



National Oceanography
Centre, Southampton



→ 2nd COASTAL ALTIMETRY WORKSHOP

Forthcoming Altimeter Technologies Application in the Coastal Zone

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6-7 November 2008, Pisa, Italy





Agenda

Recap:

Requirements and Issues

Hiawatha:

a Cautionary Tale

Charge to Presenters:

Delay-Doppler; Alti-Ka; Wide Swath

Delay-Doppler:

Technical Introduction





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Recap of Issues: Coastal Altimetry

Sea Surface Height

Tracking/retracking

Wet troposphere measurements and corrections

Sea State Bias; Tides; Inverse Barometer

Significant Wave Height

Wave shape

Spatial and temporal correlation scales

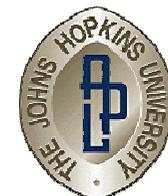
Wind Speed

Proximity to shoreline

Resolved and averaged footprints

Density of coverage

Revisit period





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Hiawatha: a Cautionary Tale

Adapted and condensed from Prof. Leo Moser's parody on W. W. Longfellow's epic poem "Hiawatha", originally recorded on 04 May 1963 by Prof. Mientka, subsequently published (with permission from Prof. Moser's surviving family) by W. E. Mientka, American Mathematical Monthly, Vol. 79, No. 6, 1972.







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Hiawatha Designs an Experiment (1/2)

**Hiawatha, mighty hunter, He could shoot ten arrows upward,
Shoot them with such strength and swiftness That the last had left the bow-string
Ere the first to earth descended.**

**This was commonly regarded As a feat of skill and cunning.
Several sarcastic spirits Pointed out to him, however, That it might be much more
useful If he sometimes hit the target. "Why not shoot a little straighter And employ
a smaller sample?"**

**Hiawatha, who at college Majored in applied statistics, Pointed out
that (in the long run) Independent observations, Even though they missed the
target, Had an average point of impact Very near the spot he aimed at. "This,"
they said, "was rather doubtful; Either he must hit the target Much more often
than at present, Or himself would have to pay for All the arrows he had wasted."**

**Hiawatha, to convince them, Organized a shooting contest. All the other tribal
marksmen, Ignorant (benighted creatures) Of experimental setups, Used their time
of preparation Putting in a lot of practice Merely shooting at the target.**





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Hiawatha (2/2)

Thus it happened in the contest That the scores were most impressive With one notable exception. This, I hate to have to say it, Was the score of Hiawatha, Who as usual shot his arrows, Shot them with great strength and swiftness, Managing to be unbiased, But not one arrow hit the target. “There!” they said to Hiawatha, “That is what we all expected.”

Hiawatha, nothing daunted, Called for pen and called for paper. Through analysis of variance Norm and mean and deviation, Showed that after all were figured, Everybody else was biased, but his average hit the bulls-eye.

Tribal elders, not accepting, Forever banned our Hiawatha From all future competitions.

In a corner of the forest Sits alone our Hiawatha Permanently reflecting On the normal law of errors. Wondering in his idle moments If perhaps increased precision Might perhaps be sometimes better Even at the cost of bias, If one could thereby maybe sometimes Register upon the target.





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A Real Shooting Contest

Make life simple for H: One-dimensional problem

Target bulls-eye 1/2 mm, but **H** one-arrow standard deviation = 1/2 m

H know number of arrows $> (\text{standard deviation} / \text{bulls-eye})^2 = 1,000,000$

The elders give H one year to hit the target

H on horseback, ride past target once every 10 days

On 36 passes, **H** has only 30,000 arrows each time

H mighty fast, 2000 arrows per second; **H** horse mighty fast, 7 km/sec

H need 15 seconds to shoot; need string of identical targets > 100 km long

*If “arrow” = radar altimeter pulse, then “Hiawatha” = **YOU !!***





Hiawatha: a Cautionary Tale (Commentary)

- 1) *Hiawatha “accurate”; not “precise” with few arrows*
- 2) *Precision => averaging; hence basin-scale precision does not necessarily carry over to the coastal zone*
- 3) *Coastal altimetry implies severe limits on correlation scales--spatial and temporal*
- 4) *Precision degrades inversely as the square root of the minimum (correlation or measurement) scale length*
- 5) *Coastal applications as well as potential technologies have to pass the “giggle test” especially for claimed precision wrt required (and achievable) precision*





