Linearity/Non-Linearity

SIS(100) investigations

Raw Data examples and outliers

fitting ranges

residuals

Linearity Introduction

- Several bands showing non-linear response at low radiances
- Problem: no clearly identified mechanism
  - Optics, Si detectors are usually very linear
  - electronics are measured linear to 8 bits with Ecal
    - ramp data not yet examined
    - ADCs 16 bit data gives mixed results
  - Possible mechanism in ROICs
- Request from August Workshop that we re-examine linearity of SIS(100) calibration
  - SBRS stands behind linearity of SIS(100) output and calibration
  - Landsat data *may* indicate small nonlinearity in calibration

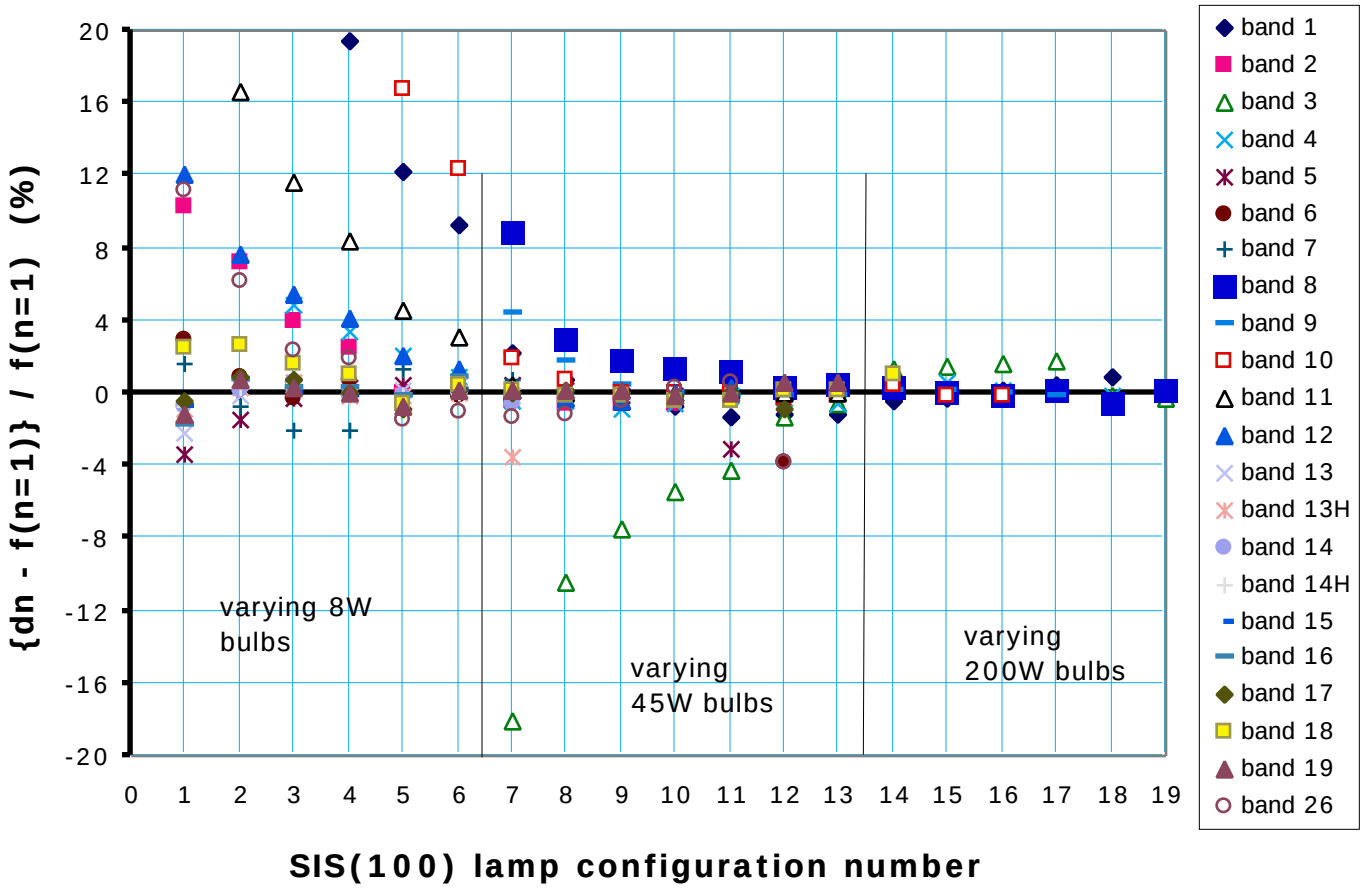
Linearity introduction 2

- Fitting over range of 0.3Ltyp to 0.9Lmax
  - may wish to switch to 0 to 0.9Lmax
    - however, there are often only one or two additional data points
      - Spec. Ltyp is very close to low end of dynamic range, which was set by Lmax requirements.
    - feedback appreciated
- Rejecting obvious outliers
  - cause not yet identified
- First cut at residuals indicates some possible improvement in going to non-linear algorithm

SIS(100) Investigations

- SIS(100) calibrated at multiple bulb levels
  - MCST has not reviewed January 1997 calibration of SIS(100)
  - Calibration transfer spectrometer linear to 0.5%
  - Uncertainties provided to date are only at one level and only as a percentage
    - need to know how uncertainties scale with radiance before final curve fit coefficients can be determined
  - Plots against lamp configurations indicate non-linearity not limited to one configuration or set of bulbs
- Landsat, using a transfer radiometer, observes small non-linearities in SBRS calibration values
  - *But* we don't overlap on all bulb levels
  - *And* we see much more non-linearity than Landsat attributes to the sphere

Relative residuals in Linear fittings (0.3 Ltyp to 0.9 Lmax) as a function of SIS lamp configurations for all reflective bands, middle channel, sample 1, UAID 1504

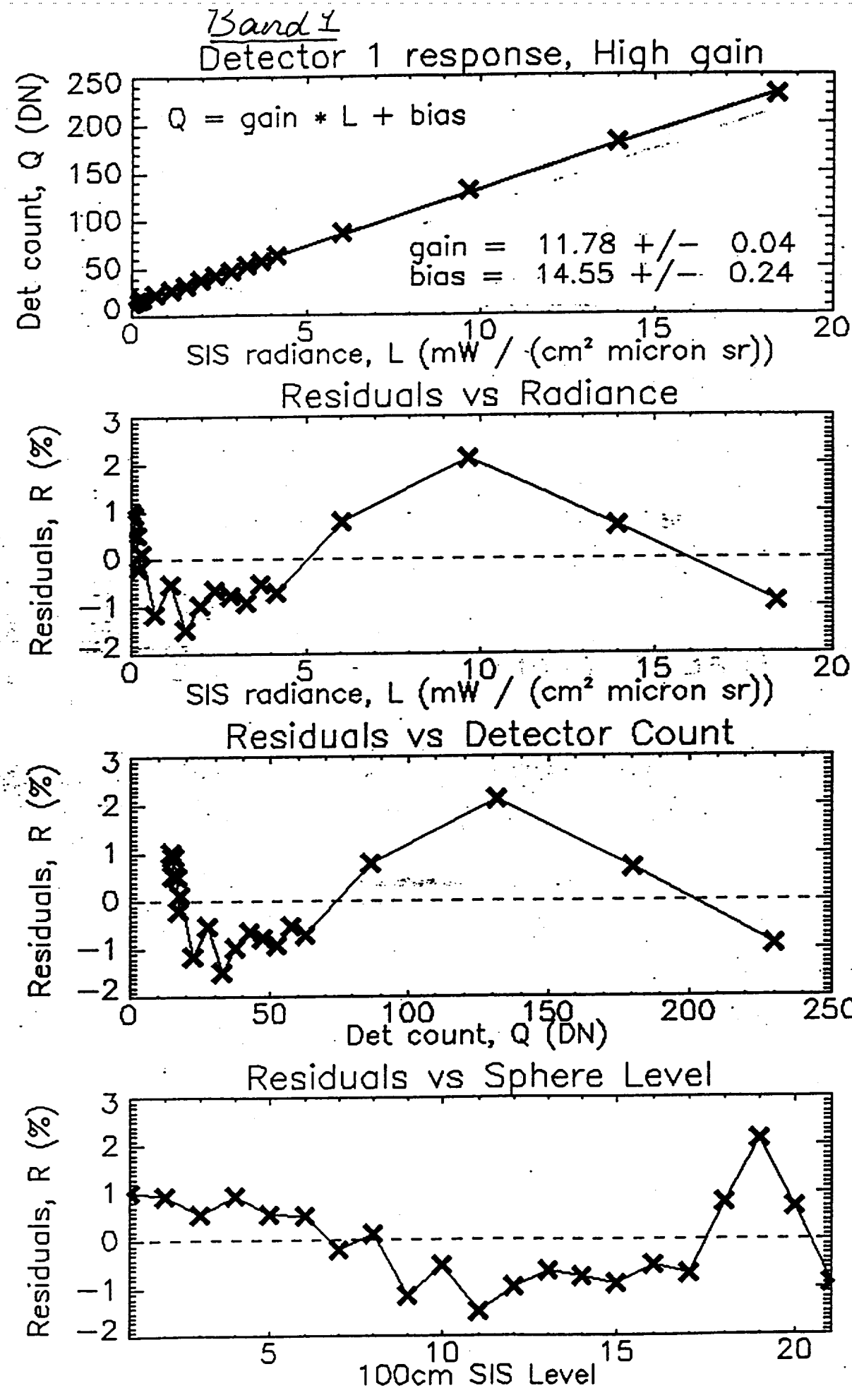


Bulb Configurations for RC01 Tests

Confg_Number	SIS_Lamp_Numbers 8W_45W_200W	Bands at Ltyp	Bands at Saturation
1	1_0_0	5,7,18	
2	2_0_0	16	
3	3_0_0	17,26	
4	4_0_0	6,14,15,19	
5	5_0_0	13	16
6	8_0_0	2	
7	10_1_0	1	15
8	10_2_0	12	13,14
9	10_3_0	4,11	
10	10_4_0		
11	10_5_0		5
12	10_8_0	10	7,26
13	10_9_0	3	6,12,17
14	10_9_1	9	11,18
15	10_9_2		2
16	10_9_3		
17	10_9_4	8	10
18	10_9_8		
19	10_9_14		4

