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Input Data

- raw pixel data
  - pixel values
  - bias, gain setting, CCD ID (filter), ...
- raw calibration data
  - flats = f (filter, amplifier, time)
  - CCD (radiation) damage history
- PSF library
- Input Catalog
  - color or spectral type
  - star identification, FOV identification
  - (brightness)
  - (flags: multiple, confusion ...)
- satellite status
  - spin information (smearing)
  - near Earth / eclipse ?
  - scattered light sources (bright objects nearby)
    $\longrightarrow$ access to wider area of Input Catalog

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Subtasks

→ 1–dim profiles

⇒ 2–dim postage stamps

- raw data calibration (bias, flat)
- initial steps
  - locate peak
  - check: location w.r.t. window boundaries
  - check: saturation? no star?
  - determine start parameters (moments)
- fit (several models, methods)
  astrometry might use different procedure as photometry
- anlalyze fit parameters and fit errors
  - profile width ⟶ ssmmeeaarriinngg
  - multiple? defects?
  - check background, confusion
  - (compare to input catalog expectation)
  - classify object, set flags
- ITERATIONS with new PSF's ...

Output Parameters

- event by event fit results
  - fit parameters (astrometry & photometry)
  - fit errors, χ^2
  - flags, object classification
- empirical PSF data
  - select suitable candidates
  - pixel values scaled to PSF template requirement
- "going through" data, tag on to output files or use DB
  - raw data items: time (row numbers), CCD ID, ...
  - input catalog data for later comparison

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Relationship to other components

$\Longleftarrow$ Input Catalog (tiles)

$\Longleftrightarrow$ PSF library (new module: determine PSF's)

$\Longrightarrow$ FIRST LOOK

$\Longrightarrow$ SPIRAL REDUCTION (1 FOV crossing, spiral)

$\Longleftarrow$ final iteration after all PSF's available ?
(depending on time–scale of variability,
this could be completed in sections)

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Approaches, models, algorithms

- moments / center of mass $\longrightarrow$ start parameters
- astrometric fit: 4 approaches investigated so far

  A) Gauss model $\longrightarrow$ large pixel phase errors

  B) determine and use perfect PSF ($\approx$ 0.2 % level) $\longrightarrow$ NO pixel phase error

  C) simultaneously estimate fit parameters and PSF for group of stars

  D) use approximate PSF $\longrightarrow$ small pixel phase errors, calibrate out in spiral reduction step
- photometry (total flux vs. model result) $\longrightarrow$ Rob Olling for more details
- PSF characterization: option Hermite polynomials

No – Problems

- CPU time requirement o.k. ($\approx$ 1/10 of real time) even some test code already available for various approaches
- still enough photons, 1/500 pixel *random* error possible (if PSF $\approx$ symmetric), about 1 magnitude "slack"

Problems

- PSF fits
  - too many PSFs: approach **B)** seams not feasible
  - numerical stability: approach **C)** seems not to work
  - remains approach **A)** and **D)**:
    $\longrightarrow$ some pixel phase error will need calibration
  - aperture effects: smearing = f(...)
    $\rightarrow$ different amount of charge lost from window
- optical distortion
  - current design: 3.6 "/deg^3 (3 pixel at edge of FOV)
  - in–scan smearing $\approx$ 0.2 to 1.7 pixels = f (CCD)
  - non-linear effect up to 1/4 pixel
    $\longrightarrow$ asymmetric profiles
- optical fabrication errors, alignment tolerances
  - asymmetric profiles
  - instrumental PSF is undersampled
  - need for movable optical component
  - stability problems
  - no clear idea about how to "focus"

Problems ... (continued)

- other systematic errors as a function of ...
  - magnitude (detector is not perfectly linear, digitization effects on asymmetry in wings ...)
  - color (spectral type)
  - CCD gain setting, filters ...
  - scattered light from Earth, Moon, planets, bright stars
- effects of radiation damage
  will charge injection work ?
  changes on what time scale ?
- need to calibrate position offsets for each PSF
  definition of "center" needs to be related
- normal geometric mapping calibration
  3rd order optical distortion, filters

We are almost still in the feasibility study phase, various instrument design options are under consideration.