DARK ENERGY
SURVEY

Preliminary Curtis Schmidt Optical Design Analysis

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Use information on known component spacings to estimate Curtis Schmidt optical design

- Various pieces of documentation
  - CTIO drawings/schematics
  - Reports of unknown origin
  - Description of Burrell Schmidt on KPNO
    - Pat reports that the Curtis Schmidt is similar in design
    - Nassau, J. J. 1945 ApJ 101 275
- Create ZEMAX model
  - Use above information
  - Design principles of classic Schmidt
  - Design for DES-r band filter (550-700nm)
  - Allow slight changes in optical prescription to optimize image quality to replicate known Schmidt performance
    - <25 micron images over ~1.3 degree field
      - With some vignetting from existing folding flat
    - Constrain focal length to be 2135.6 mm
      - Reproduces known Schmidt plate scale

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Performance

- Predicted performance based on model
  - Without corrector

Off-axis Field Position (degrees)	Rms spot diameter (microns)	80% encircled energy diameter (microns)
0	12	11
0.2	11	11
0.4	7	15
0.8	11	16
1.0	24	24
1.2	39	42
1.5	69	75
1.7	105	95

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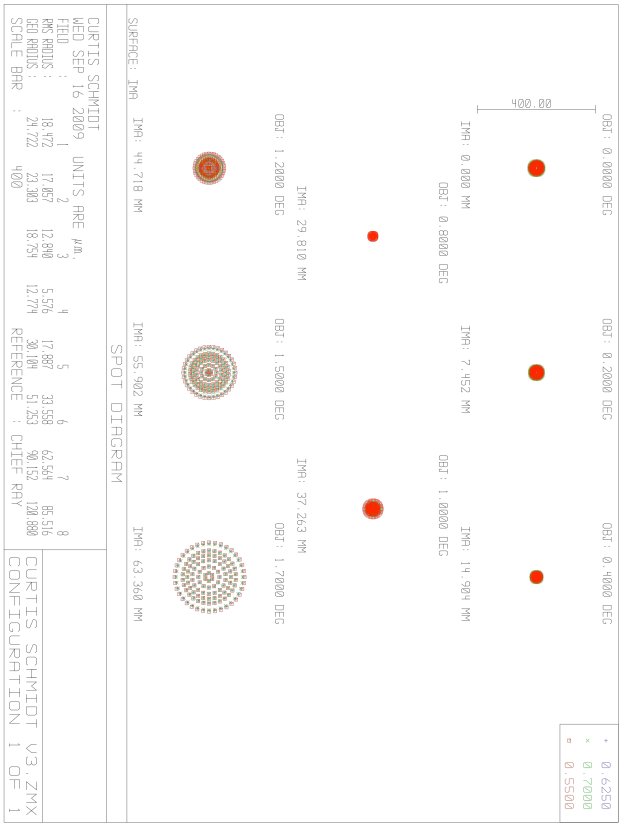
Spot diagram



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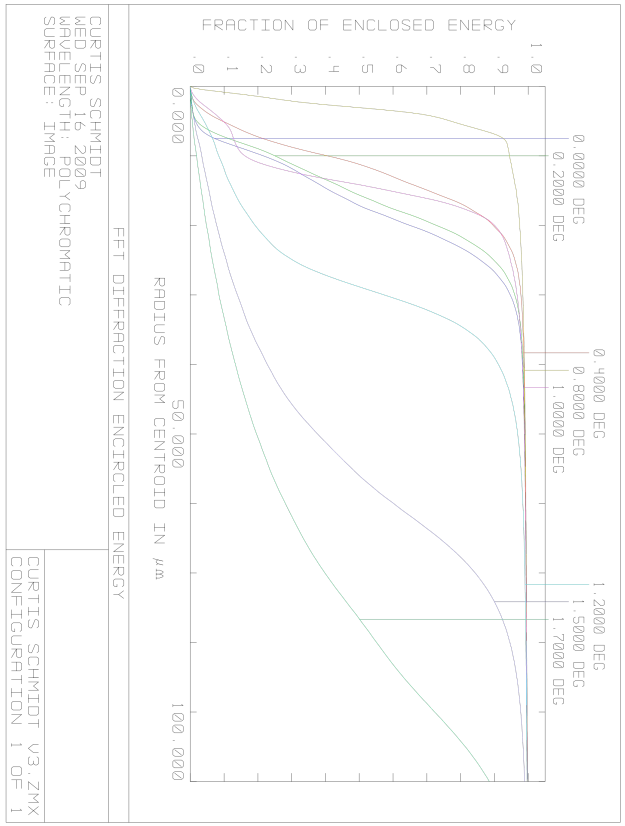
Encircled Energy



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Summary

- Schmidt performs adequately over field diameter of ~1.6 degrees with additional optics
  - 80% encircled energy <15 microns
  - Stars will look “square”
- Beyond this field performance degrades quickly
  - Field curvature increases image size to >>15 microns
- Design simple singlet “field flattener” to improve performance

