FCP Short Course

Data Validation and Reduction for Fatigue

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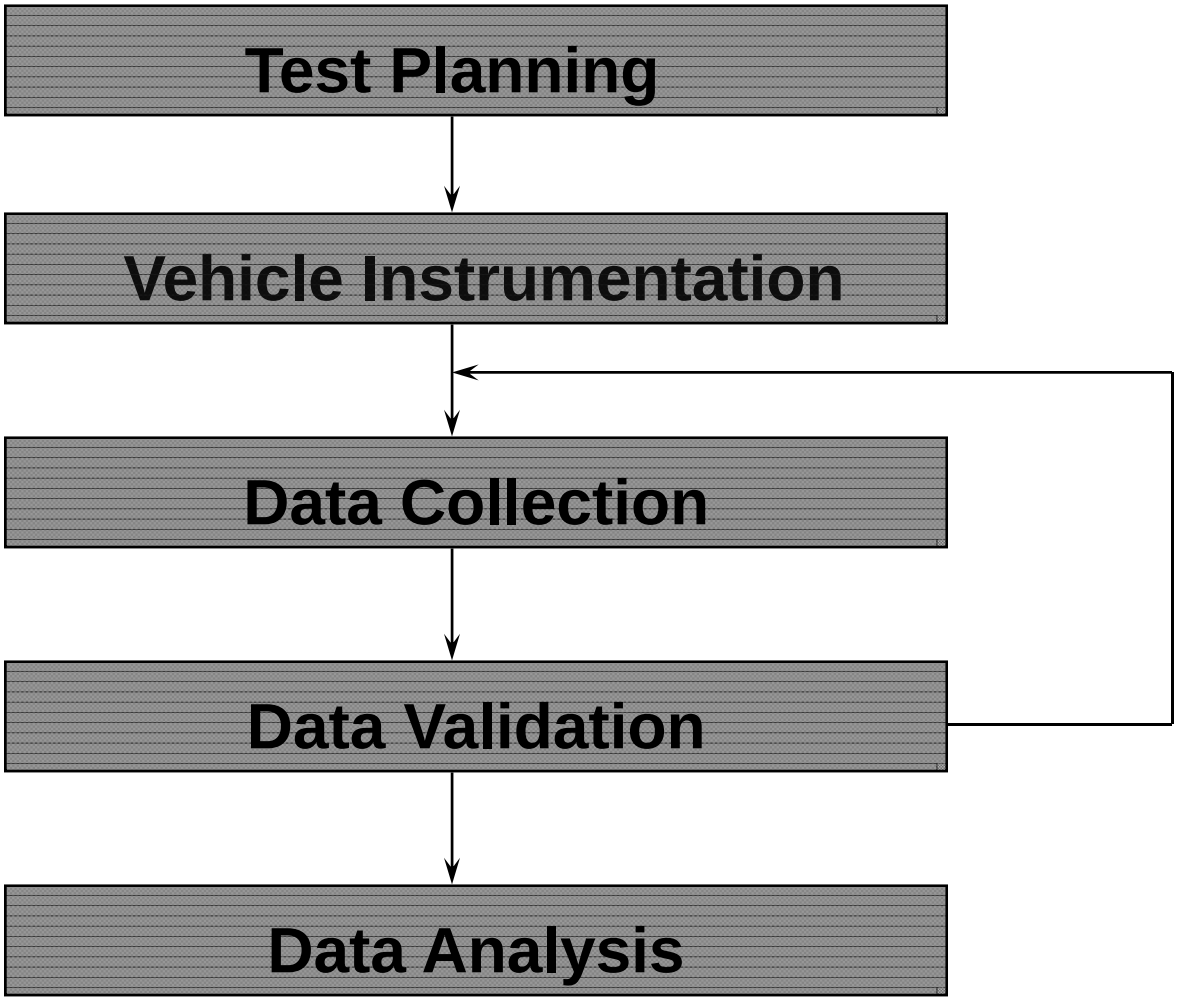
Mechanical Science and Engineering

Outline

- Test Planning
- Data Acquisition
- Data Validation
- Data Reduction Modes

Data Collection Exercise



Why Do We Collect Data?

- Assess product performance
- Estimate product durability
- Establish customer usage
- Model Verification
- Put Out Fires
- Other

Data Collection Equipment

- Analog Tape Recorders
- Digital Tape Recorders
- Solid State Digital Devices
  - Data Loggers
  - Time History Recorders
  - Field Computers

Data Collection Equipment

Field Data Collection

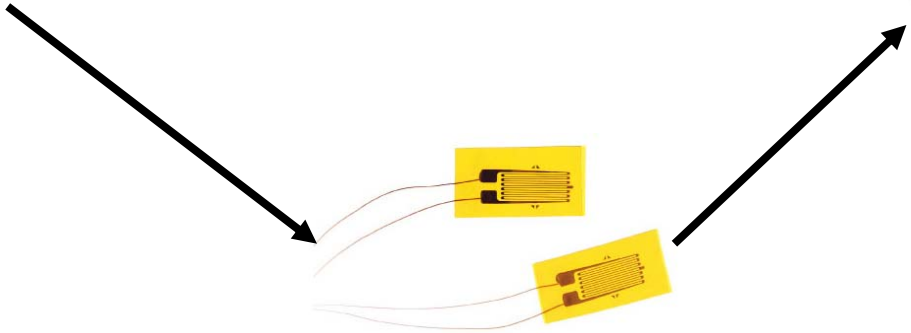
- Field tests are expensive
- Do it in one trip
  - Do I have the right data?
  - Do I have enough to be representative?
  - Is it of sufficient quality and accuracy?
- Good data acquisition equipment
  - Rugged
  - Easy to use
  - Flexible

Huge Investment

Durability Testing

Test Article

Data Collector



Strain Gages

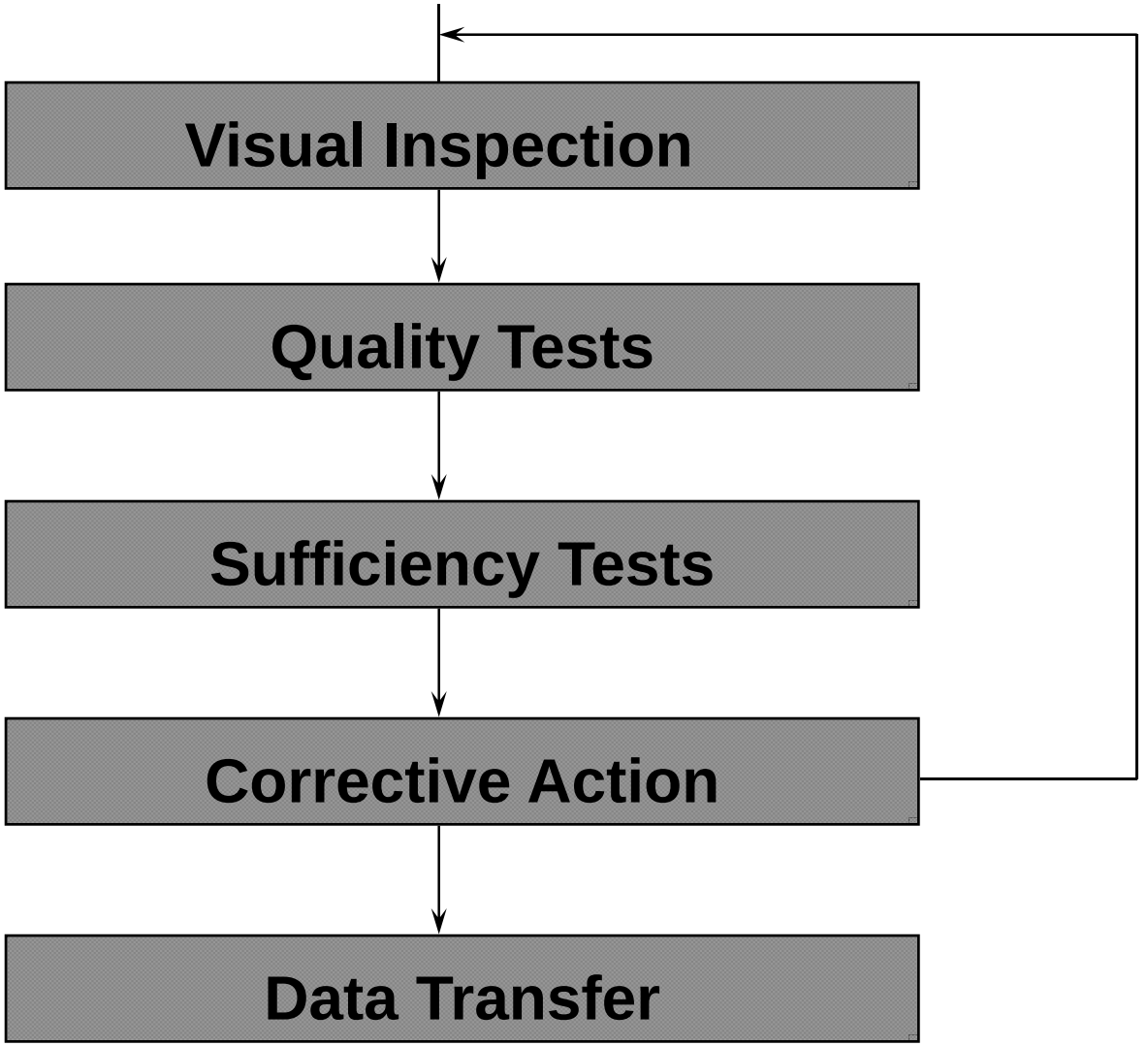
What Is Data Validation?

