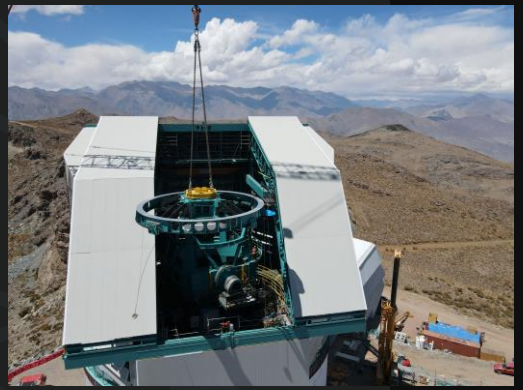
MultiProFit: galaxy fitting status update



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Intro & Summary

What is MultiProFit?

Multi-band parametric galaxy fitting, replacing CModel/meas_modelfit

Previous results from MultiProFit:

Reasonable photometry & sizes in DC2 & HSC-RC2

Current status:

Improving performance; full re-write in C++ w/pybind11 bindings; using GSL

Future plans:

Flexible models via pex_configs, new PipelineTasks, better priors, re-test deblending…

MultiProFit

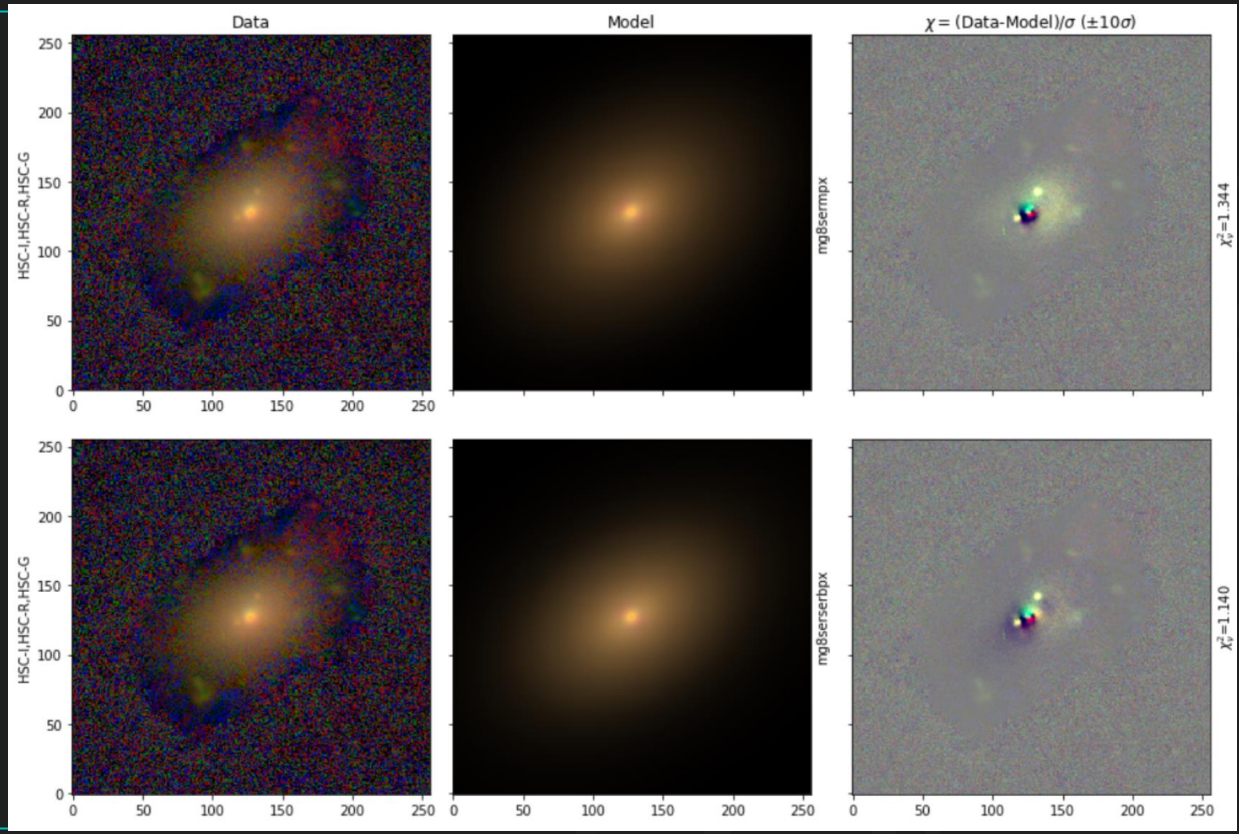
Multi-band parametric fitting

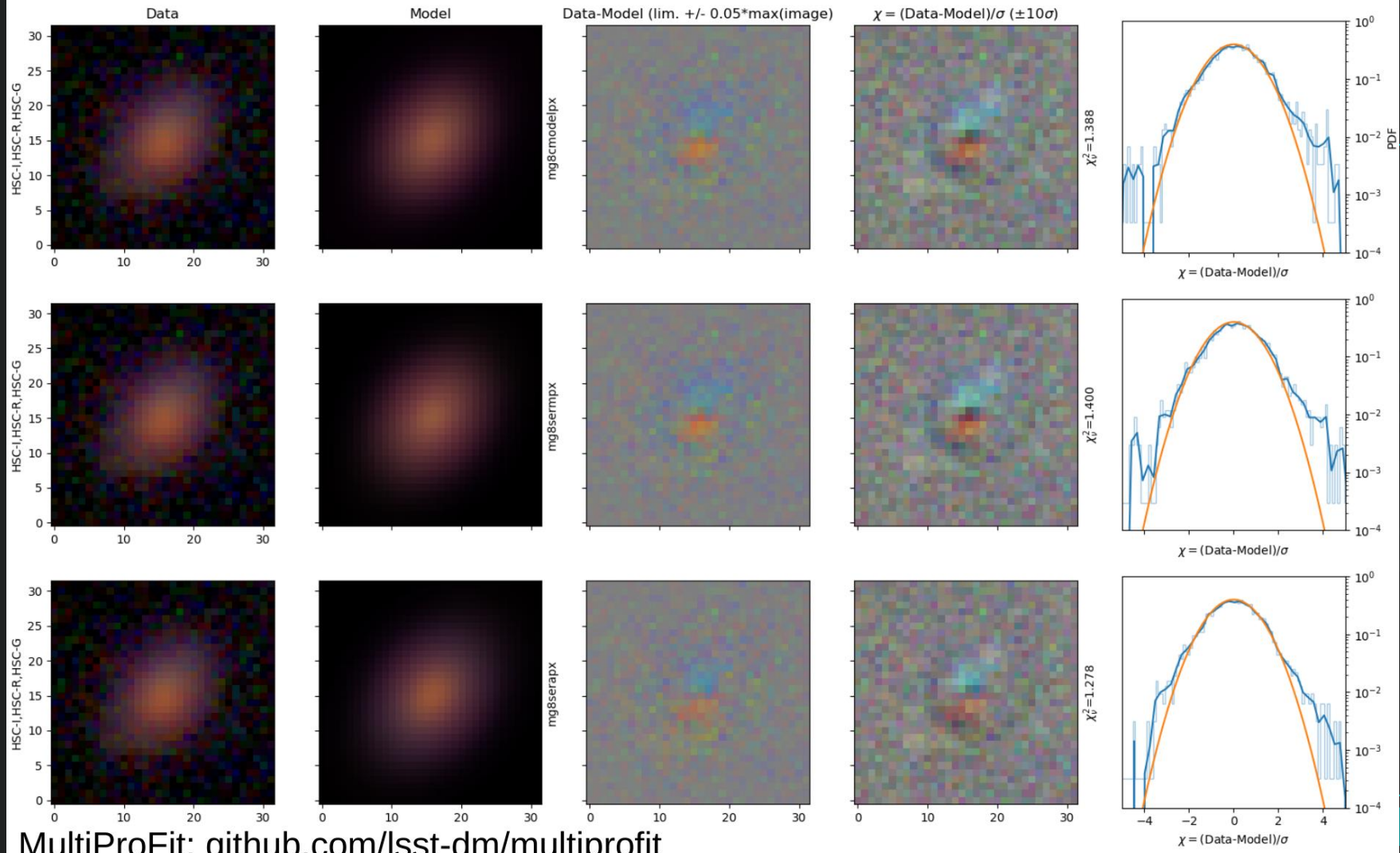
Features:

