A RADIOMETRIC MODEL FOR THE TROPOSPHERIC EMISSION SPECTROMETER (EOS/TES)

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Introduction

A radiometric model incorporating all known or estimated properties of the TES instrument has been constructed. All incident source and self-emitted photons are traced surface-by-surface from the entrance aperture to the focal plane and the consequent photoelectrons traced through the signal chain to the output of the analog-to-digital (A-D) converter (see optical schematic). From this analysis we can estimate:

Signal-to-noise ratio (SNR)
Noise-equivalent source radiance (NESR)
The dominant noise source (background photons, detector or pre-amplifier)
The peak amplitude of the ideally-sampled interferogram to optimize gain settings

Some examples of the output of this computer program (written in IDL), using parameter values shown in the table, are attached.

The filter regions chosen for this display are selected from those used for our routine "Global Survey" observations.

Description

All spectrally-dependent parameters (e.g., source radiance, filter transmittance, etc.) have been interpolated onto a common 5 cm^{-1} grid (i.e., 0.1 cm max OPD) using measured values wherever available, "best estimates" otherwise.

During test and calibration the parameters will be refined and adjusted to bring them into agreement with measurements of both the internal blackbody and external standards. The goal is <5% difference between the two.

After launch, the parameter files will be periodically updated so that their trends can be used to estimate component degradation over time and also to indicate when a decontamination sequence is necessary.

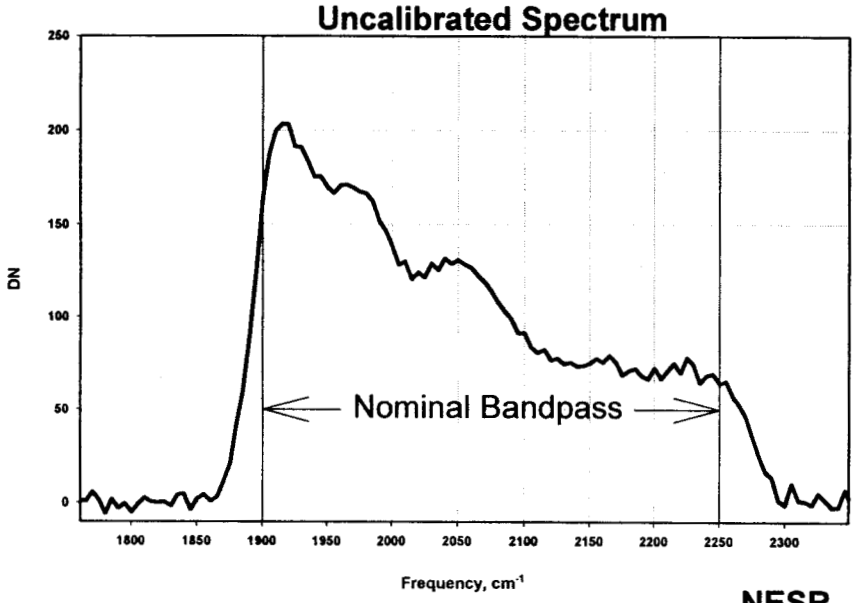
PARAMETERS WITH TEMPERATURE-DEPENDENT EFFECTS

