# Development of a SpaceWire/RMAP-based Data Acquisition Framework for Scientific Detector Applications

1. Overview of this framework
2. Application to a gamma-ray imaging detector


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Masaharu Nomachi, Iwao Fujishiro, Fumio Hodoshima,


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*International SpaceWire Conference, Dundee, Scotland, 2007 Sep.*

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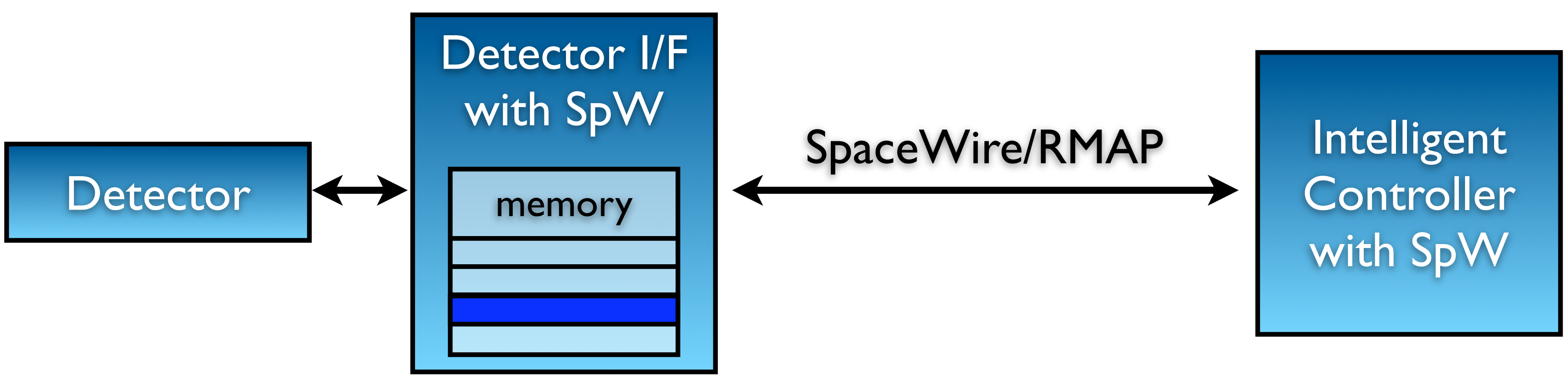

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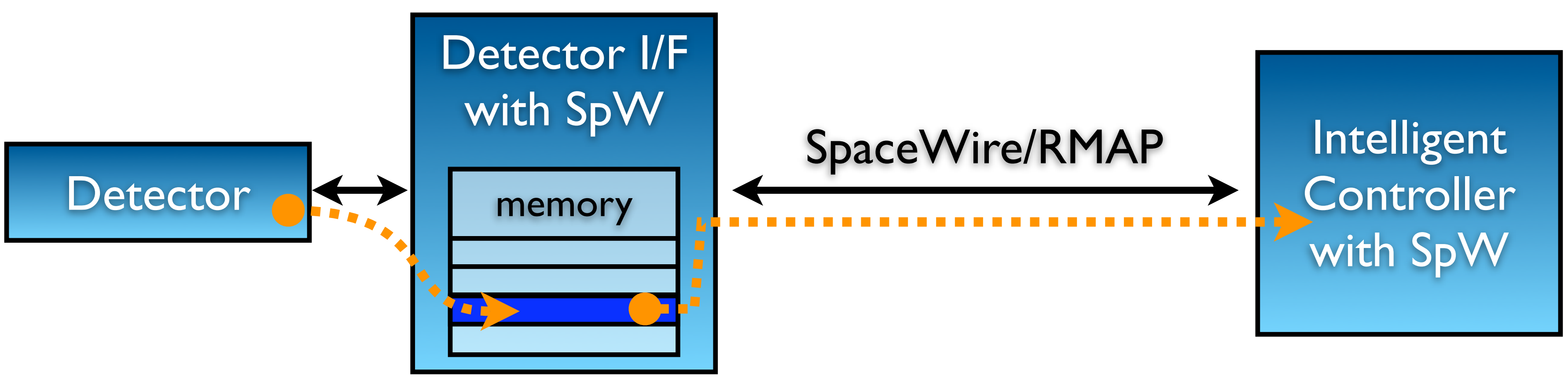

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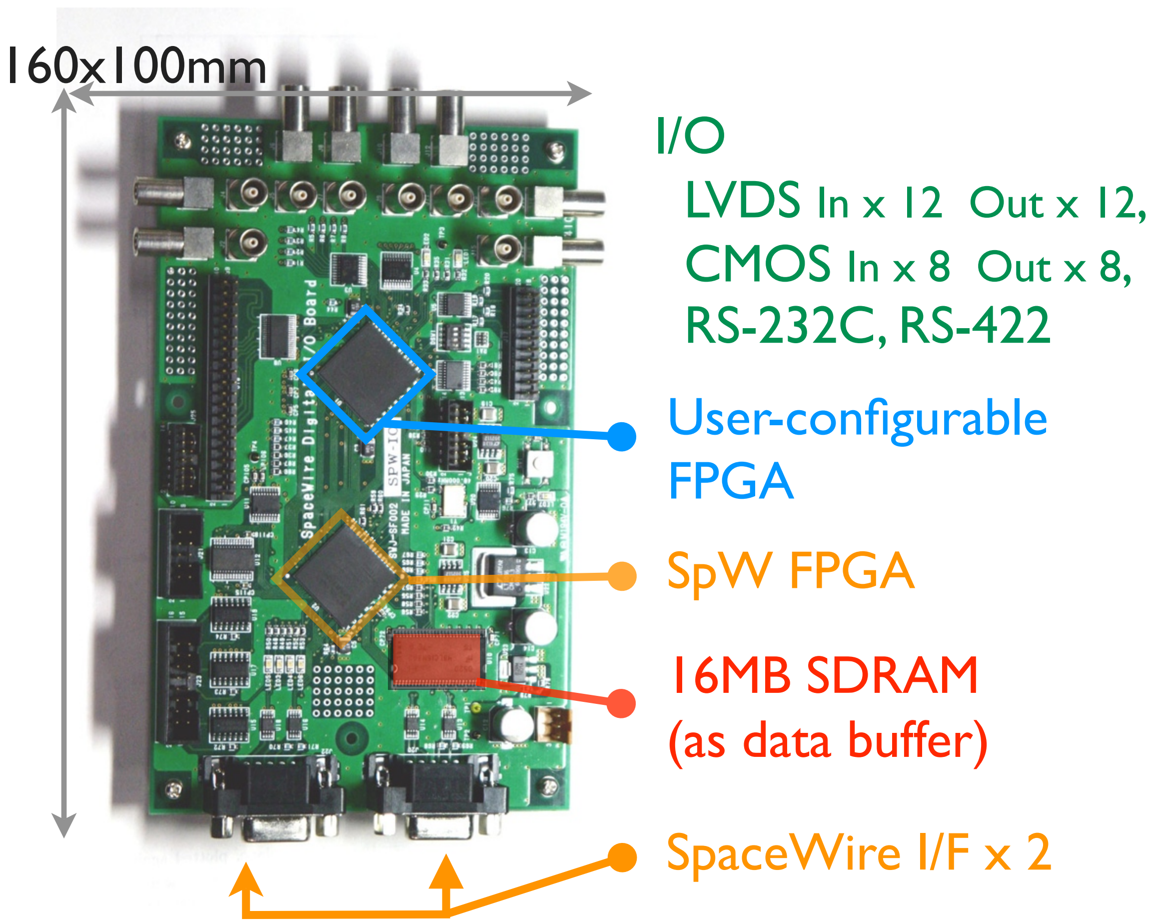


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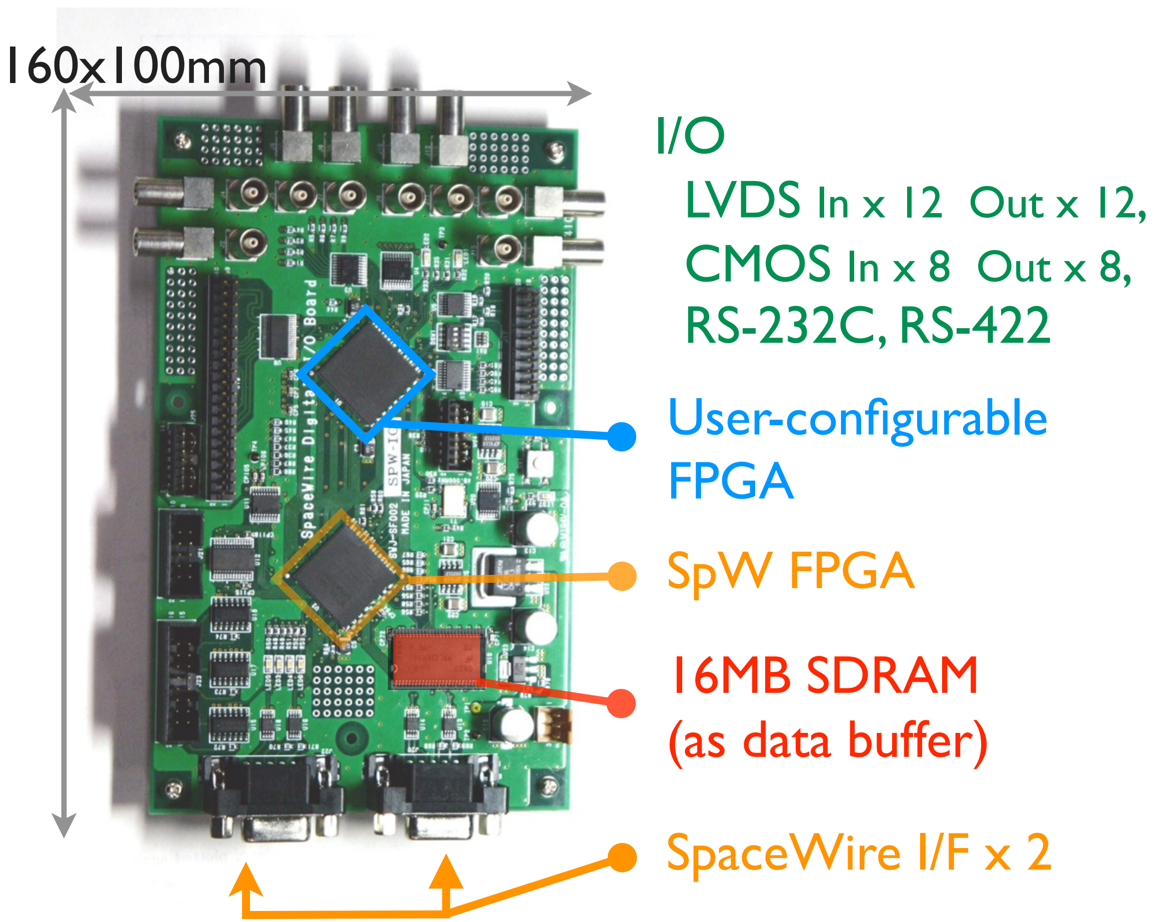


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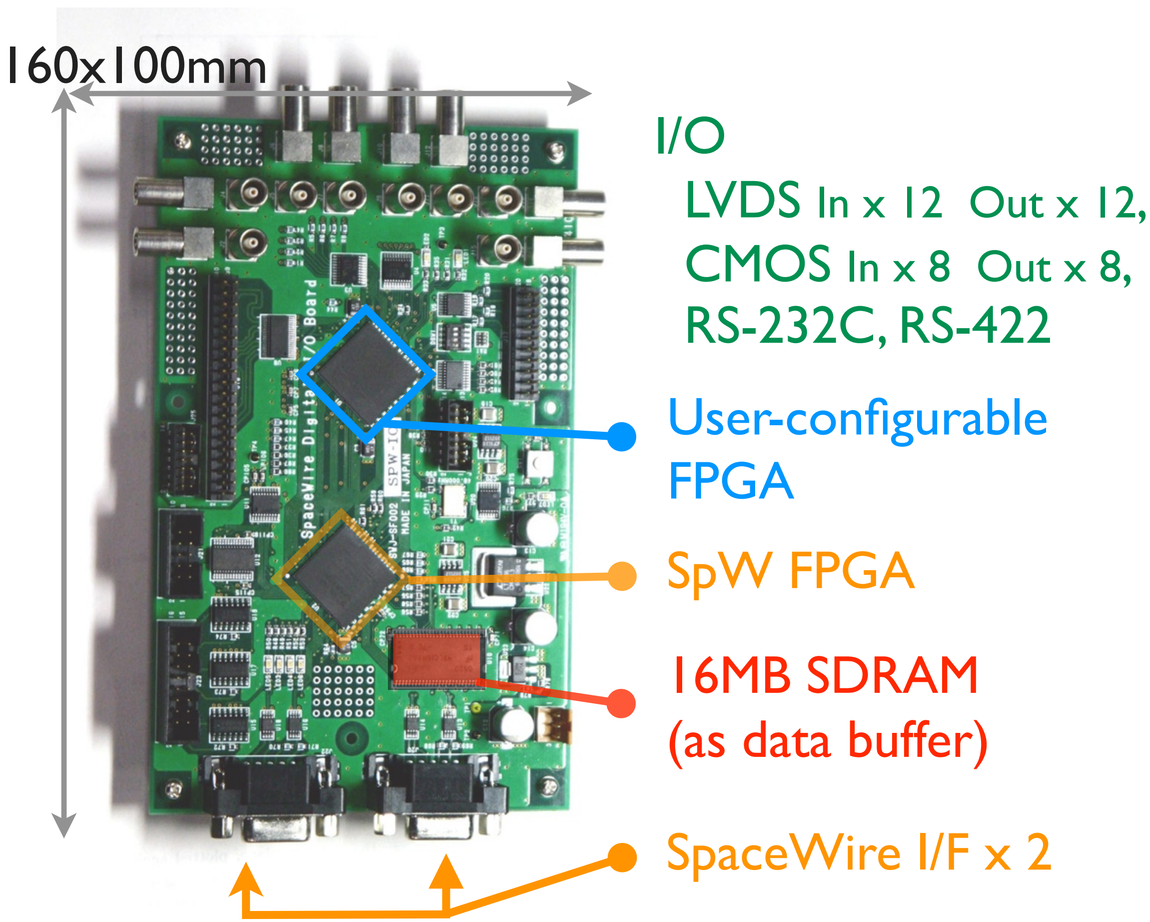


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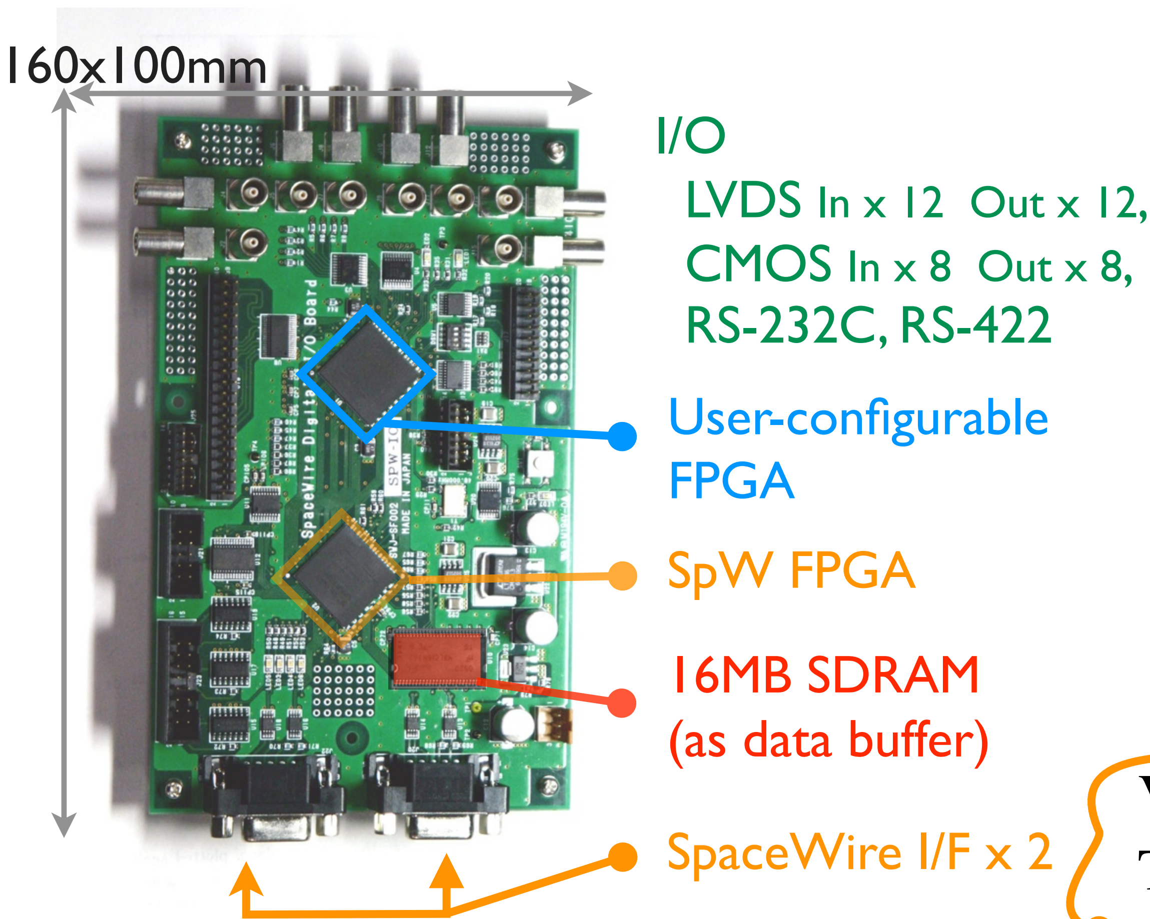


