Chromatic Effects within the Dark Energy Survey Camera's Filter System

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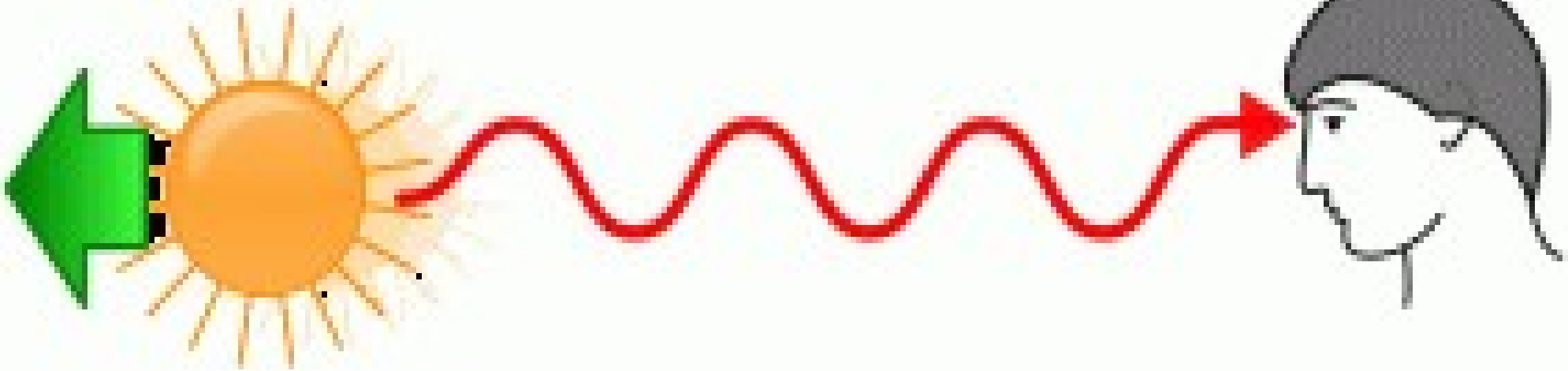
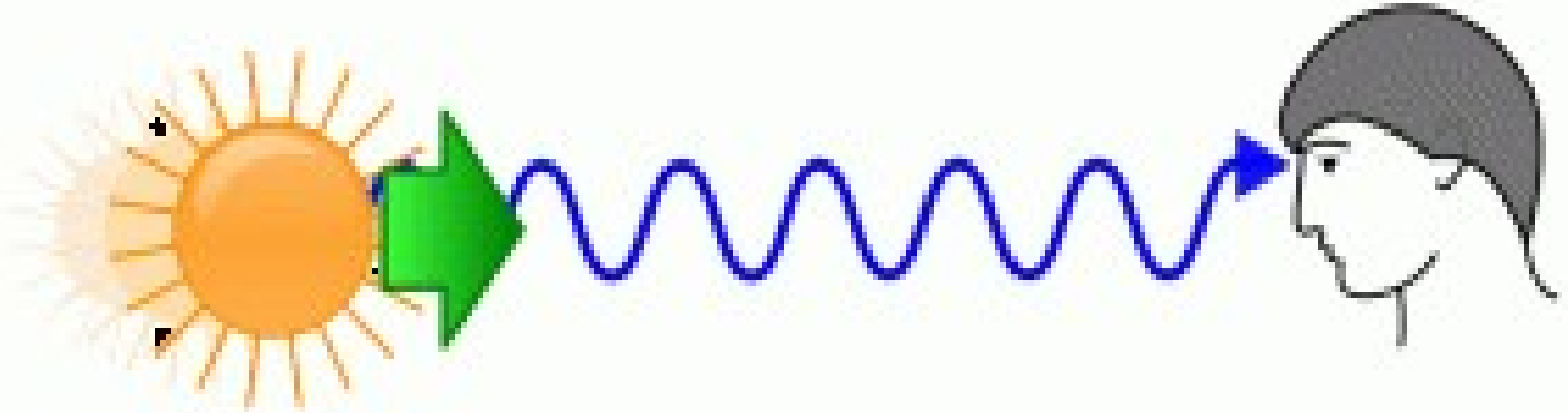
Background

- Dark Energy is the cause of the accelerating expansion of the Universe
- What is it?
  - In short, we don't know
  - Could be new force or energy
  - Could be evidence for new phenomena
  - Could be lack of something
  - Could be mathematical constant
- Physicists created Dark Energy Survey to find out.
  - 5 year project
  - Using Cerro Tololo Telescope in Chile
  - Mapping ¼ of Southern Sky to find out.
- Measuring Redshift
  - Light waves elongate as objects move away: this is redshift
  - Dark Energy causes all objects to move away from earth
  - Detecting redshift determines effect of Dark Energy

Background: Redshift and Blueshift



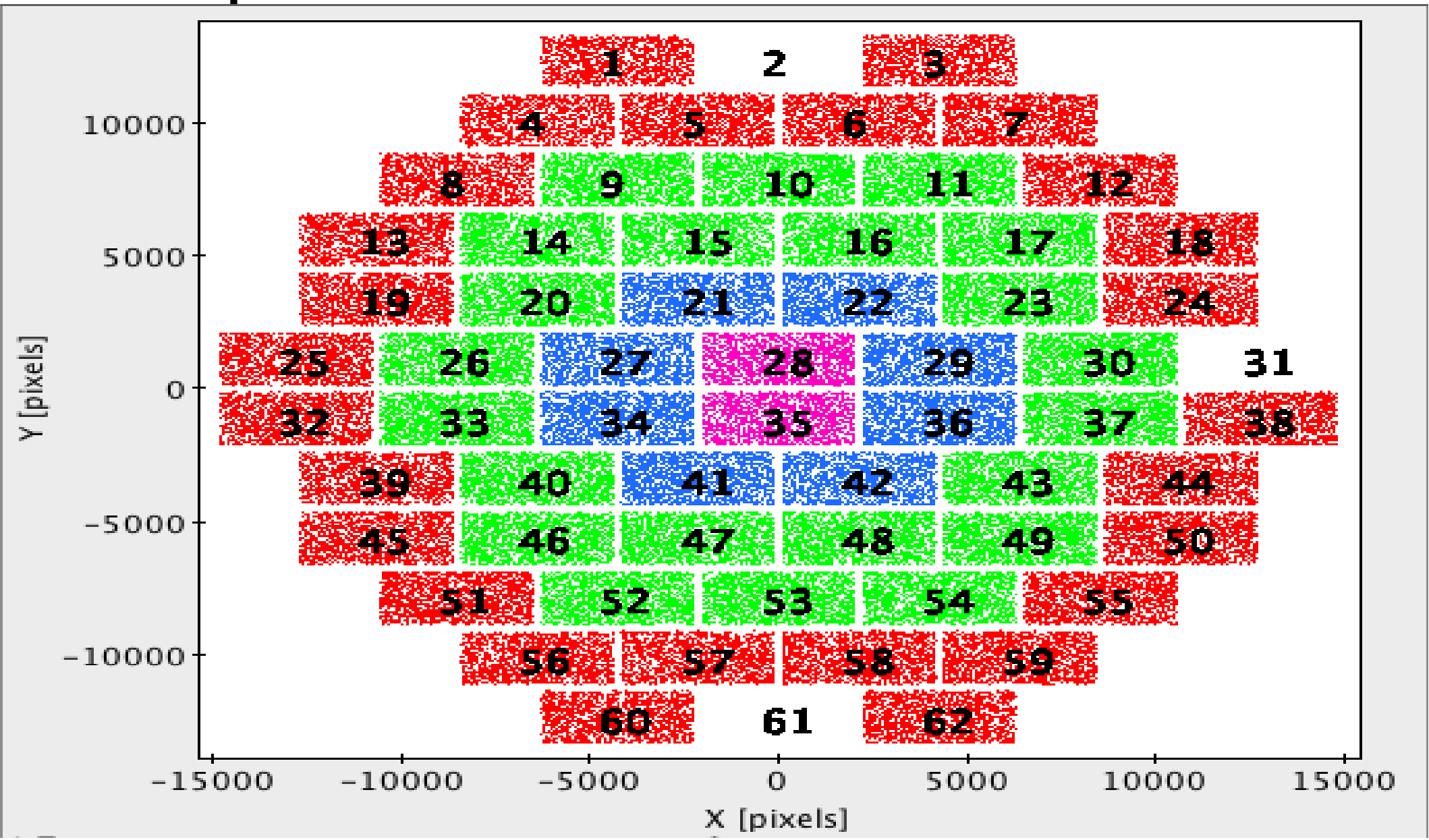


- Image Credit: http://scopeweb.mit.edu/articles/seeing-red-the-cosmological-redshift/

Experiment

- Dark Energy Camera (DECam) used to measure objects for DES.
- DECam comprised of array of multiple CCDs (“chips”)
- How well do we understand the total filter response throughout the focal plane?
- Do the measurements of the filters and CCDs change over time?

Experiment: DECam Focal Plane



- Credit: Dr. Douglas Tucker

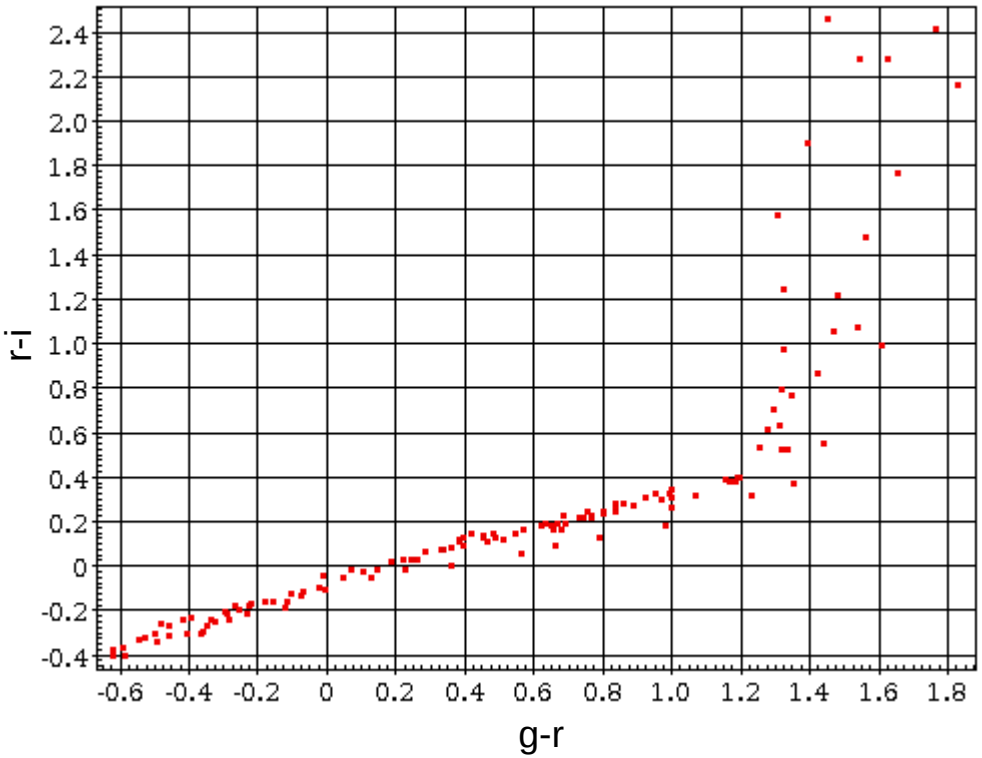
Procedure

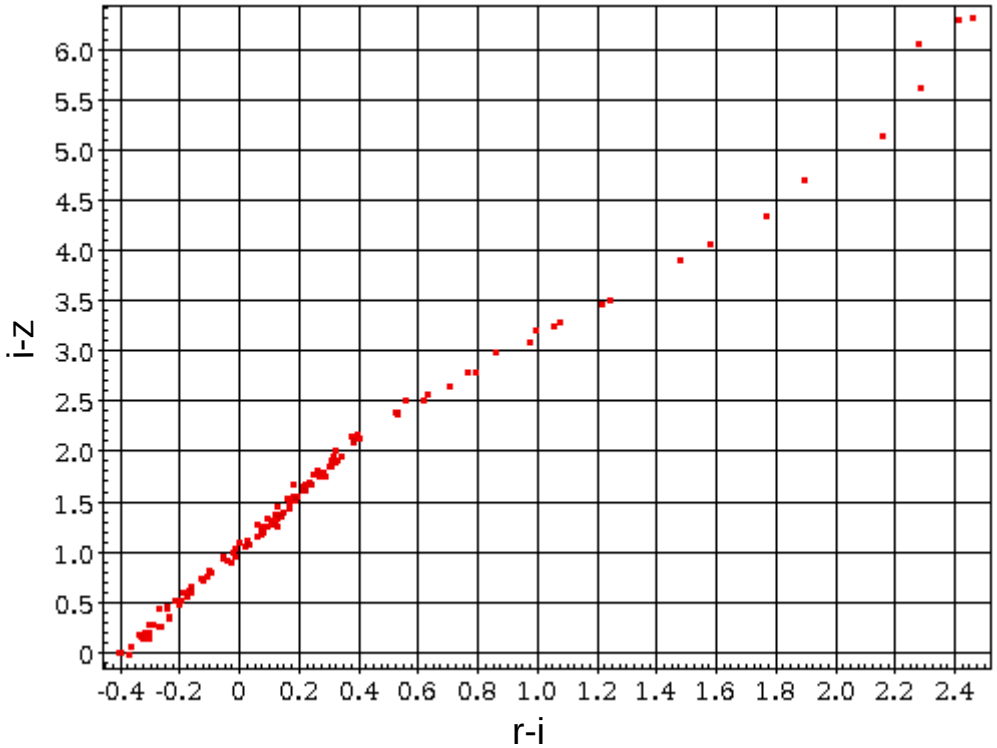
- Obtain filter curves
- Run them through Synphot
  - Use Pyraf
  - This is to compare to Pickles (1998) synthetic data
- Plot the following ratios:
  - (g-r) vs. (r-i)
  - (r-i) vs. (i-z)
  - (i-z) vs. (z-y)
- Obtain actual star data from DES

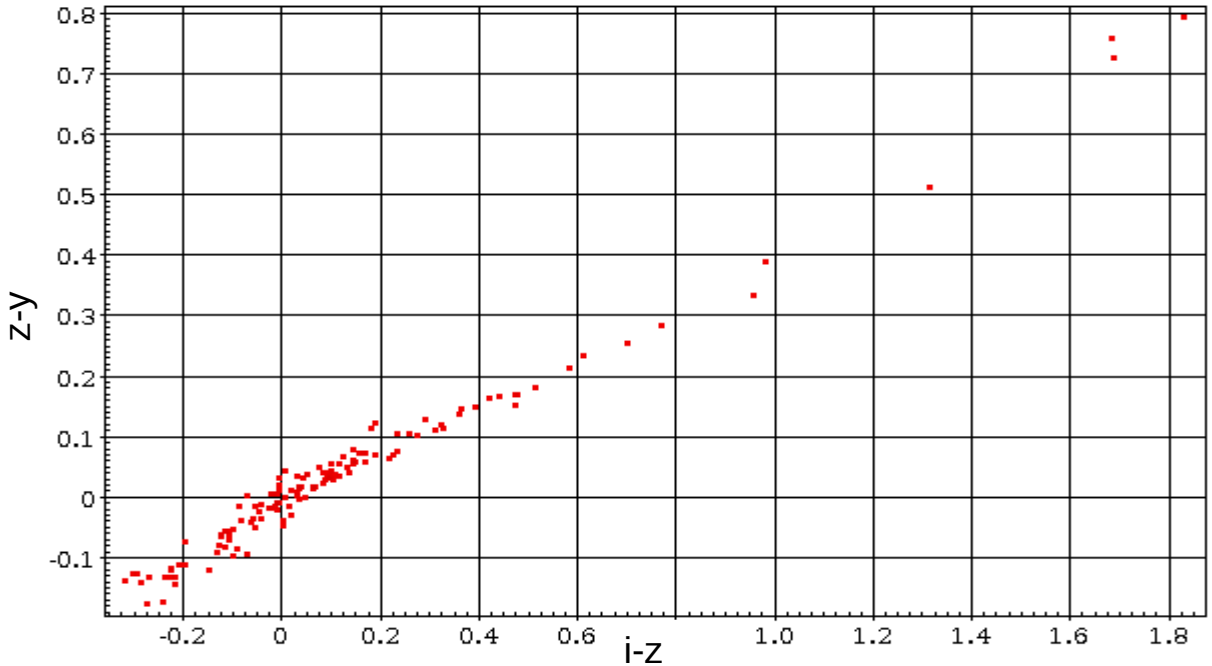
Procedure (Part 2)

- Plot star data with these ratios
- Compare Data
- Use these ratios to compare inconsistencies
  - (g-r) vs. change in g magnitude
  - (g-r) vs. change in r magnitude
  - (i-z) vs. change in i magnitude
  - (i-z) vs. change in z magnitude
  - (z-y) vs. change in y magnitude
- Compare trend-lines against one another

