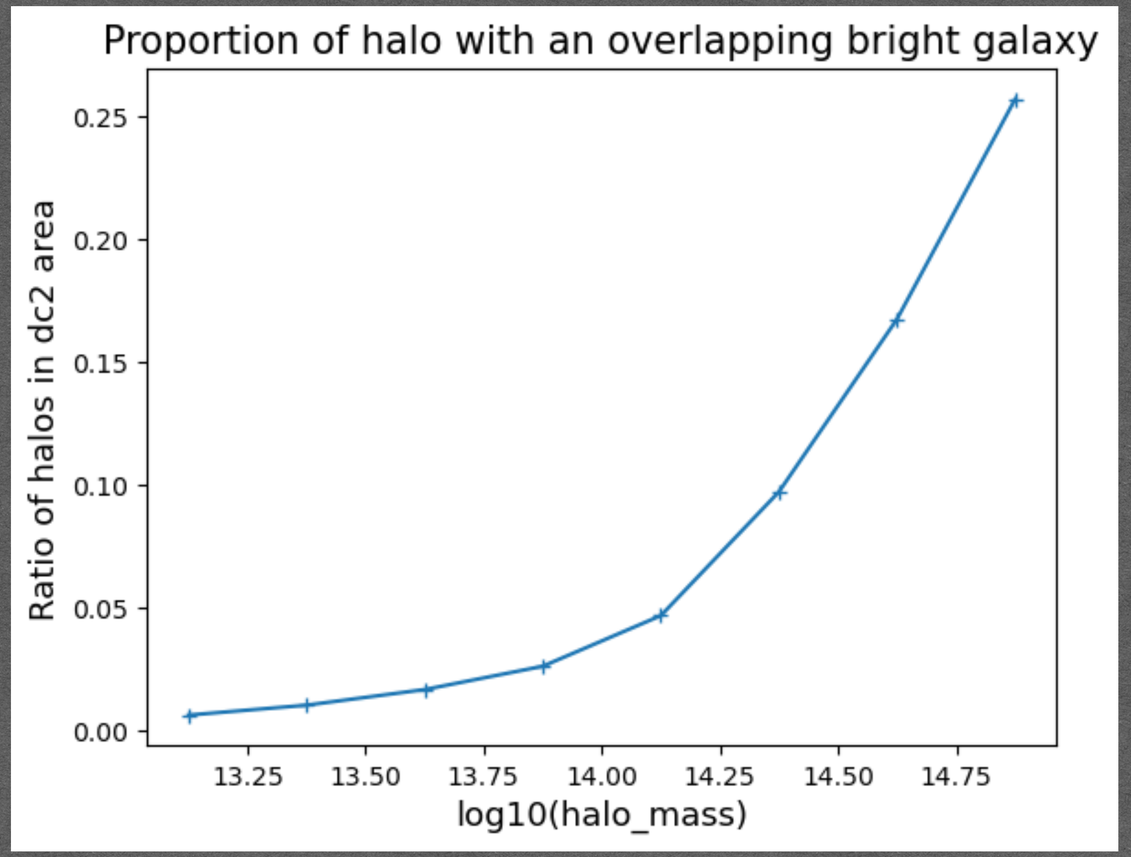

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