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Responsiveness

Issues	Requirements	DDA	Alti-Ka	Wide Swath
SSH/SLA	<i>(User)</i>			
Retracking	<i>(Technical)</i>			
Wet Tropo	<i>(Technical)</i>			
Tides	<i>(Technical)</i>			
Bias, Baro	<i>(Technical)</i>			
SWH	<i>(User)</i>			
Shape	<i>(Technical)</i>			
Scale	<i>(Technical)</i>			
Footprint	<i>(Technical)</i>			
Proximity	<i>(User)</i>			
WS	<i>(User)</i>			
Density	<i>(User)</i>			
Revisit	<i>(User)</i>			

Each application implies potentially a unique set

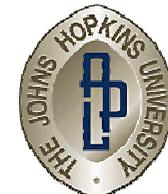
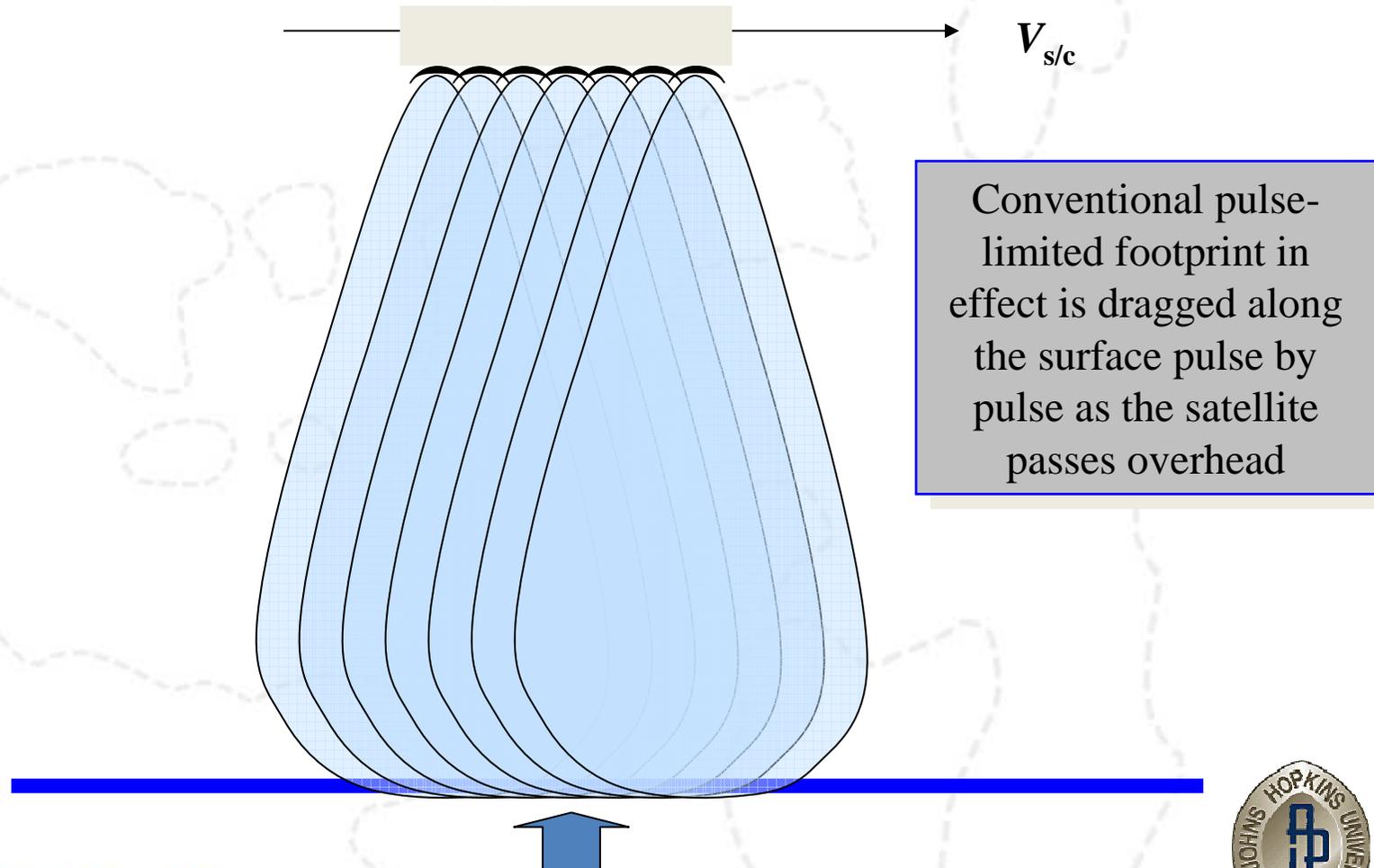
Instrument technology- and orbit-dependent

