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# Multibit Baseband

A novices introduction

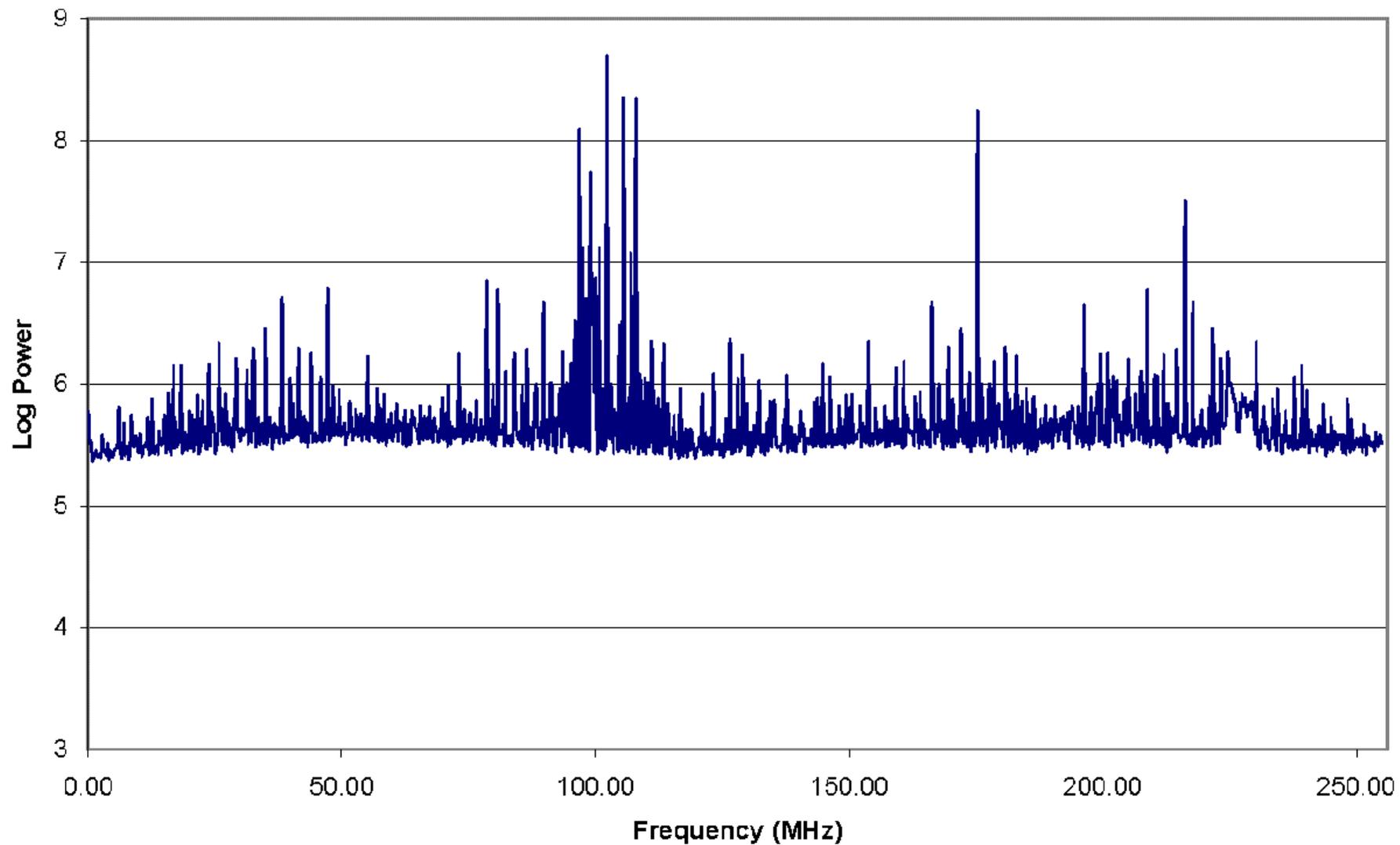
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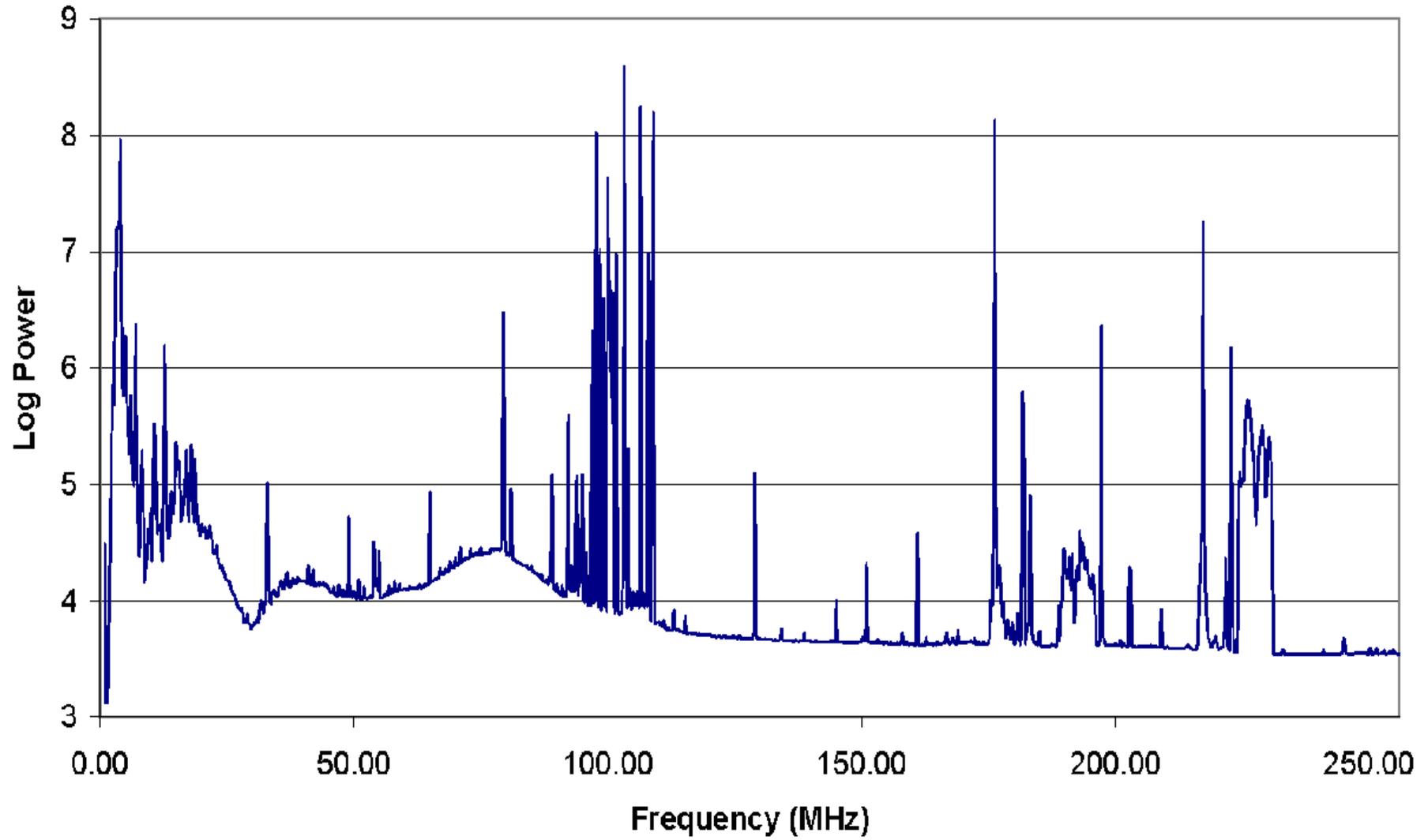
# Multibit baseband

