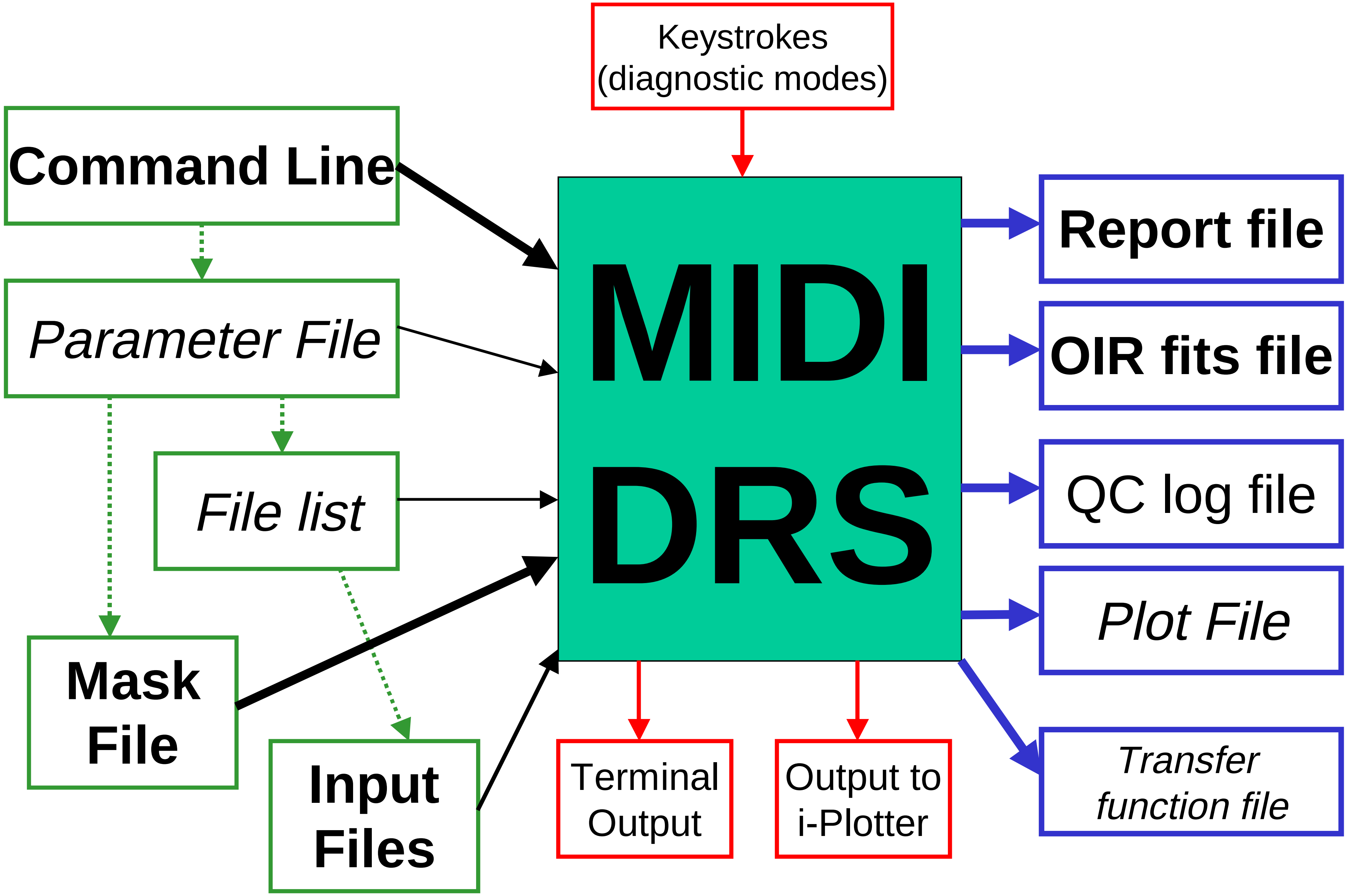
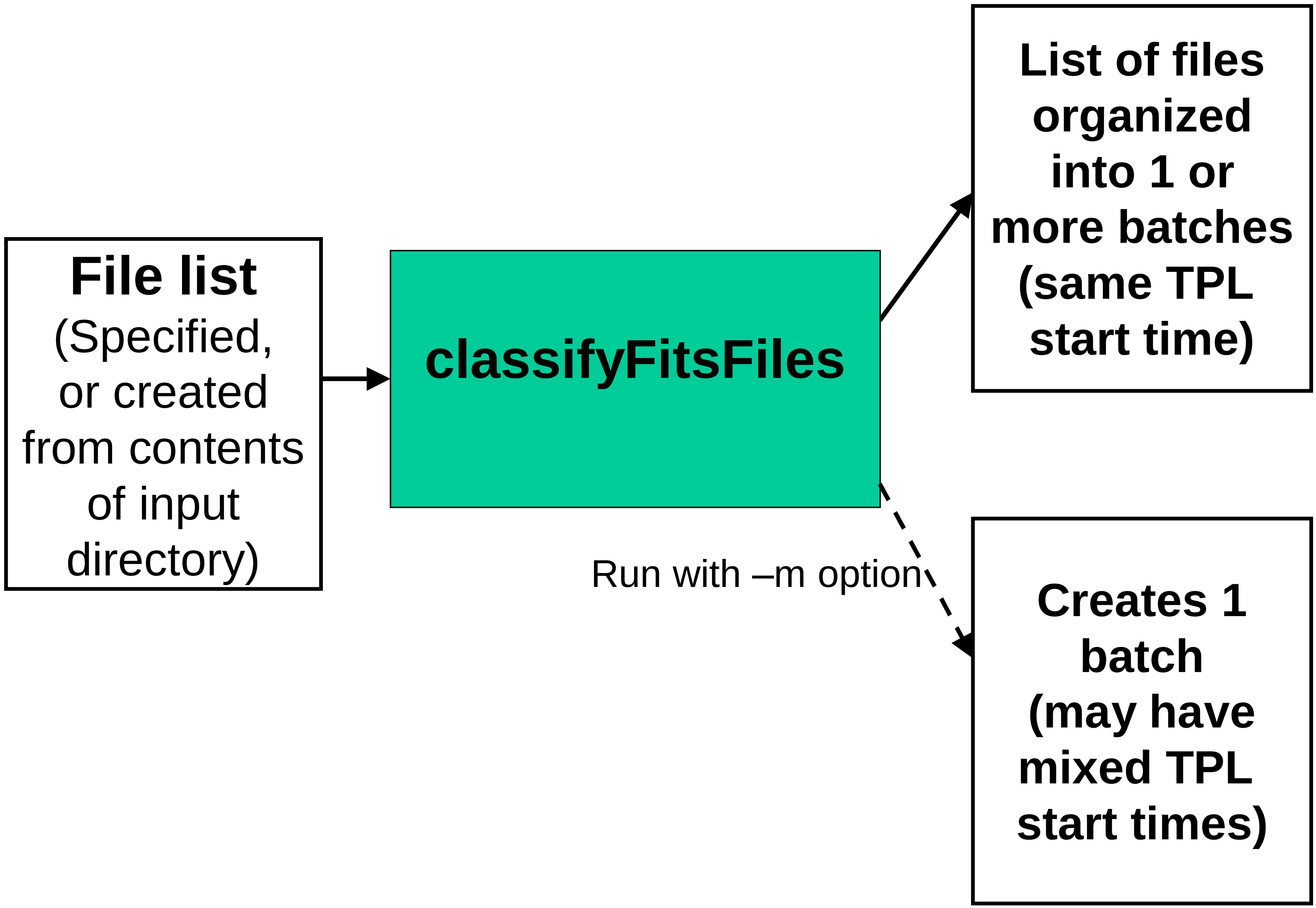
ESO MIDI Data Reduction System (pipeline)