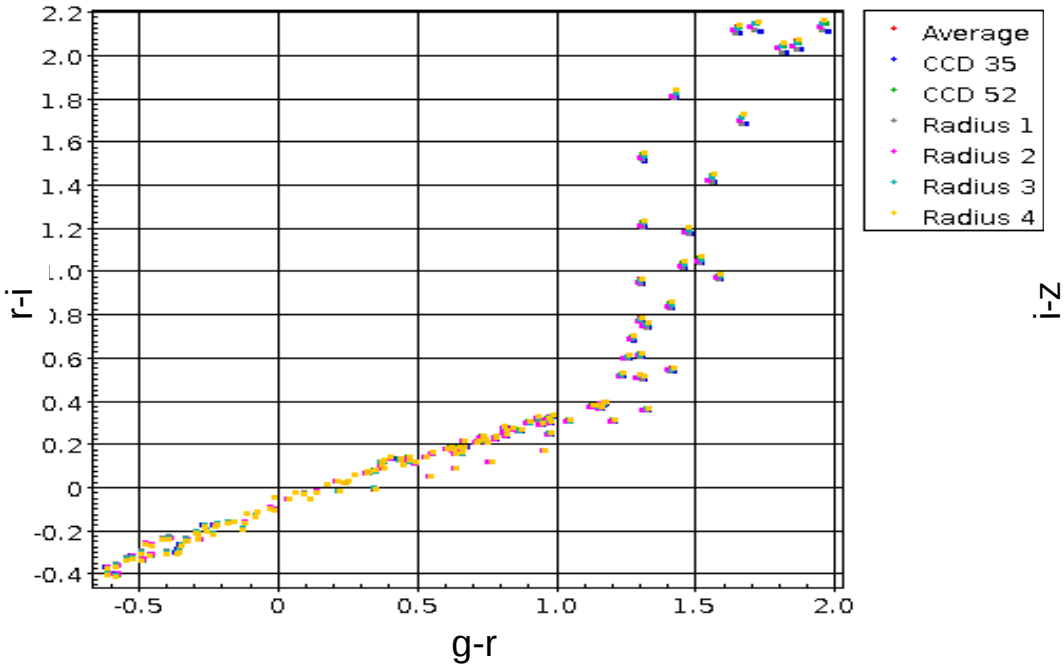
Initial Synthetic Ratios Filter Set 005

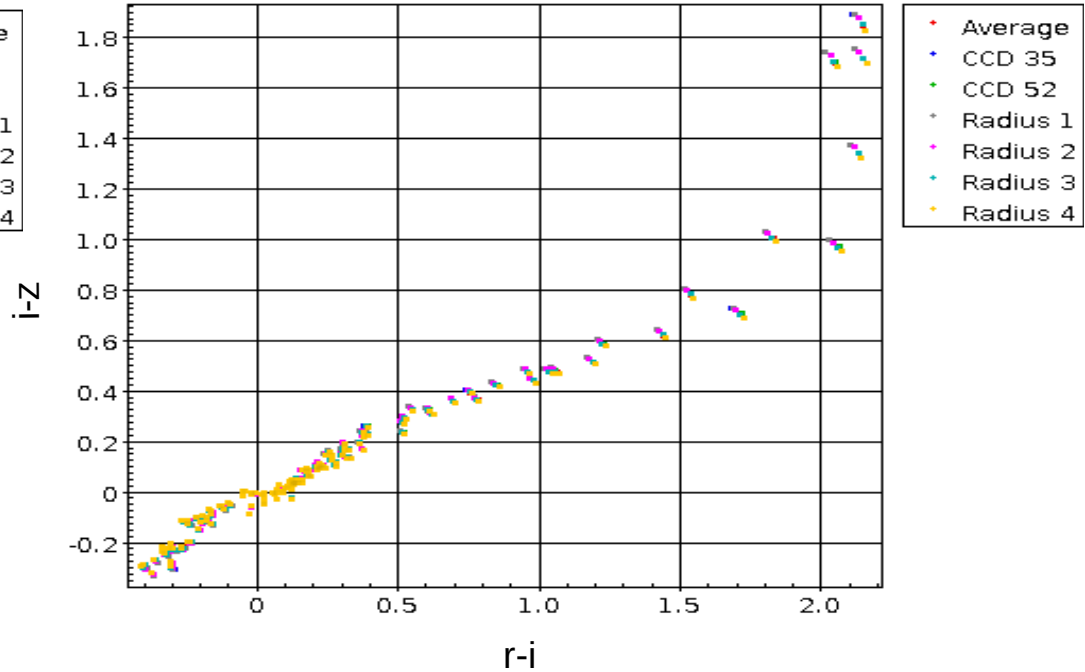


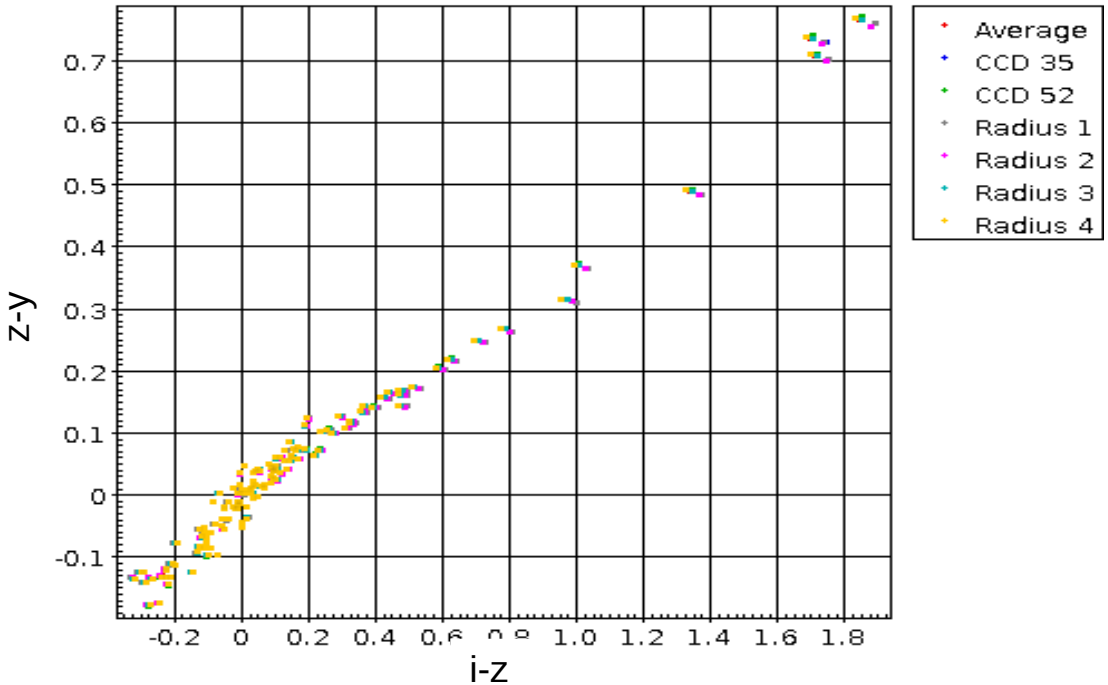




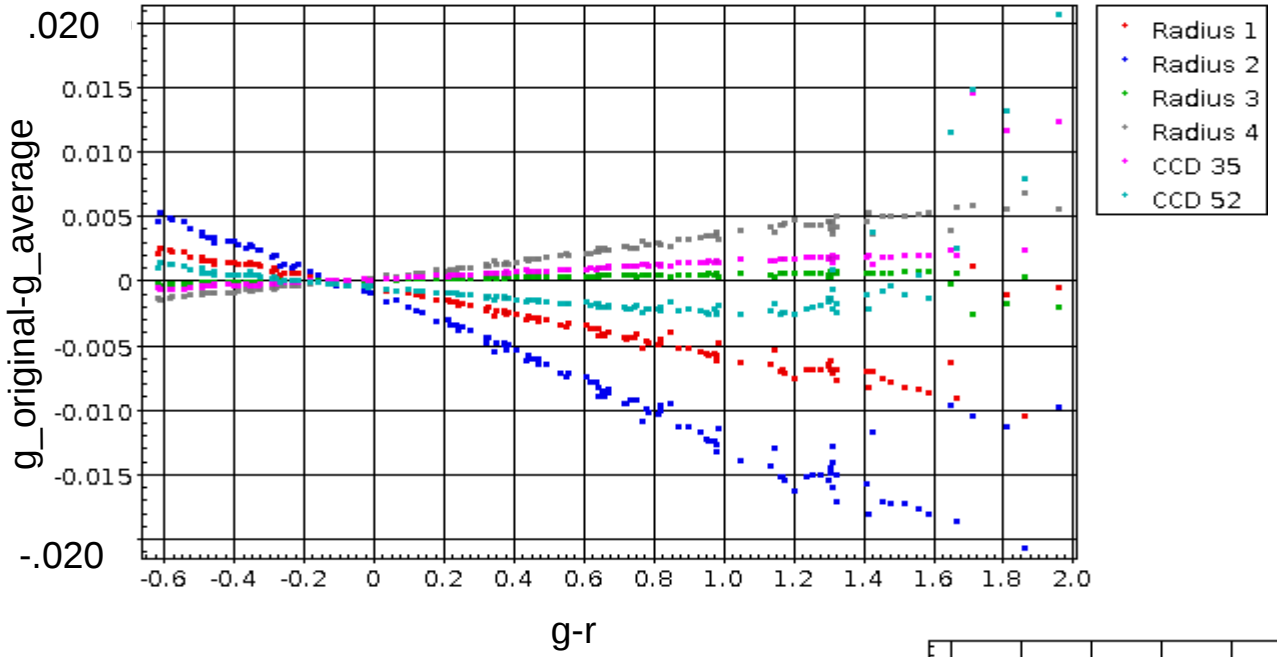
Initial Synthetic Ratios Filter Set 2015