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Field flattener

- Single lens
- Fused silica
- Put 33 mm above detector plane
  - Random choice
  - Could be optimized in conjunction with mechanical design
- Optimize for performance over 2.4 degree field
  - 1.2 degree off-axis

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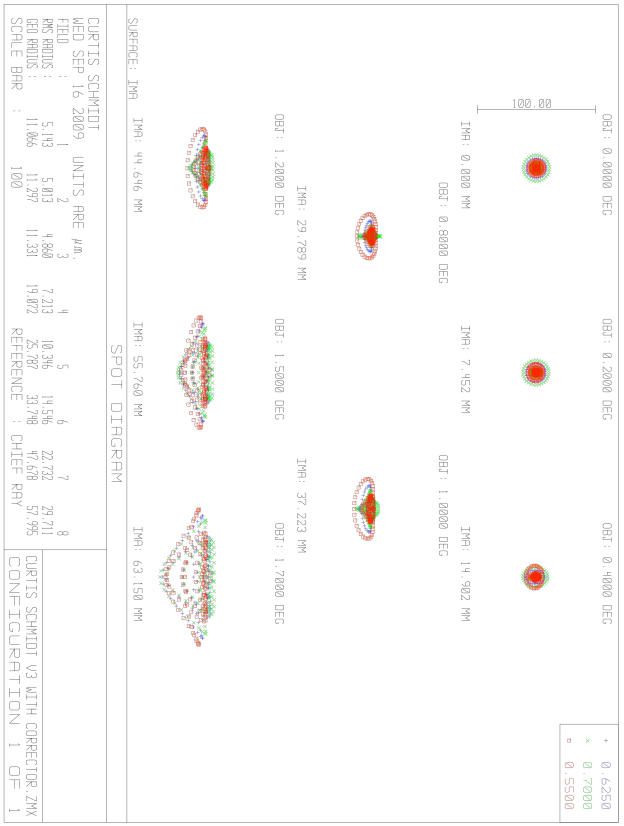
Performance with field flattener

- Predicted performance based on model
  - Without corrector

Field Position (degrees)	Rms spot diameter (microns)	80% encircled energy diameter (microns)
0	5	7
0.2	5	7
0.4	5	7
0.8	7	7
1.0	10	11
1.2	15	15
1.5	23	24
1.7	30	32

Spot diagram with field flattener



Encircled energy with field flattener

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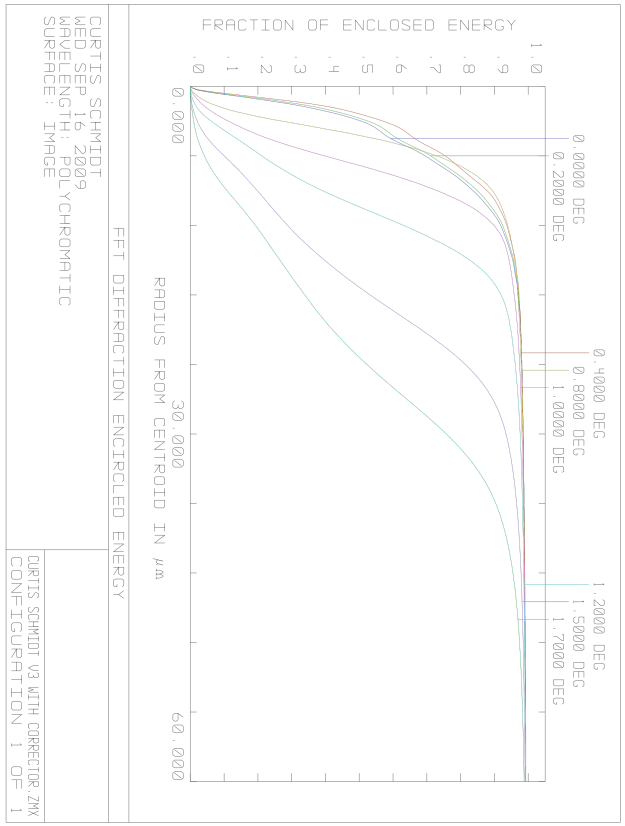

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Summary

- Performance with field flattener significantly better
  - Especially at larger field angles
  - Adequate for a ~3 degree field
- Design can probably be optimized better
  - Look at different materials
  - Investigate other detector-field flattener spacings
  - Etc.

- Demonstrates that choice of field size dictates need for additional optics

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Future tasks

- Use model to
  - Investigate size of folding flats with position “above” primary
    - Determine throughput versus field size at several different positions
    - Assume folding flat size gives zero vignetting
  - Look at performance in other bands
  - Determine maximum detector size for continued use of 100mm x 100mm size filters
- Update model as additional information becomes available