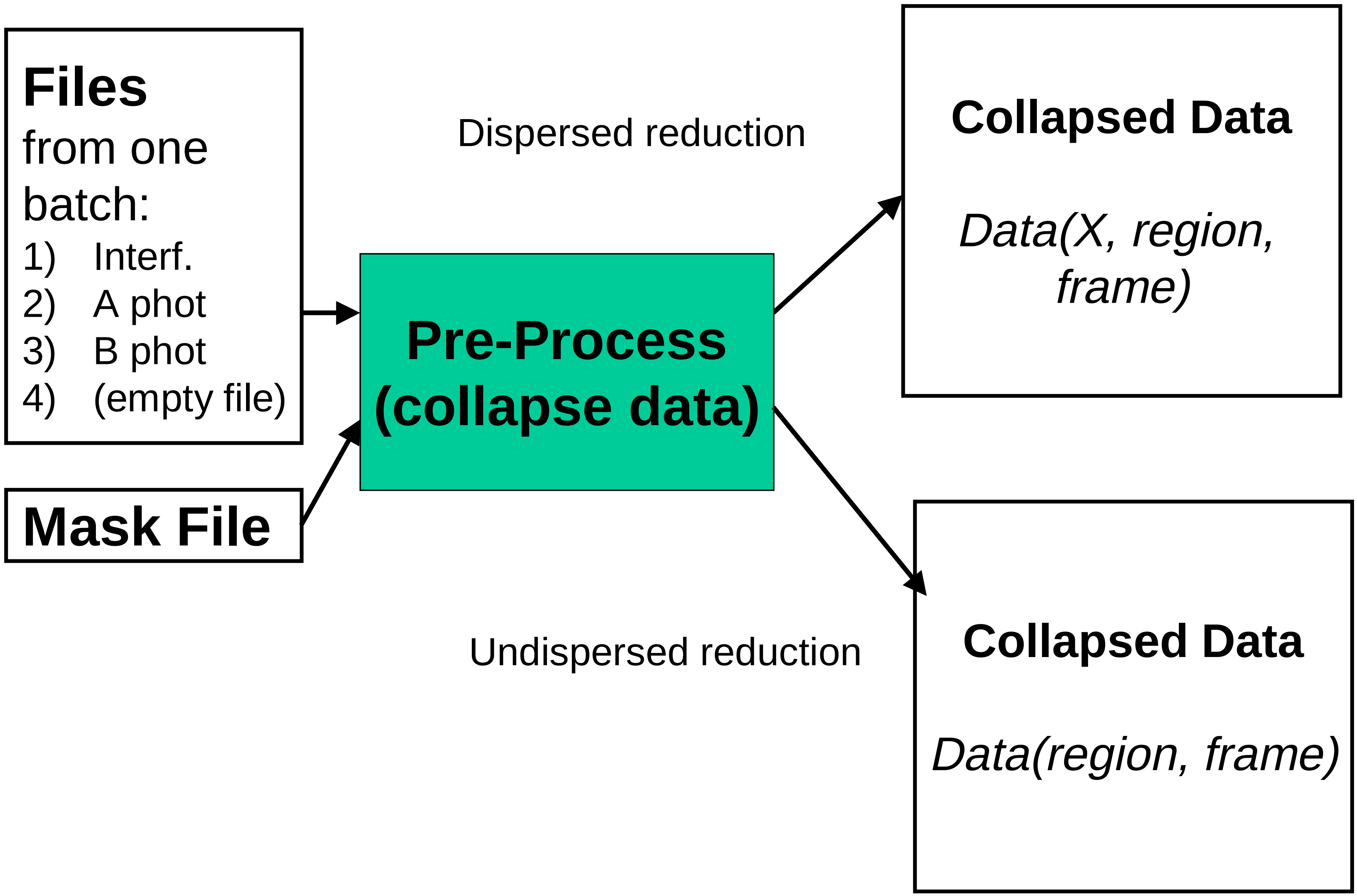
Jeff Meisner


Keystrokes
(diagnostic modes)
Command Line
Parameter File
File list
Mask File
Input Files
MIDI DRS
Terminal Output
Output to i-Plotter
Report file
OIR fits file
QC log file
Plot File
Transfer function file

> ./midiDataReduction -a ./argumentFile2.lst

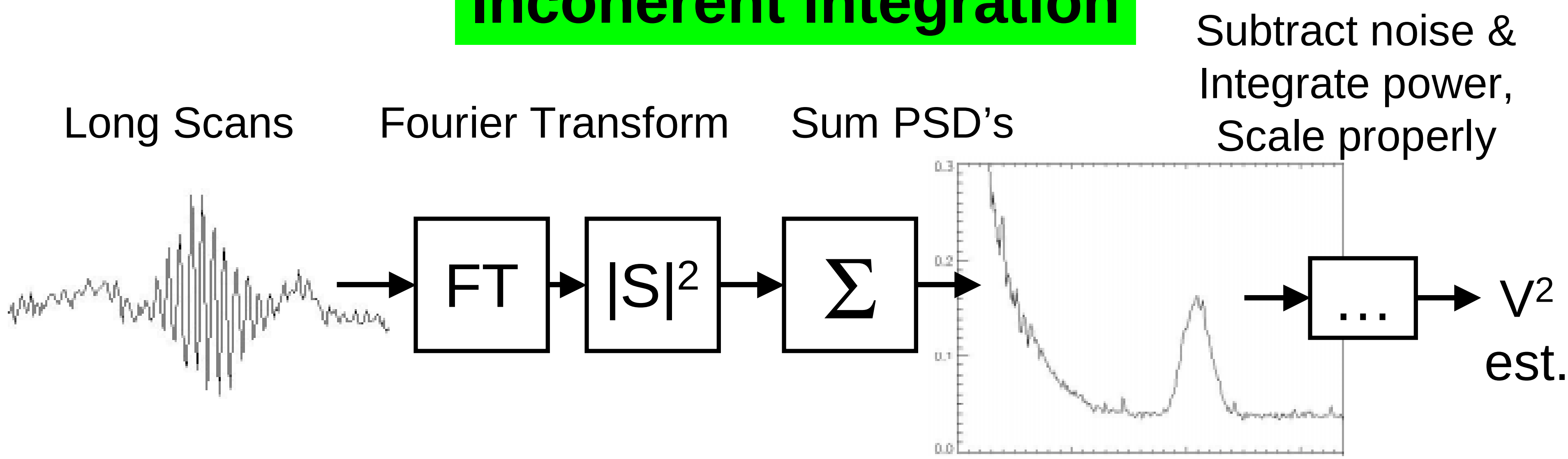
```
IN_DIR ~/mididata/alfori/fileset1
OUT_DIR ./
OUT_NAME MIDI_dispersed
MASK_DIR ../Masks/
MASK_NAME
TRF_WRITE ./MIDI_transferFunction.trf
PROCESSING DISPERSED
PROCESSING UNDISPERSED
DEBUG 3
VERBOSE 0
PLOT_FILE 0
DISPLAY_ONLY 0
MEM_CHECK 0
CUBE_DATA 0
COMBINE_CHANNELS 1
```


File list
(Specified, or created from contents of input directory)
classifyFitsFiles
List of files organized into 1 or more batches (same TPL start time)
Run with –m option
Creates 1 batch (may have mixed TPL start times)