- Process of verifying that the data collected meets the objectives set forth during test planning
- Data quality is sufficiently high
- Data quantity is enough to ensure statisical relevancy
- Data can sometimes be corrected

What Kind of Effort Is Validation?

- Most laborious, least interesting form of data analysis
- Time consuming - 20% to 50% of total data analysis effort
- Critically important - bad data begats bad analysis

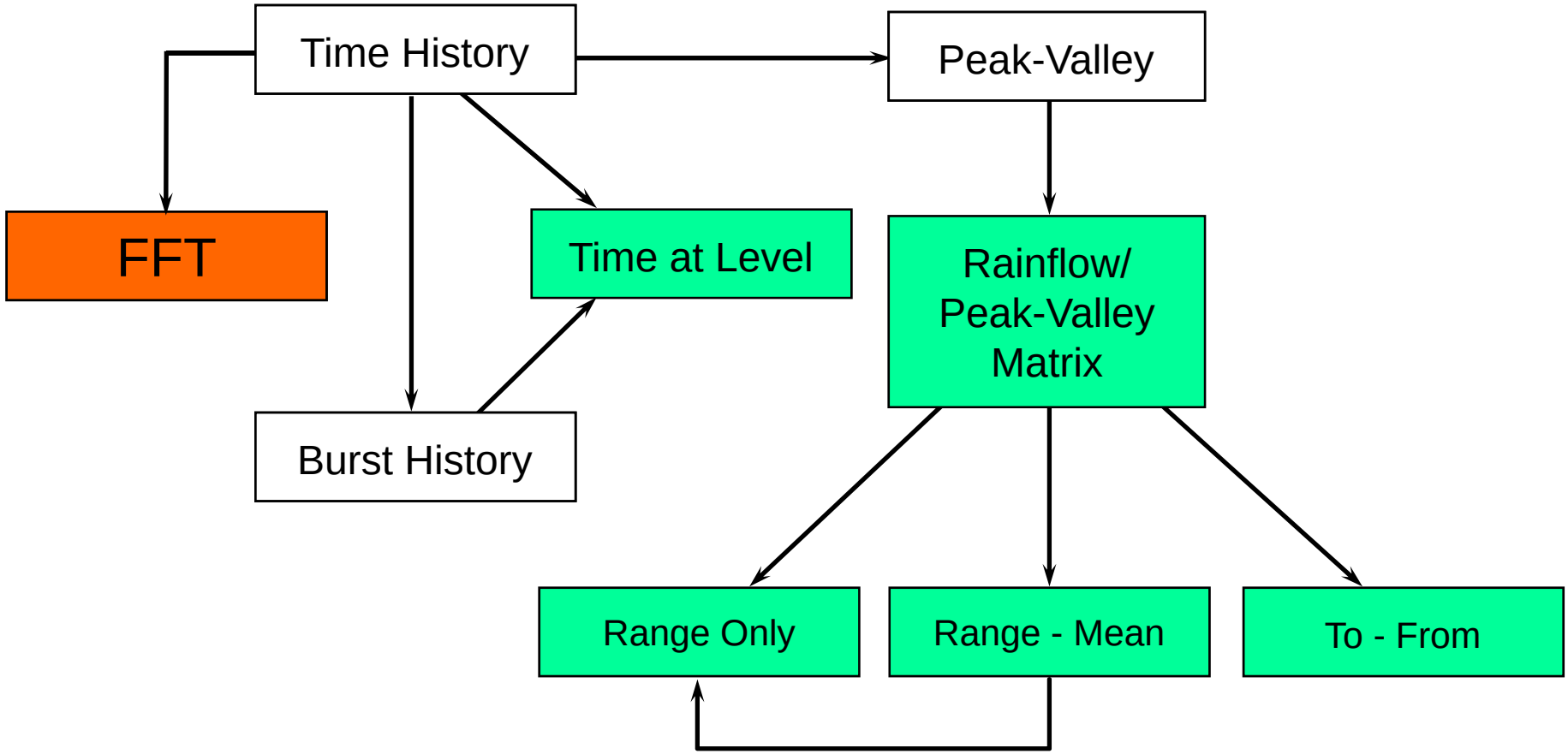
Data Validation Steps



Outline

- Time History
- Time at Level Histograms
- Sequential Peak Valley
- Peak Valley Matrix (Markov)
- Rainflow Matrix
- FFT

Relationship of Modes



Data Mode Uses

Time History - everything

Burst History - finding rare events

Sequential Peak Valley - durability analysis

Time @ Level Histogram - usage and performance determination

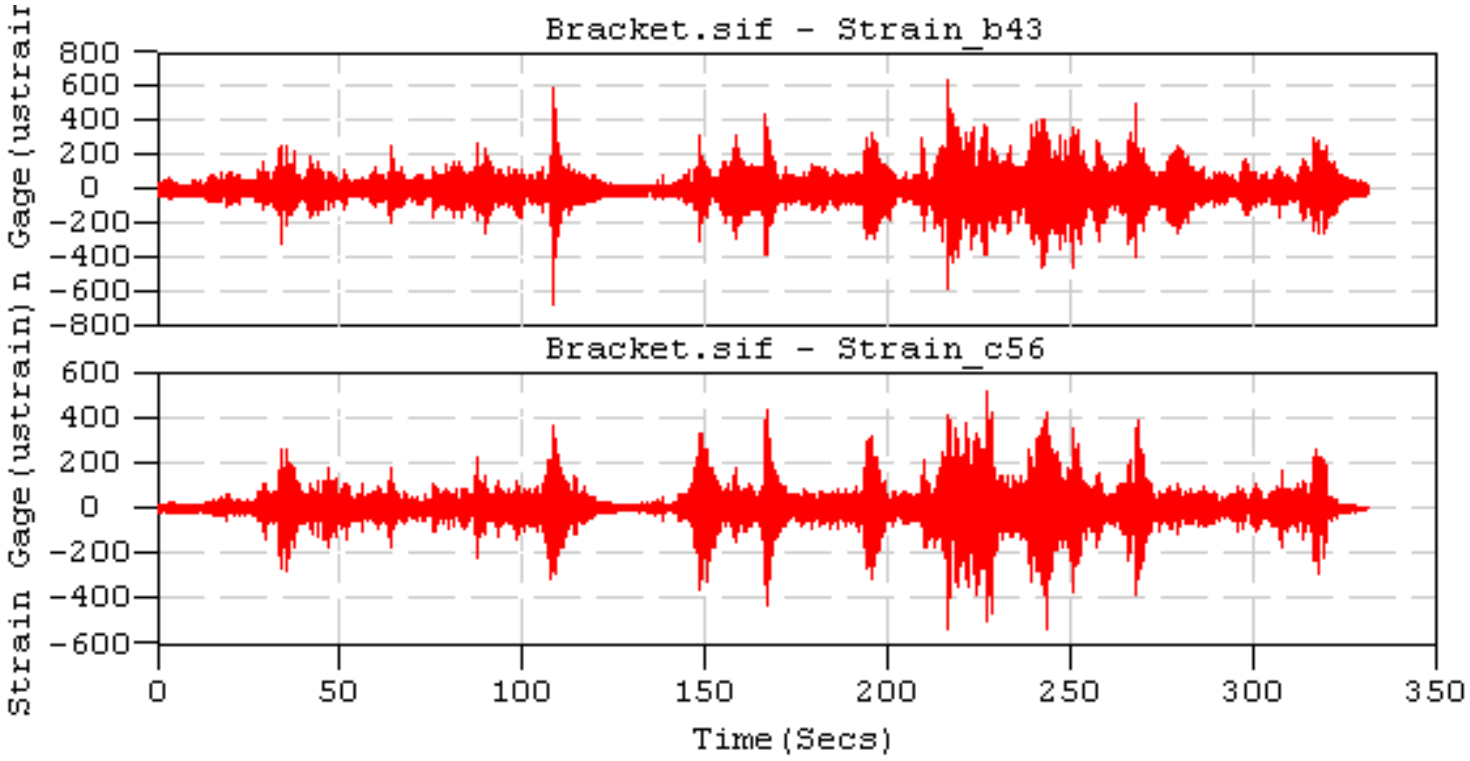
Peak Valley Matrix - statistical history characterization