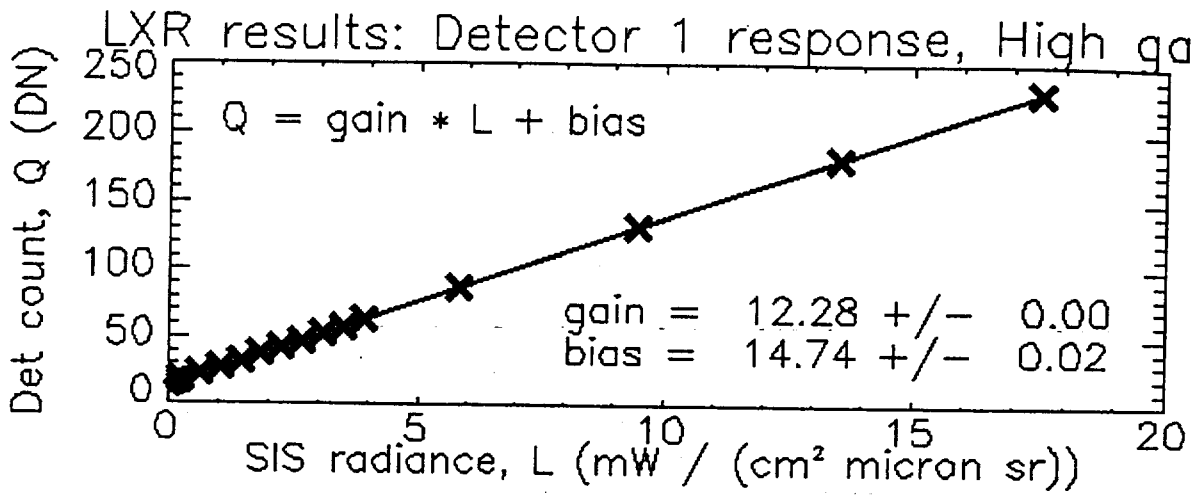
Landsat look at SIS(100) linearity

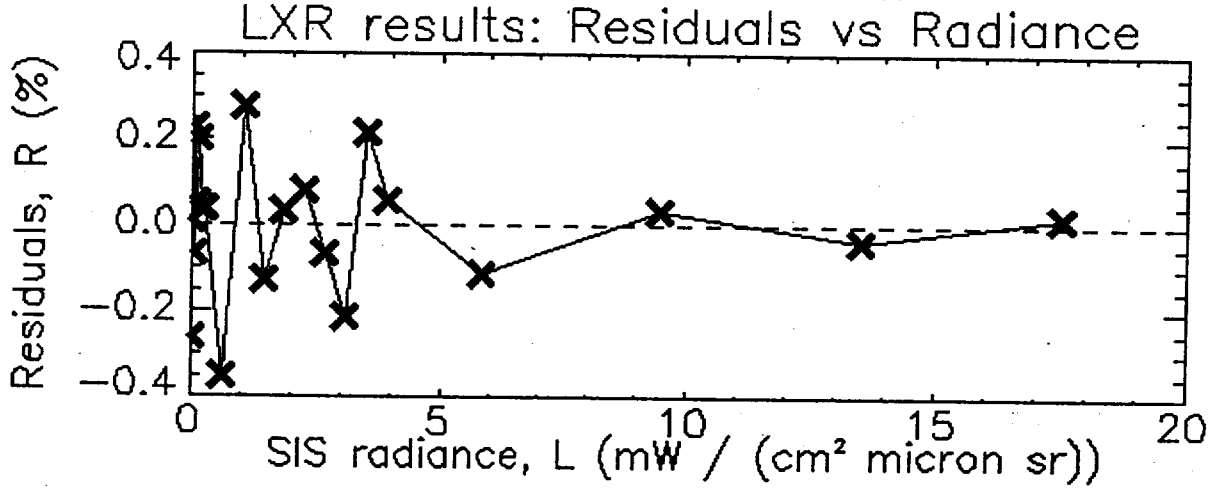
- *Preliminary* results from John Barker
- Landsat had their transfer radiometer (LXR) look at the SIS(100) at the same time Landsat was
- Residuals to a linear fit, when using SBRS values for the calibration of the SIS(100) are ~1% and show some non-linear behavior
- Residuals to a linear fit, when using the simultaneous LXR values to redo the calibration of the SIS(100) are ~0.2% and are very linear

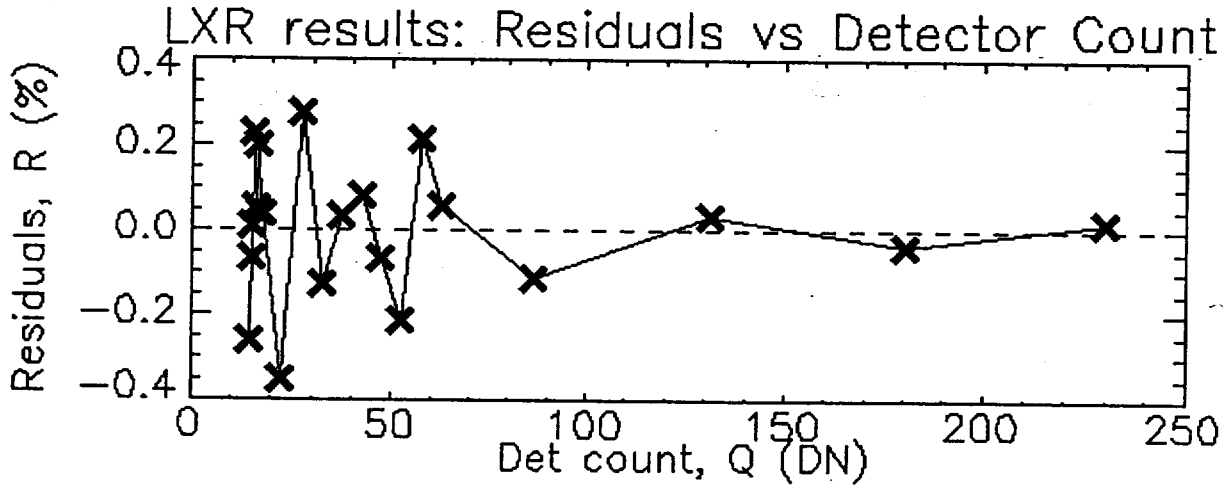


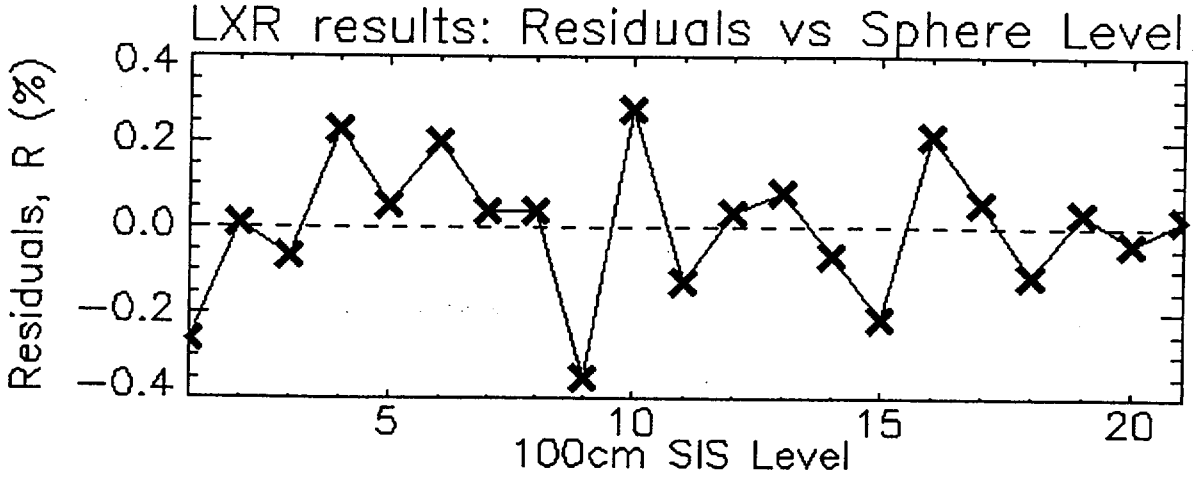
LANDSAT Band 1 (MODIS Band 3)

Band 1

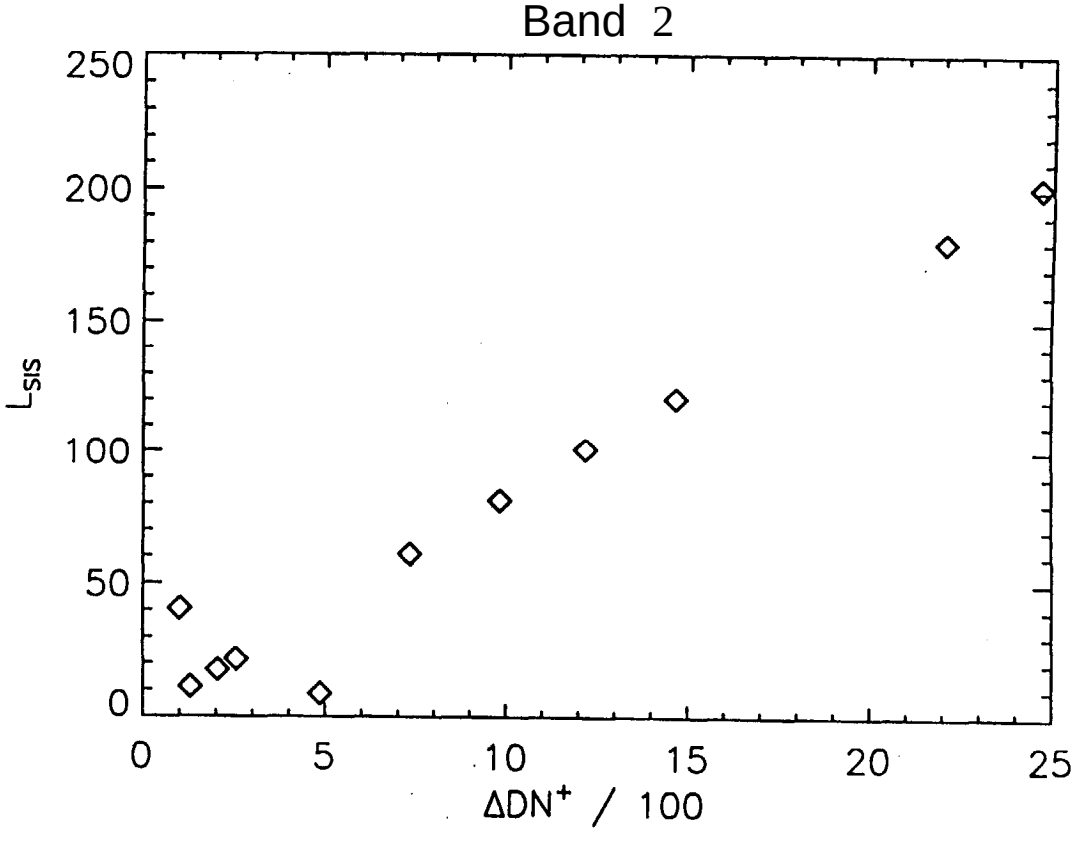

LXR results: Detector 1 response, High gain
Q = gain * L + bias
gain = 12.28 +/- 0.00
bias = 14.74 +/- 0.02
Det count, Q (DN)
SIS radiance, L (mW / (cm² micron sr))


LXR results: Residuals vs Radiance
Residuals, R (%)
SIS radiance, L (mW / (cm² micron sr))


LXR results: Residuals vs Detector Count
Residuals, R (%)
Det count, Q (DN)