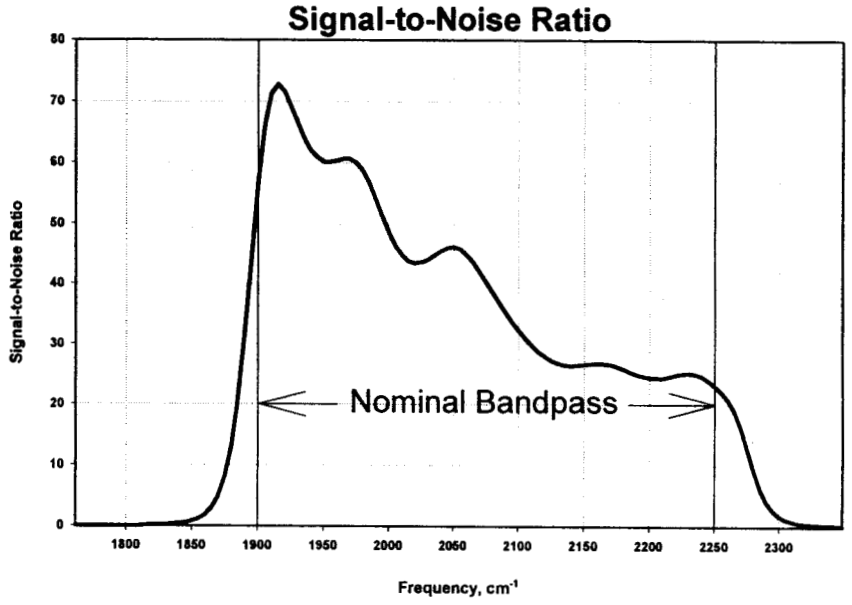
Element	Parameters	Temperature
Pointing System	2 Reflections R=0.99 (BOL); R=0.97 (EOL)	290K
	2 Emissions ϵ = 1-R (default)	290K
Spectrometer	15 Reflections	180K
	15 Emissions	180K
	KBr Beamsplitter & Compensator	180K
Focal Plane Assemblies	2 Lenses	77K
	1 Dichroic Filter	77K
	1 Bandpass Filter (up to 5 choices)	77K
	1 MCT 1x16 Detector Array	65K
	1 Pre-Amplifier	77K

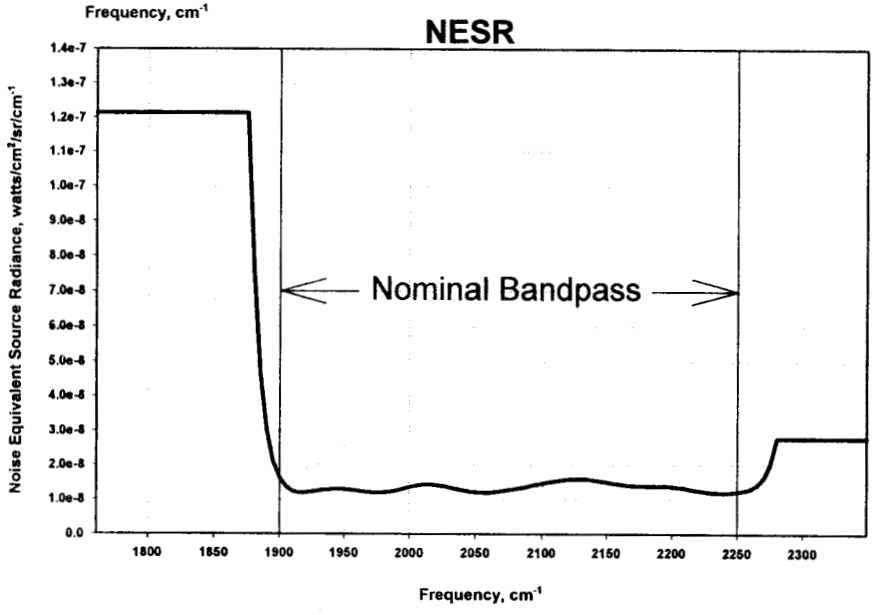
PARAMETERS WITH TEMPERATURE-INDEPENDENT EFFECTS

Étendue	9.448x10-5 cm^2.sr
Cassegrain Obscuration	0.75
Factor for Single-Ended Operation	0.5
Post-Amplifier	ASIC Filter, Gain=2.5 x 4 Switchable Gain Steps
A-D Converter	±5 V input; $\pm 2^{15}$ DN Output
Maximum Optical Path Difference	Short (Nadir & Calibration) Scan: ±8.45 cm
	Long (Limb) Scan: ±33.79 cm
Spectral Sampling Distance	Short Scan: 0.0592 cm^{-1}
	Long Scan: 0.0148 cm^{-1}
Scan (Integration) Time	Short Scan: 4 seconds
	Long Scan: 16 seconds
Factor for Alias Split	0.5

