Update on morphology WP activities

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(GAL-SWG - morphology)

EUCLID France - 7 Janvier 2016

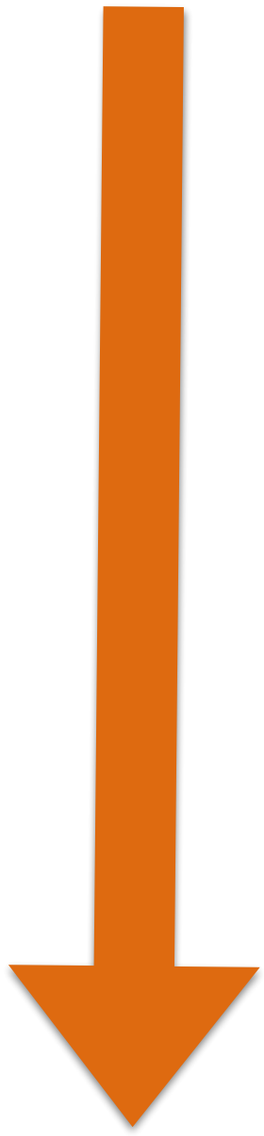
Morphology WP in a nutshell

- Legacy Galaxies WP
- Provide? Request? shape / morphology measurements for EUCLID galaxies
- France leadership - DUC (SWG) - DOLE (OU-MER?)
- Close relation with OU-MER (cataloguing), OU-SHE (shape), OU-VIS (background), OU-SIR (size estimate required), OU-PHZ

Morphology?

Fundamental legacy value of EUCLID

- Star/galaxy separation - **ALL OUs**
- Ellipticity, size, Sersic index, C, A, S, G - **ALL OUs**
- B/T - **Legacy**: **SWGs + OU-PHZ?**
- internal structure, clumps, spiral arms, merger signatures, lenses? - **Legacy**: **SWGs + OU-PHZ? +OU-SHE?**



Which morphologies?
Precision?
Which codes?
Test and provide algorithms

MORPH WP

Codes

OU-MER

OU-VIS

“Euclidization” + Cataloguing

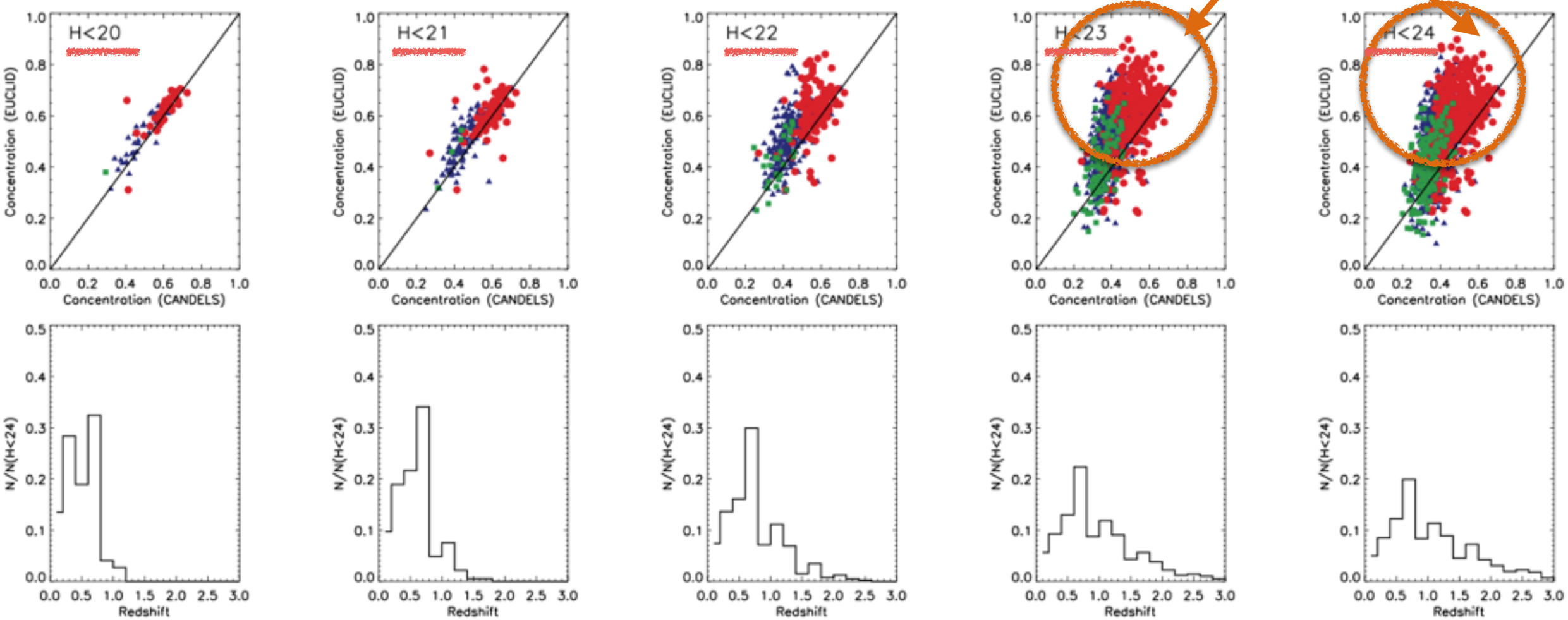
background

“Realistic” imaging

OU-SIM

Concentration (EUCLIDized CANDELS DC1 - OU-MER)