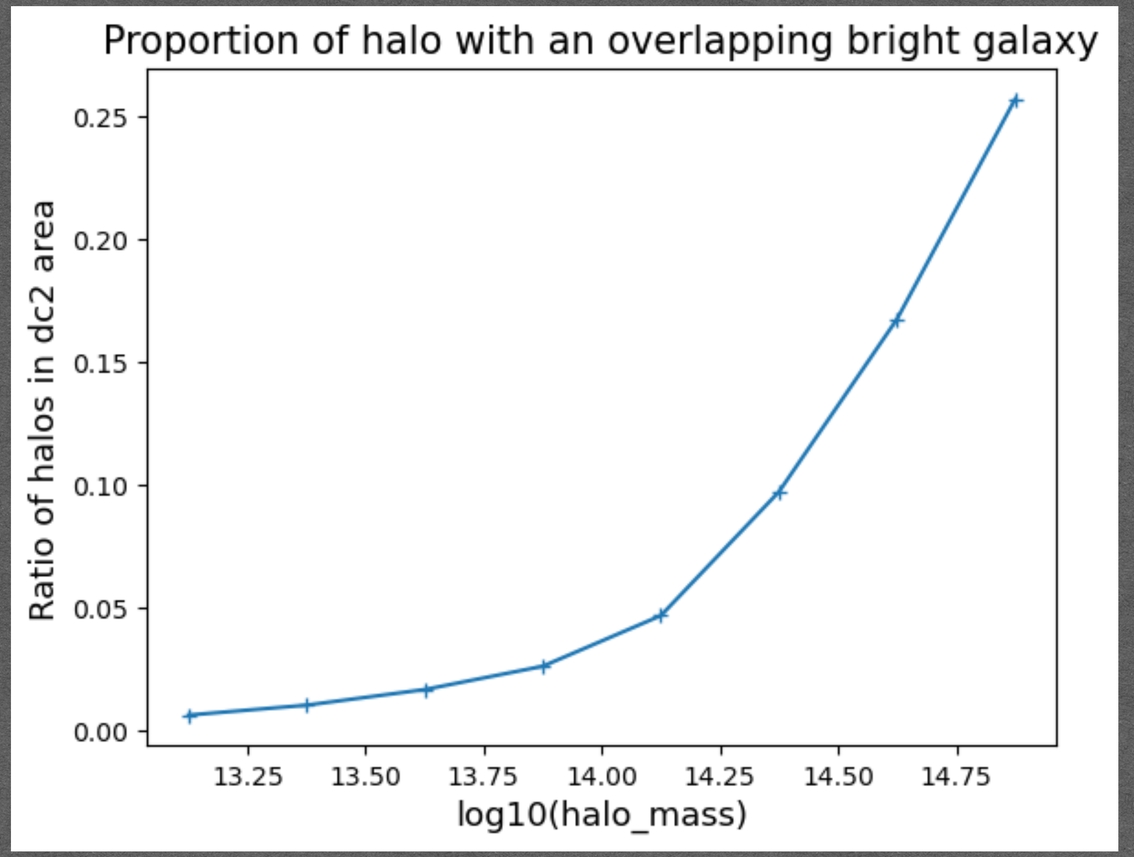
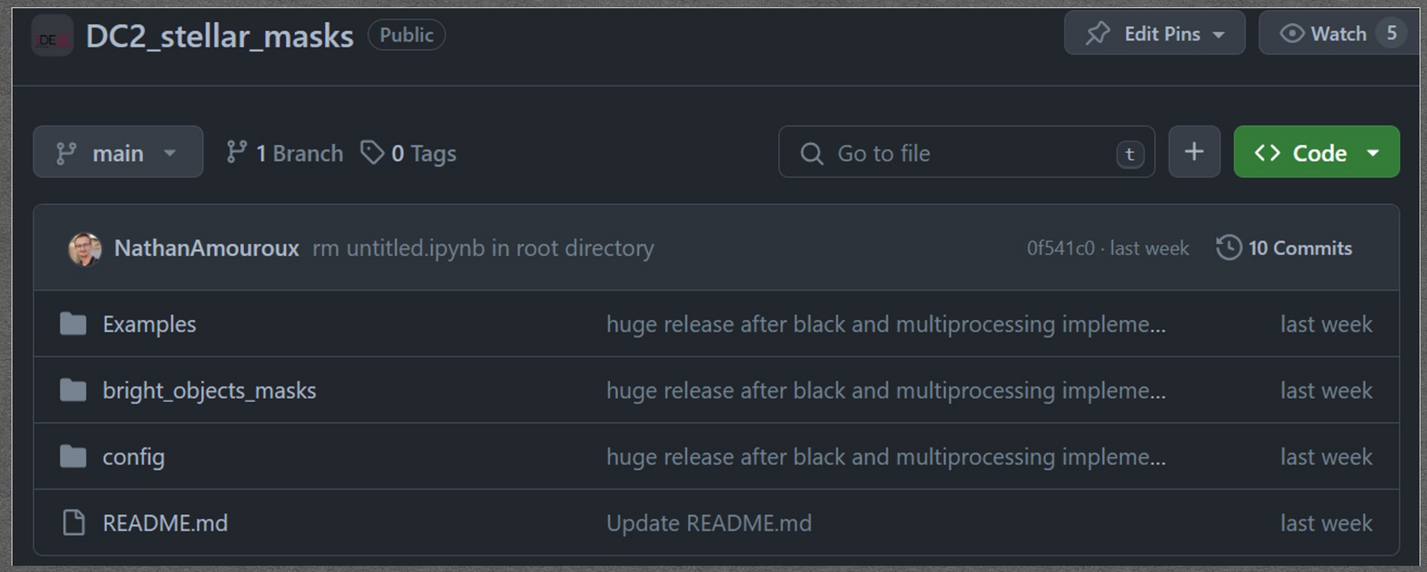


Galaxy masking isn’t as trivial as stars !