- Gaussian mixture Sersic profile (not just n=1, n=4)
- Analytic gradients
- Flexible PSF & source models
- Parameter transforms
- Linear flux optimization

Downsides:

- Slower than meas_modelfit
- No shapelet PSF





MultiProFit: github.com/lsst-dm/multiprofit

Why MultiProFit?

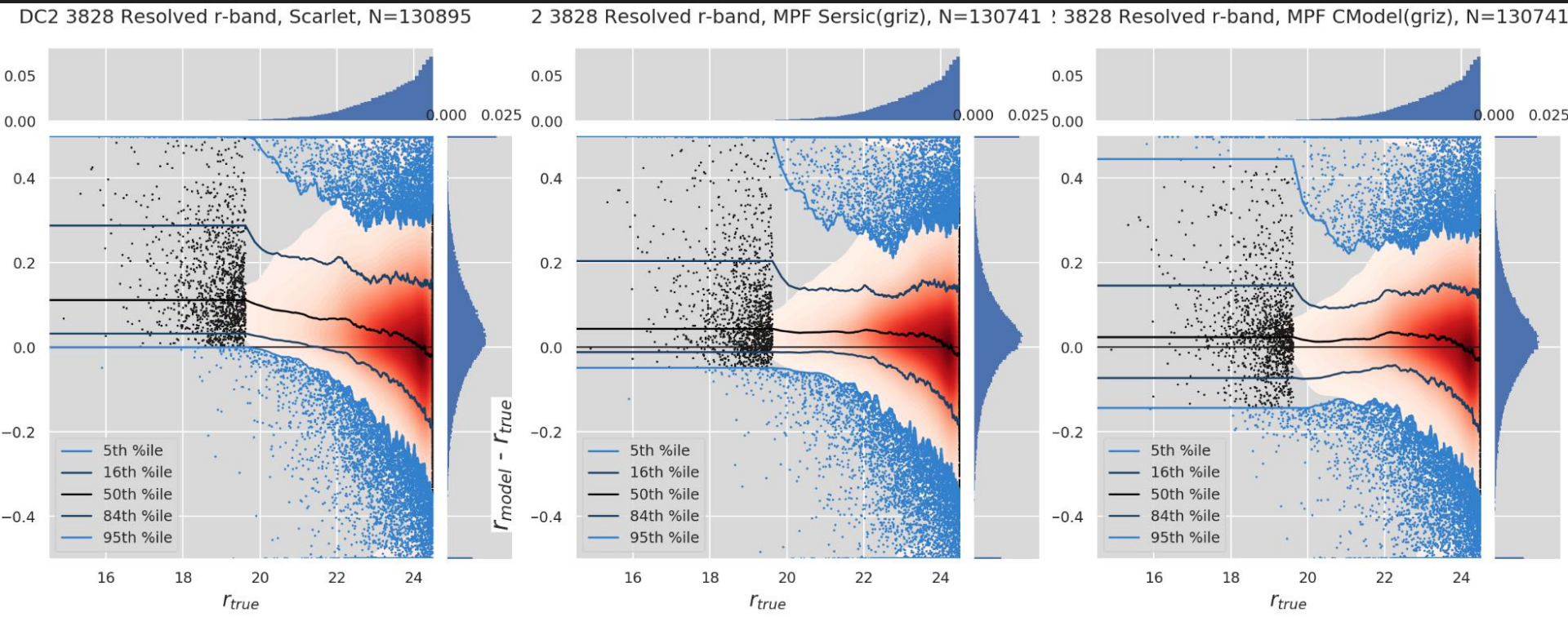
Practical:

