Regarding baffles

Chapter I

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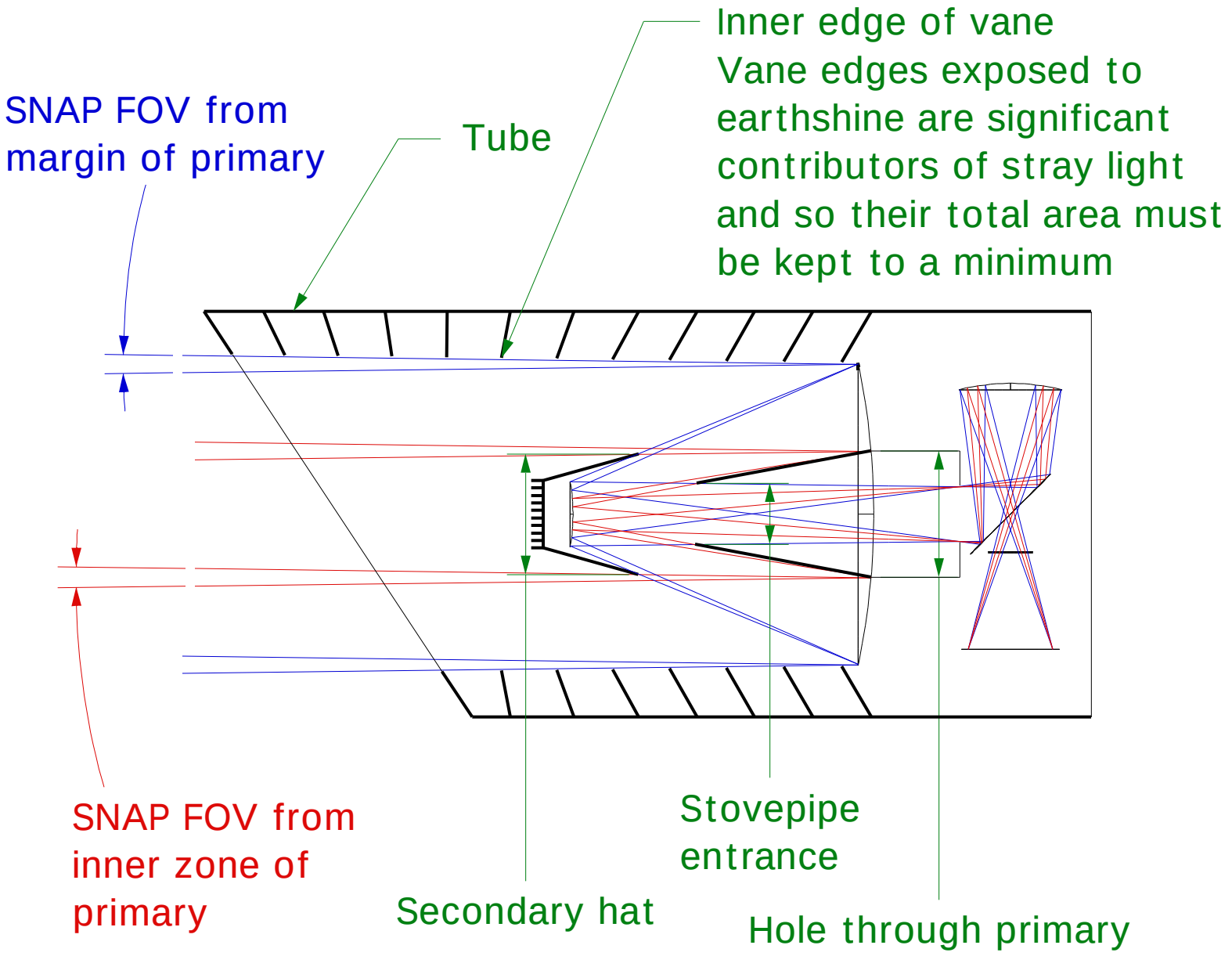
Parameters

Inputs	Outputs
* Roll on axis to mow lawn	*Sunshade cut angle
* Pitch to and from sun/earth to increase field area	*Length of baffle tube
	*Number of baffle vane edges
*Choice of fairing - large or small	*Size of secondary hat
	*Size of hole through primary

Items in red contribute to stray light/contrast
while items in green contribute to the amount of light gathered/speed.

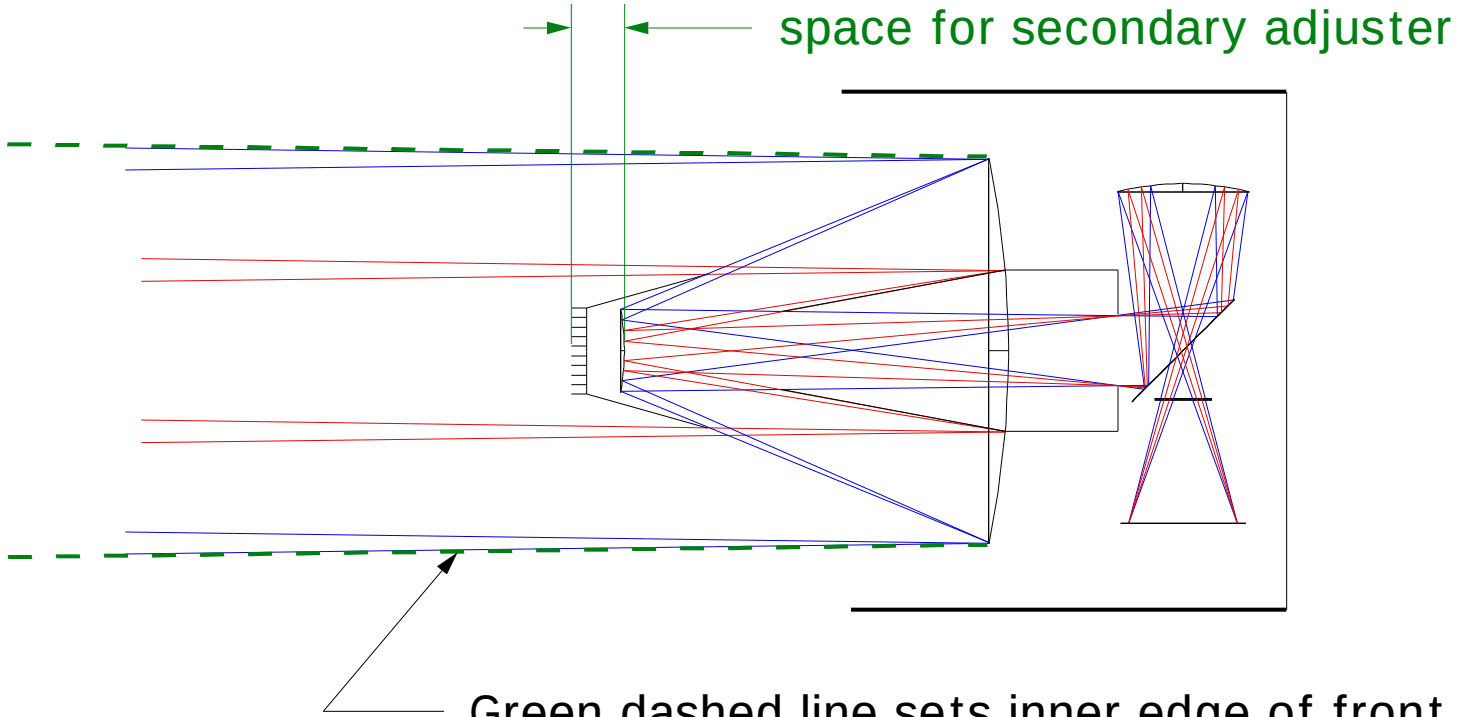
Section 1) Fitting a secondary hat and a primary hole
Section 2) Fitting vanes into the baffle tube