LXR results: Residuals vs Sphere Level
Residuals, R (%)
100cm SIS Level

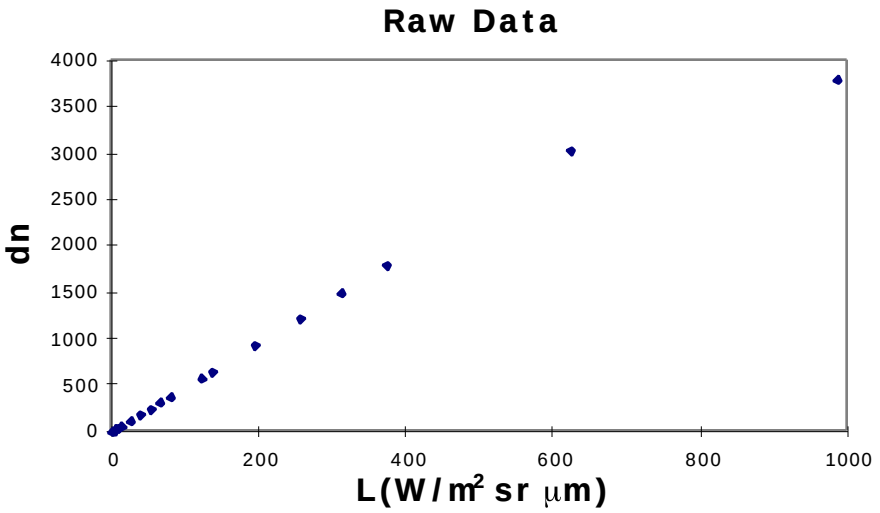
Example of Raw Data with outliers

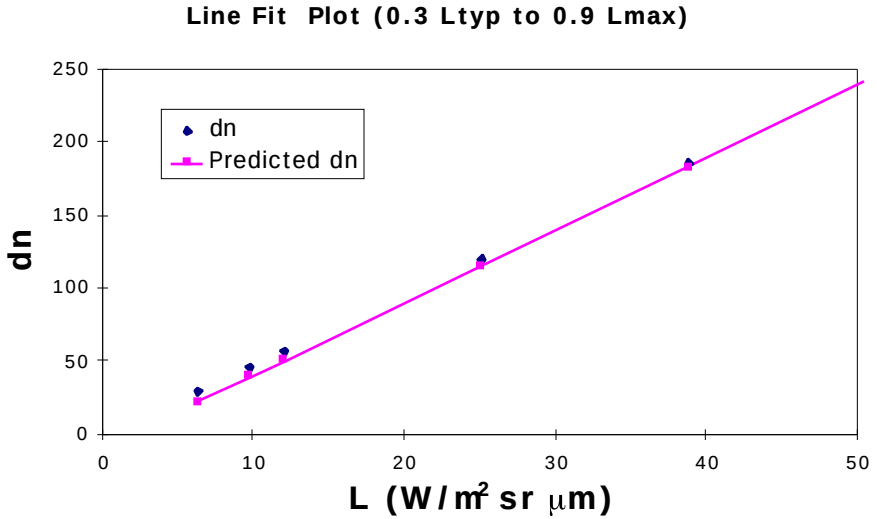


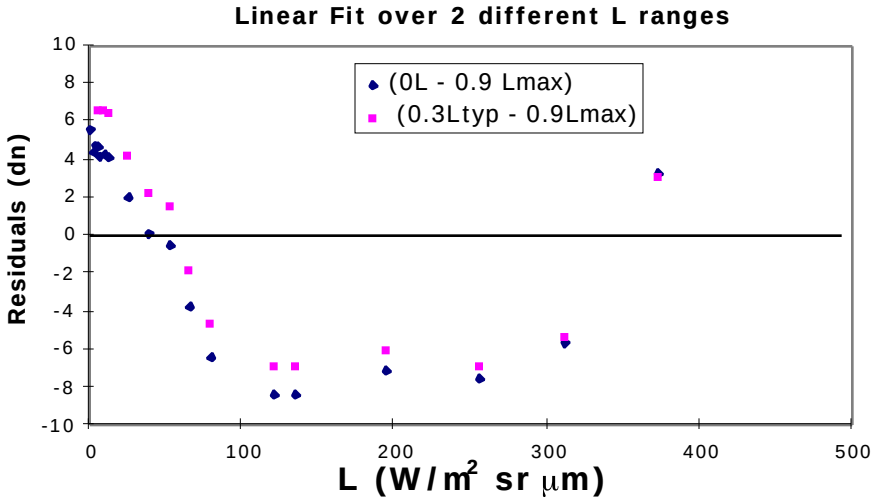
EOS

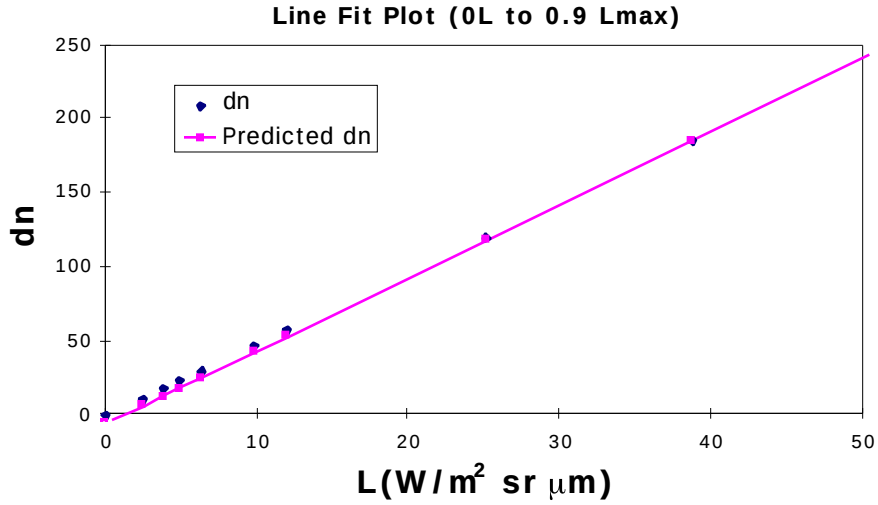
MODIS
SBRC

Fitting Range Example
Band 1 Channel 10 Subframe 1
Cold Plateau

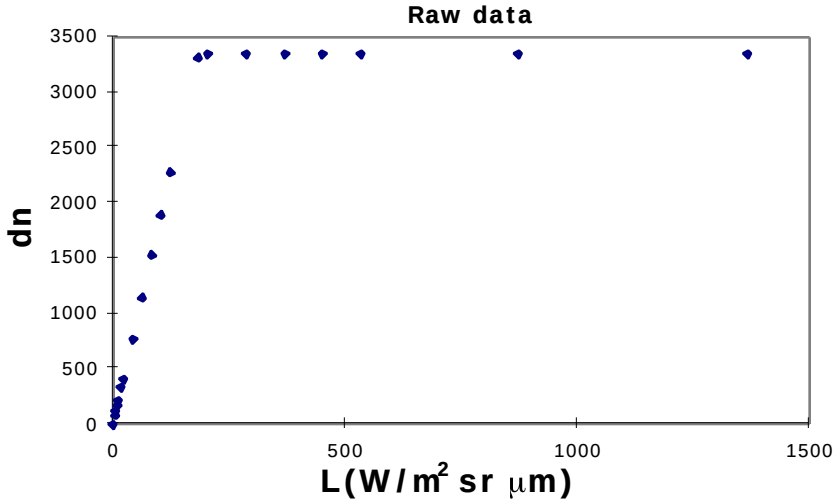


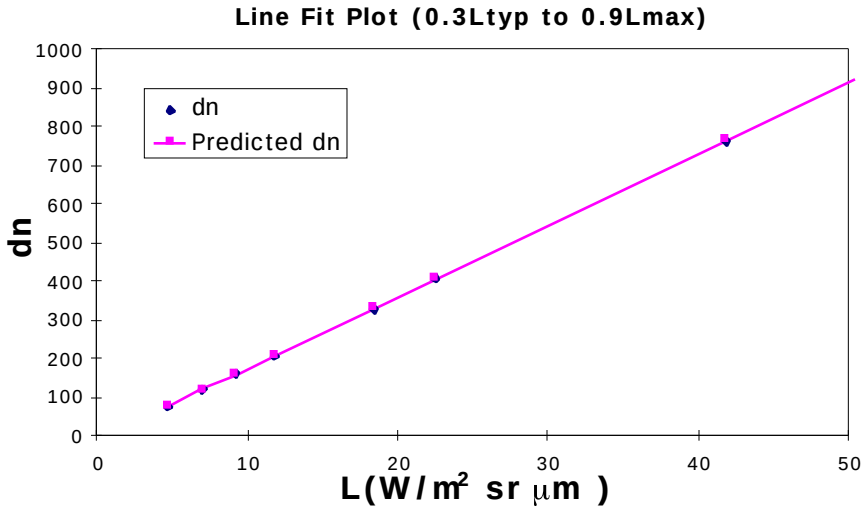


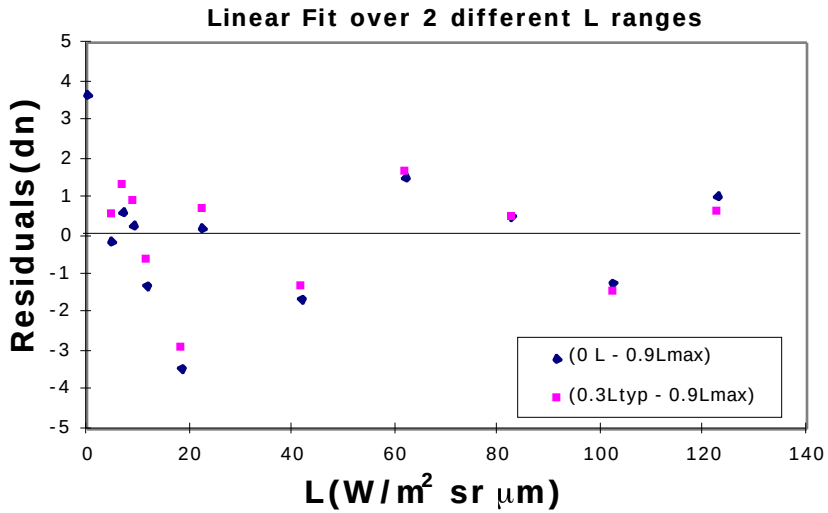


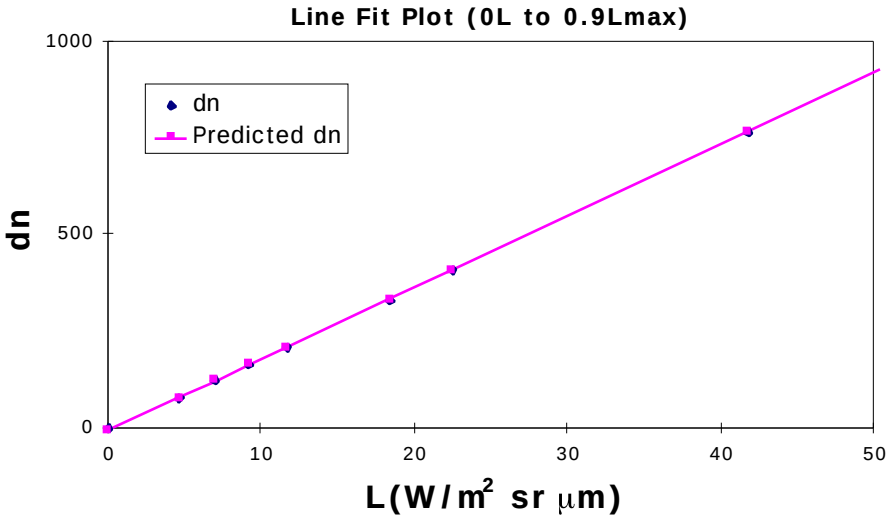


Fitting Range Example
Band 17 Channel 5 Cold Plateau

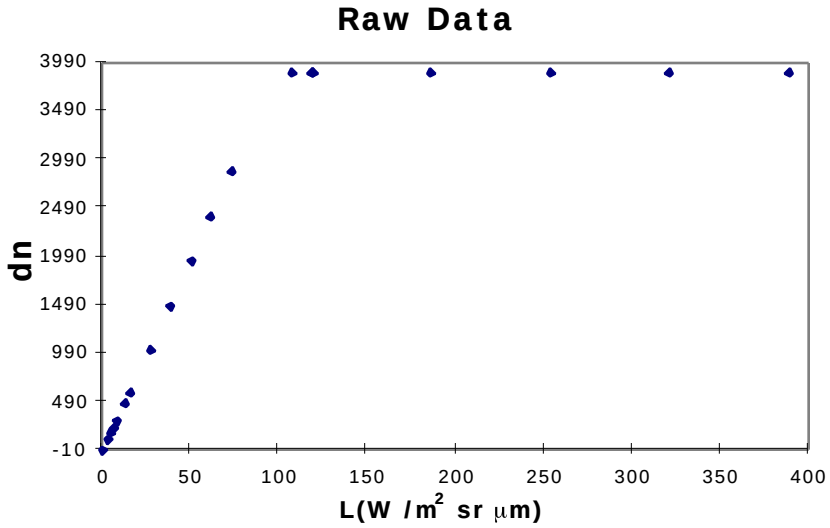