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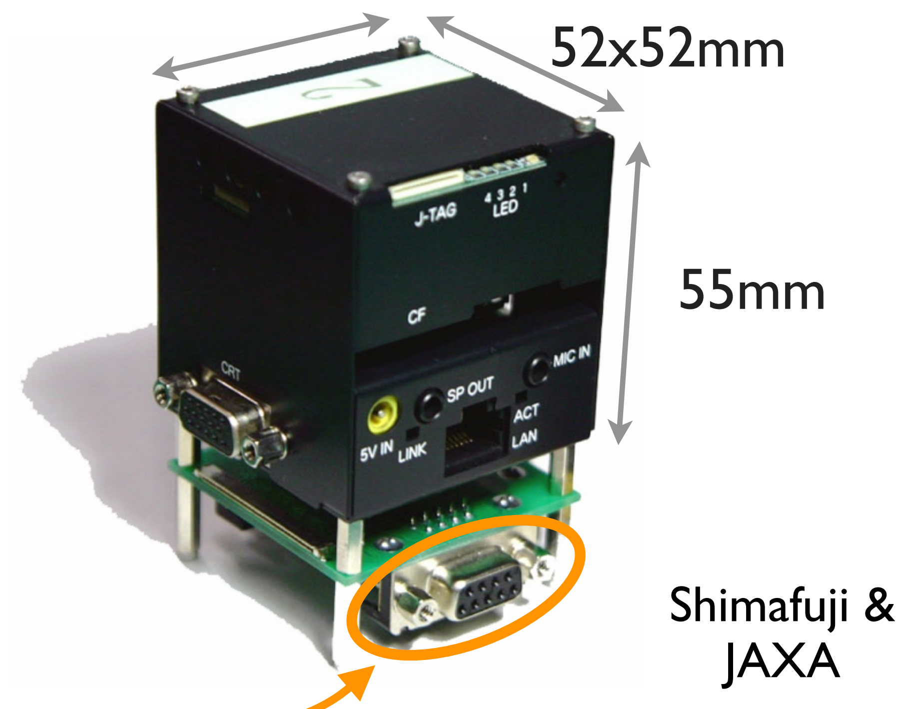


VR5701(MIPS core) 200-300MHz,
TRON OS, 64MB RAM, LAN,
SpaceWire I/F x3, stereo audio, RS232C

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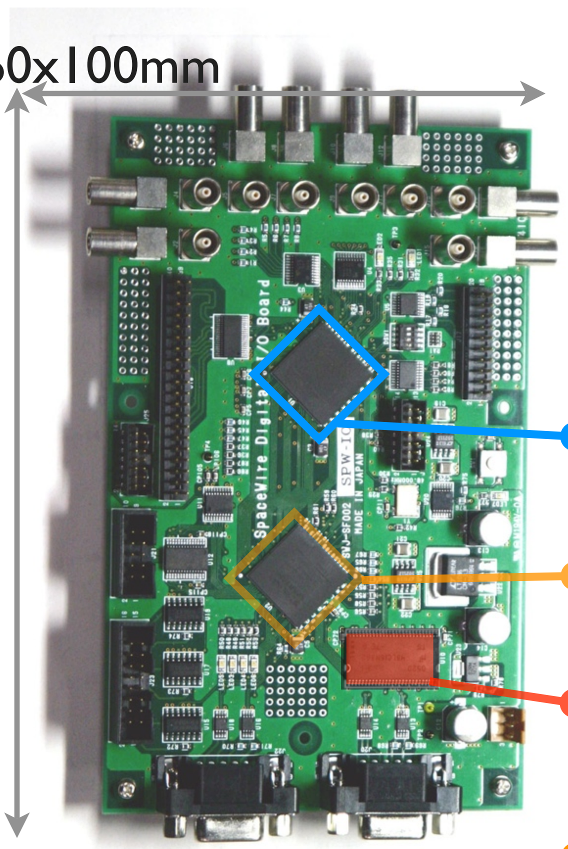
160x100mm



I/O
LVDS In x 12 Out x 12,
CMOS In x 8 Out x 8,
RS-232C, RS-422

User-configurable FPGA

SpW FPGA

16MB SDRAM (as data buffer)

SpaceWire I/F x 2

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52x52mm

55mm


Shimafuji & JAXA

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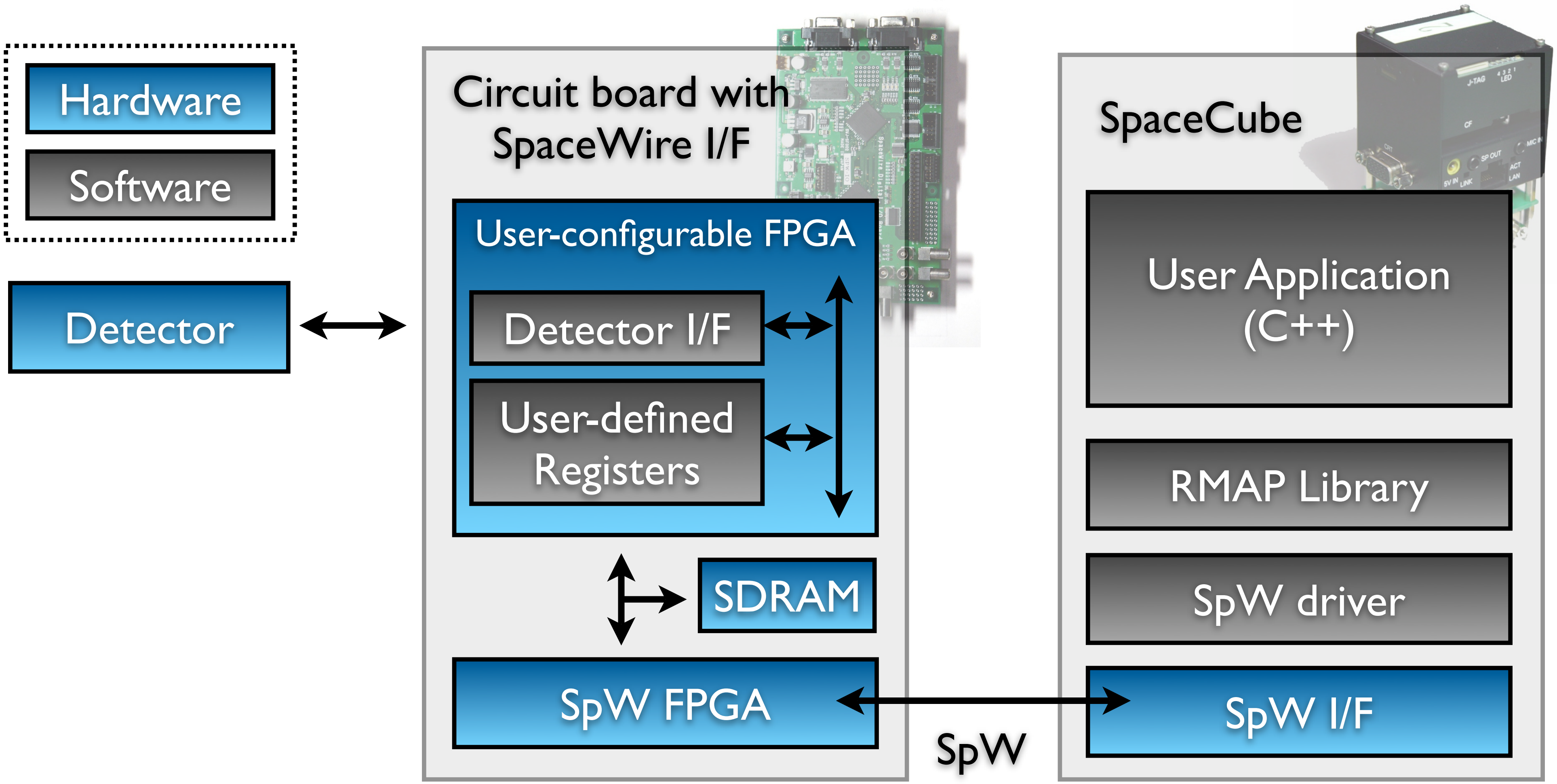
# Block diagram of the DAQ framework



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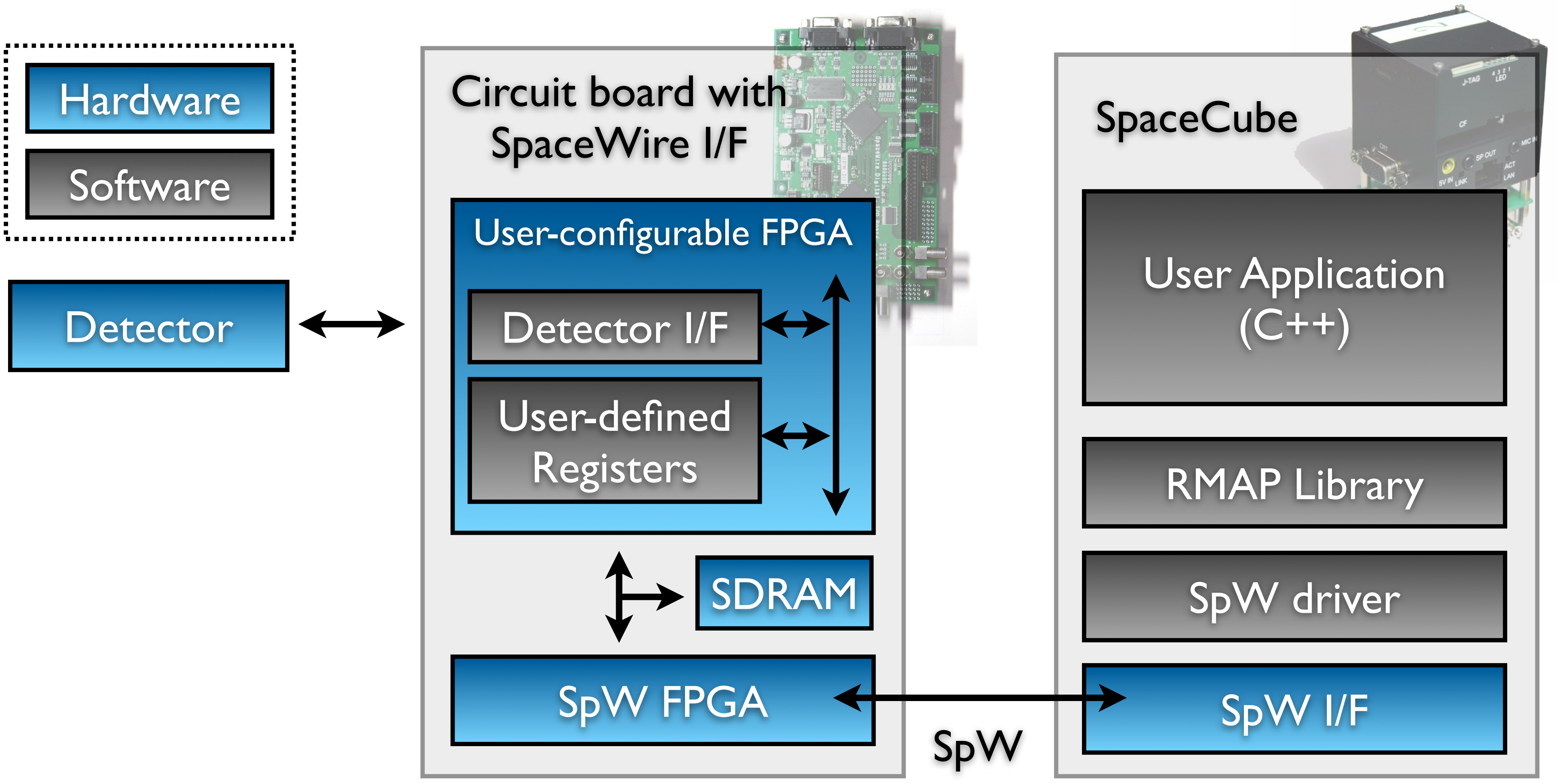

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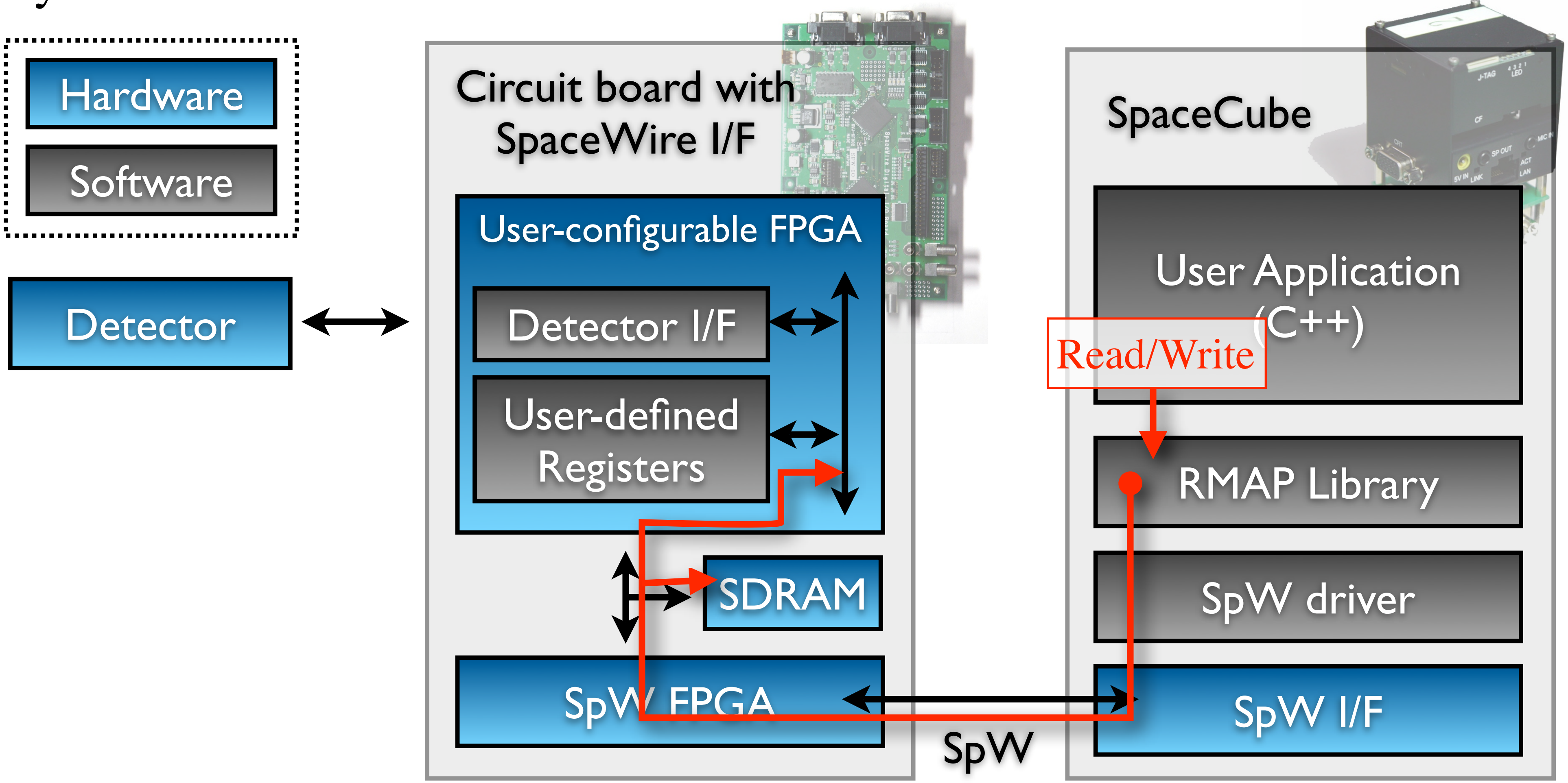