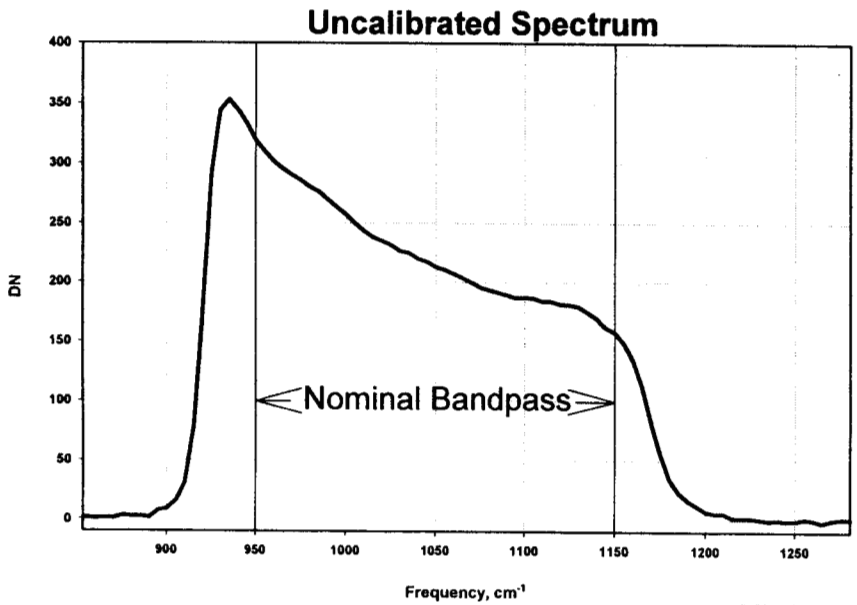
Filter 1A1, 300K blackbody source, gain step=2
(Frame=Alias)
System is background limited

