



DARK ENERGY
SURVEY

DES Point-Source Saturation Limits and PreCam Exposure Times

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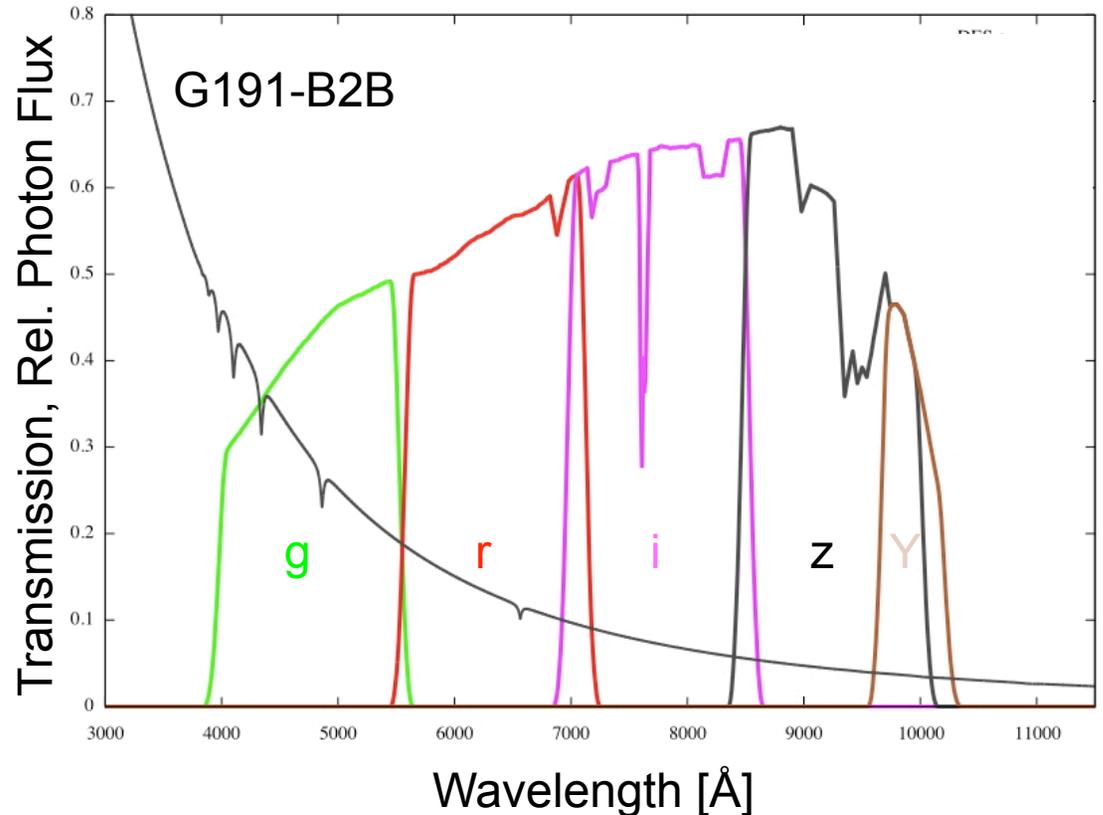
DES Calibrations Telecon
13 May 2009



Basic Exposure Time Calculator

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- Take the current best estimate of the total filter responses for the DES filters (from Huan Lin).
- Take a spectrophotometric standard from the HST CalSpec database (e.g., G191-B2B).
- For each filter, calculate the total detected photon counts per second for a $m_{AB}=20$ object.
- For aperture photometry, assume point sources have a Gaussian profile, and use an aperture of radius = $1.0 \times \text{FWHM}$ for S/N calculations.

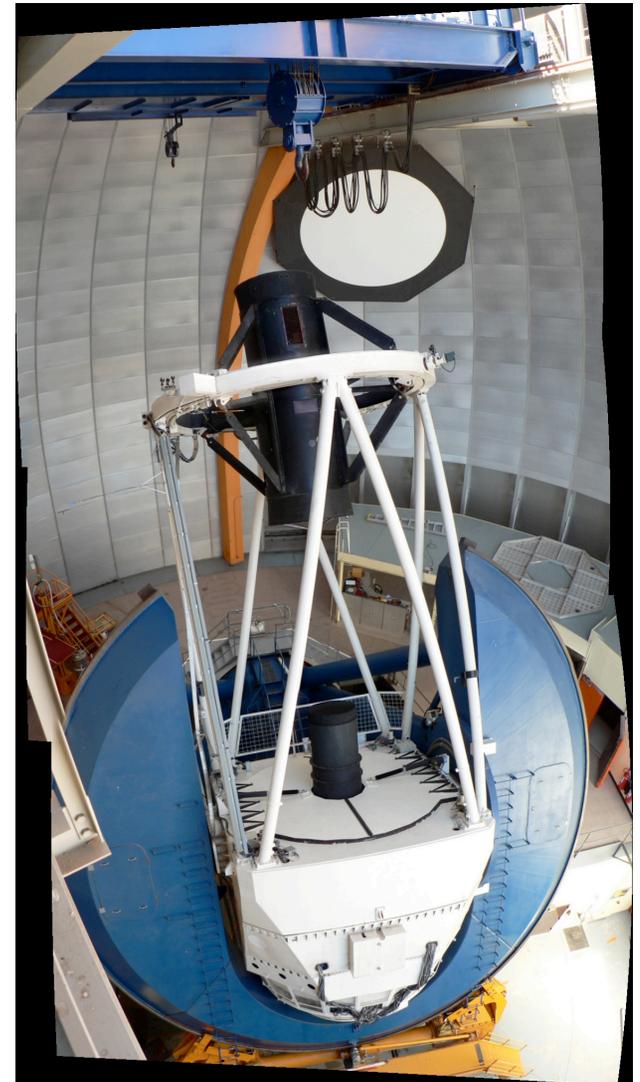




Assumptions for DES Science Exposures

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- 100 sec exposure times
- 10.62 m² effective area of primary mirror
 - 4.0m mirror with 15% obscuration
- 0.9 arcsec seeing (FWHM)
- 0.27 arcsec pixels
- Full well of 130,000 electrons (lower limit from TDR)
- Sky background of
 - g=21.7 mag/arcsec²
 - r=20.7 mag/arcsec²
 - i=20.1 mag/arcsec²
 - z=18.7 mag/arcsec²
 - Y=18.0 mag/arcsec²





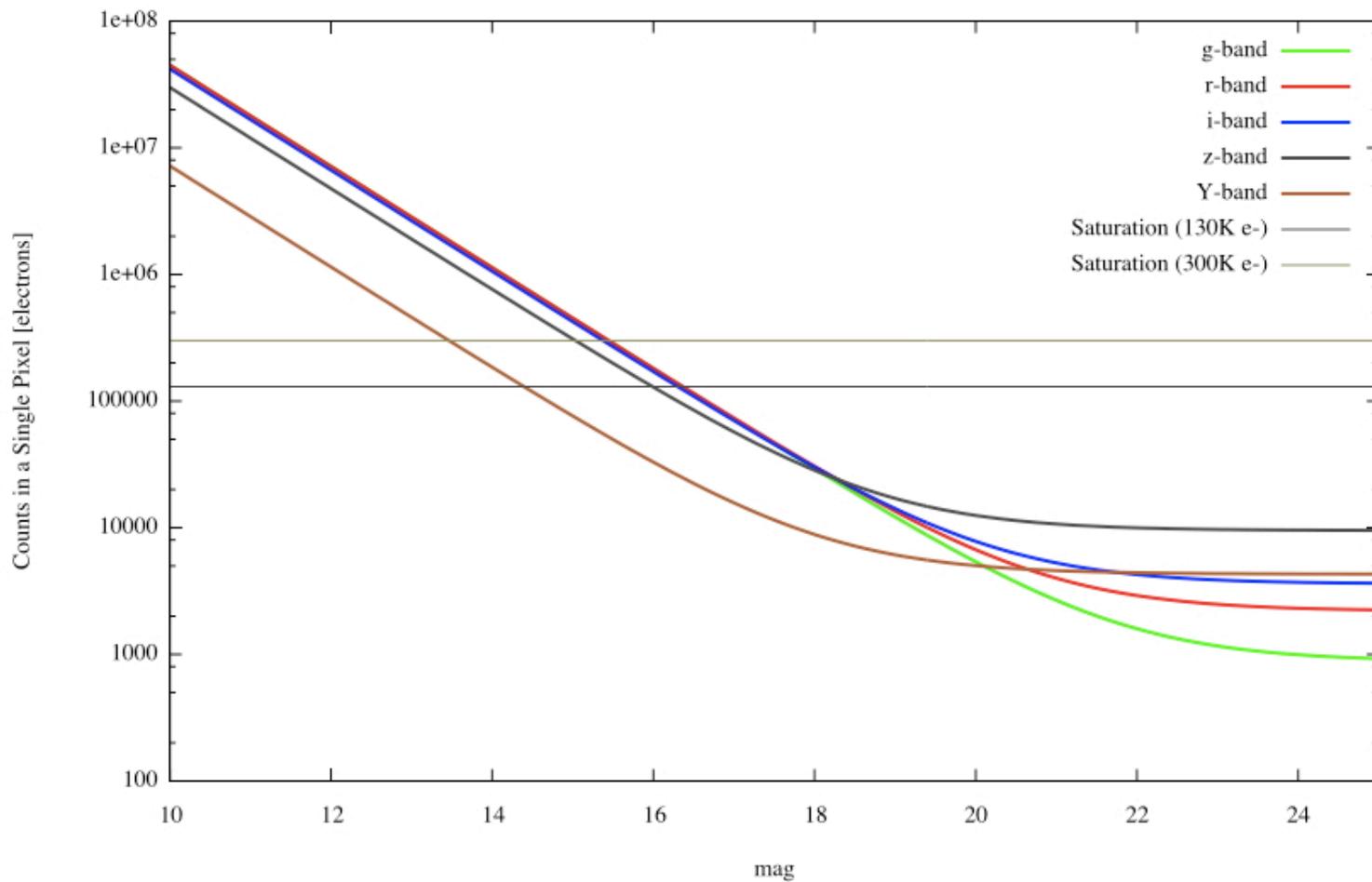
DES Nominal 100-sec Science Exposure Point-Source Saturation Limits