TMA62 & typical baffle - terminology



1) Secondary Hat

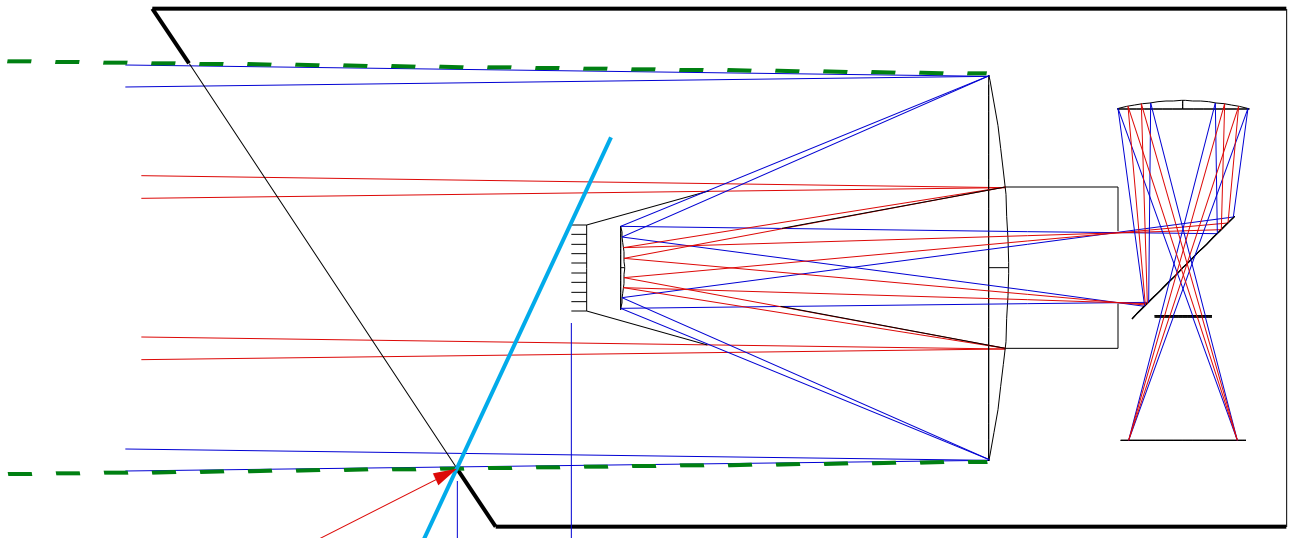
After the baffle tube length is set, one can proceed to the design of the secondary hat and the primary hole. If the tube diameter is also set, one can proceed to the design of the vanes. Therefore, we start with the baffle tube length.



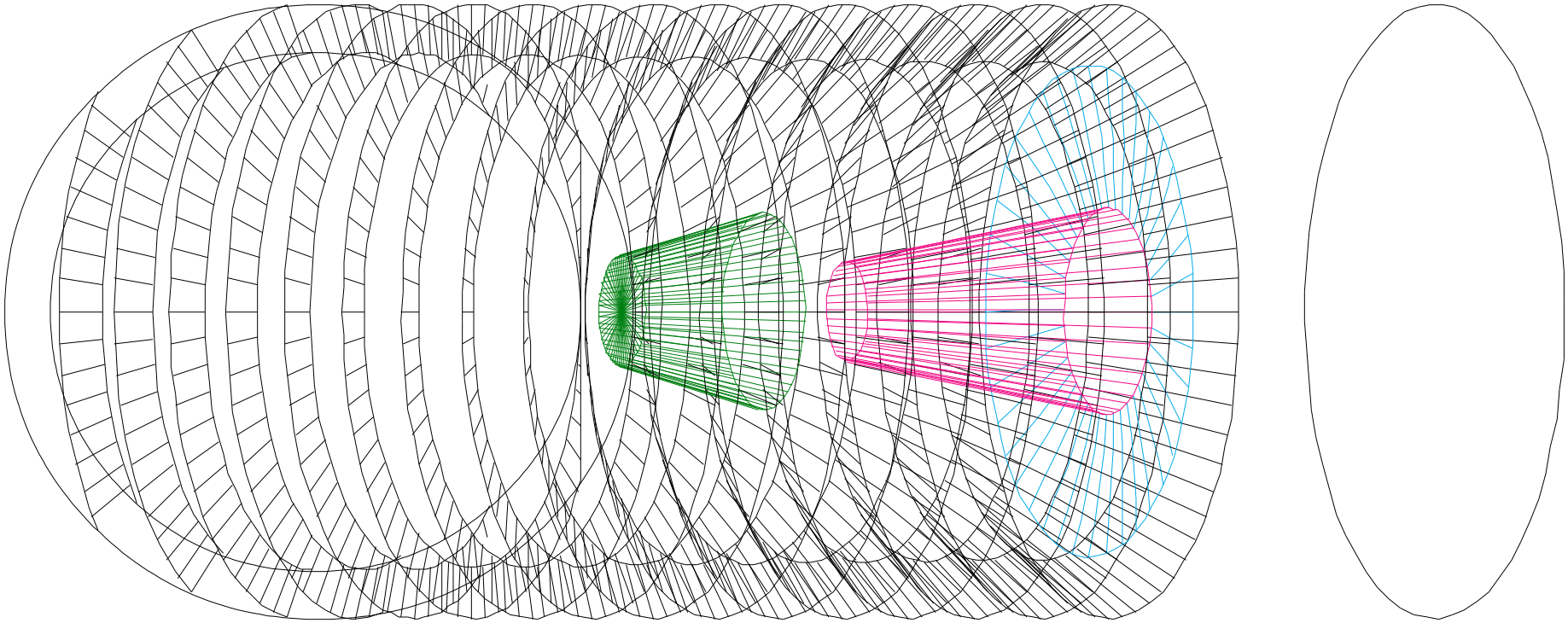
The green lines which have been added are 10 mm outboard of the extreme marginal rays. The 10 mm is clearance to allow construction tolerance.

The earth is up to 22° above the equator of 'scope. Add 3° for the subtended half angle of the earth. This gives a 25° earthshine line.

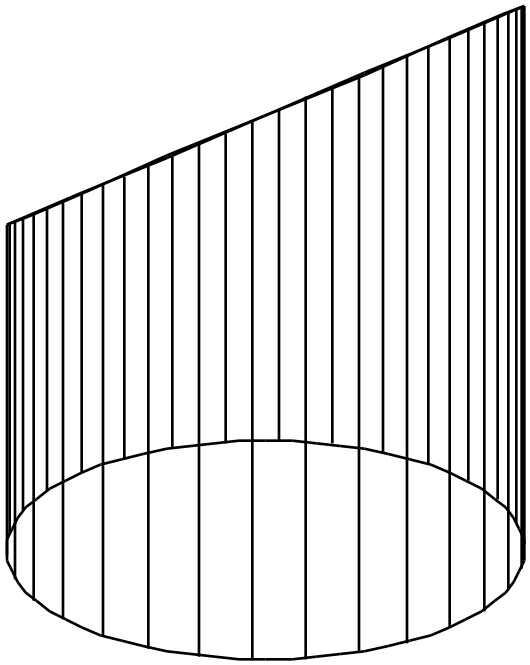
Earthshine line shown just tangent to edge of secondary hat for minimum length of short edge of baffle. Earthshine is very bright and shouldn't be allowed to make a bounce off the crown of the hat to a nearby vane and into the primary. It may help to put egg crate vanes on the crown of the hat (shown).



By way of example, here is a 2.5 m diameter baffle pitched 25° towards the line of sight. Note that the line of sight to the hat is blocked. This is a minimum-length baffle.

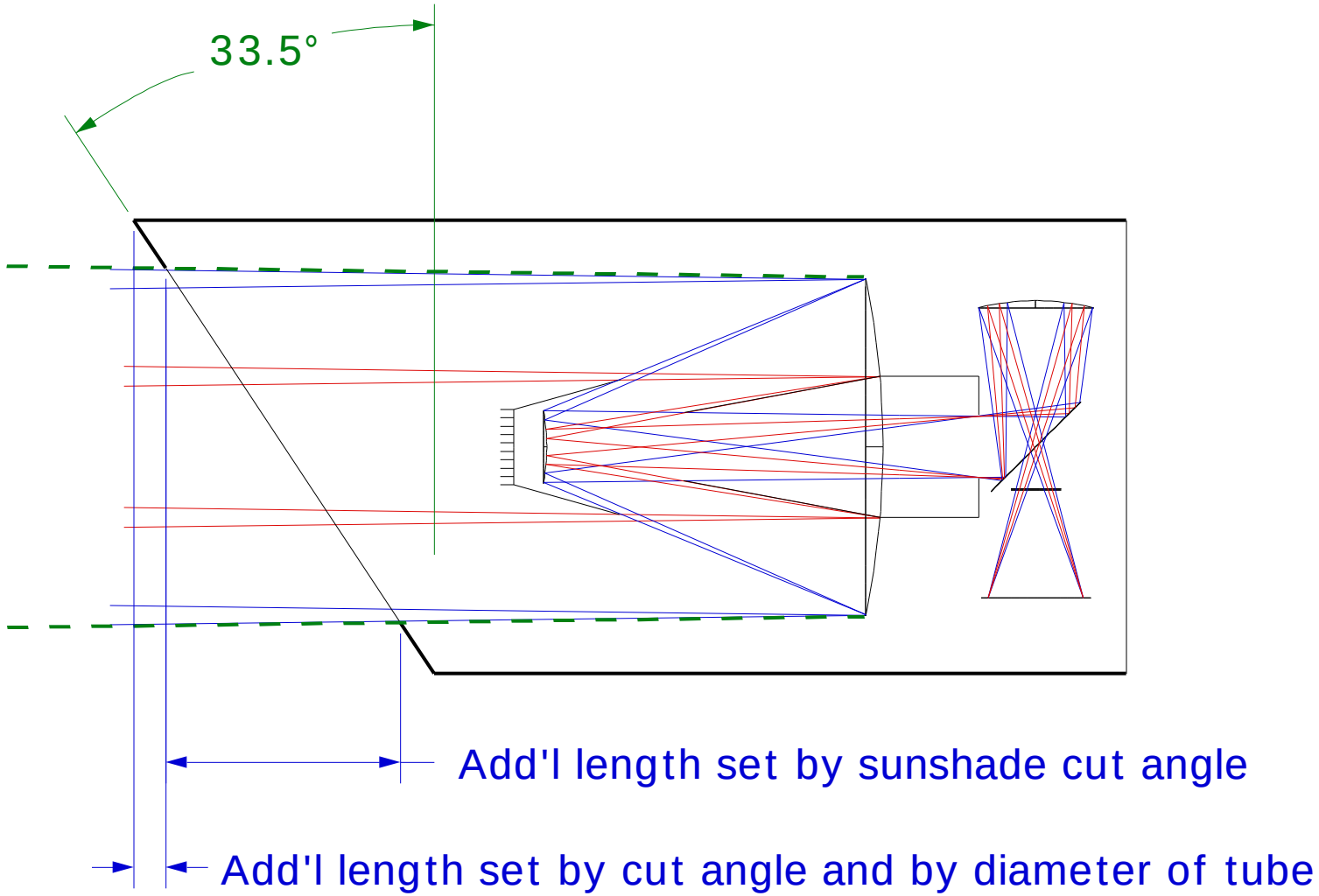


The sunshade is cut at 33.5° to allow rotating the 'scope 45° on axis when pitched 25° towards the line of sight.