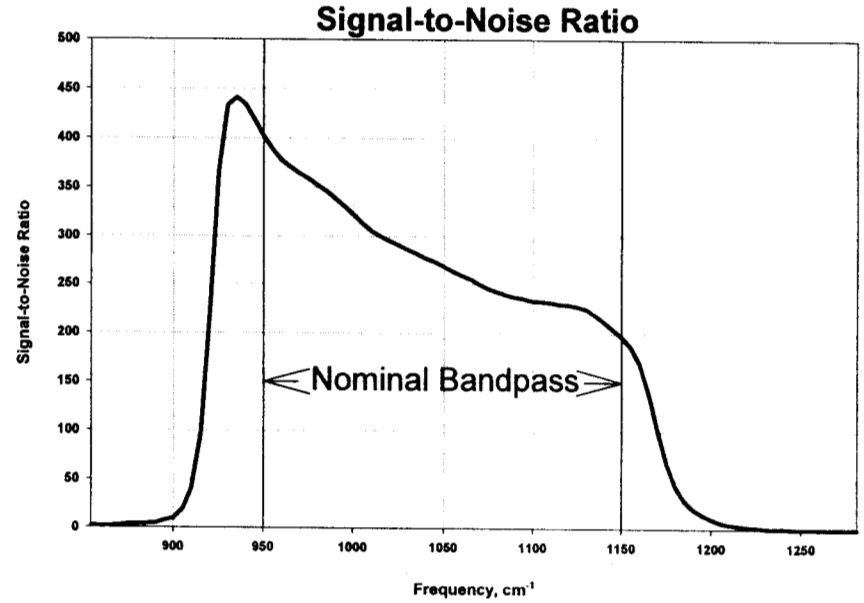


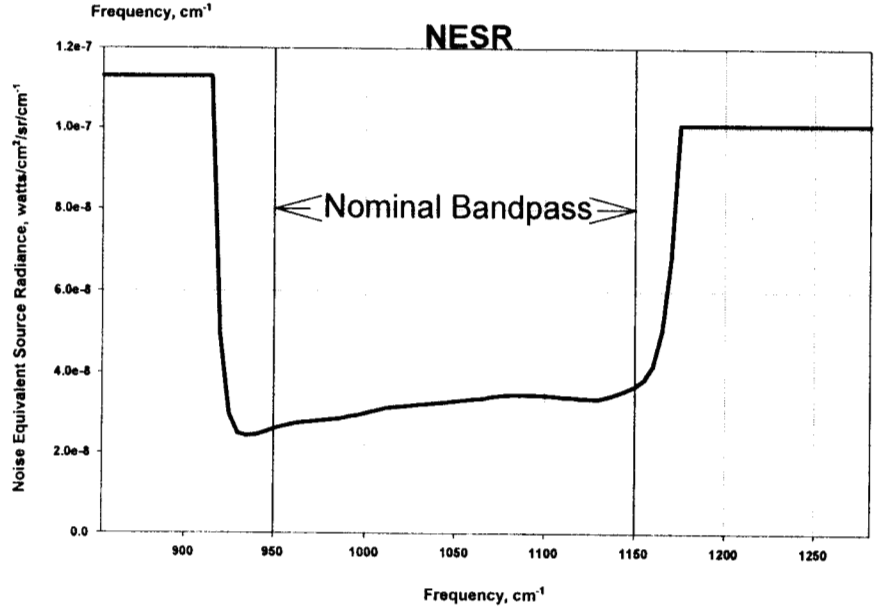




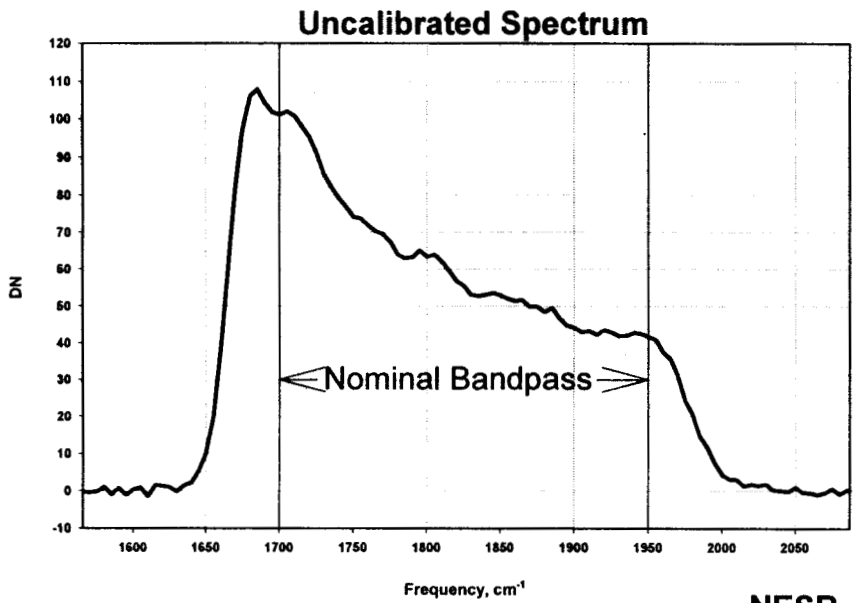
Filter 1B2, 300K blackbody source, gain step=2
(Frame=Alias)
System is background limited