Unresolved/faint — very high concentration



ETGs

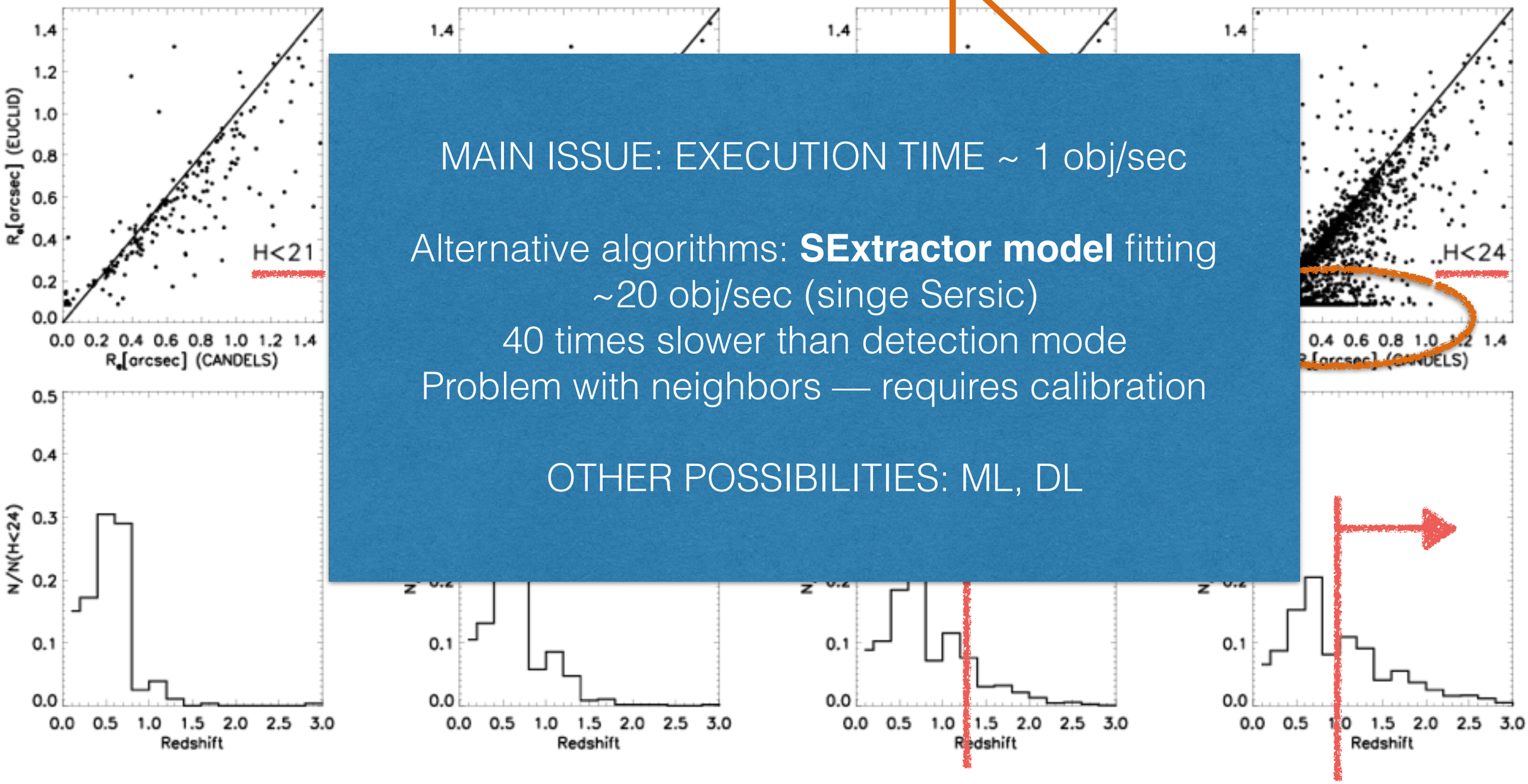
LTGs

Irr

CAS codes provided to OU-MER (MHC, Conselice) - test in progress

Galaxy sizes: galfit

Unresolved objects



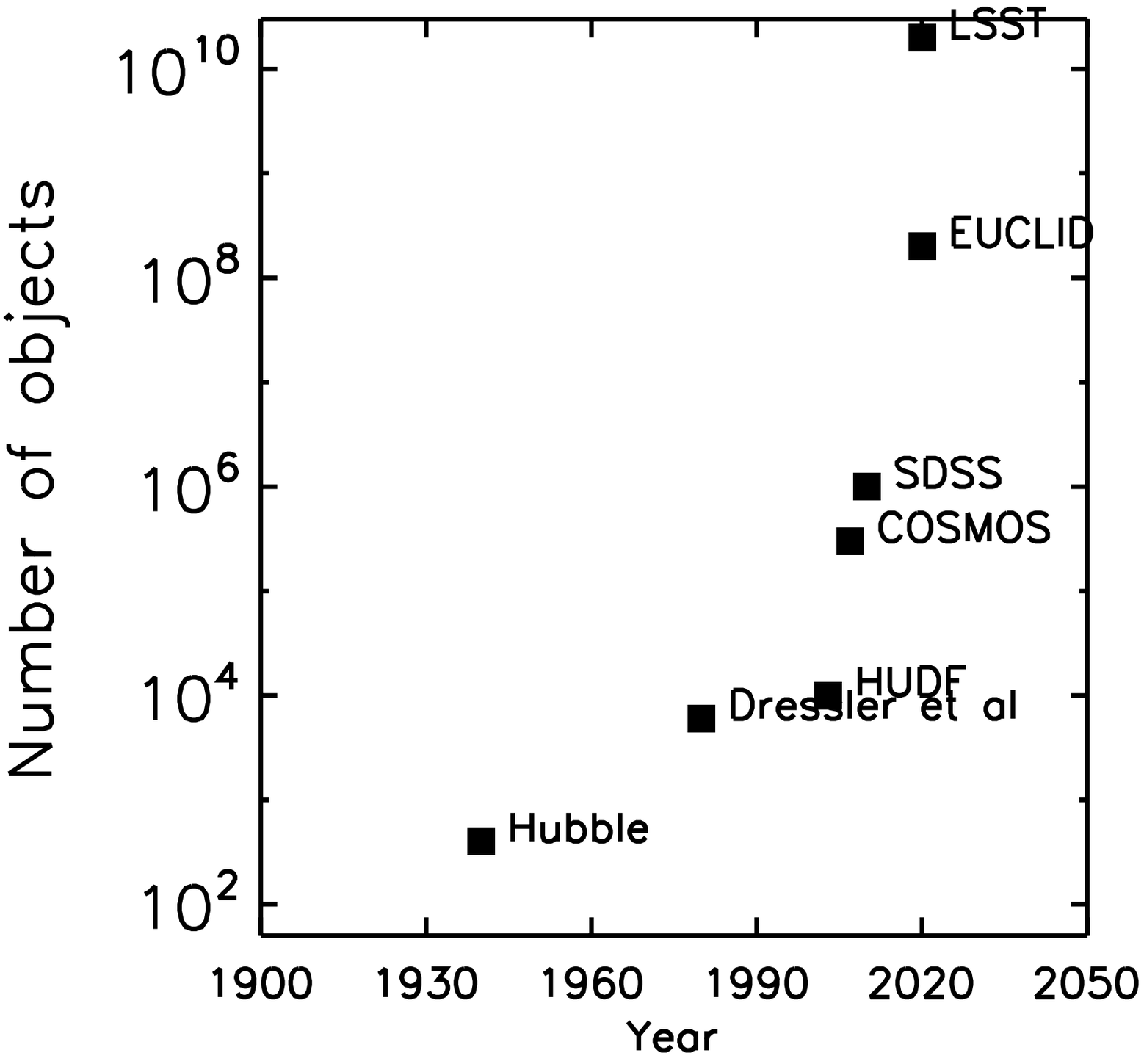
MAIN ISSUE: EXECUTION TIME ~ 1 obj/sec

