Custom SHARAD Processing via the CO-SHARPS Processing Boutique

Than Putzig,[1] Roger Phillips,[1] Bruce Campbell,[2] Jeff Plaut,[3] Jack Holt,[4] Fabrizio Bernardini,[1] Anthony Egan,[1] and Isaac Smith[1]

[1] Southwest Research Institute, Boulder, CO (contact: nathaniel@putzig.com); [2] Smithsonian Institution, National Air and Space Museum, Washington, DC; [3] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; [4] University of Texas, Austin, TX

The Colorado Shallow Radar Processing System (CO-SHARPS) provides custom processing tools for SHARAD data users.

Why provide boutique processing?

Planetary Data System (PDS) products use fixed parameters, chosen to optimize each processor's results on a global basis.
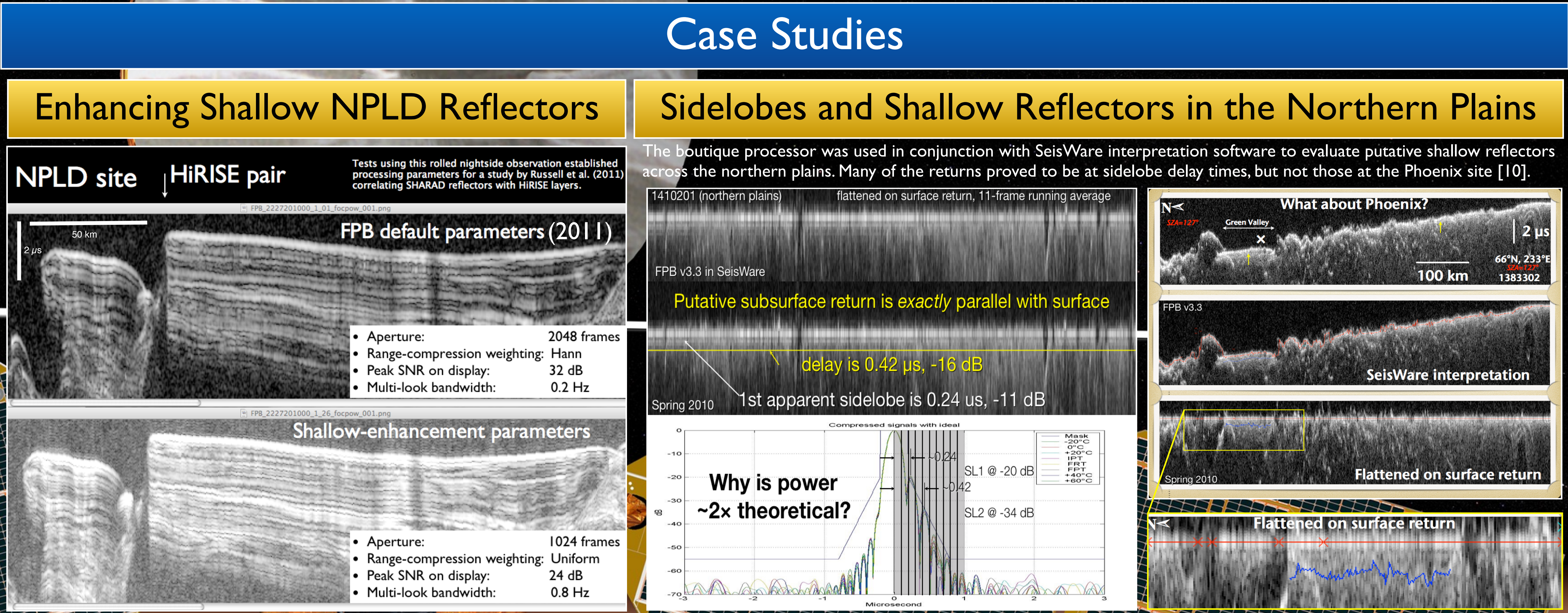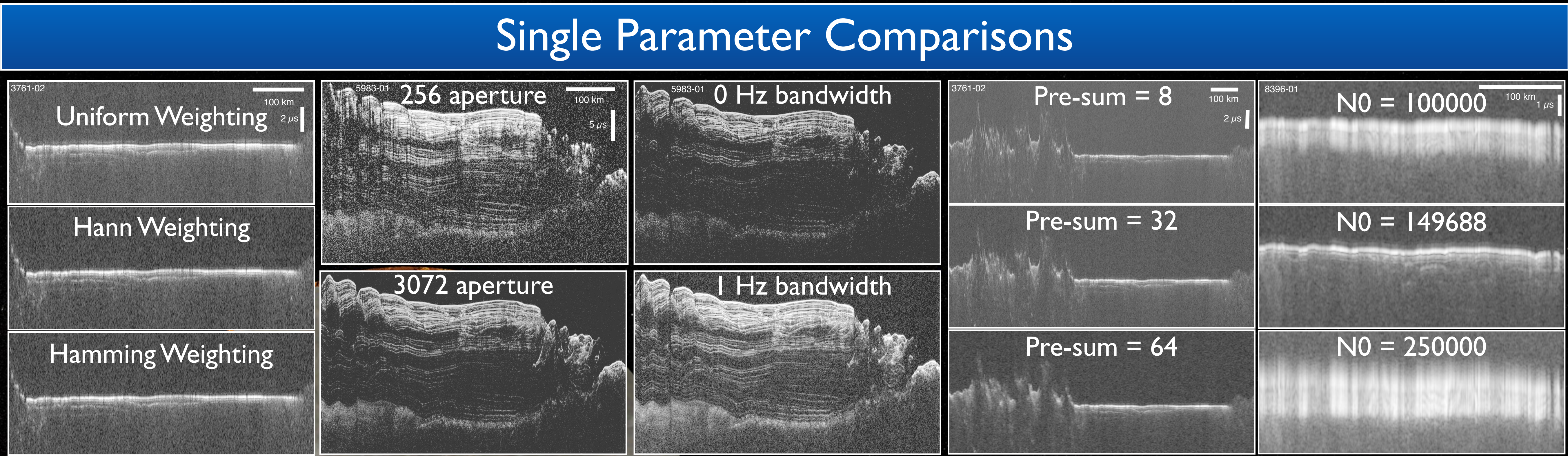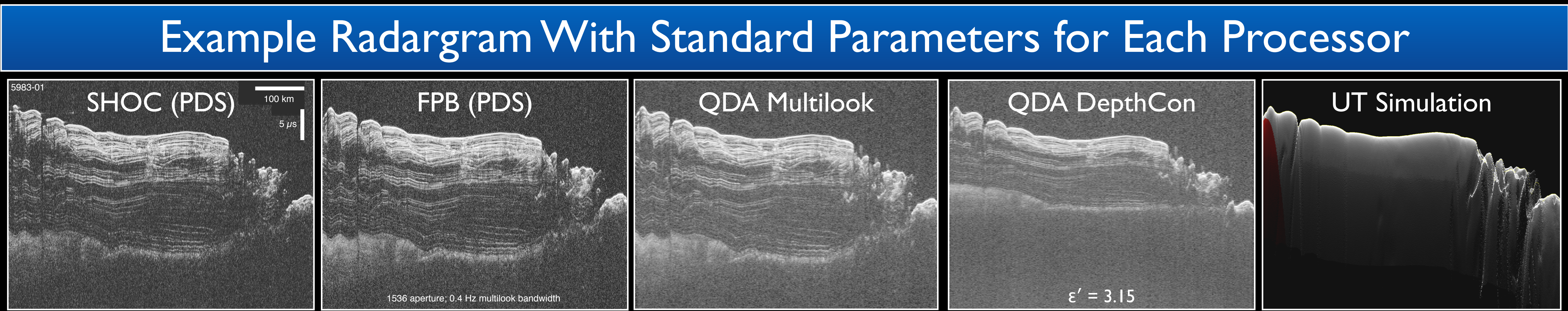
Regional or local features may not be optimal with default parameters. A custom set of parameters, perhaps dependent on specific science goals, are often desired.

SHARAD Processors

Designation	Source	Availability	Features
SHOC	SHARAD Operations Center, Rome, Italy	PDS Standard Products [1]	Phase-gradient autofocus [2]; Hann weighting; 300 m frame interval
FPB	Smithsonian Institution, Washington DC, USA	PDS Supplemental Products [5]; CO-SHARPS Boutique	Image-optimization autofocus [3]; User-chosen aperture, weighting, multilook bandwidth; 460 m frame interval
QDA	Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA	CO-SHARPS Boutique	Ω-K focusing [6]; User-chosen summing, weighting, Chapman params [7]; Depth conversions; Variable interval
UTS	University of Texas Institute for Geophysics, Austin, TX, USA	CO-SHARPS Boutique (with QDA)	Incoherent facet-based MOLA [4] clutter simulator [8]

Adjustable Parameters

Ranges with ~ = recommended. Defaults in **bold** (* = batch runs). Grey = fixed.