Rainflow - durability analysis and statistical history characterization

FFT –everything like a time history but in the frequency domain

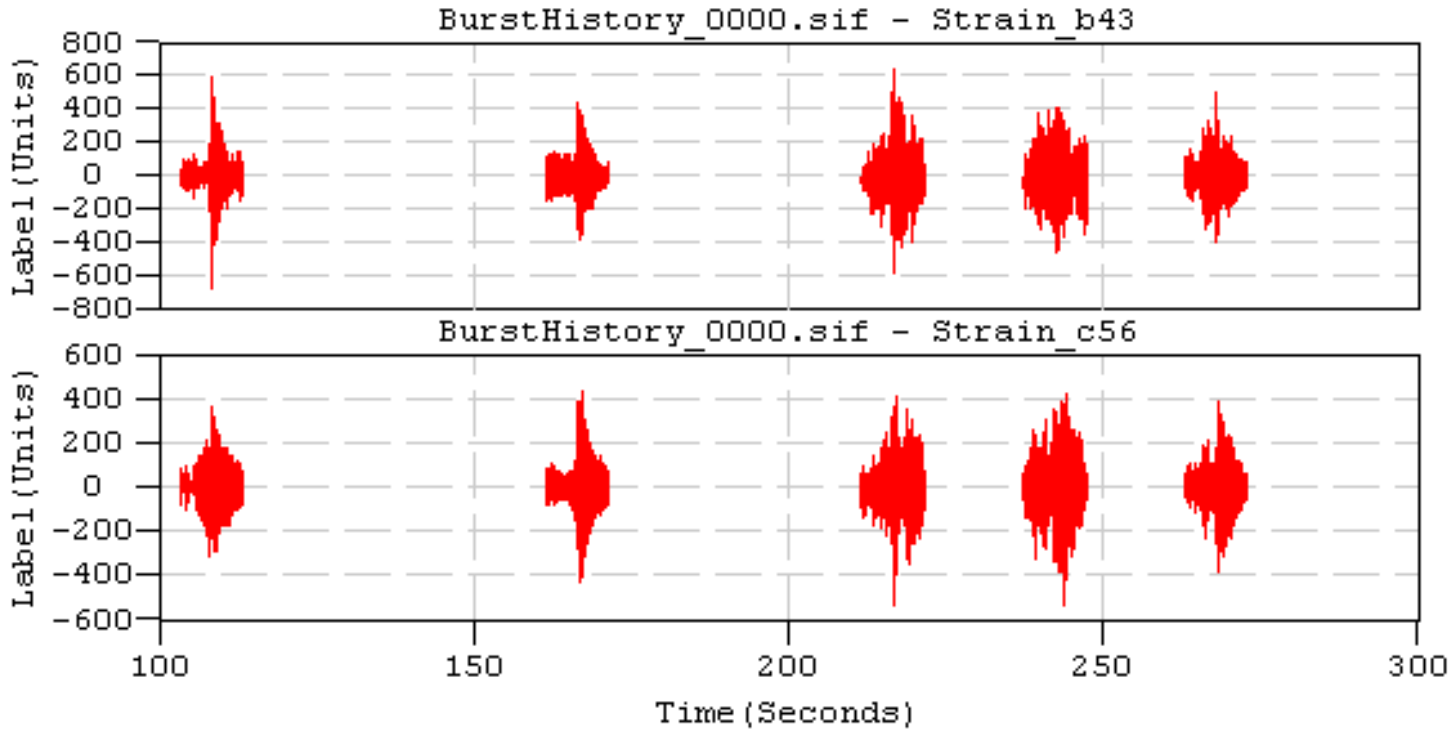
Time History

- Maintains amplitude
- Maintains sequence
- Maintains phase between multiple channels
- Maintains frequency content



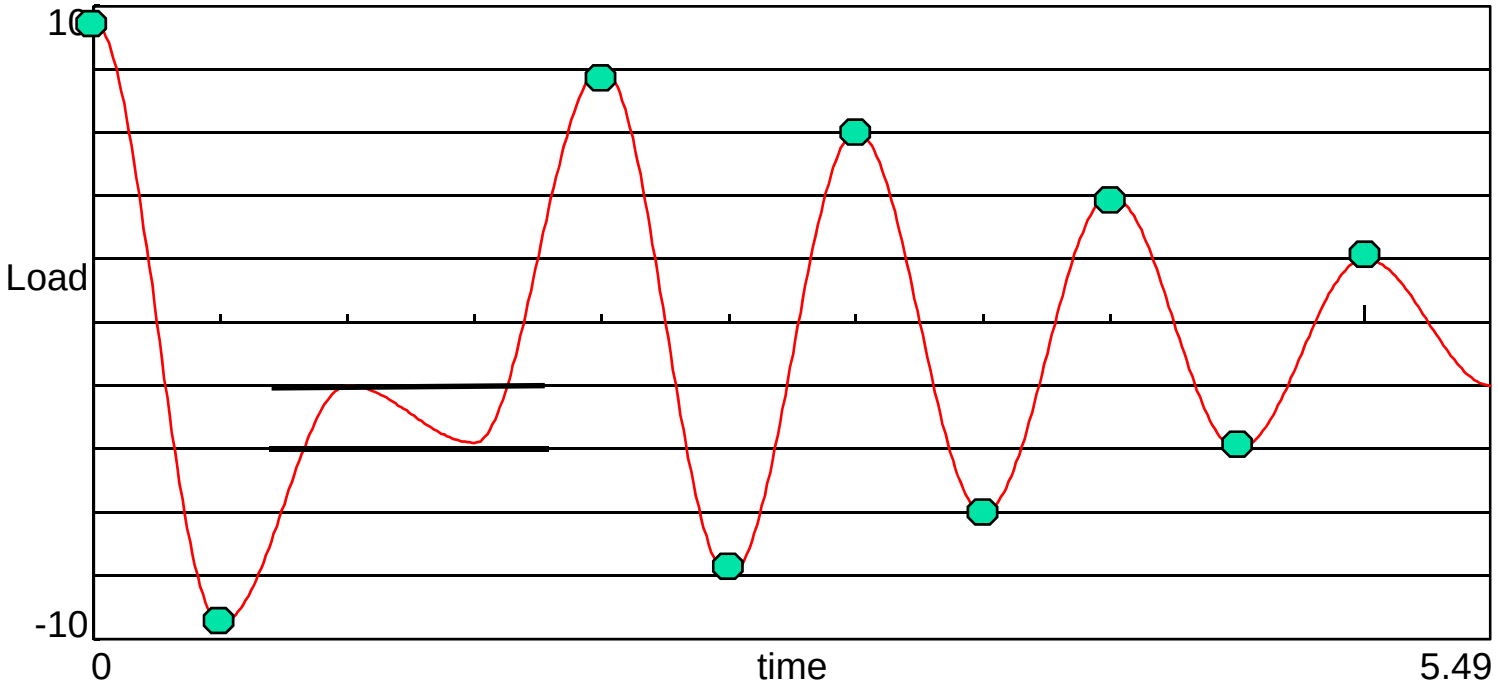
Burst History (Triggered)

- Maintains amplitude
- Maintains sequence
- Maintains phase between multiple channels
- Maintains frequency content