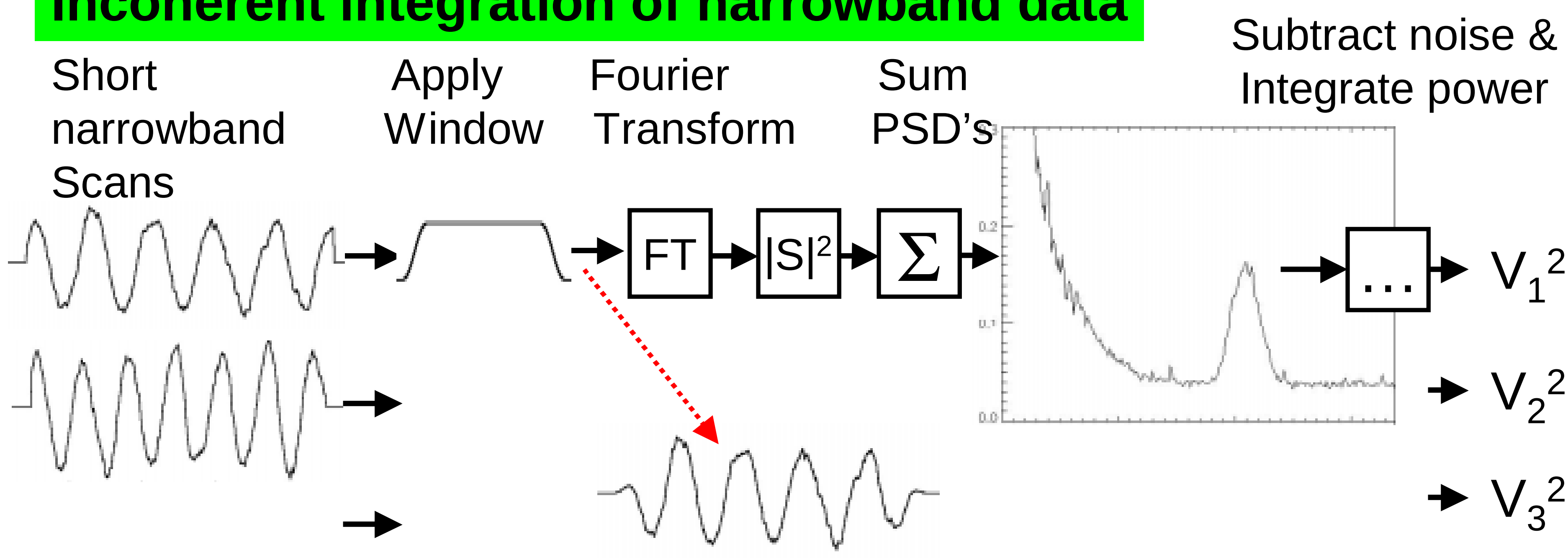


Collapsed frames are organized into “scans”

Incoherent integration



Incoherent integration of narrowband data



Estimation of noise level

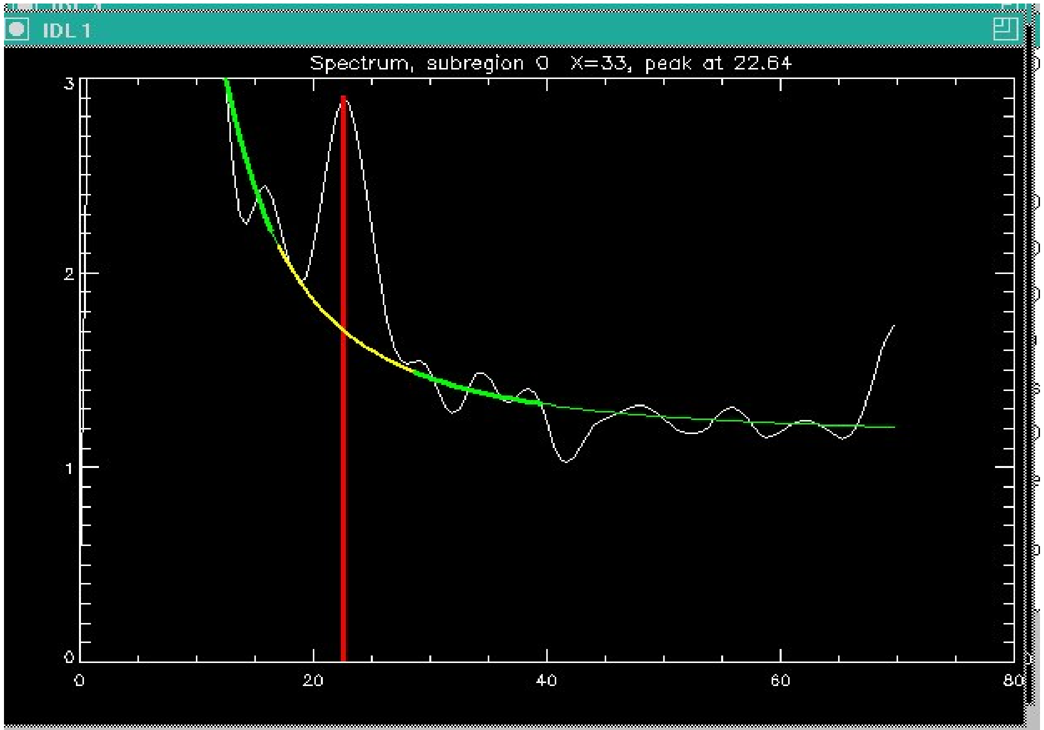
3-parameter fit:

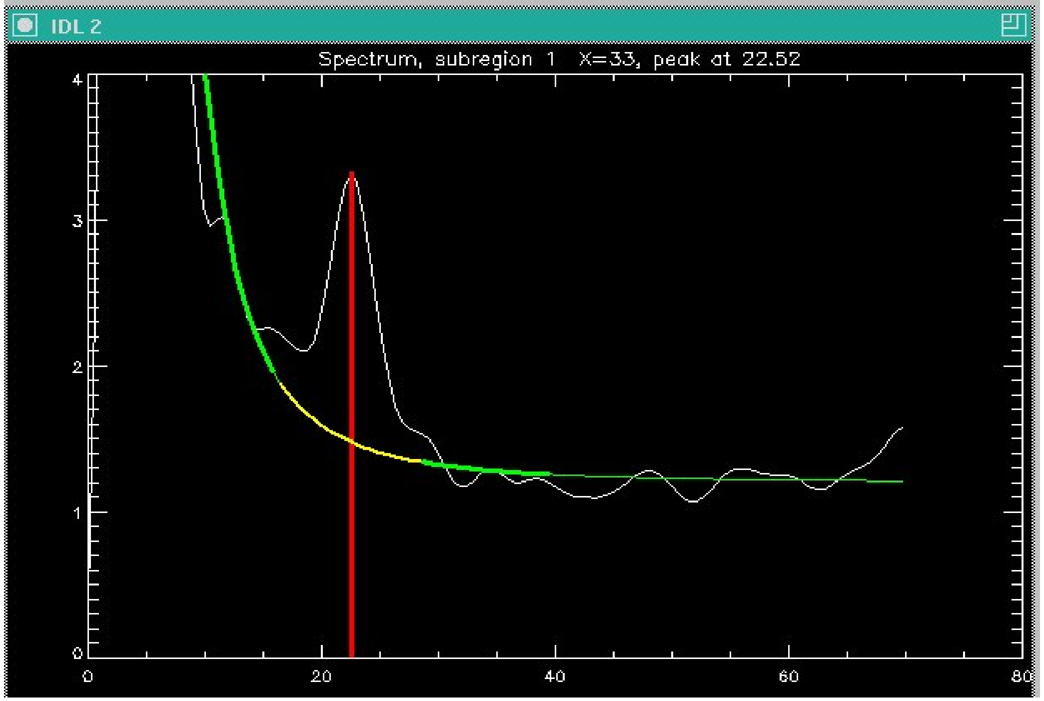
1) White noise level
2) Level of 1/f noise
3) Power law of 1/f noise

Integration of power under spectrum minus noise, over possible fringe frequencies → V^2 (unnormalized)

+ Estimate of error (not yet implemented)

Algorithm also returns estimated optical frequency for each channel (red line)