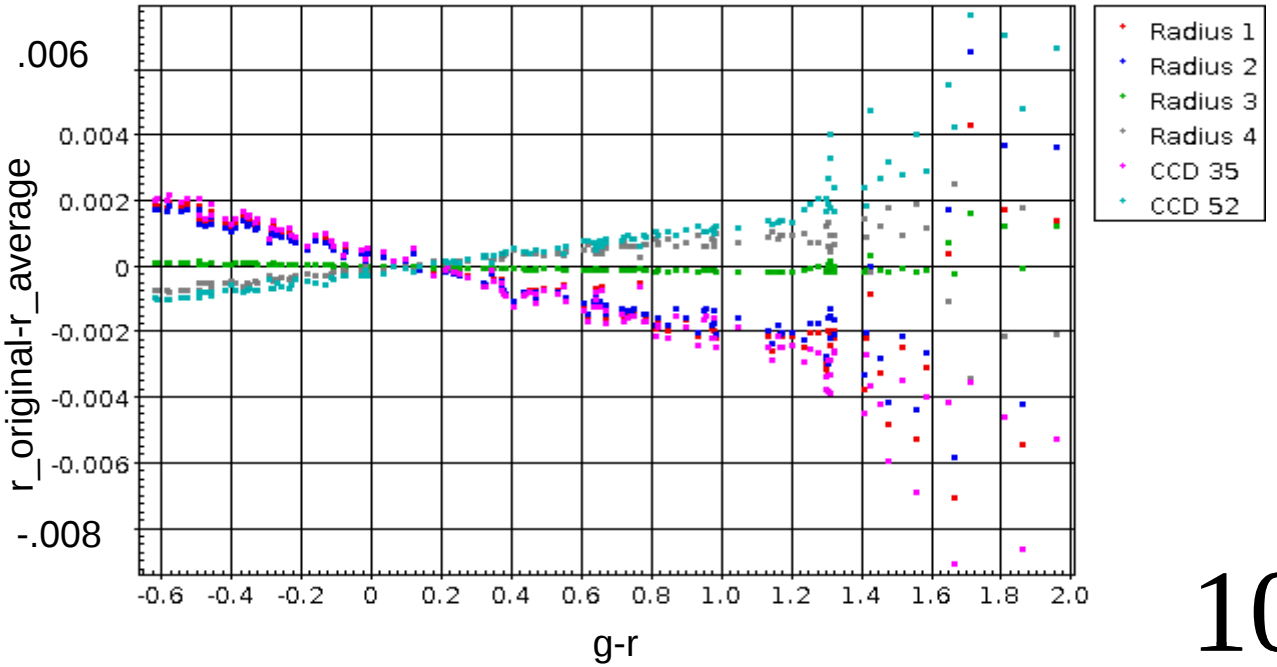


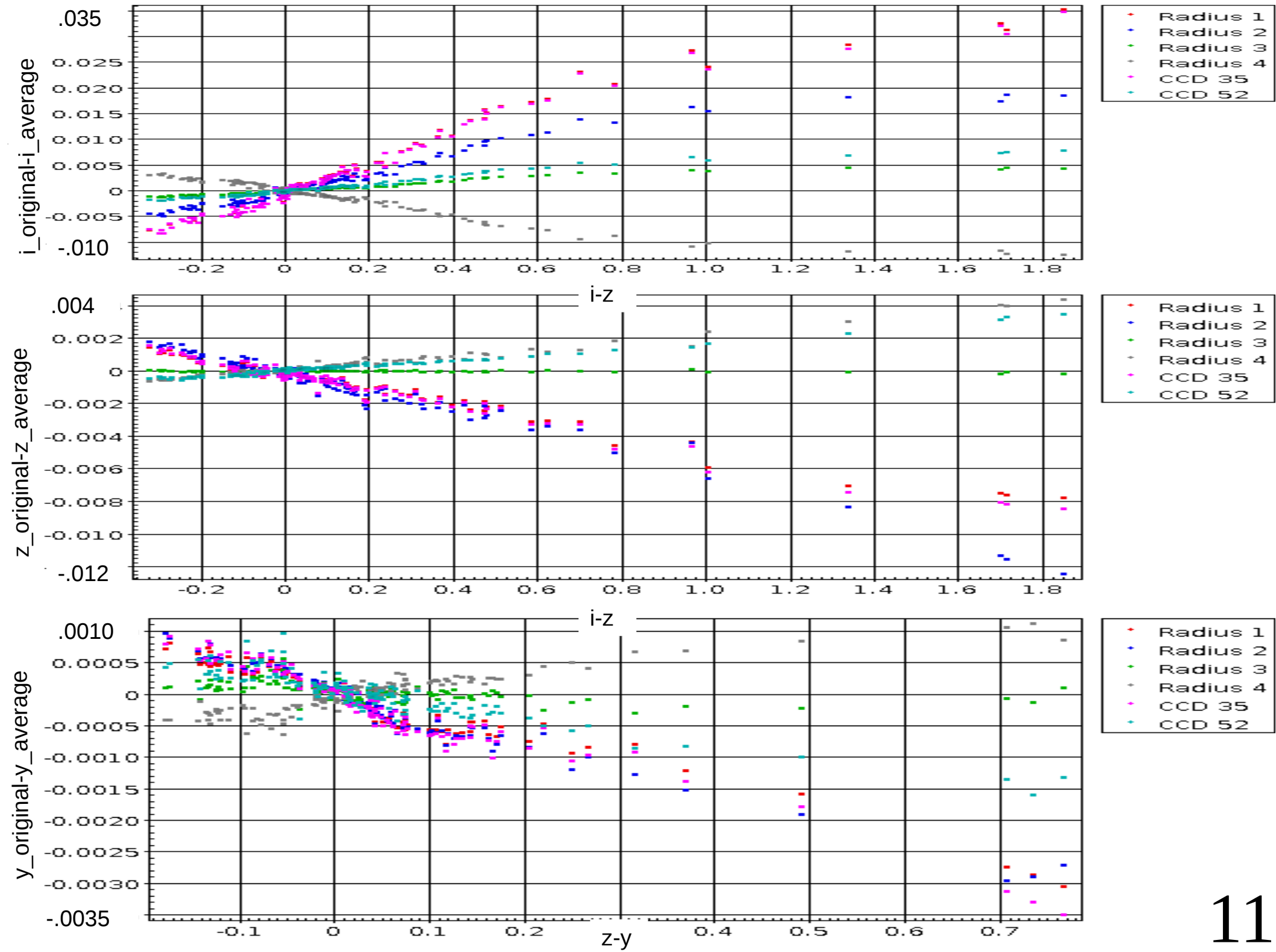




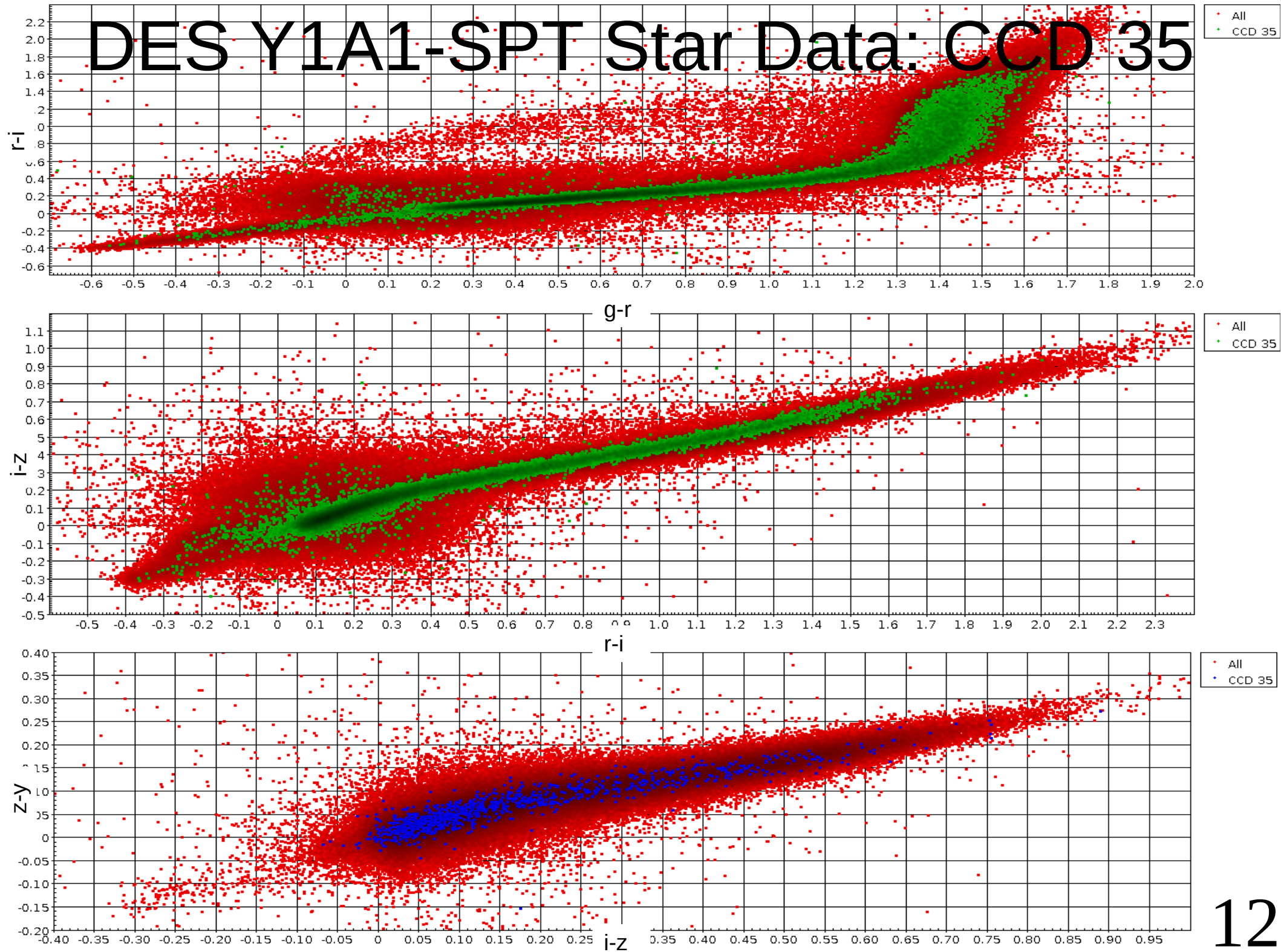
2015 Synthetic Trend Analysis



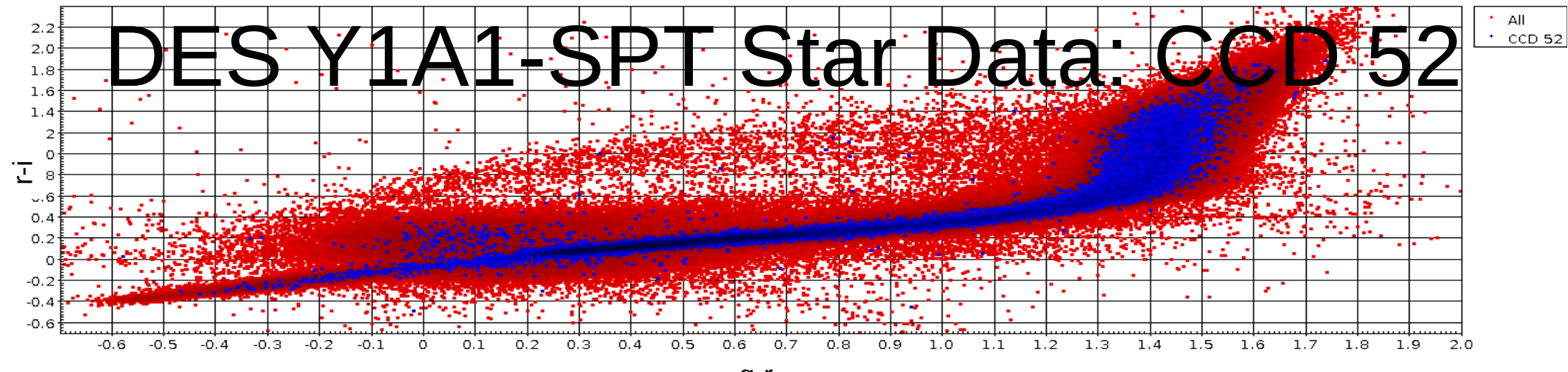


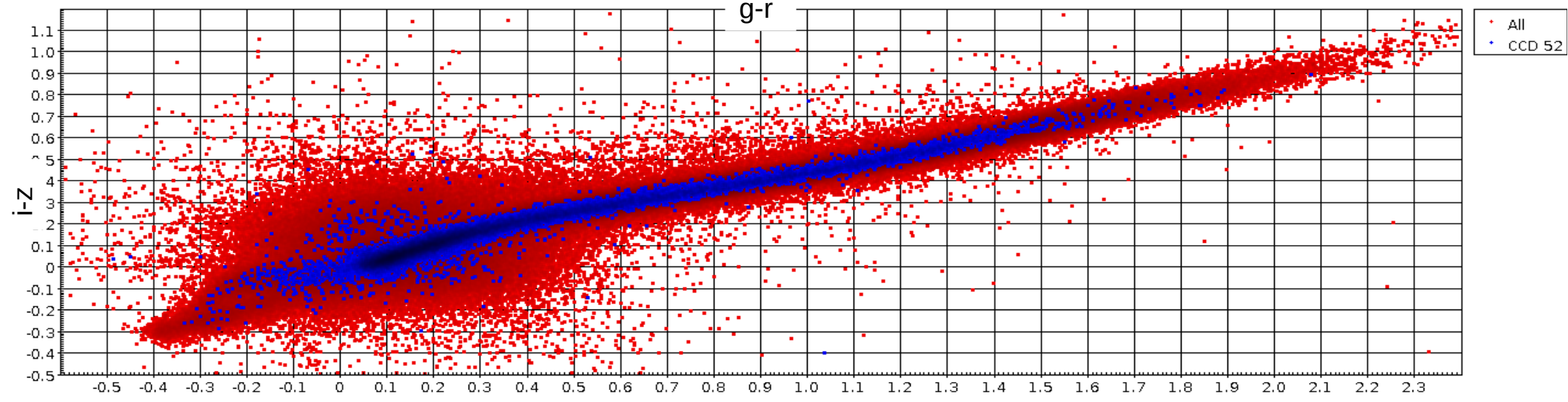

i_original-i_average
i-z
Radius 1
Radius 2
Radius 3
Radius 4
CCD 35
CCD 52
z_original-z_average
i-z
Radius 1
Radius 2
Radius 3
Radius 4
CCD 35
CCD 52
y_original-y_average
z-y
Radius 1
Radius 2
Radius 3
Radius 4
CCD 35
CCD 52

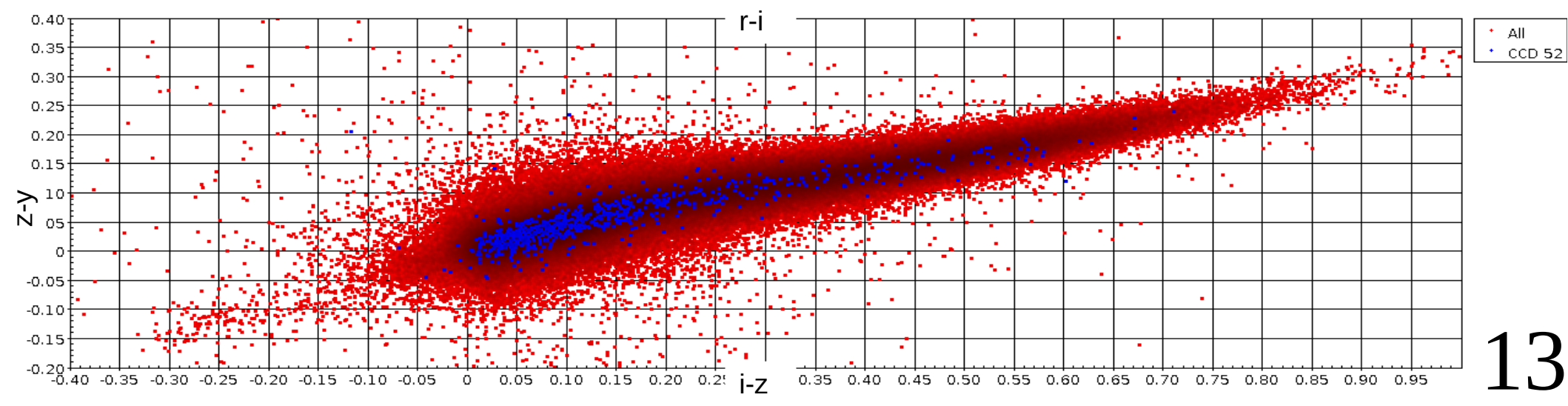
DES Y1A1-SPT Star Data: CCD 35



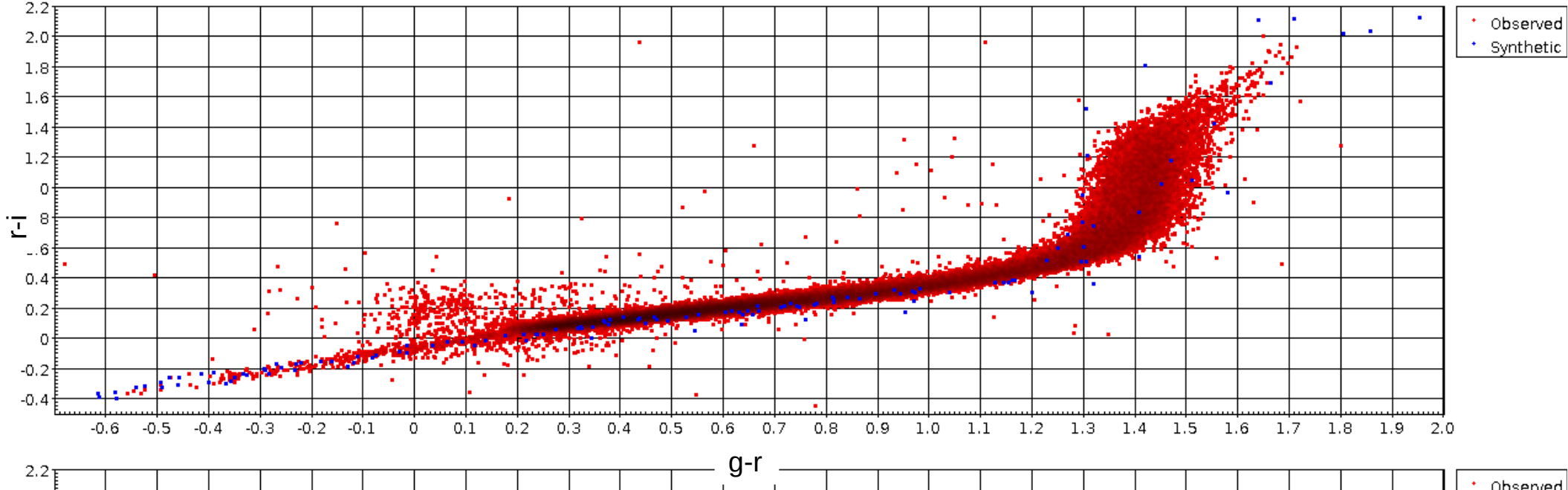
DES Y1A1-SPT Star Data: CCD 52

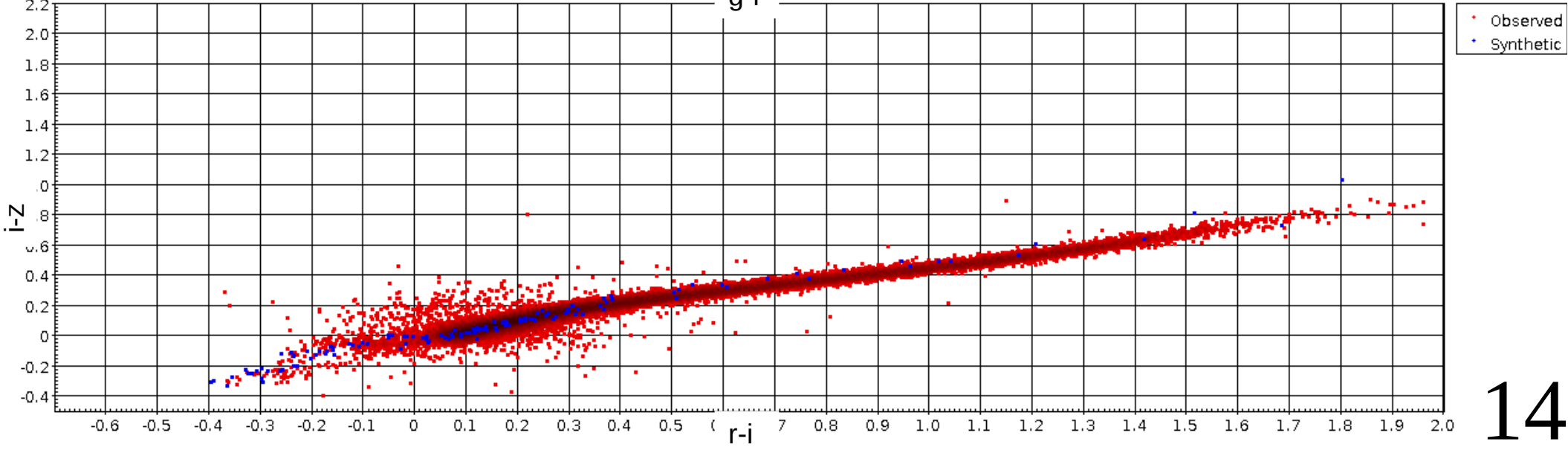




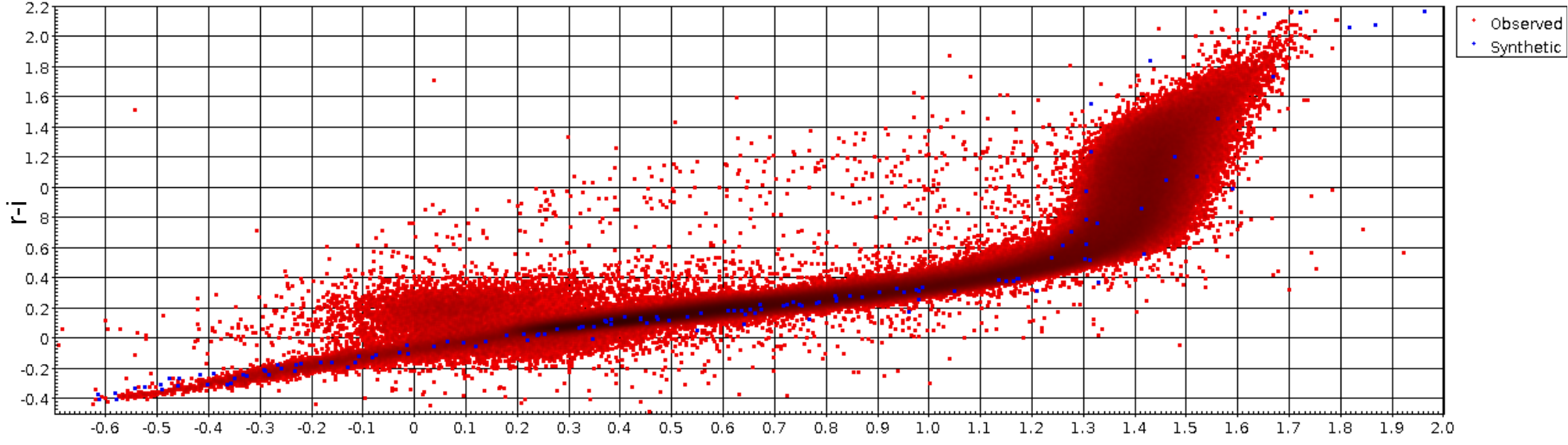


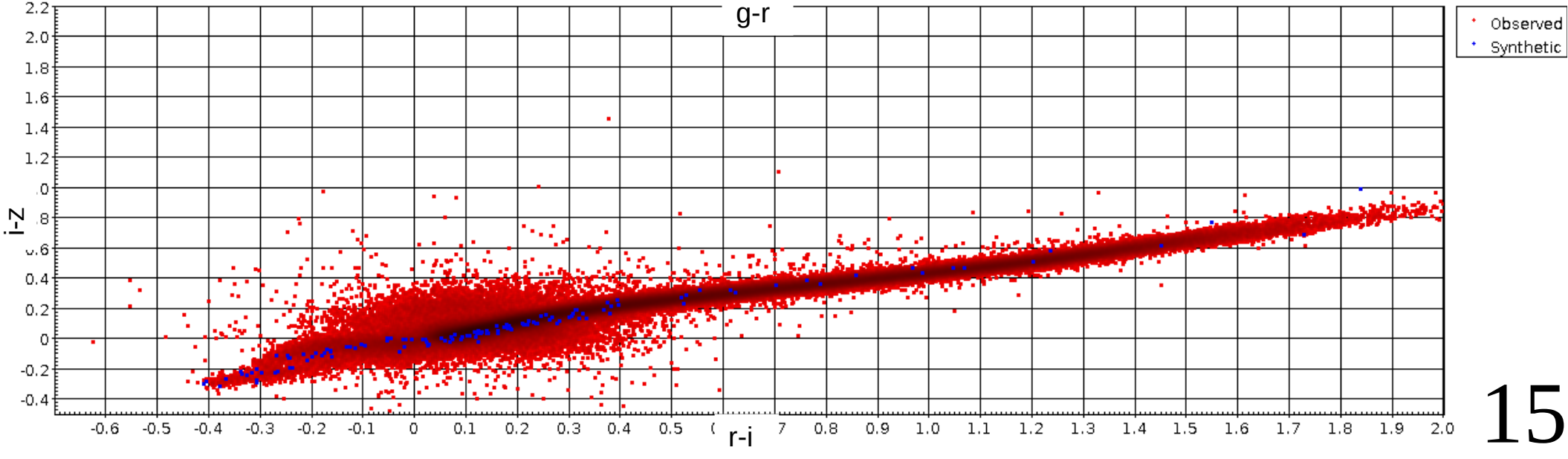
Star Data vs. Synthetic Data (Radius 1)



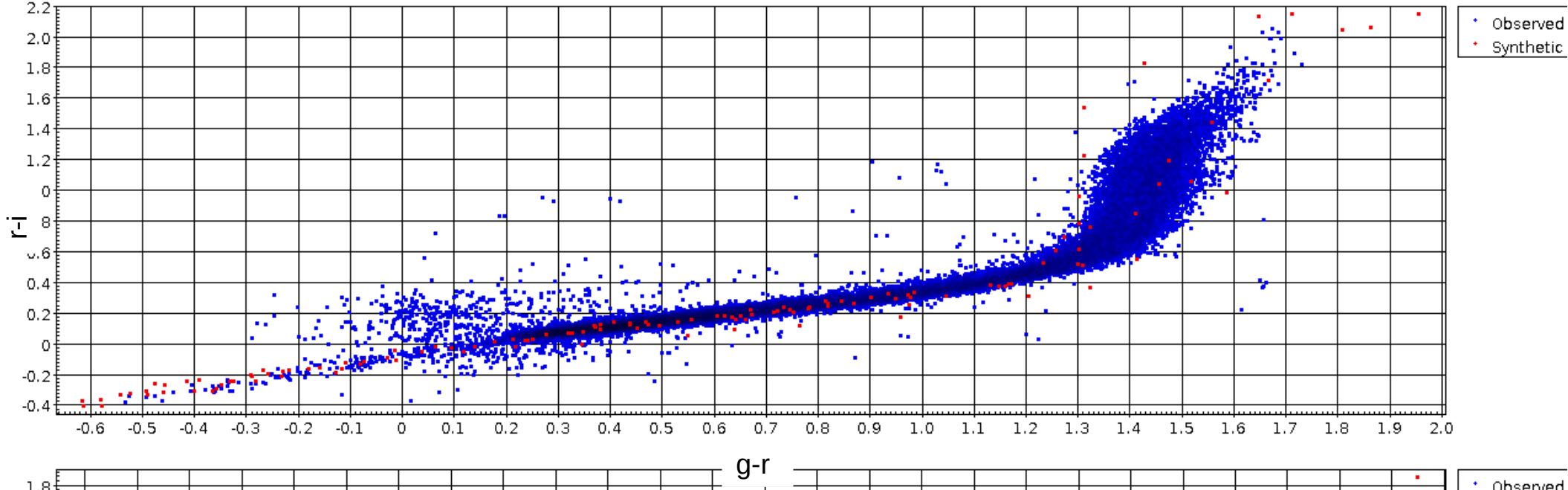


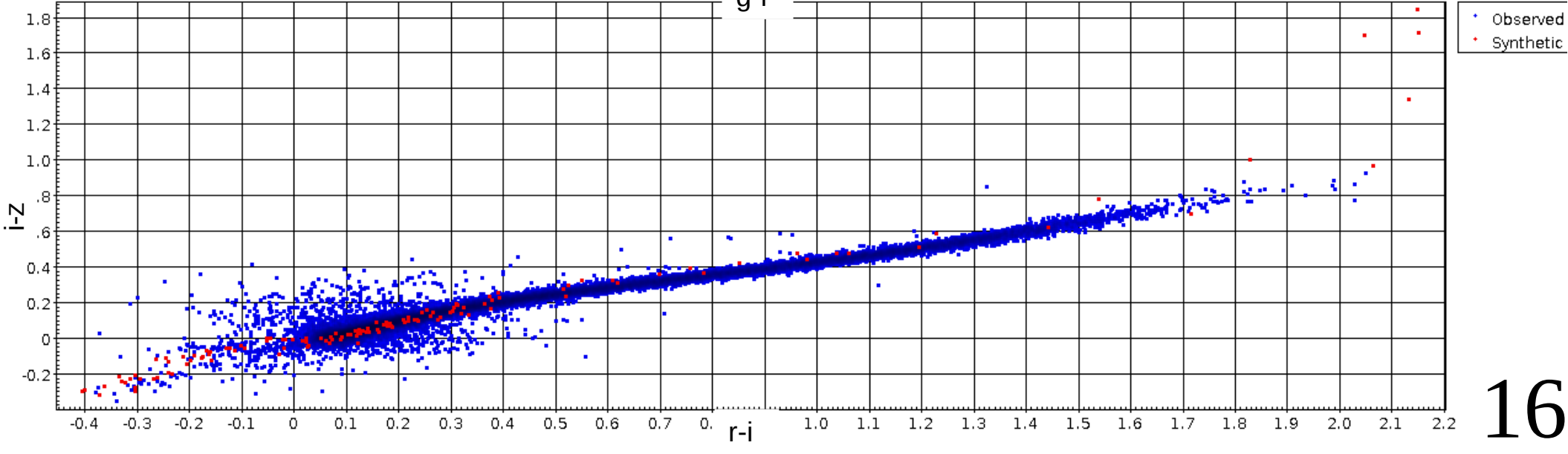
Star Data vs. Synthetic Data (Radius 4)



