GODDARD SPACE FLIGHT CENTER

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TO: SAFIRE

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SUBJECT: OPTICAL DESIGN CONCEPT

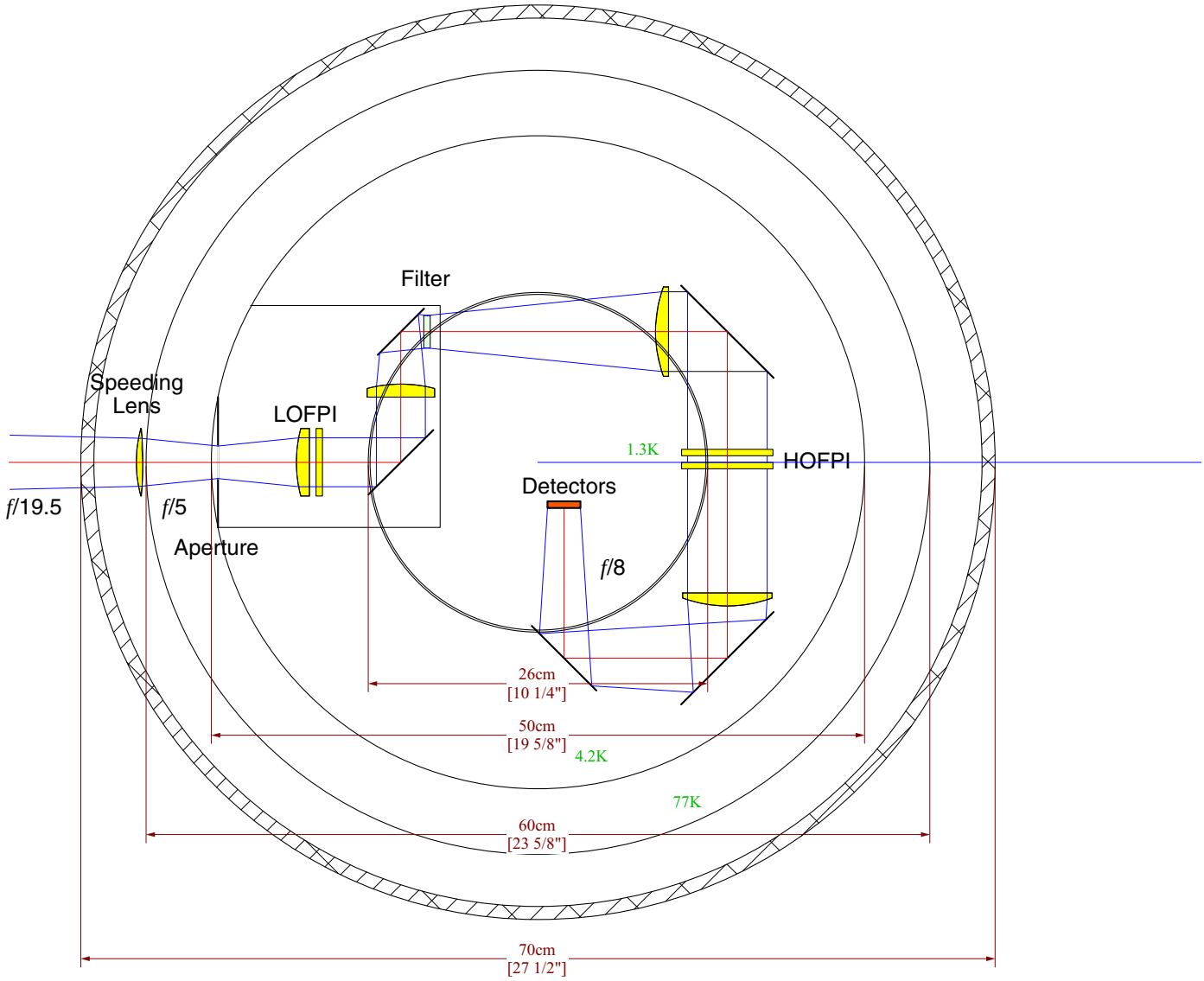
DATE: 2000-04-14

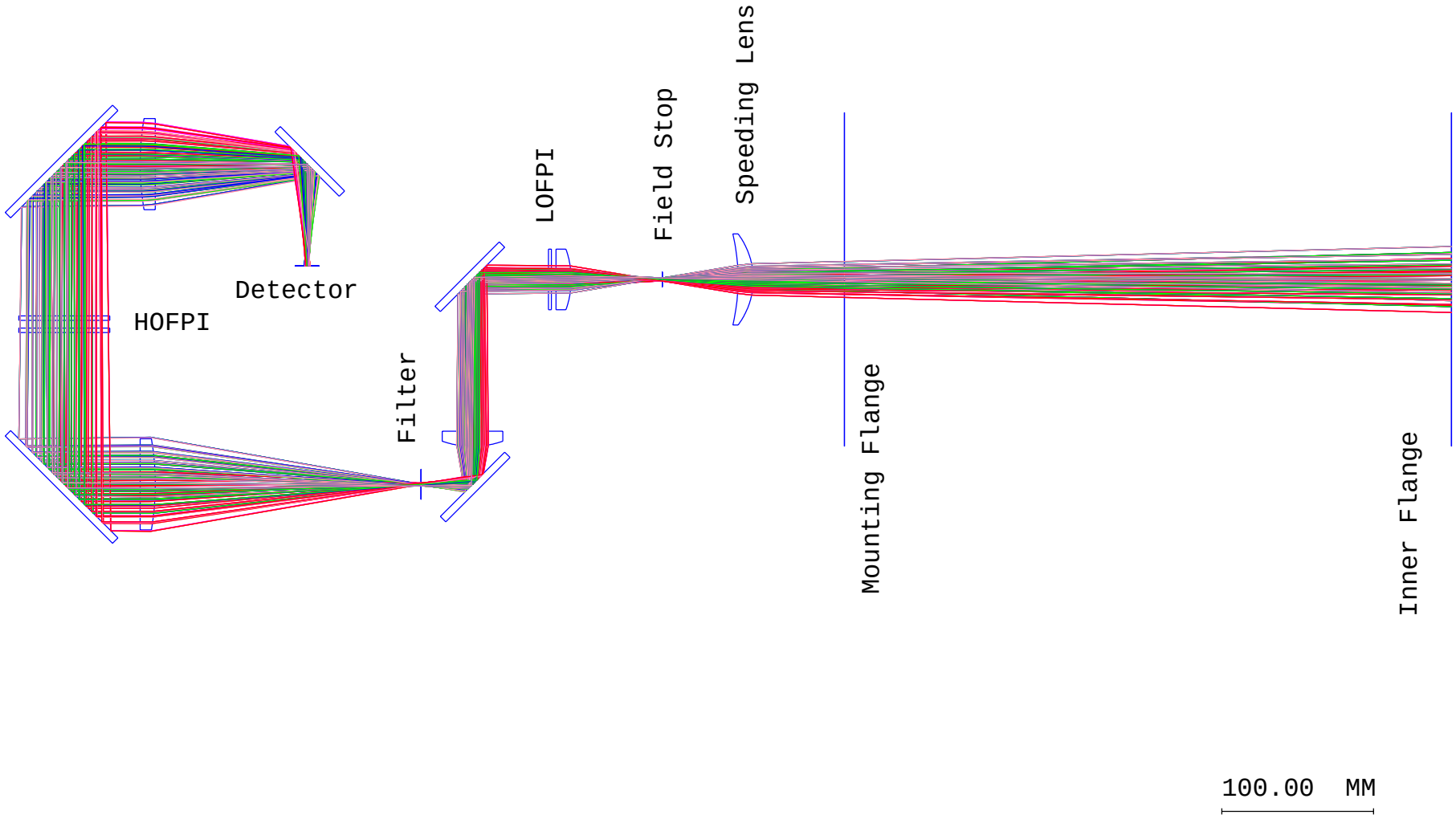
SAFIRE OPTICS CONCEPT

Due to instrument volume limitations, we must try to compress the SAFIRE optics into a cylindrical approximately 50cm in diameter and 30cm high. These dimensions are within 10cm of the absolute maxima allowable. Some tricks can be played in using the on-axis portion of the beam as additional optics volume (i.e. set the instrument away from the telescope and place some on-axis optics in that space).

I have tried to come up with a concept which looks correctly sized and possibly feasible. A sketch is included on the following page, using only thin-lens calculations. A full Code V model (page 3) agrees with this result, but has substantial spherical abberration. The models for SAFIRE and SOFIA are included.

My concept is only one of many possible; I chose to make all elements with power out of crystal quartz (n~2) lenses, which are reasonably flat and transmissive. In this manner, all beam steering uses flat mirrors only, which are easy to align. To first order, the lens alignment is not critical; it is the focusing which will be a bit harder. I have also determined that the chromatic aberration from either quartz or polyethylene lenses is insignificant as compared to the focal depth. This assumes no image plane curvature.