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Figure 0

Total Counts for a Point Source (+Sky) in a Single Pixel for a Nominal 100-sec DES Science Exposure
(Assumes 0.9-arcsec FWHM seeing and Gaussian PSF)





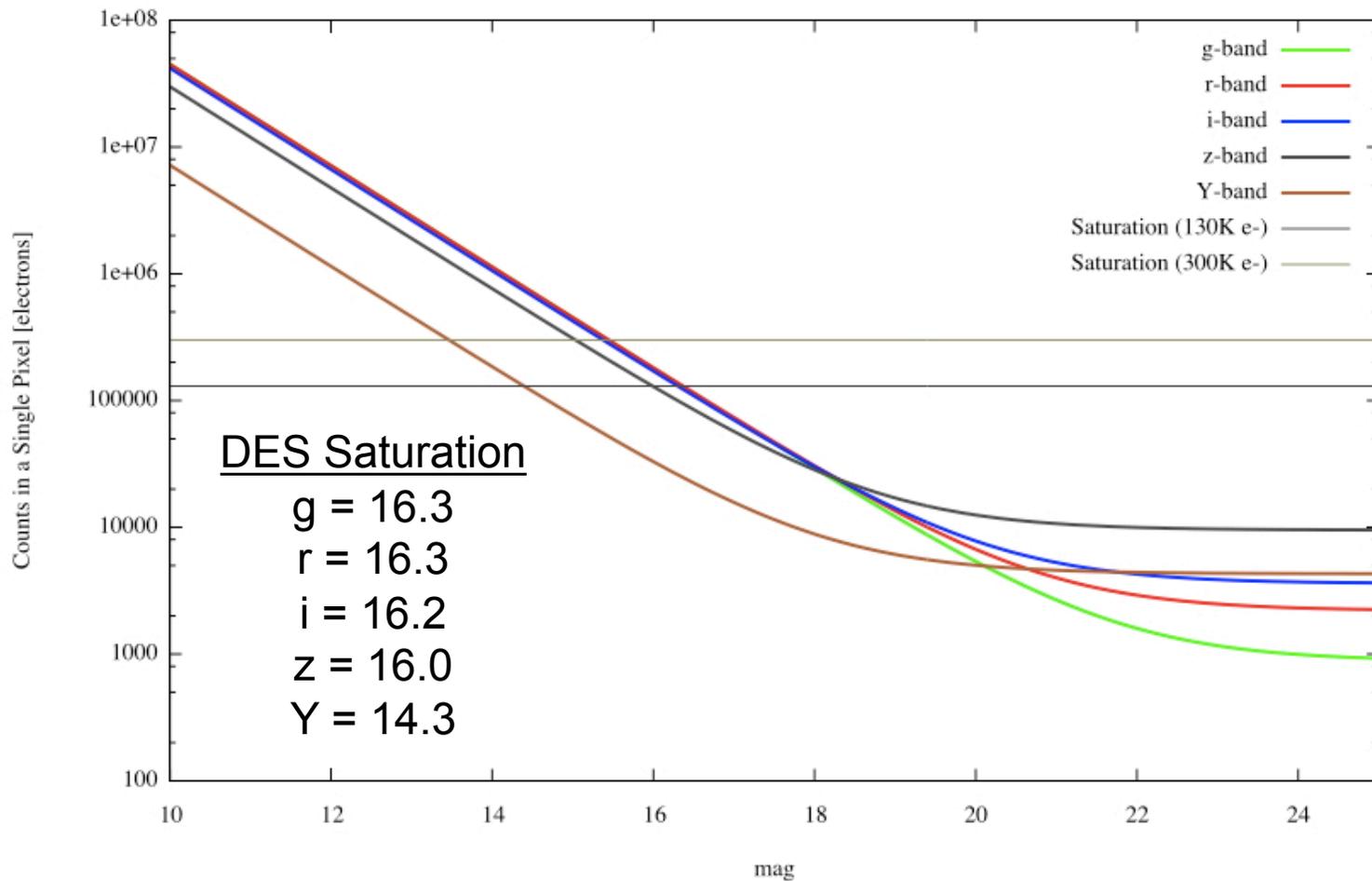
DES Nominal 100-sec Science Exposure Point-Source Saturation Limits

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Figure 0

Total Counts for a Point Source (+Sky) in a Single Pixel for a Nominal 100-sec DES Science Exposure
(Assumes 0.9-arcsec FWHM seeing and Gaussian PSF)

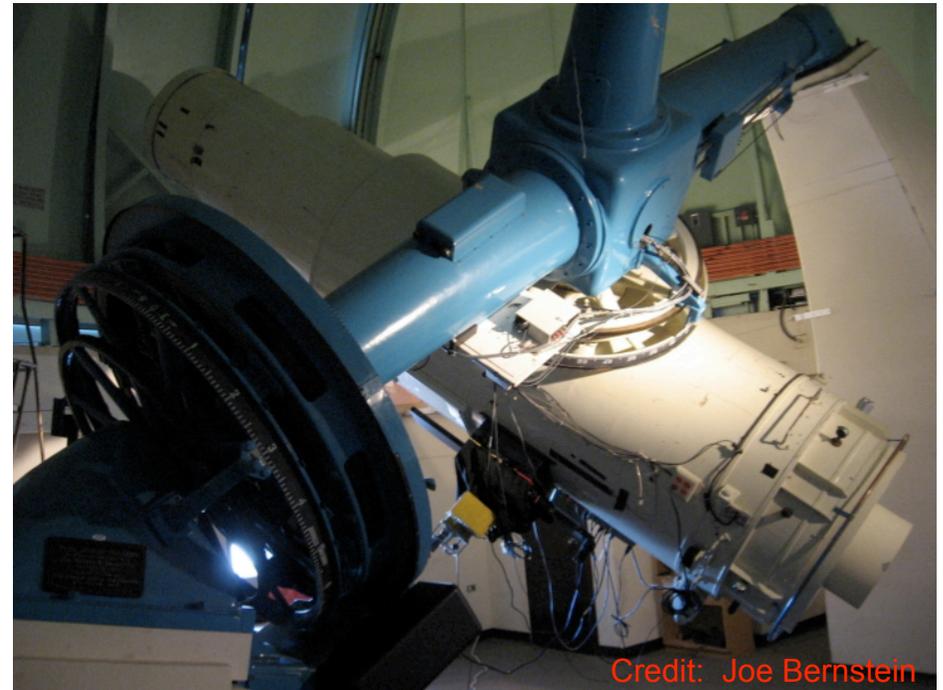




Assumptions for PreCam Exposures

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- University of Michigan Curtis-Schmidt
- 0.24 m² effective area for light collection
 - 0.6m aperture with 15% obscuration
- 2.0 arcsec seeing (FWHM)
- 1.43 arcsec pixels
- Full well of 130,000 electrons
- Sky background of
 - g=21.7 mag/arcsec²
 - r=20.7 mag/arcsec²
 - i=20.1 mag/arcsec²
 - z=18.7 mag/arcsec²
 - Y=18.0 mag/arcsec²



- Optimize the exposure times so that a star that is 1.5 mag fainter than the nominal DES saturation limit will have a $S/N \geq 50$.

