



EPFL

MICRO-517

Optical Design with ZEMAX OpticStudio

Lecture 11

02.12.2024

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Design Projects

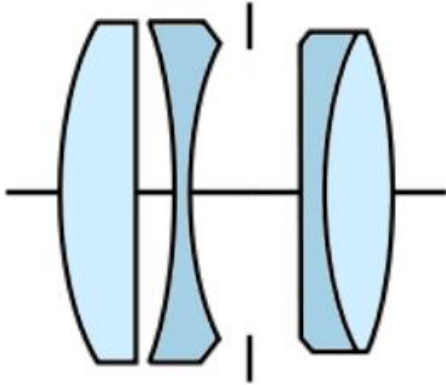
Choices of Designs

- The Tessar lens
- Keplerian telescope system
- High-NA long-WD microscope objective
- Double-telecentric lens system

Requirements and Grading

- Due 01.02.2024
- Main reference: C. Velzel, *A Course in Lens Design*
- Use F.d.C. wavelengths in all design
- Use at least 0, 0.7, 1.0 field settings
- Full score 100 points
- Report: 50 points
 - Intro 10 points: what we are designing, specification
 - Design 30 points: ideas, analyses, layout, predesign, optimization
 - Insights 10 points: remaining issues, what did we learn, what can be improved
- ZEMAX design: 50 points
 - Functionality 25 points: works as specified
 - Performance 25 points: how well it works (aberration correction)
- Bonus points

The Tessar Lens



Tessar 1912



Tessar 1952

Specification

- f 50mm, F/2.8
- Field of view $w = 20^\circ$
- For 1-inch image sensor
- Use dedicated stop plane