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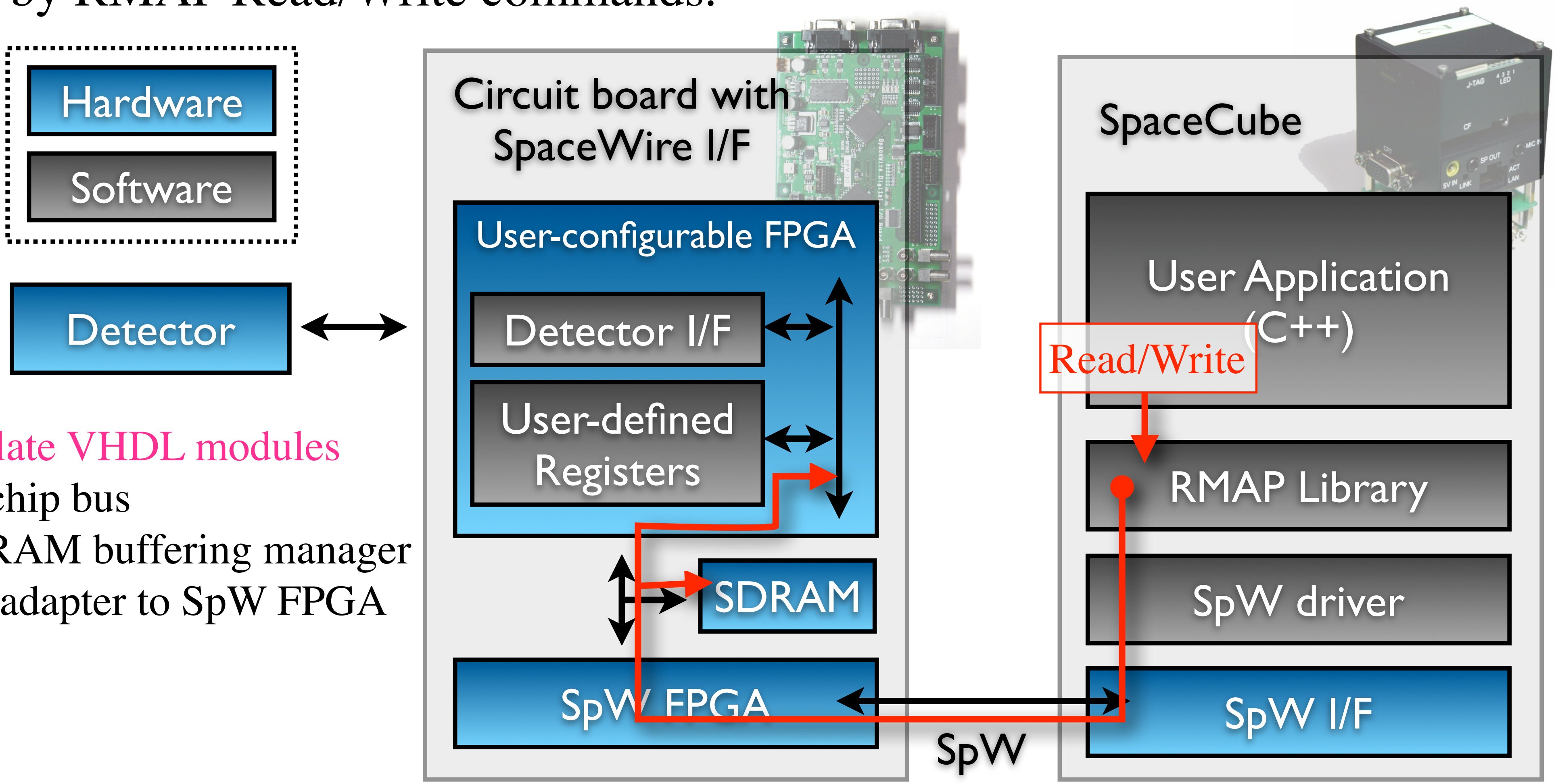


Template VHDL modules

- on-chip bus
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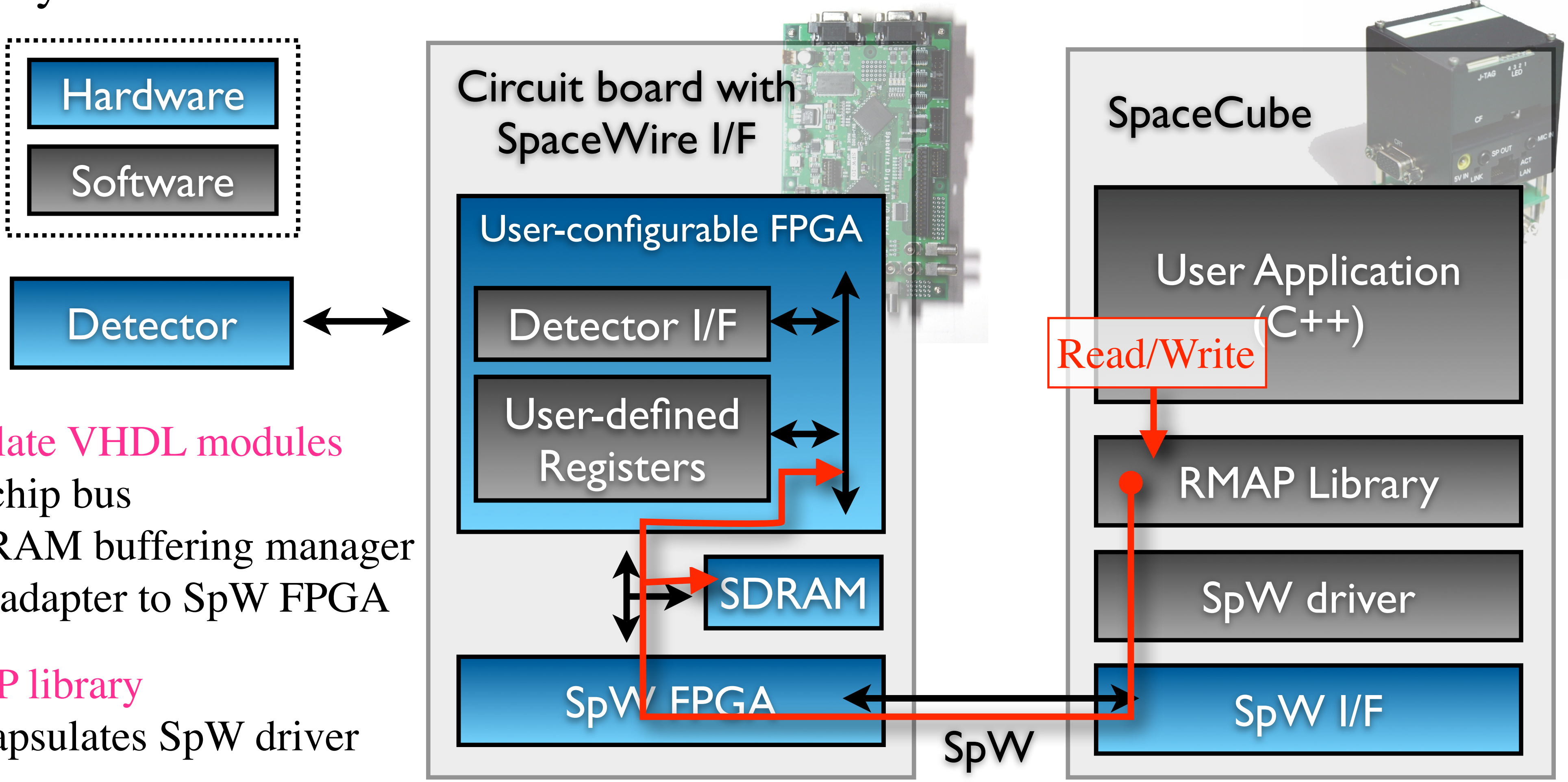


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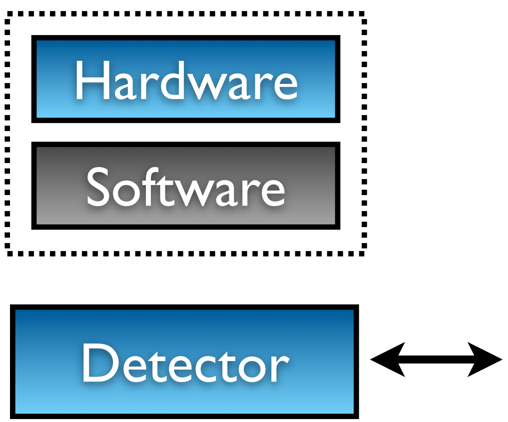


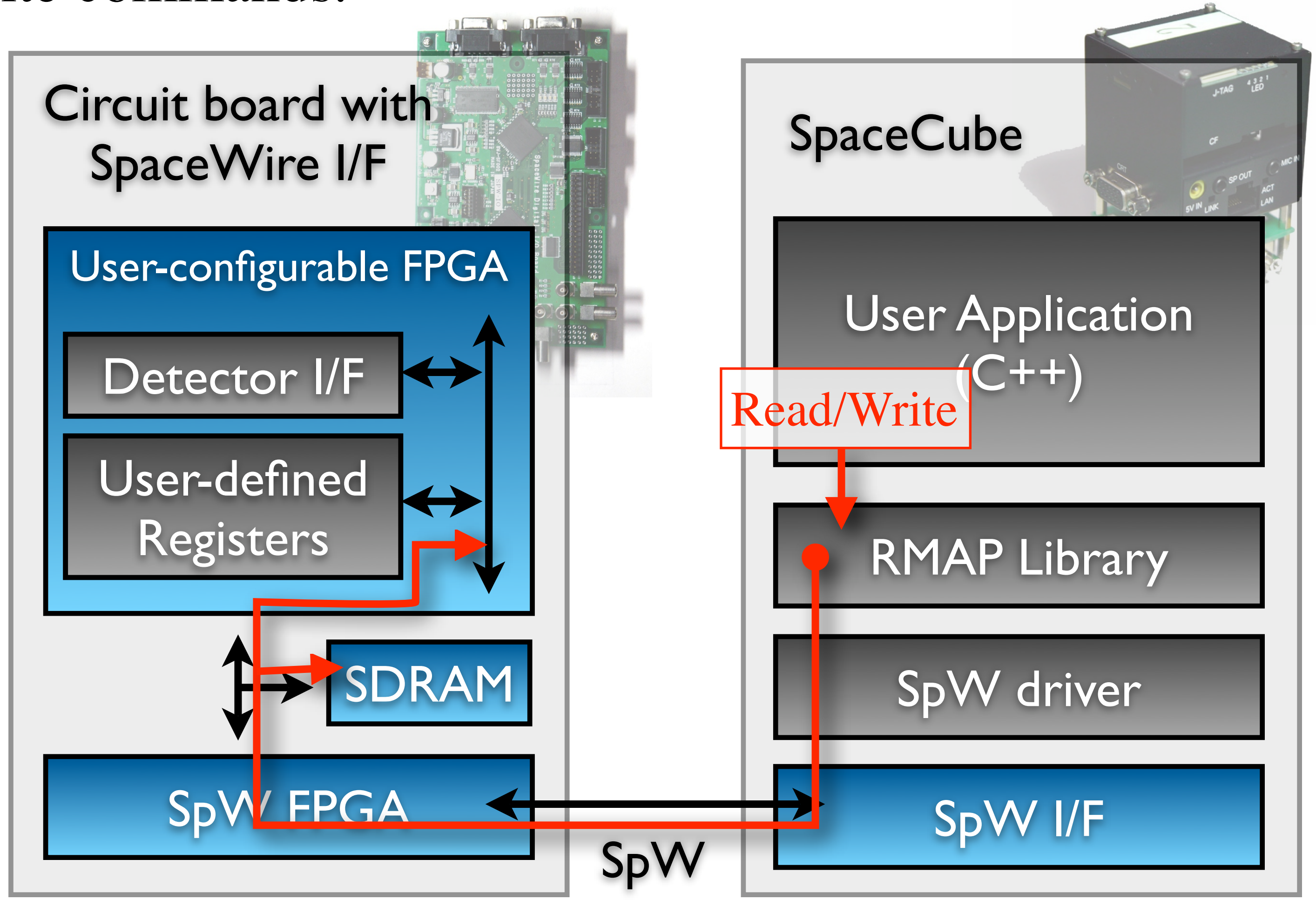


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Current status : Implementation finished, improvements going on.

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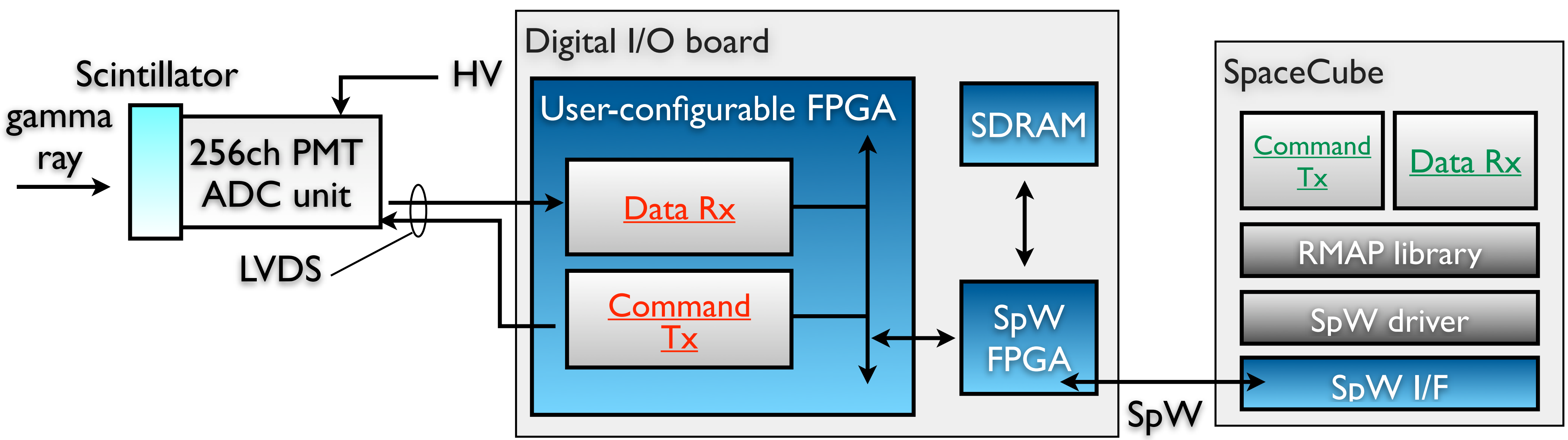

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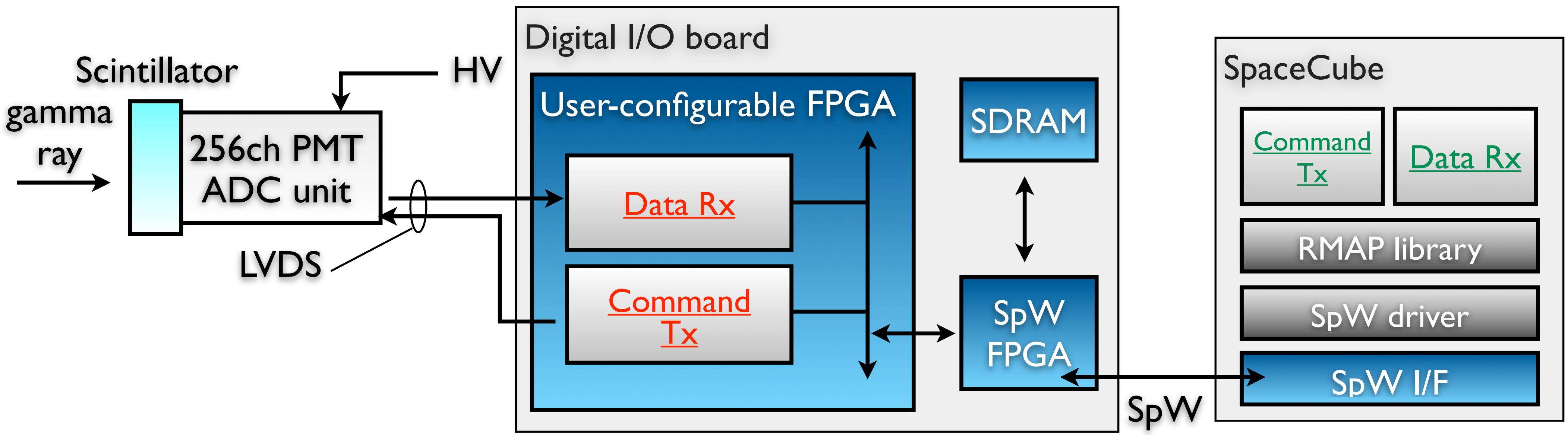