Peak Valley Extraction

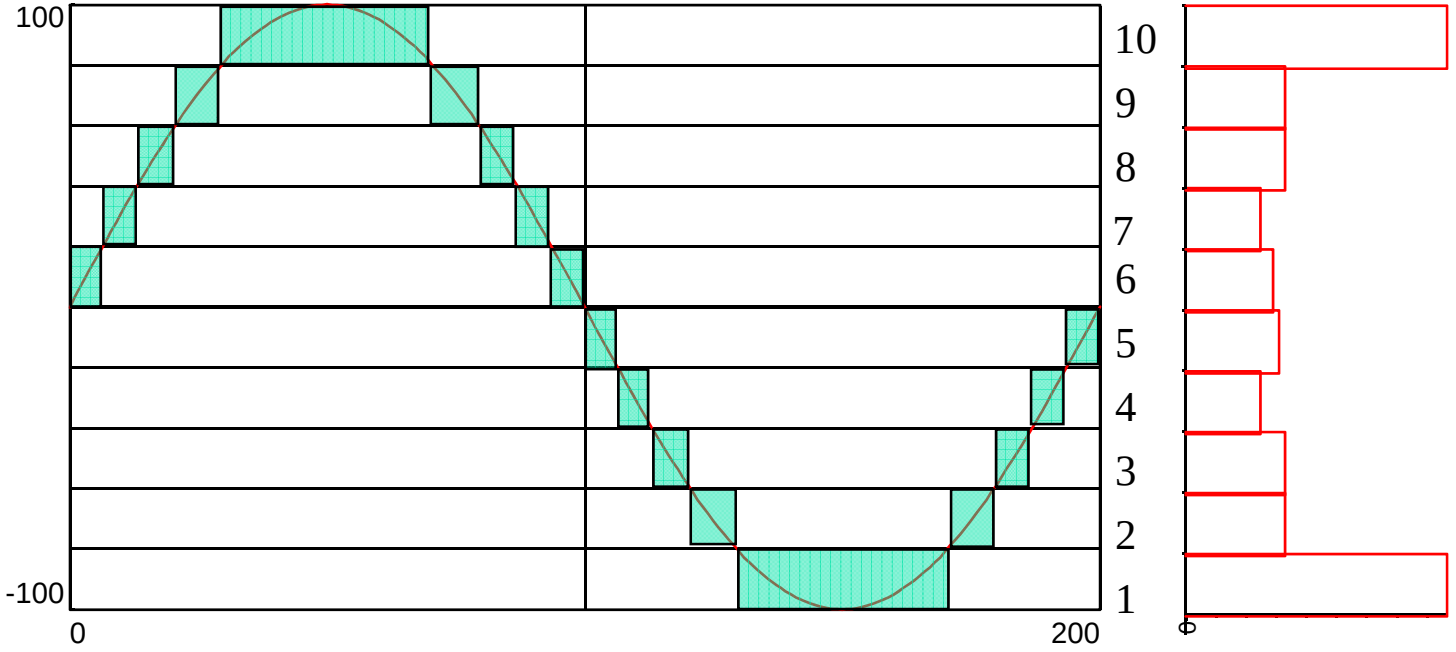
- Maintains amplitude
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content



Time At Level Histogram

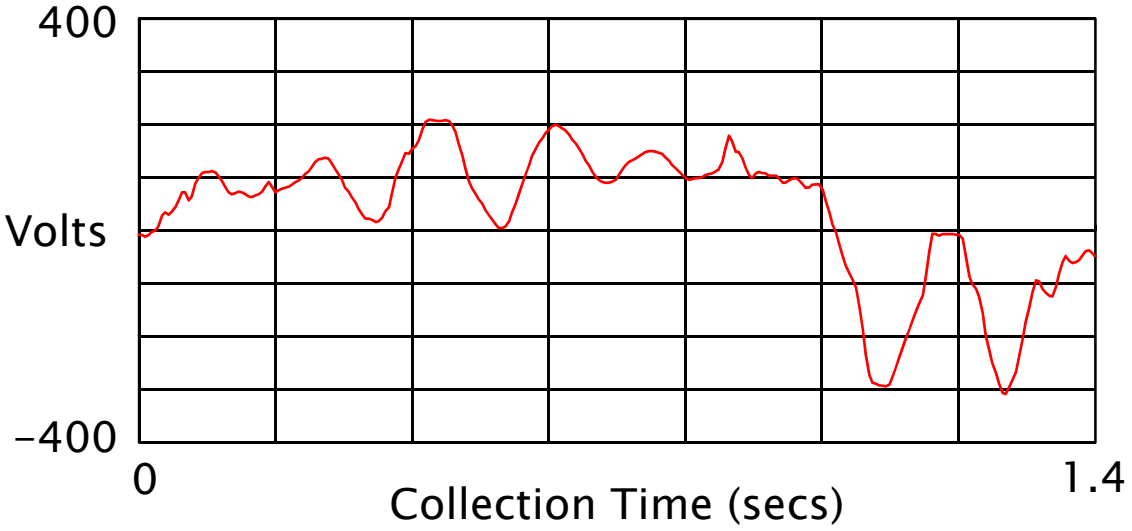
- Maintains statistics
- Destroys sequence
- Destroys phase between multiple channels
- Destroys frequency content

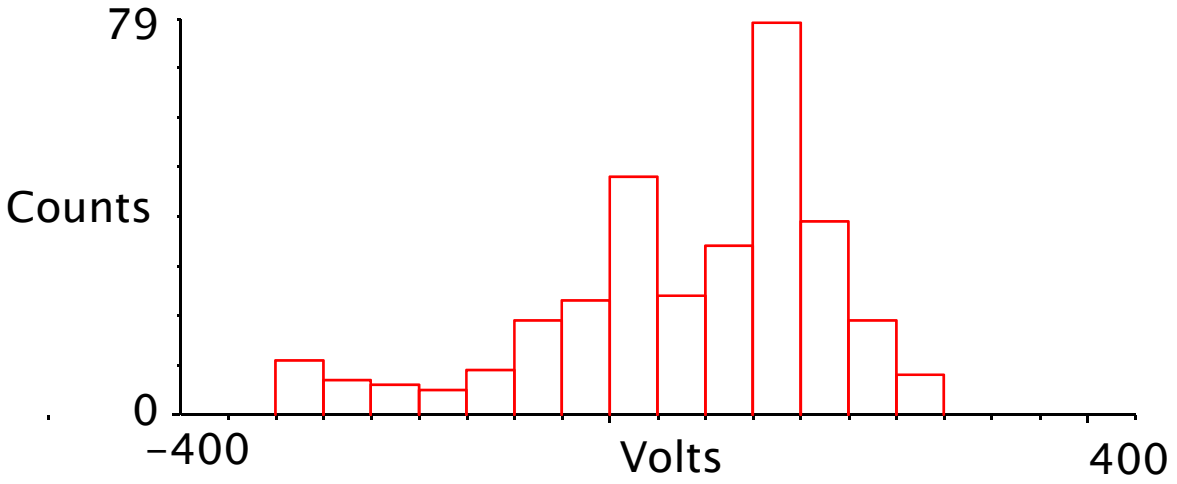
Counts the total number of samples in each input signal category.