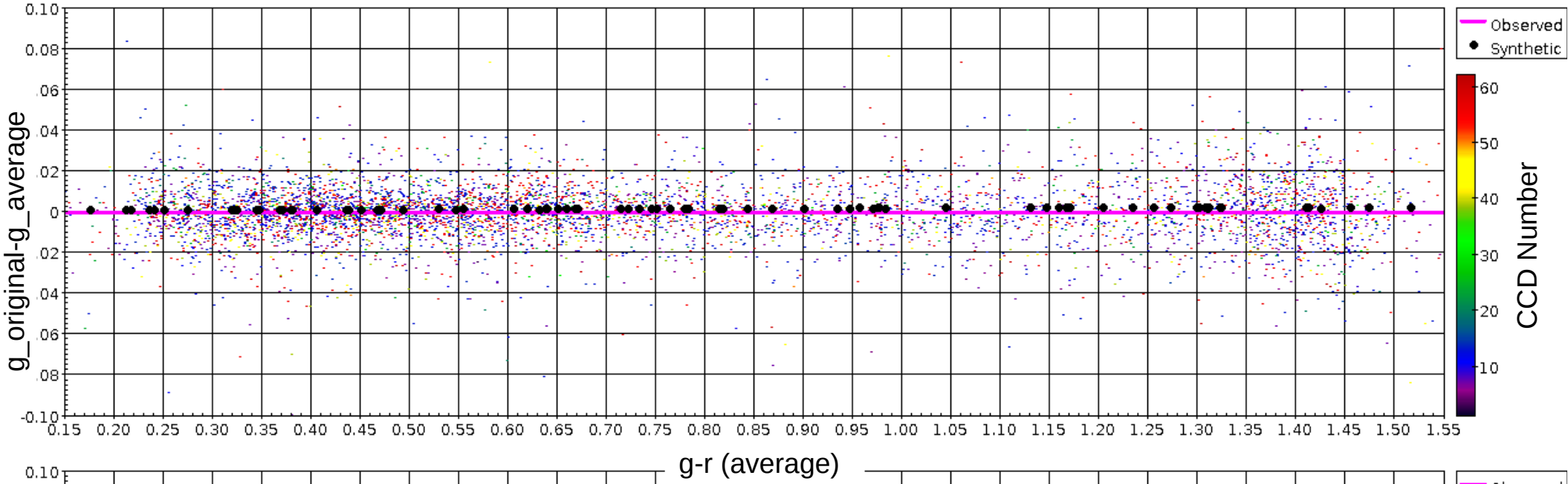


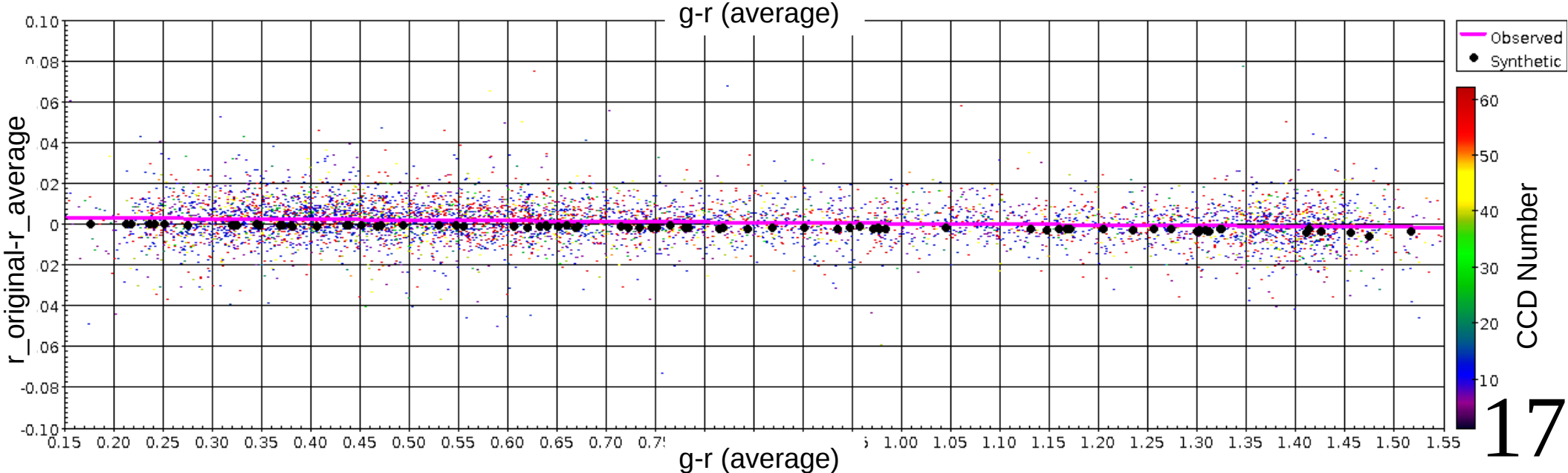
Star Data vs. Synthetic Data (Average filter curve)



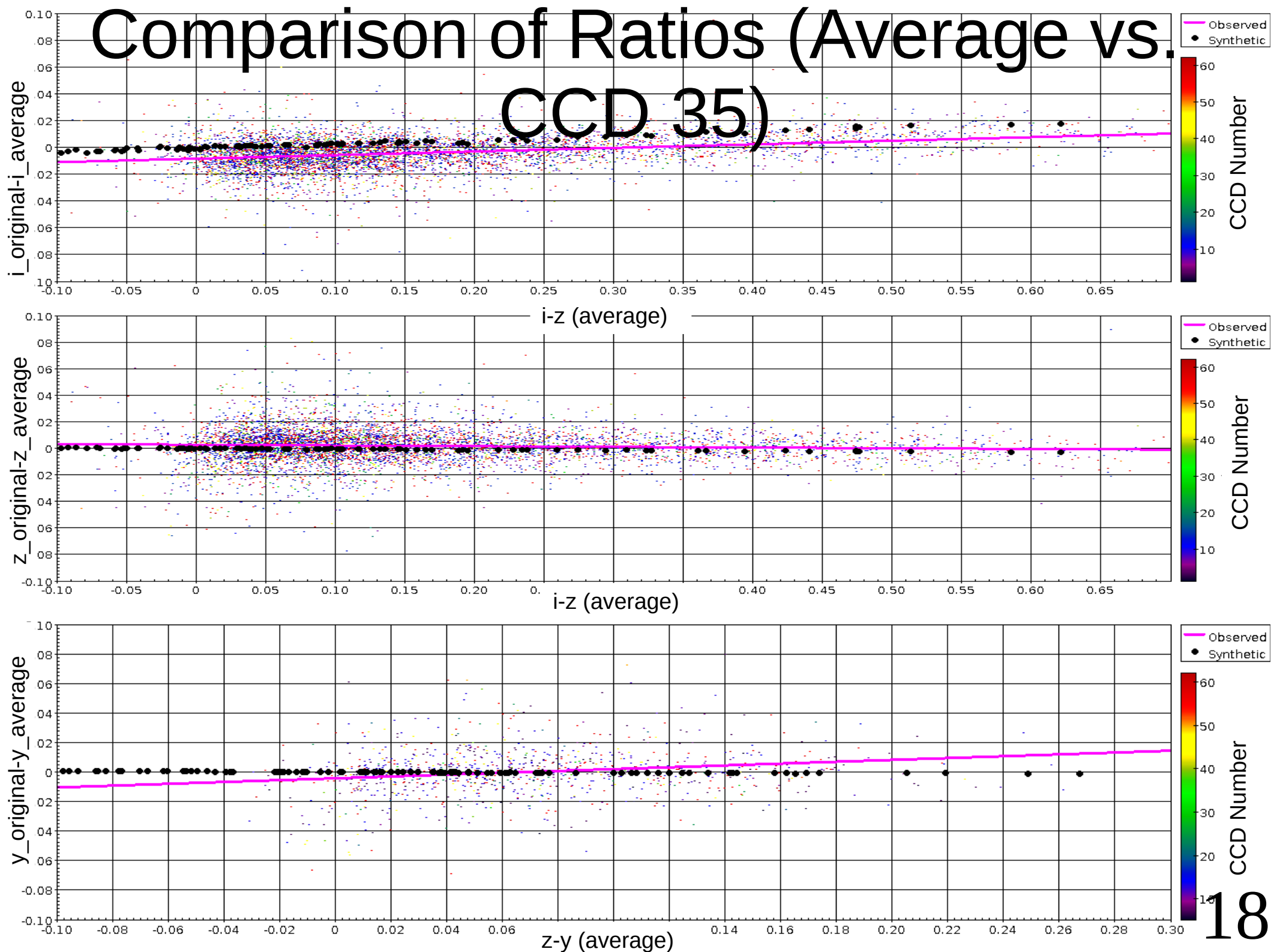


Comparison of Ratios (Average vs CCD 35)

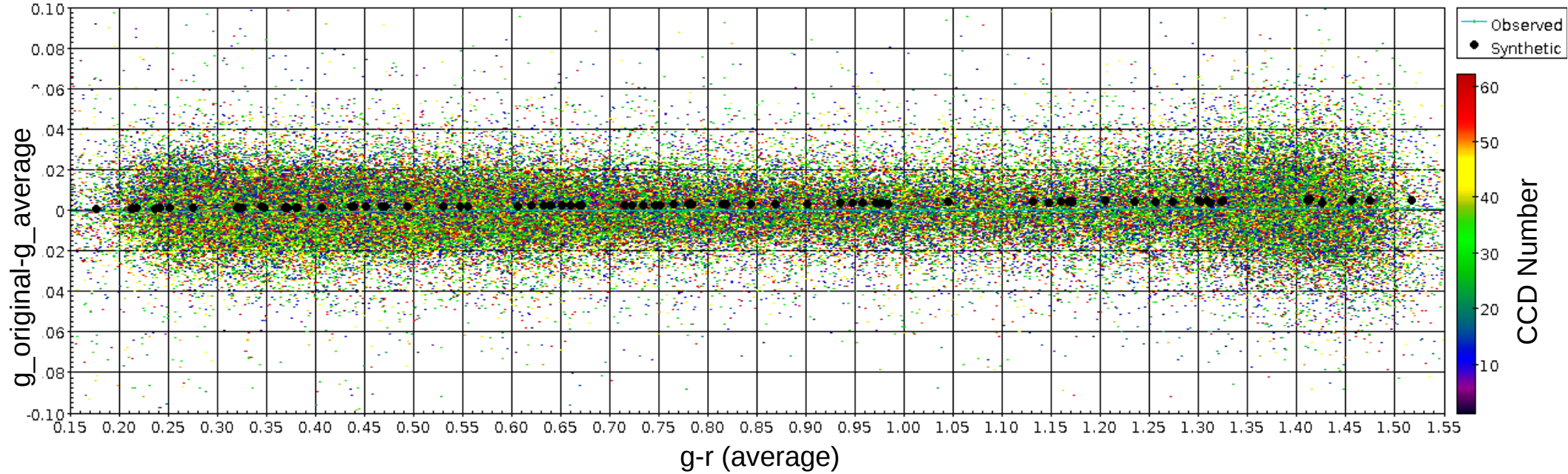


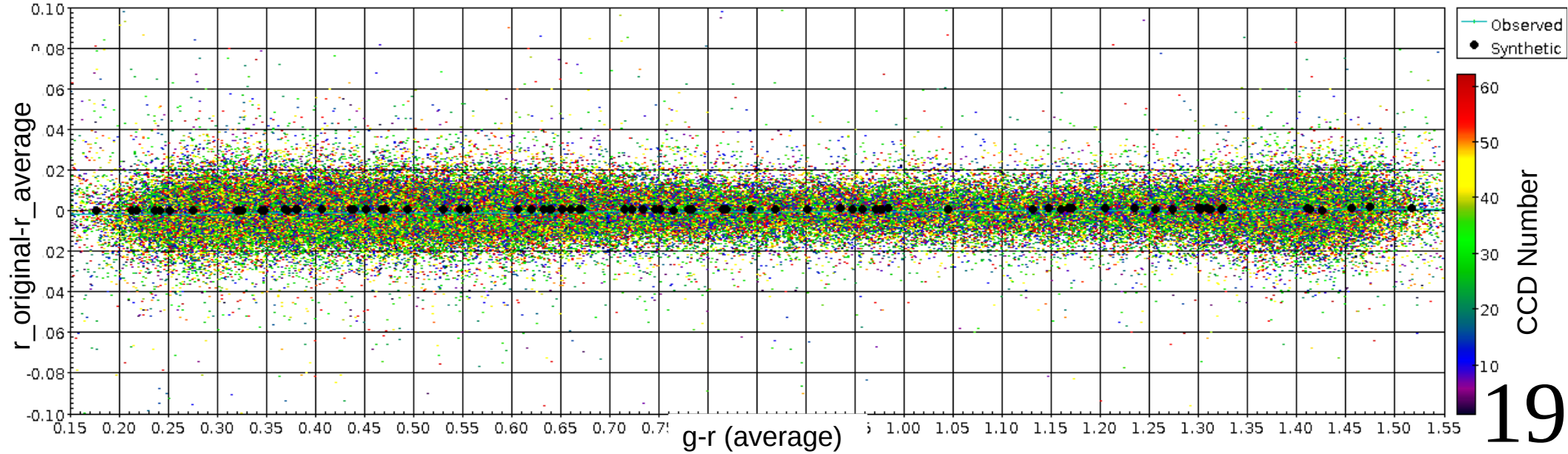


Comparison of Ratios (Average vs. CCD 35)

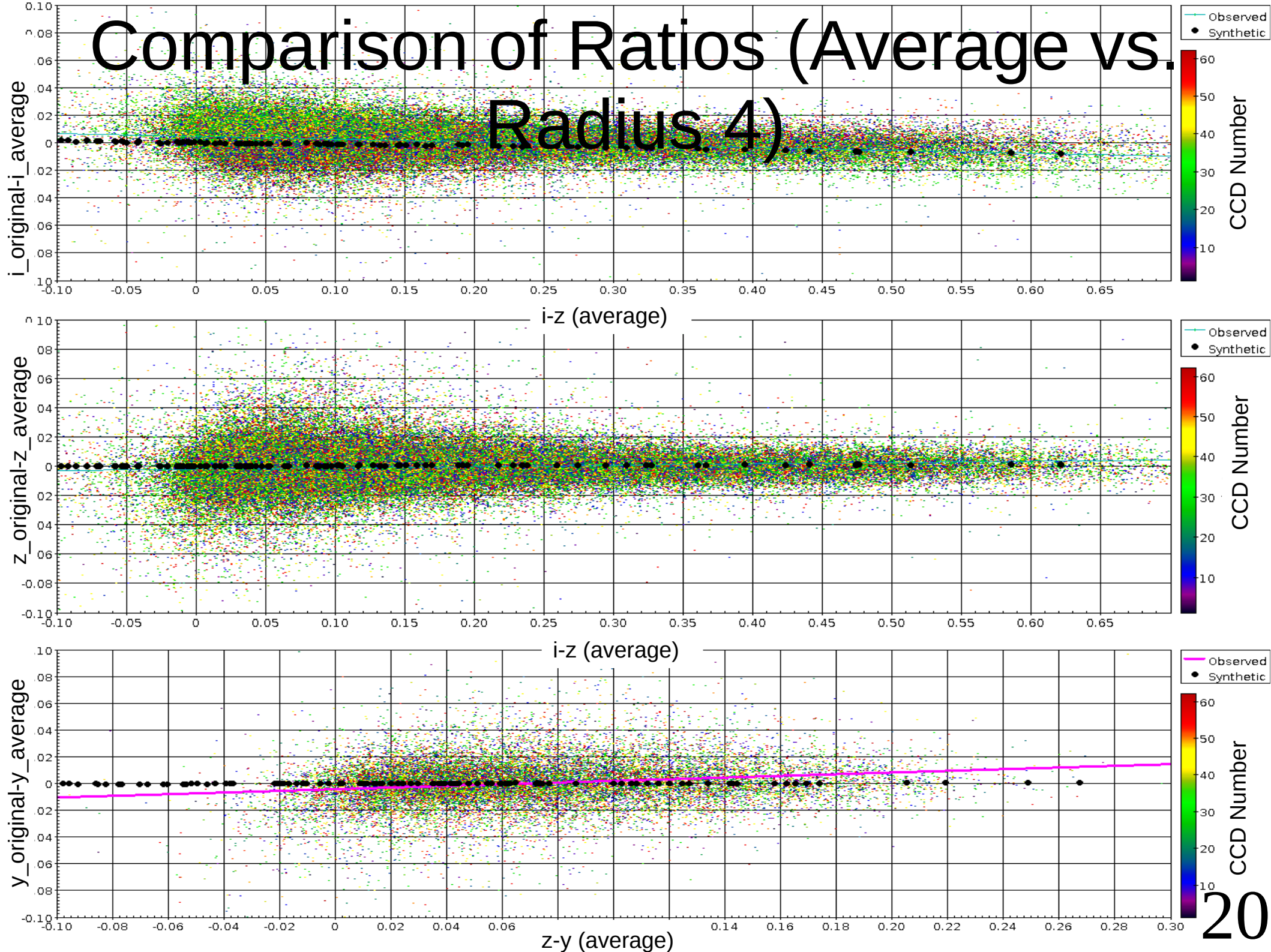


Comparison of (Average vs Radius 4)