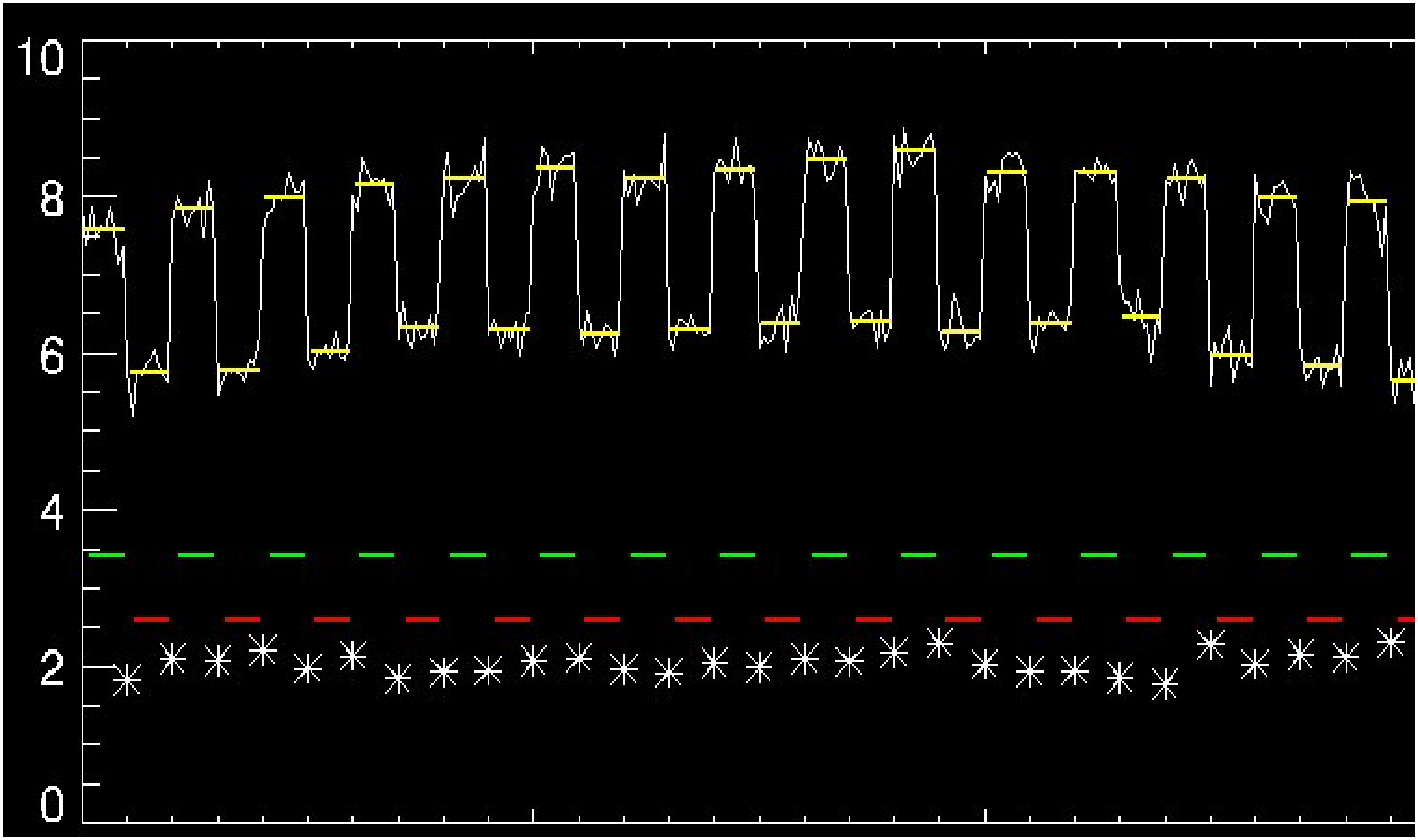




Photometry estimation:

Use A-open and B-open chopping runs (taken after interferometry)

Future: use the result from chopping *during* interferometry.



Raw Signal

Average On/Off (yellow)

tartype:

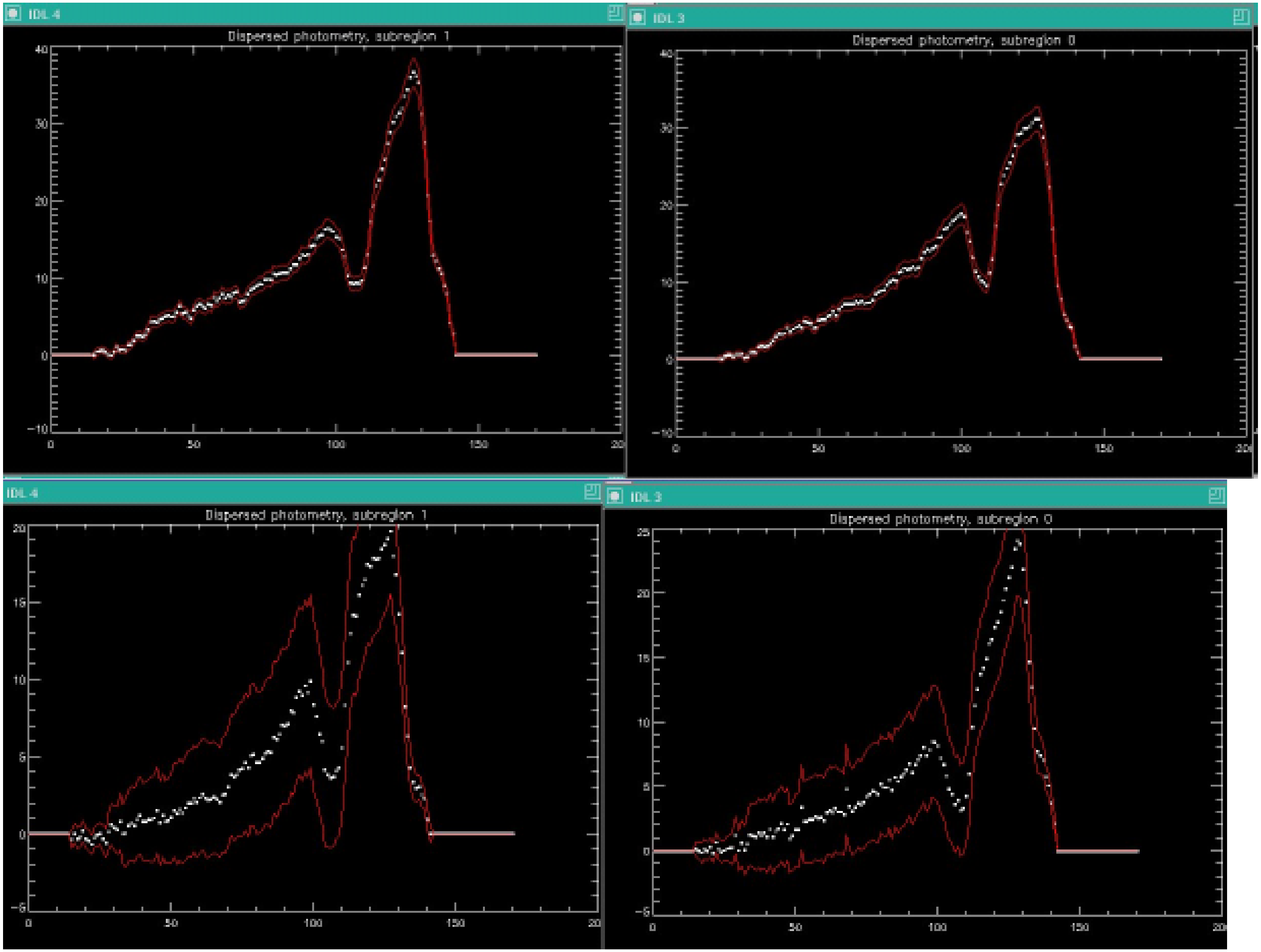
'T'

'S'

