Brief Introduction to FAST 19-Beam Digital Backend

Zhu, Yan

FAST Feed List

No.	RF Band(MHz)	IF Band (MHz)	Bandwidth (MHz)	Pol.	Beam Number	Sample Rate (MSa/s)	Nyquist Zone	Band Coverage
A1	70-140	70-140	70	C	1	400	1	VHF
A2	140-280	140-280	140	C	1	700	1	VHF
A3	560-1120	1300-1860	560	C	1	2000	2	
A4	1100-1900	1100-1900	800	C	1	2000	2	L
19 beam-> **C1-C19**	1050-1450	1050-1450	400	L	19	1000	3	L
A5	2000-3000	50-1050	1000	C	1	2200	1	S
B1	270-1620	270-850	580	L	1	2000	1	
B2		950-1620	670			2000	2	

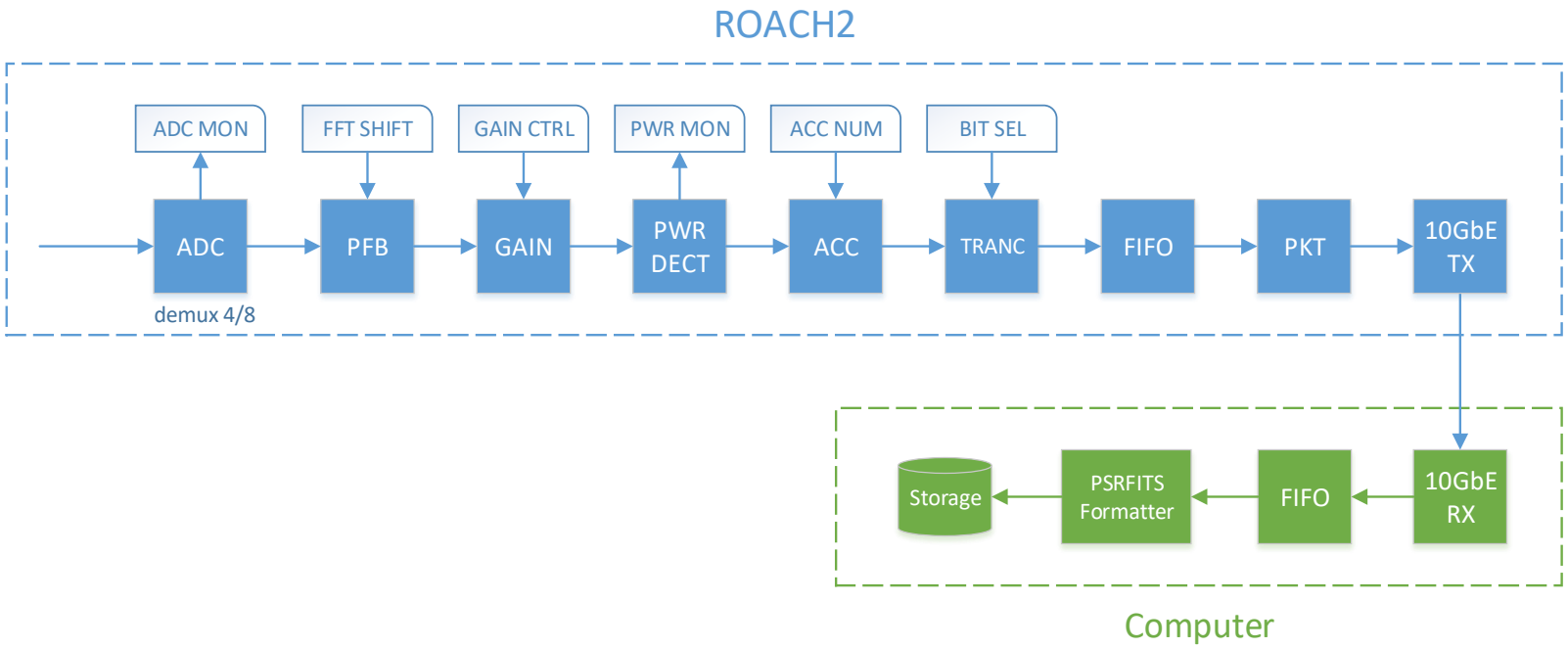
- Different colors indicate different feed supporting platform
- A1 can be part of 2 platforms
- Diagonal line indicates down converter is needed.