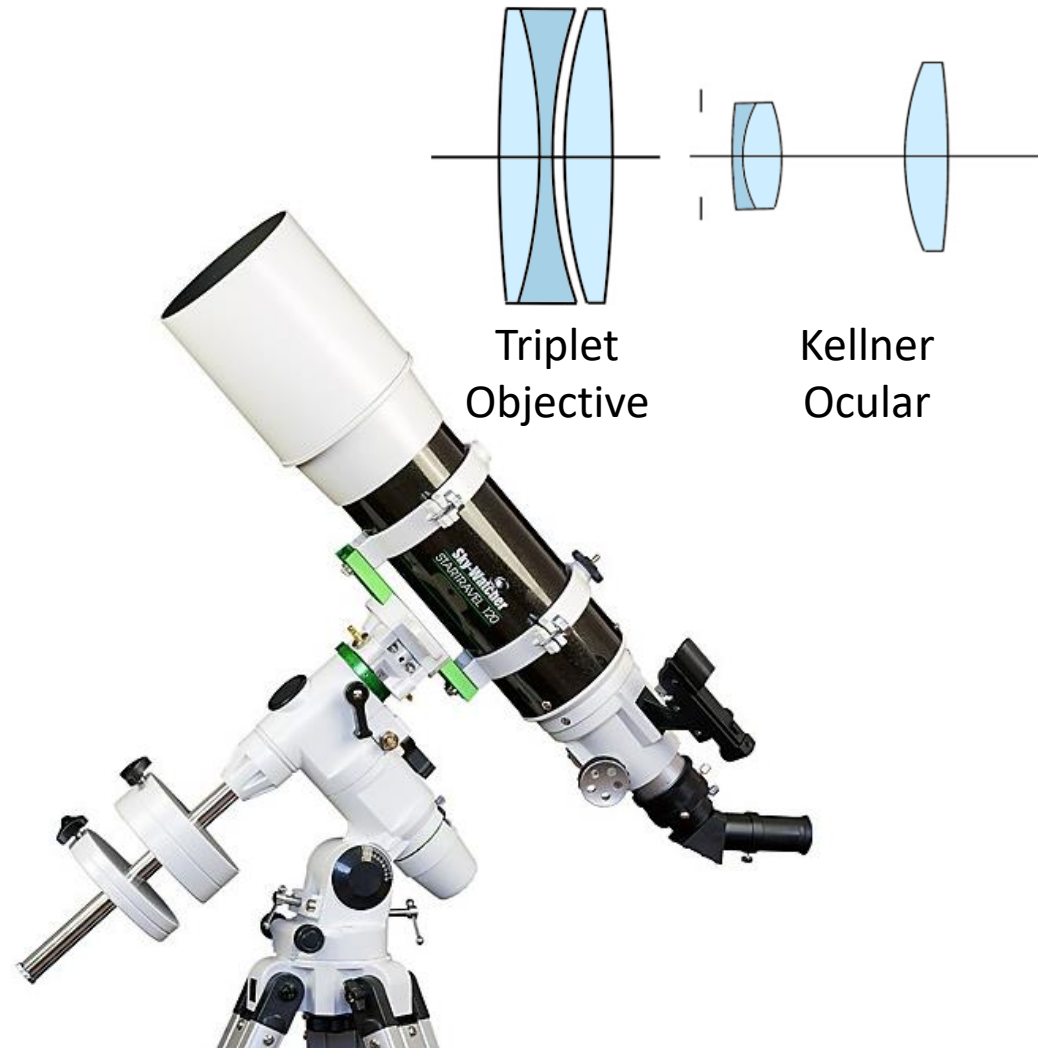
Bonus points

- Use of aspherical surfaces: +5
- Evaluate different stop sizes: +5

Hints

- Begin with a Cooke Triplet
- Split element 3 into doublet with same power (not for color correction)
- Element 3 glass: similar V different n

Keplerian Telescope System



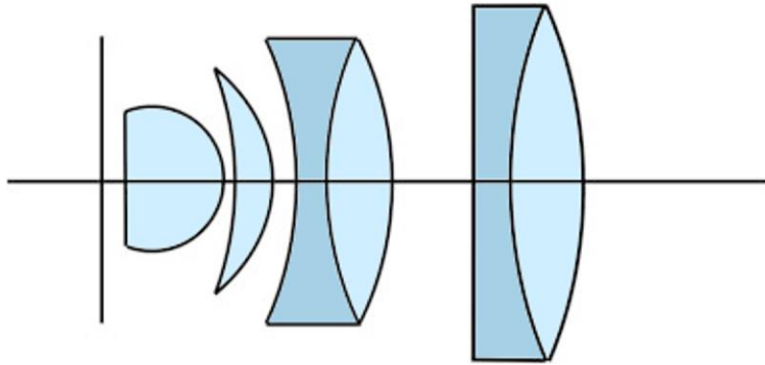
Specification

- 180mm aperture
- Magnification (angular) 120x
- Achromatic objective + ocular
- Designed separately
- May need field lens
- Fill human vision span (120°)

Bonus points

- Apochromatic (triplet objective): +10
- Use of aspherical surfaces: +5
- 90° axis steering prism: +5

High-NA Long-WD Microscope Objective



Specification

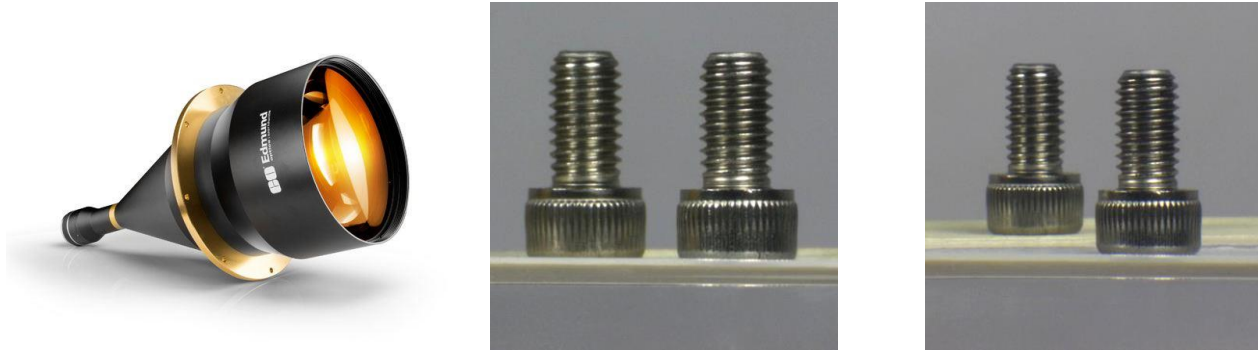
- 20×, NA 0.8, WD 3 mm
- Infinite-conjugation
- 200 mm tube length
- Full field of view 500 μm

Bonus points

- Challenge: +5
- Achromatic: +10
- Use of aspherical surfaces: +5
- Use of aplanatic surfaces: +5