Detected transition amplitudes

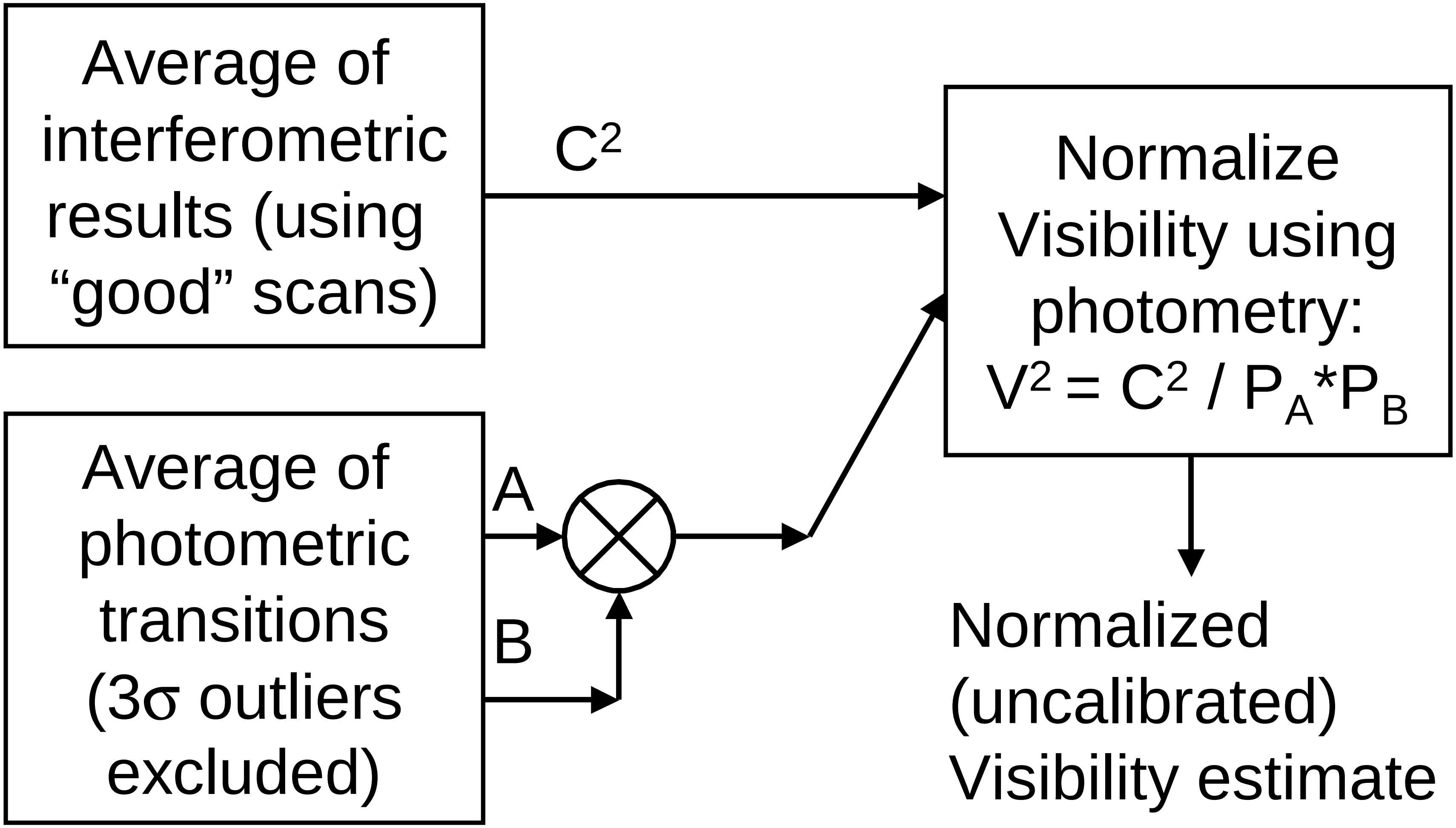
Raw Transitions → Find rms → Discard 3σ outliers & repeat; Average

Dispersed photometry results, with error bars (red)

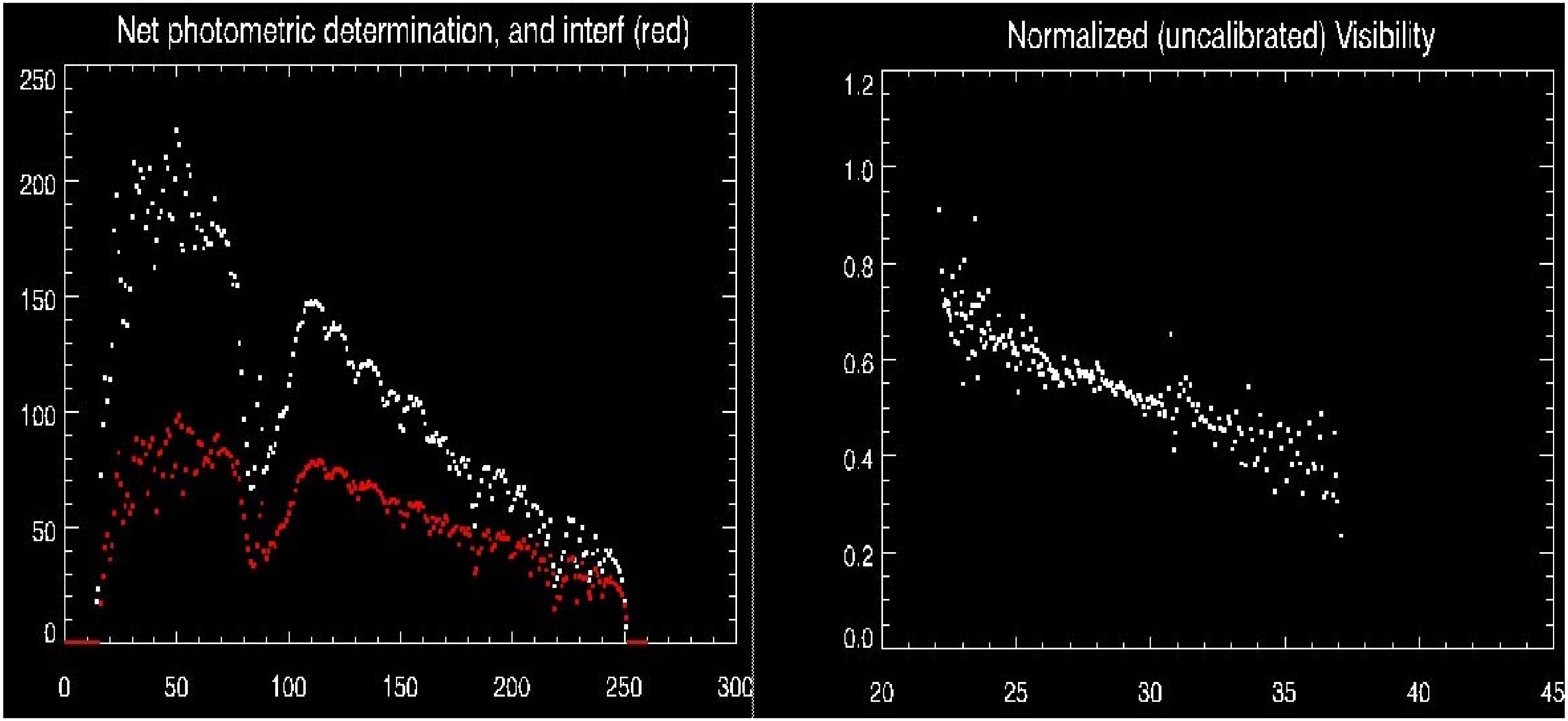


Good

Bad!