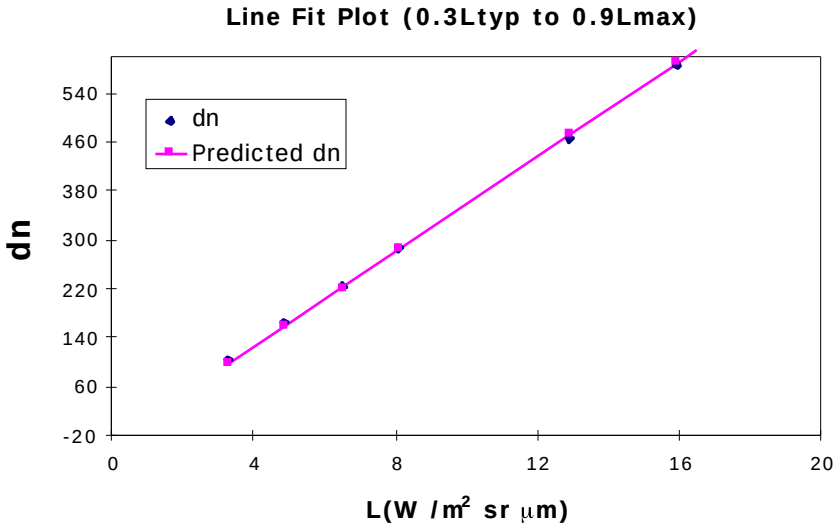


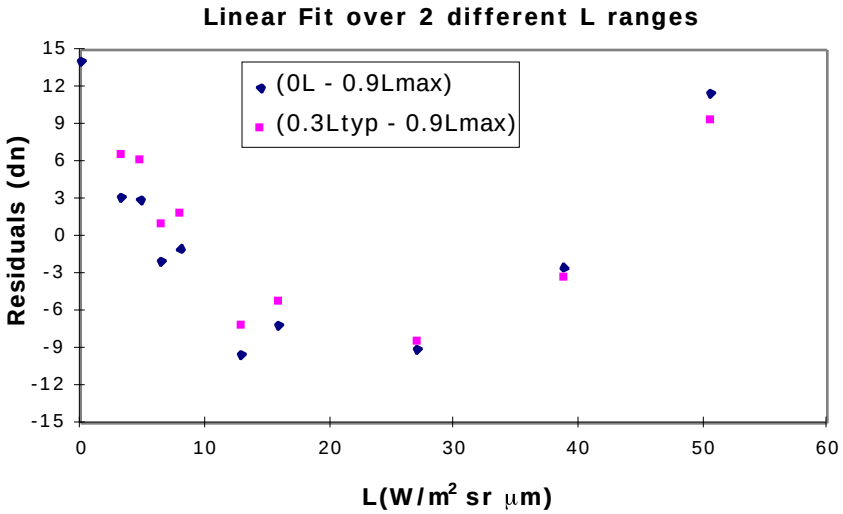


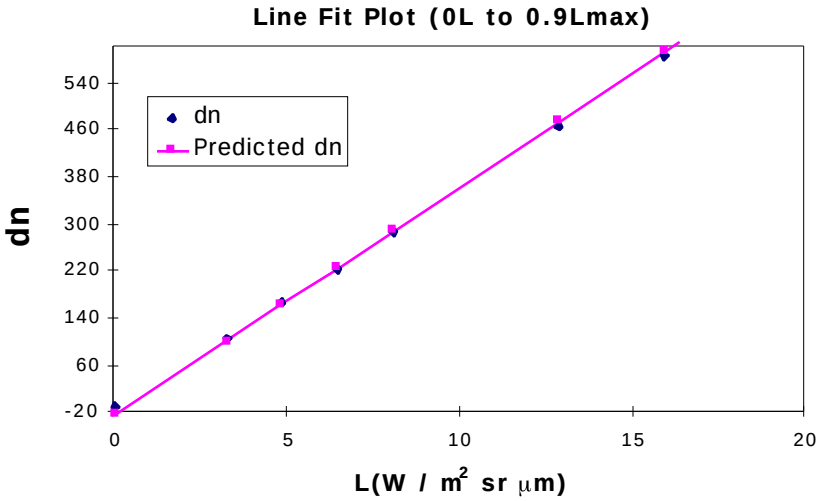


Fitting Range Example
Band 26 Channel 5 Cold Plateau





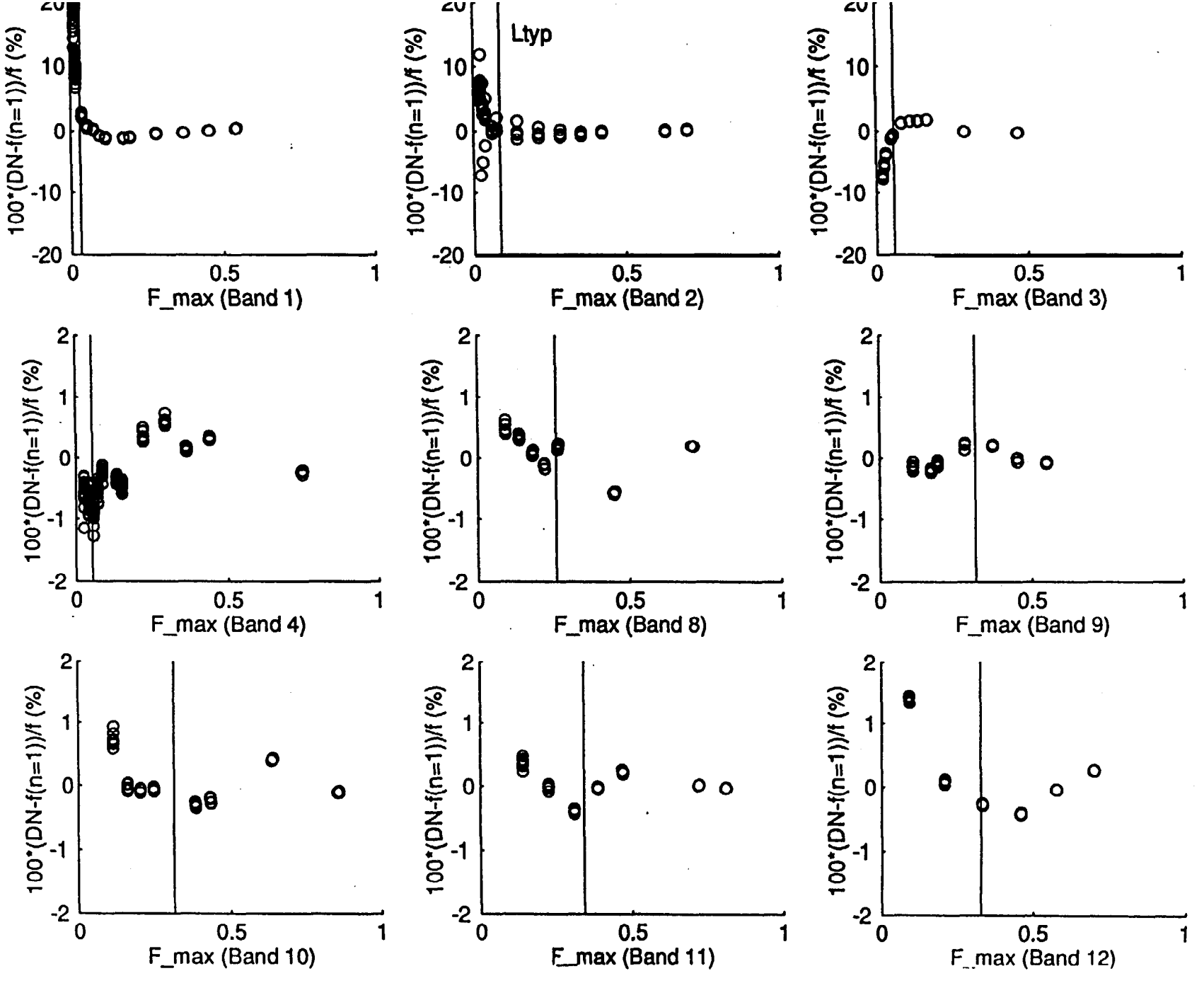




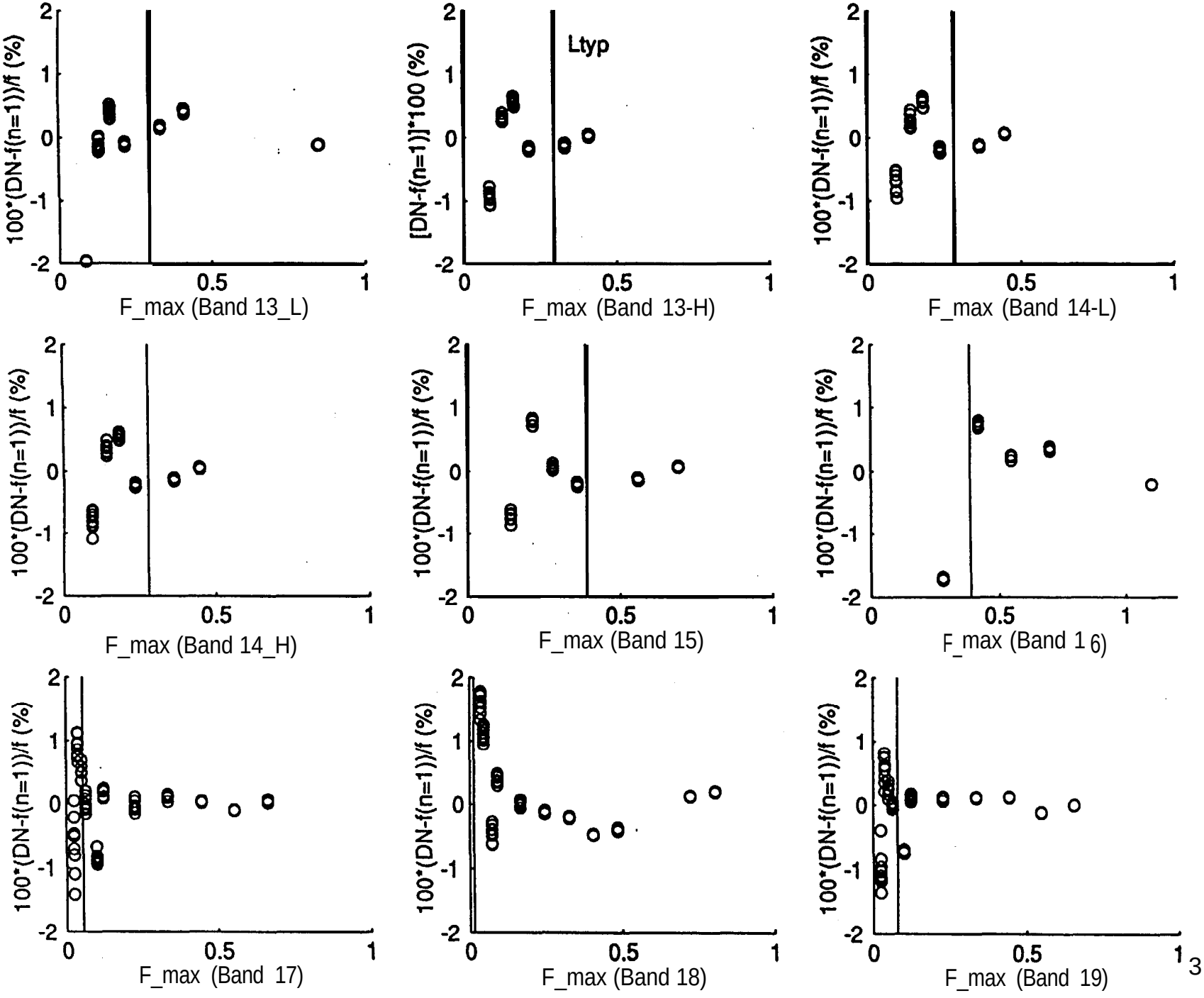
Residuals indicate some improvement in going to non-linear algorithm for some bands

- Caveats:
  - Still a work in progress
  - Following residuals plotted vs. dn instead of DN*
  - Following residuals do not incorporate SIS(100) uncertainty when computing fit
  - %Residual does not necessarily translate directly into %uncertainty in product