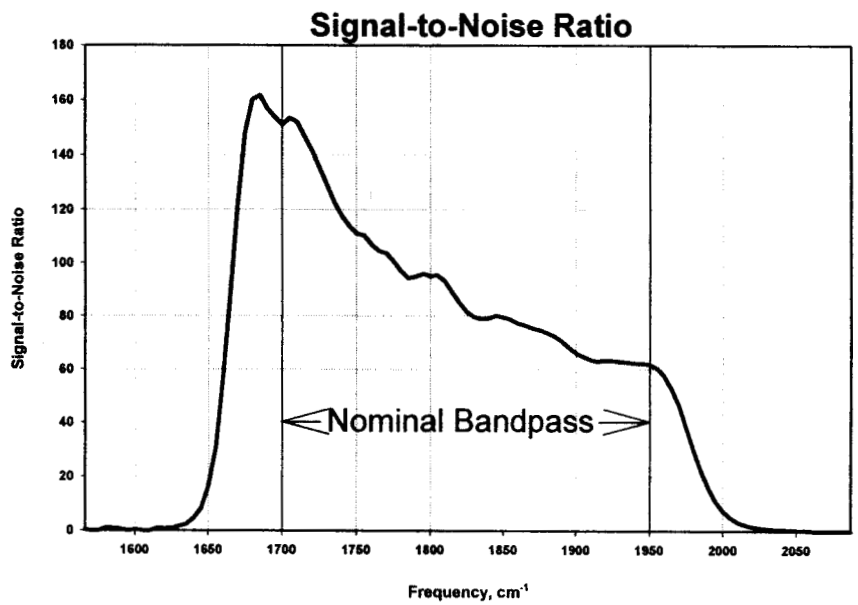


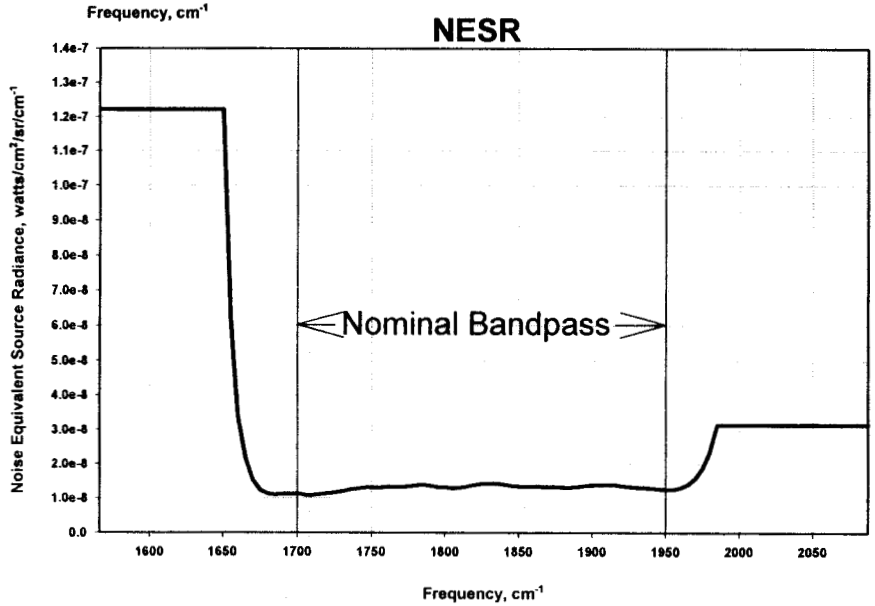




Filter 2A4, 300K blackbody source, gain step=2
(Frame=Alias)
System is background limited