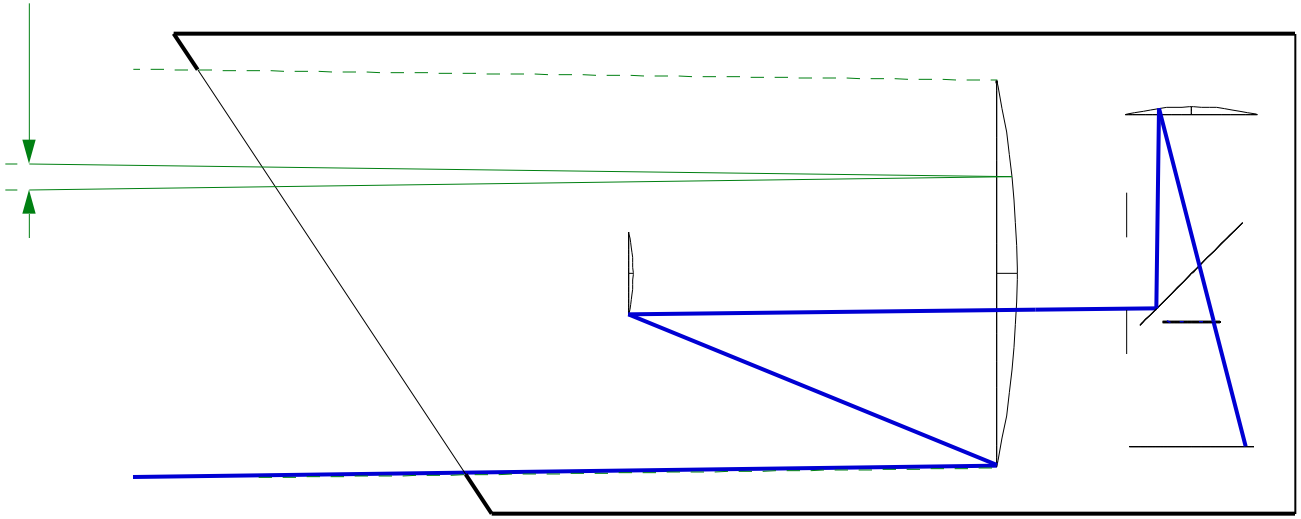
This graphic shows the baffle cut at 33.5° with the 'scope rotated 45° and pitched 25°. Note that there is no line of sight into the baffle.

This graphic shows the effect of the 33.5° cut on the baffle tube's length.



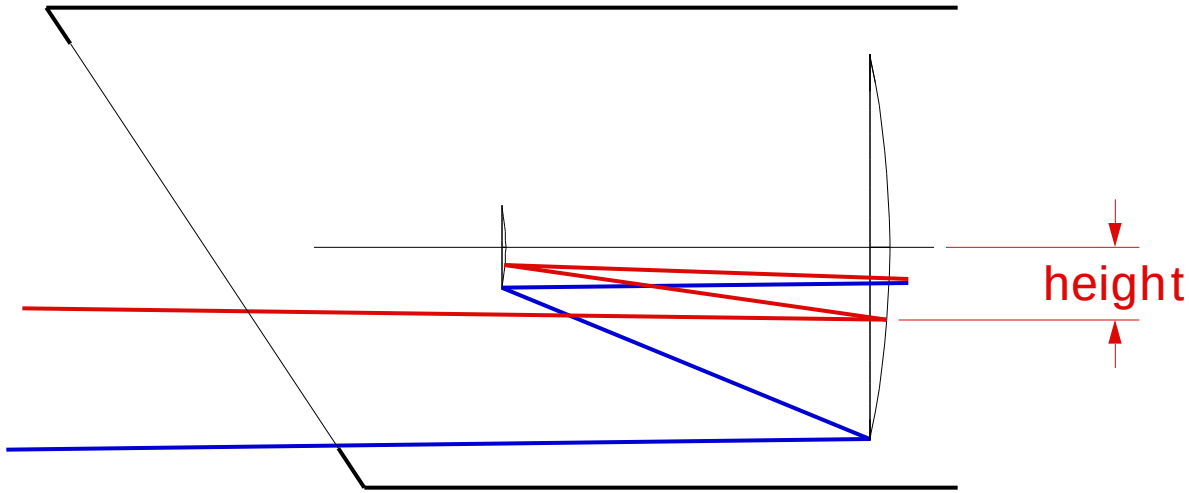
Having set the position of the entrance to the baffle, we can proceed with the design of the secondary hat and primary hole. We don't want to vignette any field cone from any point on the surface of the primary because that would lead to inaccuracies in photometry.

typ field cone

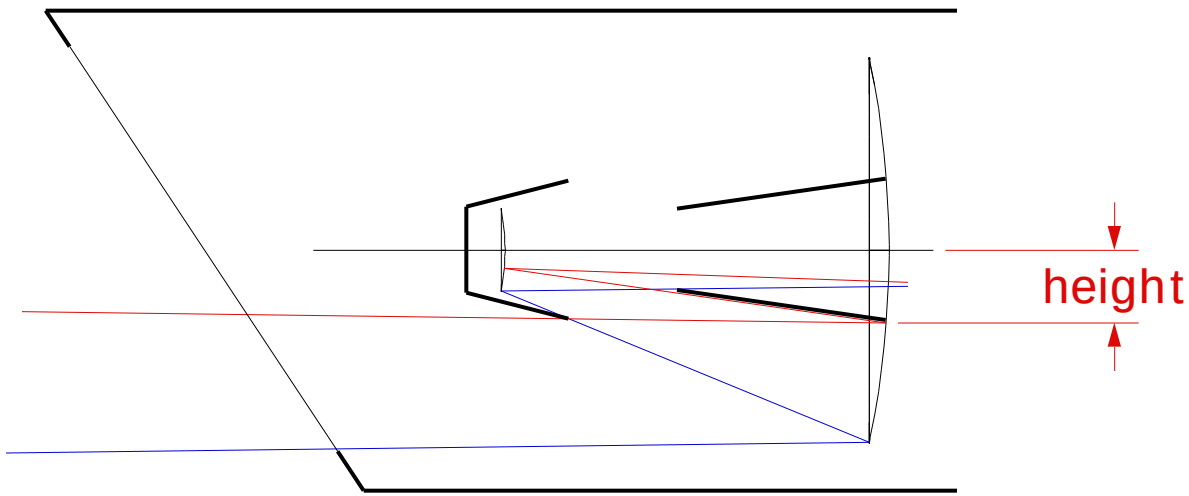


Lay in an extreme marginal ray - we certainly don't want to vignette it.

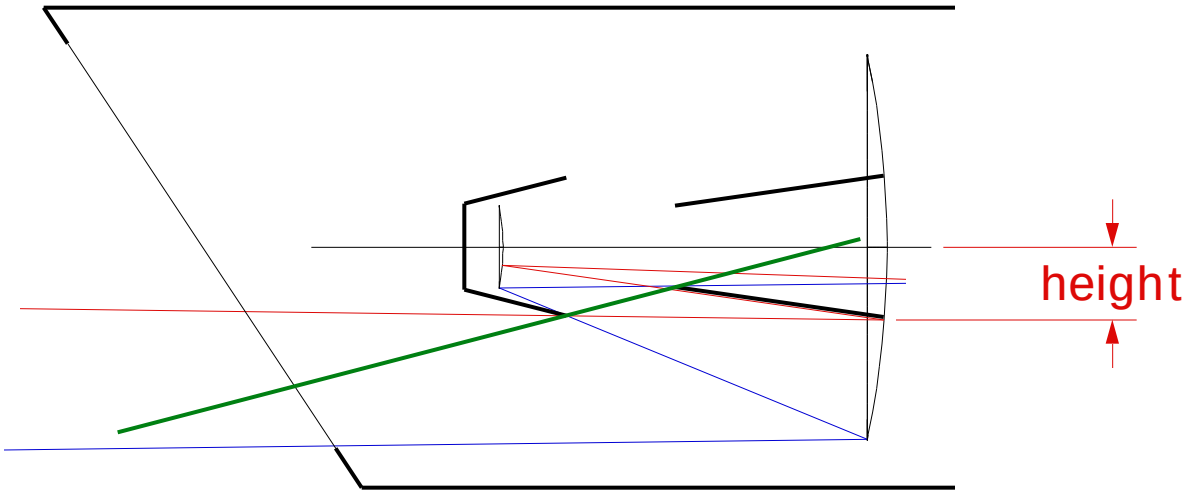
Next we lay in an extreme central ray at an arbitrary height on the primary. We don't want to vignette this ray either. Note that this extreme ray is coming from upper left while the blue extreme ray is coming from lower left.