- Possible improvement in bands 1, 2, 3, 5, 6, 12, 16, 18, 26.

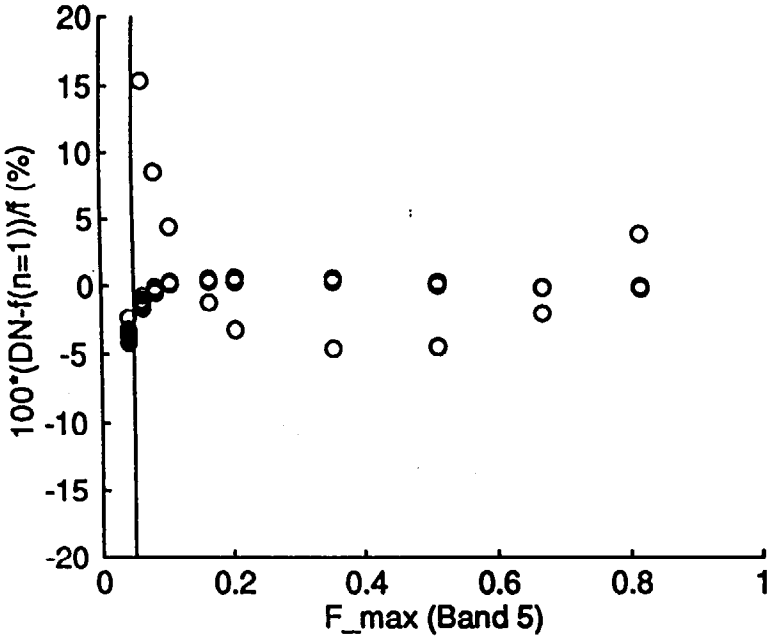
Relative residual of DN_vs_L linear fitting in VIS/NIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau, sample 1

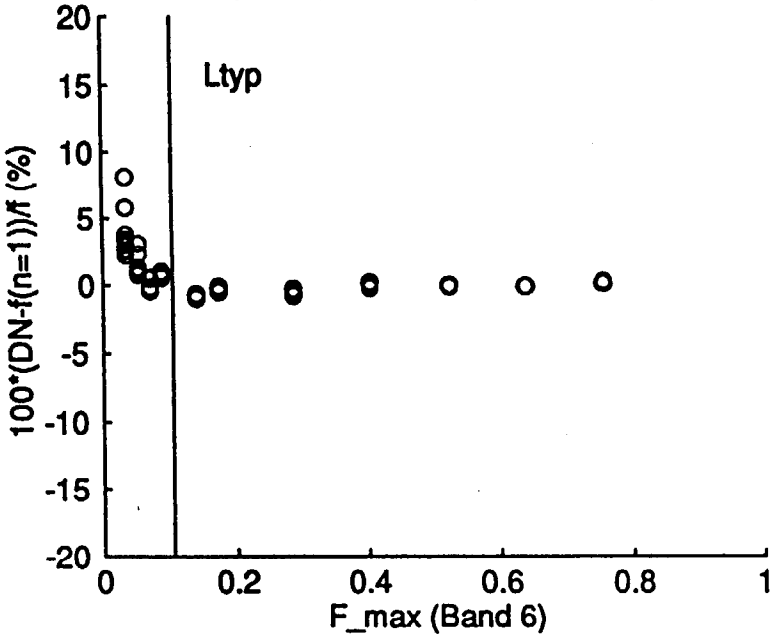


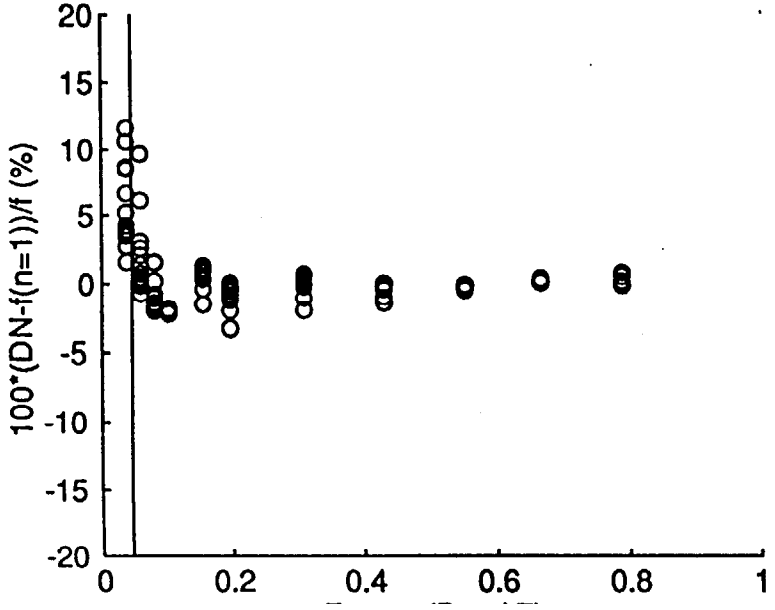
Relative residual of DN_vs_L linear fitting in NIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau

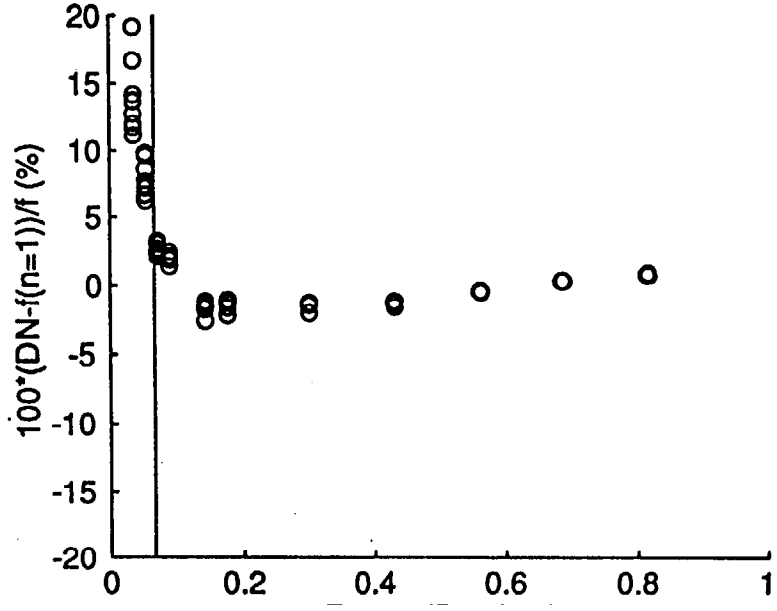


Relative residual of DN_vs_L linear fitting in SWIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau, sample 1