Yes/No; Nominal performance; error bars



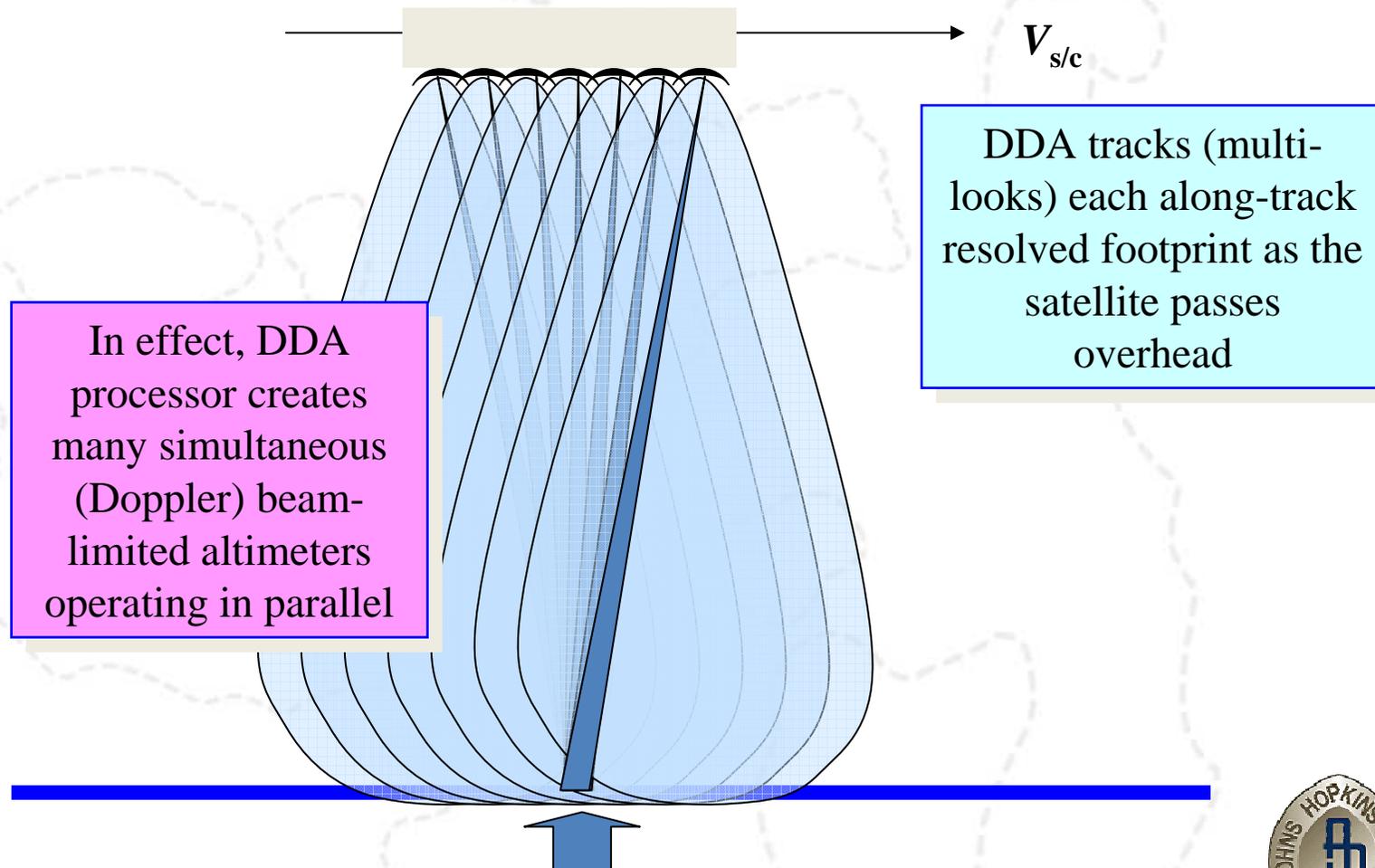
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Conventional Pulse-Limited ALT footprint scan