DESC DC2 stellar masks project

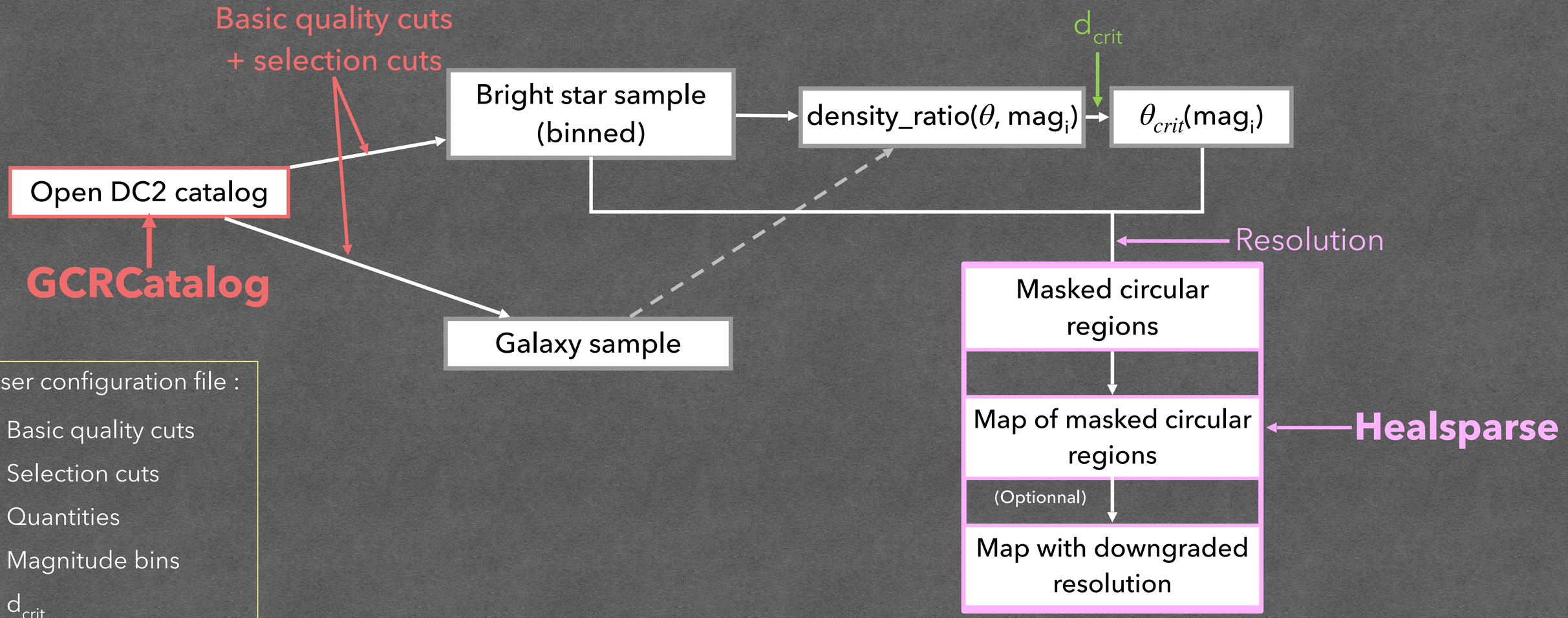
- Working groups have different needs for masks (quality cuts, resolution, …)
- Masks need to be studied
- We want them to be customizable