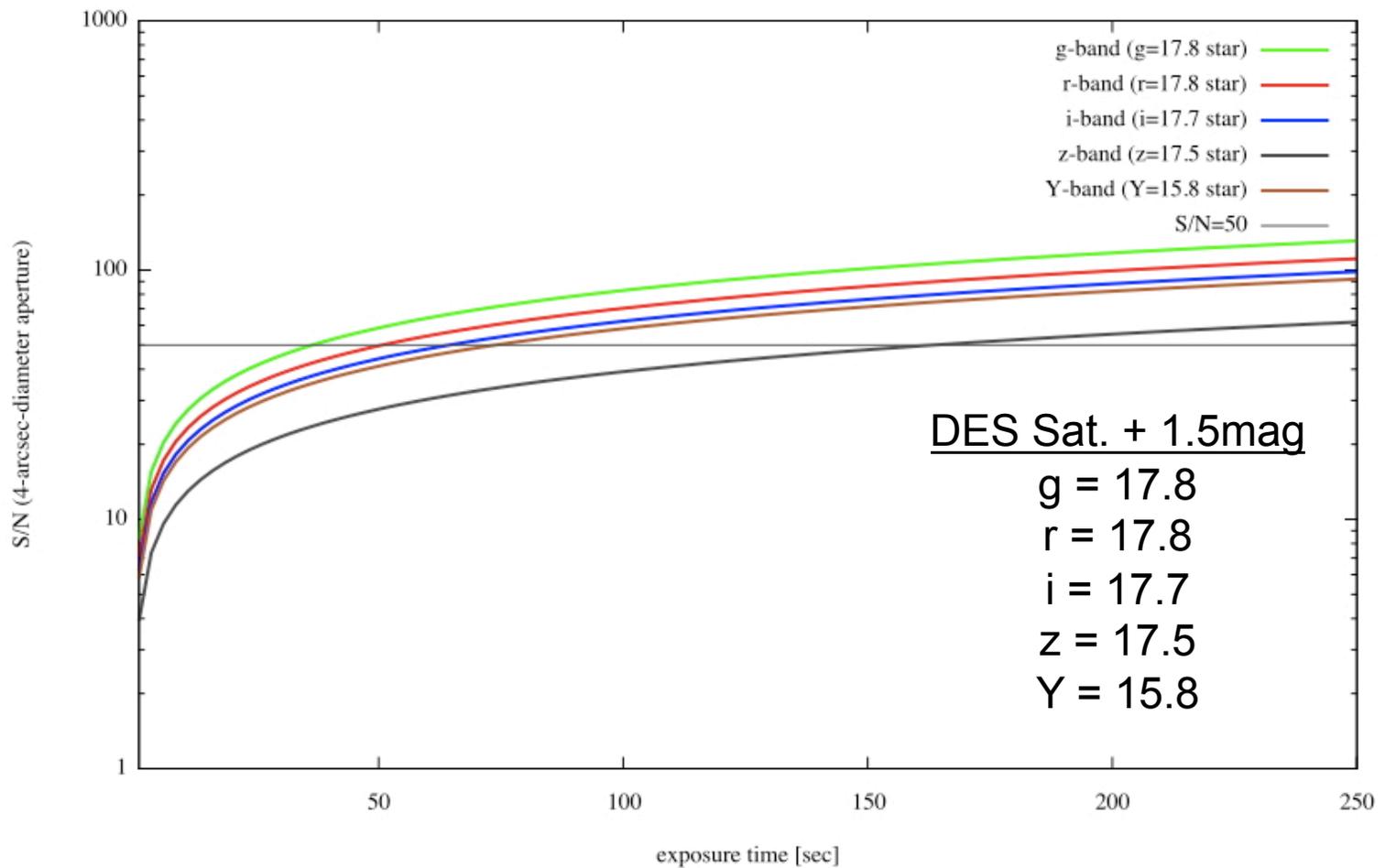


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PreCam Exposure Times to Reach DES Saturation + 1.5mag (S/N=50)

Figure 0

PreCam S/N for a Point Source at mag+1.5 of the DES Saturation Limit
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)

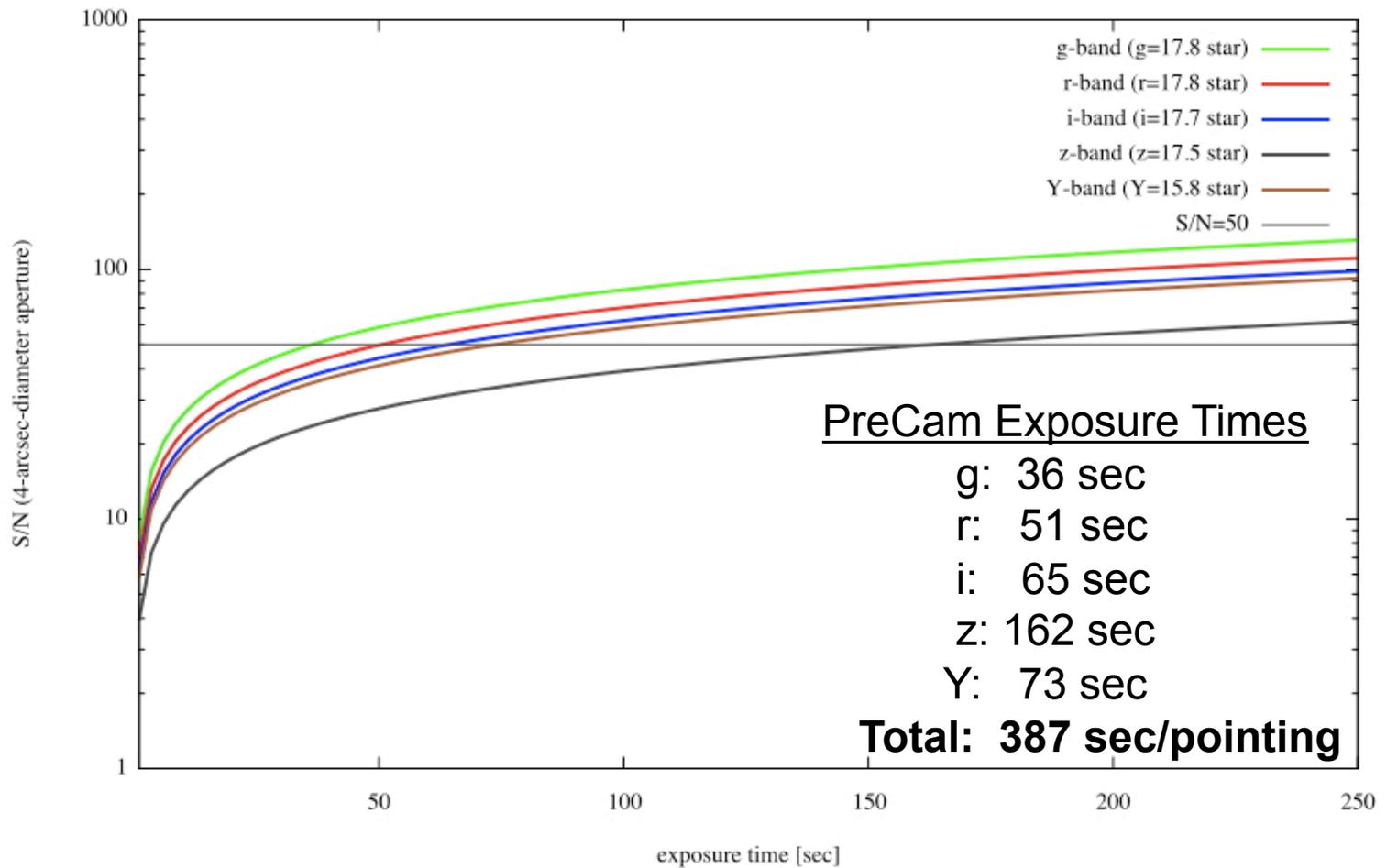




PreCam Exposure Times to Reach DES Saturation + 1.5mag (S/N=50)

Figure 0

PreCam S/N for a Point Source at mag+1.5 of the DES Saturation Limit
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





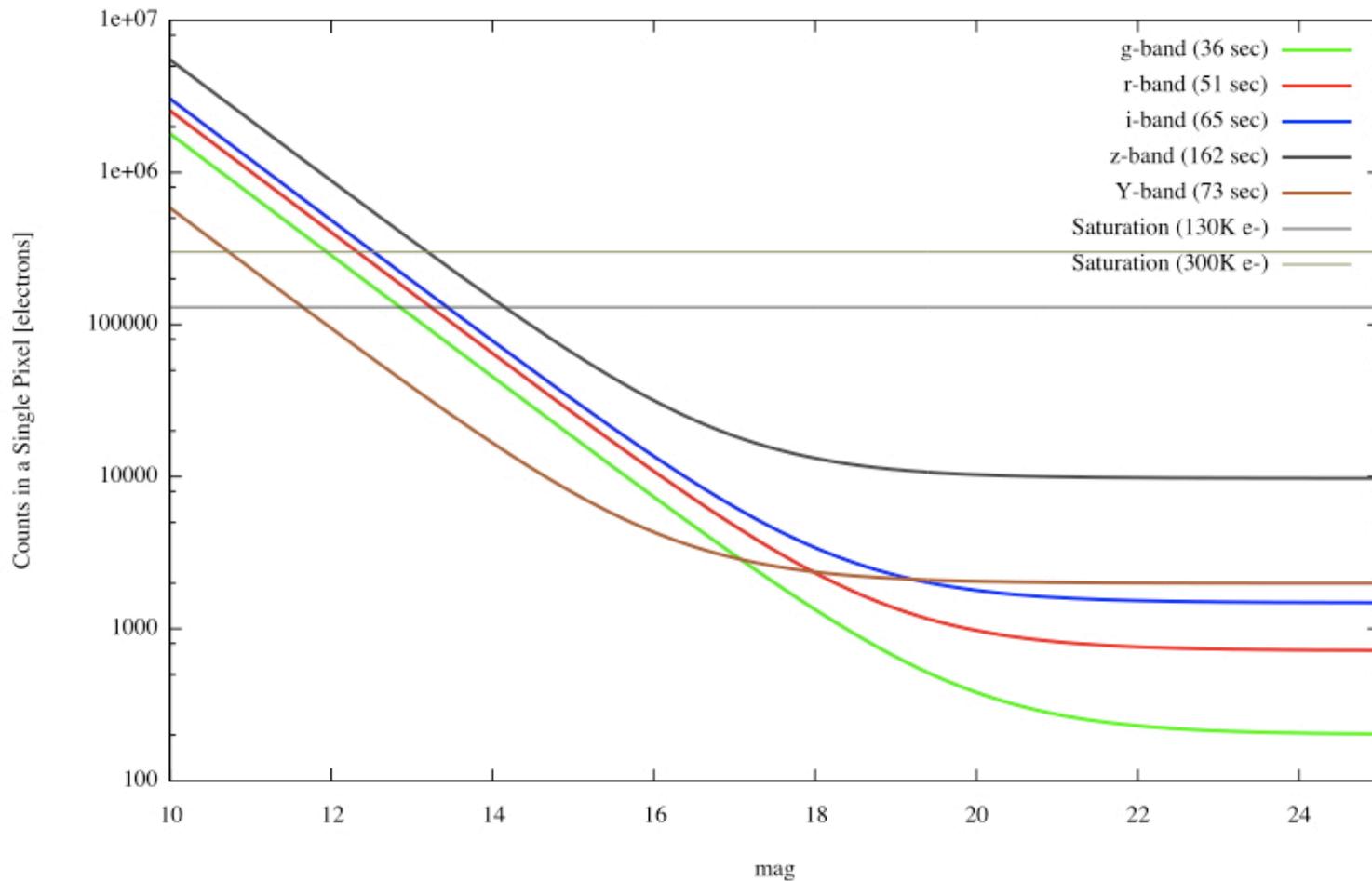
Saturation Limits for PreCam Exposures (Interesting for Bright Science with PreCam)