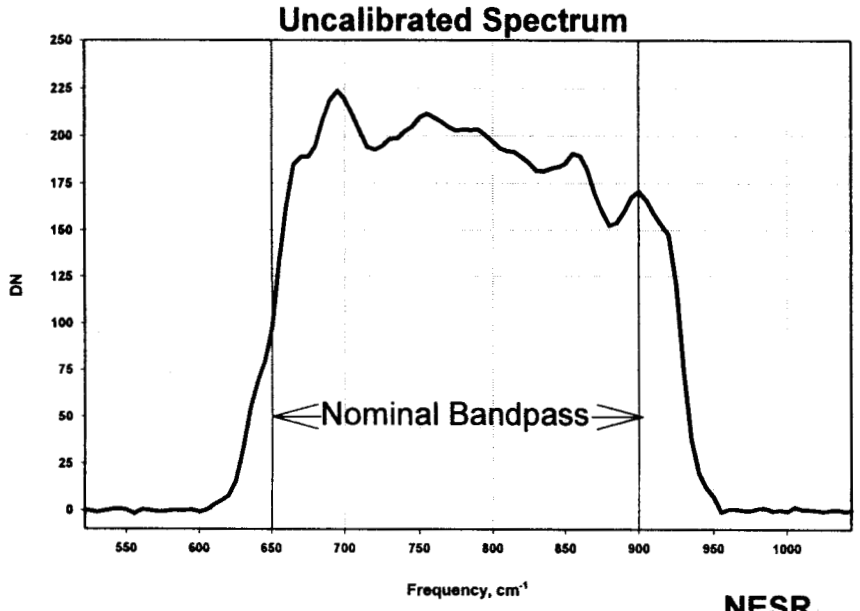


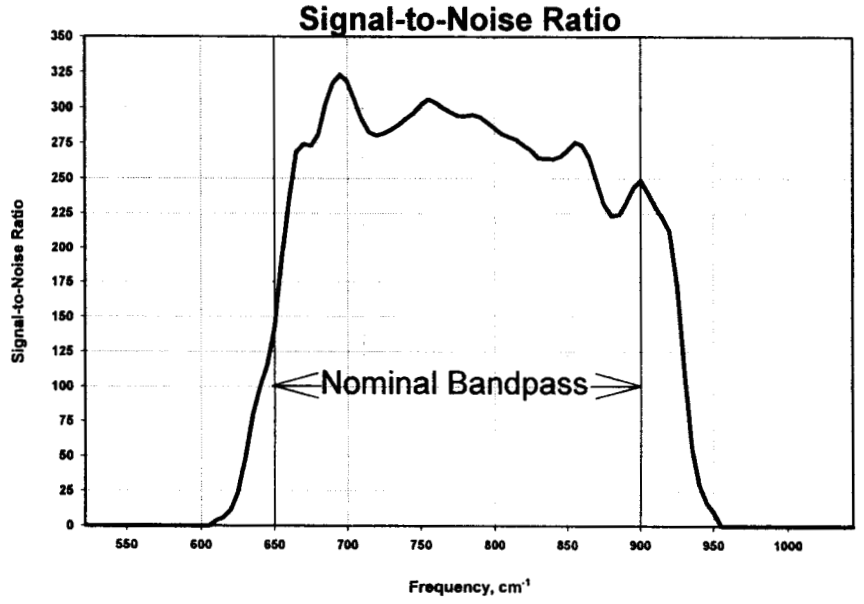


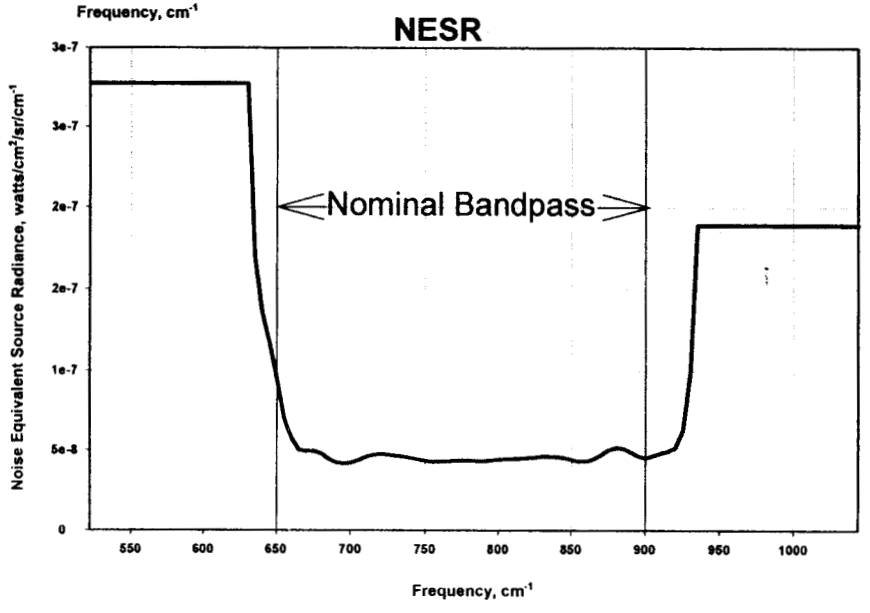