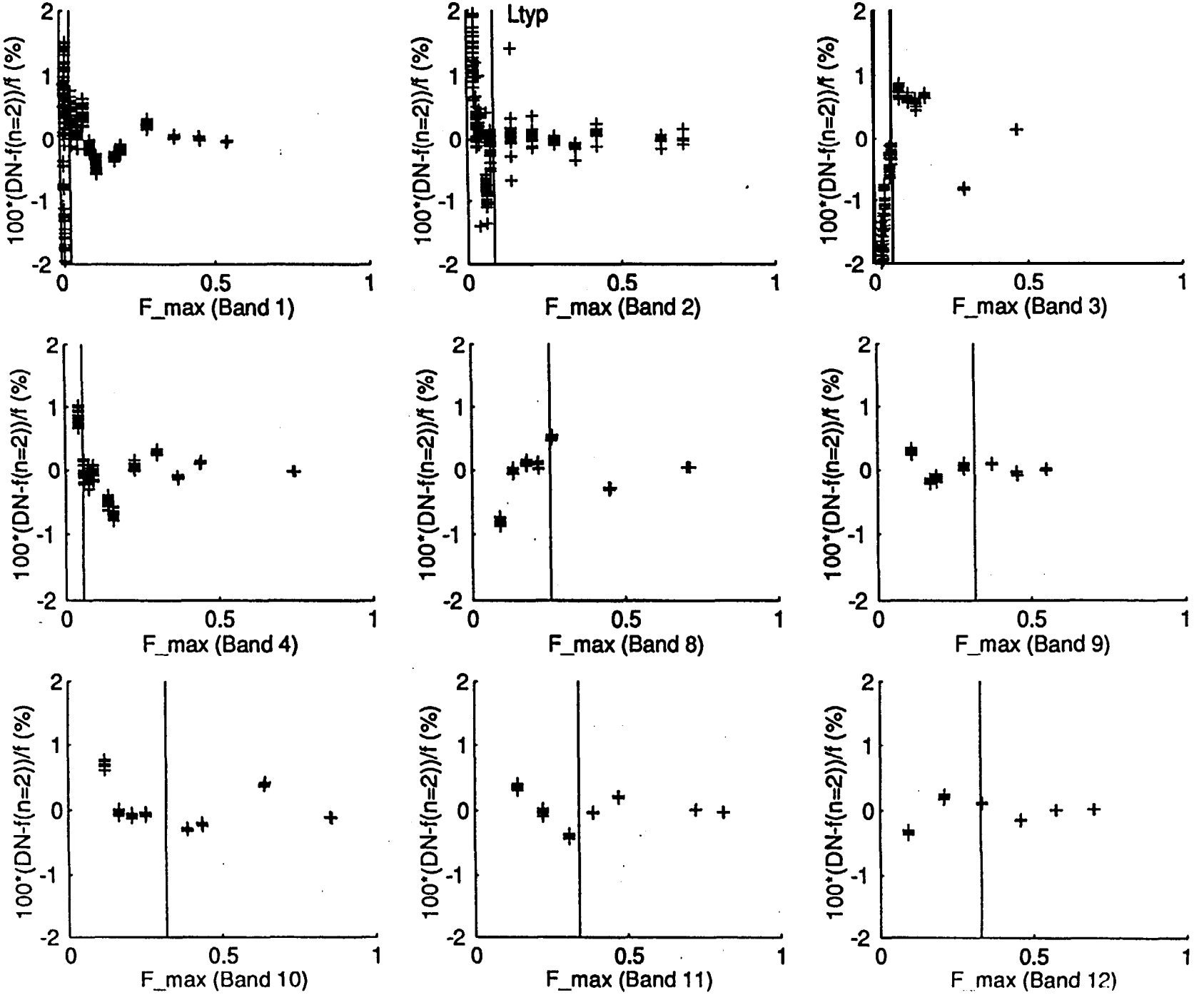




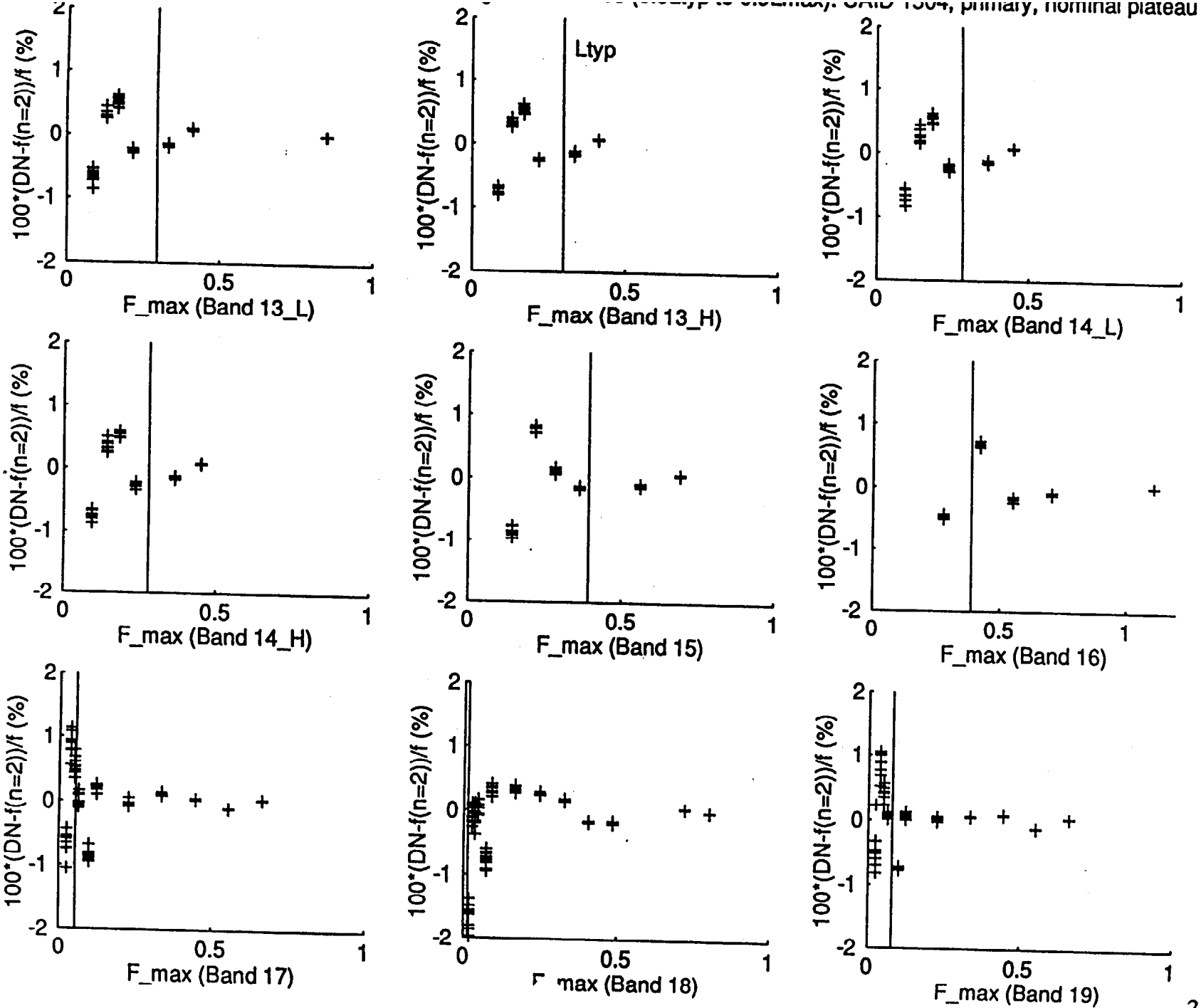




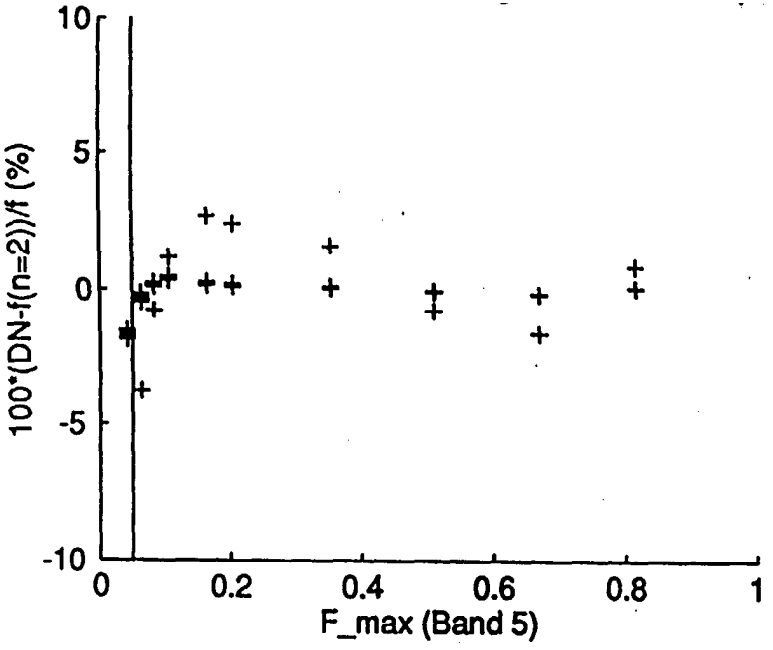
Relative residual of DN_vs_L quadratic fitting in VIS/NIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau, sample 1

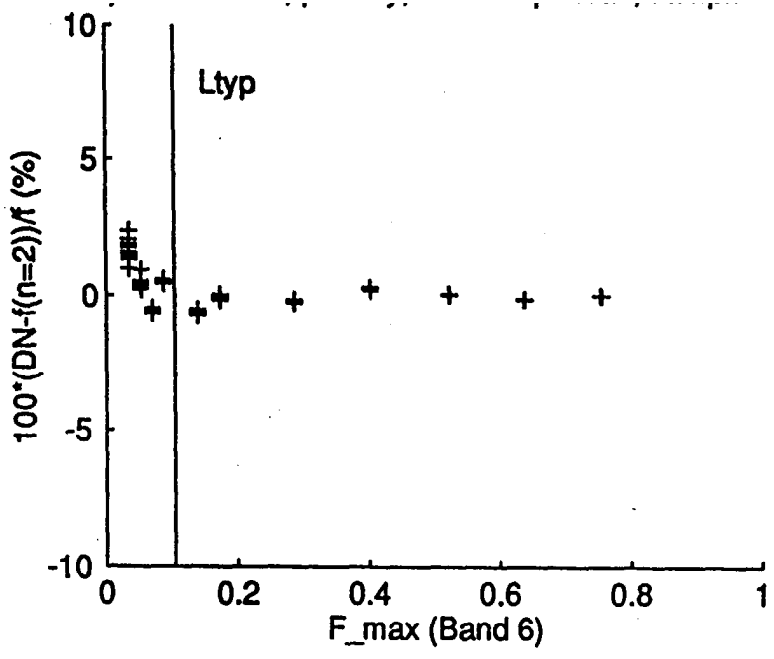


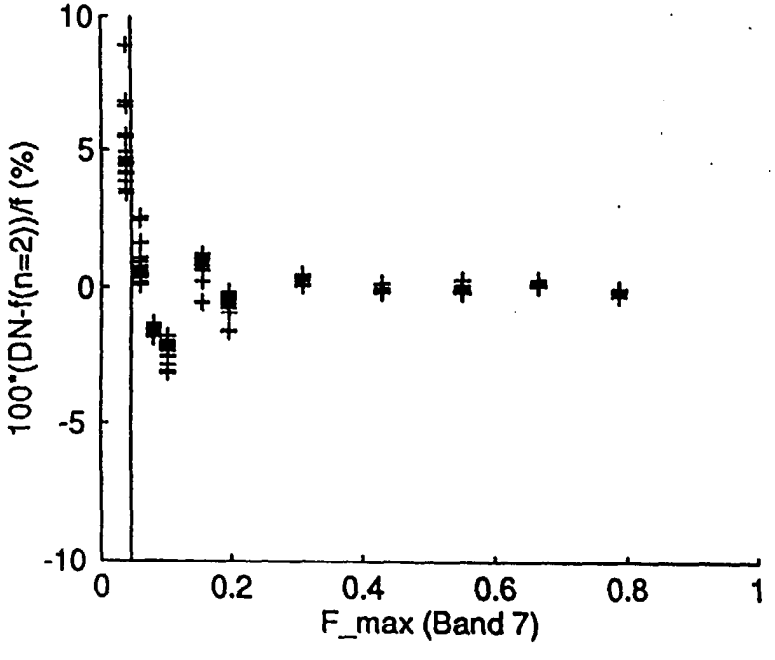
Relative residual of DN_vs_L quadratic fitting in NIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau

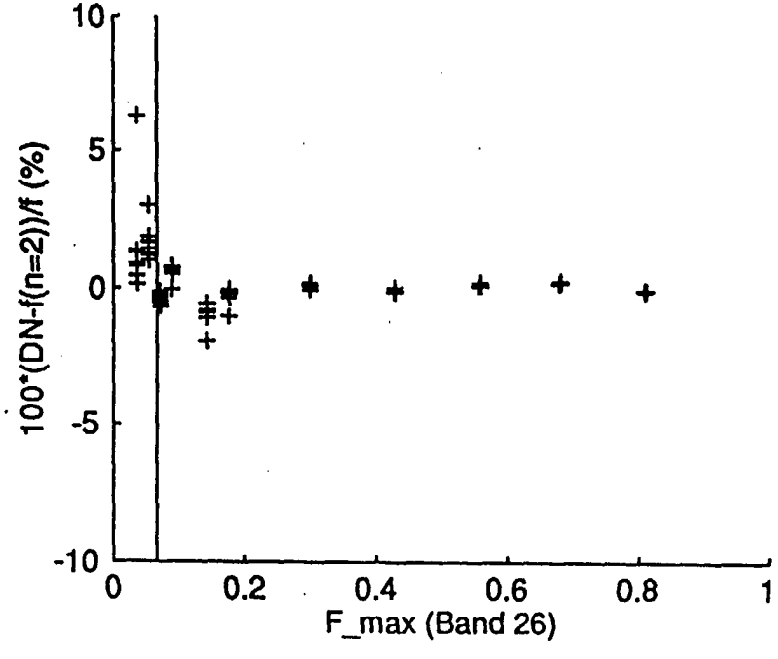


Relative residual of DN_vs_L quadratic fitting in SWIR bands (0.3Ltyp to 0.9Lmax). UAID 1504, primary, nominal plateau, sample 1

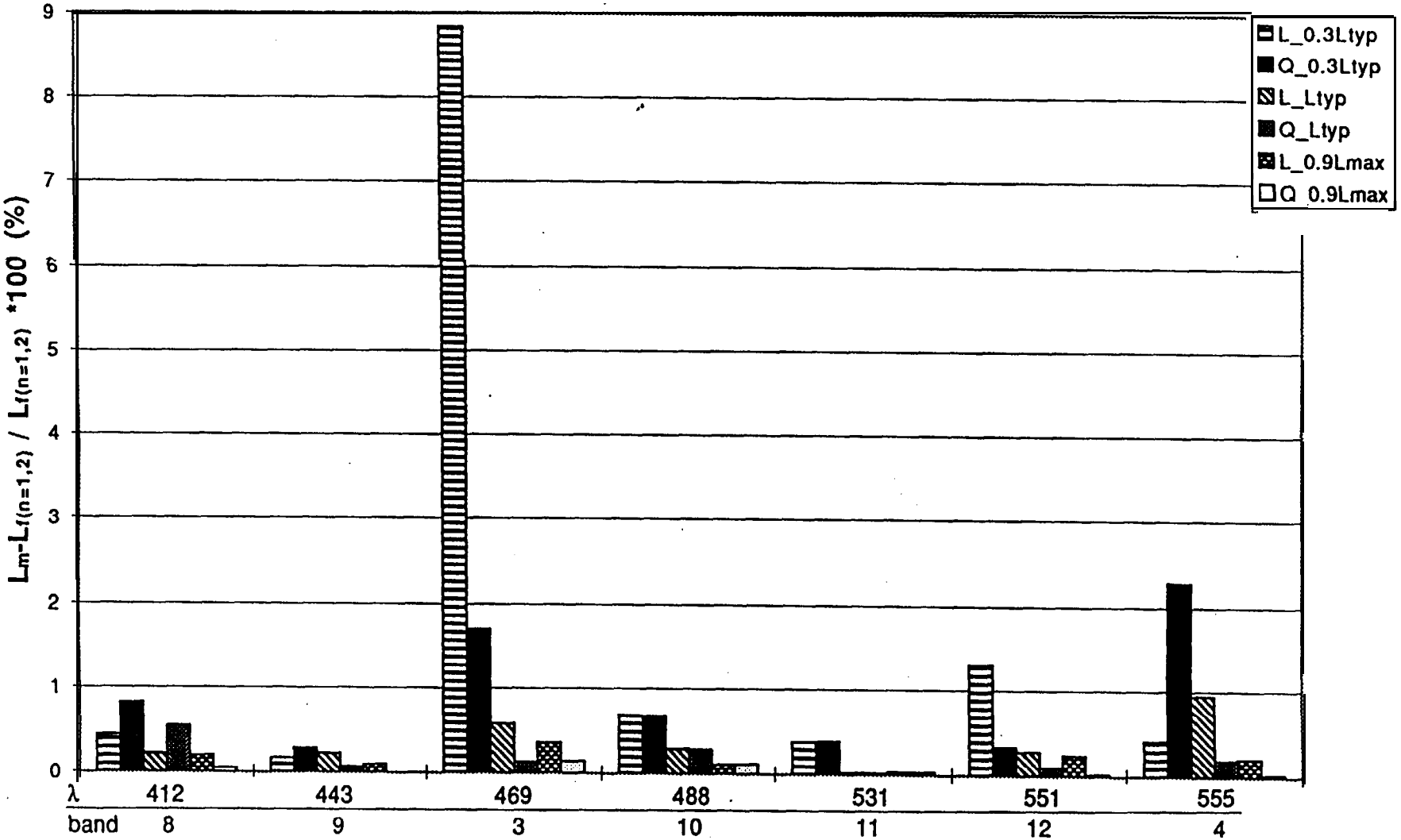








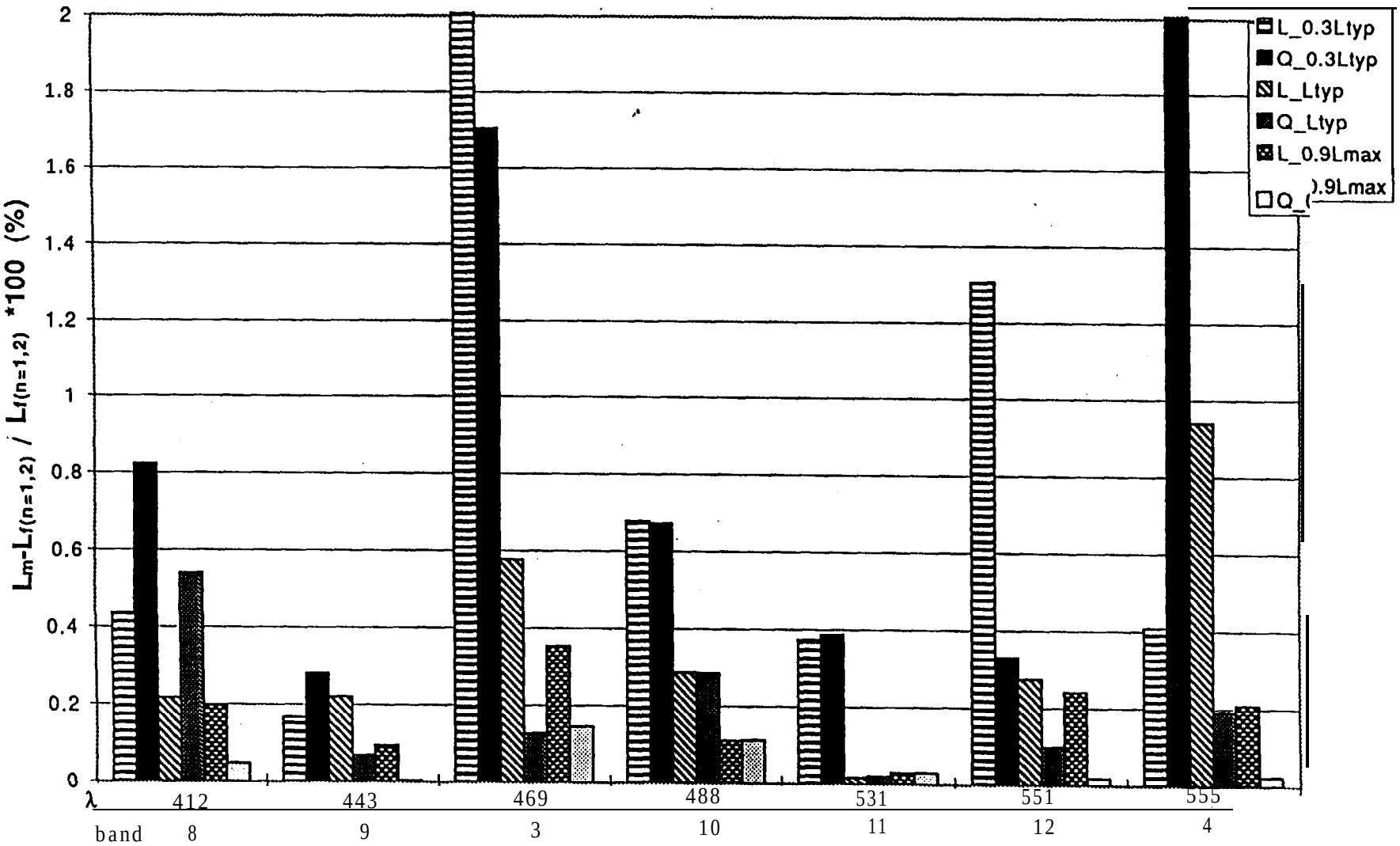
Relative residuals in L from linear and quadratic fittings at 0.3Ltyp, Ltyp and 0.9Lmax



Band center λ in nm (band 8,9,3,10,11,12,4) in VIS FP

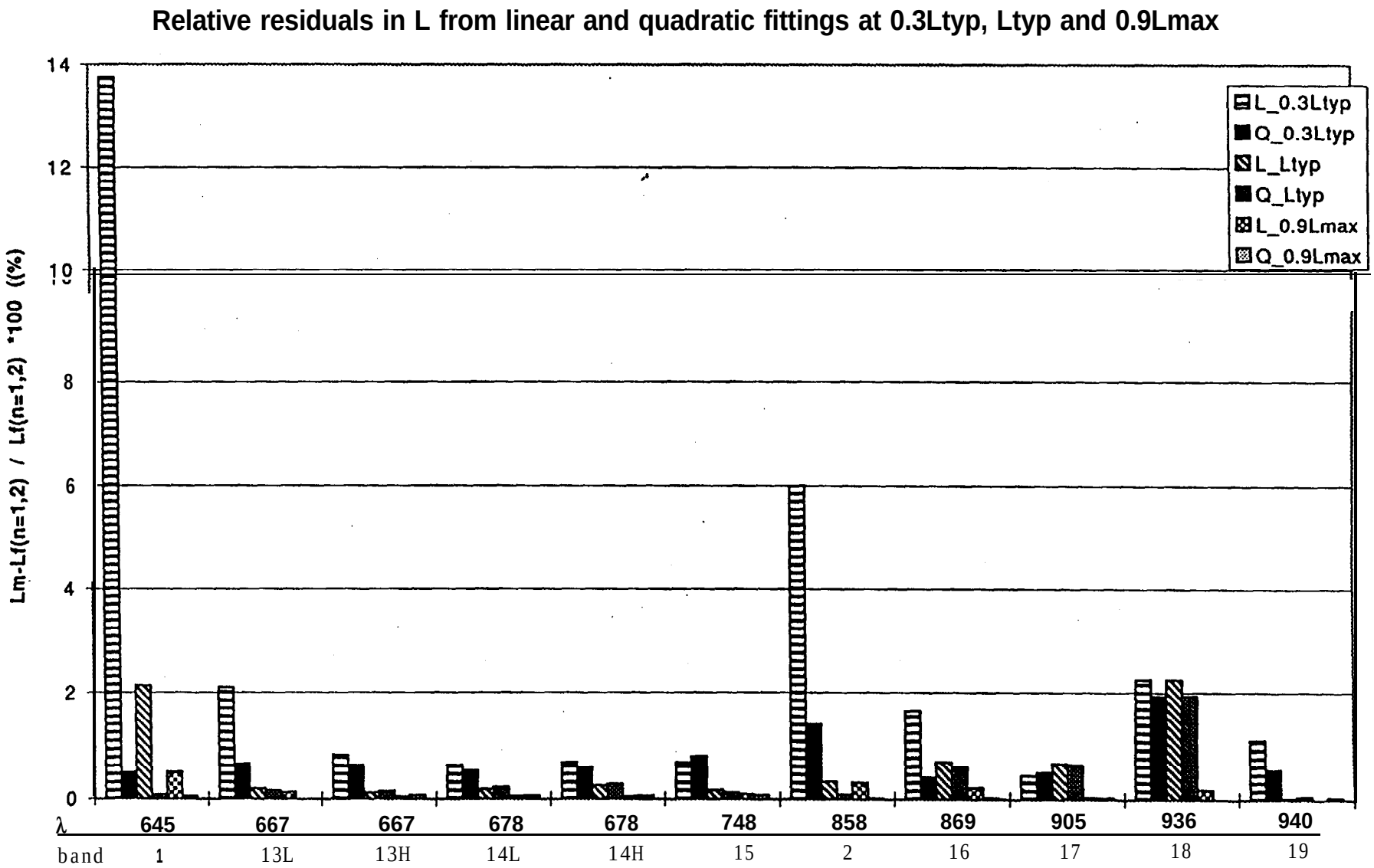
For each band, listed in order: L_0.3Ltyp, Q_0.3Ltyp, L_Ltyp, Q_Ltyp, L_0.9Lmax, Q_0.9Lmax