Alternative algorithms: **SExtractor model** fitting
~20 obj/sec (singe Sersic)
40 times slower than detection mode
Problem with neighbors — requires calibration

OTHER POSSIBILITIES: ML, DL

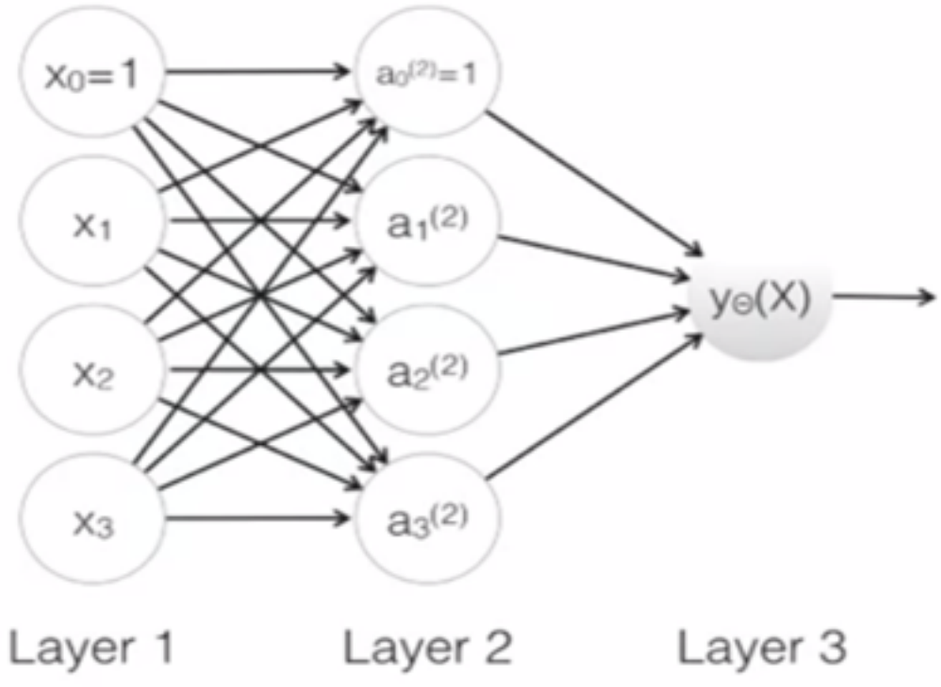
Objects at z>1, faint/unresolved in EUCLID images…