Add in the secondary hat and stovepipe such that they do not block the extreme marginal and central rays.

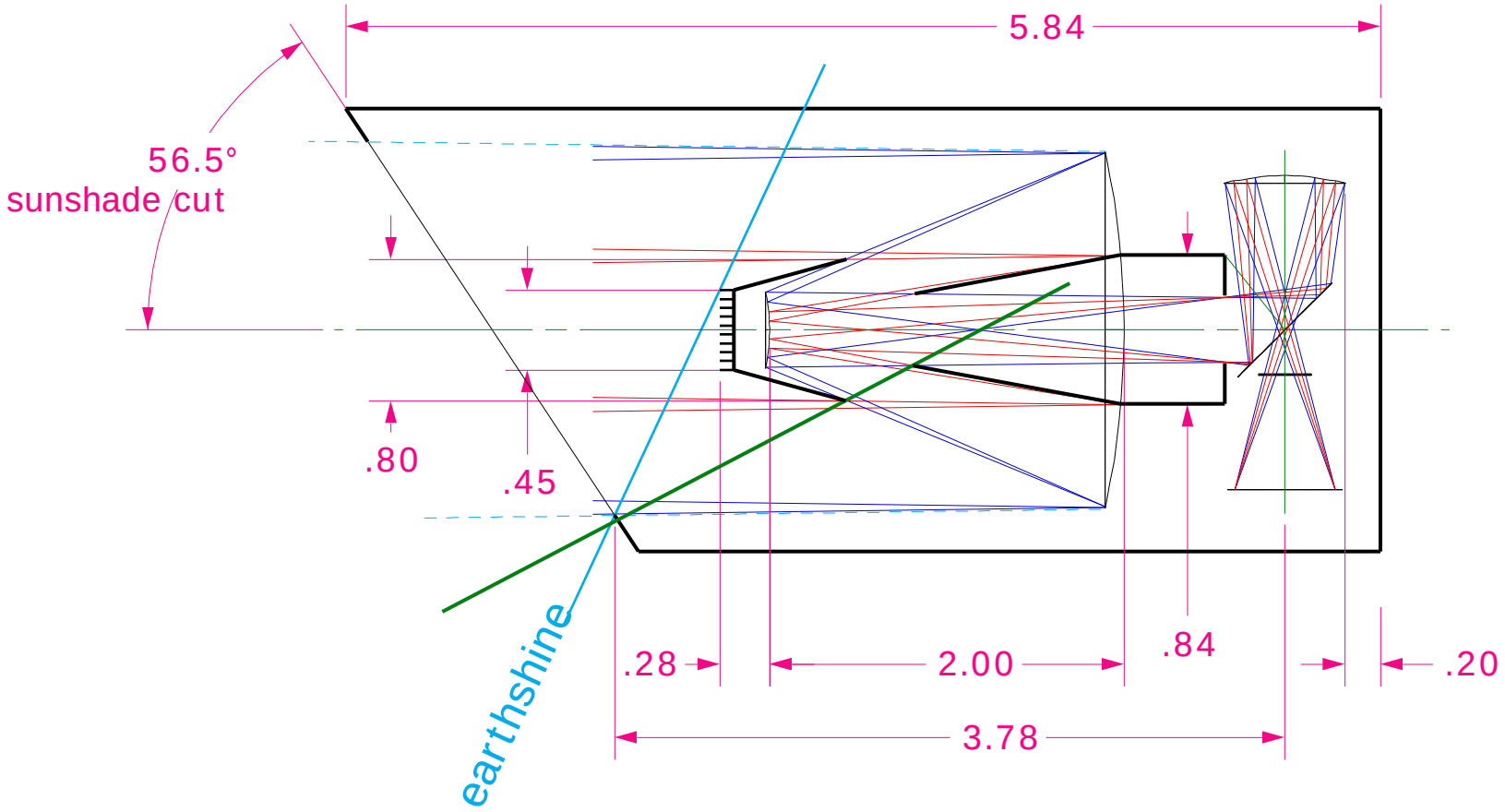


Lastly, we must check to see that there is no line of sight into the stovepipe.



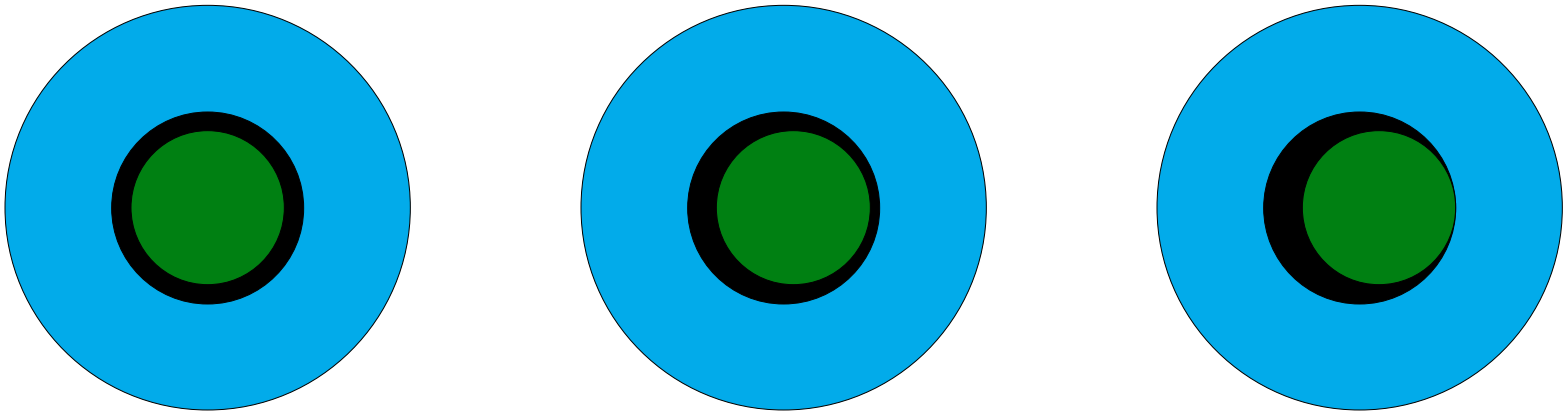
In this case there is a line of sight into the stovepipe, so we must increase the height of the incident extreme central ray.

By suitably adjusting the height of the central ray, we get this.
Again, this is for the minimum baffle length.

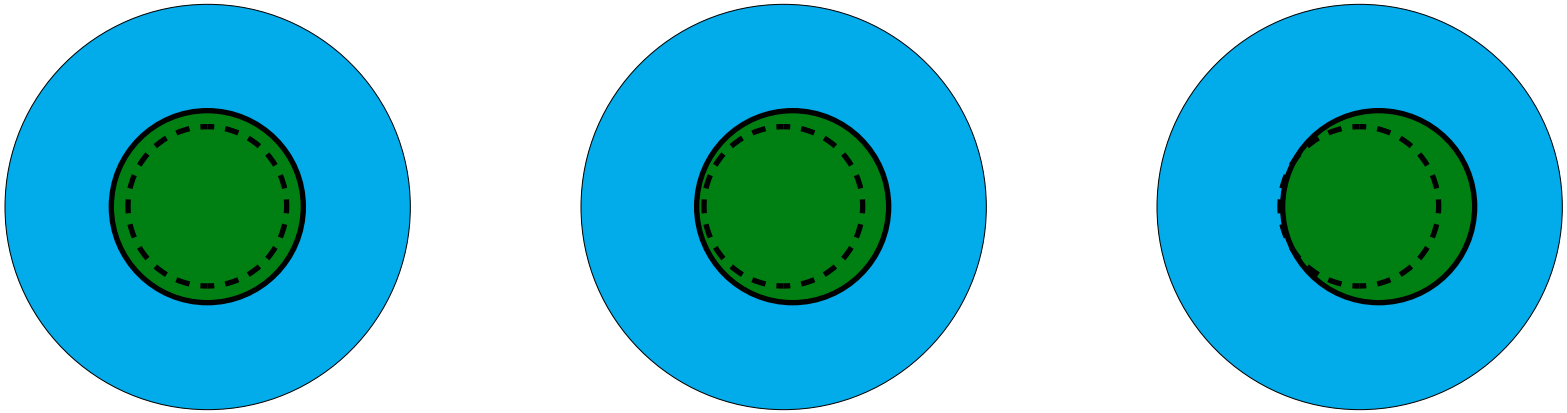


The line of sight into the stovepipe is now blocked by the baffle.