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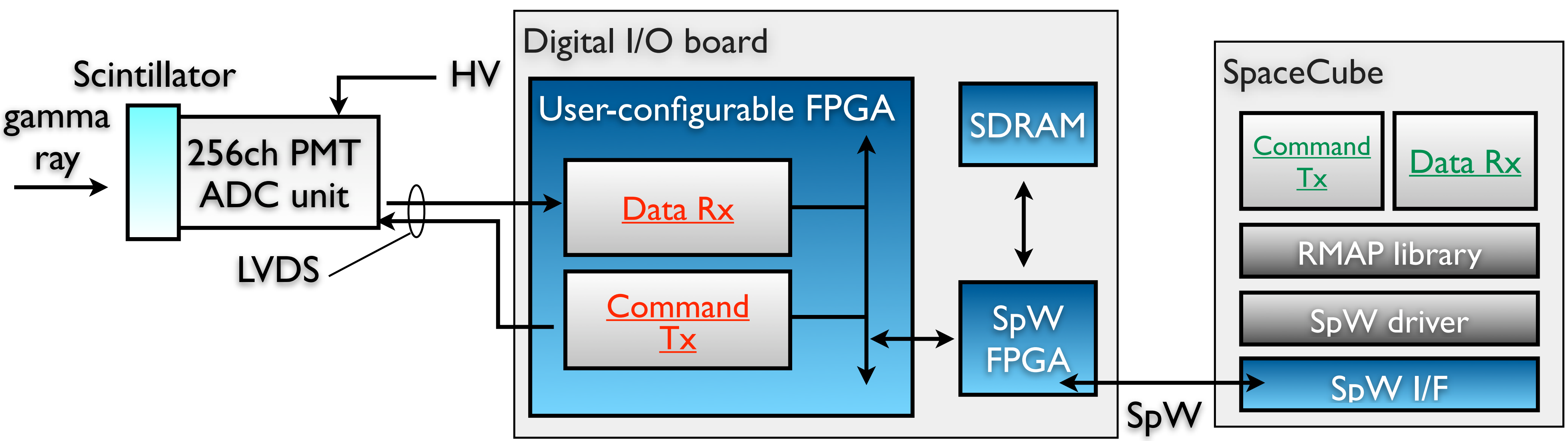

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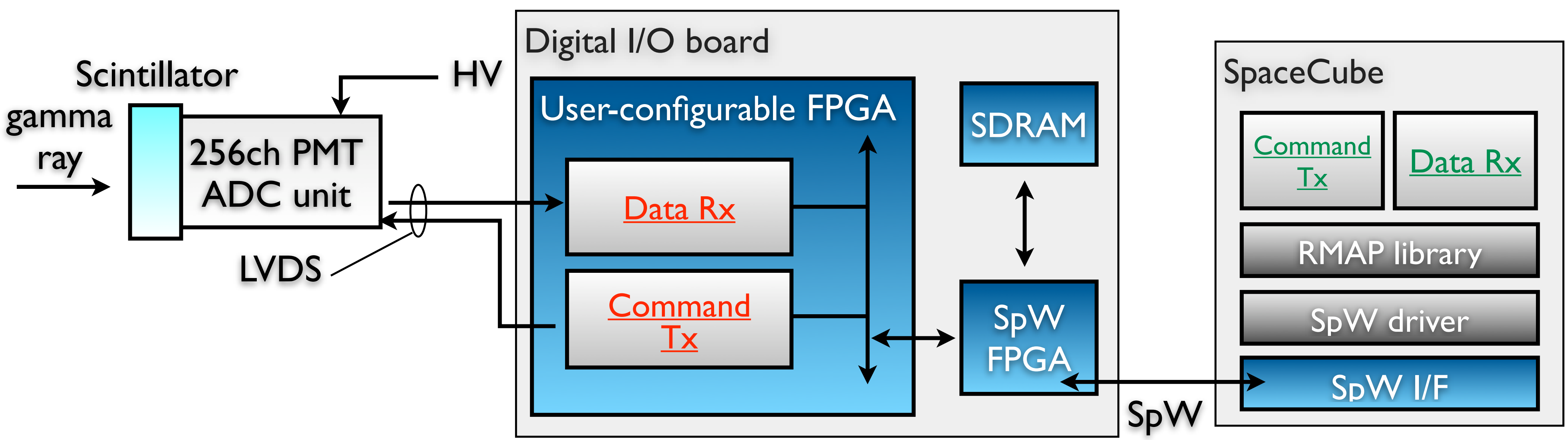

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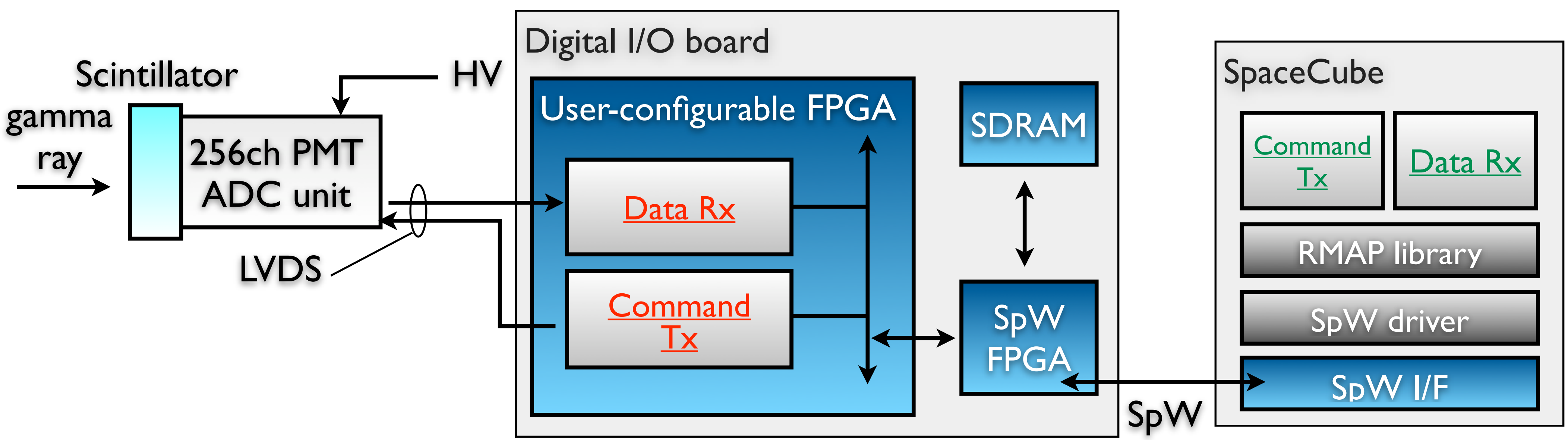

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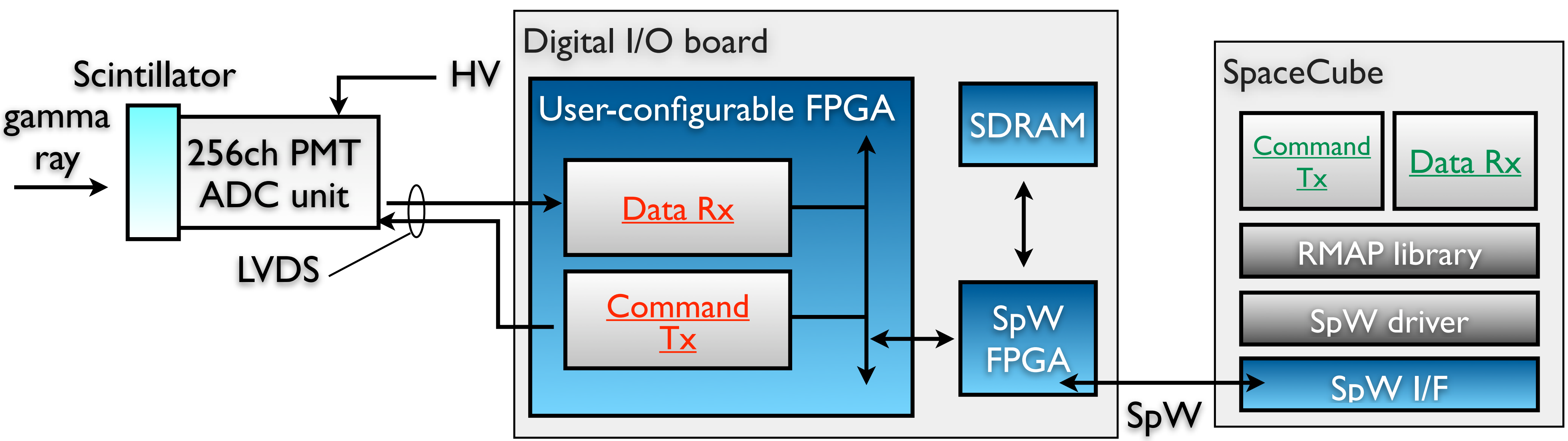

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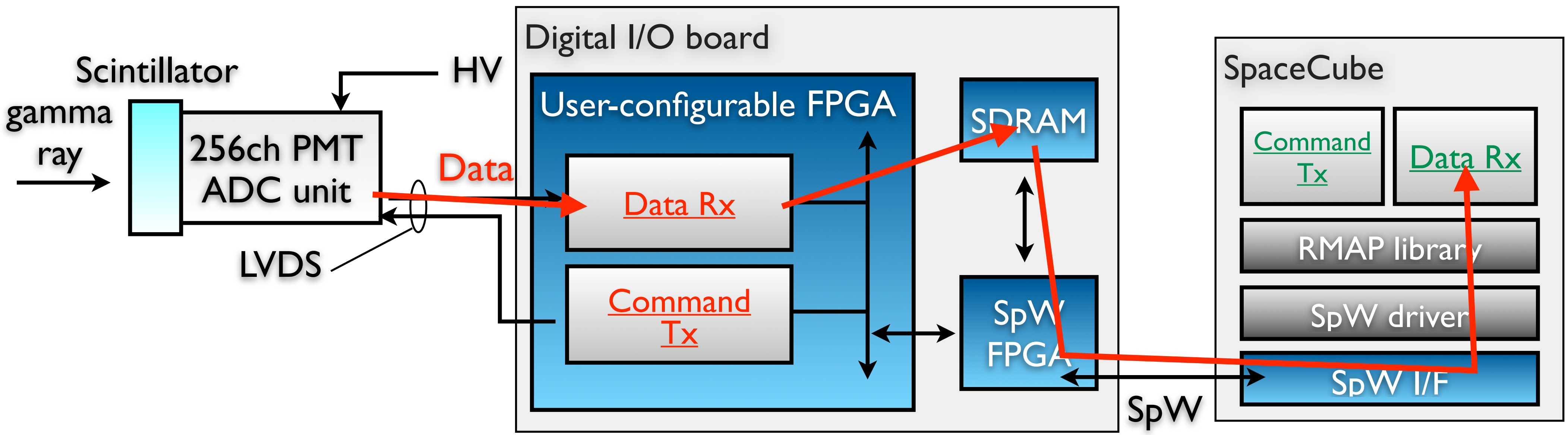

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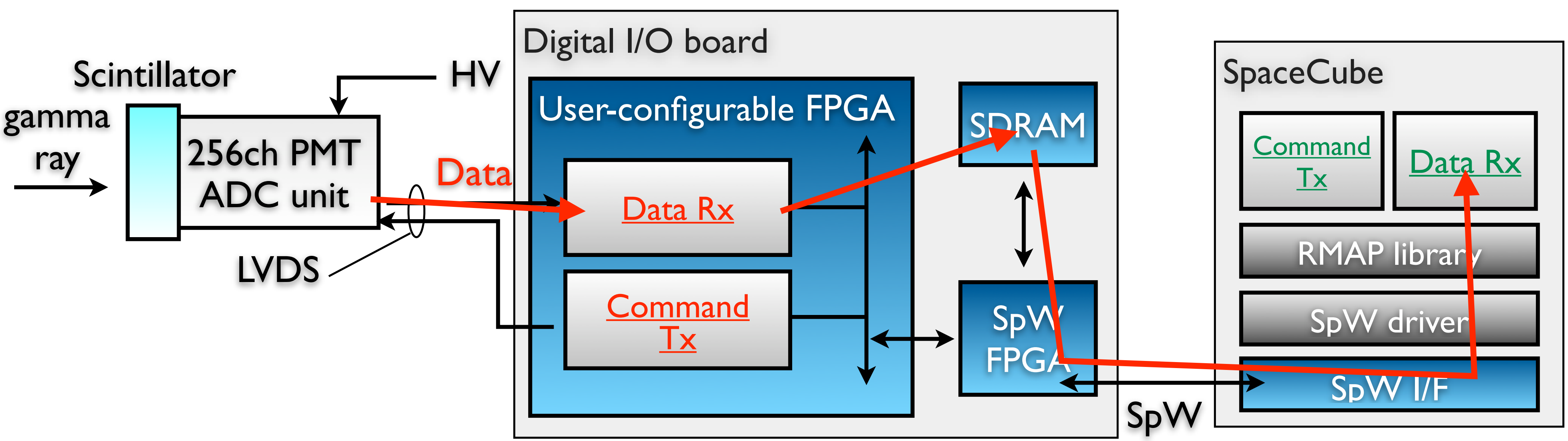

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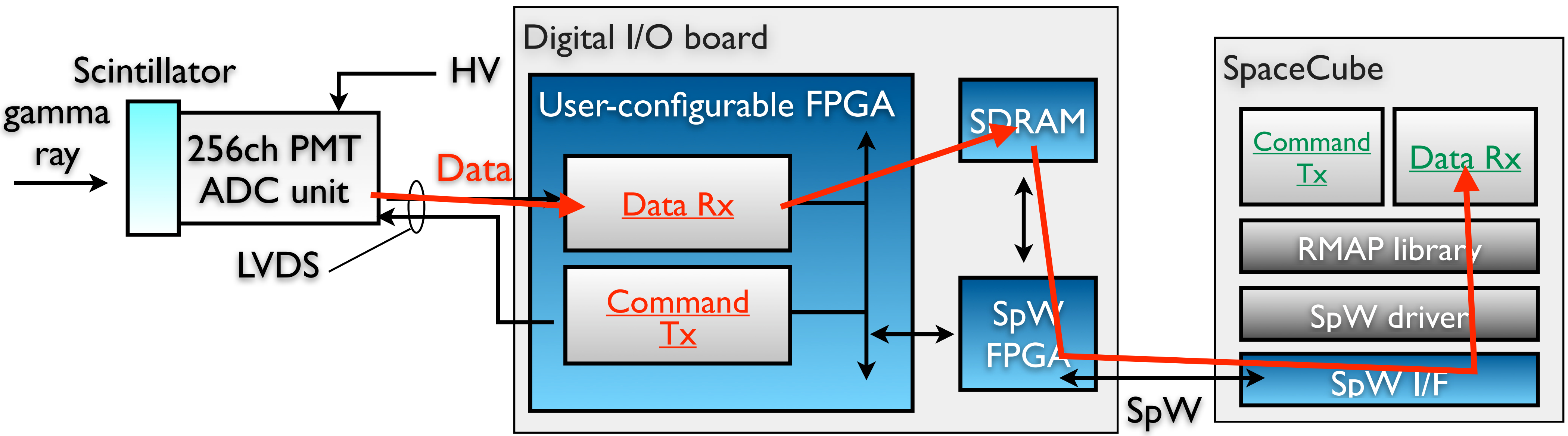

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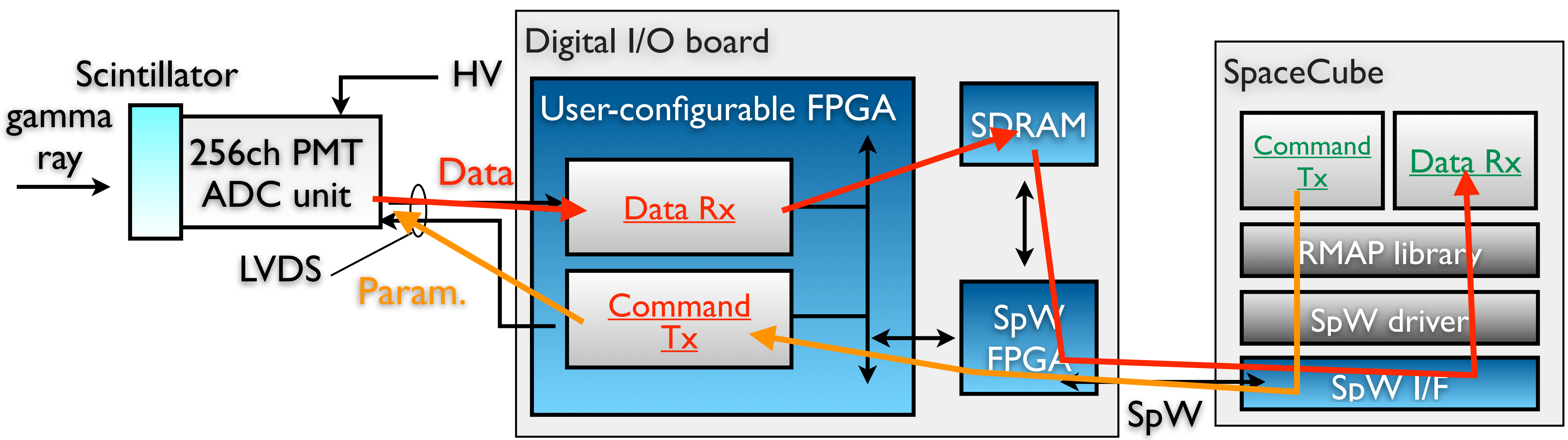