Big-data opportunities: DEEP LEARNING FOR EUCLID



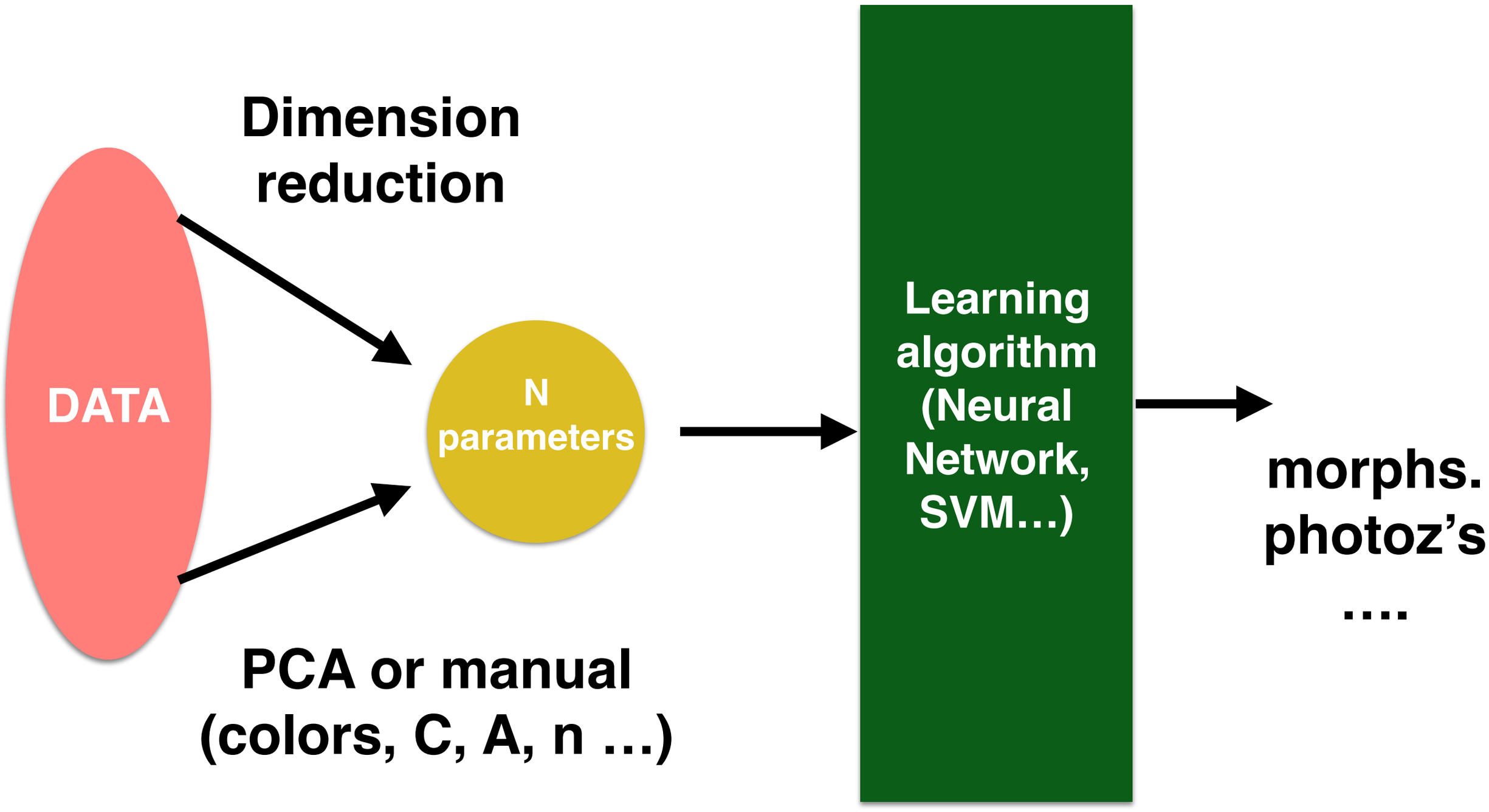
Deep convolutional neural networks

- Hubel & Wiesel 1962 + LeCun 1998
- Mimic the human brain
- Learn non-linear features (from pixels!) using hidden layers
- Very expensive in computing time
  - GPUs…
- Very popular, used by *all* the technology giants (Google, Microsoft)



- 99.2% accuracy

- 94.3 % accuracy


Dimension reduction
DATA
N parameters
Learning algorithm (Neural Network, SVM…)
morphs.
photoz's
....
PCA or manual (colors, C, A, n …)

OPTIMAL FEATURES

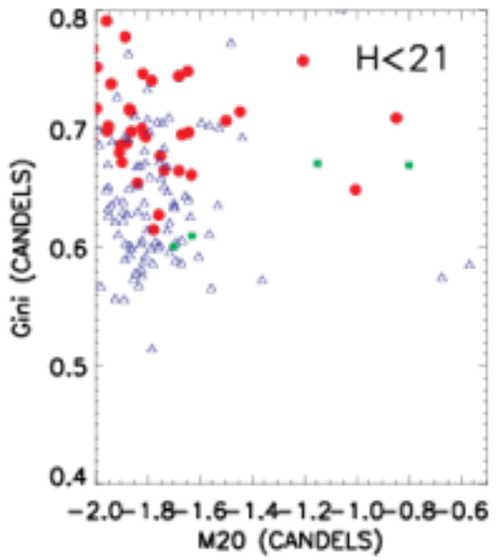
DATA

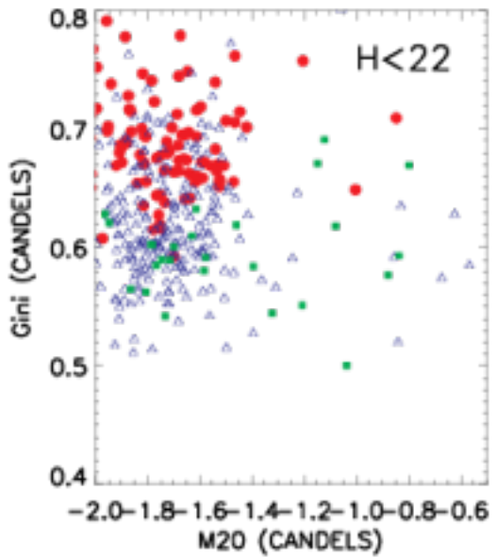
FEATURE LEARNING LAYERS

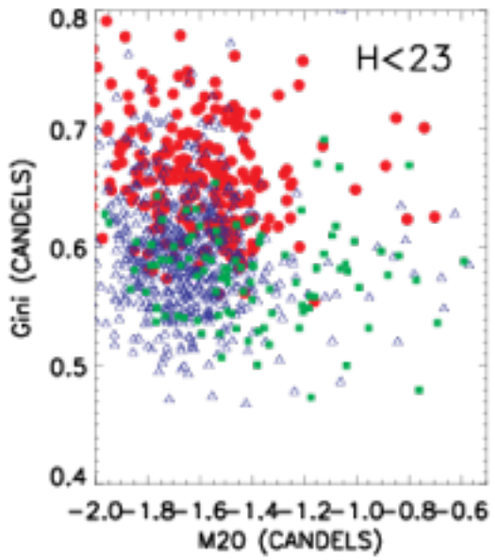
Learning algorithm (Neural Network, SVM…)