Scientific Goal

- 19 beams survey
  - Pulsar
  - HI
  - FRB
  - SETI

19-beam Pulsar Spectrometer

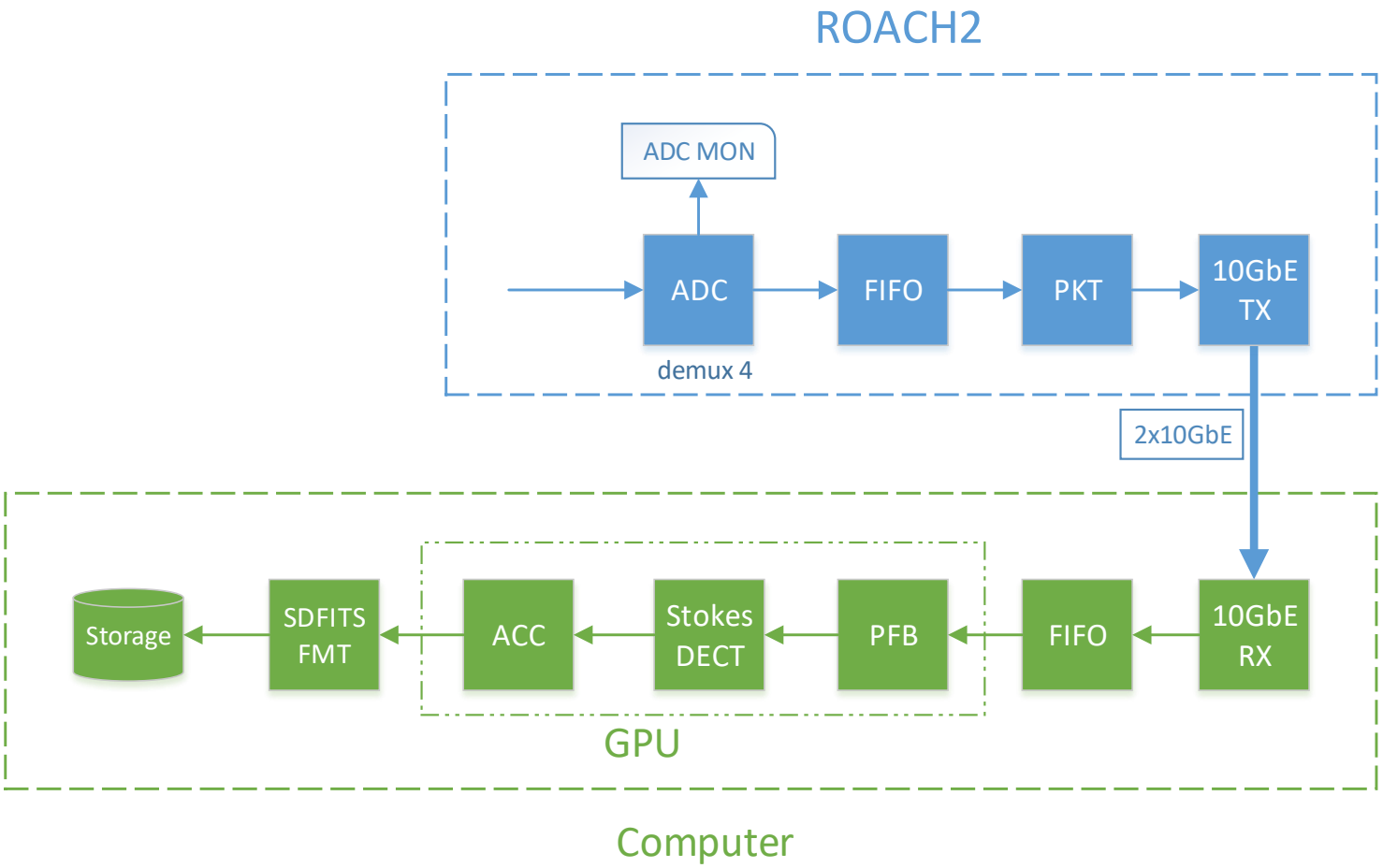
- Pulsar search machine
  - 0-512MHz max bandwidth
  - 1k, 2k,4k,8k channels – 4k by default
  - Fast dump ~ 50us (up to 3us@1k)
  - 8 bits output
  - 2 pol (AA,BB)
  - PSRFITS