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Figure 0

Total Counts for a Point Source (+Sky) in a Single Pixel for an Optimum Set of PreCam Exposures
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





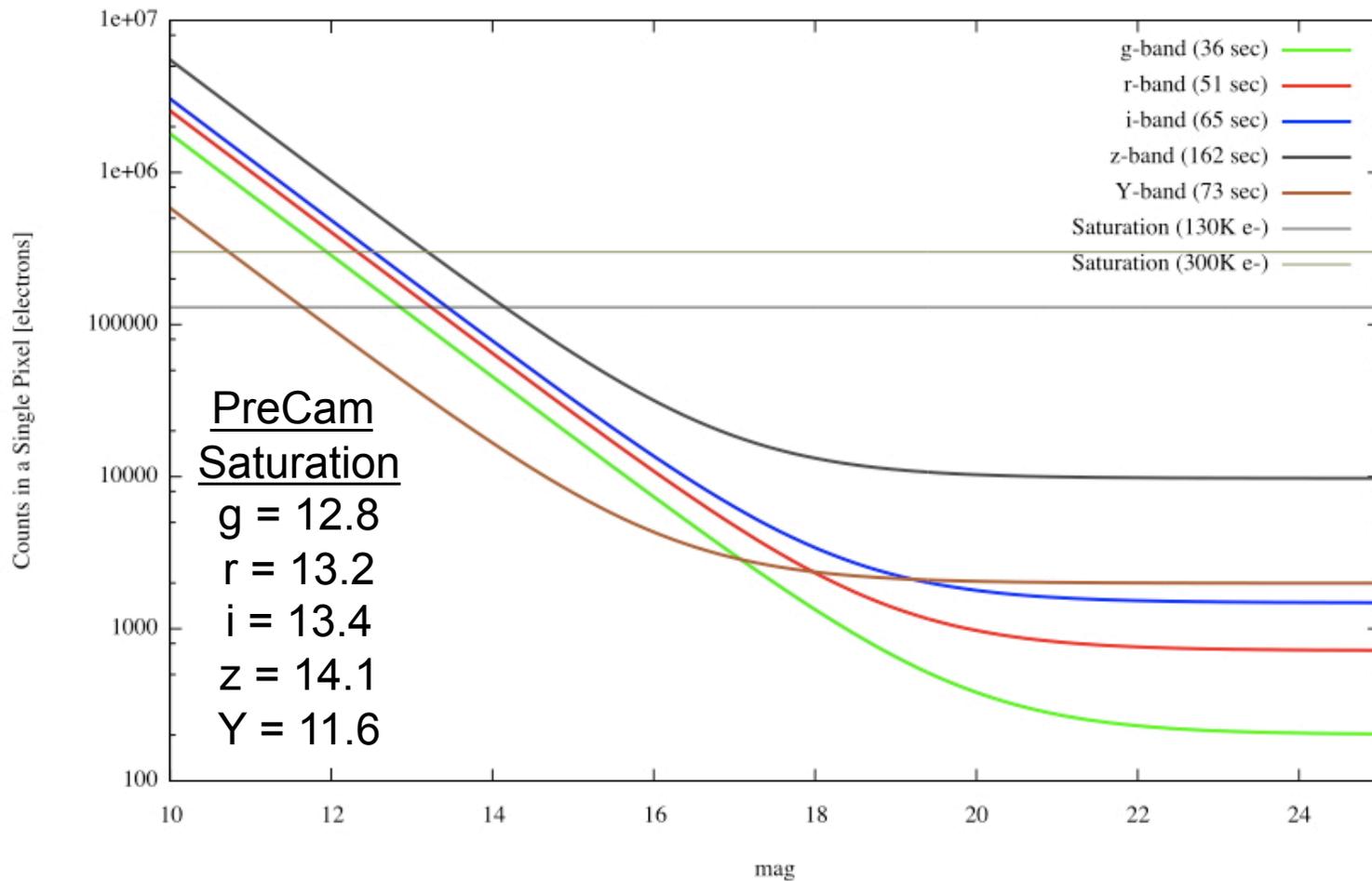
Saturation Limits for PreCam Exposures (Interesting for Bright Science with PreCam)

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Figure 0

Total Counts for a Point Source (+Sky) in a Single Pixel for an Optimum Set of PreCam Exposures
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)



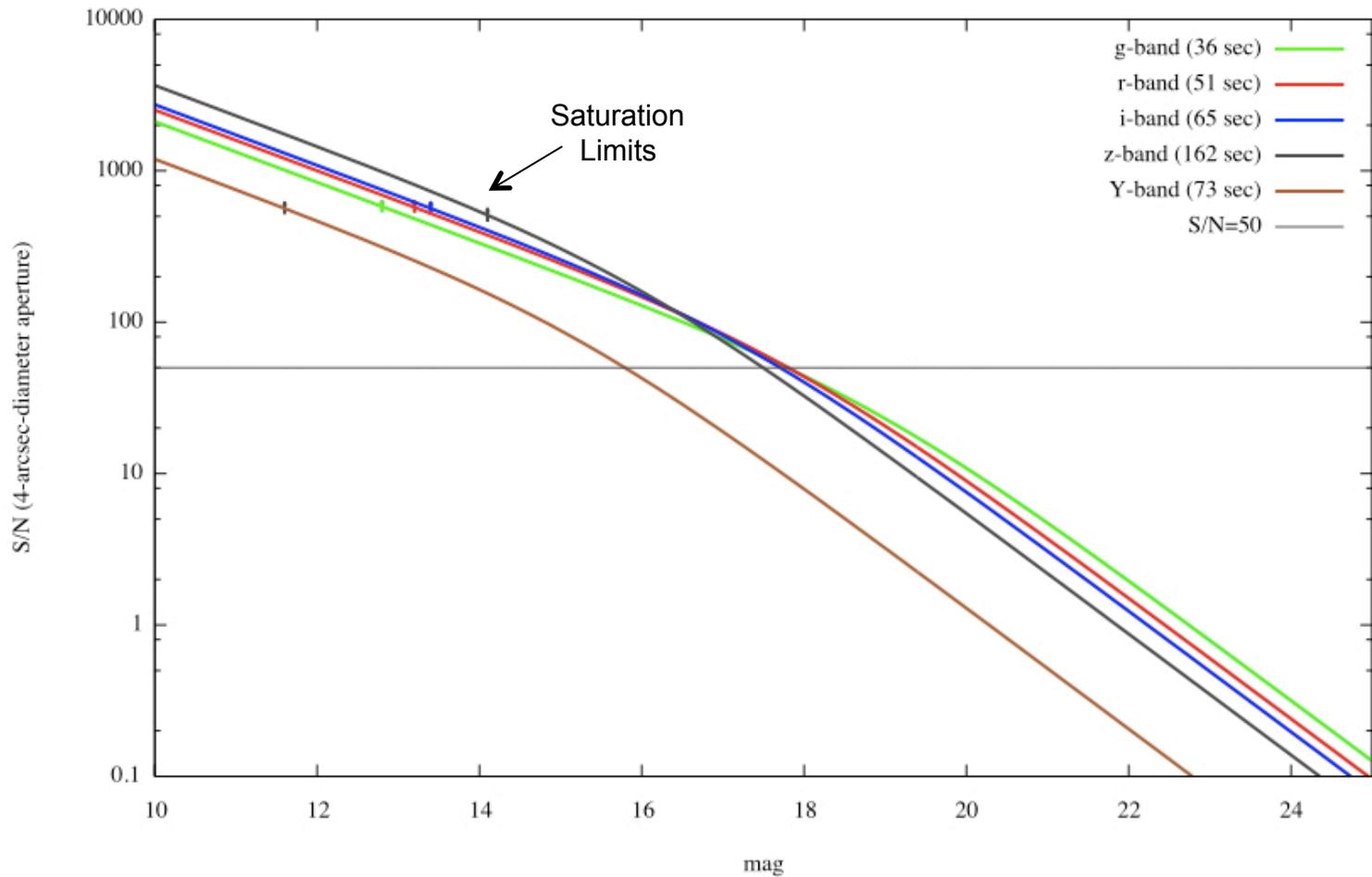


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S/N vs. Mag for PreCam Exposures (Bright Science + Overlap with DES)

Figure 0

PreCam S/N for an Optimum Set of Exposure Times
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)