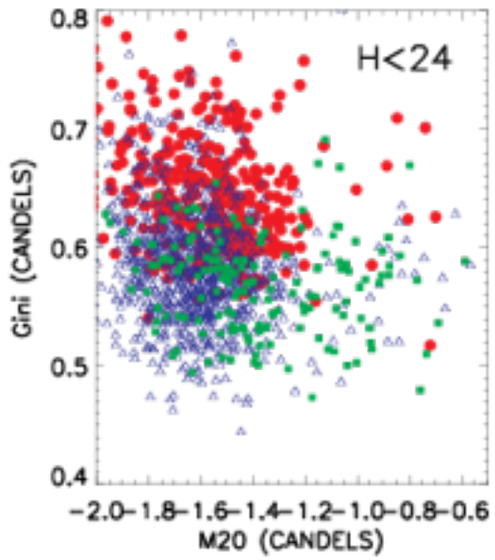
morphs.
photoz's
....

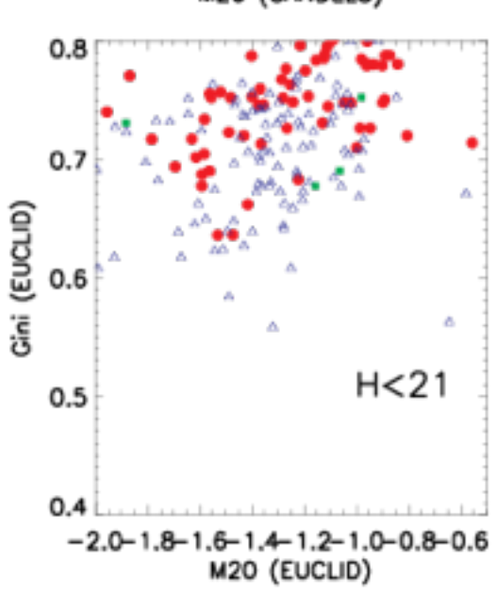
Gini-M20 plane (EUCLID emulated images)