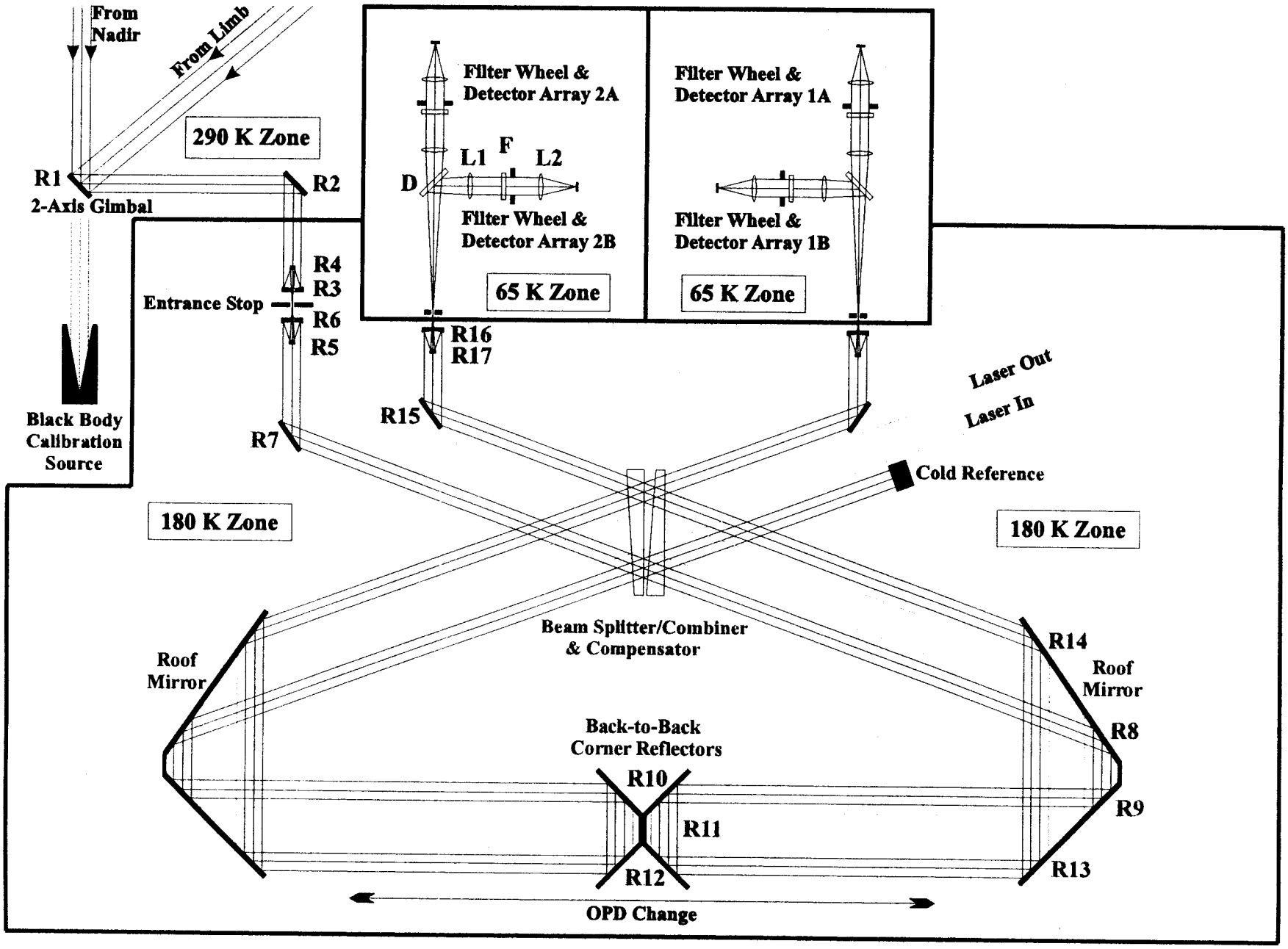
Filter 2B1, 300K blackbody source, gain step=1
(Frame=Alias)