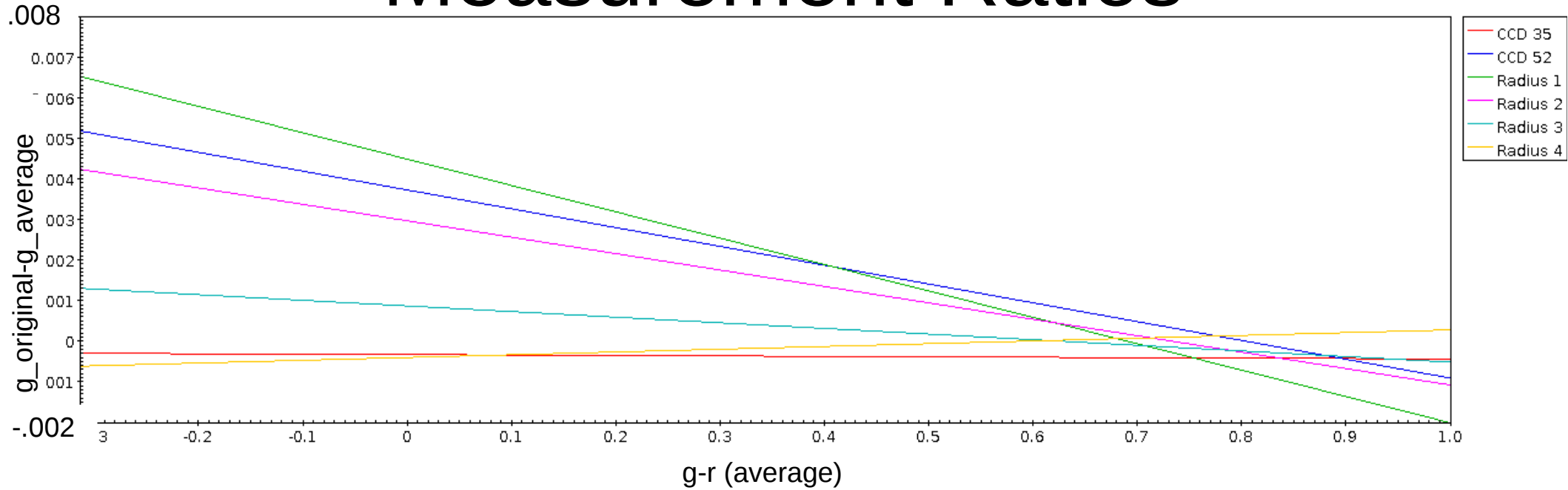


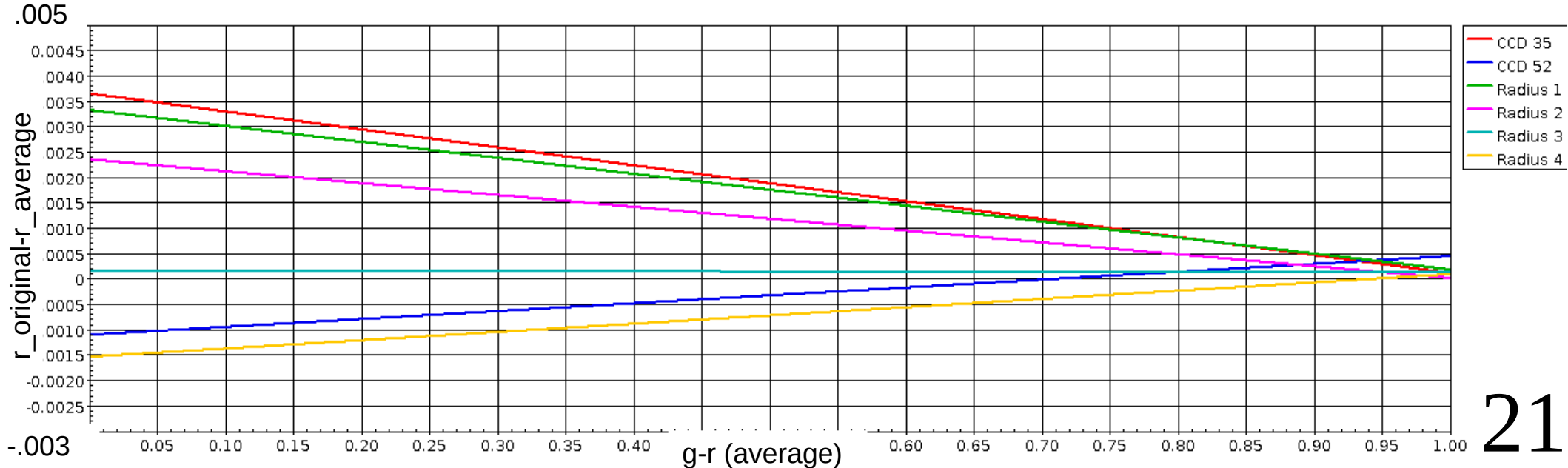


Comparison of Ratios (Average vs. Radius 4)

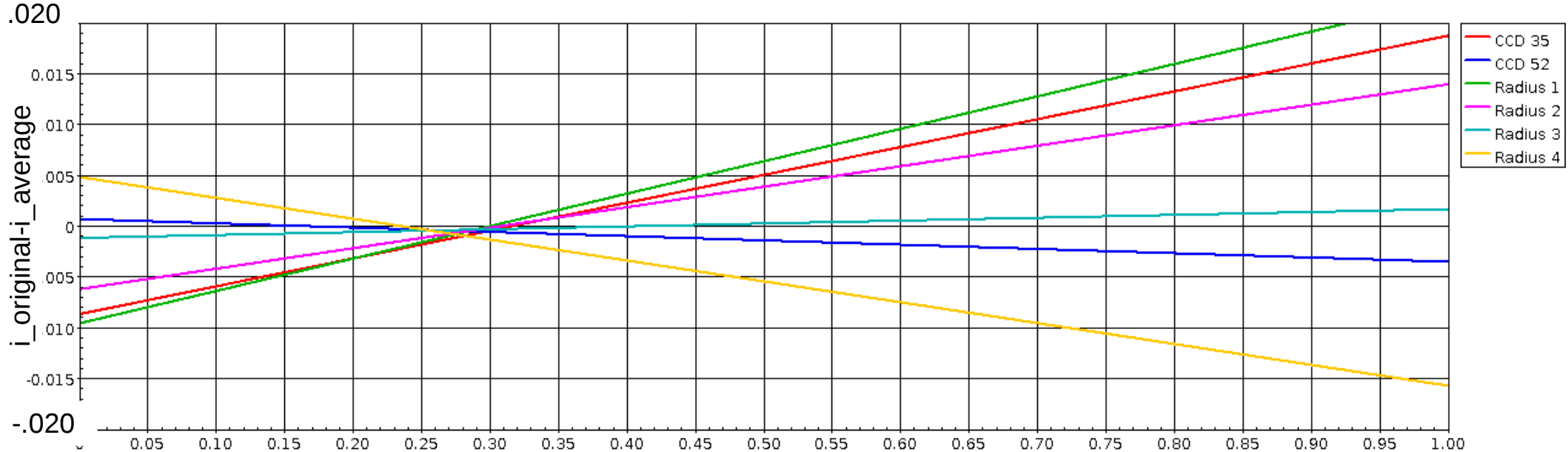


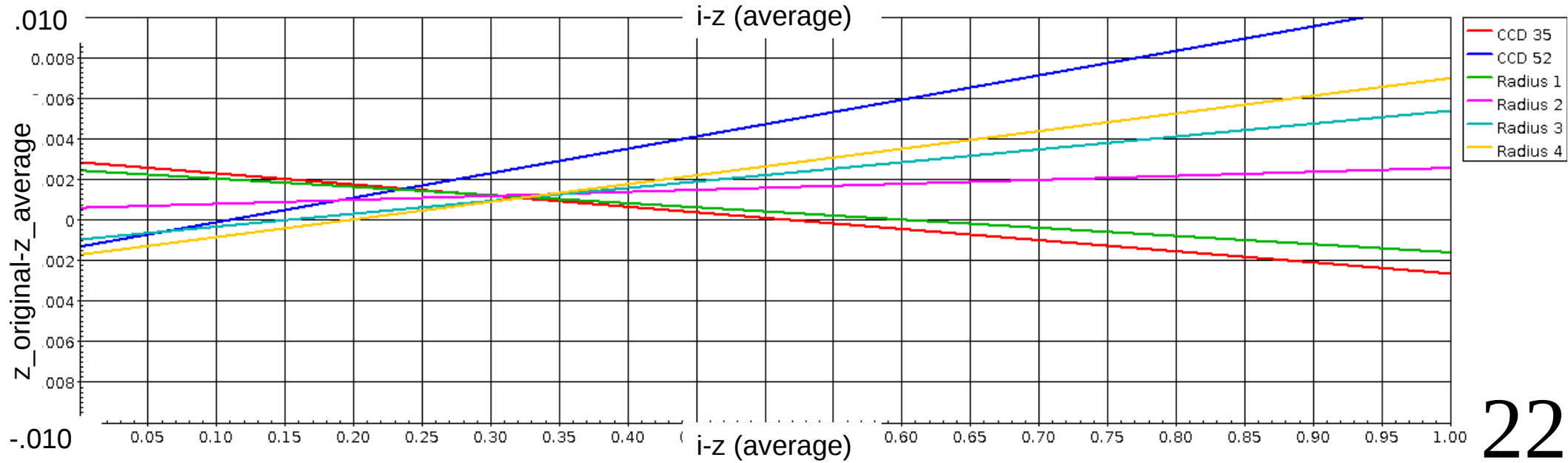
Trend-lines for Inconsistency Measurement Ratios





Trend-lines for Inconsistency Measurement Ratios



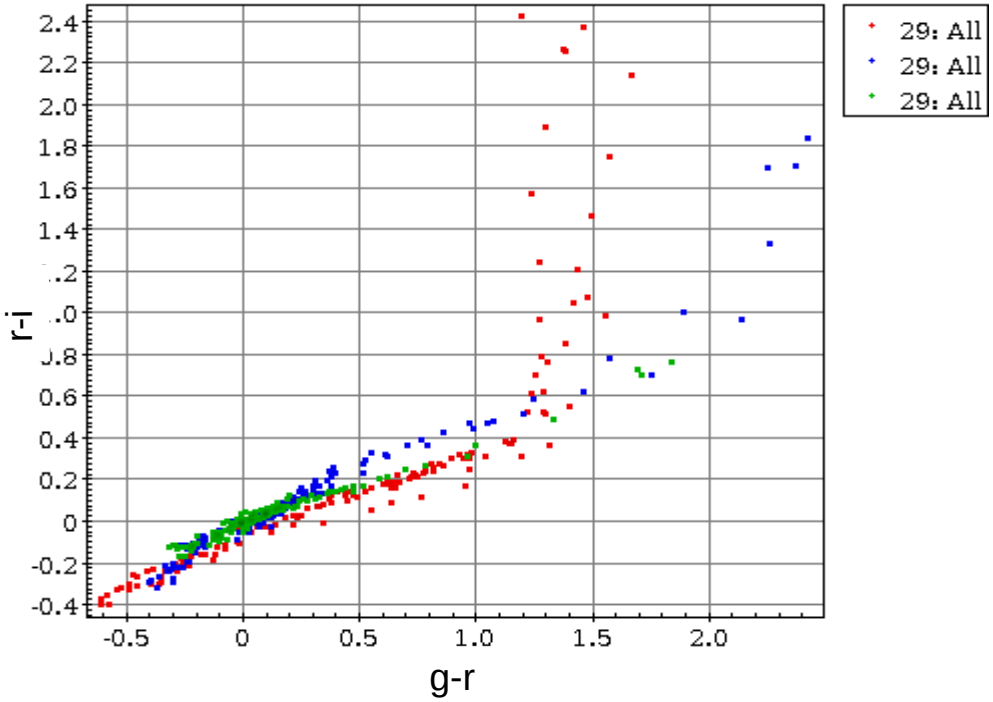


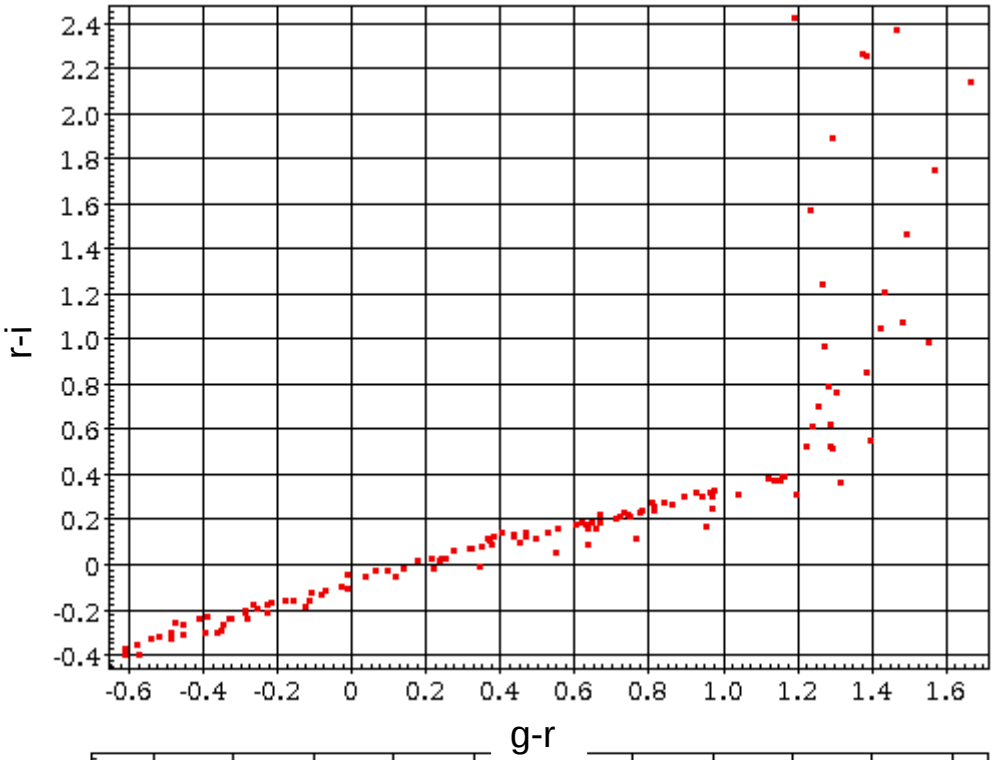
Conclusion

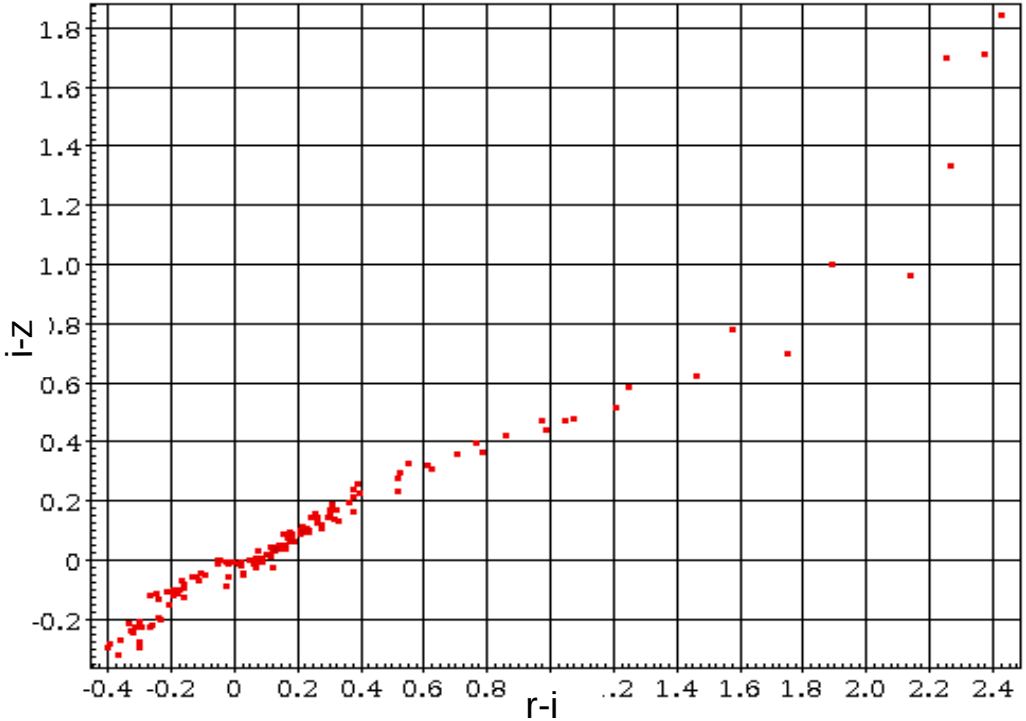
- No significant error in the DECam over the focal plane
- Only slight trends in the i band across the focal plane
- Very minor but could expose a potential problem
- Ongoing investigation into the error of the i band
- But are there inconsistencies across the DECam focal plane over time?