This is the view of the telescope head on from an infinite perspective. As the 'scope is yawed to full half field, the hat moves to the edge of the hole in the primary.



It is also possible to make the hat larger and the hole in the primary smaller:

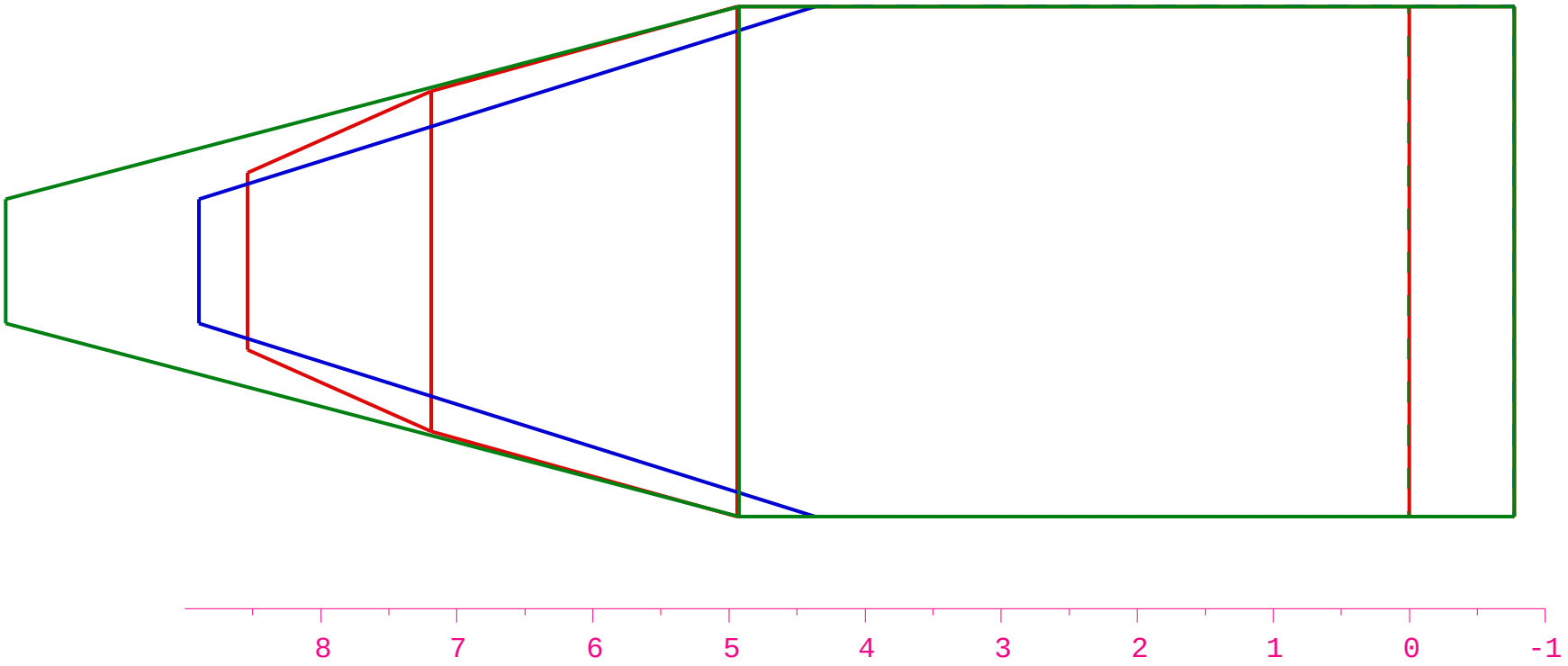


In either case there is no vignetting, but in the latter case, the hat assumes the diameter of the hole in the former case and vice-versa, so there is no light gain.

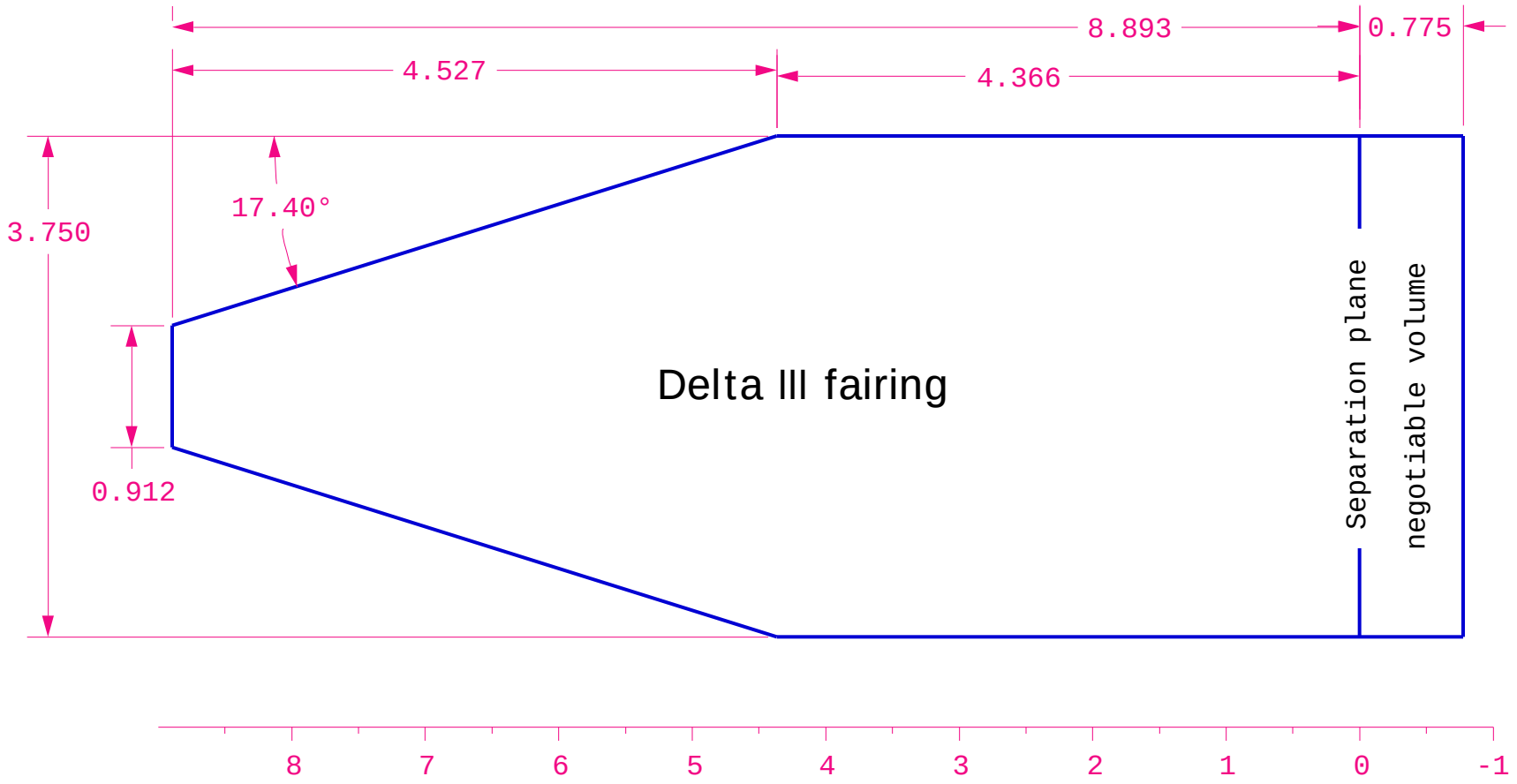
2) Fitting vanes into the baffle tube

SNAP has to fit in a fairing. There are a number of fairings available. Our baseline is the Delta lll fairing. This will limit the size of the baffle tube and that has an effect on the size and number of vanes.