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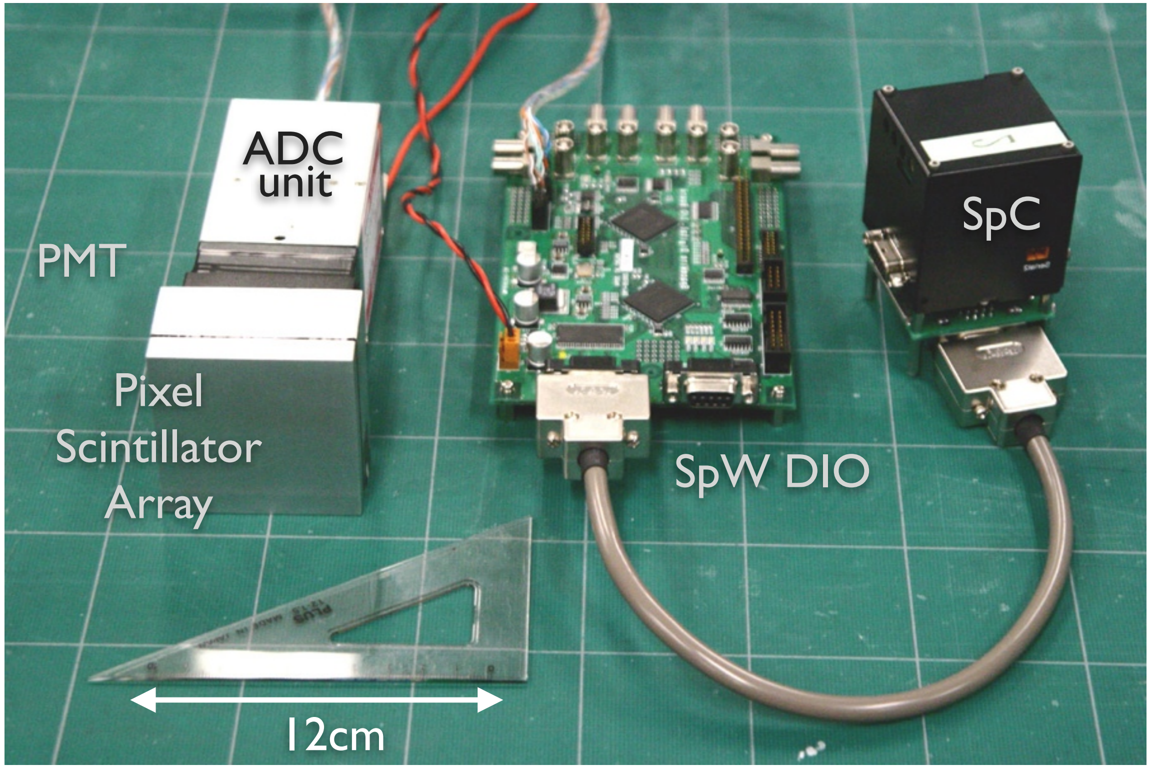

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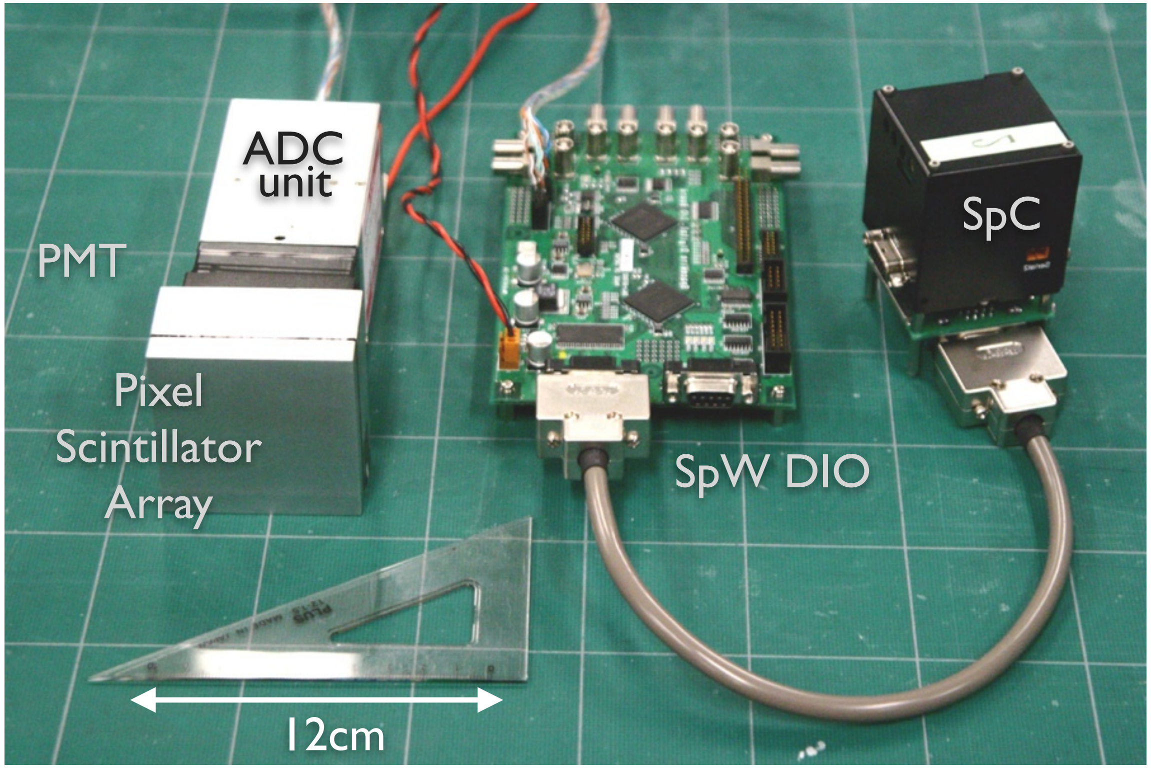

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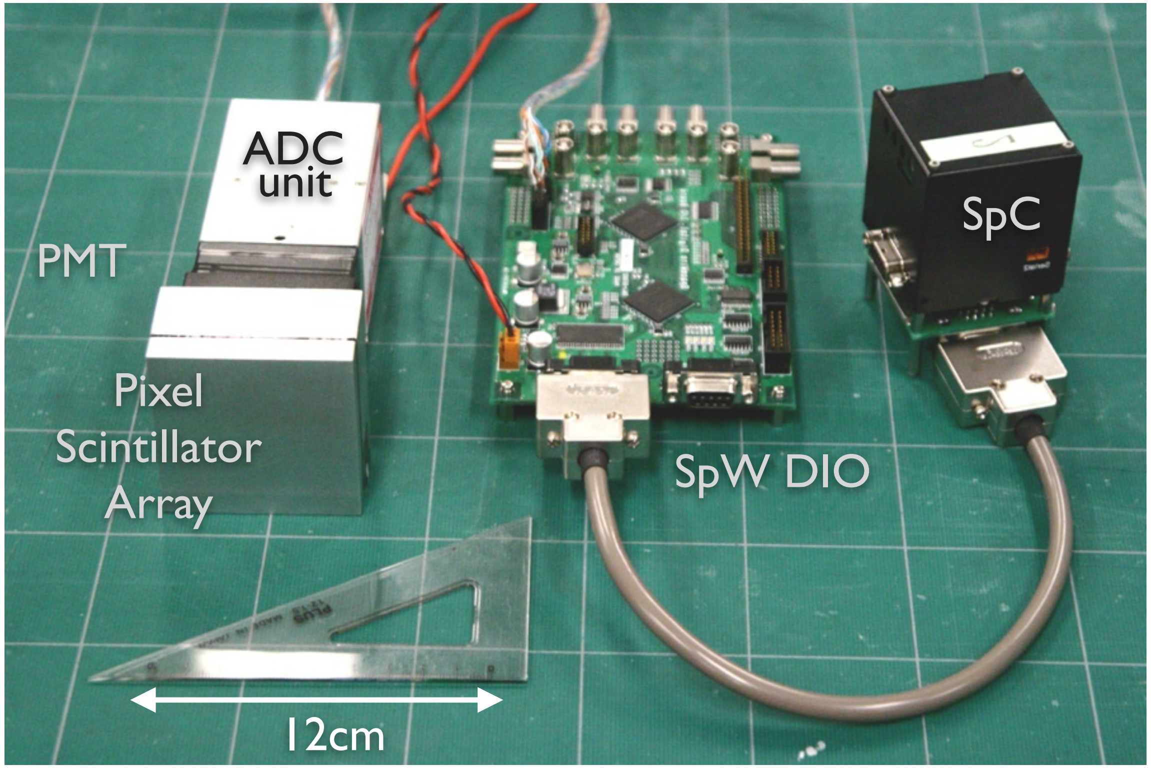


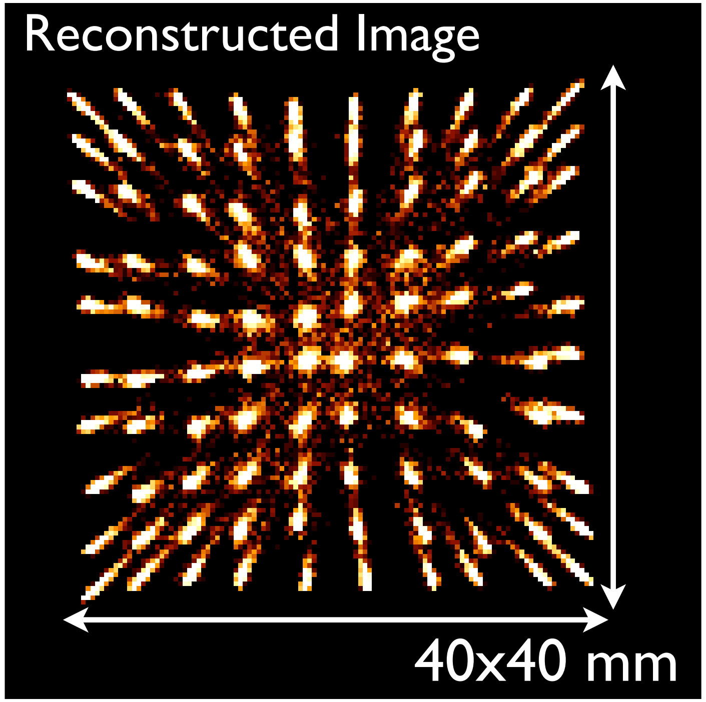


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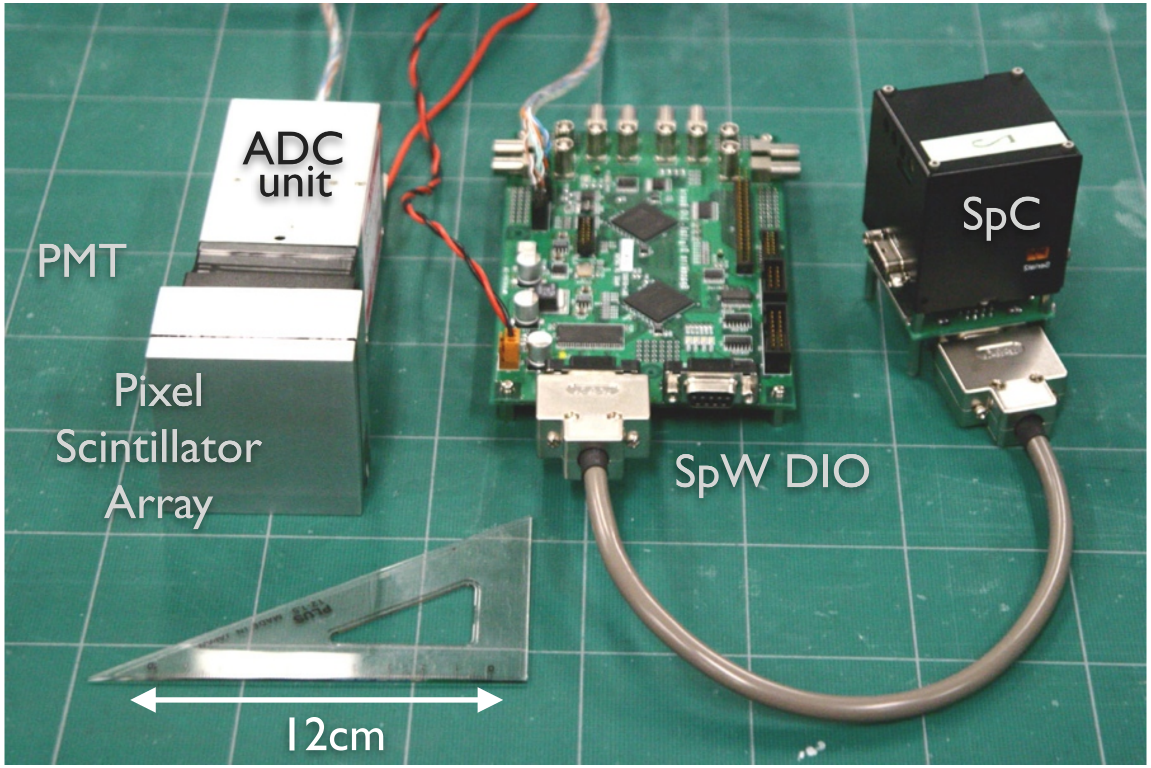


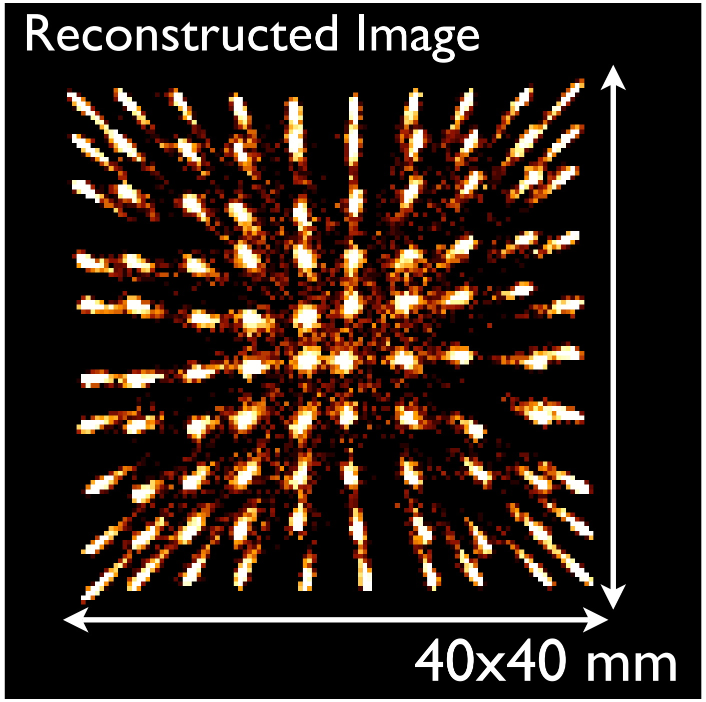


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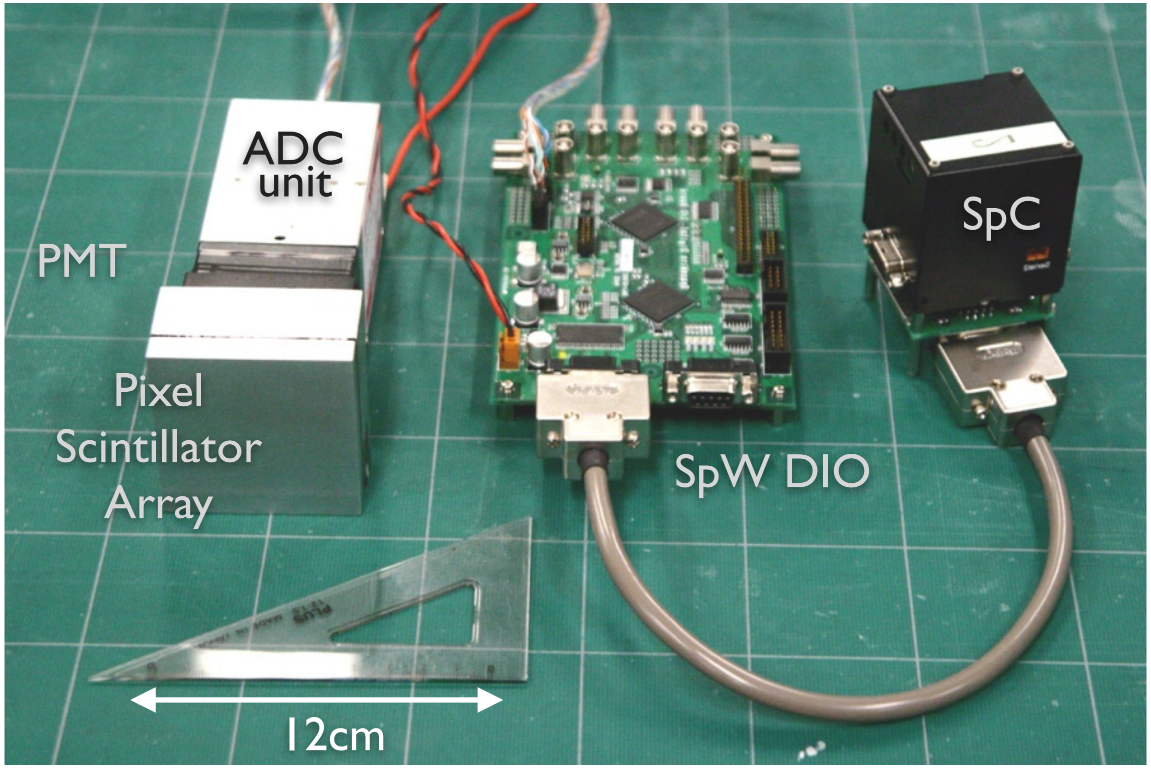