→ DC2_stellar_mask package



DESC DC2 stellar masks project

Workflow

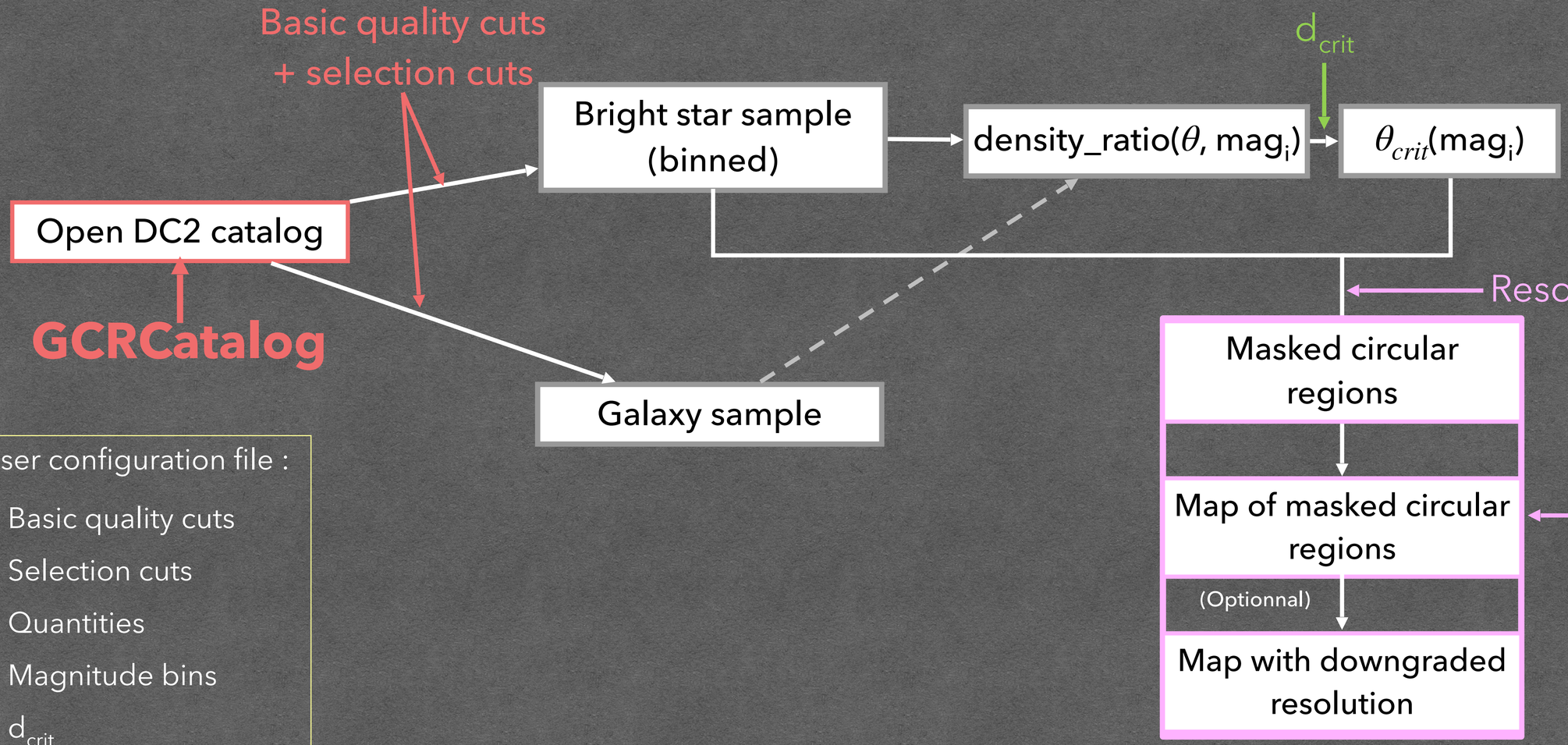


User configuration file :

- Basic quality cuts
- Selection cuts
- Quantities
- Magnitude bins
- d_{crit}
- Resolution

DESC DC2 stellar masks project

Workflow



User configuration file :

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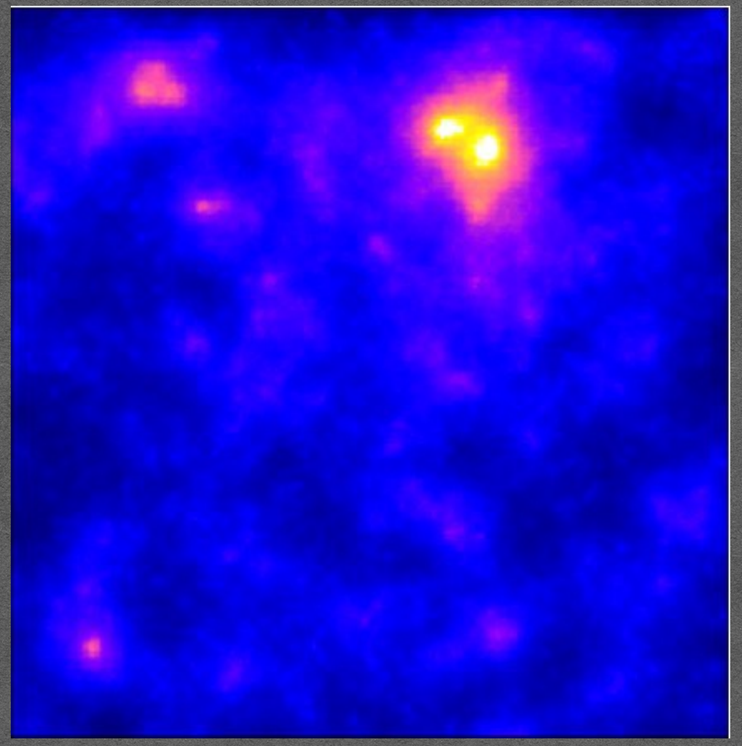
- Resolution