Average of interferometric results (using "good" scans)
C²
Normalize Visibility using photometry: V² = C² / P_A*P_B
Average of photometric transitions (3σ outliers excluded)
A
B
Normalized (uncalibrated) Visibility estimate

Results in graphical form



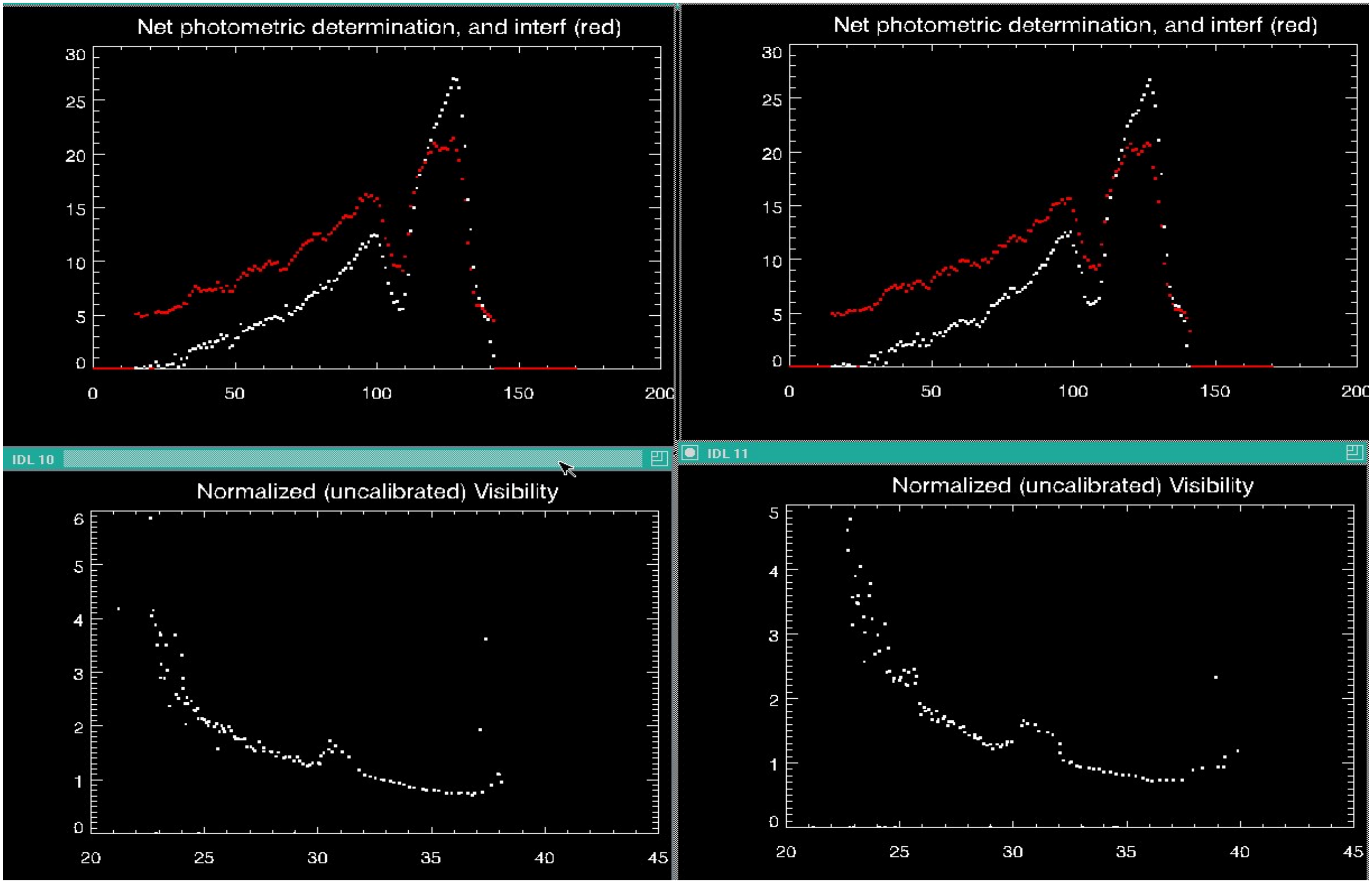
REPORT:

Normalized Visibility Results:

Wavelength calibration is computed from the interferometry

Channel X	Wavelength microns	THz	Net photometry ADU/frame	Visibility^2 normalized	RMS Visibility Error percent from photomErr	from vis	net
…..							
124	8.63	34.744	49.58	0.595	28.6	0.0	28.6
125	8.57	34.965	50.83	0.577	27.5	0.0	27.5
126	8.50	35.282	52.34	0.577	26.5	0.0	26.5
127	8.44	35.527	53.71	0.548	24.8	0.0	24.8
128	8.37	35.802	52.38	0.495	24.3	0.0	24.3
129	8.33	36.008	50.43	0.483	23.7	0.0	23.7
130	8.25	36.334	44.57	0.472	23.7	0.0	23.7
131	8.20	36.540	38.68	0.469	24.4	0.0	24.4
132	8.15	36.777	28.75	0.429	26.5	0.0	26.5
133	8.10	37.031	23.41	0.382	27.4	0.0	27.4
134	8.00	37.468	16.93	0.430	29.4	0.0	29.4
135	7.91	37.882	14.09	0.380	32.5	0.0	32.5
…..							

When the photometry is wrong, the visibility determination suffers….