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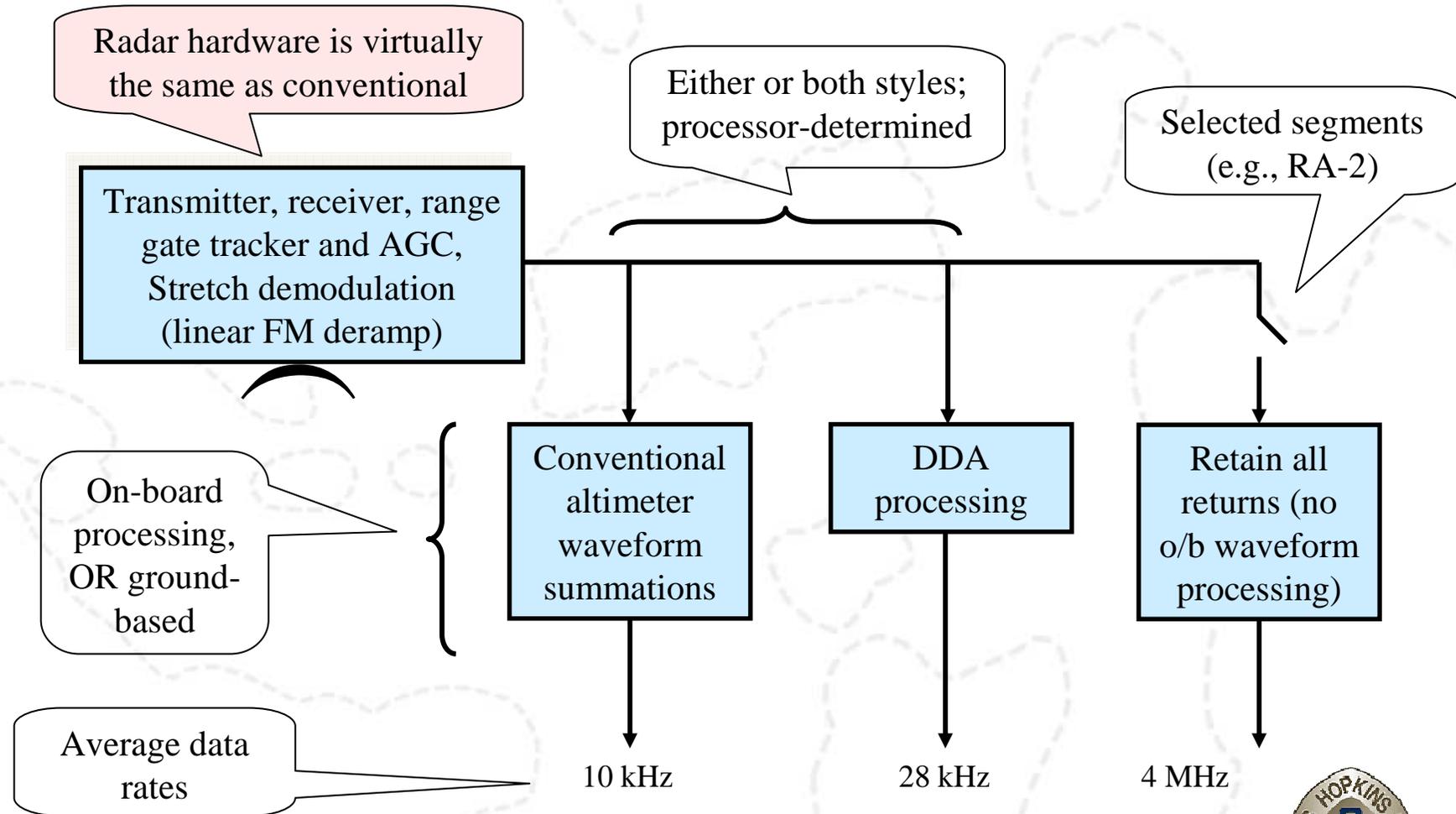
DDA: a set of narrow-beam limited altimeters, SpotLighting





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DDA Relies on Richer Data Processing





Charge to Presenters:

Overview of technology and mission

Responsiveness to coastal applications

Precision/Accuracy (key parameters)

Advantages

Disadvantages