1D Time At Level

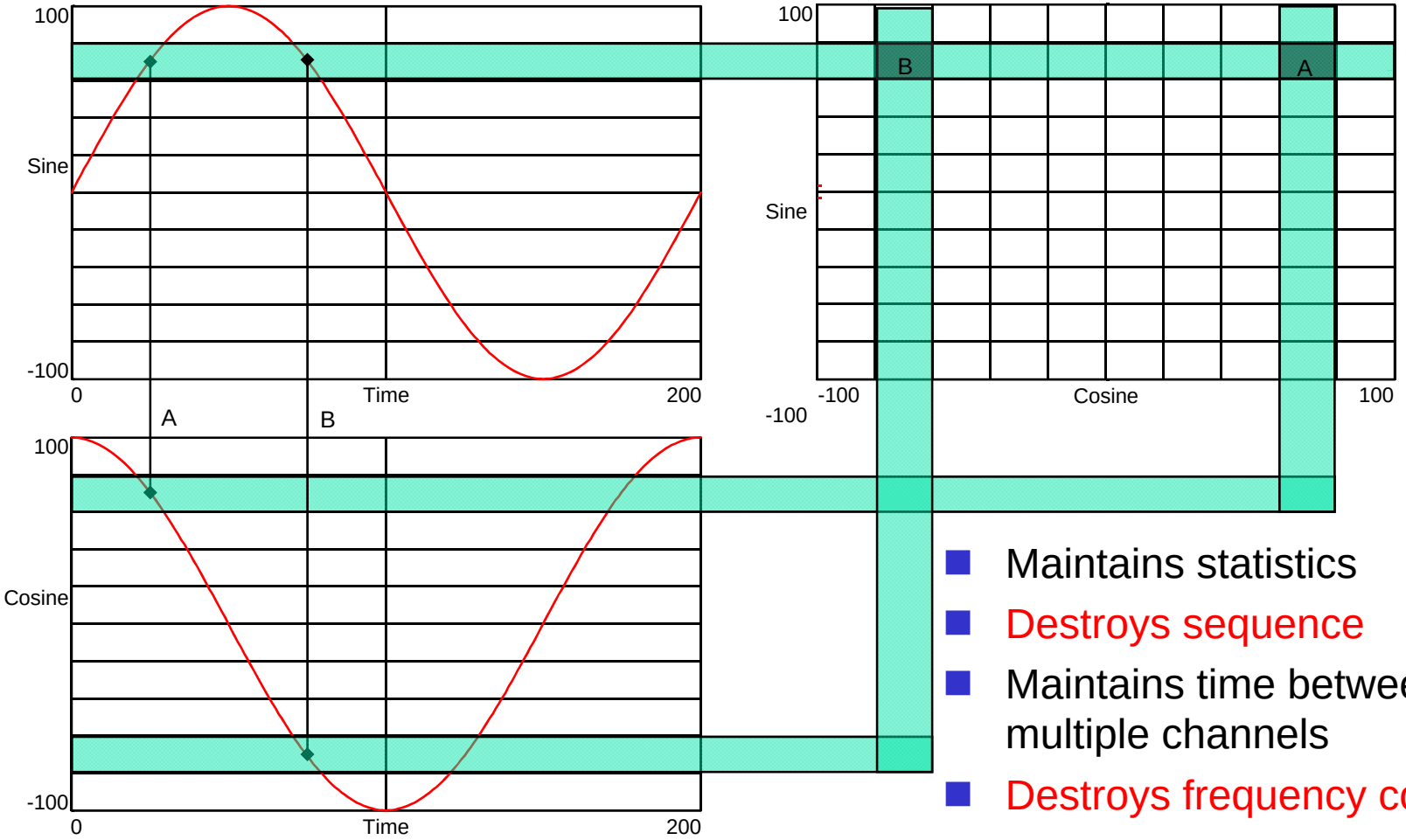
Counts the total number of samples in each input signal category.





2D Time At Level

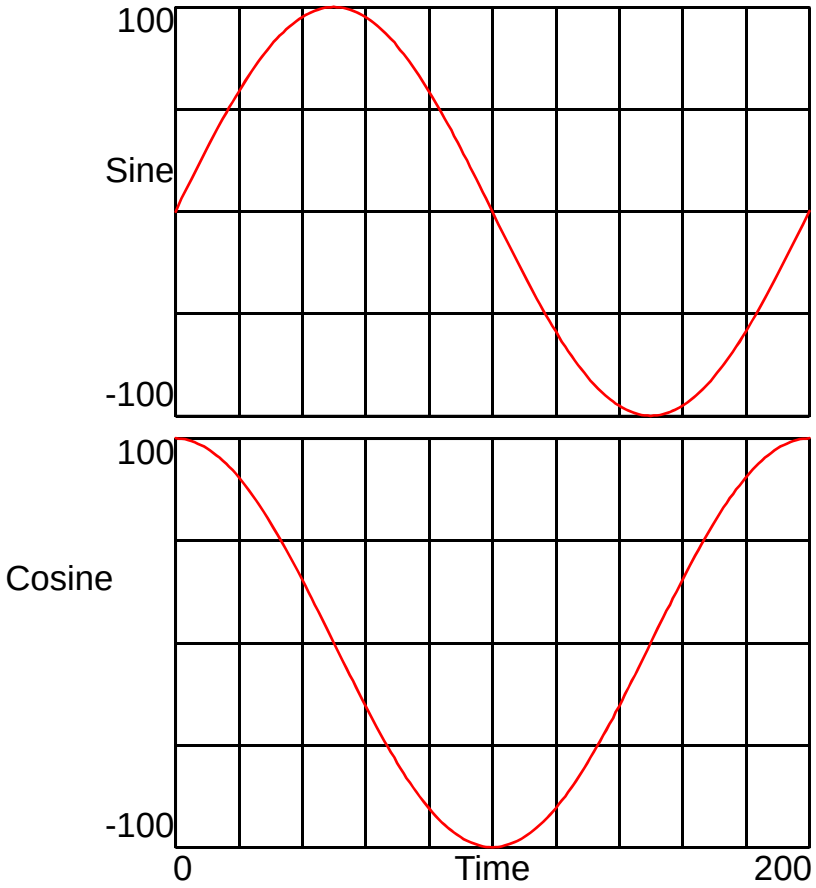
Counts the total number of samples in each unique combination of input signal categories

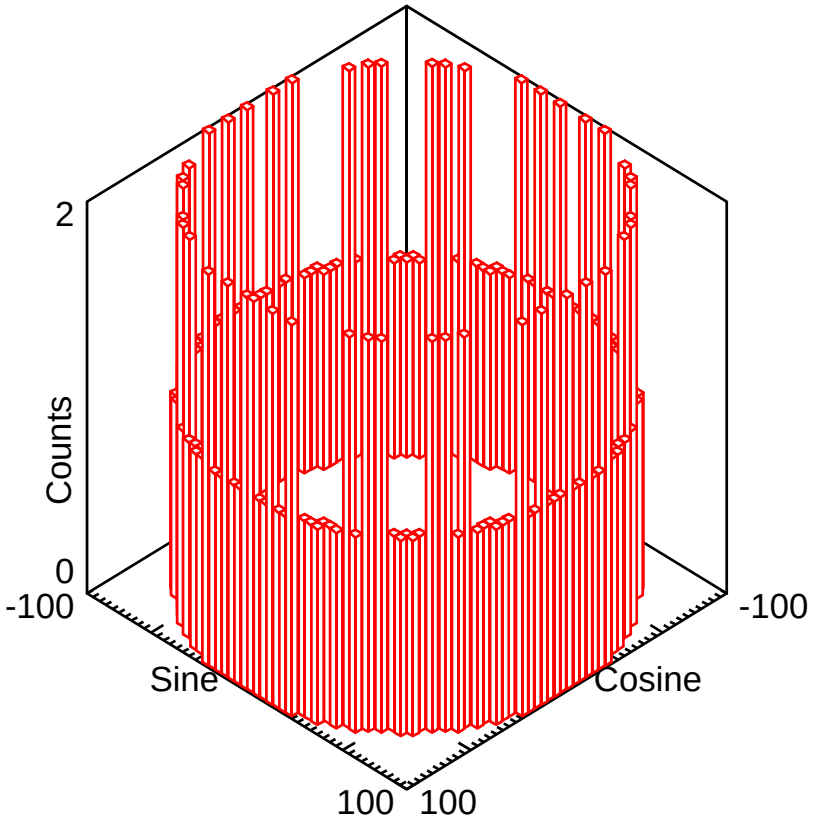


- Maintains statistics
- Destroys sequence
- Maintains time between multiple channels
- Destroys frequency content