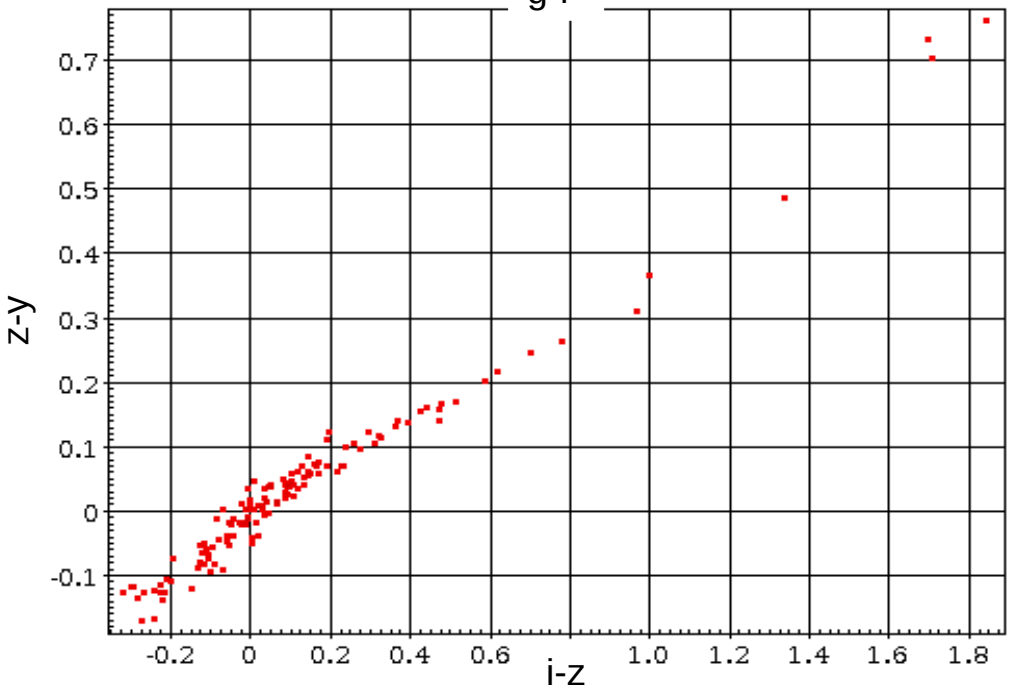
Additional Slides and Graphs

Initial Synthetic Ratios Filter Set 2014

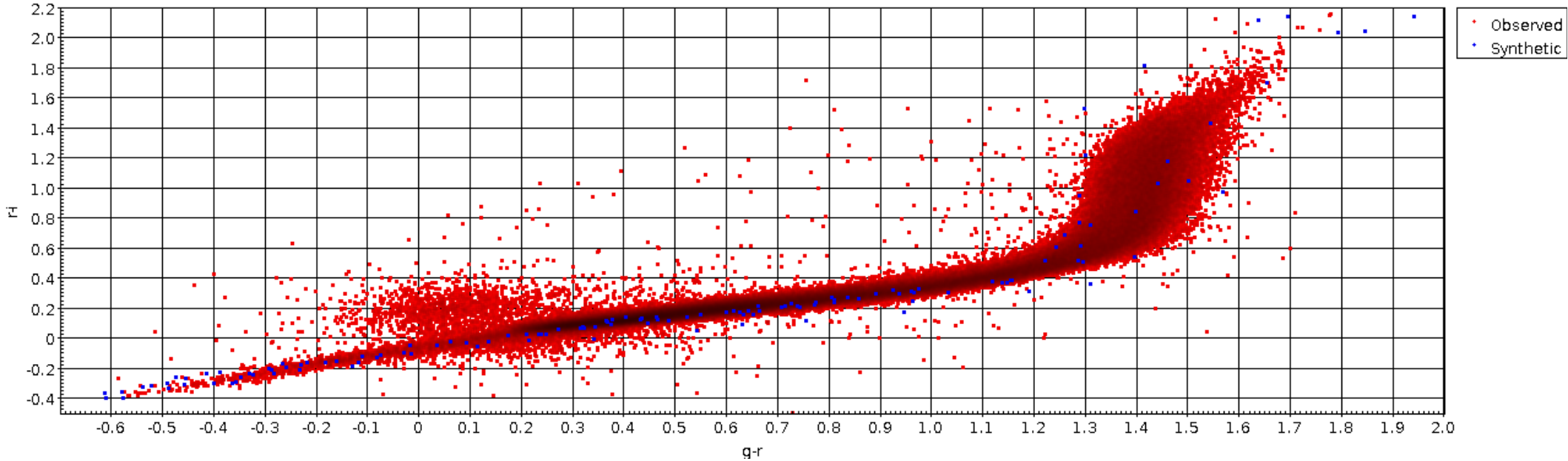


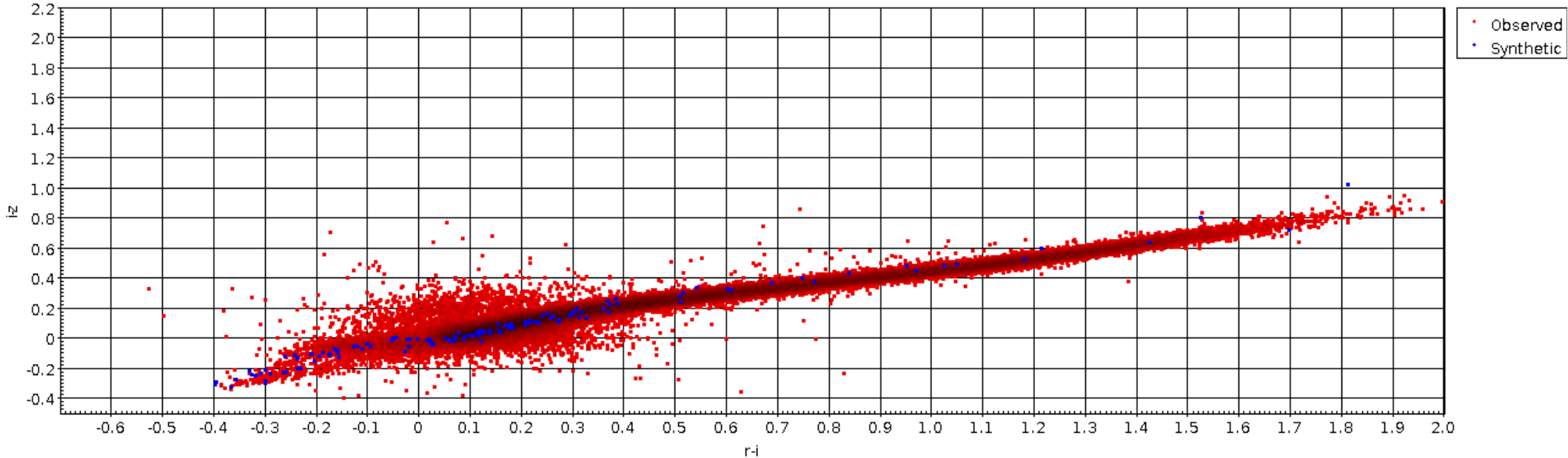




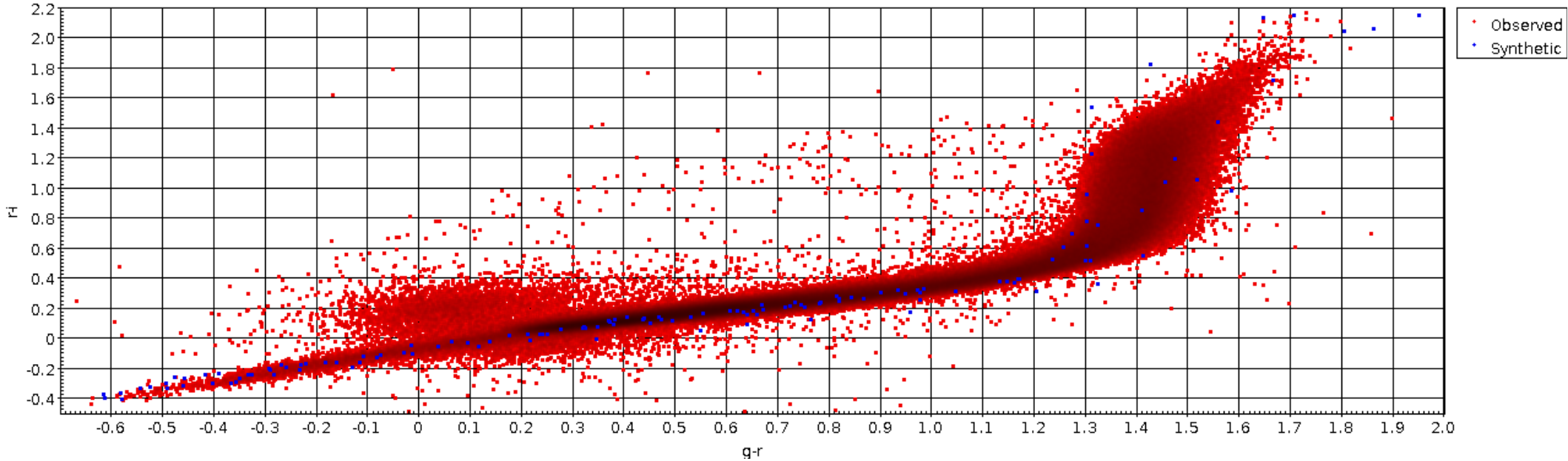


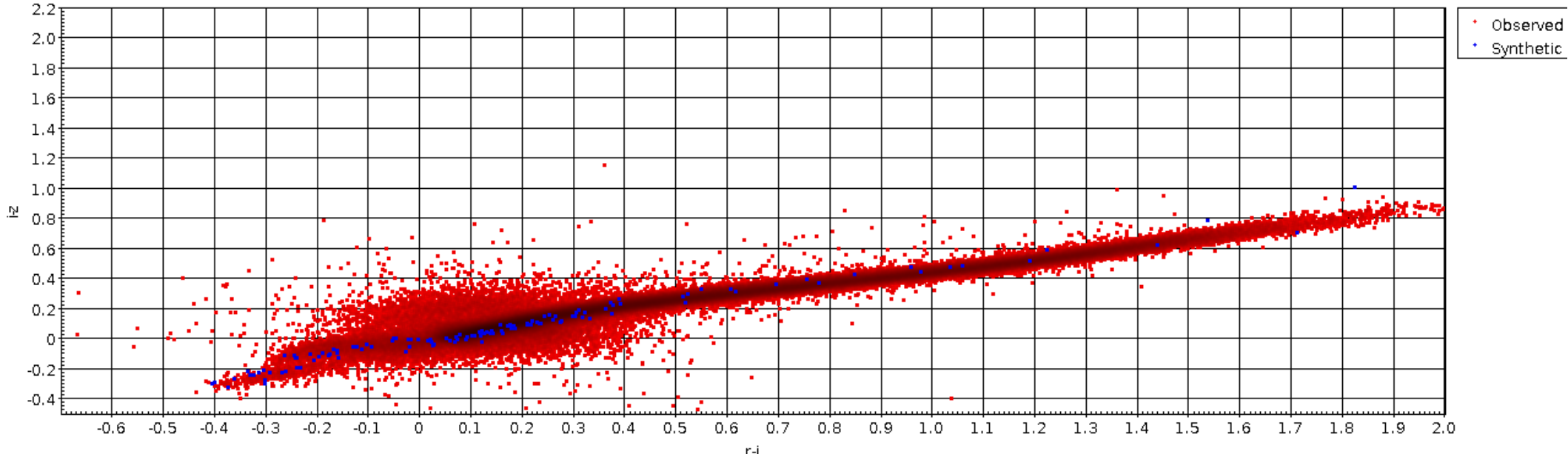
Star Data vs. Synthetic Data (Radius 2)



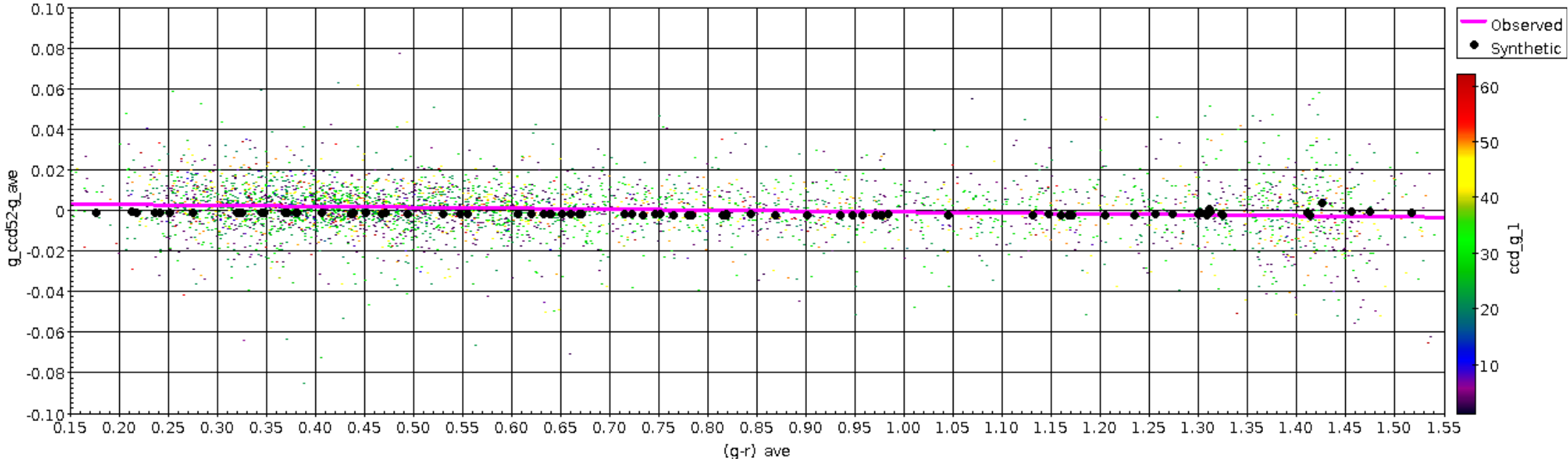


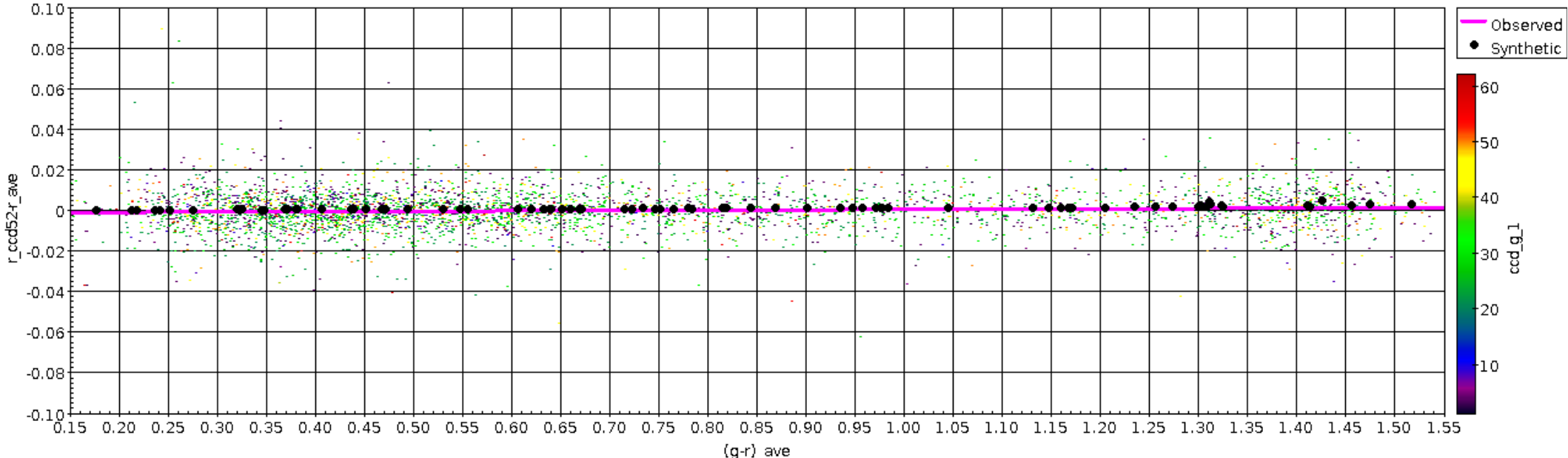
Star Data vs. Synthetic Data (Radius 3)

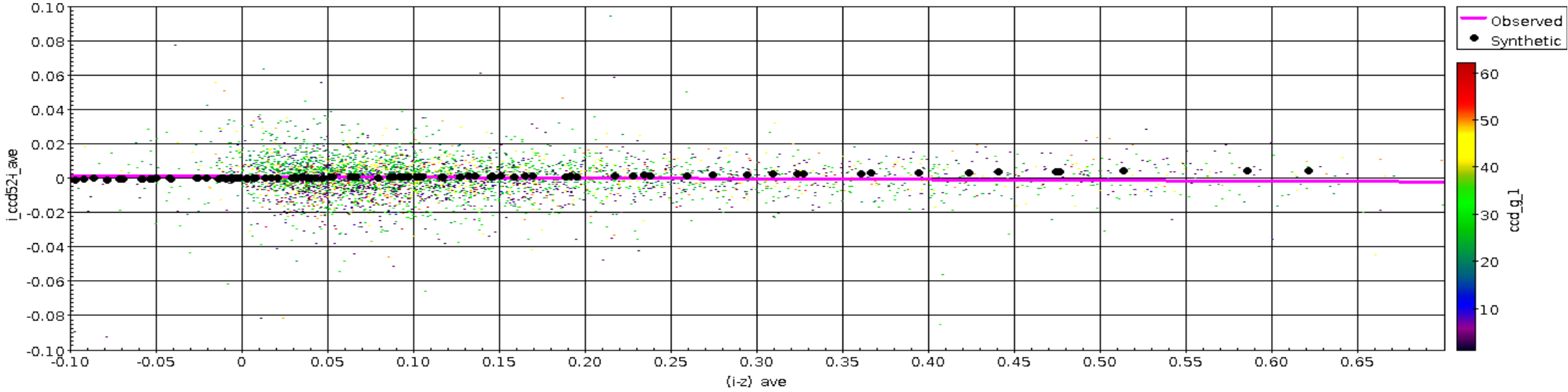


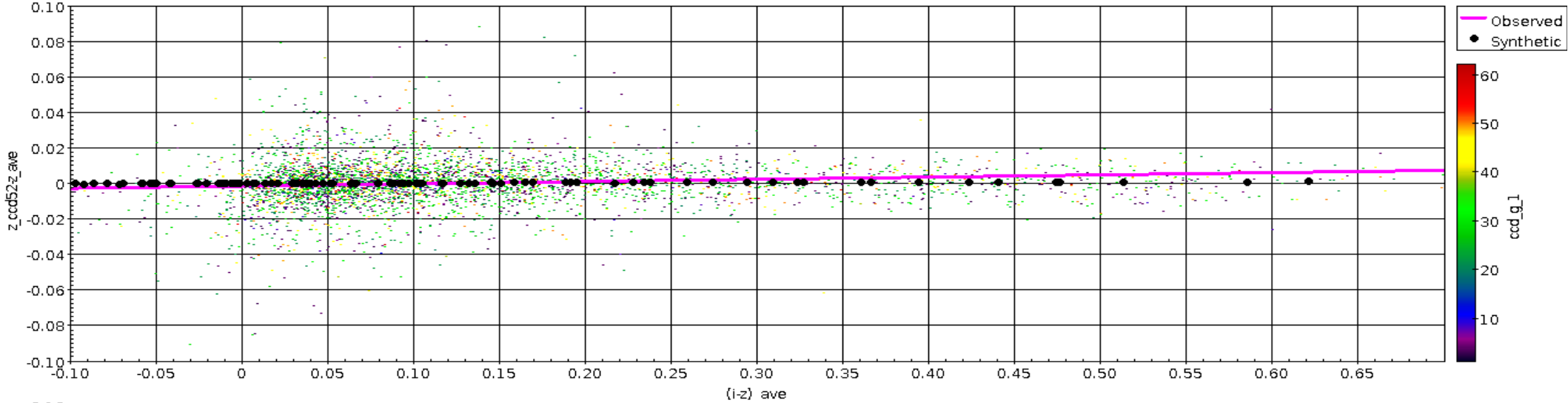


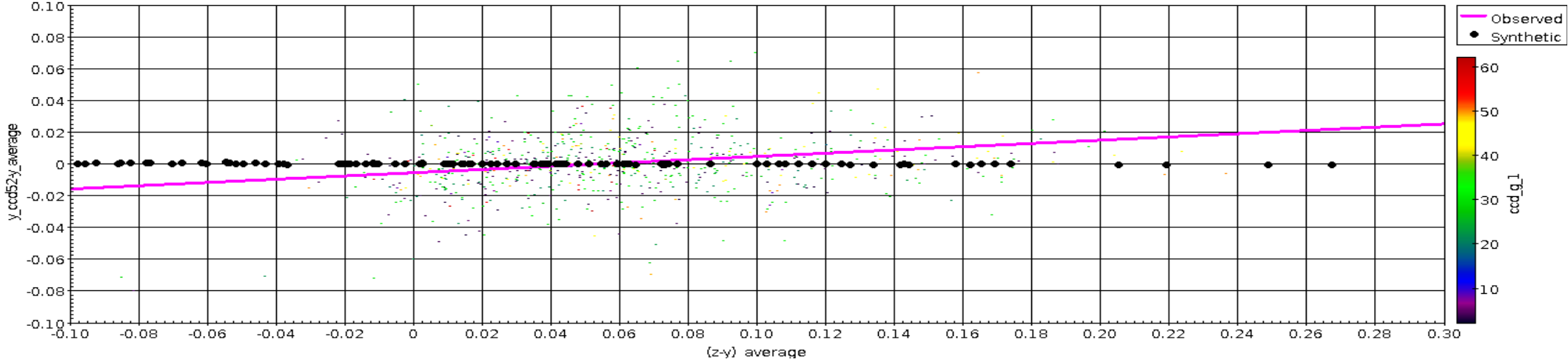
Inconsistency Measurement Ratios (Average vs CCD 52)