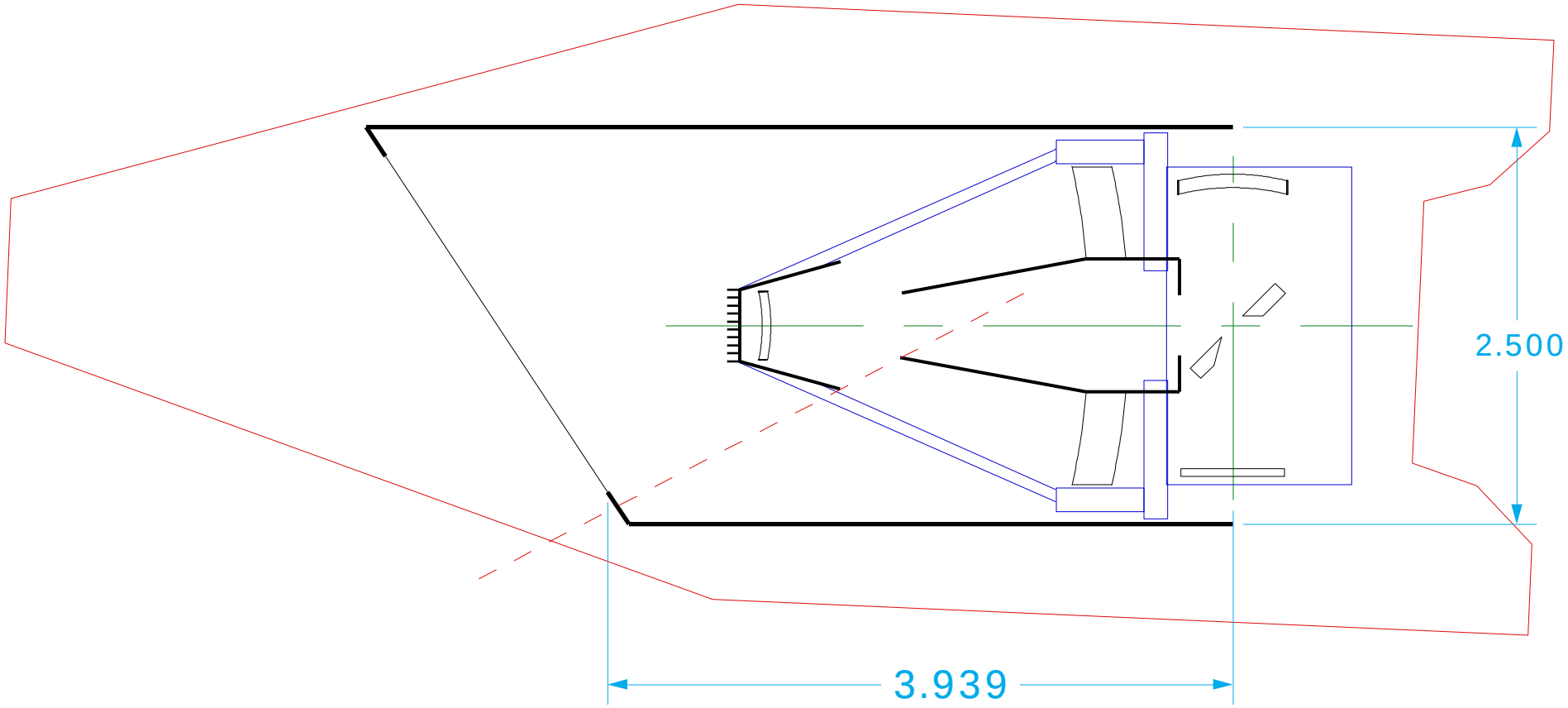
Delta III
Sea Launch
Atlas V extended fairing



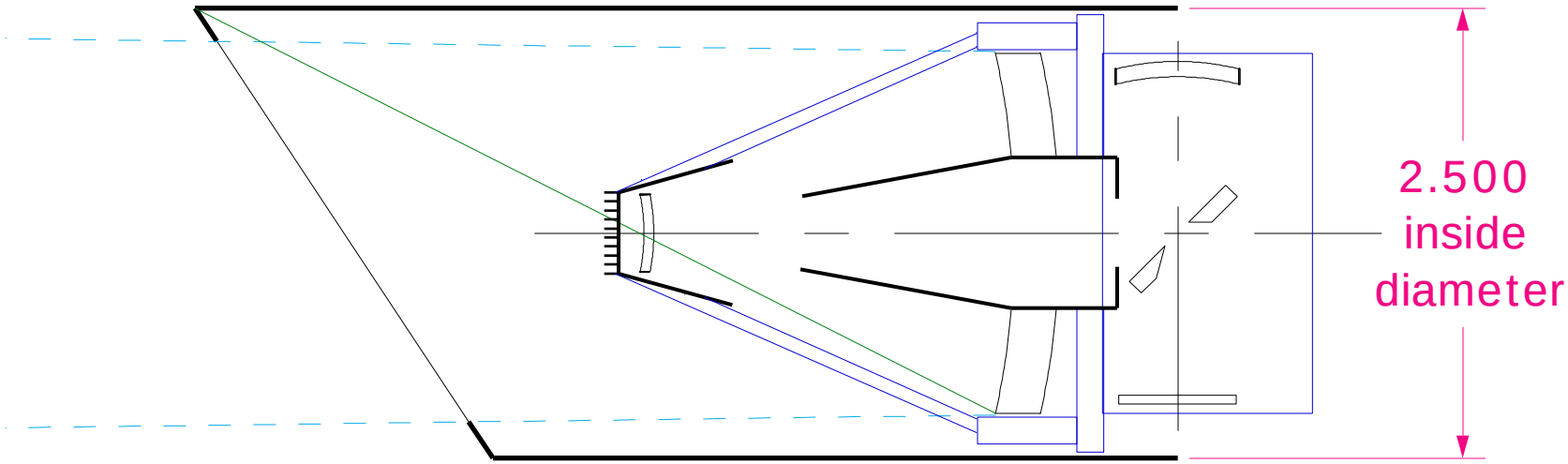
The outline of SNAP must fit into this fairing:



This is what Dave Pankow tells us will fit in the Delta III fairing. Dave cut the baffle tube diameter to a minimum, shifted it in the fairing, and tilted it to achieve the length shown.

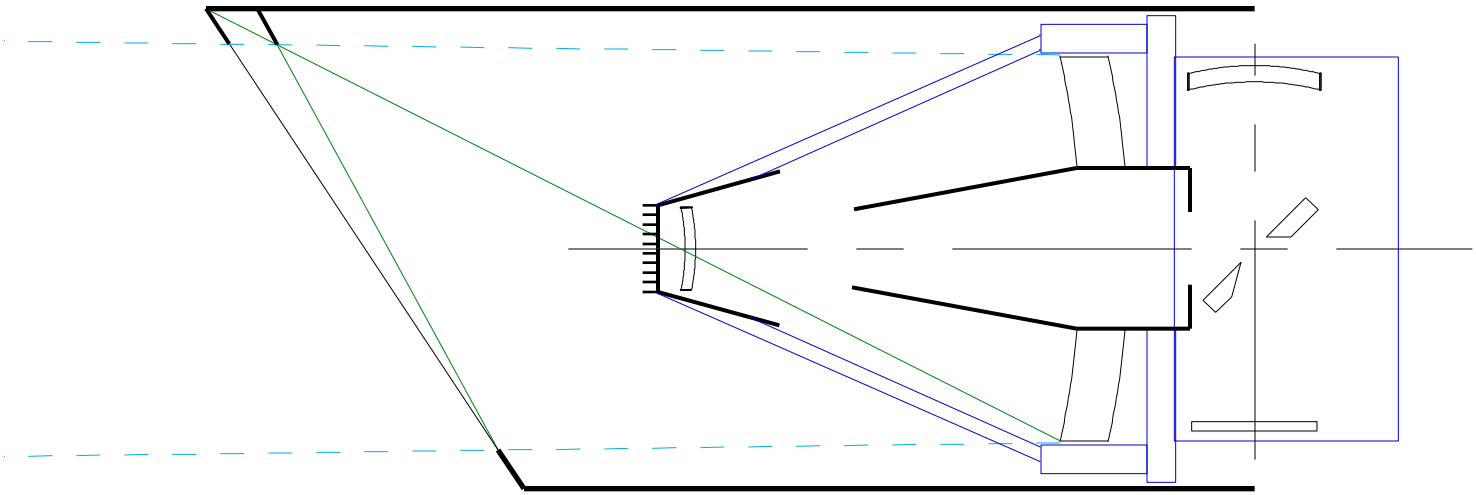


First we lay in a line from the margin of the primary to the farthest unlit region.