Double-telecentric Lens System



Specification

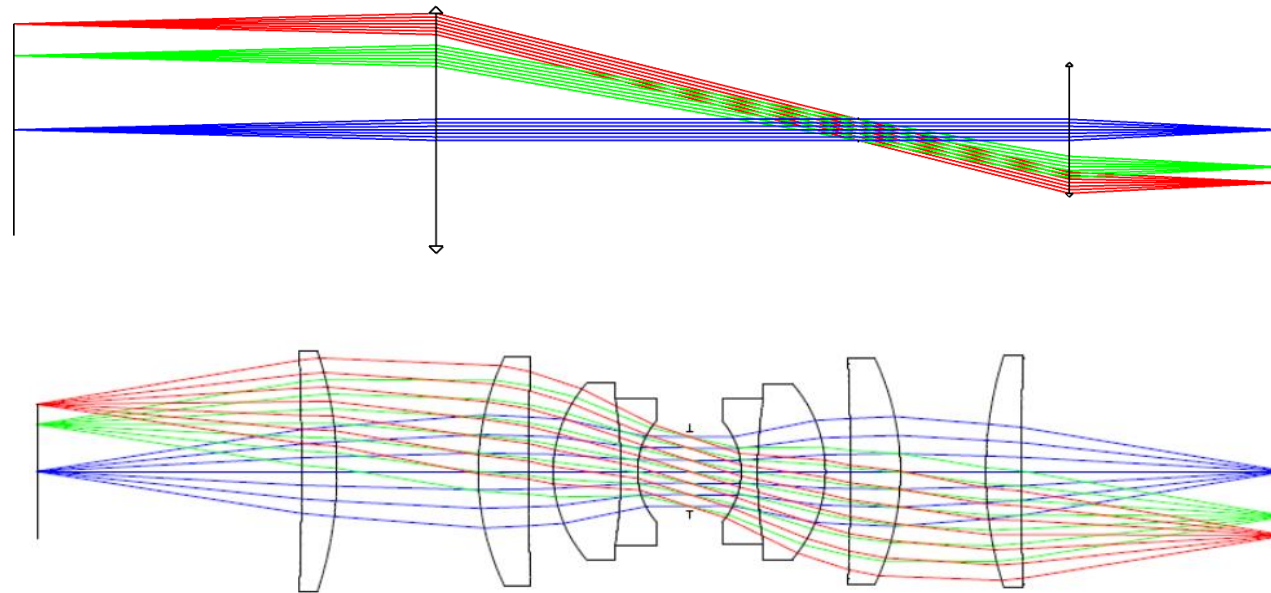
- Double telecentricity
- Magnification 3:1 (0.333×)
- For full-frame image sensor

Bonus points

- Challenge: +10
- Apochromatic: +10
- Use of aspherical surfaces: +5
- Use of aplanatic surfaces: +5

Hints

- Object distance must be finite
- Strategic stop position
- Design left and right half separately and combine



Questions?

- User specifications may not be always clear
- May not even be reasonable or feasible
- When in doubt, communication is very important
- You should always raise your questions before committing serious design efforts

Appendix: Image Sensor Sizes



Full Frame
36.00 x 24.00 mm



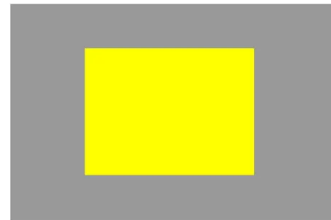
APS-H
27.90 x 18.60 mm



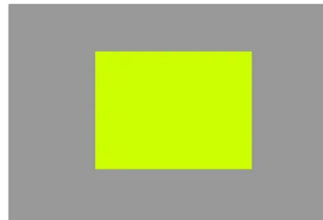
APS-C
23.60 x 15.60 mm



APS-C (Canon)
22.20 x 14.80 mm



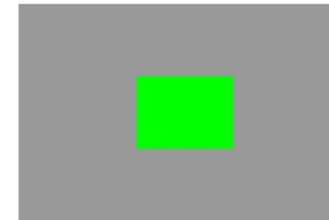
1.5"
18.70 x 14.00 mm



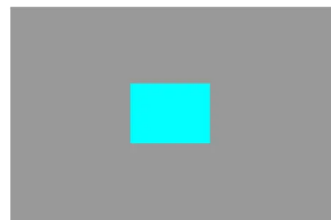
Micro Four Thirds 4/3"
17.30 x 13.00mm



1"
12.80 x 9.60 mm



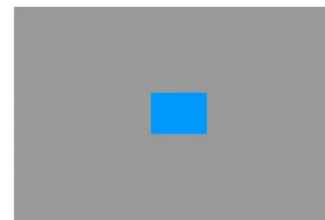
1/1.2"
10.67 x 8.00 mm



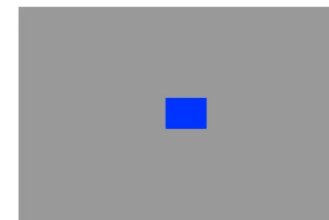
2/3"
8.80 x 6.60 mm



1/1.7"
7.60 x 5.70 mm



1/2.3"
6.17 x 4.55 mm



1/3.2"
4.54 x 3.42 mm