- More accurate sizes/magnitudes than Scarlet* (it depends)
- Gaussian mixtures = analytical convolution & gradients, so always fast (if done right)
- Infinite resolution deconvolved model (sampling still an issue)

More Philosophical:

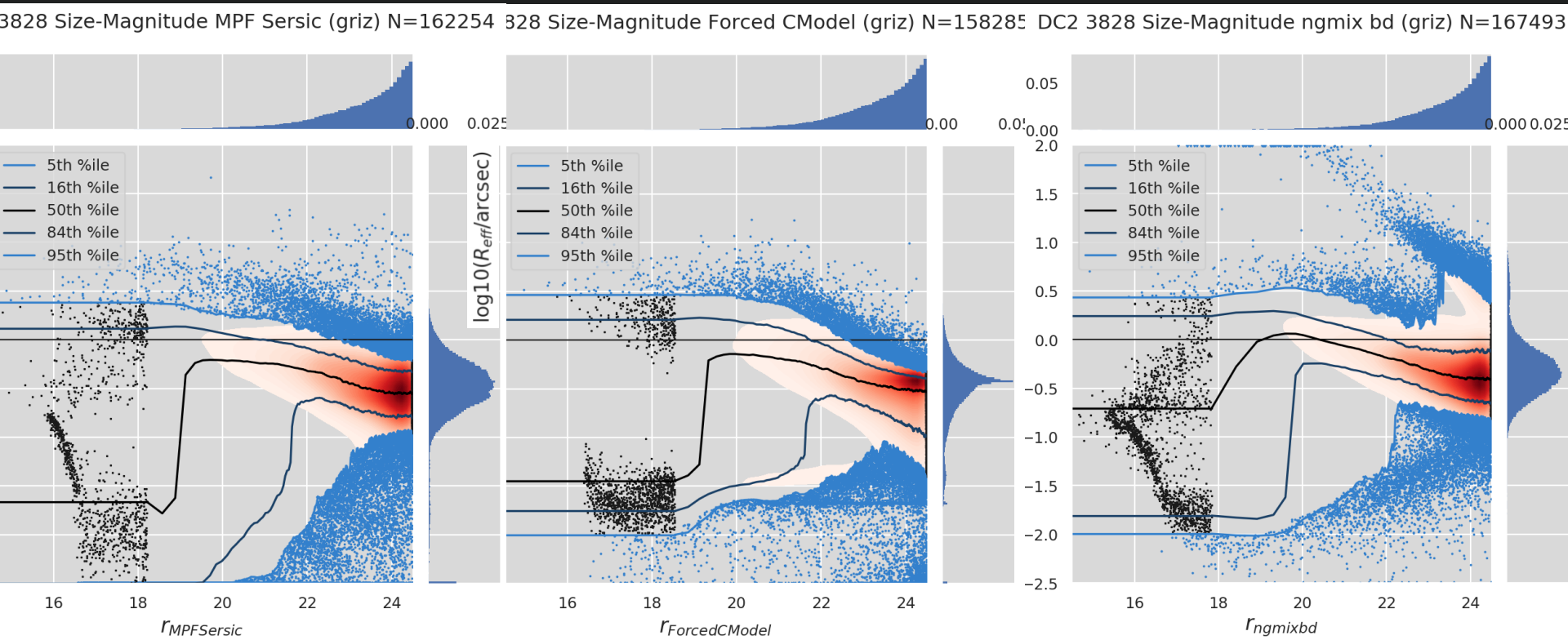
- Elliptically-symmetric, monotonic models probably better for smooth, barely resolved galaxies, and low surface brightness outskirts (PSF and galaxies)
- Parametric models can have advantages if parameter values are meaningful
- Why not? Multiple, different methods always useful