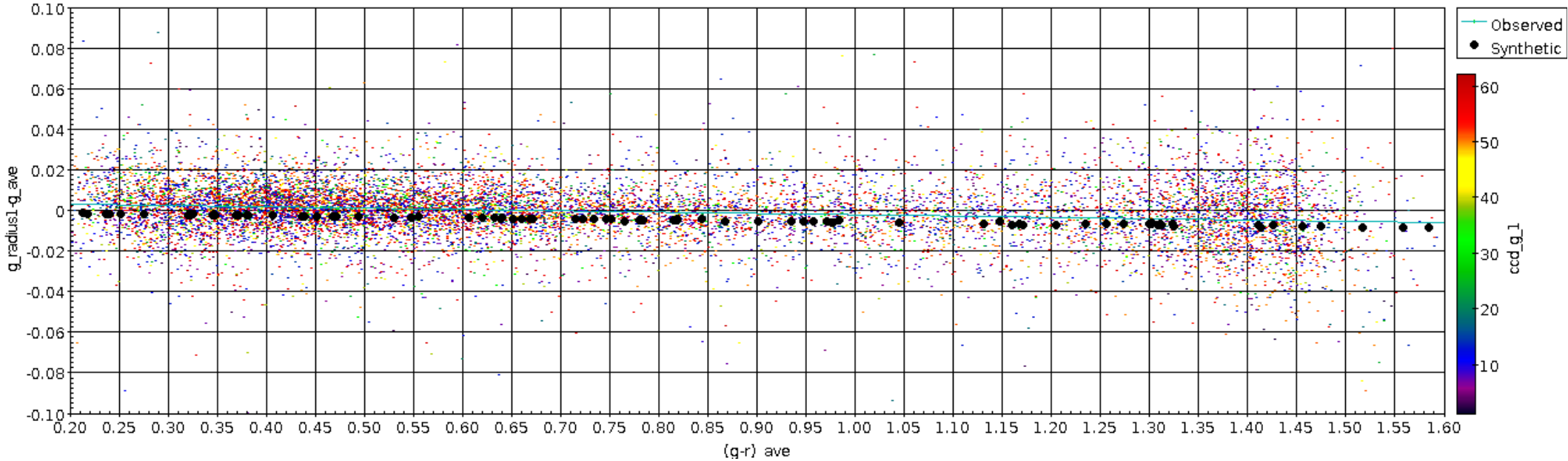


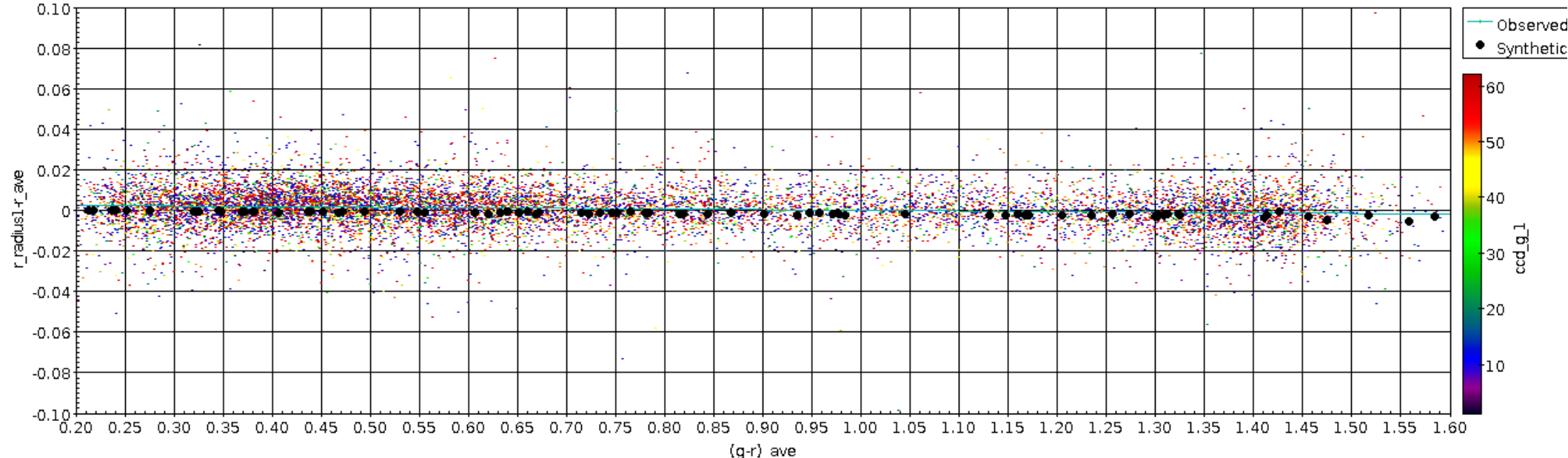

Observed
Synthetic
i_ccd52-i_ave
(i-z) ave
ccd_g_1

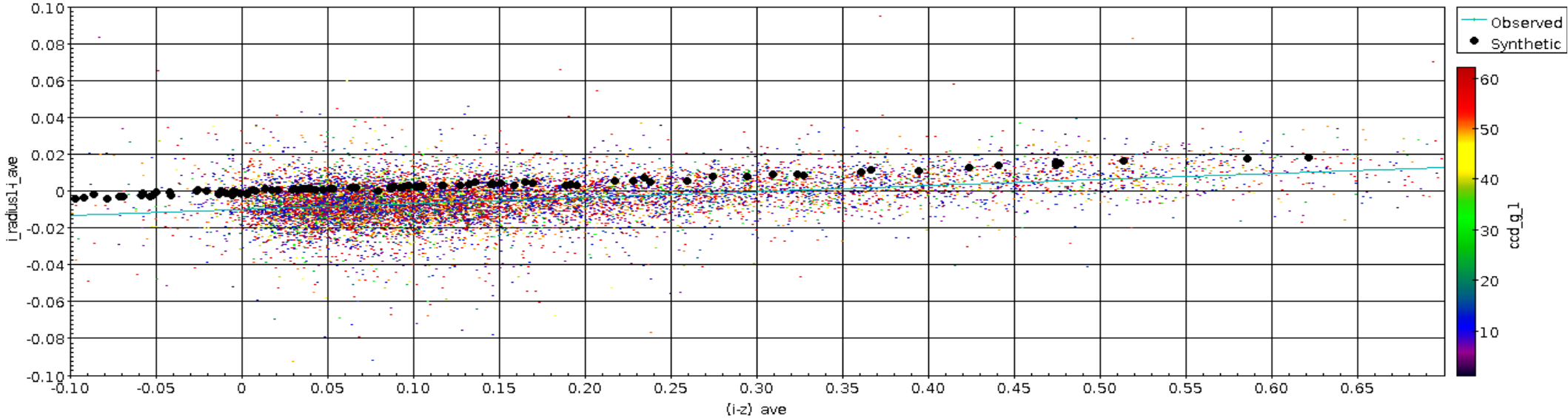

Observed
Synthetic
z_ccd52-z_ave
(i-z) ave
ccd_g_1

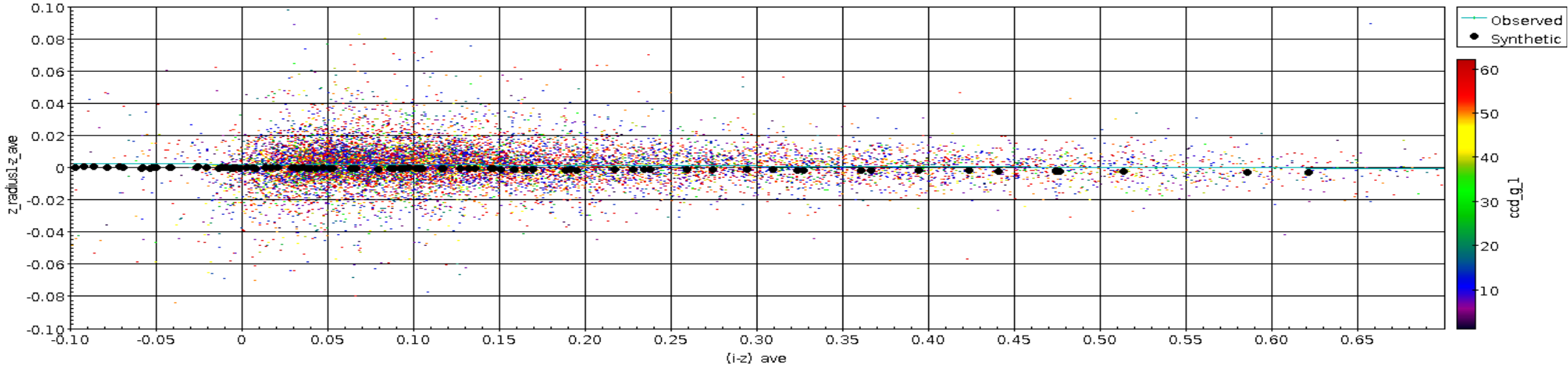

Observed
Synthetic
y_ccd52-y_average
(z-y) average
ccd_g_1

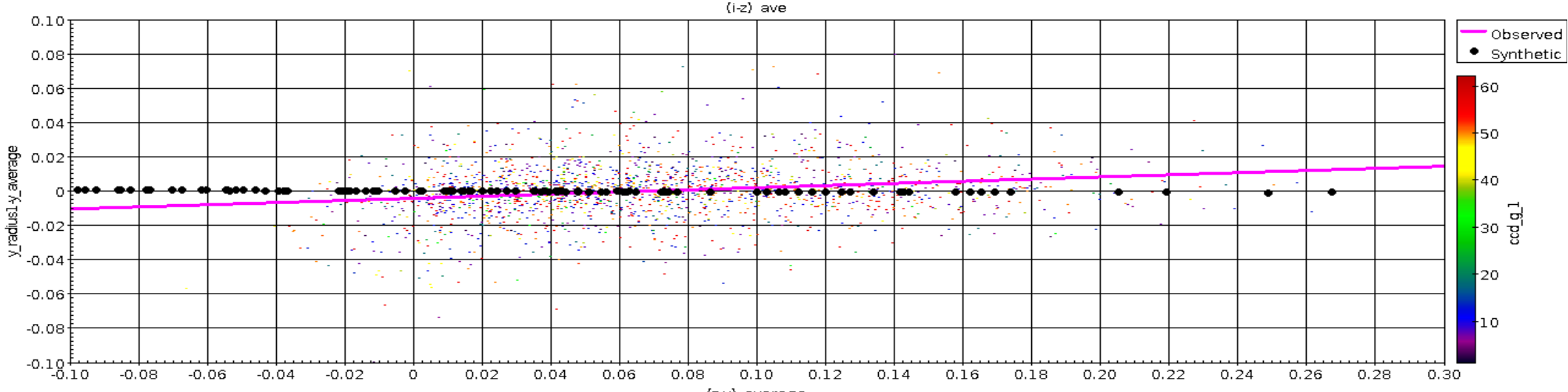
Inconsistency Measurement Ratios (Average vs Radius 1)



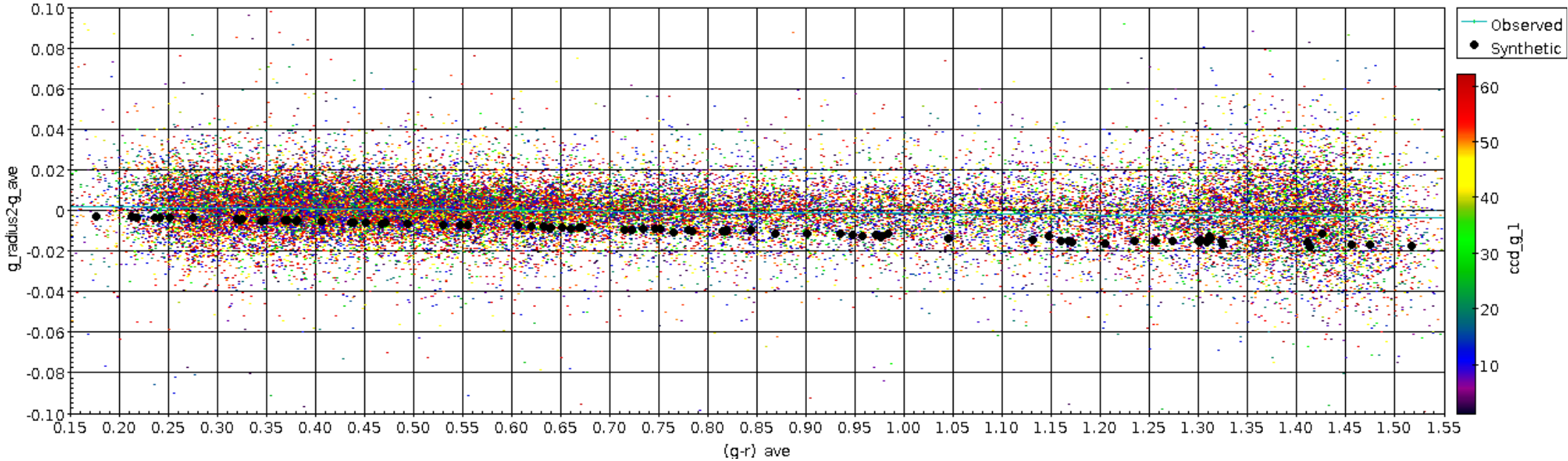


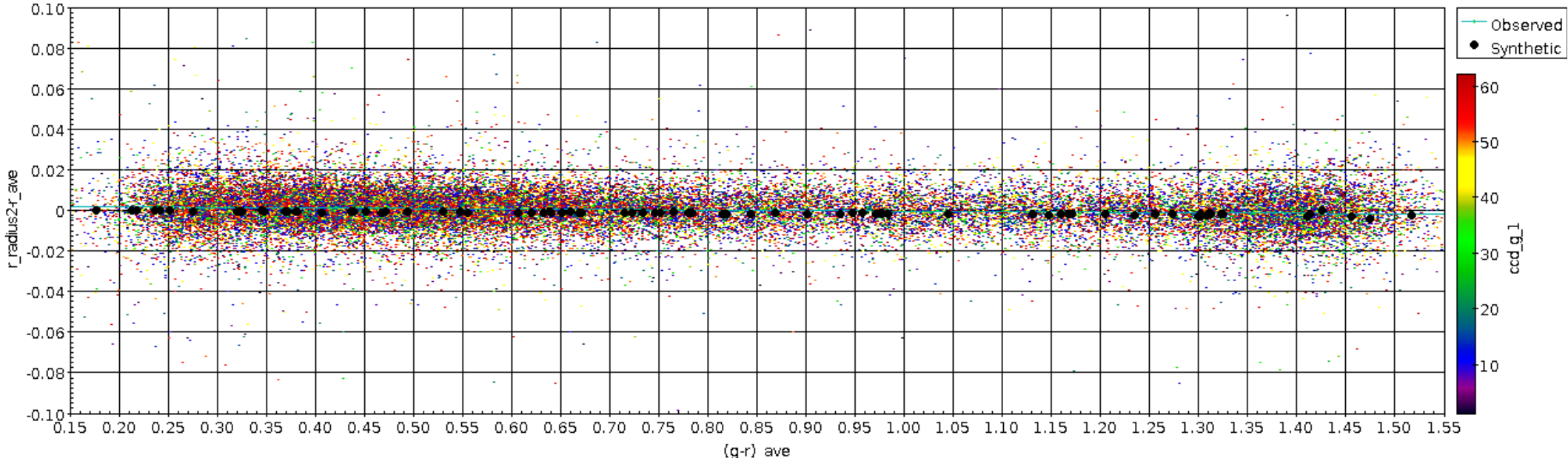

Observed
Synthetic
i_radius1-i_ave
(i-z) ave
ccd_g_1

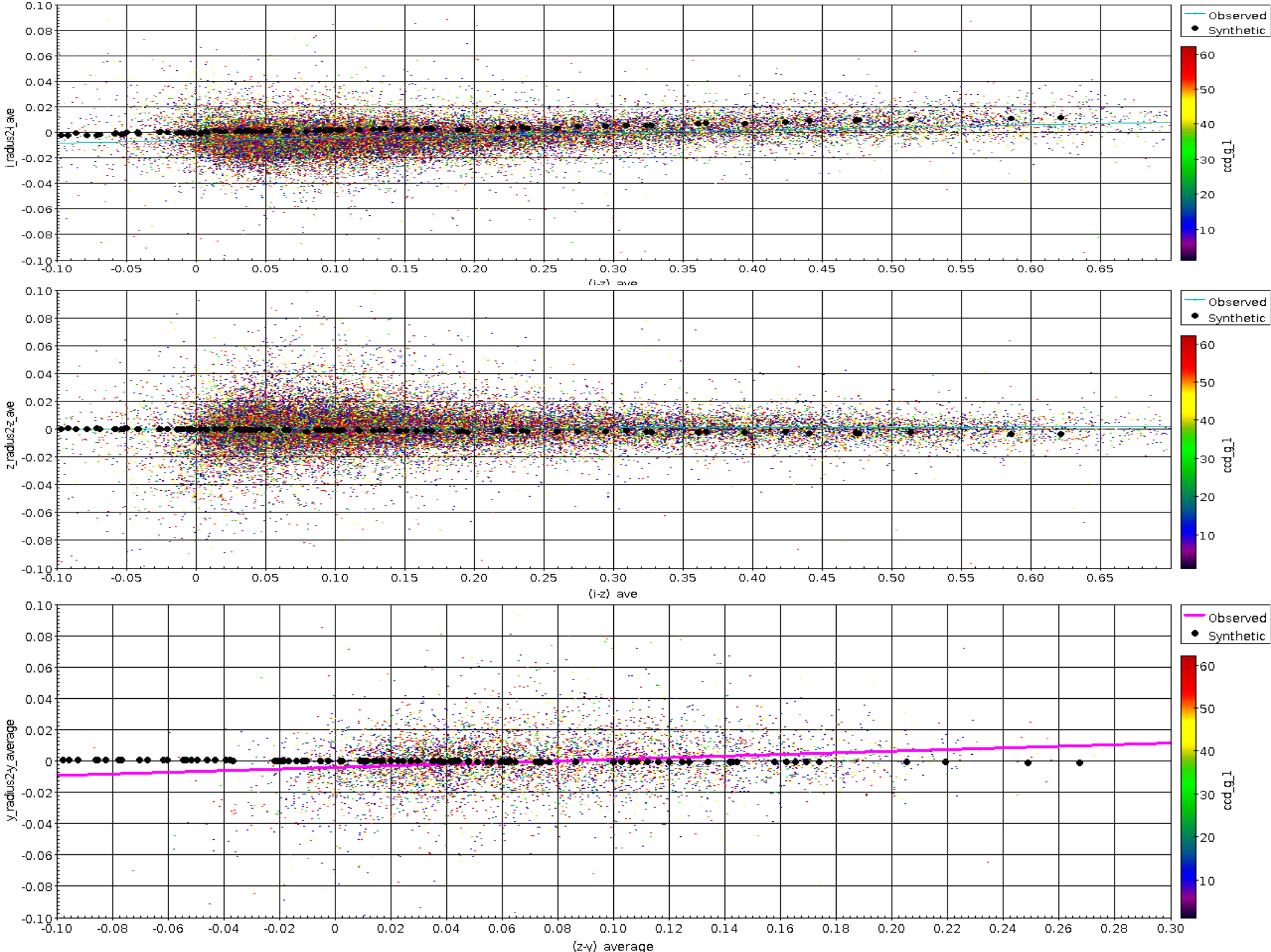

Observed
Synthetic
z_radius1-z_ave
(i-z) ave
ccd_g_1


Observed
Synthetic
y_radius1-y_average
ccd_g_1

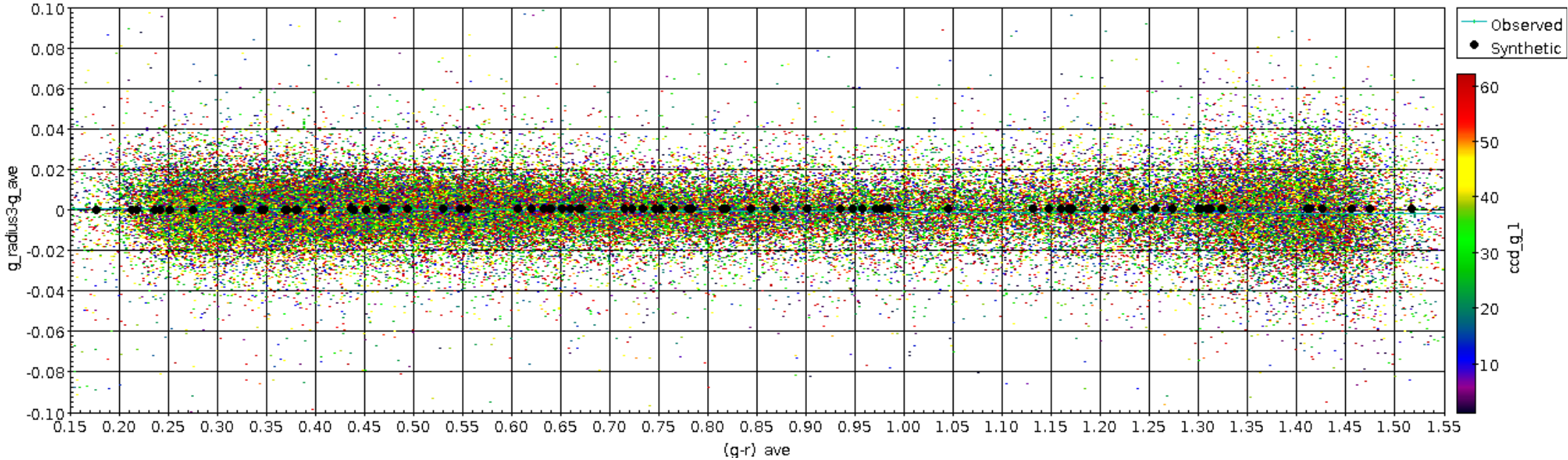
Inconsistency Measurement Ratios (Average vs Radius 2)