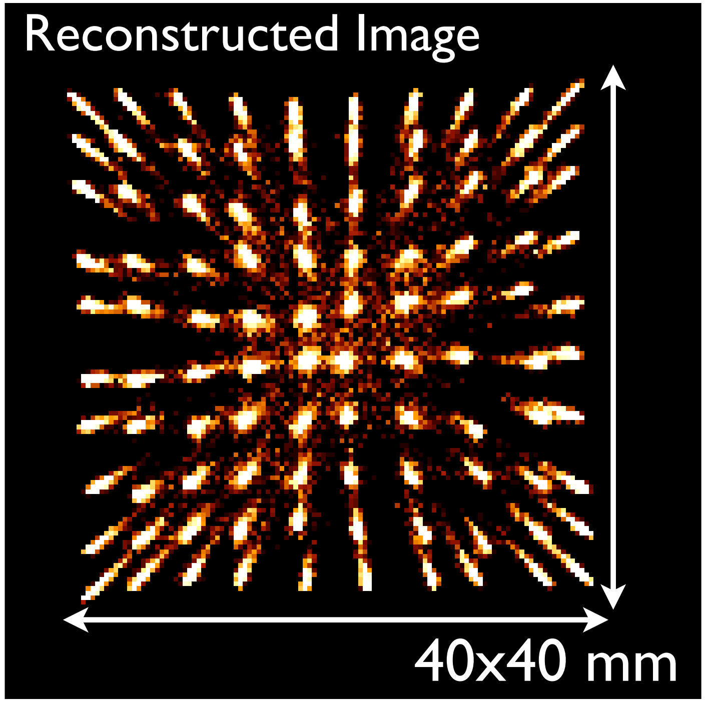


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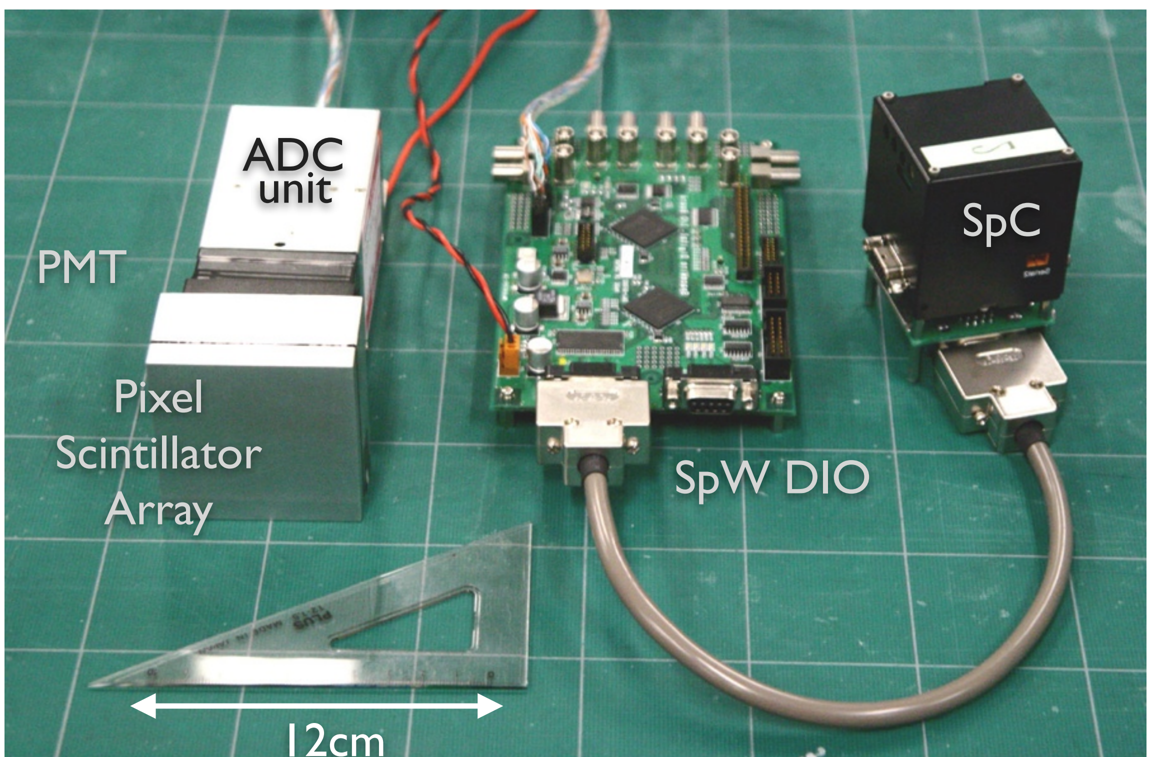


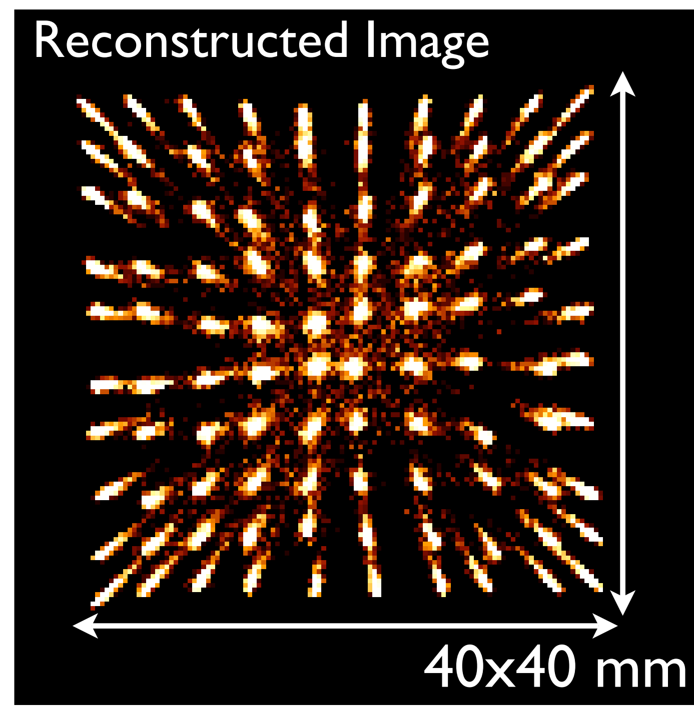


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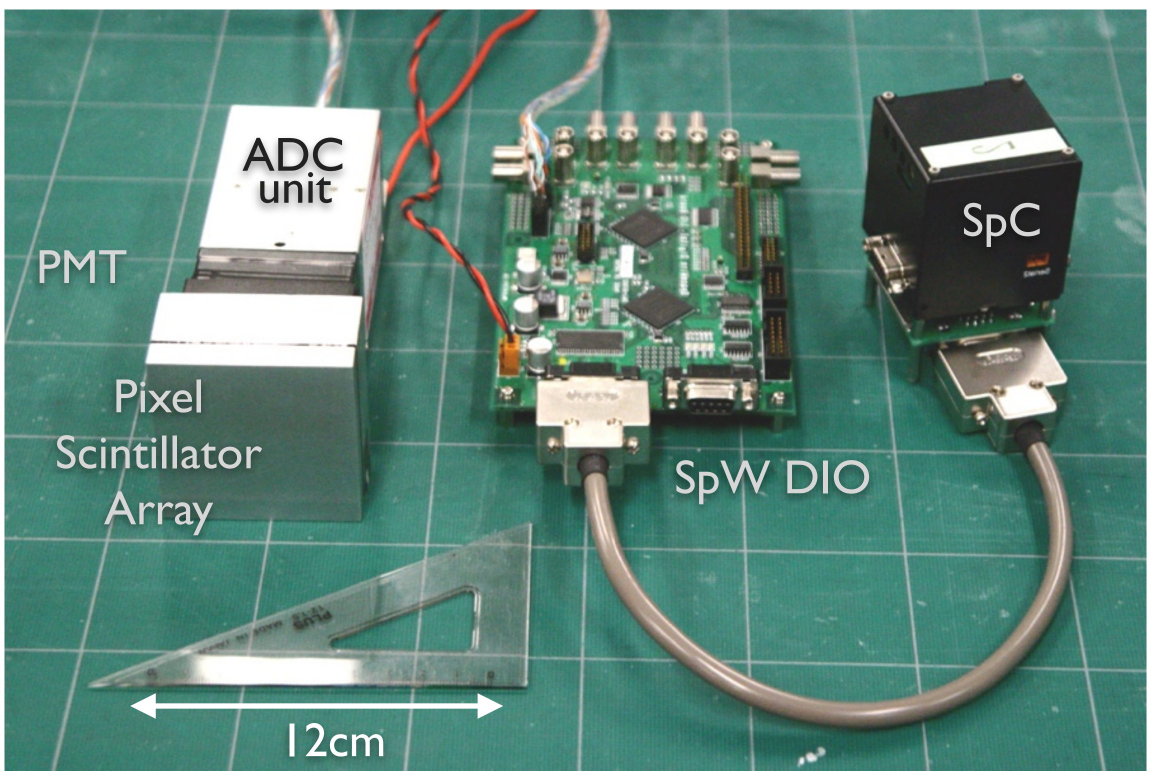


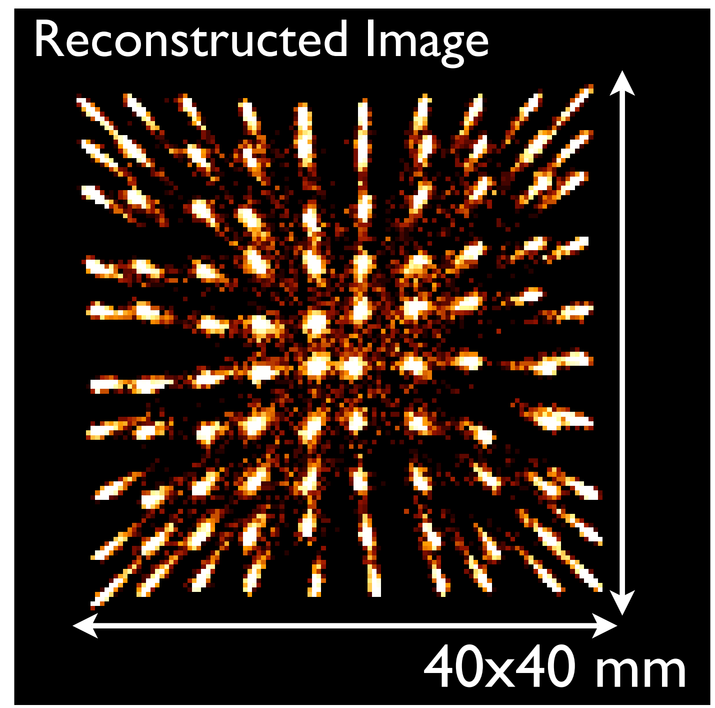


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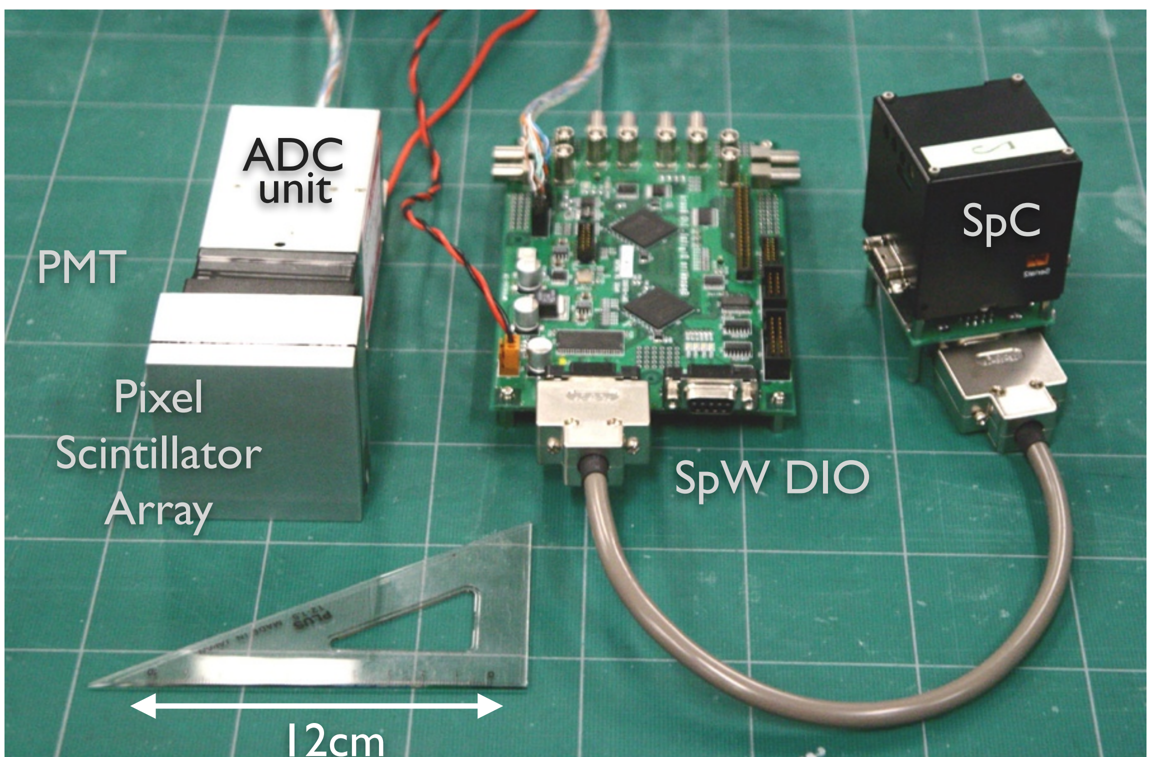
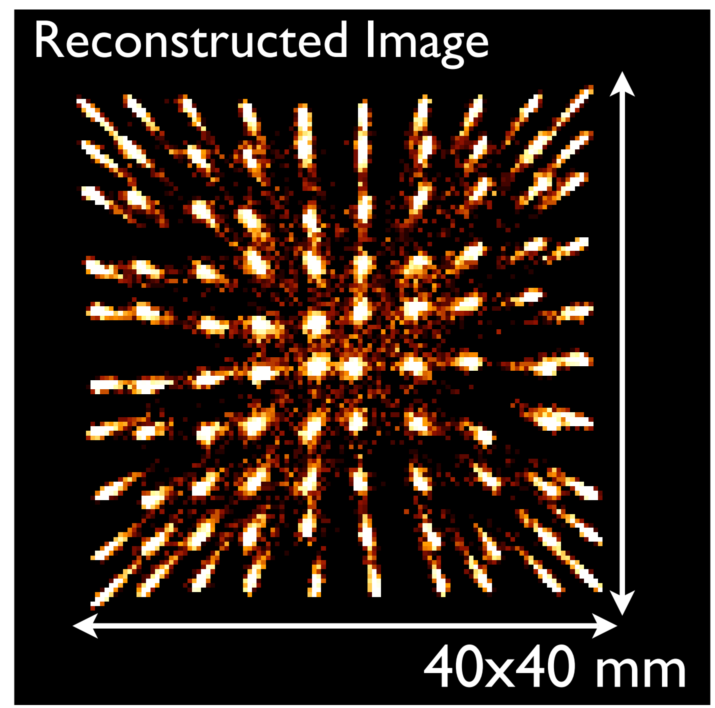
with β-ver SpW IP core (to be improved)