Parallelization over tracts → T ~ 15mins

AMICO algorithm

Mask validation in cluster finders

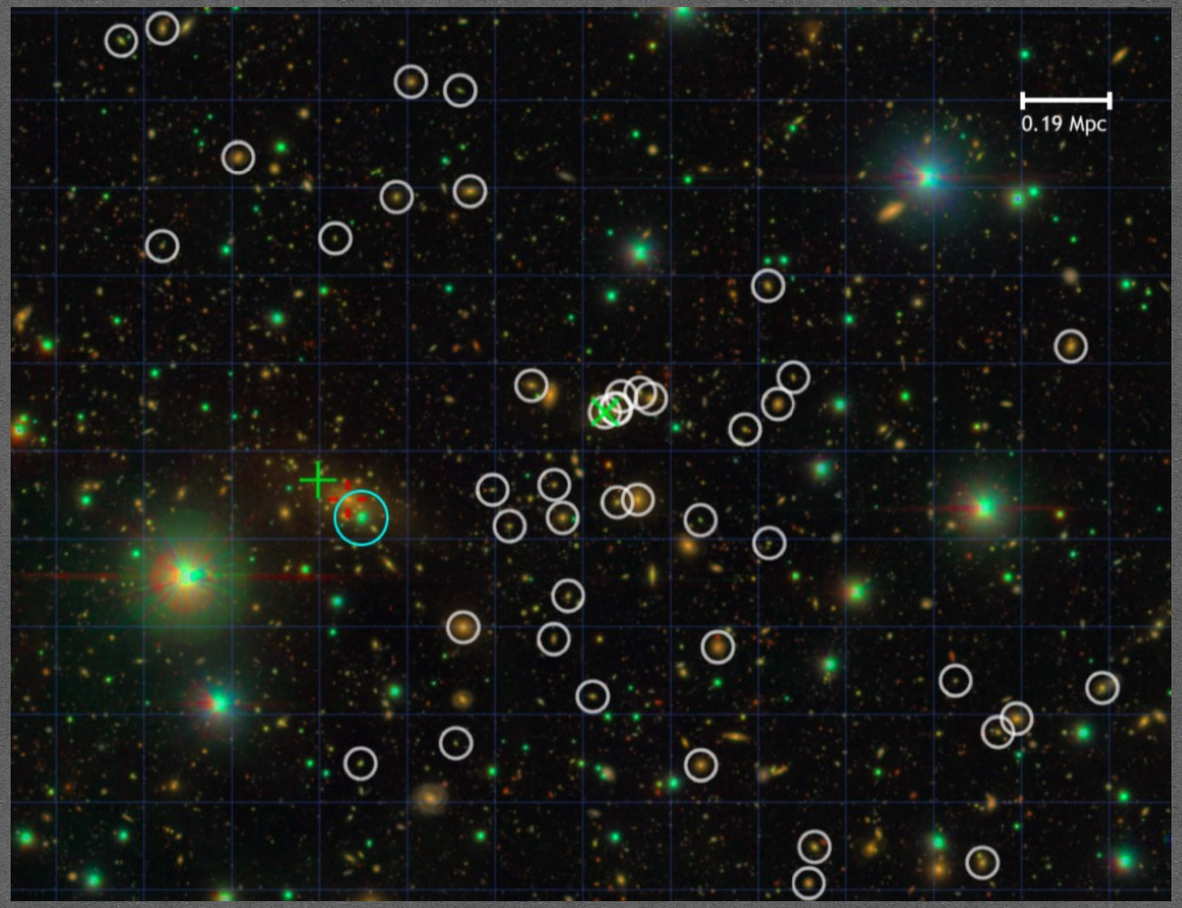
- AMICO = Adaptative Matched Identifier of Clustered Objects
- New algorithm being added to DESC galaxy cluster algorithms
  - Under validation with DC2 data
- Currently running on Euclid and KiDS data
- Based on optimal filtering
- Iterative cluster detection on 3D SNR map
- Galaxy member association with clusters



Example of SNR map on 1x1 deg2 portion of the sky

AMICO algorithm

Mask validation in cluster finders



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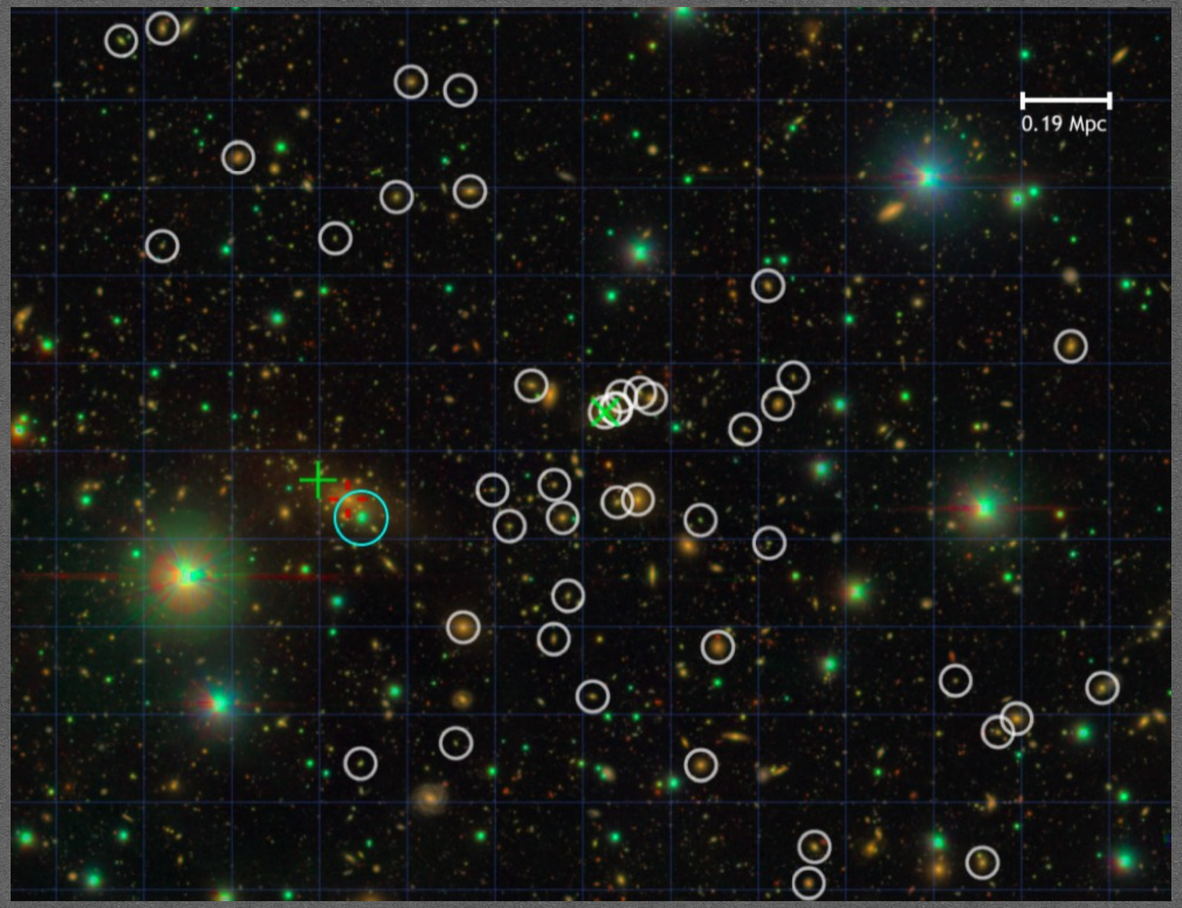