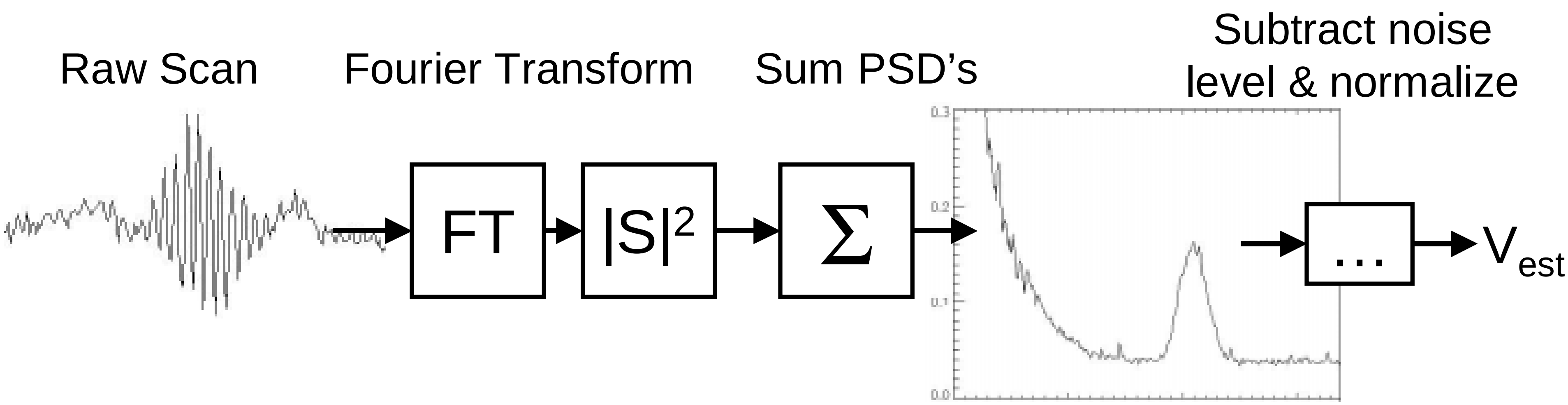


END OF TALK ON ESO PIPELINE

Incoherent, coherent and quasi-coherent integration

Incoherent integration

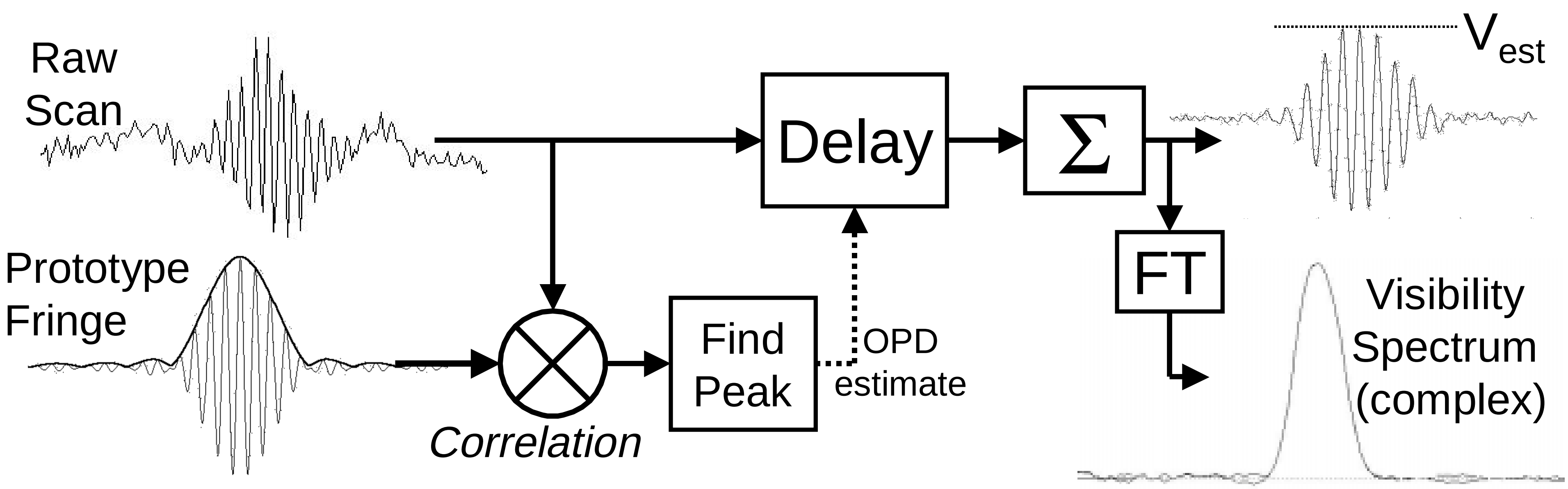
- No attempt to find the atmospheric OPD
- Treats signal as additional noise source (perhaps with a particular spectral content)
- Result dependent on subtraction of assumed noise level



Incoherent, coherent and quasi-coherent integration

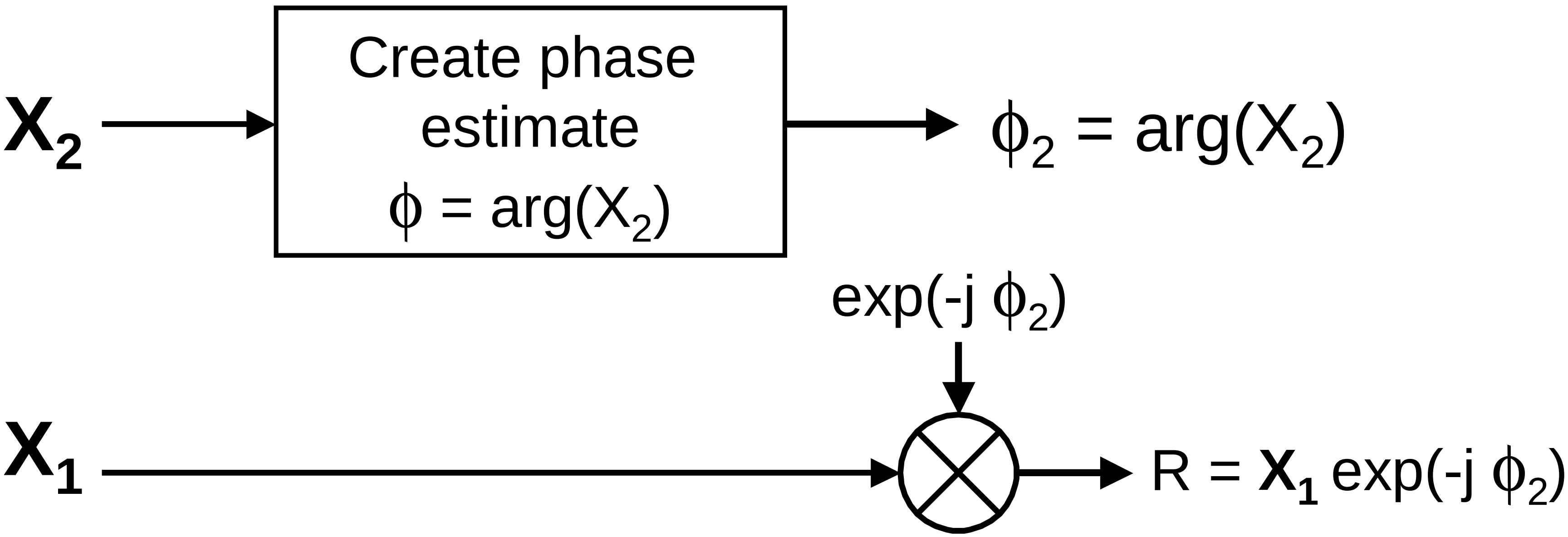
Coherent integration

- Use the data (possibly from a different source) itself to estimate the atmospheric OPD τ
- Uses the estimate of τ to correct the data
- Integrate the corrected data to obtain an average



Incoherent estimation as a "special case" of coherent estimation …..

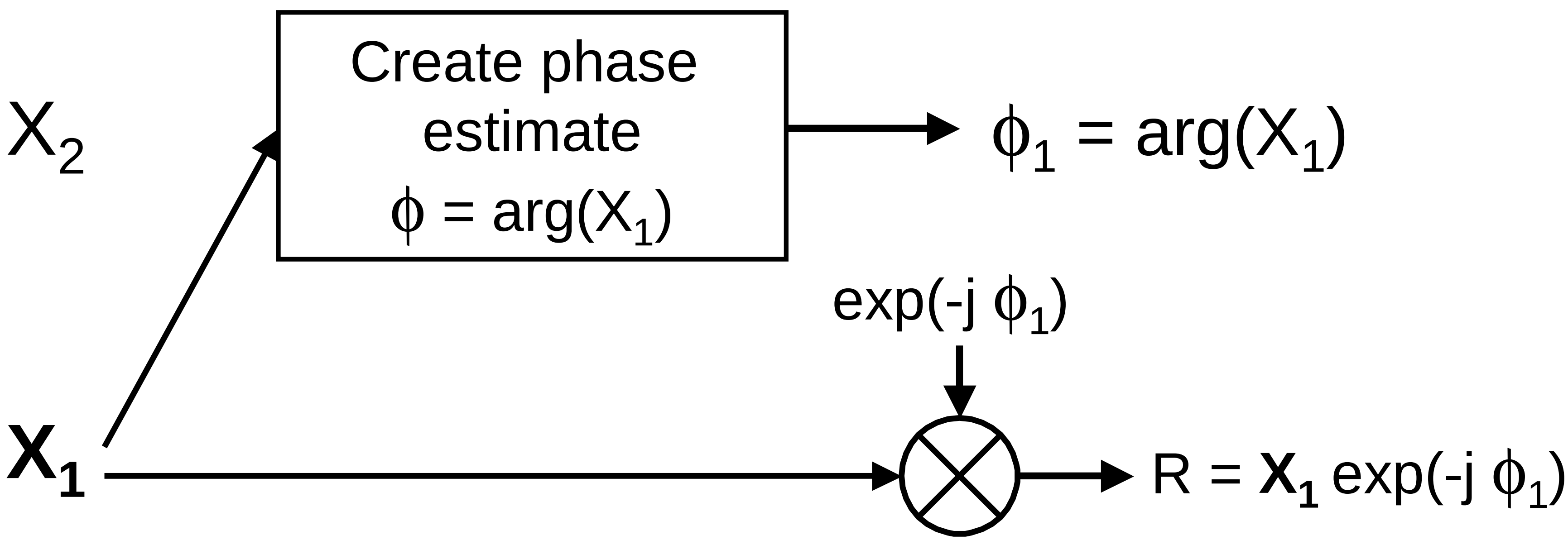
Real coherent estimation using two interferometric signals with uncorrelated noise sources:



$E\{R\} = \tfrac{1}{2}\,|\mathbf{V}|\,\exp(-\tfrac{1}{2}\sigma^2)$

Incoherent estimation as a “special case” of coherent estimation …..