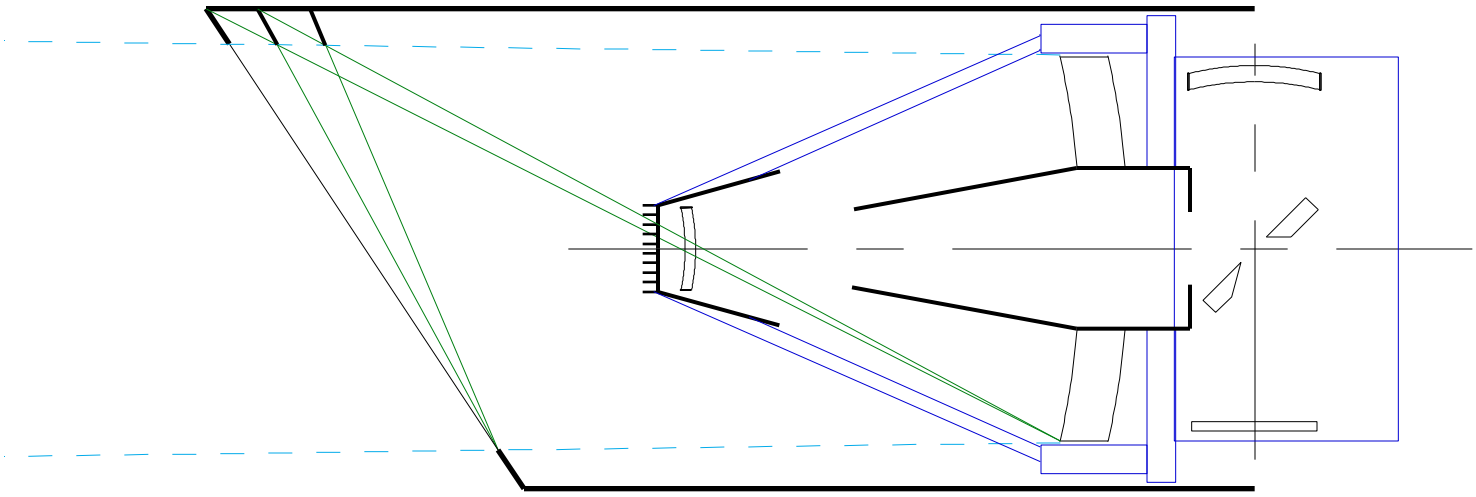
Where the green line and the cyan extreme ray clearance lines cross, we'll need a vane to protect the primary from light off the interior of the tube. To provide manufacturing tolerance, we also shift each vane 10 mm to the left of its theoretical position.

First vane added. Note that the vane points at the short edge of the baffle's faceplate. This is so earthshine can't "get under" the baffle and light its underside.



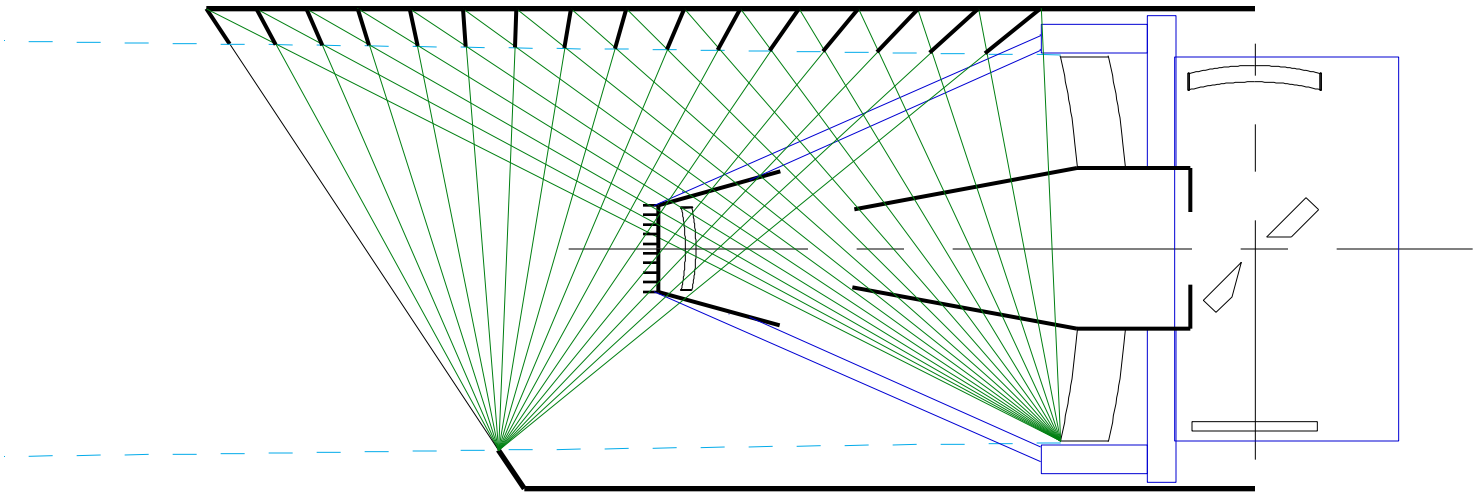
An alternative scheme would have the vanes radial, but the present scheme has some tendency to send light out the way it came and also Dave Pankow prefers conical vanes to promote vane stiffness.

And so on, ad infinitum, ad nauseum....



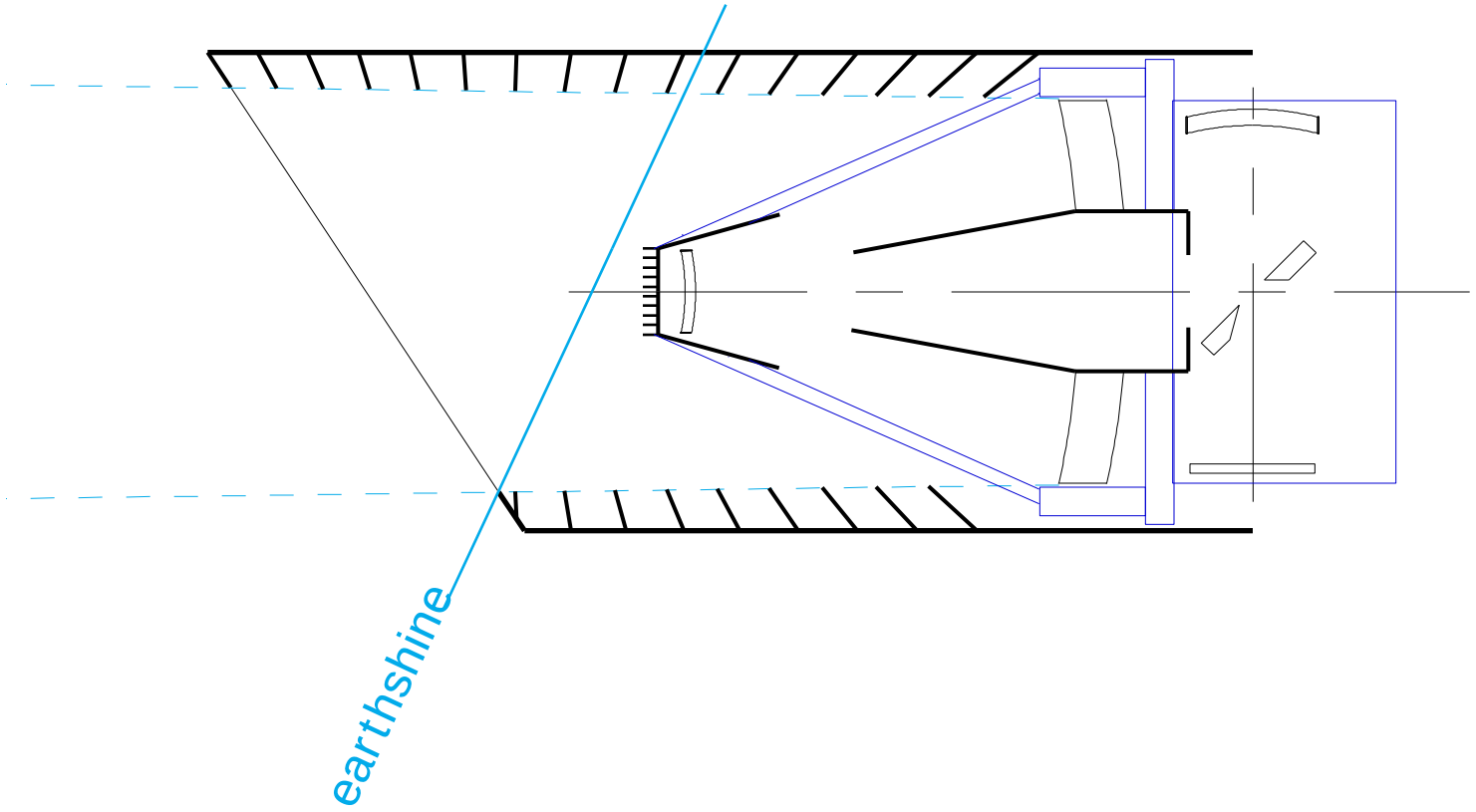
Until....

We have a full set of vanes on one side of the tube.



