1. For a **broad overview on absolute photometry,** here are Links to cryo and warm papers :
    1. https://ui.adsabs.harvard.edu/abs/2005PASP..117..978R/abstract
    2. https://irsa.ipac.caltech.edu/data/SPITZER/docs/files/spitzer/spie_8442_inpress1.pdf
2. **Download your dataset from the Spitzer Heritage Archive**. We include here completed absolute photometry on 5 stars used to do the absolute calibration of IRAC. We choose these stars as our example because they have well-studied, published absolute fluxes. The 5 stars are: 'KF09T1', 'NPM1p67', 'KF06T2', 'KF06T1', 'NPM1p68'. This is a good fiducial dataset for anyone else wanting to validate their own absolute photometry pipeline. The full set of calibration stars used on IRAC is given in Reach et. al., 2005 (linked above) and will appear in the Spitzer observing logs (https://irsa.ipac.caltech.edu/data/SPITZER/docs/spitzermission/observingprograms/observinglogs/)
    1. When given the dialog box of which files to download, choose to download the Level 1 products (bcds). Choosing BCDs allows you to retrieve images with your target that may be inside larger dithered AORs where not every image has your target in it. It is good to get the raw files because saturation is most easily determined from a raw file. Precision absolute photometry on mosaics is not recommended.
    2. Downloading all of the data on the calibration stars is too much for a test. AORs used in the plots below are listed here for reproducibility. These are somewhat randomly chosen warm mission observations. The same method is also valid for cryo data. ['r59269888', 'r58938112', 'r58729216', 'r57824000', 'r54342400', 'r52323072', 'r42029568', 'r41611776', 'r41243136', 'r64633600', 'r64590592', 'r64025344', 'r63226624', 'r62411520', 'r62305024', 'r46086656', 'r45550080', 'r45406720', 'r45269504', 'r51512064', 'r52036352', 'r68420608', 'r68449280', 'r68518912', 'r68740096', 'r68760576', 'r69661696', 'r50688768', 'r50760448', 'r50844416', 'r51018496', 'r51071744', 'r51997440', 'r43944448', 'r42154496', 'r42002944', 'r44386816', 'r44225024', 'r45201920', 'r45365760', 'r45271552', 'r45408768', 'r60275456', 'r50819840', 'r50843392', 'r50953984', 'r51017472', 'r50995968', 'r71631872', 'r71524608', 'r71465728', 'r71446528', 'r71419136', 'r71384320', 'r71341312', 'r71309312', 'r71289856', 'r70868736', 'r51043072', 'r51778304', 'r51511040', 'r51798784', 'r51996416', 'r52286208', 'r53488384', 'r68215808', 'r54055680', 'r68240384', 'r68467712', 'r68535296', 'r69638144', 'r68580352', 'r69728256', 'r71447040', 'r71309824', 'r69877760', 'r68580608', 'r68517888', 'r68240640', 'r67670528', 'r65845248', 'r65484544', 'r68781056', 'r68581632', 'r69639424', 'r68706304', 'r70099968', 'r69729536', 'r71420672', 'r71342848', 'r71448064', 'r71633408']
3. **Try looking at the images**, If you have a relatively small dataset, and potentially mask out image artifacts or remove artifact-affected frames from consideration. A summary list of IRAC artifacts is here:

    https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/warmfeatures/

    or for more description check here:

    https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/33/.

    If you have a large dataset, this will not be possible, but then you have the advantage of distributions of fluxes. One potential code to assist in displaying and masking is imclean:

https://irsa.ipac.caltech.edu/data/SPITZER/docs/dataanalysistools/tools/contributed/irac/imclean/

4. **Calculate the centroids** of the target object using a first moment box centroid such as the one available on the IRAC website:

   https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/pixelphase/box_centroider.pro

5. **Perform aperture photometry** on the images at the returned centroid locations
   1. use the bcd.fits files for photometry or convert bcd's into units of electrons for more accurate uncertainty calculations. The conversion from MJy/sr (units used in the bcd images) to electrons is *GAIN * EXPTIME / FLUXCONV where GAIN, EXPTIME and FLUXCONV are the keywords from the bcd header. Most photometry routines will calculate uncertainties for you.
   2. use a 10 pixel aperture radius with 12 - 20 pixel aperture background
   3. if using idl aper - use /exact which does a better job of calculating the intersection of a circular aperture with square pixels.
   4. if using idl aper - use /flux to keep measurements in flux units instead of converting to magnitudes.
   5. readnoise values are included in the image headers
6. **Apply two photometric corrections**:
   1. array location dependent correction:

      https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/16

      https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/locationcolor/

   2. pixel phase correction:

      https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/17/

      https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/pixelphase/

   3. One potential code to use which applies both corrections and is valid for both warm and cryo data is

      https://irsa.ipac.caltech.edu/data/SPITZER/docs/dataanalysistools/tools/contributed/irac/iracaphotcorr/

      Be aware that this code requires you to have used a 3 pixel aperture radius with [3,7] pixel aperture background annulus. If you do this, you will also need to apply an aperture correction since the calibration photometry is based on a [10,12-20] system.

   4. Alternatively make the corrections separately using codes which allow you to keep the [10,12-20] aperture, background annulus system.
      1. use this code to correct for pixel phase effect for cryo data:

https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/pixelphasecryo/

and this code to correct for pixel phase effect for warm data:

https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/pixelphase/pixel_phase_correct_gauss.pro

2. Then download the images linked at the middle (for cryo) or bottom of this page (for warm) and find the correction value at the position of your target centroid https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/locationcolor/

7. Do you need to apply an **aperture correction**? Did you use [10,12-20] all the way through? It is possible to get better results with a smaller aperture because less noise is included in the aperture. If not using [10,10-20] then aperture corrections can be found here in Section 4.7:

https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/17/

8. **Compare to a fiducial.** What you have after all of this is actually F*K* for your stars. If you are doing the example of calstar photometry, we can compare the F*K* fluxes derived here to the values that IRAC used in its absolute calibration. You should find a distribution of fluxes for each star that are within a few percent of the values listed below. So, if you plot a histogram of fluxes which are normalized by the values listed here, the peaks of each star will not be at exactly 1. This is because the conversion from data to flux must be a single value for all IRAC data per channel, but is derived from a subset of 10 stars which necessarily can not all have exactly the same conversion as they have different spectral shapes and different model fits to their spectral shapes.
    1. Name Sp Type 3.6 4.5 5.8 8
    2. NPM1p64_0581 A0V 63.2339 41.131 26.3354 14.5169
    3. HD165459 A1V 649.5405 422.2187 270.4229 149.2474
    4. NPM1p60_0581 A1V 38.3283 24.8056 15.848 8.765
    5. 1812095 A3V 8.7111 5.6768 3.6412 2.0087
    6. KF08T3 K0.5III 11.9084 7.2624 4.7604 2.781
    7. KF09T1 K0III 166.6144 102.1363 66.7753 38.859
    8. KF06T1 K1.5III 13.2892 8.0002 5.2731 3.1052
    9. KF06T2 K1.5III 10.2563 6.1744 4.0732 2.3965
    10. NPM1p67_0536 K2III 807.3312 482.7083 319.5507 188.4689
    11. NPM1p68_0422 K2III 556.244 327.1062 218.5646 129.2563
9. **Apply a color correction**. If you want a flux which can be compared to any instrument's absolute flux, then calculate a color correction and divide into F*K* to arrive at F*. Sample color corrections are given here:
https://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/15/

Assuming K stars have temp = 5000K, the color corrections for the cal star sample above are [1.0063, 1.0080]