Relative residuals in L from linear and quadratic fittings at 0.3Ltyp, Ltyp and 0.9Lmax

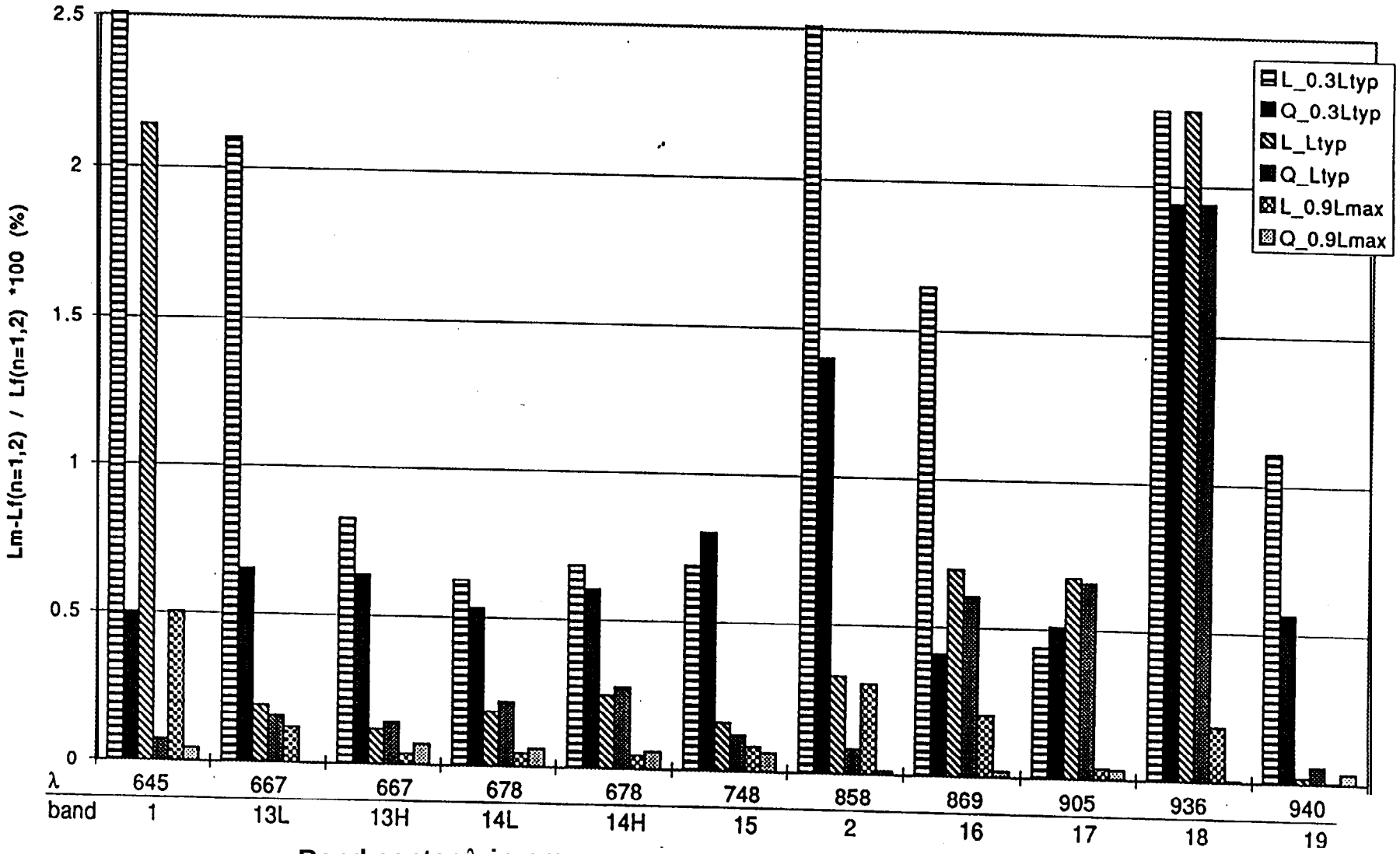


Band center λ in nm (band 8,9,3,10,11,12,4) in VIS FP

For each band, listed in order: L_0.3Ltyp, Q_0.3Ltyp, L_Ltyp, Q_Ltyp, L_0.9Lmax, Q_0.9Lmax


Relative residuals in L from linear and quadratic fittings at 0.3Ltyp, Ltyp and 0.9Lmax
Lm-Lf((n=1,2) / Lf(n=1,2) *100 ((%)
14
12
10
8
6
4
2
0
L_0.3Ltyp
Q_0.3Ltyp
L_Ltyp
Q_Ltyp
L_0.9Lmax
Q_0.9Lmax
λ 645 667 667 678 678 748 858 869 905 936 940
band 1 13L 13H 14L 14H 15 2 16 17 18 19
Band center λ in nm (1,13,13H,14,14H,15,2,16,17,18,19) in NIR FP
For each band, listed in order: L_0.3Ltyp, Q_0.3Ltyp, L_Ltyp, Q_Ltyp, L_0.9Lmax, Q_0.9Lmax

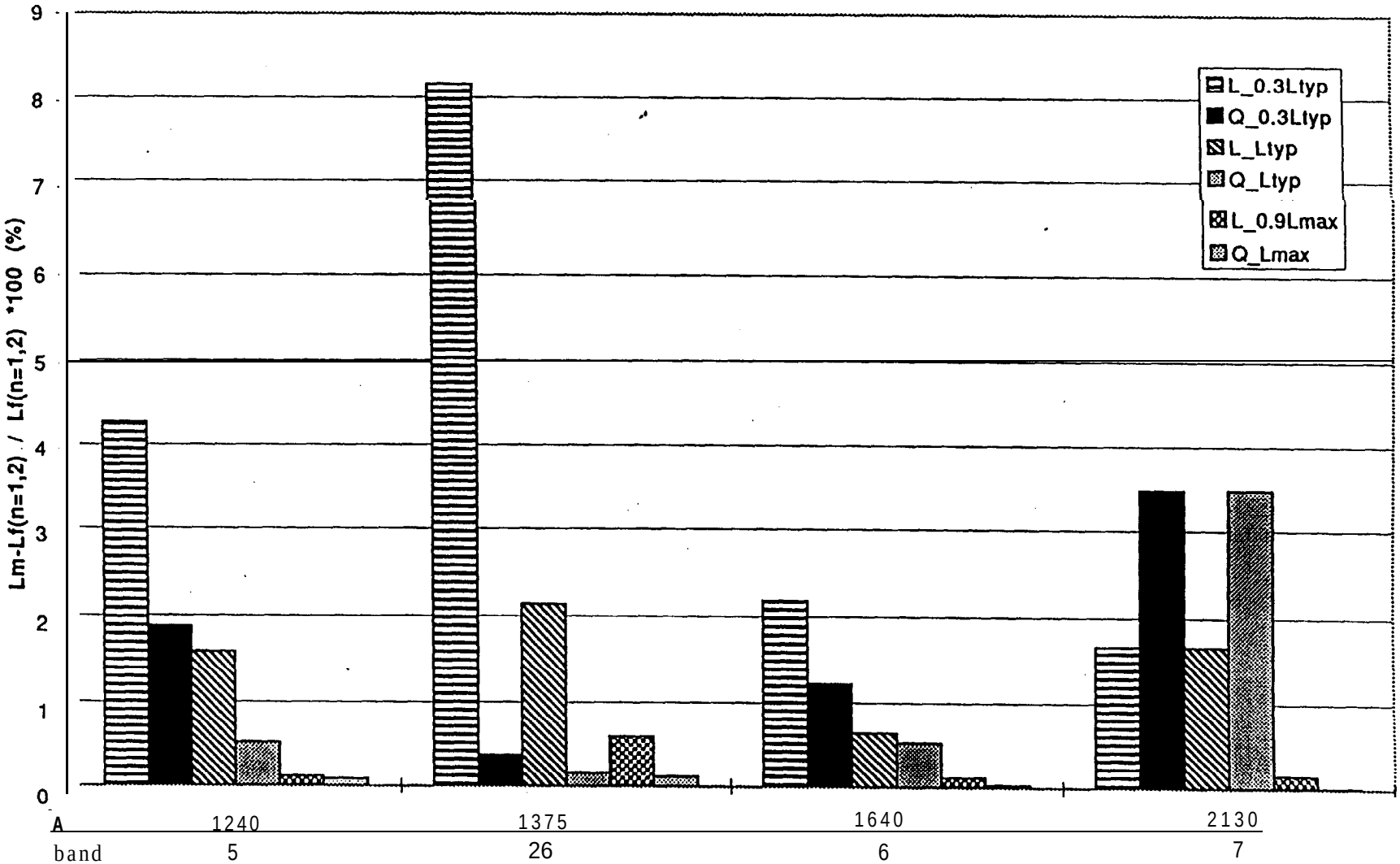
Relative residuals in L from linear and quadratic fittings at 0.3Ltyp, Ltyp and 0.9Lmax



Band center λ in nm (1,13,13H,14,14H,15,2,16,17,18,19) in NIR FP

For each band, listed In order: L_0.3Ltyp, Q_0.3Ltyp, L_Ltyp, Q_Ltyp, L_0.9Lmax, Q_0.9Lmax

Relative residuals in L from linear and quadratic fittings at 0.3Ltyp, Ltyp and 0.9Lmax



Band center λ in nm (band 5,26,6,7) in SWIR FP

For each band, listed in order: L_0.3Ltyp, Q_0.3Ltyp, L_Ltyp, Q_Ltyp, L_0.9Lmax, Q_0.9Lmax