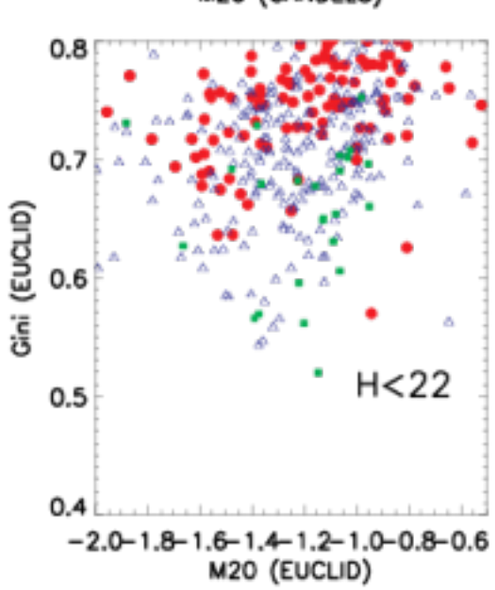


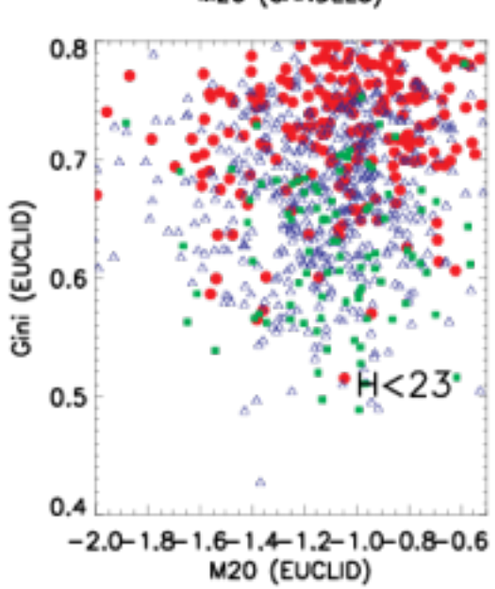


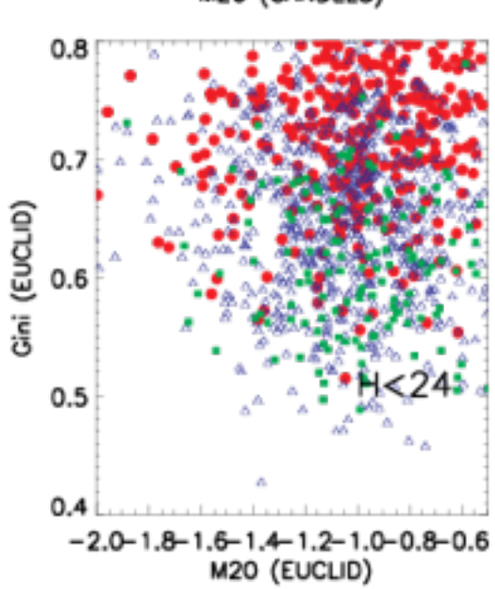


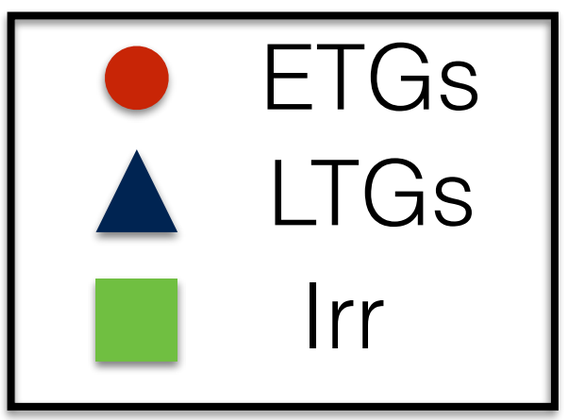












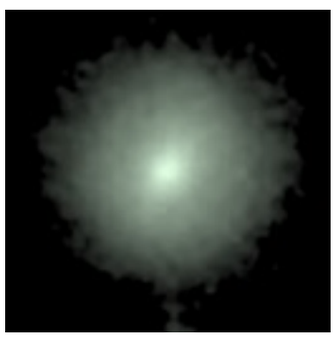
Very noise/resolution dependent…

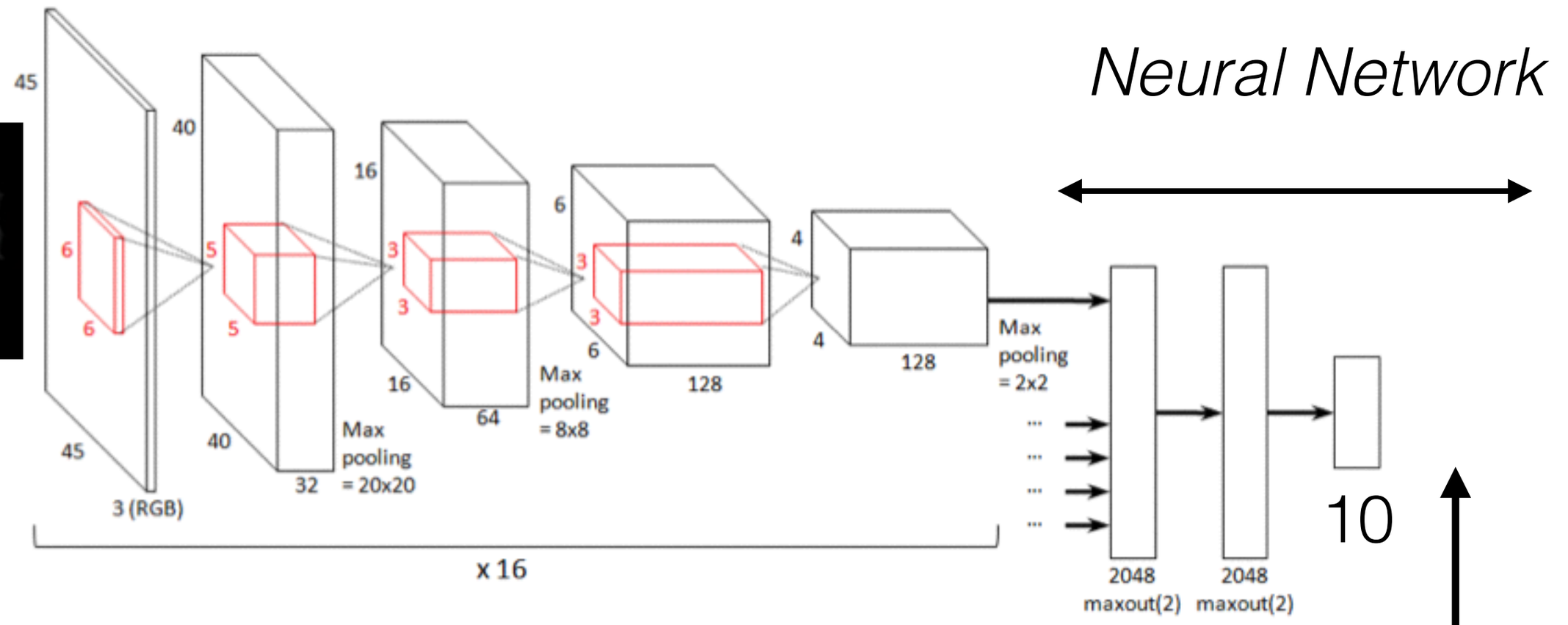
CONVNET for CANDELS

- **TRAIN**: ~50.000 redundant galaxies in GDS (~10 days)
- **CLASSIFY**: GDN, COSMOS, UDS, GDS (~8h/field)