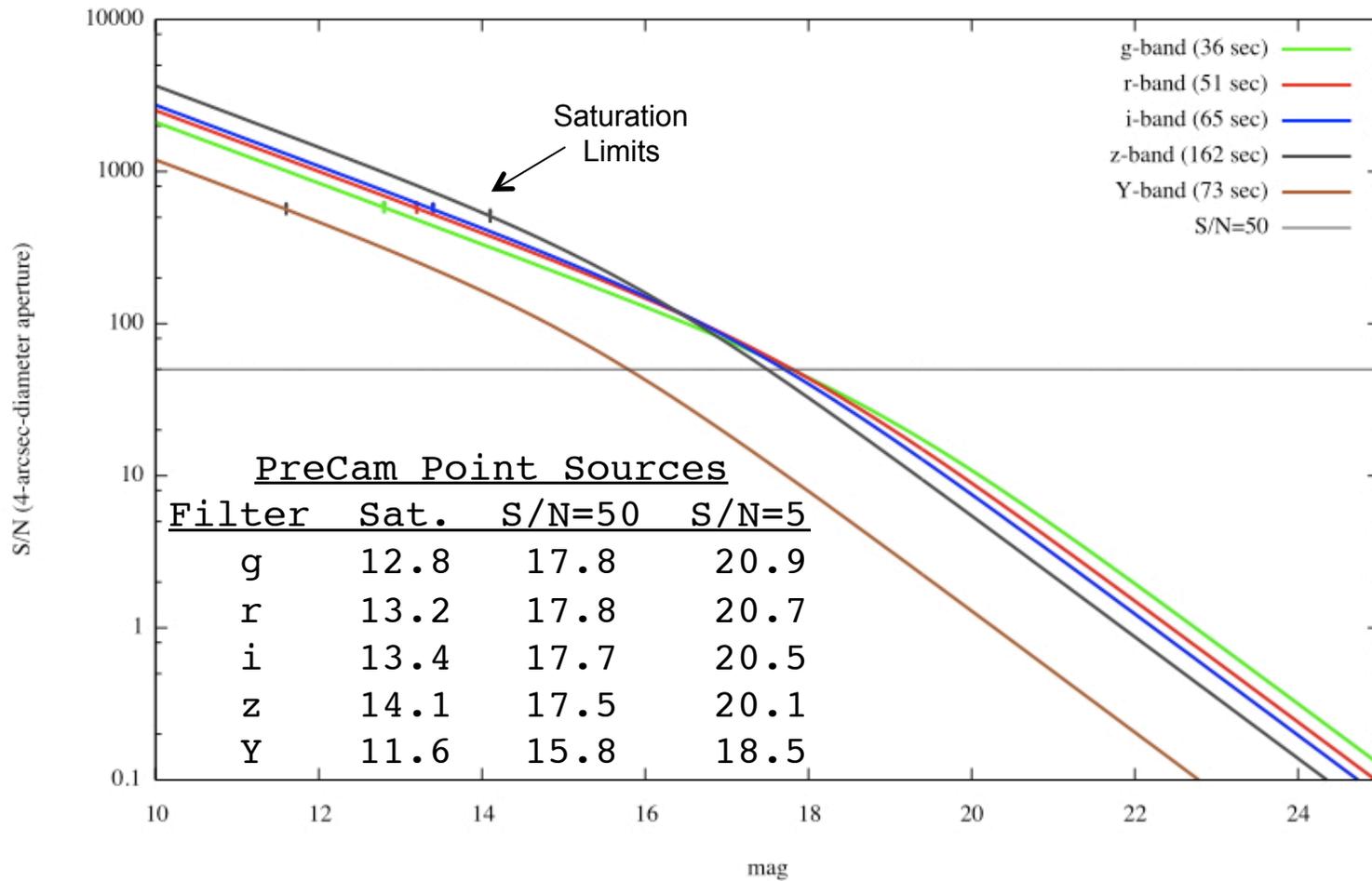




S/N vs. Mag for PreCam Exposures (Bright Science + Overlap with DES)

Figure 0

PreCam S/N for an Optimum Set of Exposure Times
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





Conclusions

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- A point source in a nominal 100-sec DES Science exposures under dark-sky conditions will saturate at $g=16.3$, $r=16.3$, $i=16.2$, $z=16.0$, $Y=14.3$
- PreCam should aim for a point-source $S/N \geq 50$ at $g=17.8$, $r=17.8$, $i=17.7$, $z=17.5$, $Y=15.8$ (i.e, 1.5 mag deeper than the point-source saturation limit for DES).
- To achieve this goal, PreCam exposure times should be at least 36 sec, 51 sec, 65 sec, 162 sec, 73 sec in g , r , i , z , Y , respectively (at least 387 sec of exposure time per pointing).
- For these exposure times, it is estimated that PreCam will achieve the following for point sources:

<u>Filter</u>	<u>Saturation</u>	<u>S/N=50</u>	<u>S/N=5</u>
g	12.8	17.8	20.9
r	13.2	17.8	20.7
i	13.4	17.7	20.5
z	14.1	17.5	20.1
Y	11.6	15.8	18.5



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Extra Slides



Count rates: DES (Blanco+DECam)

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mag=20 object		Sky Background		
Filter	e-/sec	Filter	mag/arcsec ²	e-/sec/pixel
g	584.56	g	21.7	8.8
r	586.25	r	20.7	22.3
i	542.49	i	20.1	35.9
z	394.44	z	18.7	95.0
Y	93.67	Y	18.0	43.1

For a mag=20 point source:

- + Multiply the "mag=20 object" count rate by 0.93738 for an aperture of radius = 1.0 FWHM (0.9 arcsec for DES).
- + Multiply the "mag=20 object" count rate by 0.07695 for an estimate of the count rate in a single pixel (assuming the point source is centered on the pixel's center). This is useful for saturation limit estimates. Note that this fractional value is different than that for the PreCam exposures.



Count rates: PreCam

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mag=20 object		Sky Background		
Filter	e-/sec	Filter	mag/arcsec ²	e-/sec/pixel
g	13.21	g	21.7	5.6
r	13.25	r	20.7	14.1
i	12.26	i	20.1	22.8
z	8.92	z	18.7	60.2
Y	2.12	Y	18.0	27.3

For a mag=20 point source:

- + Multiply the "mag=20 object" count rate by 0.93738 for an aperture of radius = 1.0 FWHM (2.0 arcsec for PreCam).
- + Multiply the "mag=20 object" count rate by 0.37968 for an estimate of the count rate in a single pixel (assuming the point source is centered on the pixel's center). This is useful for saturation limit estimates. Note that this fractional value is different than that for the DES exposures.

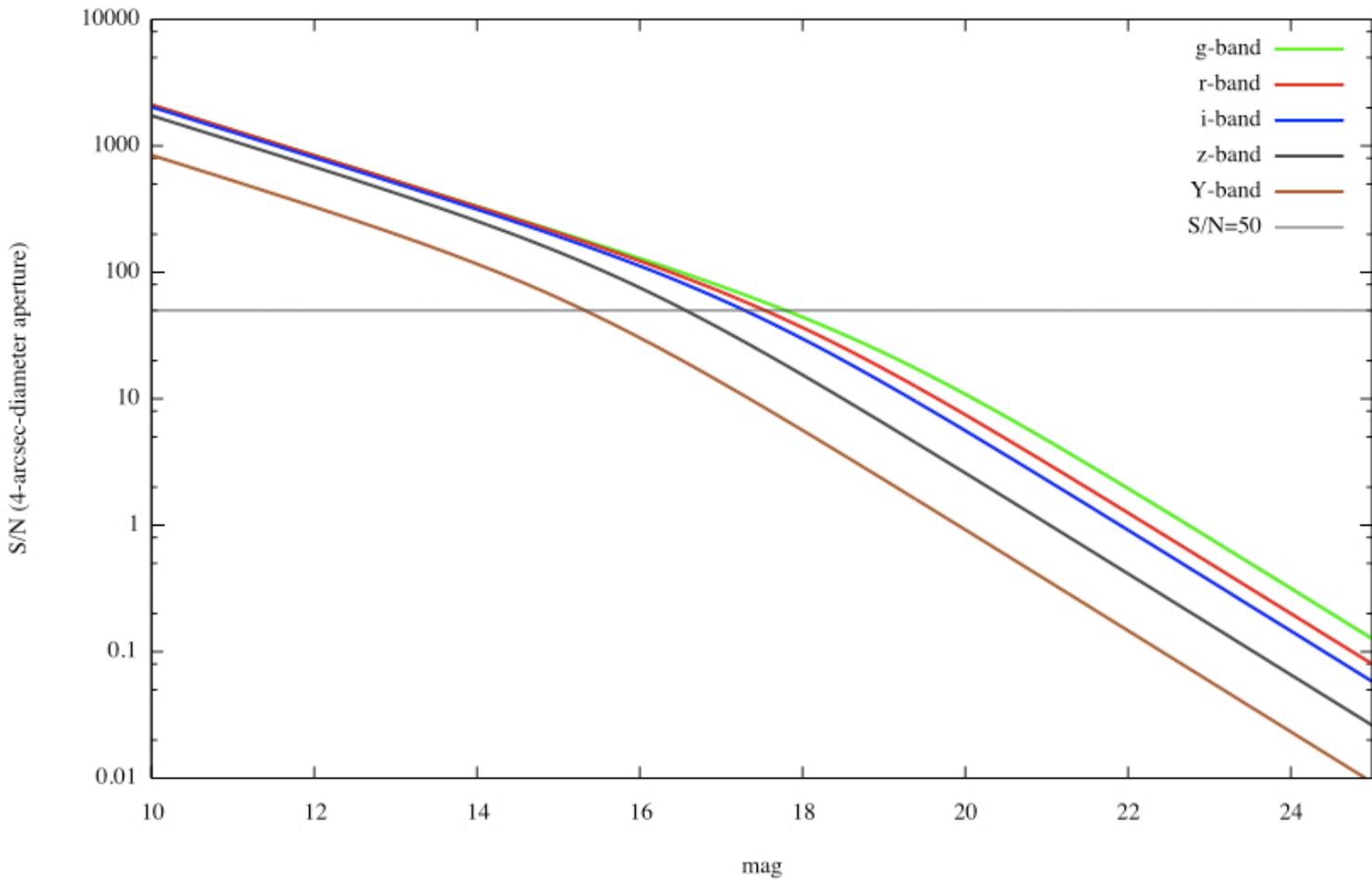


S/N vs. Mag for PreCam 36-sec Exposure (PreCam g-band Exposure Time)