System is Detector Noise Limited

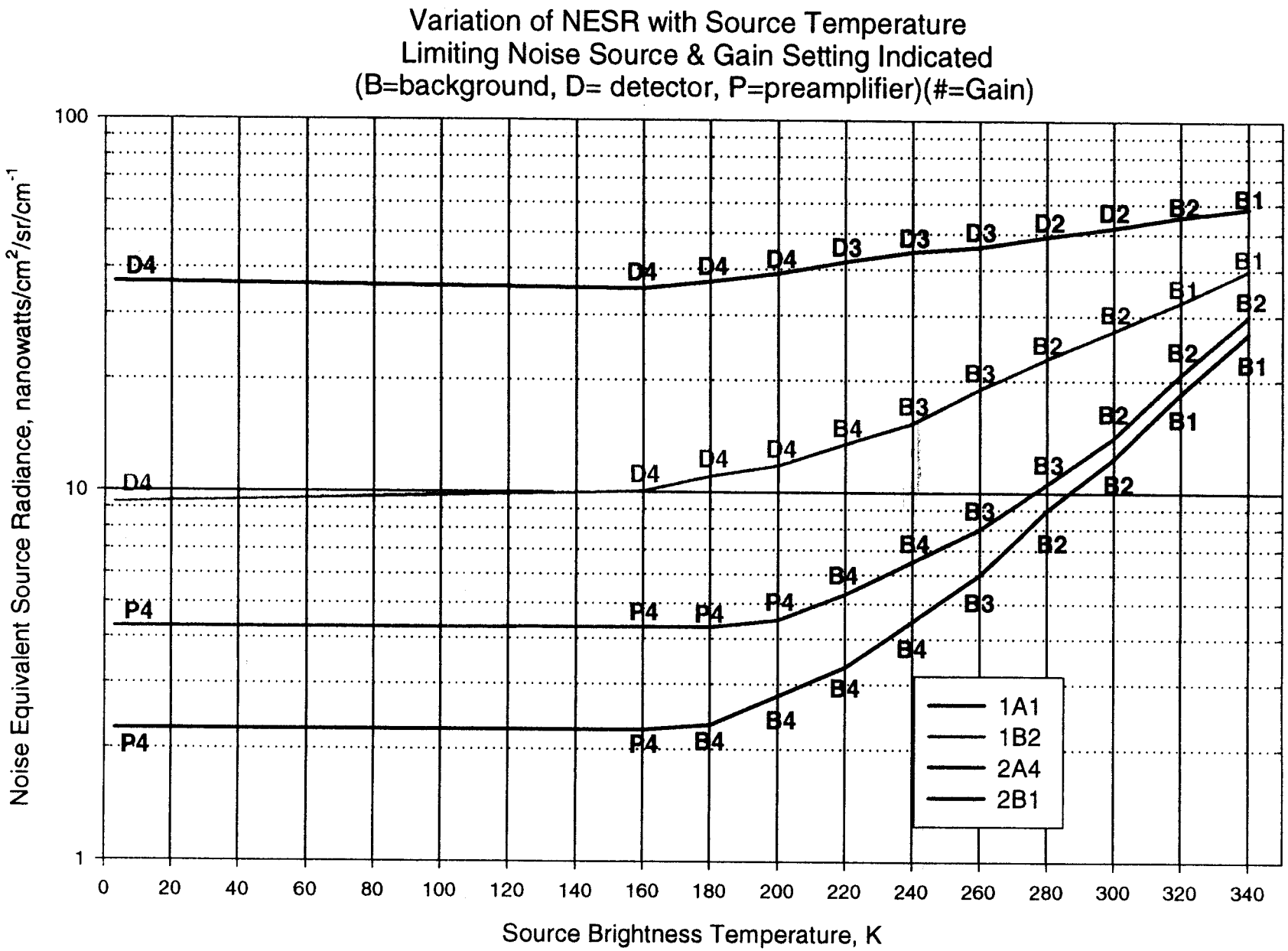








Elements labeled in green are typical components of the radiometric model


Variation of NESR with Source Temperature
Limiting Noise Source & Gain Setting Indicated
(B=background, D= detector, P=preamplifier)(#=Gain)
Noise Equivalent Source Radiance, nanowatts/cm²/sr/cm⁻¹
Source Brightness Temperature, K
100
10
1
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
1A1
1B2
2A4
2B1