Parameter	FPB	QDA
Aperture (frames)	256–3072 (1536)	4096
Range-compression weighting	uniform, cosine bell, **Hann**, Hamming	uniform, **Hann**
Peak SNR in PNG (dB)	~16–64 (32)	30
Multilook bandwidth (Hz)	0–1 (0.4)	15
Fractional Doppler bandwidth	n/a	0.25–1.0
Total presum	n/a	8–64 (8*, 32)
Frame interval	460 m	Changes with presum
Dielectric for depth conversion	n/a	~2.0-10.0 (0.0=OFF, 3.1*)
Chapman N0 (#e⁻/cm³)	n/a	0=1000-orbit table, 1=function, 2= obs. table

Now Featuring Optional SEG-Y Output

Many users employ geophysical interpretation software (SeisWare, Landmark, Geoframe, etc.) to analyze radargrams. SEG-Y is a commonly used industry format for input seismic data, but works for radargrams as well.

Example Radargram With Standard Parameters for Each Processor

SHOC (PDS) — 1536 aperture; 0.4 Hz multilook bandwidth; FPB (PDS); QDA Multilook; QDA DepthCon (ϵ' = 3.15); UT Simulation

Single Parameter Comparisons

Uniform Weighting; Hann Weighting; Hamming Weighting; 256 aperture; 3072 aperture; 0 Hz bandwidth; 1 Hz bandwidth; Pre-sum = 8; Pre-sum = 32; Pre-sum = 64; N0 = 100000; N0 = 149688; N0 = 250000

Case Studies

Enhancing Shallow NPLD Reflectors

NPLD site | HiRISE pair

Tests using this rolled nightside observation established processing parameters for a study by Russell et al. (2011) correlating SHARAD reflectors with HiRISE layers.

FPB default parameters (2011)
- Aperture: 2048 frames
- Range-compression weighting: Hann
- Peak SNR on display: 32 dB
- Multi-look bandwidth: 0.2 Hz

Shallow-enhancement parameters
- Aperture: 1024 frames
- Range-compression weighting: Uniform
- Peak SNR on display: 24 dB
- Multi-look bandwidth: 0.8 Hz

Sidelobes and Shallow Reflectors in the Northern Plains

The boutique processor was used in conjunction with SeisWare interpretation software to evaluate putative shallow reflectors across the northern plains. Many of the returns proved to be at sidelobe delay times, but not those at the Phoenix site [10].

Putative subsurface return is *exactly* parallel with surface — delay is 0.42 μs, -16 dB. 1st apparent sidelobe is 0.24 us, -11 dB

Why is power ~2× theoretical?

SL1 @ -20 dB; SL2 @ -34 dB

What about Phoenix? Green Valley; SeisWare interpretation; Flattened on surface return

User Interface

Boutique Processing

The CO-SHARPS Processing Boutique

CO-SHARPS Access

http://boulder.swri.edu/sharad.php

Southwest Research Institute Planetary Science Directorate

SHARAD Science Operations at SwRI Boulder

CO-SHARPS Access

Beginning 2014 March 16, web access to the CO-SHARPS Processing Boutique is available by request. Please click the 'Request Access' button and complete the email form. A CO-SHARPS staff member will respond with instructions for accessing the system.

Pre-processing for 3D Volumes [9]