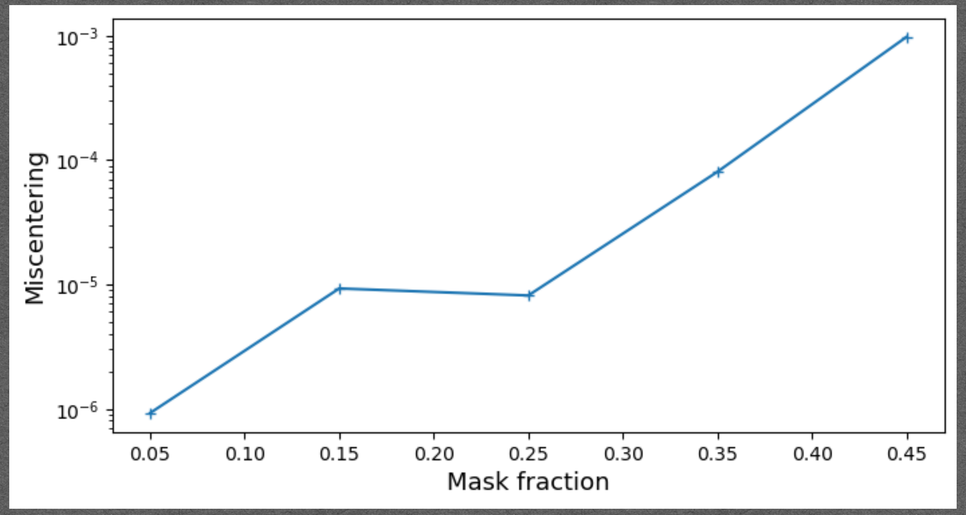

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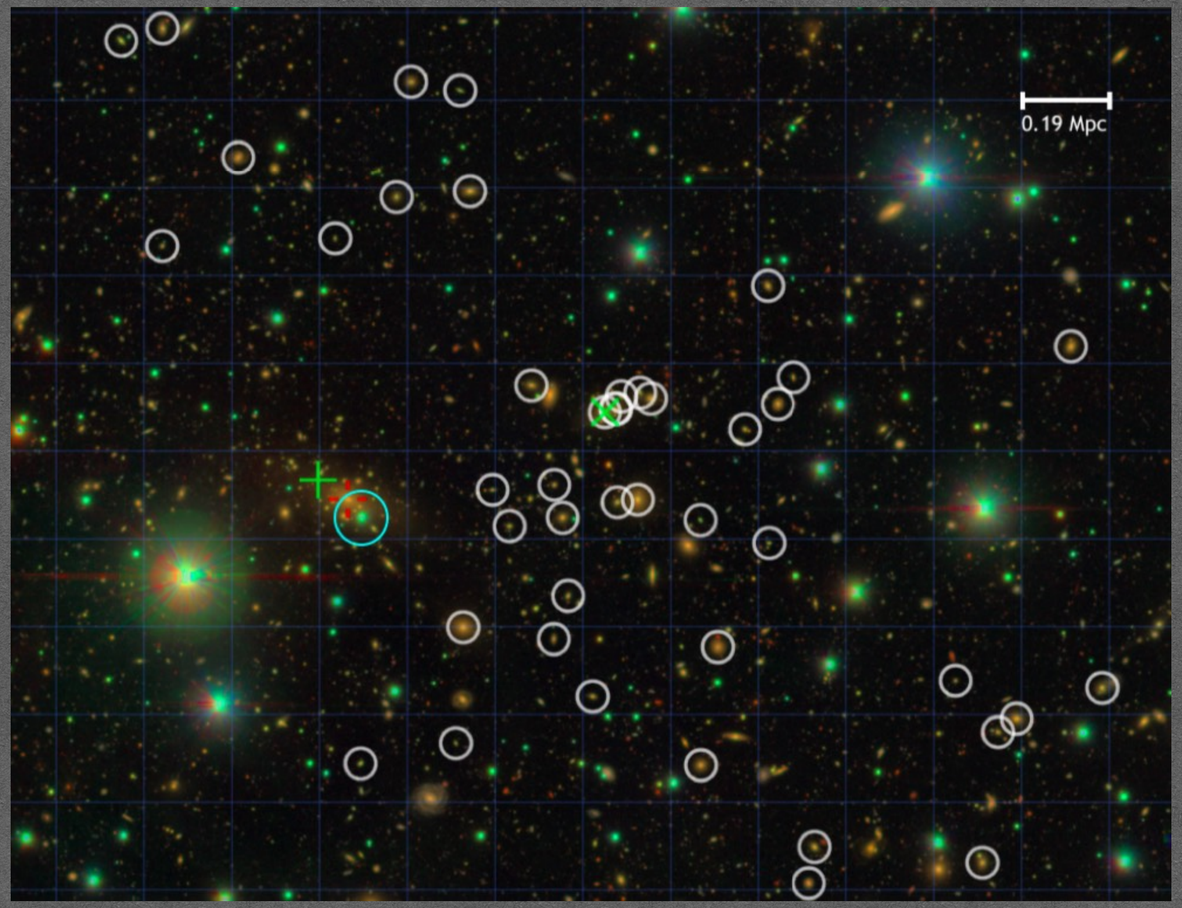
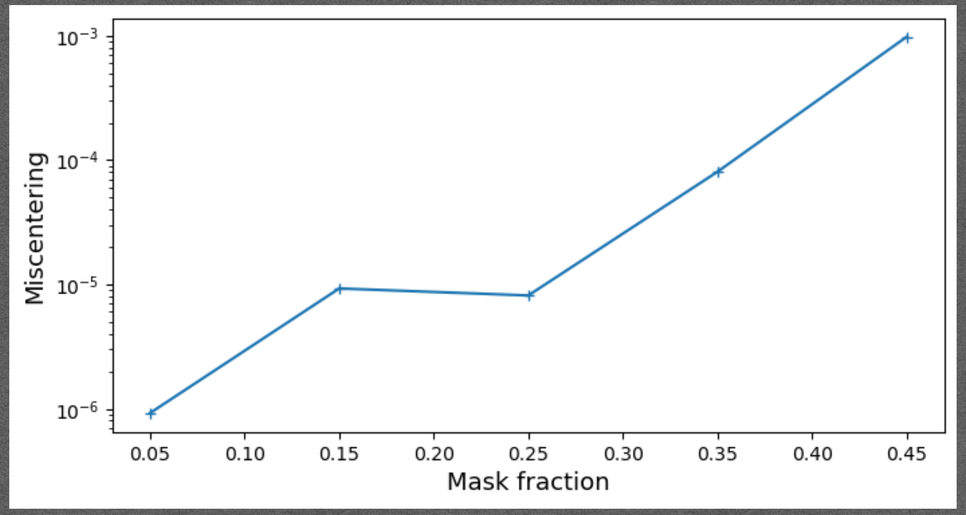
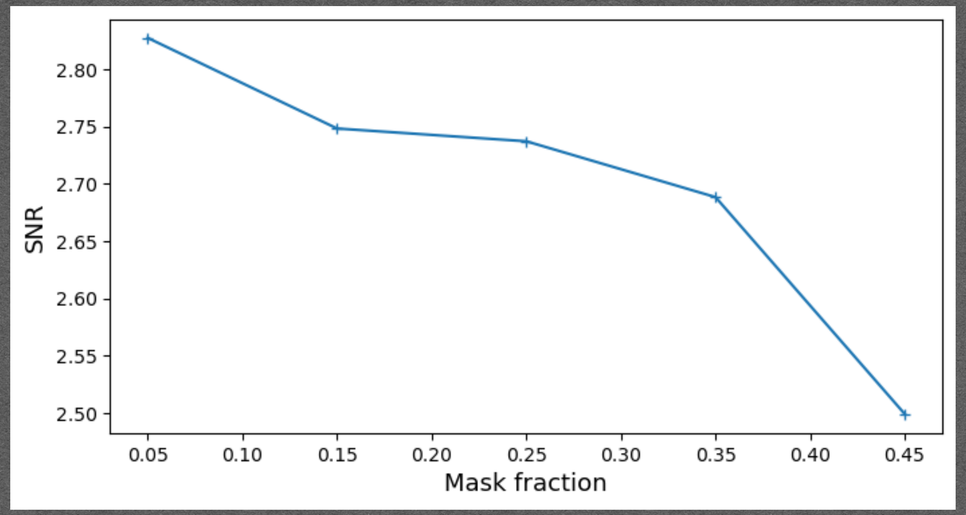
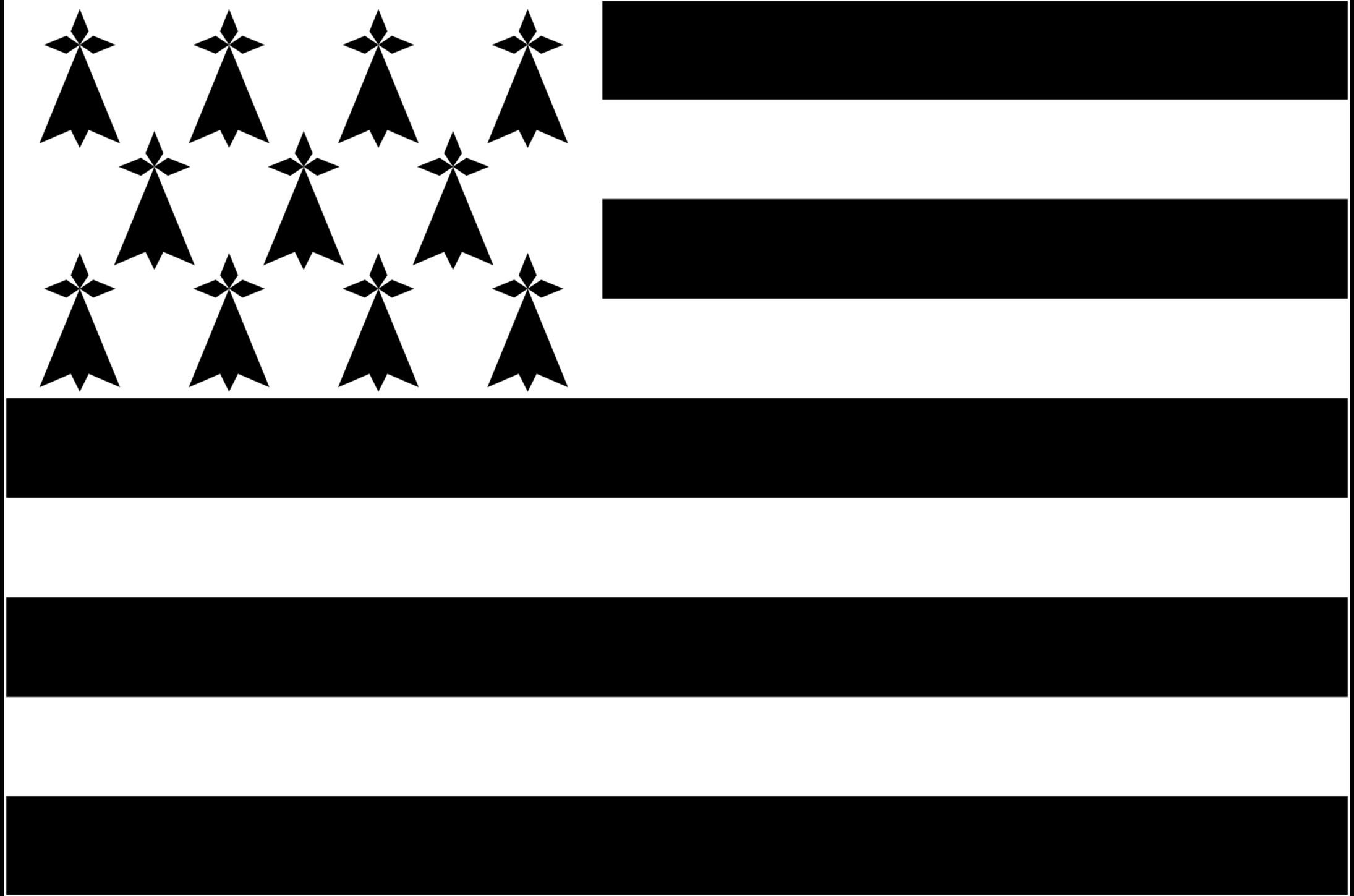






Conclusion

- Rubin final steps are happening now ! 😊
- Tool created for easy and customizable mask generation
- First masks made on the DC2 simulation
- Masks studied in cluster finders (AMICO, WAZP, redMaPPer)
- Masks for galaxies are on the way

Prospects

- Discuss with working groups about bright galaxy masks
- Produce / study the future galaxy + star mask
- Try the code / study on coming ComCam catalogs
- Continue the study of mask’s impact on cluster finders