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Figure 0

S/N for a Point Source for a 36-sec PreCam Exposure
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





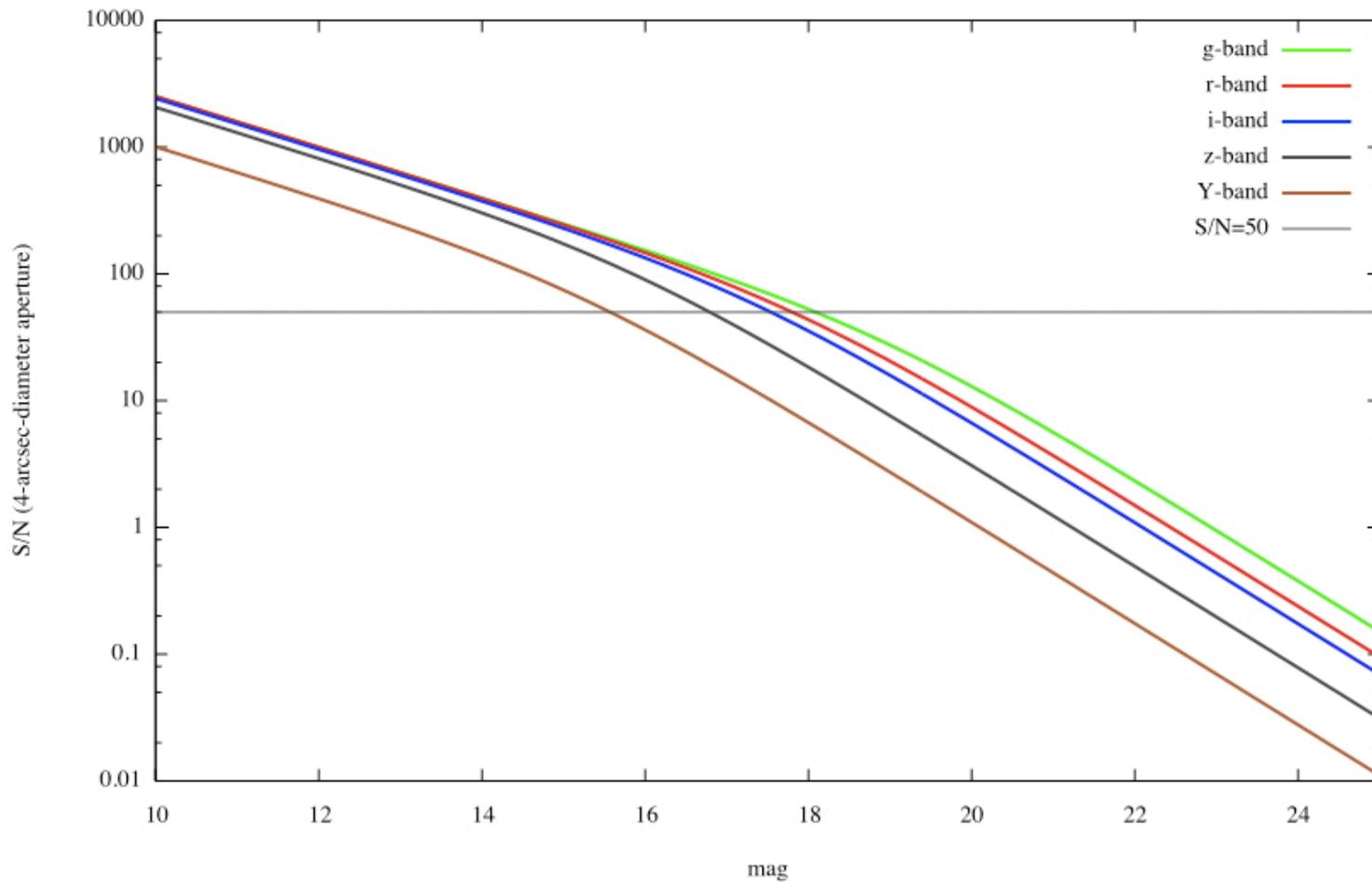
S/N vs. Mag for PreCam 51-sec Exposure (PreCam r-band Exposure Time)

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Figure 0

S/N for a Point Source for a 51-sec PreCam Exposure
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





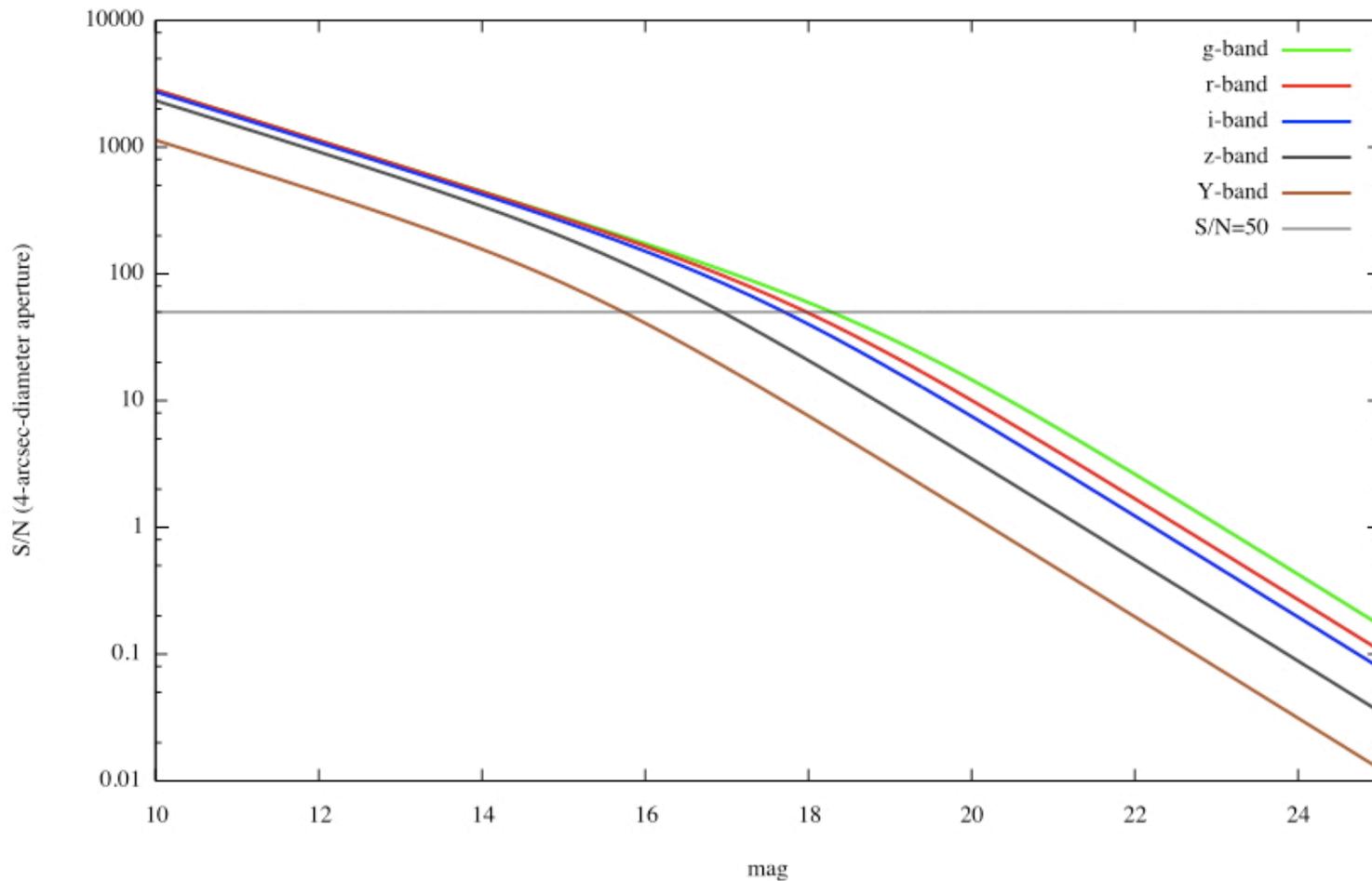
S/N vs. Mag for PreCam 65-sec Exposure (PreCam i-band Exposure Time)

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Figure 0

S/N for a Point Source for a 65-sec PreCam Exposure
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)