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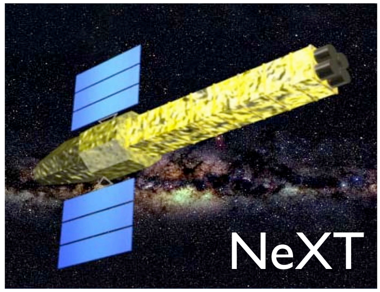

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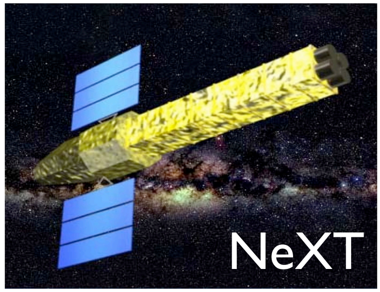

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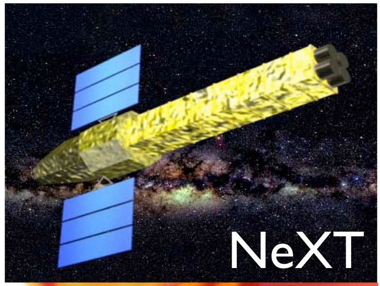


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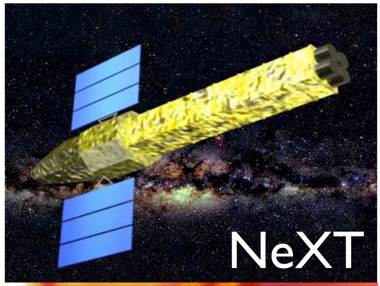
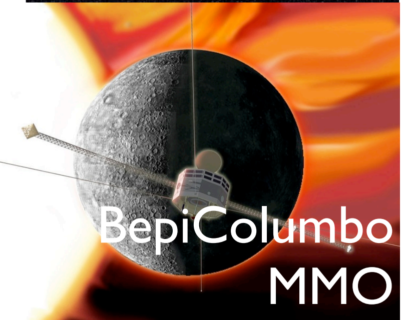
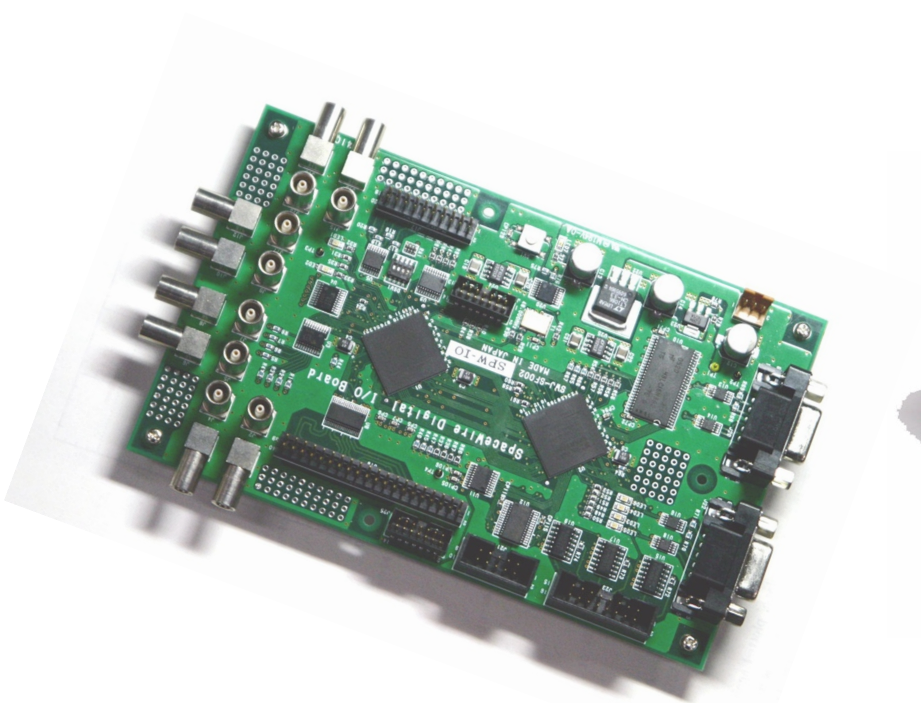


# Summary


SPW-IO
MADE IN JAPAN


J-TAG
4 3 2 1
LED
CF
CRT
MIC IN
SP OUT
5V IN
LINK
ACT
LAN

# Summary

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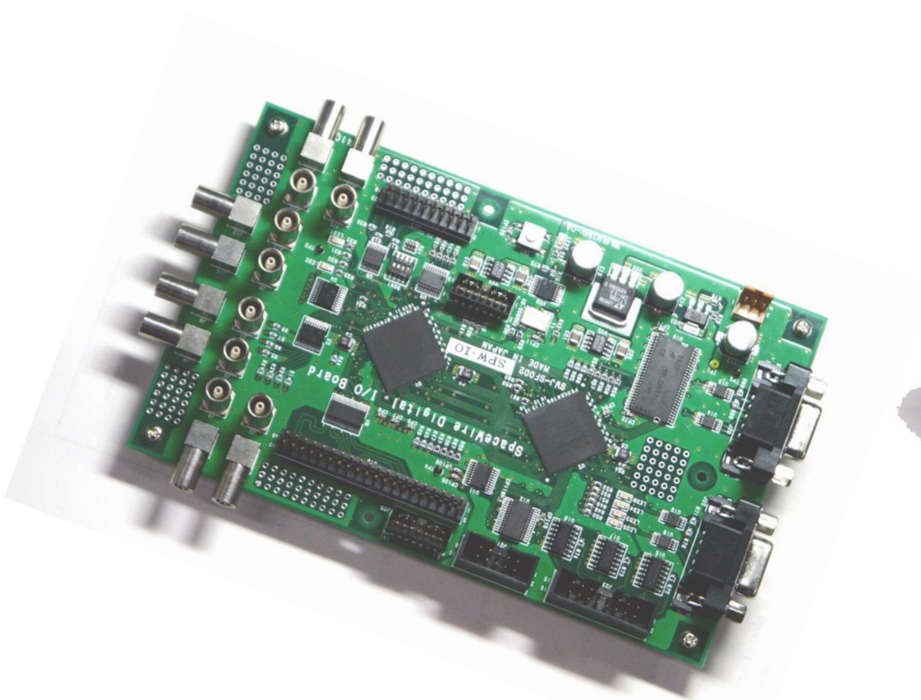


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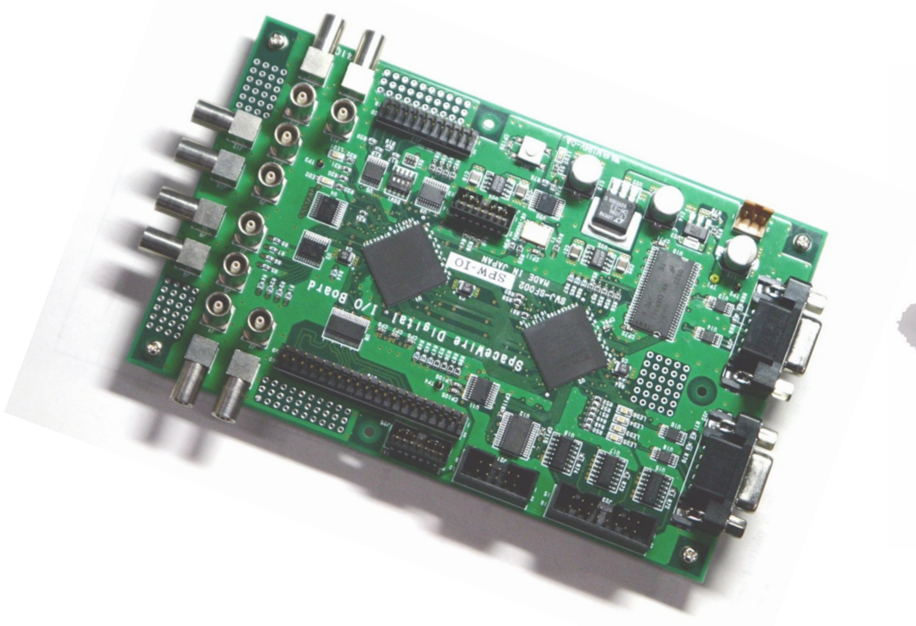
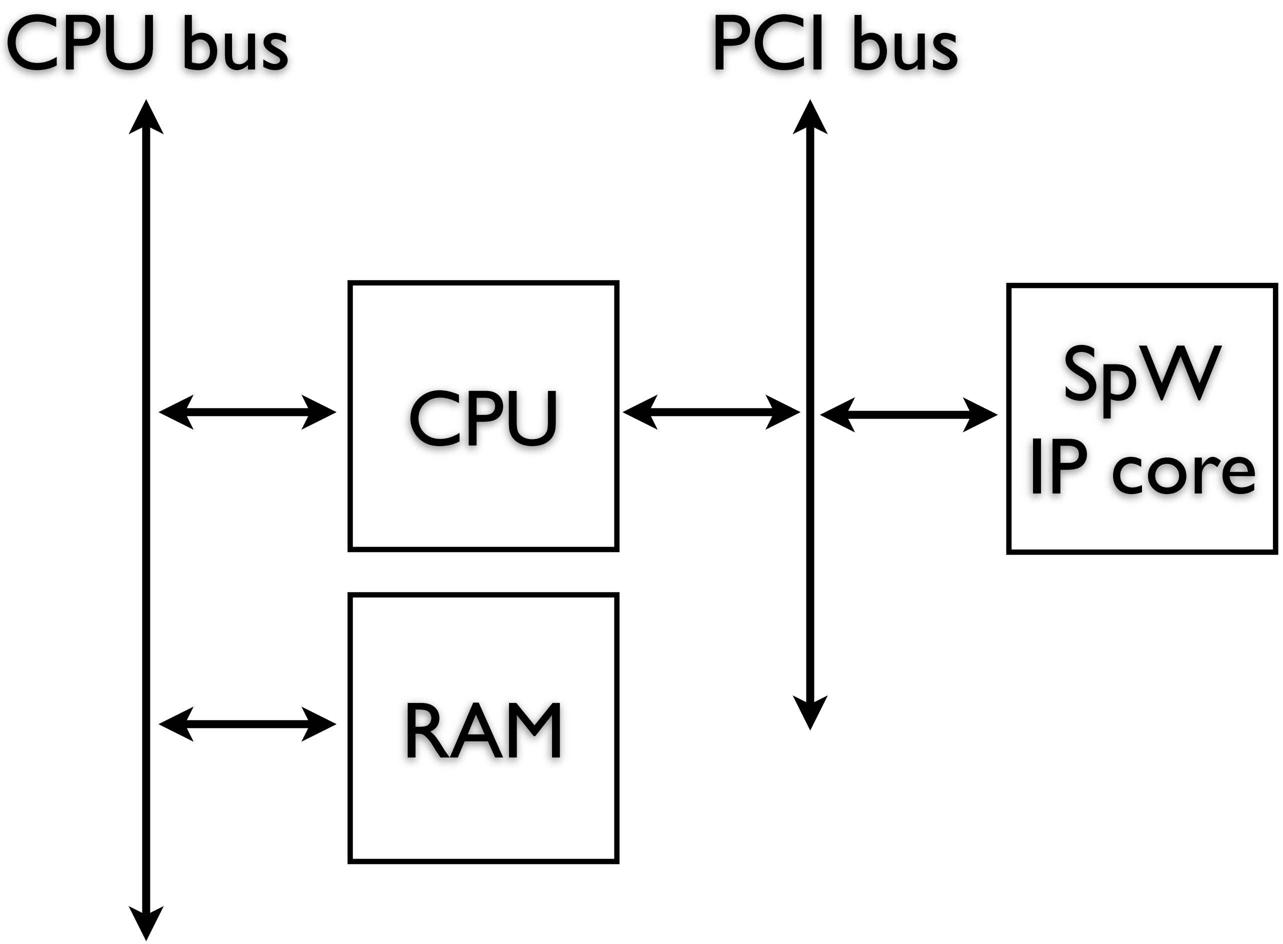
- The DAQ framework is **used in a number of missions**.
  - ground based experimens, balloon missions, satellite missions.



# Kakushi Slides

# Data Transfer Between SpW IP core and CPU/RAM



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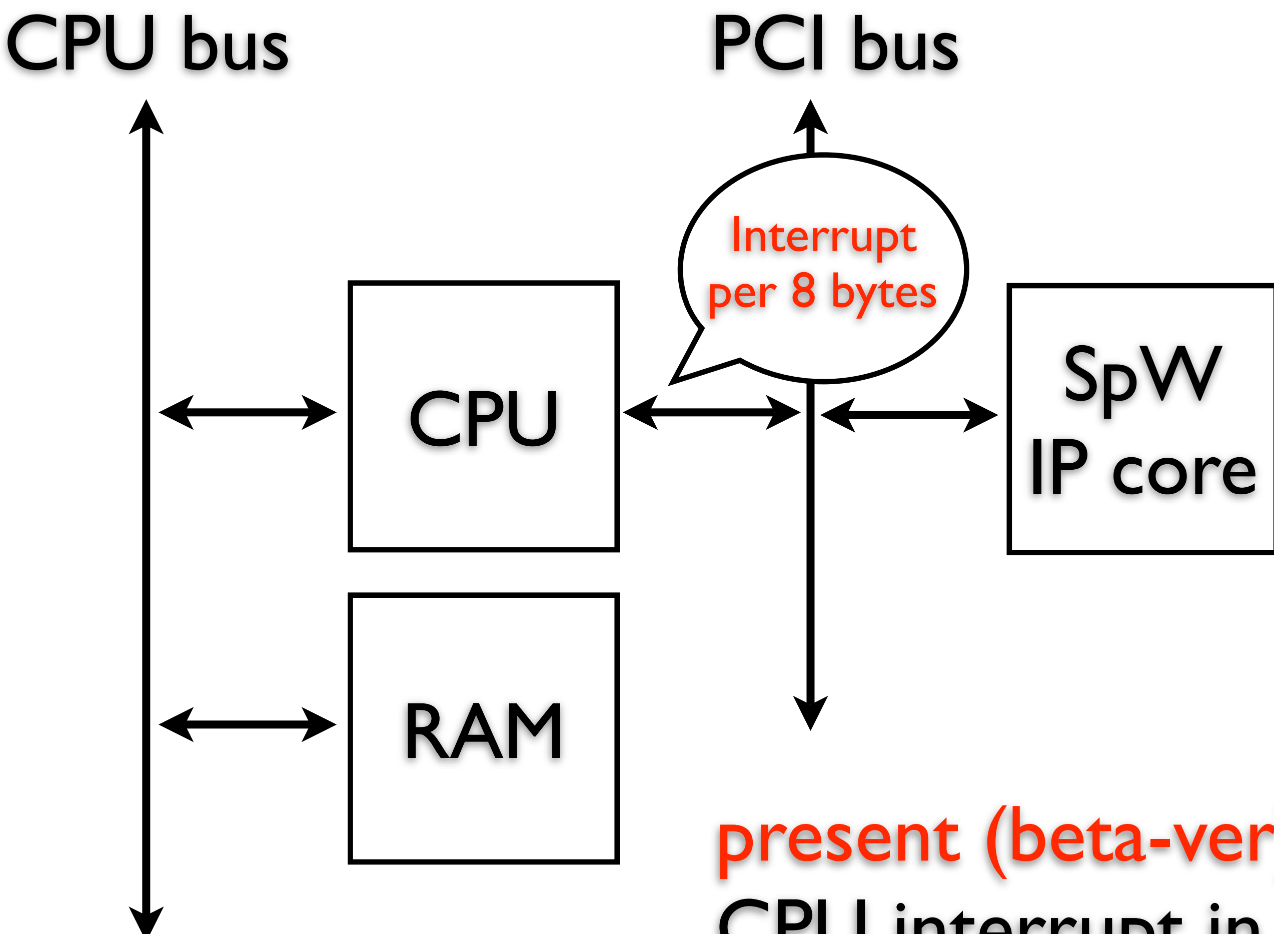