FPB (PDS) — 1536 aperture; 0.4 Hz multilook bandwidth; FPB (3D input) — 3072 aperture; 0.8 Hz multilook bandwidth
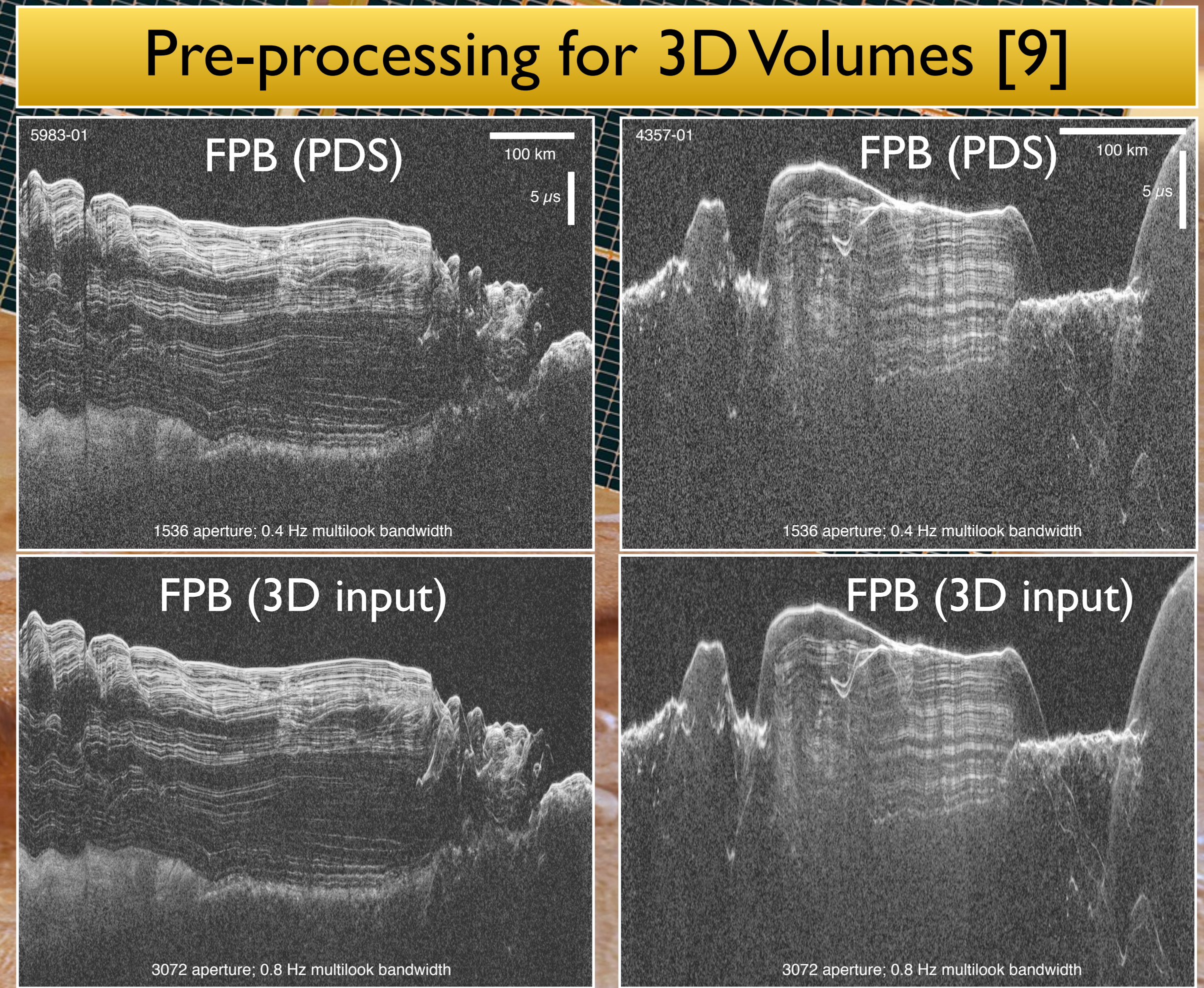
References: [1] Slavney S., Orosei R. 2007, MRO SHARAD Reduced Data Record Software Interface Specification v1.0, PDS Geosciences Node. [2] Eichel P.H., Jakowatz Jr. C.V. Jr. 1989, Optics Lett. 14, 1101–1103. [3] Campbell B.A. et al. 2011, IEEE Geosci. Remote Sens. Lett. 8(5), 939–942. [4] Smith D.E. et al. 2001, JGR 106, 23,689–23,722. [5] Campbell B.A. 2014, U.S. SHARAD Data Product Description for the PDS v2.1, PDS Geosciences Node. [6] Cumming I.G., Wong F.H. 2005, Digital Processing of Synthetic Aperture Radar, Ch. 8, Artech House, Boston. [7] Safaeinili A. et al. 2007, GRL 34, L23204. [8] Holt J.W. et al. 2006, JGR 111, E06S24. [9] Putzig et al. 2015, AGU Fall Meeting, Abstract P53G-05. [10] Putzig et al. [2014], JGR 119, 1936–1949.