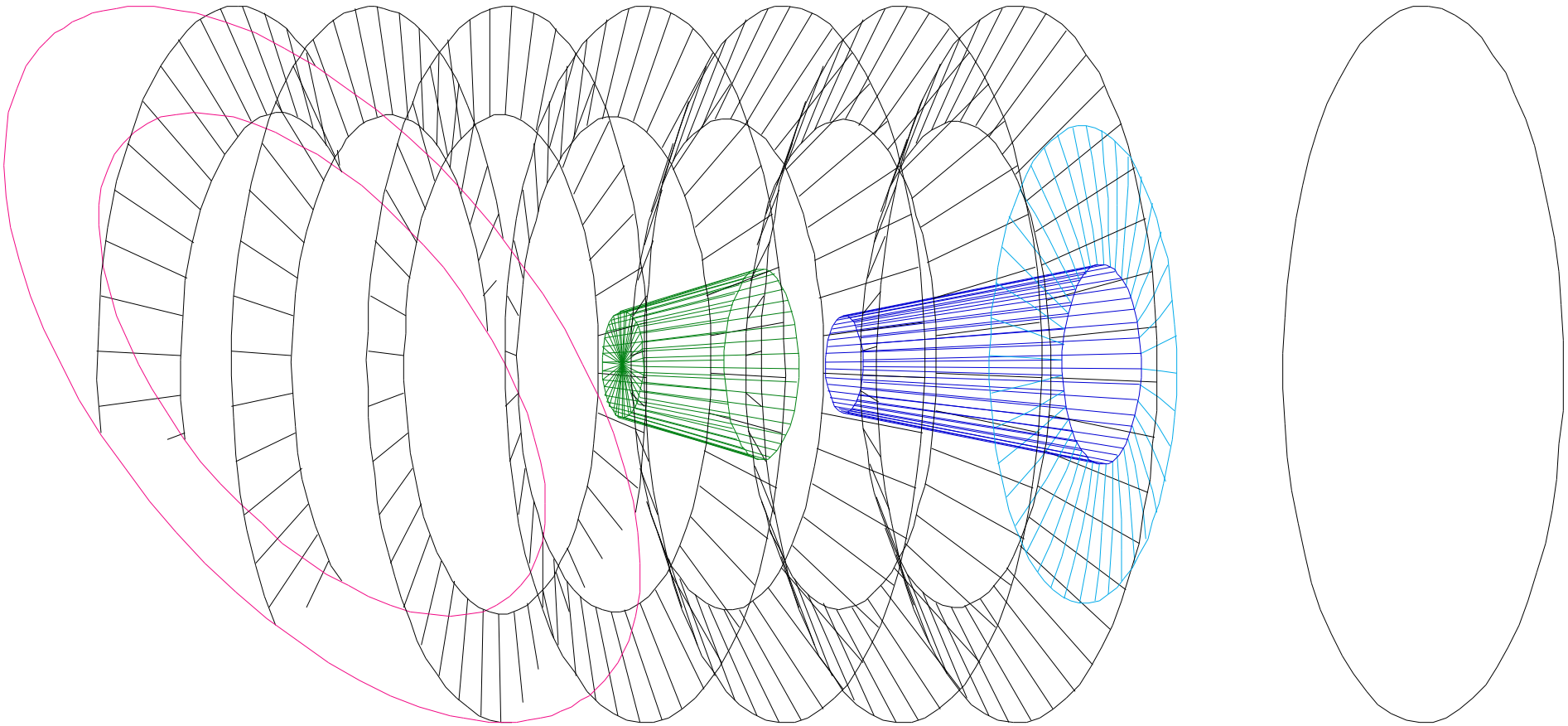
We then reflect those to other side to complete the cones.

And we get this figure:



Past the earthshine line, there's no real advantage in any particular cone angle.

Here's a 3 m baffle. Note very few vanes.



Advantage: fewer vanes

Disadvantages: Leads to a shorter baffle tube and the vanes have a longer radial dimension, possibly leading to a stiffness problem.

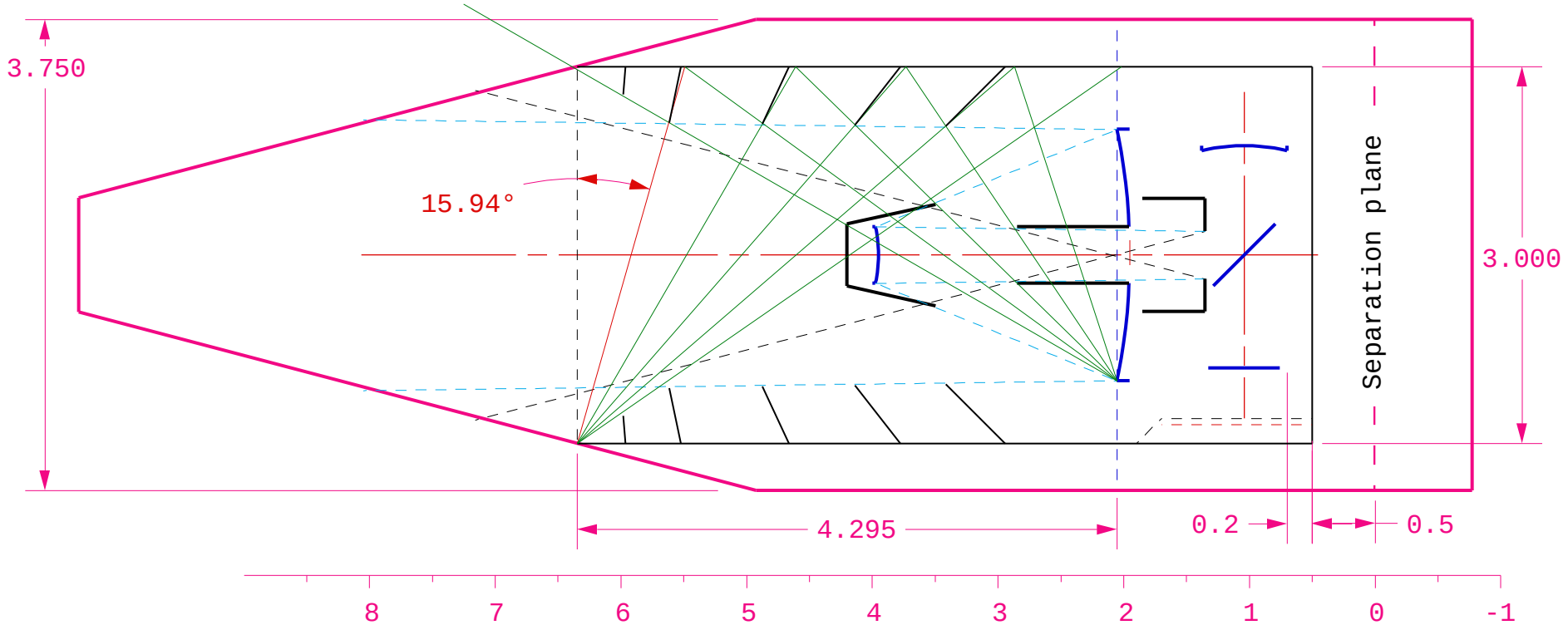
This spreadsheet gives an idea of the lengths to which we would have to go to reduce the hat and primary hole diameters.

HatSize4.xls

	A	B	C	D	E	F	I	J	K	L	M	N	O
1													
2					line of	primary face		greatest tube length				primary face	
3		primary	unvignetted		sight into	to line of	cut angle	from back of craft for			least*	to mouth	
4		face to	primary	mirror area	stovepipe,	sight axial	degrees	tube of diameter, meters			stovepipe	of stovepipe	
5	hat size	hat edge, m	hole dia	loss, %	degrees	intercept, m		2.5	2.7	3.0	diam., m	m	
6													
7	0.450	-	0.450	0.00	0.00	-infinity	33.50	infinite	infinite	infinite	-	-	
8	0.658	1.634	0.700	0.08	9.52	-0.325	33.50	9.275	9.342	9.441	0.402	0.872	
9	0.707	1.579	0.750	0.09	13.47	0.106	33.50	7.656	7.722	7.821	0.403	0.948	
10	0.756	1.513	0.800	0.12	19.50	0.446	33.50	6.499	6.565	6.665	0.405	1.017	
11	0.799	1.463	0.840	0.13	27.62	0.695	33.50	5.761	5.827	5.927	0.406	1.083	
12	0.818	1.440	0.860	0.14	31.40	0.770	33.50	5.545	5.611	5.710	0.407	1.104	
13	0.862	1.385	0.900	0.16	45.49	0.962	33.50	5.043	5.109	5.209	0.408	1.162	
14	0.964	1.261	1.000	0.21	89.96	1.260	33.50	4.317	4.384	4.483	0.410	1.260	
15													
16							A->	0.240	0.340	0.490			
17							B->	5.370	5.421	5.499			
18													
19											* greatest is primary hole diam.		
20			Note: distance from primary face to back end of spacecraft is 1.55 m										
21			if clearance from edge of tertiary to back end of spacecraft				A) max. radial vane dim						
22							B) minimum baffle length for this tube diameter						
23							if earthshine not to hit hat and top of hat						
24							.276 m from secondary vertex						
25													

Sheet1 / Sheet2 / Sheet3

Atlas V extended fairing, interior
Cyan lines are stay-clears. Clearances 10 mm.
Ecliptic orbit, 3.0 m D trumpet shade allows pointing up to
15.9° off ecliptic poles and 360° rotations about scope axis
with only 5 baffle vanes (plus diffraction edges, not shown).



Here's an interesting idea from Mike Sholl - the trumpet baffle. The distal vanes can't be seen from the primary. Unfortunately, we can't tip off the ecliptic much unless the baffle is very long.

Synopsis

The earthshine line and the secondary hat position set the minimum baffle tube length. (But we want the longest tube possible.)

The length of the baffle sets the hat diameter and the diameter of the hole in the primary.

A smaller diameter baffle tube allows for a longer baffle, but results in the need for more vanes and vane edges.