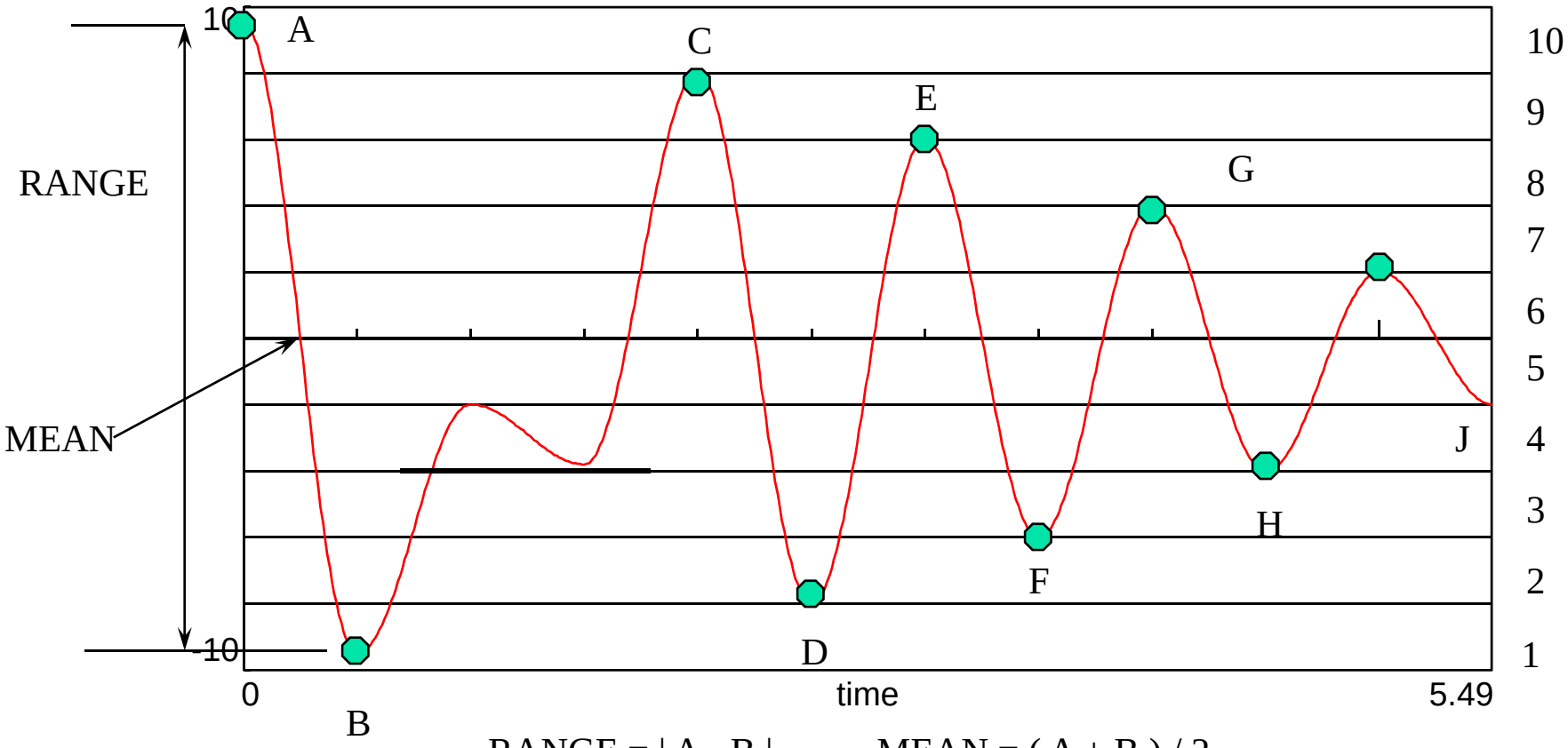
2D Time At Level

Counts the total number of samples in each unique combination of input signal categories





Peak Valley Matrix

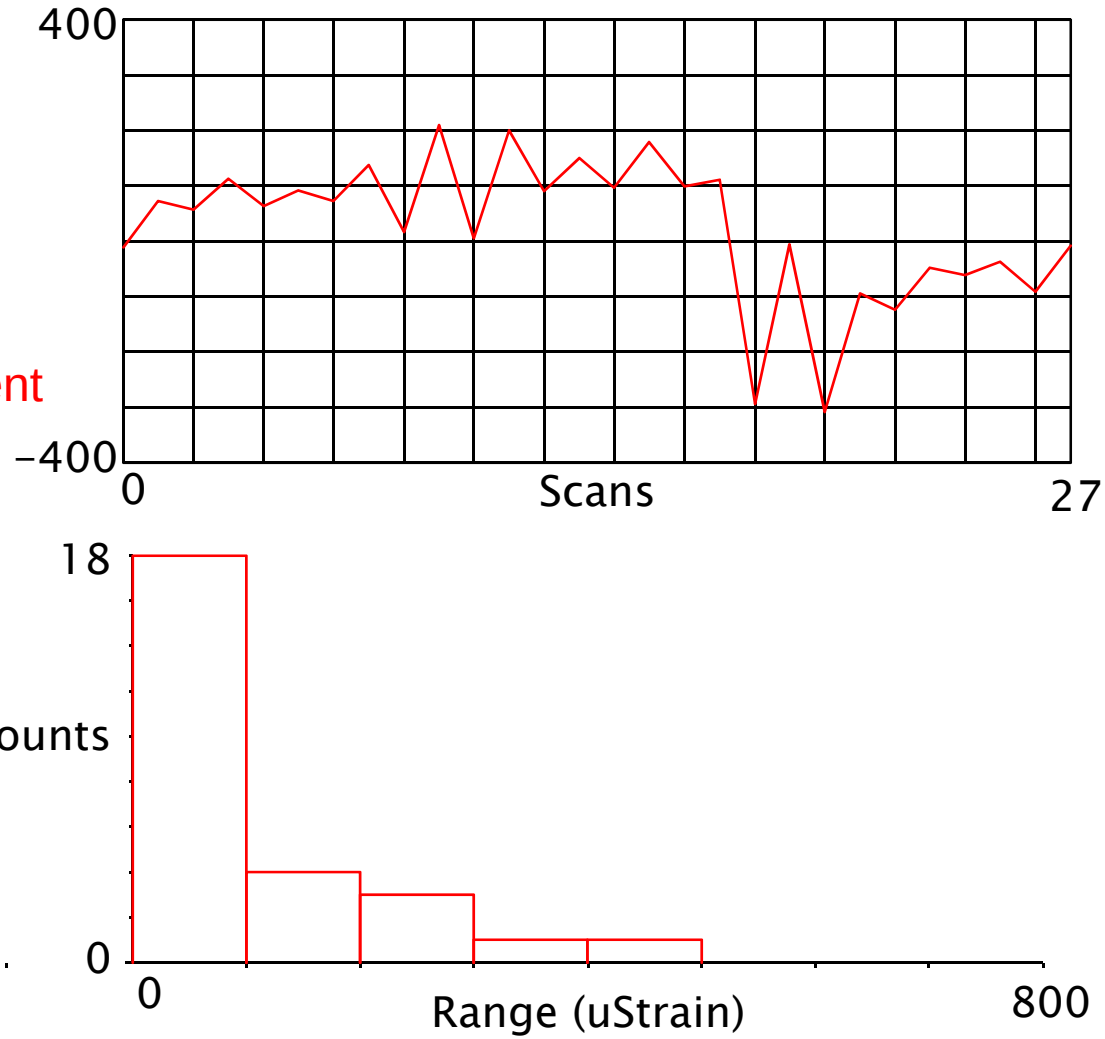


RANGE = | A - B | MEAN = (A + B) / 2

PEAK VALLEY PAIRS = AB, BC, CD, DE, EF, FG, GH, HI, IJ, …...

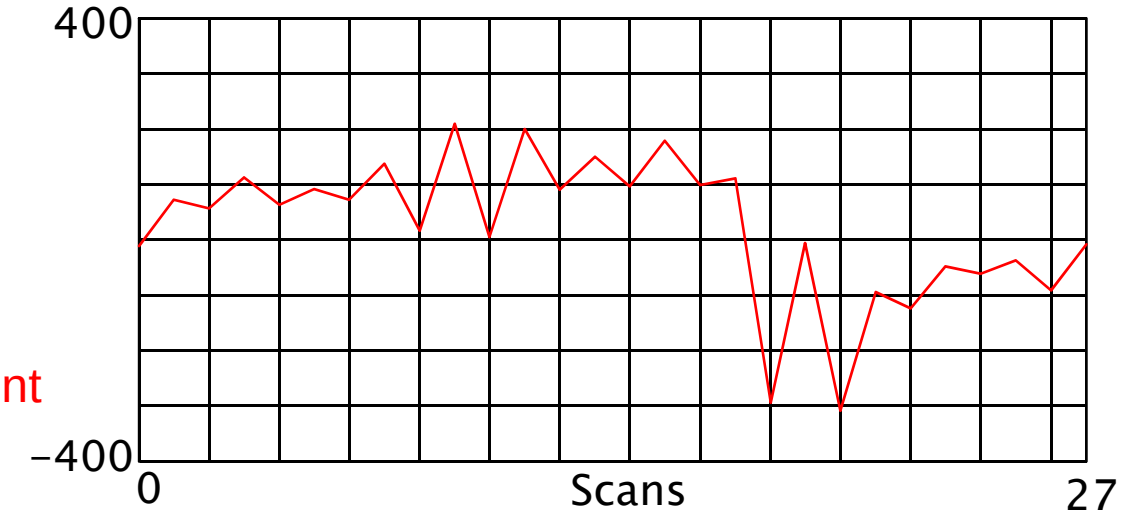
Peak Valley Matrix (Range Only)

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content



Peak Valley Matrix (Range-Mean)