19-beam HI Survey

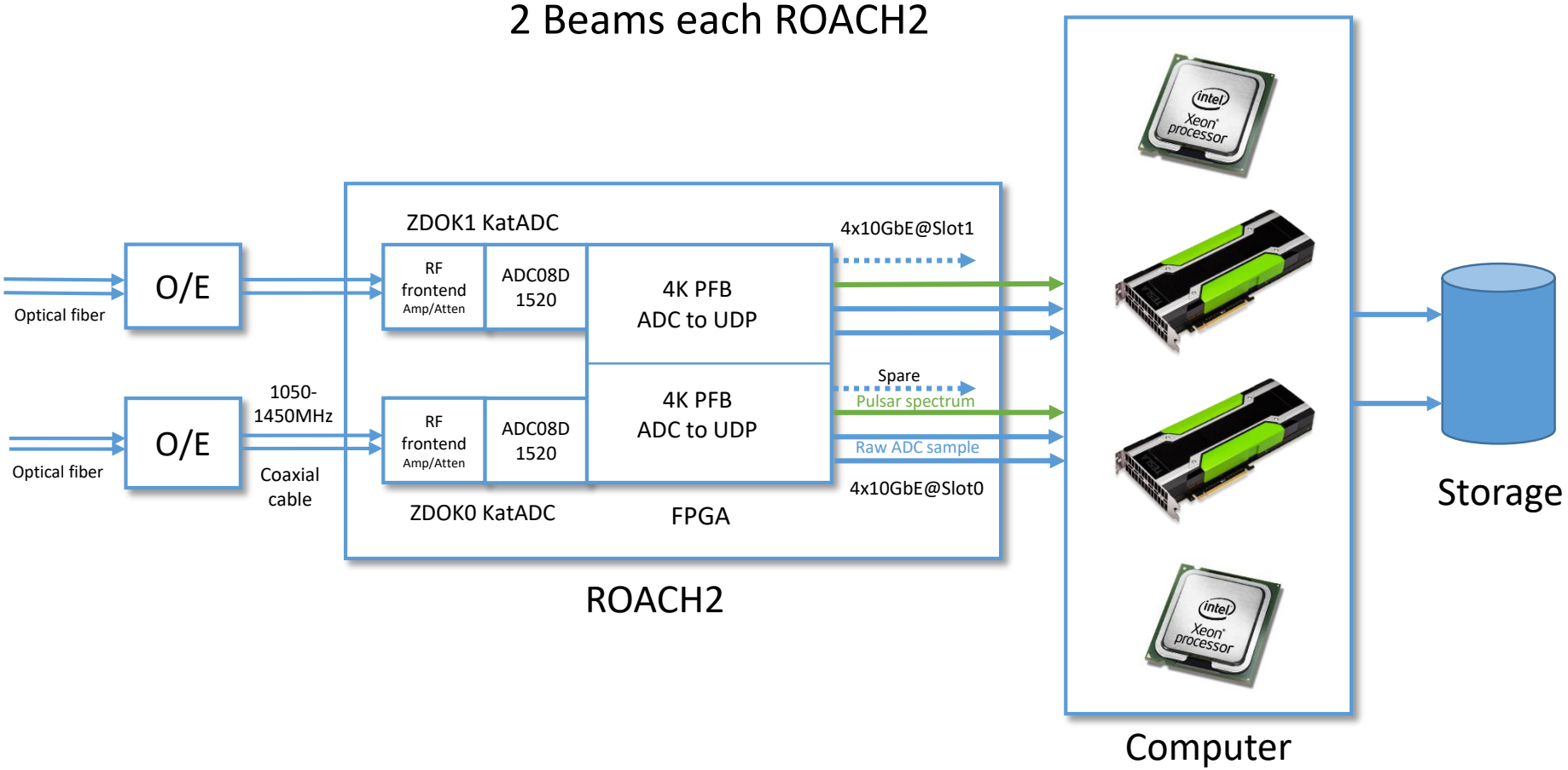
- Input IF 1050~1450MHz
- Selected 20MHz around 1420±10MHz
- Sampling bits 8
- Output channels 128k for 500MHz (3.9kHz,0.8km/s)
  64k for 20MHz(0.3kHz, 0.06km/s)
- Polarizations full stokes
- Integration 0.1~1s
- Output bits 32 bit float
- File format SDFITS