Filter
Speeding
Lens
LOFPI
1.3K
HOFPI
Detectors
f/19.5
f/5
Aperture
f/8
26cm
[10 1/4"]
50cm
[19 5/8"]
4.2K
77K
60cm
[23 5/8"]
70cm
[27 1/2"]



SAFIRE Preliminary Optics Layout

14-Apr-00

```
RDM;LEN       "VERSION: 8.40       LENS VERSION: 49       Creation Date: 16-Feb-2000"
TITLE 'SAFIRE Preliminary Optics Layout'
EPD   2500
NFO   1
FFO   0.0
IFO   0.0
DIM   M
WL    150000.0
REF   1
WTW   1
INI   ' '
XAN   0.0 0.005 0.005 0.005 0.0 -0.005 -0.005 -0.005 0.0
YAN   0.0 0.005 0.0 -0.005 -0.005 -0.005 0.0 0.005 0.005
VUX   0.0
VLX   0.0
VUY   0.0
VLY   0.0
PRV
 PWL 150000
 'Qtz' 2.0
 'HDPE' 1.5
 'SI Mnt' 1.1
 'Field' 1.1
 'Filter' 1.1
END
WTF   1.0
SO    0.0 0.1e13
S     0.0 906
S     -6400 -2754 REFL
  CON
  K   -1
  CIR L'out' 1352.5
  CIR OBS L'in' 210
  CUM -6600.0; THM 350.0
S     -954.13 1761.6 REFL
  STO
  CON
  K   -1.2980
  CIR 176
  CUM 0.0; THM -145.0
S 0.0 0 refl
  ADE 45
  ELX 176
  ELY 249
  BEN
  THM 45
S 0.0 -4385
S 0.0 .1 'SI Mnt'
  CIR EDG 110
S 0.0 -.1
S 0 -400
S 0.0 .1 'SI Mnt'
  CIR EDG 110
S 0.0 -.1
S 0 -60
S 0.0 0
S -50 -10 'Qtz'
  CIR EDG 30
S -132 -50
  CIR EDG 30
S 0.0 .1 'Field'
  REX 5
  REY 5
S 0.0 -.1
S 0 -60
S -60 -10 'Qtz'
  CIR EDG 20
S 0 -3
S 0 -2 'Qtz'
  CIR EDG 20
S 0 -50
```



```
S 0 50 REFL
  ADE -45
  BEN
  REX 20
  REY 30
  THM 5
S 0 50
S 0 10 'Qtz'
  CIR EDG 20
S -60 0
S 0 25
S 0 -25 REFL
  ADE 45
  BEN
  REX 20
  REY 30
  THM 5
S 0 -9
S 0.0 .1 'Filter'
  CIR EDG 10
S 0.0 -.1
S 0 -175
S -175 -10 'Qtz'
  CIR EDG 30
S 0 -50
S 0 100 REFL
  ADE 45
  BEN
  REX 30
  REY 50
  THM 5
S 0 3 'Qtz'
  CIR EDG 30
S 0 5
S 0 3 'Qtz'
  CIR EDG 30
S 0 100
S 0 -50 REFL
  ADE 45
  BEN
  REX 30
  REY 50
  THM 5
S -175 -10 'Qtz'
  CIR EDG 30
S 0 -100
S 0 67 REFL
  ADE 45
  BEN
  REX 20
  REY 30
  THM 5
S 0.0 .1 'Field'
  REX 8
  REY 8
S 0.0 -.1
SI    0.0 0.0
  REX 8
  REY 8
GO
```

```
RDM;LEN       "VERSION: 8.40       LENS VERSION: 49       Creation Date: 16-Feb-2000"
TITLE ’SOFIA Telescope Assembly’
EPD   2500
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FFO   0.0
IFO   0.0
DIM   M
WL    150000.0
REF   1
WTW   1
INI   ’ ’
XAN   0.0 0.07 0.07 0.07 0.0 -0.07 -0.07 -0.07 0.0
YAN   0.0 0.07 0.0 -0.07 -0.07 -0.07 0.0 0.07 0.07
VUX   0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
VLX   0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
VUY   0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
VLY   0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
PRV
 PWL 150000
 ’si’ 3.3784
END
WTF   1.0
SO    0.0 0.1e13
S     0.0 906
S     -6400 -2754 REFL
  CON
  K   -1
  CIR L’out’ 1352.5
  CIR OBS L’in’ 210
  CUM -6600.0; THM 350.0
S     -954.13 1761.6 REFL
  STO
  CON
  K   -1.2980
  CIR 176
  CUM 0.0; THM -145.0
S 0.0 0 refl
  ADE 45
  ELX 176
  ELY 249
  BEN
  THM 45
S 0.0 -4785
S 0.0 .1 ’si’
  CIR EDG 110
S 0.0 -.1
S 0.0 -300
SI    0.0 0.0
  cir edg 60
GO
```