DESC DC2 (Rubin Data Preview) magnitudes



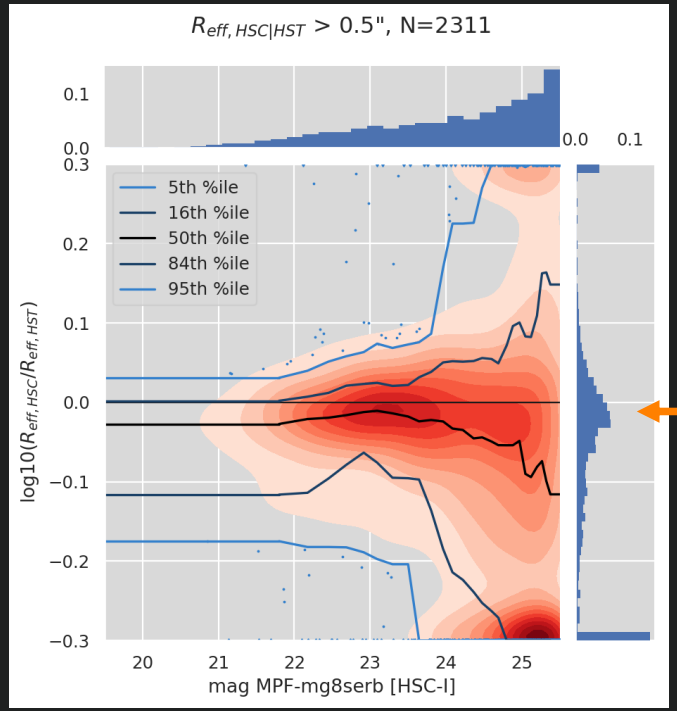
Sersic mags less biased than Scarlet*

DESC DC2 (Rubin Data Preview) sizes



Sersic sizes mostly reasonable (priors matter)