HI spectrometer

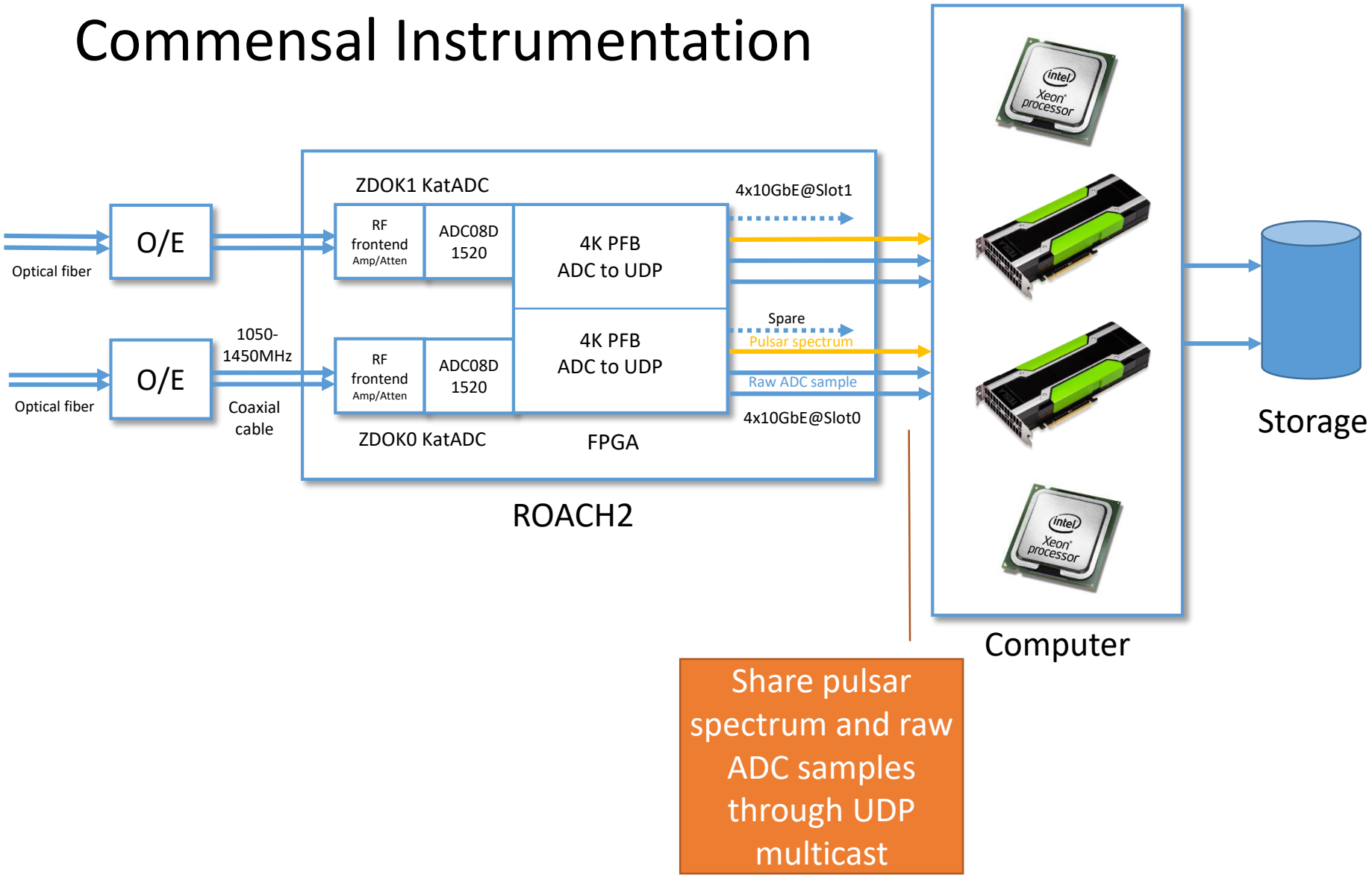


19-beam Hardware assembly

2 Beams each ROACH2



Commensal Instrumentation



UDP Packet format

- All UDP packets – 4104 bytes length
- Each UDP packet – 8 bytes sequence no. + 4096 bytes payload
- Sequence number is little endian uint64_t
- Sequence number starting from 0 after ‘reset’ or ‘ARM’ signal
- Each 10GbE interface forms a continuous byte stream after removing sequence number and concatenate payloads

Pulsar spectrum payload

- Each spectrum channel is a 8 bit unsigned integer – 1 byte
- Dual polarization channels are output interleaved

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bin0pol0 bin0pol1 bin1pol0 bin1pol1 bin2pol0 bin2pol1 …
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- For 4k channel spectrum – 1 spectrum=8192 bytes

Raw ADC payload

- Each ADC sample is a 8 bit signed integer
- One polarization occupy 1 10GbE link (1 ip:port pair)