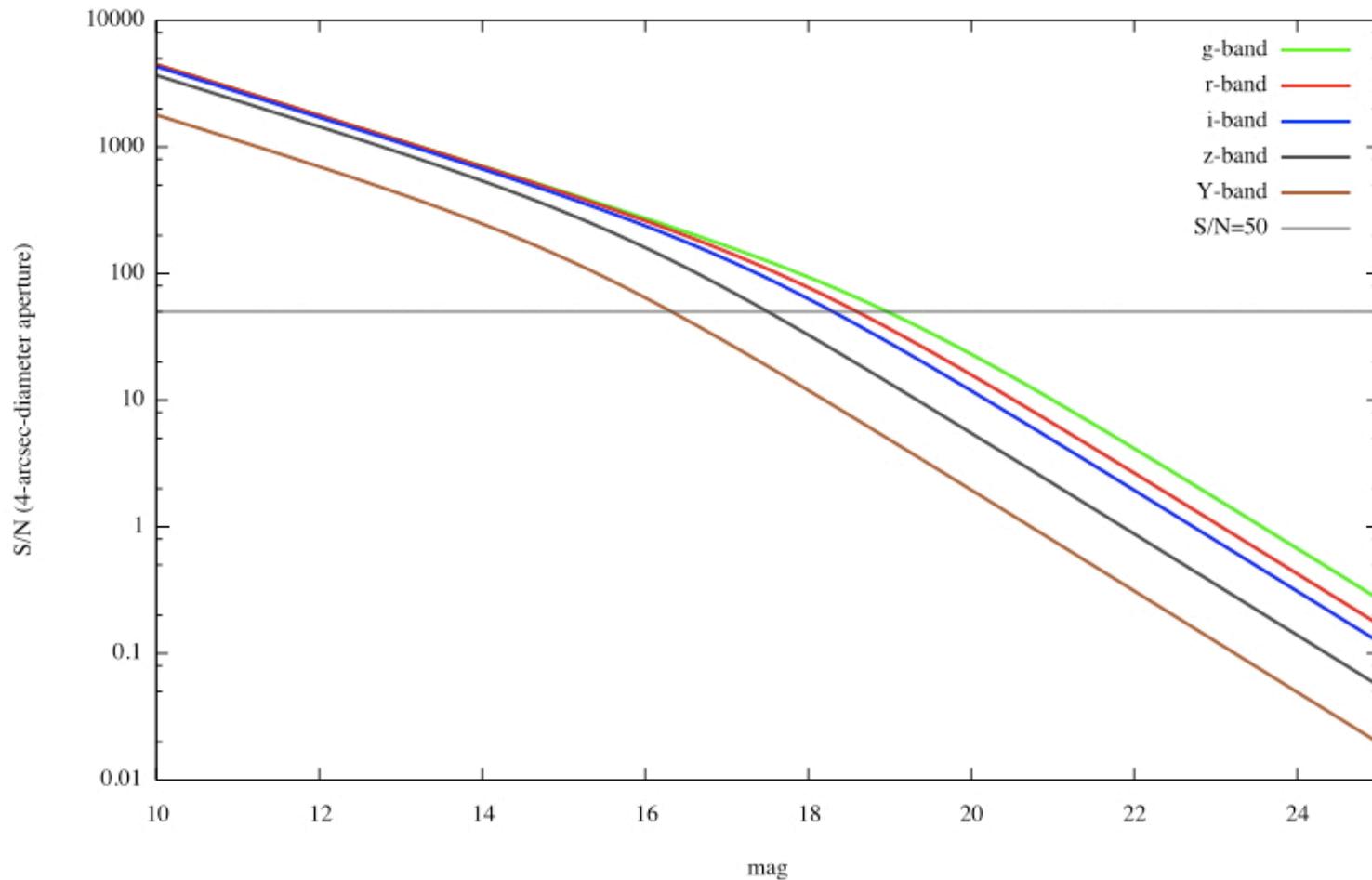


S/N vs. Mag for PreCam 162-sec Exposure (PreCam z-band Exposure Time)

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S/N for a Point Source for a 162-sec PreCam Exposure
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)



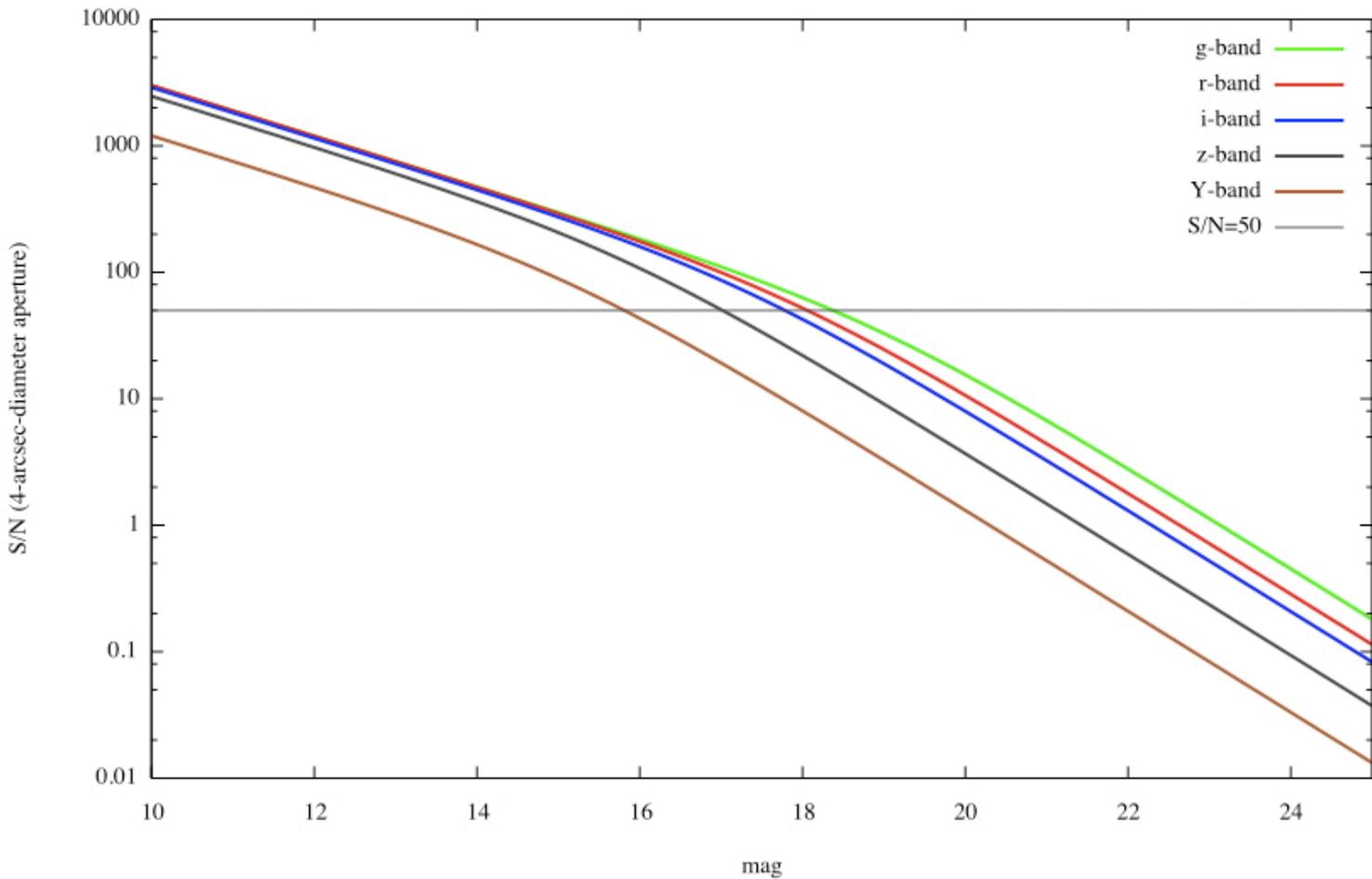


S/N vs. Mag for PreCam 73-sec Exposure (PreCam Y-band Exposure Time)

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Figure 0

S/N for a Point Source for a 73-sec PreCam Exposure
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





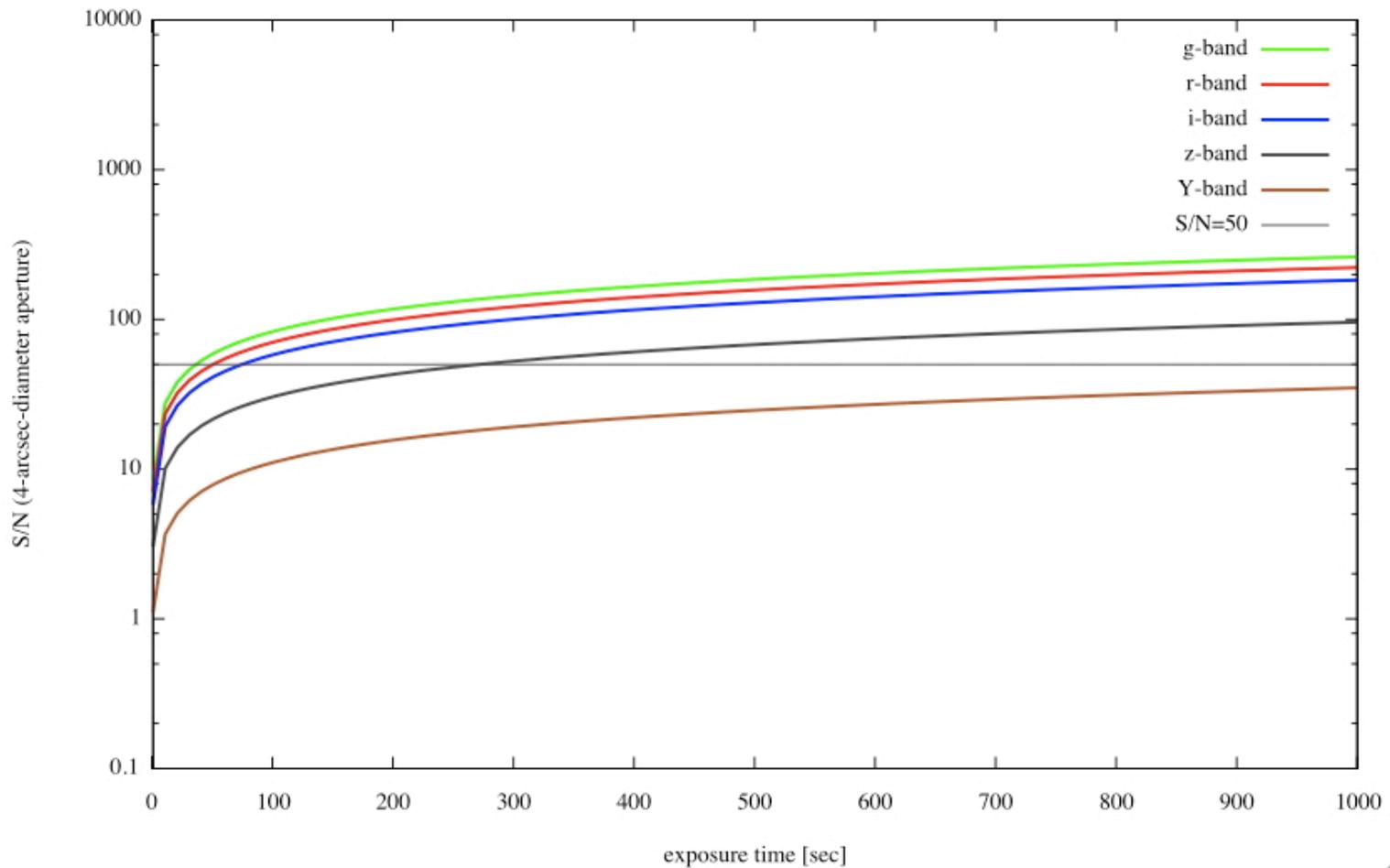
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PreCam S/N vs. ExpTime for $m_{AB}=17.8$ Point Source