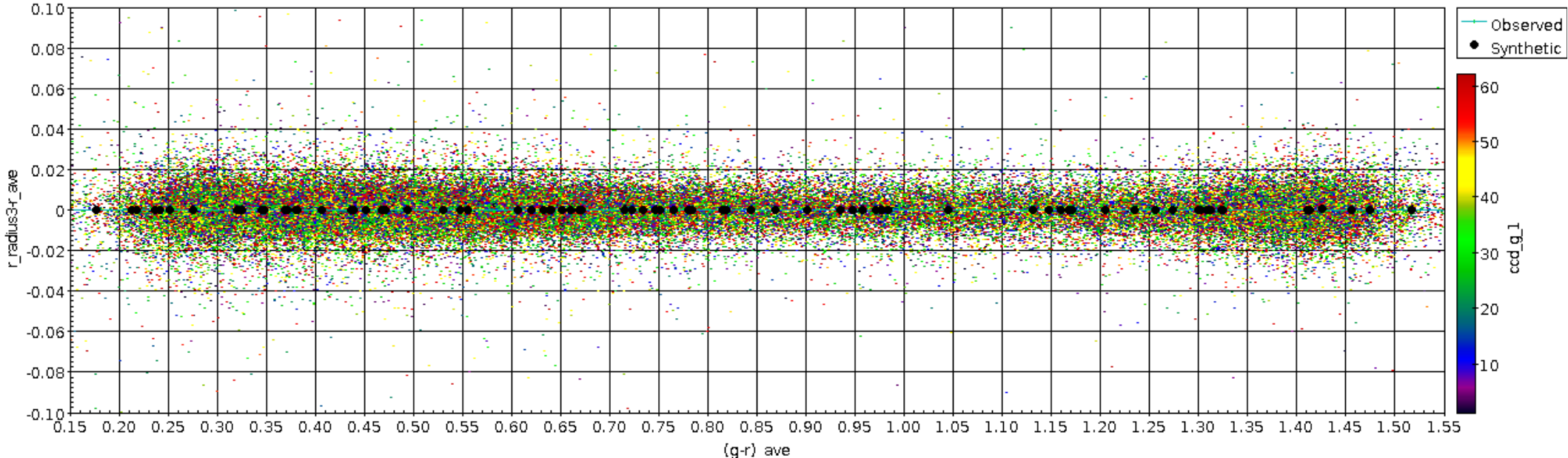


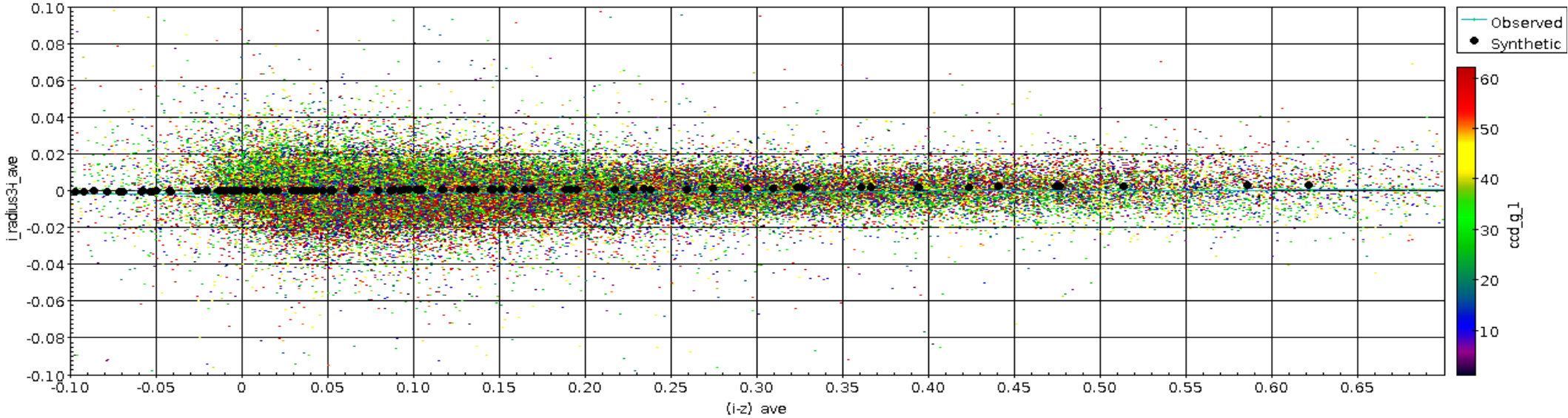


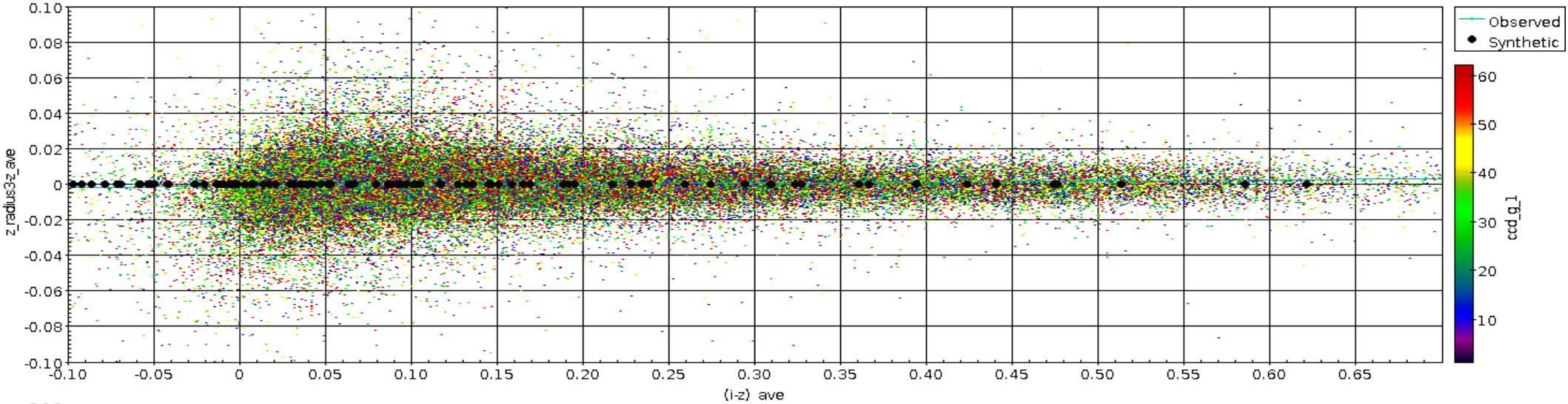

Observed
Synthetic
i_radius2i_ave
(i-z) ave
ccd_g_1
z_radius2z_ave
(i-z) ave
y_radius2y_average
(z-y) average

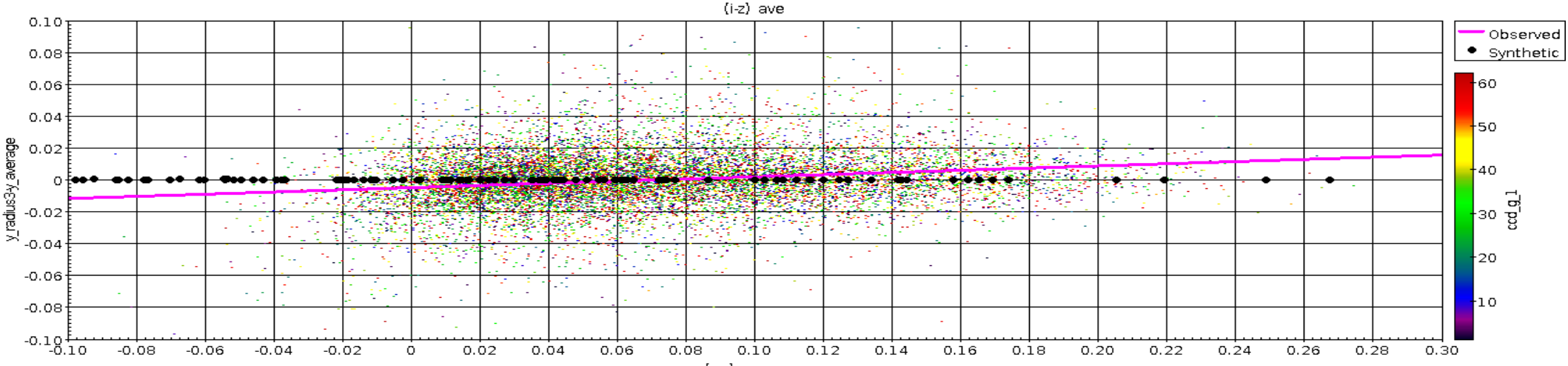
Inconsistency Measurement Ratios (Average vs Radius 3)



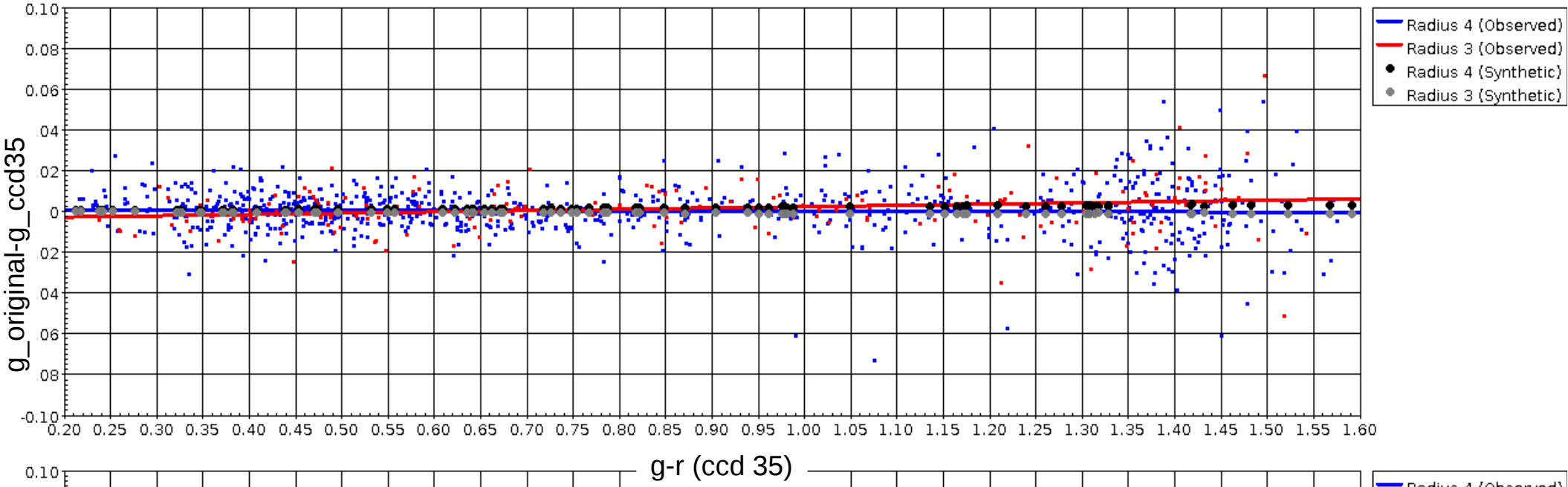


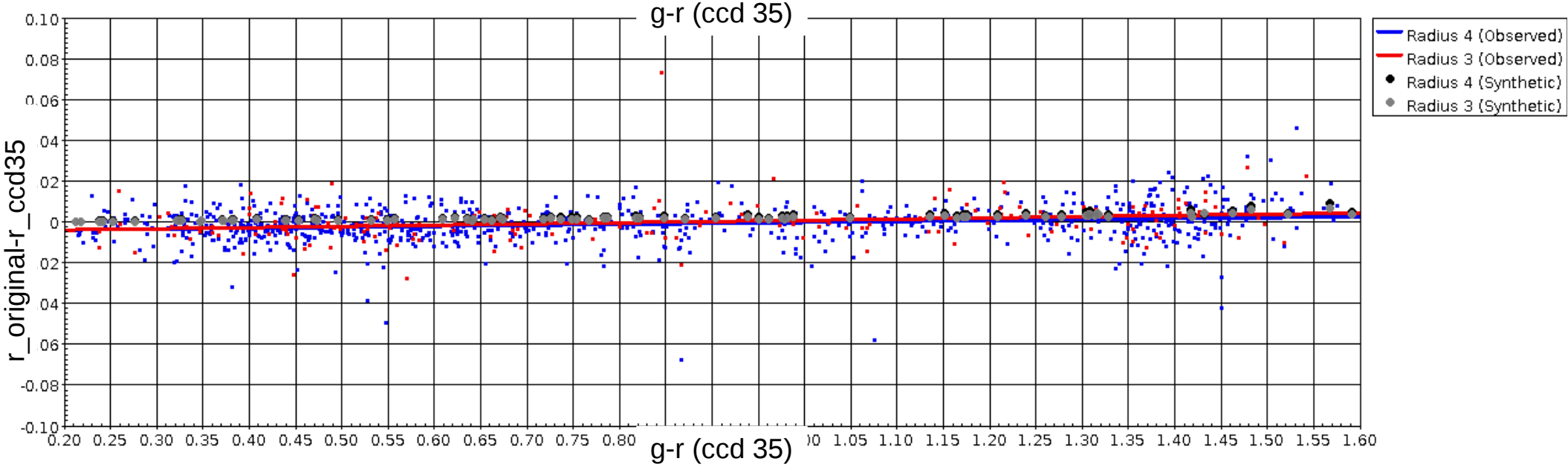

Observed
Synthetic
i_radius3i_ave
(i-z) ave
ccd_g_1

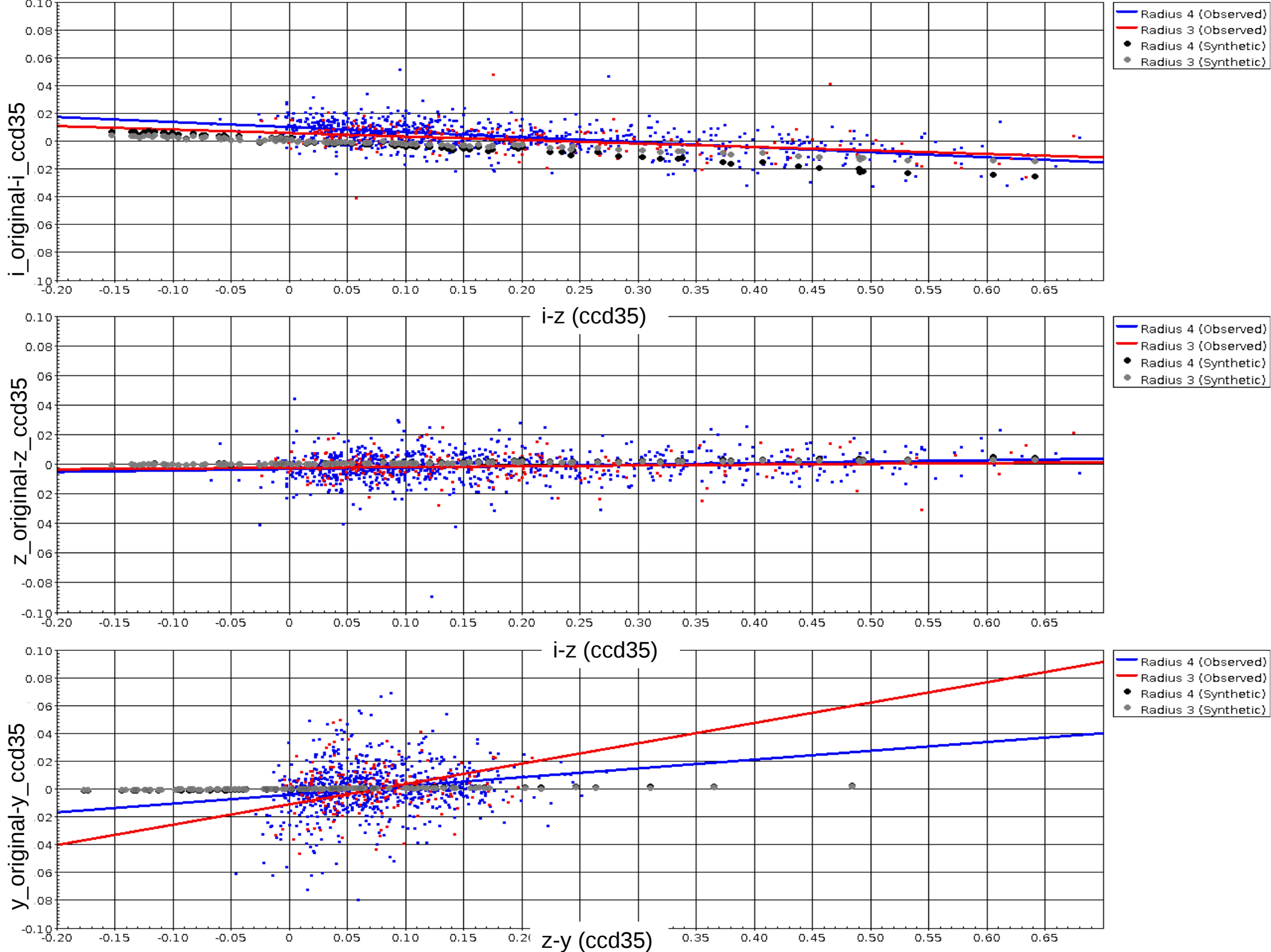

Observed
Synthetic
z_radius3z_ave
(i-z) ave
ccd_g_1


Observed
Synthetic
y_radius3y_average
ccd_g_1

Comparison to CCD 35






i_original-i_ccd35
i-z (ccd35)
z_original-z_ccd35
i-z (ccd35)
y_original-y_ccd35
z-y (ccd35)
Radius 4 (Observed)
Radius 3 (Observed)
Radius 4 (Synthetic)
Radius 3 (Synthetic)