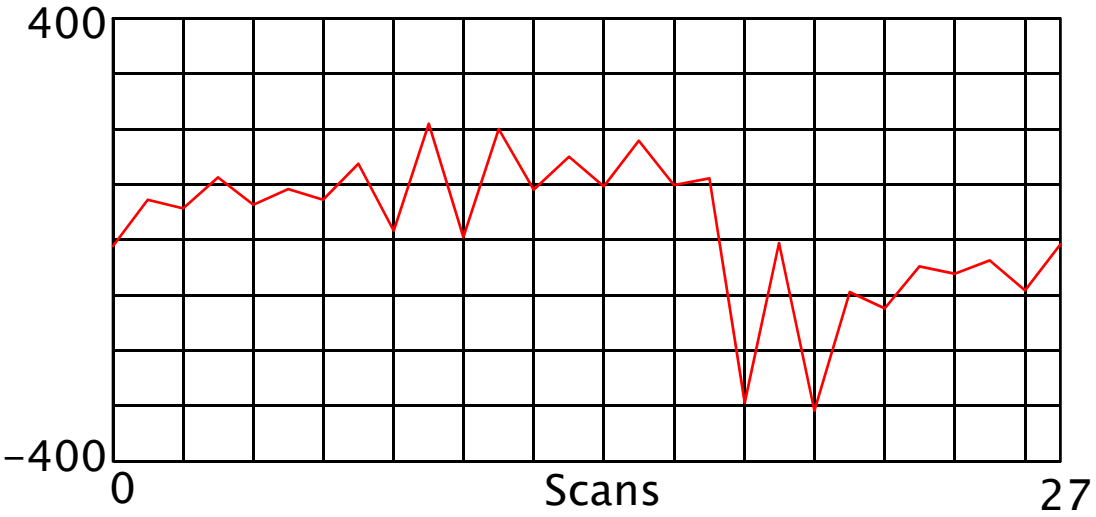
- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content



				Range				
Mean	50	150	250	350	450	550	650	750
-350								
-250			1					
-150	1		1	1				
-50	5				1			
50	6	1						
150	6	3	1					
250								
350								

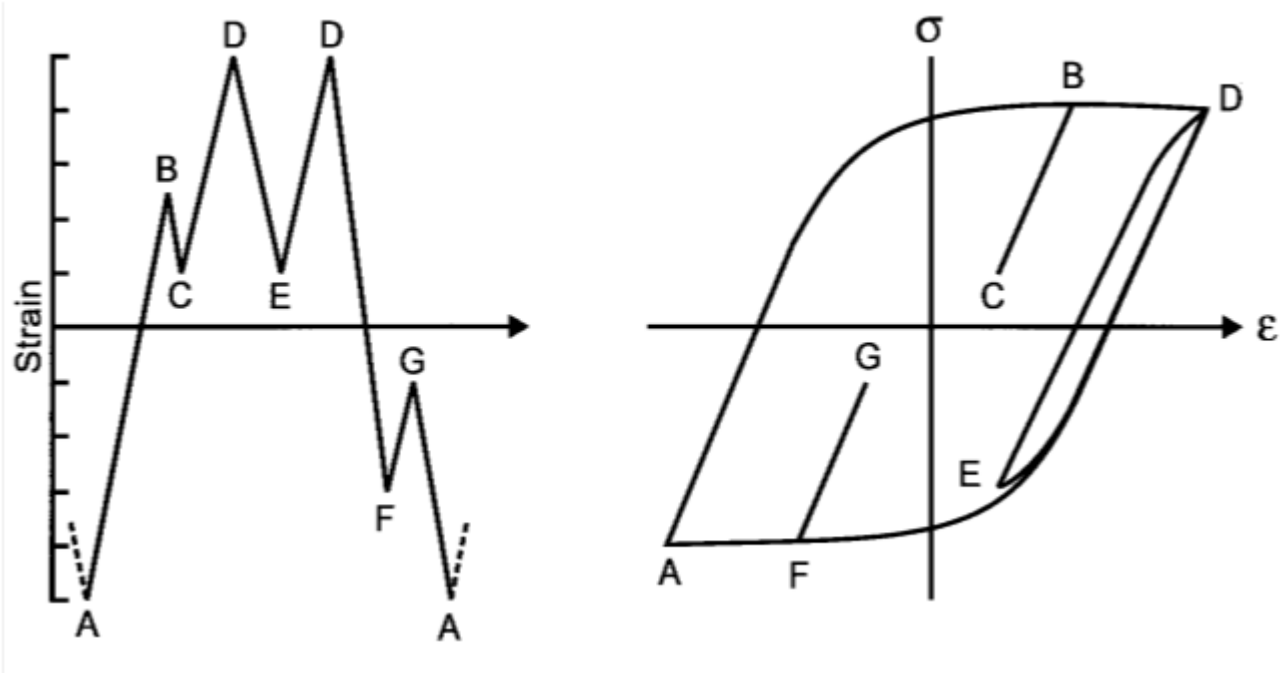
Peak Valley Matrix (To-From)

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content



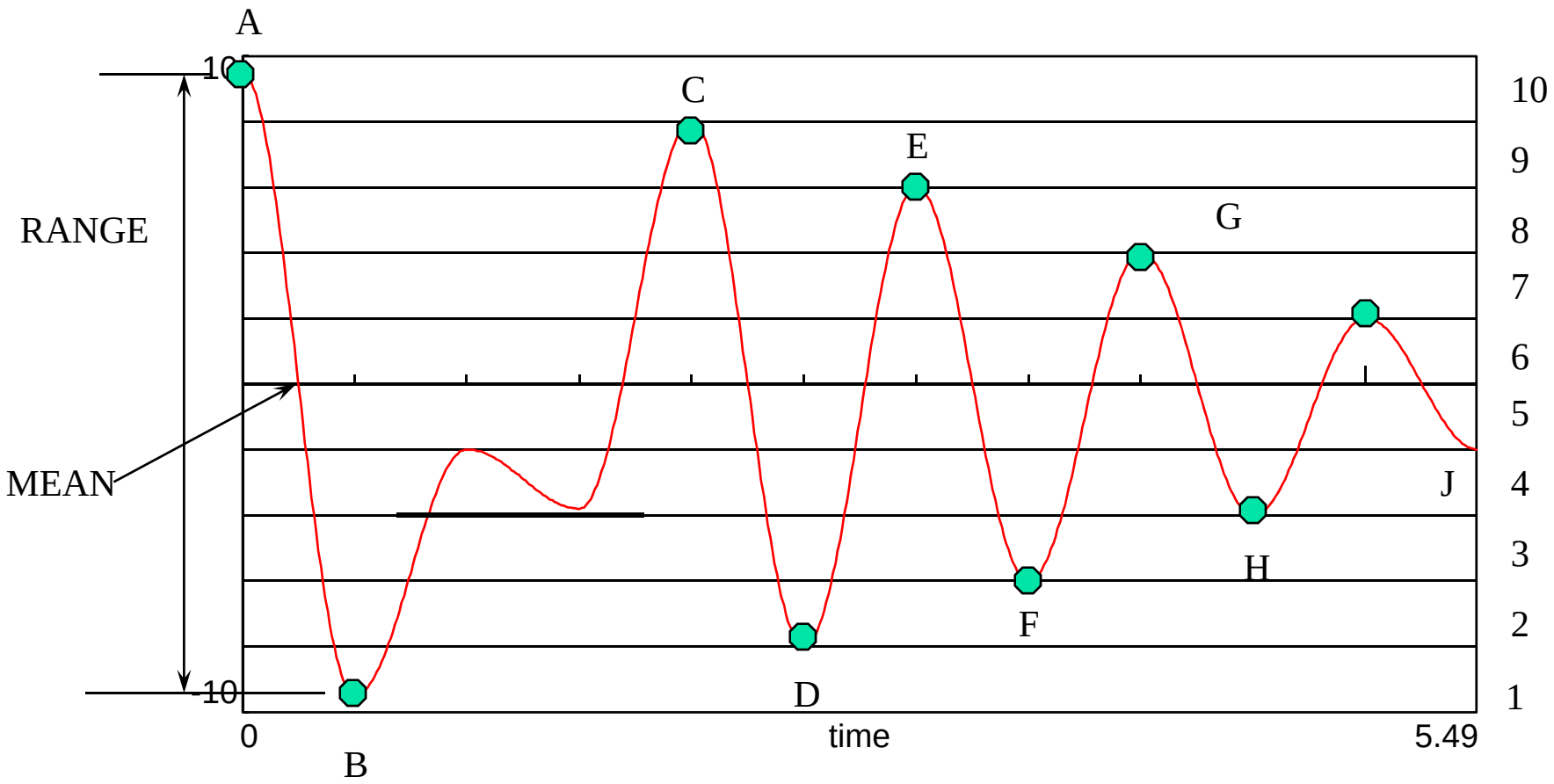
				FROM				
To	-350	-250	-150	-50	50	150	250	350
-350				1				
-250				1				
-150				1				
-50	1		1	4	1			
50					3	6	1	
150		1			5			
250					1			
350								