Figure 0

S/N for a $m=17.8$ Point Source Observed by PreCam
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





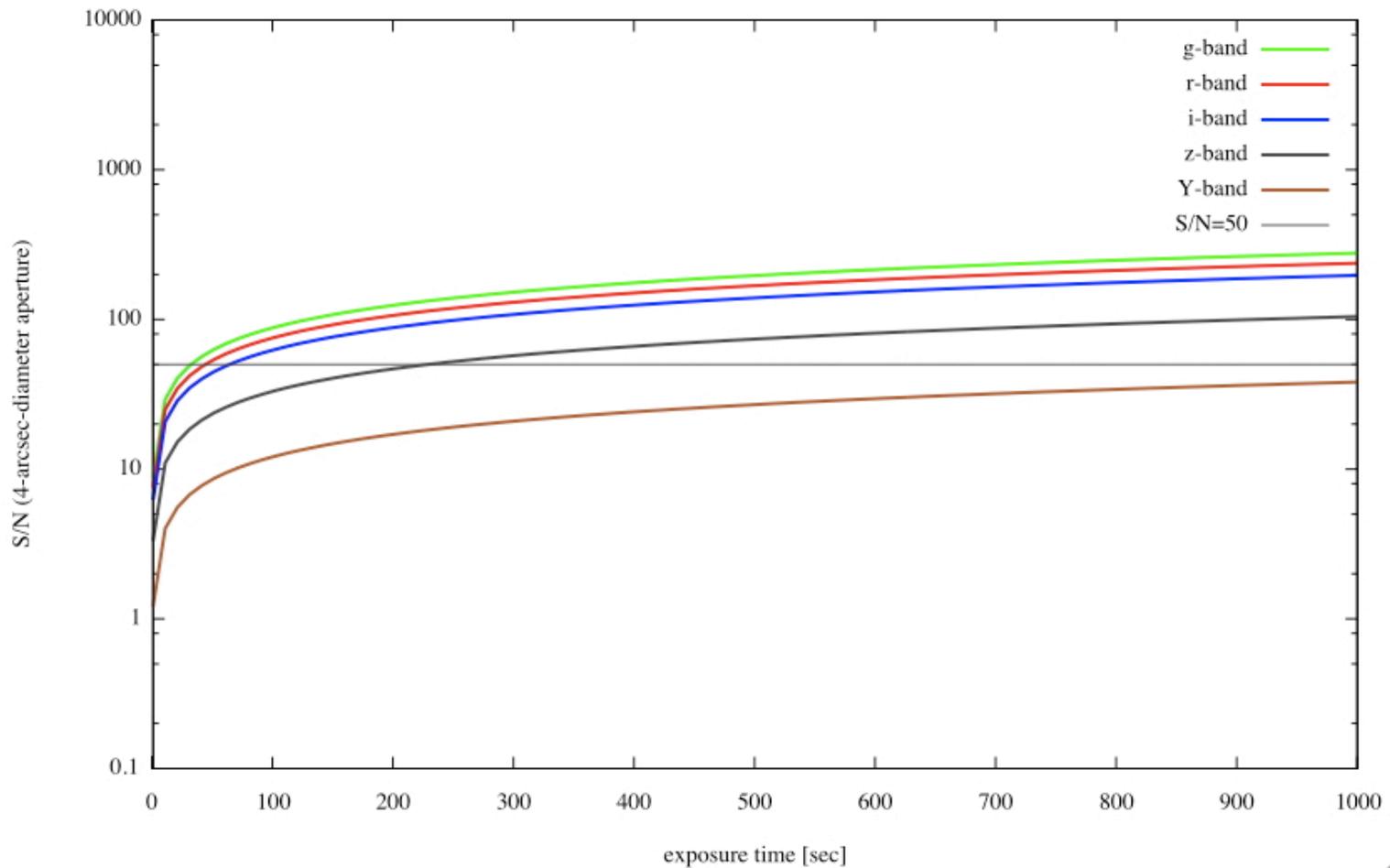
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PreCam S/N vs. ExpTime for $m_{AB}=17.7$ Point Source



Figure 0

S/N for a $m=17.7$ Point Source Observed by PreCam
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





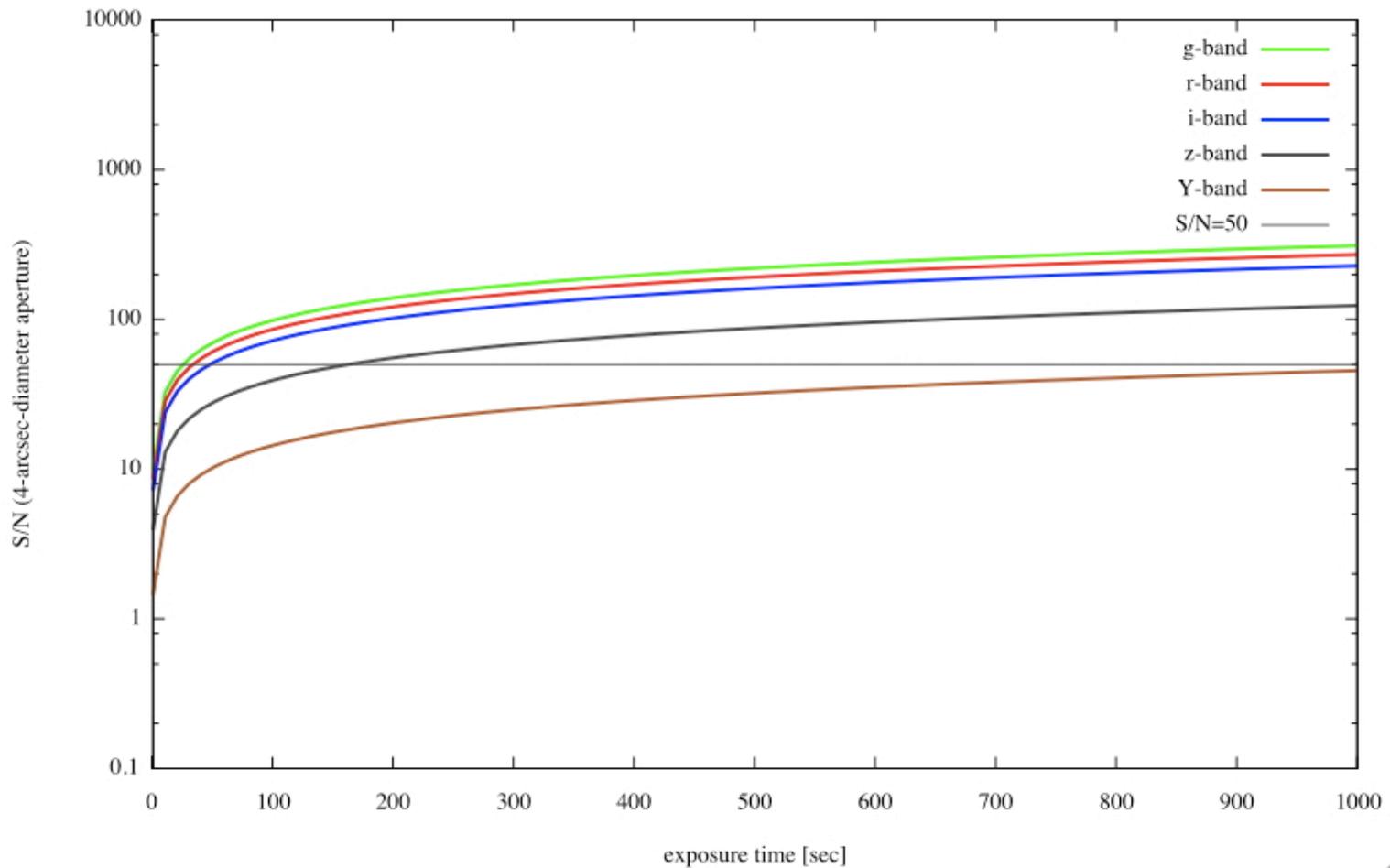
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PreCam S/N vs. ExpTime for $m_{AB}=17.5$ Point Source



Figure 0

S/N for a $m=17.5$ Point Source Observed by PreCam
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)





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PreCam S/N vs. ExpTime for $m_{AB}=15.8$ Point Source

Figure 0

S/N for a $m=15.8$ Point Source Observed by PreCam
(Assumes 2.0-arcsec FWHM seeing and Gaussian PSF)