Feature learning

Neural Network

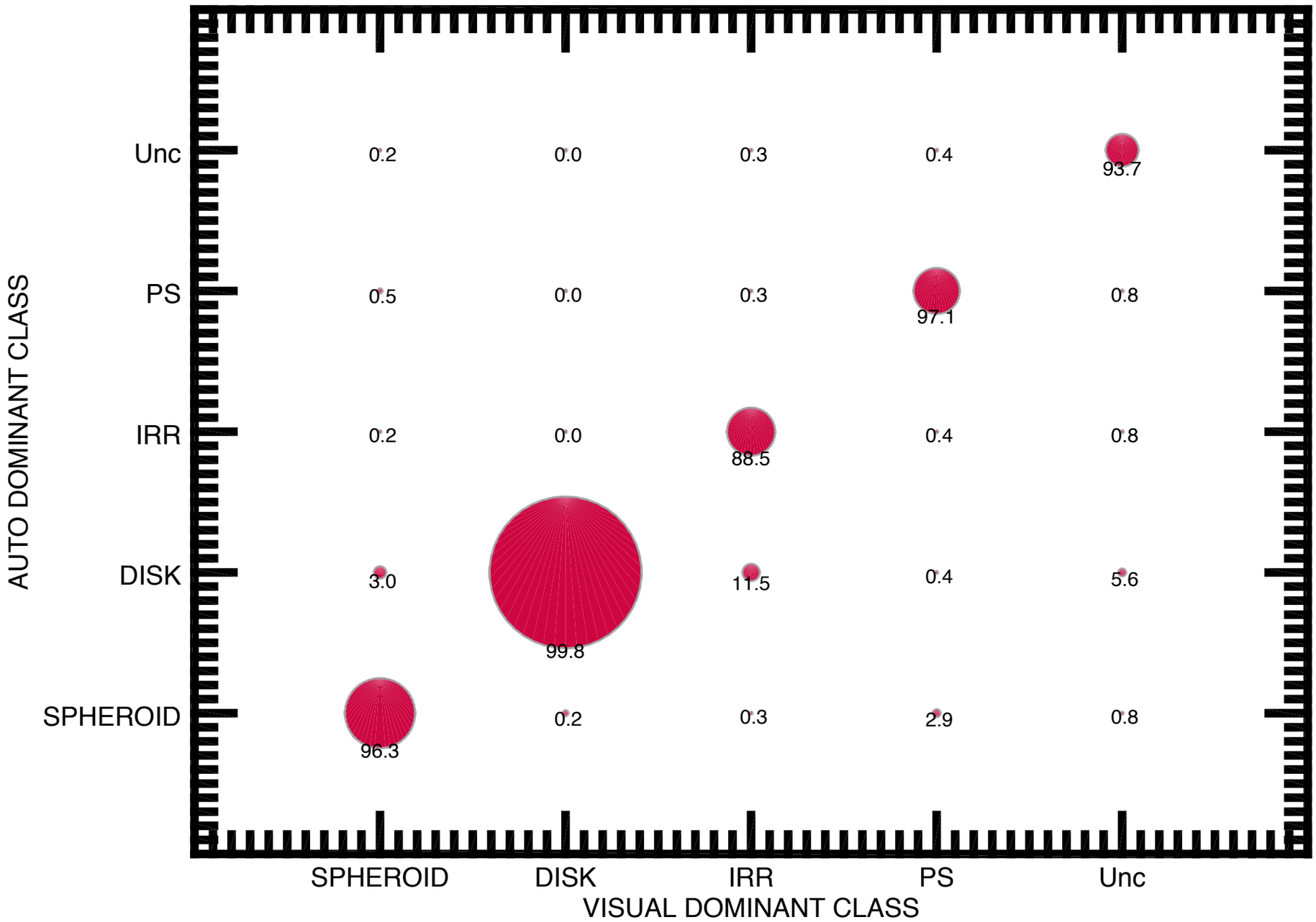




***INPUT**: RGB JPEG GDS snapshots*

***OUTPUT**: 10 probs.*

DOMINANT CLASS



SPHEROIDS

DISKS

IRR

PS

UNC

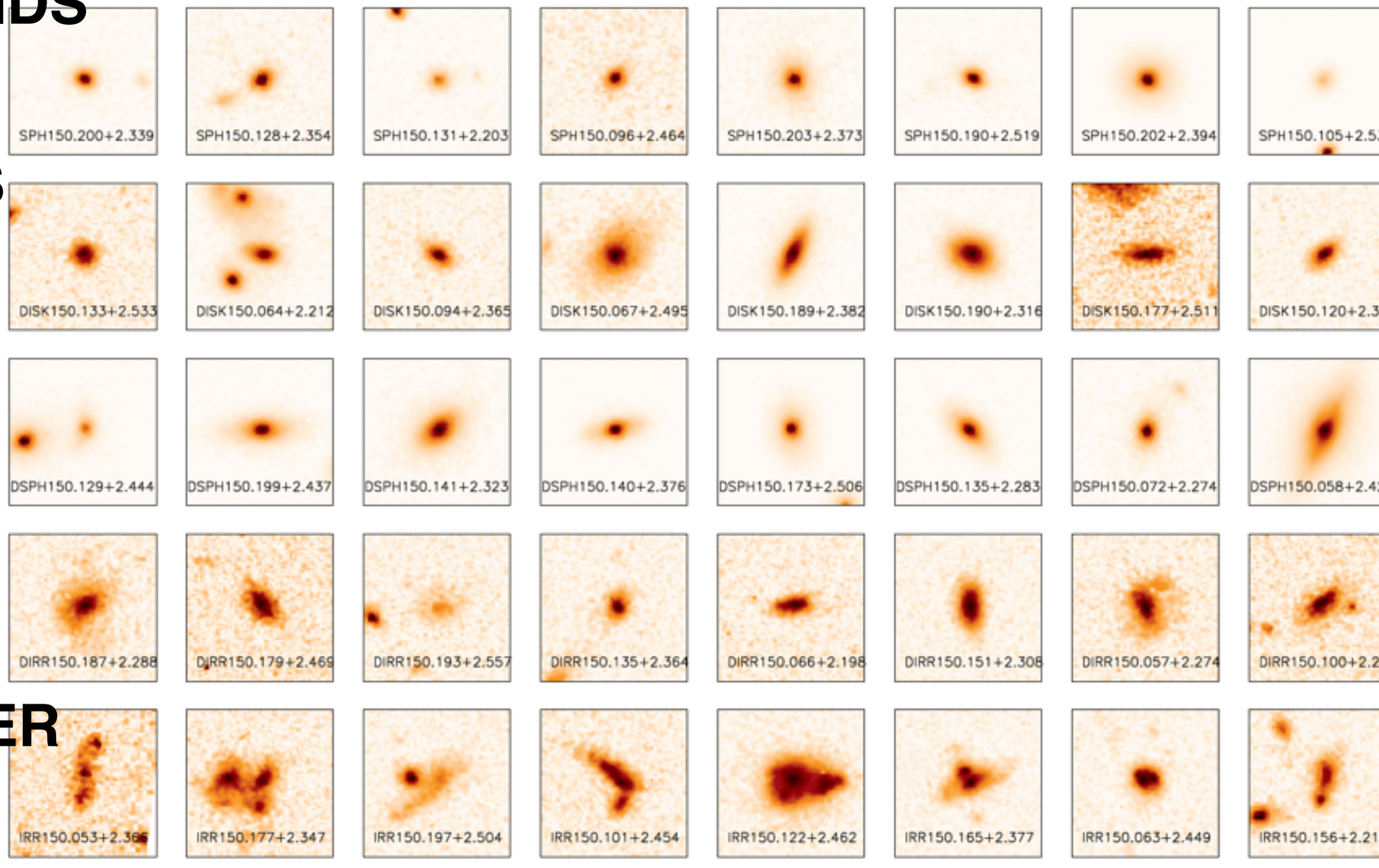
SPHEROIDS

DISKS

B+D

D+I

I/MERGER



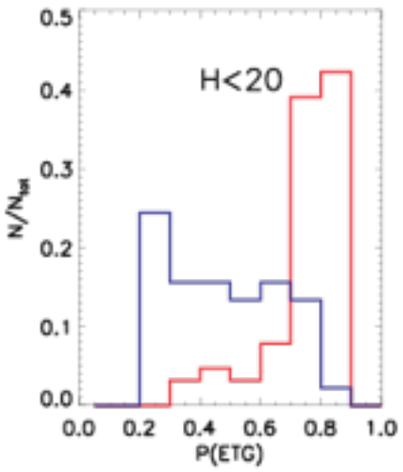
20-30% contamination in a sample of ETGs at z>1

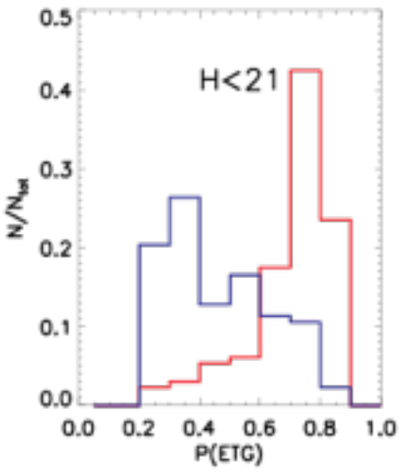
Classical ML + CAS

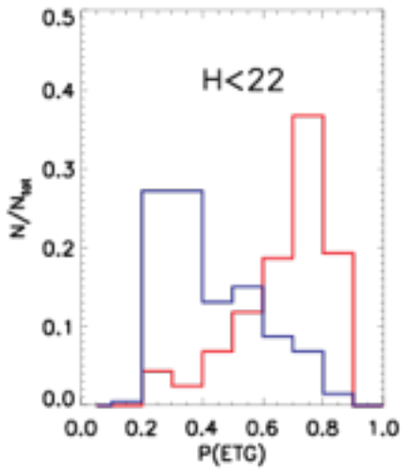
P_{thresh}	$P^{ERS}(ERS)$	$C^{ERS}(ERS)$	$P^{SDSS}(ERS)$	$C^{SDSS}(ERS)$
ETGs				
0.3	53.68	99.03	48.80	89.71