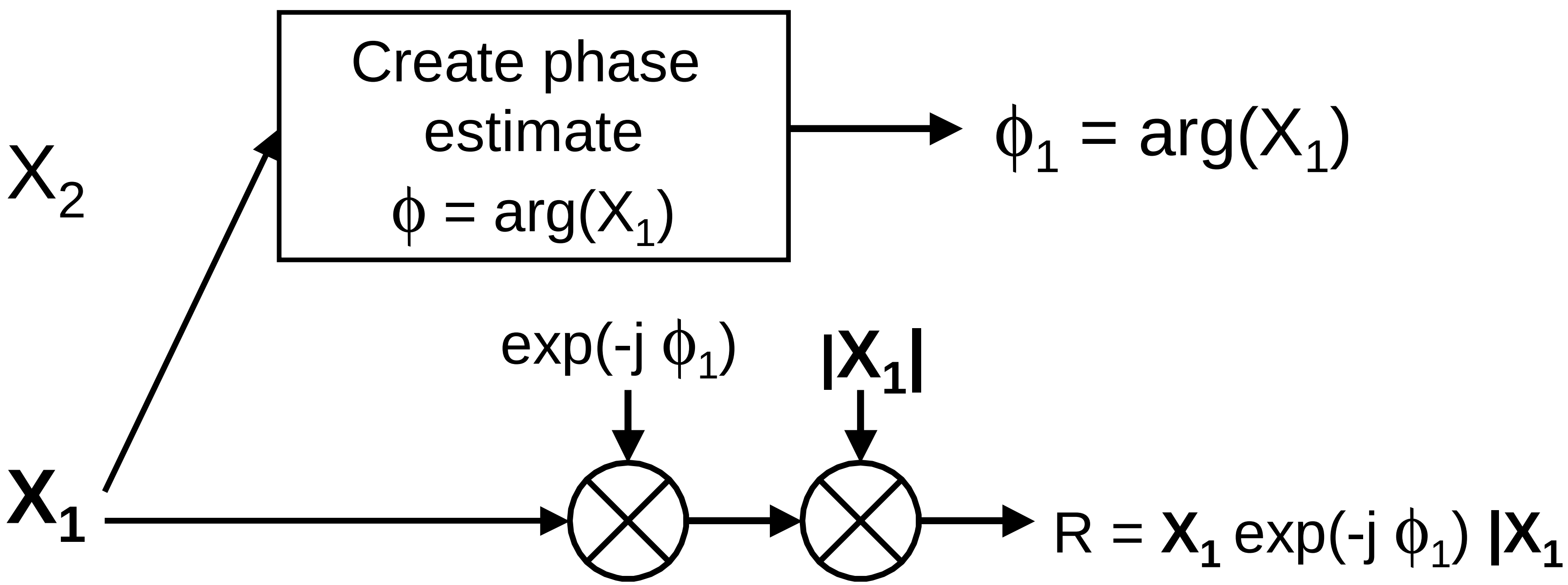
“**Cheating**” by using the *same* signal to generate the reference phase:



$E\{R\} = \tfrac{1}{2}\,|\mathbf{V}| + \text{(noise bias)}$

Incoherent estimation as a "special case" of coherent estimation …..

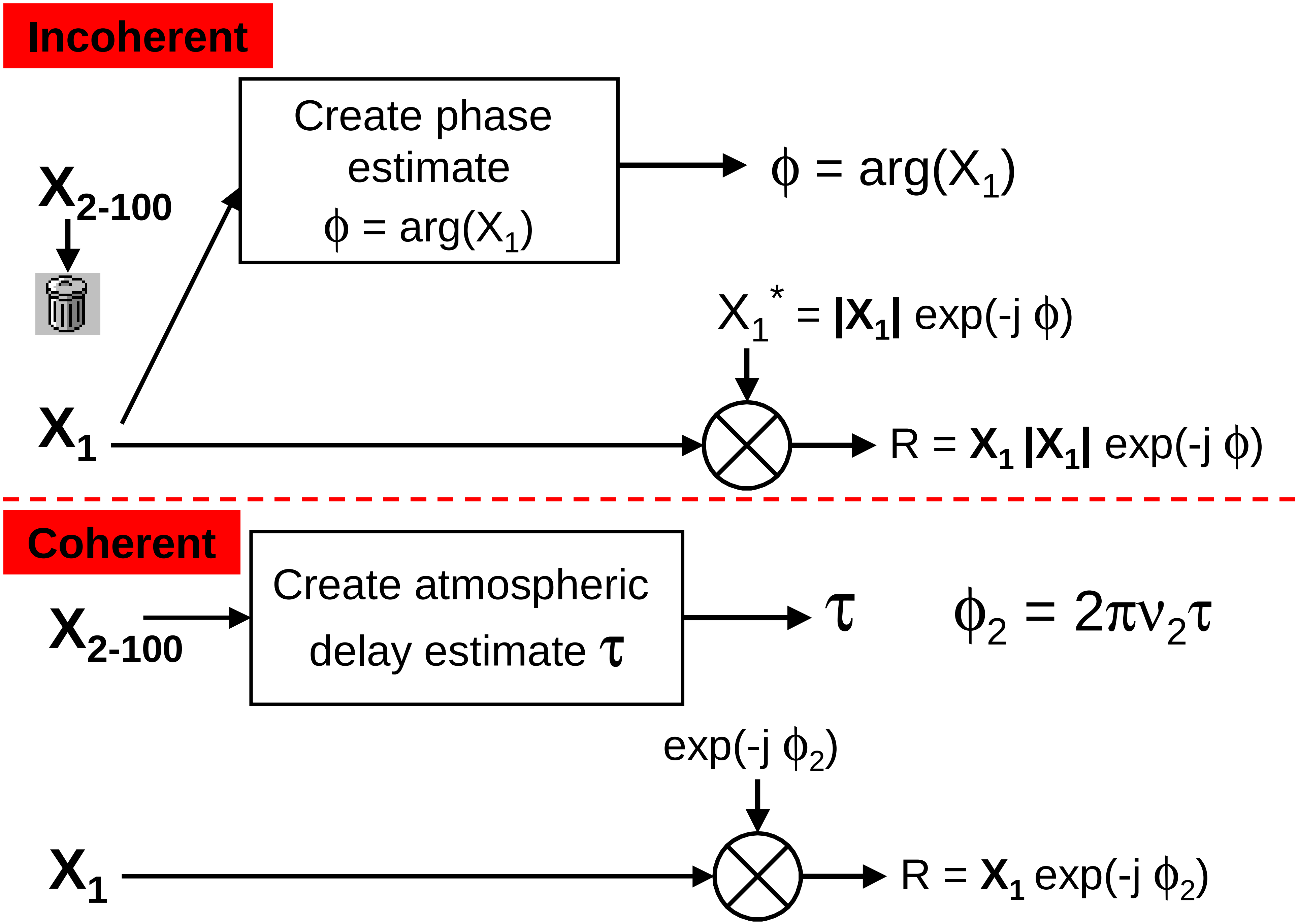
Same thing, but also multiply by $|X_1|$ (why not ☺)



$E\{R\} = \frac{1}{2}\, \mathbf{|V|^2}$ + (noise bias)

BUT LOOK:

$R = \mathbf{X_1\, X^*_1 = |X_1|^2}$


Incoherent
Create phase estimate
ϕ = arg(X1)
X2-100
X1
ϕ = arg(X1)
X1* = |X1| exp(-j ϕ)
R = X1 |X1| exp(-j ϕ)
Coherent
Create atmospheric delay estimate τ
X2-100
τ
ϕ2 = 2πν2τ
exp(-j ϕ2)
X1
R = X1 exp(-j ϕ2)

Incoherent, coherent and quasi-coherent integration

“Quasi-coherent” integration

Similar to coherent integration, except:

- Uses the *group delay* estimator to shift the signal by a large amount
- Applies an additional *phase shift* as a proxy for the remaining required OPD correction to ensure coherence
- Therefore applies a frequency-dependent time shift of $\tau_G + \phi/\nu$ instead of $\tau_G + \phi/\nu_0$