Rainflow Counting



- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content

Rainflow Counting

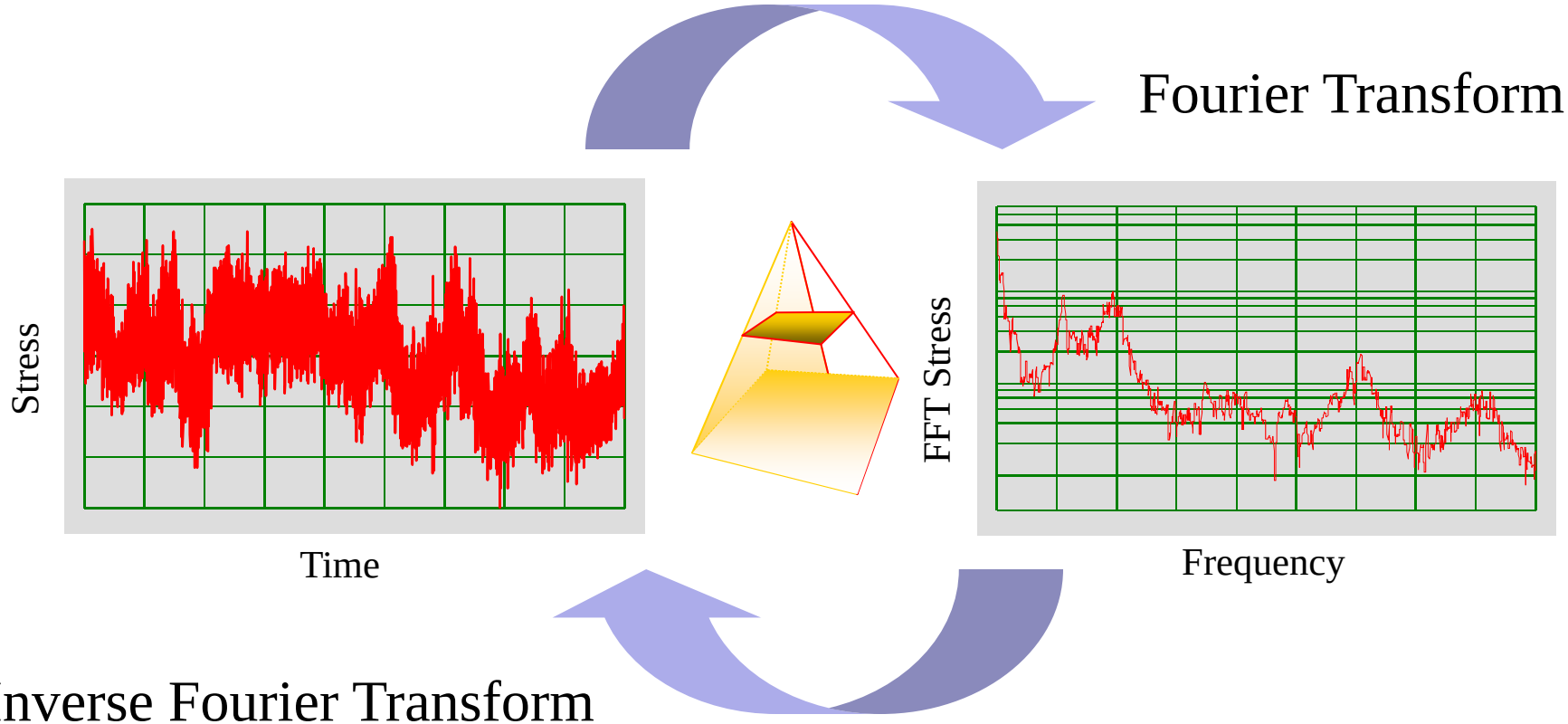


PEAK VALLEY PAIRS = AB, BC, CD, DE, EF, FG, GH, HI, IJ, ……

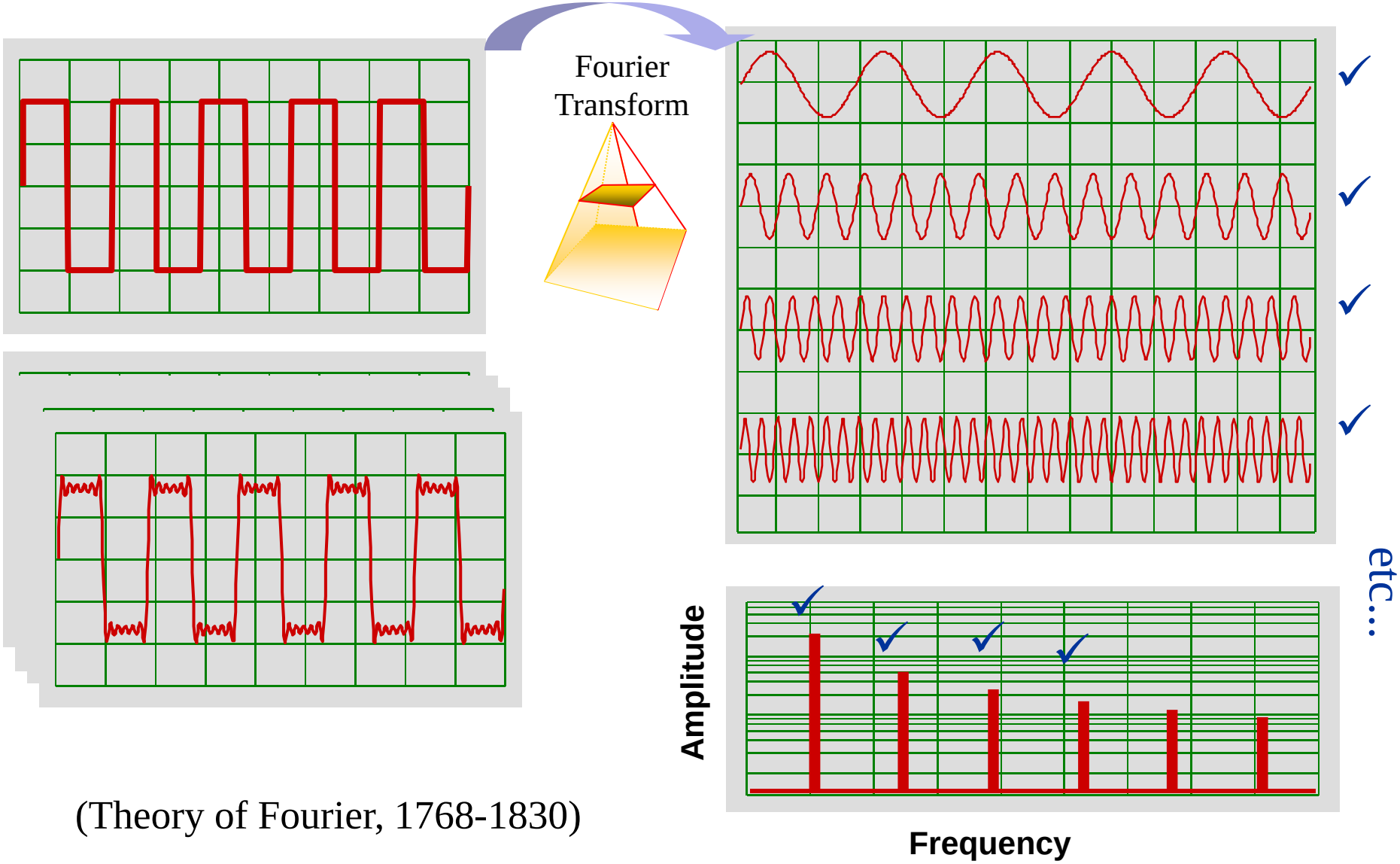
RAINFLOW PAIRS = AB, CD, EF, GH, IJ, ……

FFT (How's Fourier Work?)

Time Domain ***Frequency Domain***



How's Fourier Work?



(Theory of Fourier, 1768-1830)

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Produced by the
College of Engineering
University of Illinois at Urbana-Champaign