0.4	62.50	92.23	56.61	78.68
0.5	70.45	90.29	66.42	66.91
0.6	78.70	82.52	71.56	57.35
0.7	80.00	66.02	77.11	47.06
0.8	83.02	42.72	85.96	36.03

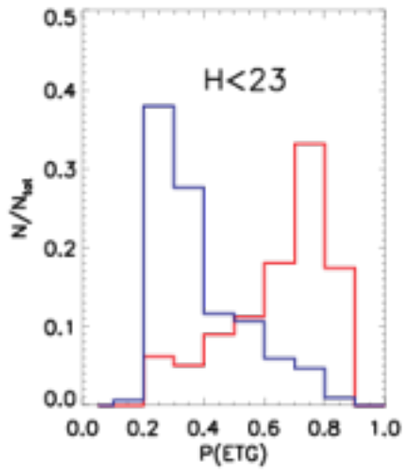
MHC+14a

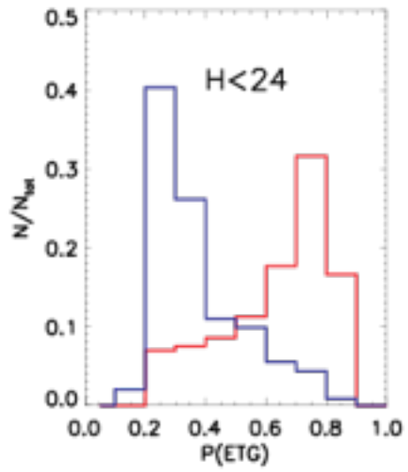
EUCLID











Action items for 2016

- First set of OU-SIM simulations should become available (analytic profiles)
  - Enough for pursuing ellipticity, size etc **algorithm testing**
- Pursue on deep-learning testing (simulations from HST + numerical)
  - Detailed morphology classification
  - B/D, sizes etc ?
  - Good news: manpower available (Student+postdoc)