- VLBI transport has traditionally been data rate limited
  - Generally prefer more bandwidth to more bits
- Available bandwidths now getting quite high
  - 16 Gbps on the horizon
  - ~ 2 GHz sky bandwidth at 2 bit
- RFI is unavoidable at these bandwidths
- Many situations may need to increase bits at expense of bandwidth

### MIT Hi Band - 2 Bit sampling



### MIT Hi Band - 8 Bit sampling



## 2 bit sampling

- Typical 2 bit sampling uses 4 levels symmetrical about zero
- Optimal SNR when ratio of states are

17%/33%/33%/17%

With the threshold from “low” to high set to 1.03 of SNR

- 12% SNR loss

## > 2 bits

- Jenet & Anderson PASP 1998 calculated optimum quantization for various bit quantisation
- Optimal levels or linear increments?

Bits	Optimal	Linear ( $\sigma$ )
2	0.8808	0.8808 1.03
3	0.9650	0.9635 1.78
4	0.9904	0.9890 3.14
5	0.9975	0.9967 5.59
6	0.9994	0.9990 10.08
7	0.9998	0.9997 18.37
8	0.99996	0.99992 33.82

# Musings.....

- Hardy any SNR advantage to optimal quantization
  - Always use linear
- Analysis ignores effect of RFI, 4 bit essentially recovers all SNR
  - For  $> 4$  bit scale RMS to 4bit level and use extra dynamic range for SNR
- Multibit samplers are not perfect
  - Many have “effective” number of bits – least significant bits may not be reliable
  - Increase RMS appropriately
  - Signatech 14bit sampler bit extended to 16 bits adding to least significant bits

# DIFX unpacking

- Ideally DIFX unpacking should give approx same voltages regardless on # bits
- Preferably yield close to normalized autocorrelation
  - Ultimately should not matter

## **Suggestion:**

- Assume optimized linear quantization for 2-4 bits
- Assume linear quantization for  $> 4$  bits with RMS scaled to optimal for 4 bits
- Same for complex sampled data?

**Astronomy and Space Science**

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Thank you

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