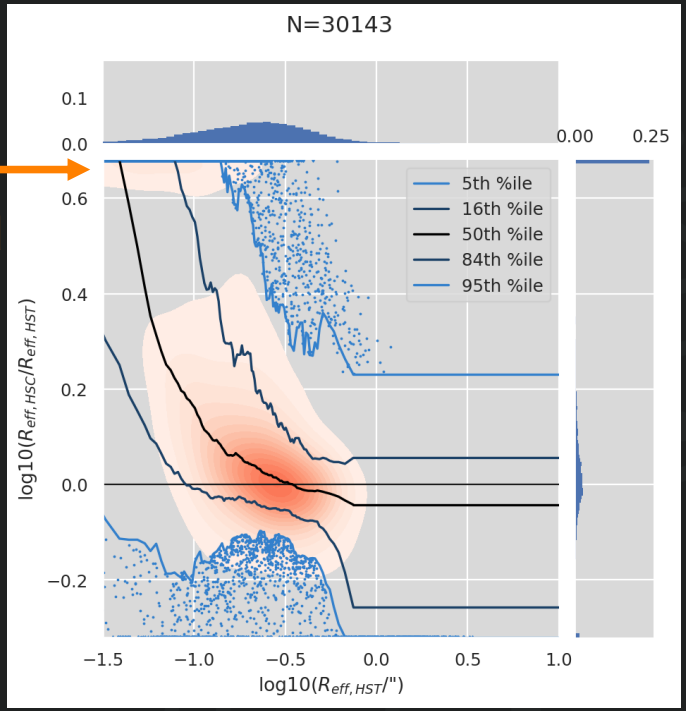
COSMOS: HSC UDeep vs HST sizes



Most outliers unresolved

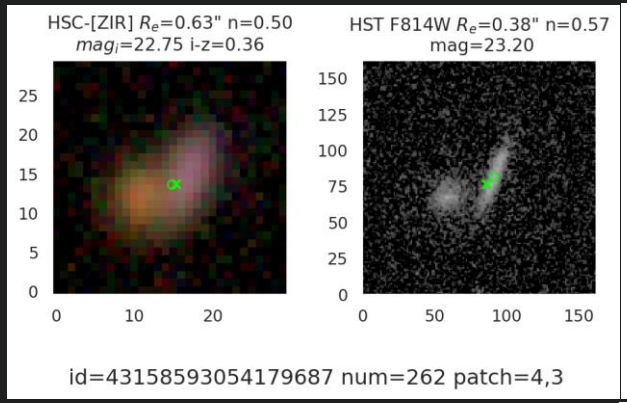
Most galaxy sizes ok-ish

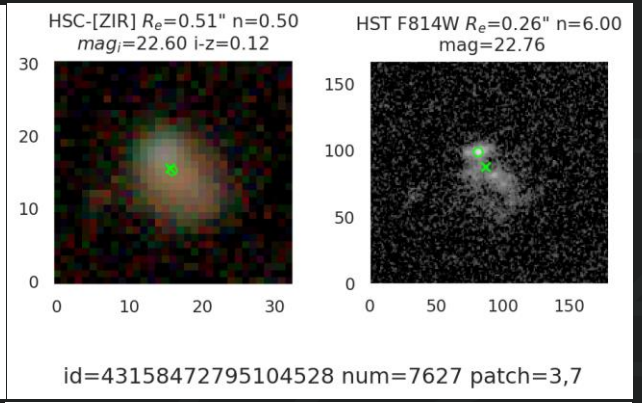
Too faint in HST?

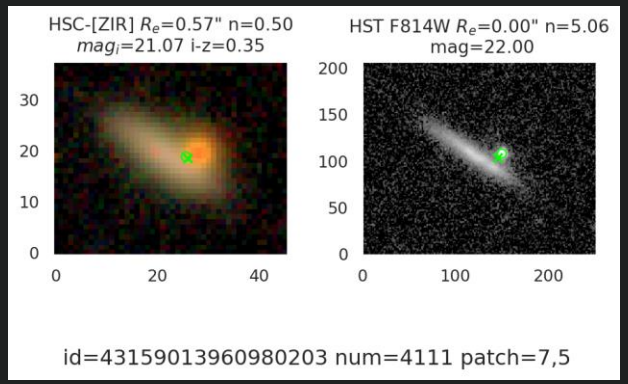


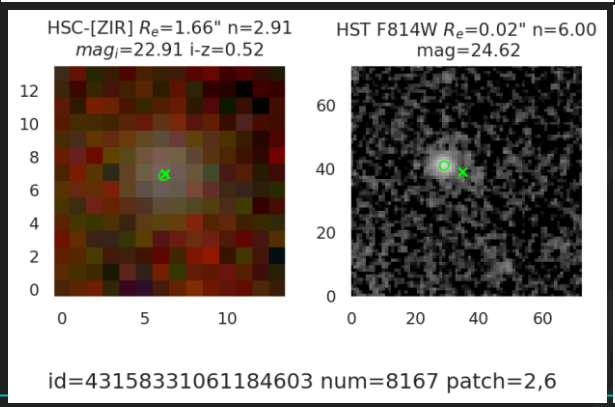
COSMOS: Problems, opportunities

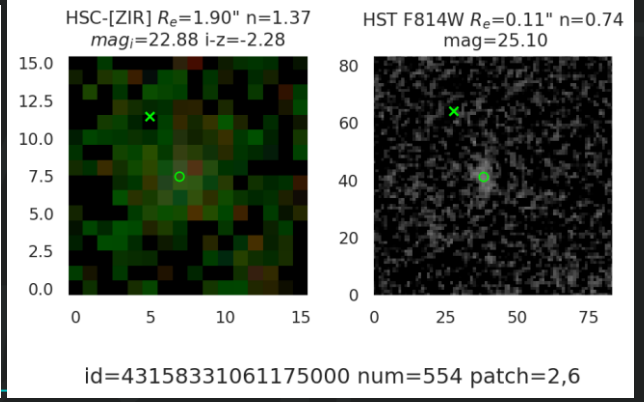
- Science opportunities and precursor for Rubin + Euclid/Roman.
- Need reliable joint source catalog and/or deblending











Current Developments

MultiProFit was too slow (~10x slower than CModel; similar to ngmix)

Complete refactoring of Python interface into separate C++ packages built w/Meson:
parameters, gauss2d => gauss2dfit => multiprofit (all on github.com/lsst-dm)

3-band Sersic now much speedier:
20^2 pix: 1 vs 12ms | 35^2: 3 vs 15 ms | 100^2: 22 vs 38ms (~10 ms floor for old code)

Currently re-implementing gradients and fitting; testing GSL optimizers next

Multi-scale fitting will be possible soon (specify pixel scale and fit sizes in arcsec)

Future Developments (Conclusion)

Model configuration with pex_config: easier testing of different models

Completely restructure PipelineTasks into modular format:

- Separate PSF + model fitting tasks
- Separate simultaneous multi-source fitting (deblending) task, w/non-linear option

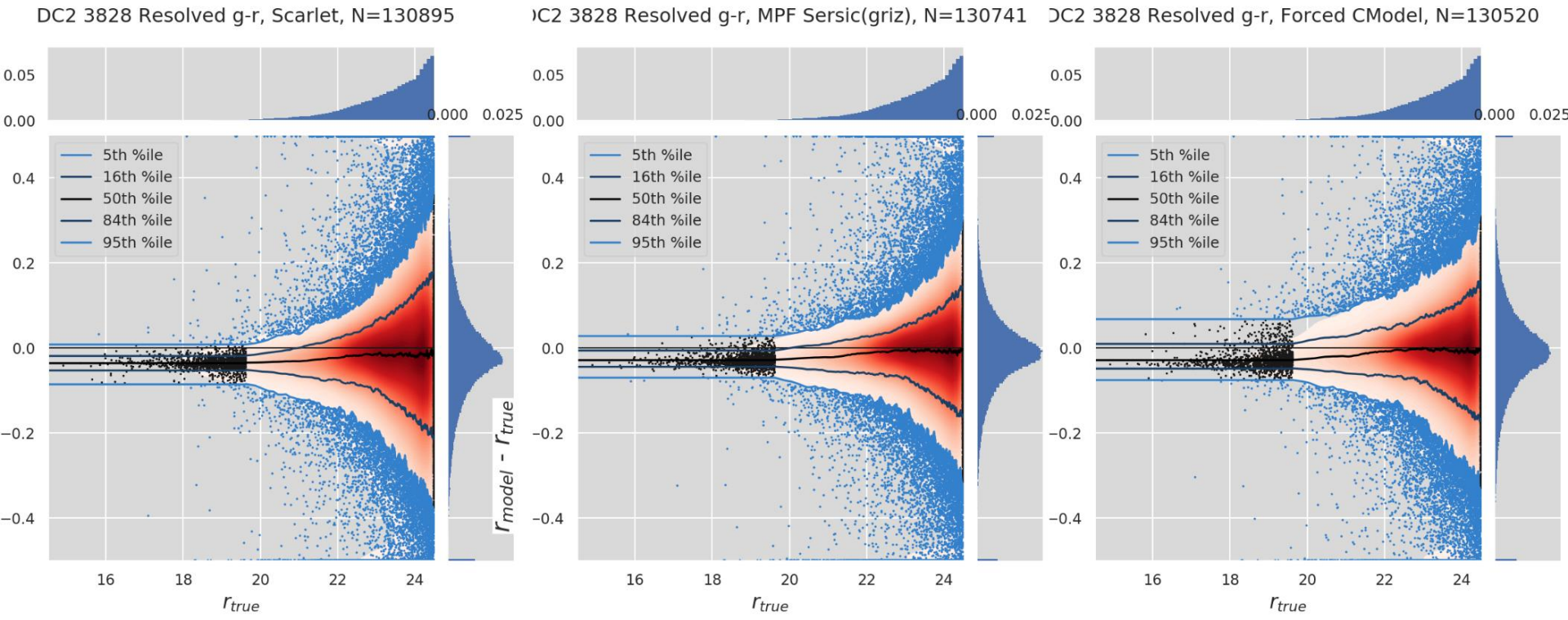
Test exponential/Sersic + point source (absorb unresolved central flux)

- Might implement pixel grid point sources in addition to Gaussian mixture

Better priors (size priors, color priors, bimodal/conditional on whether resolved)

Try non-linear deblending again, hopefully on larger scales

DESC DC2 (Rubin Data Preview) g-r colours



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