present (beta-ver) ~ 600kbps

CPU interrupt in each 8 byte transfer

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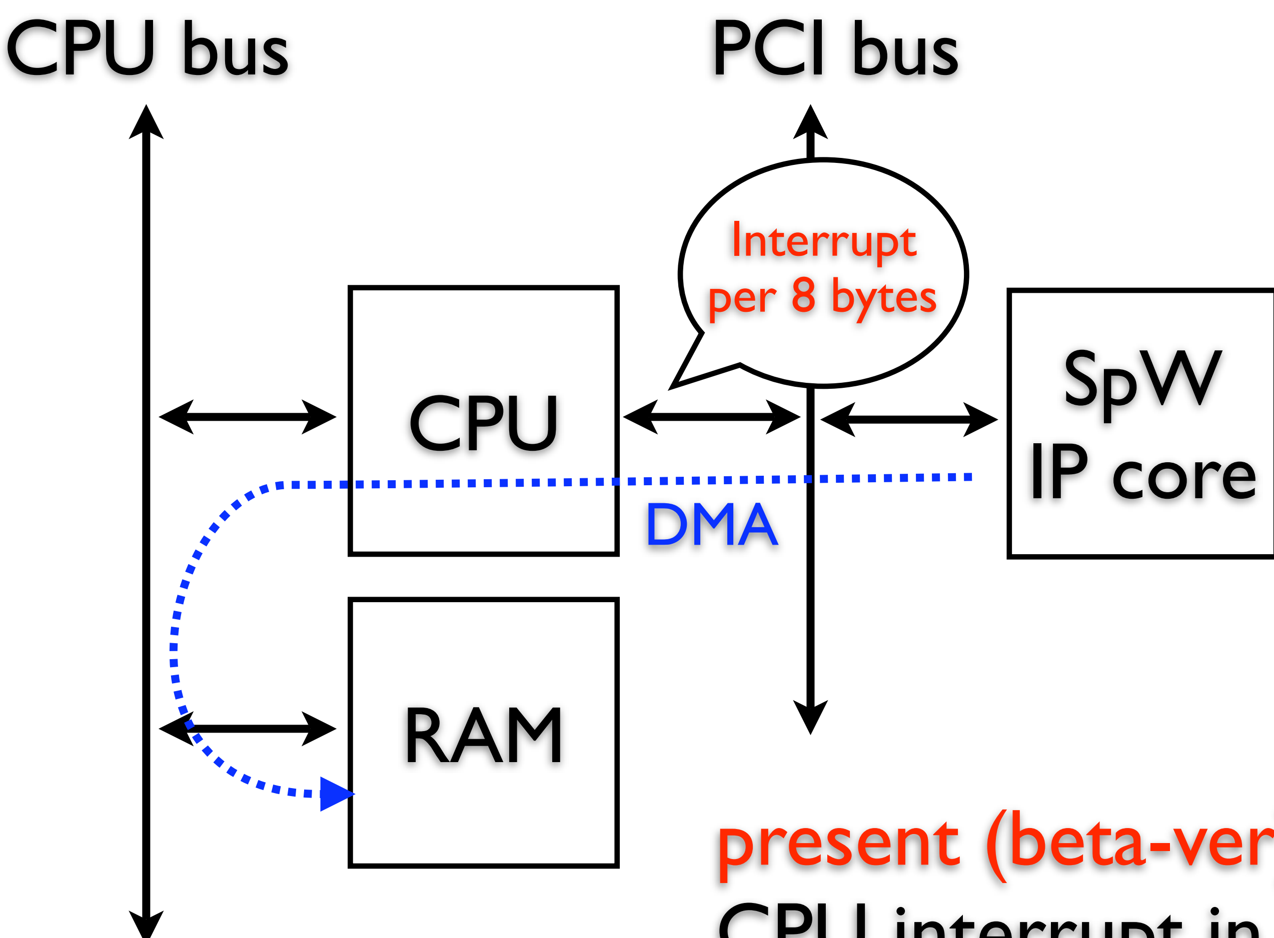


present (beta-ver) ~ 600kbps

CPU interrupt in each 8 byte transfer

near future ~ 4Mbps

direct transfer to CPU memory (DMA)

# RMAP

Remote Memory Access Protocol is ...

- one of standardized protocols over SpaceWire
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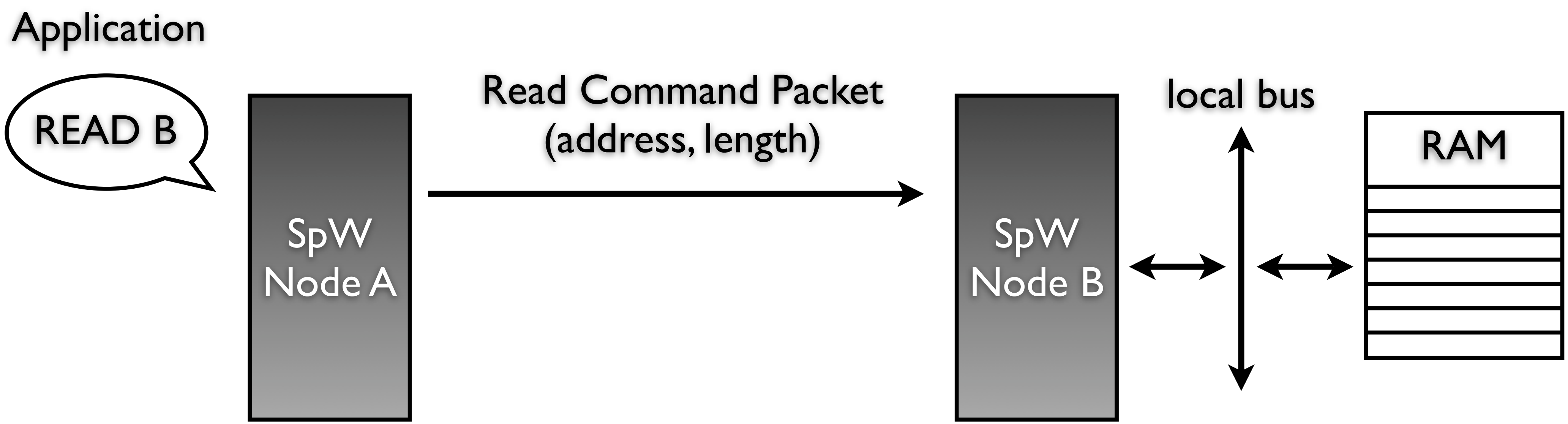

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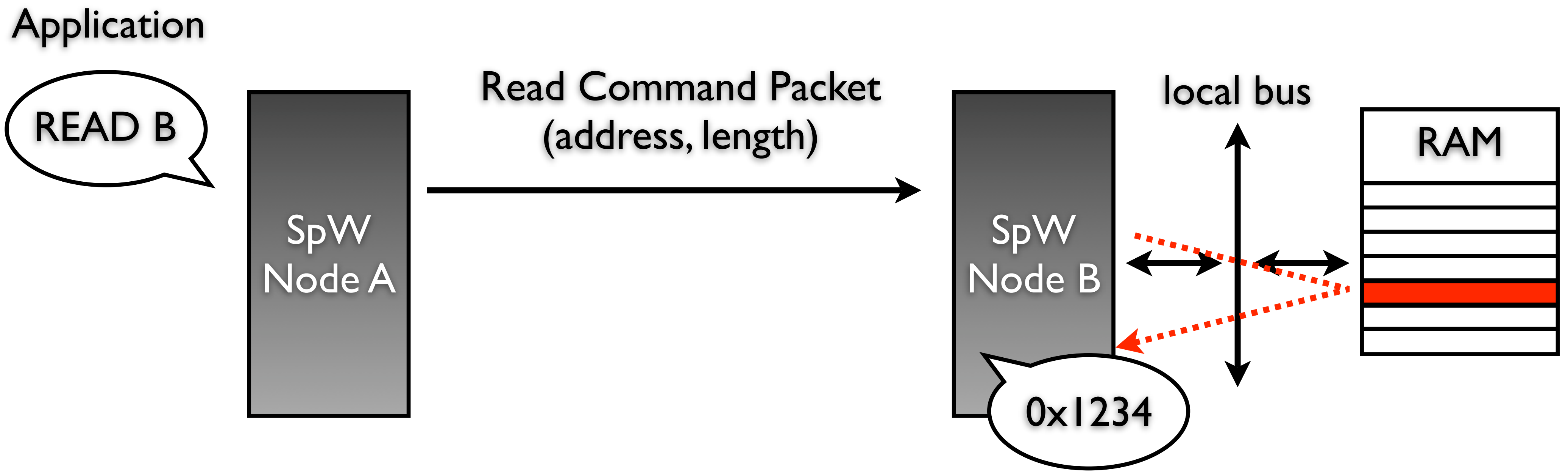

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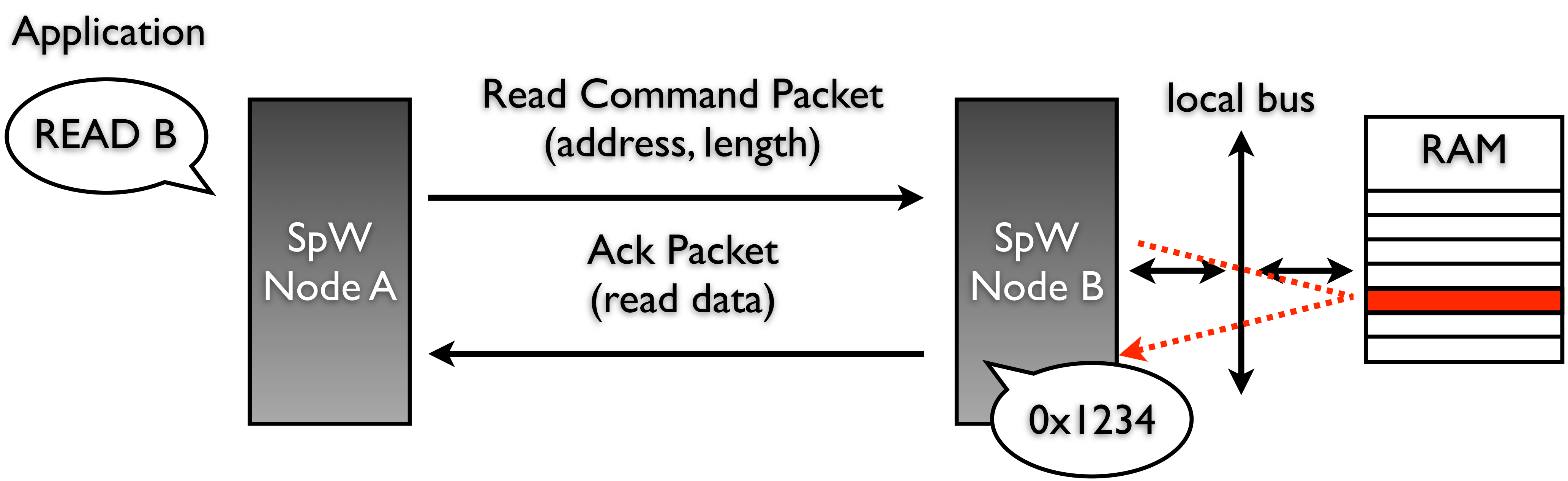

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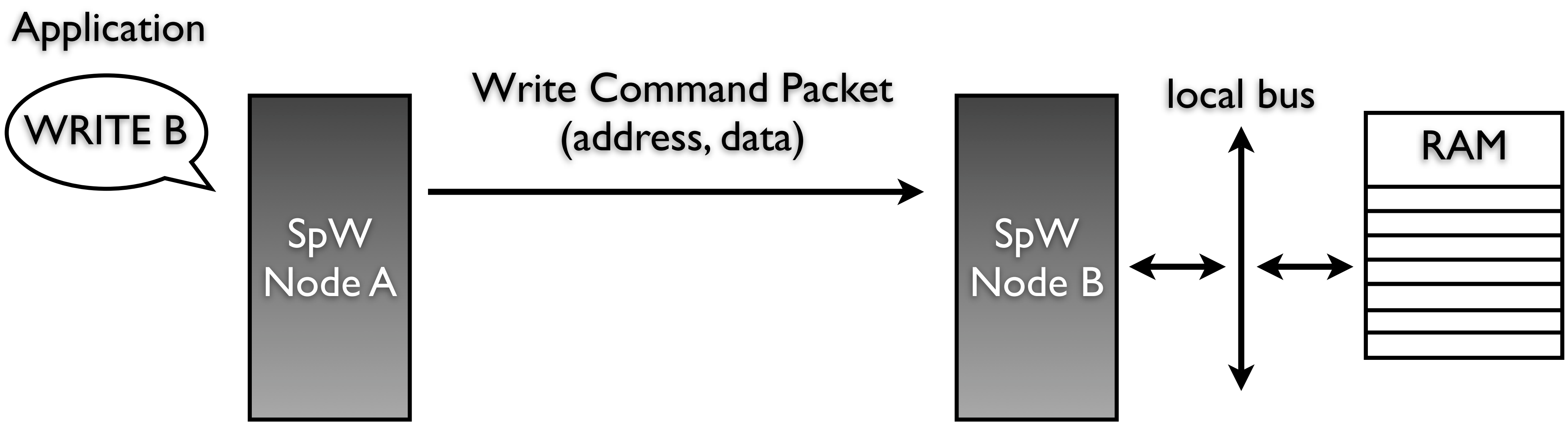


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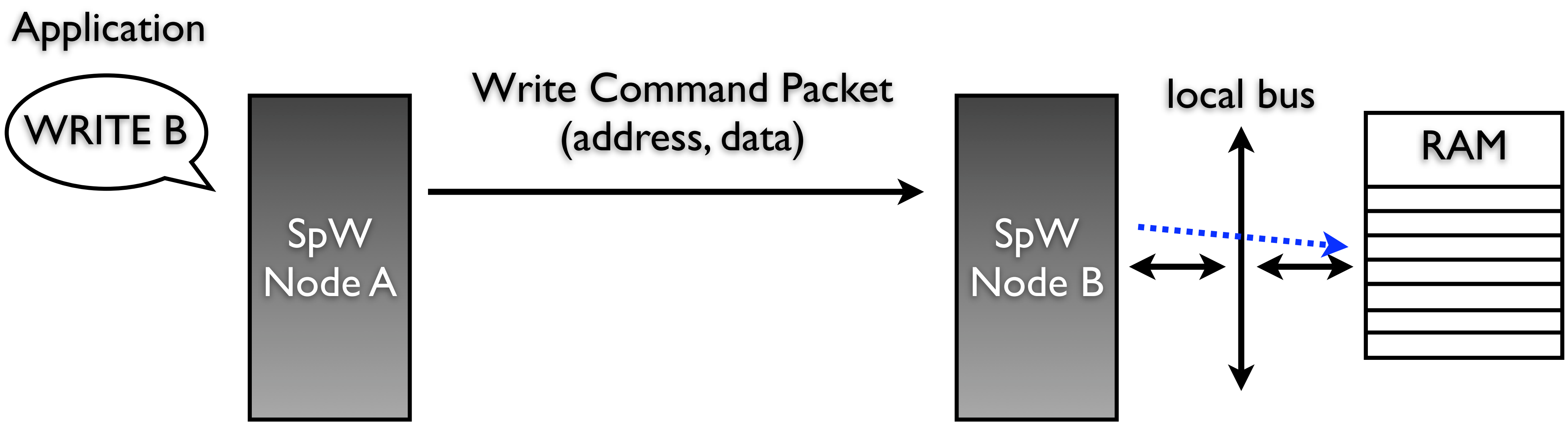


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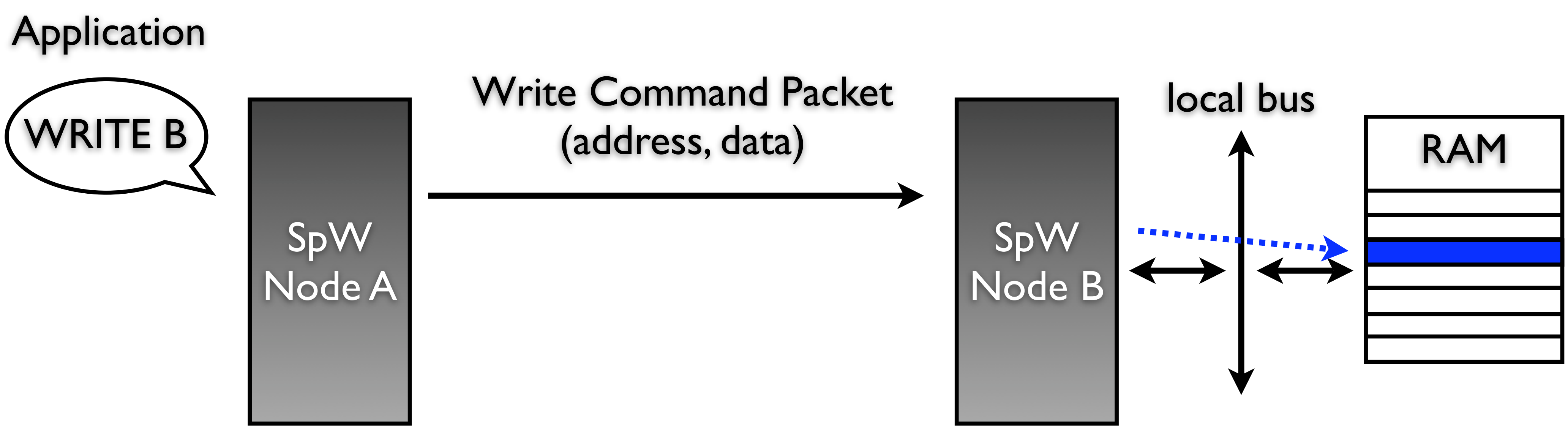


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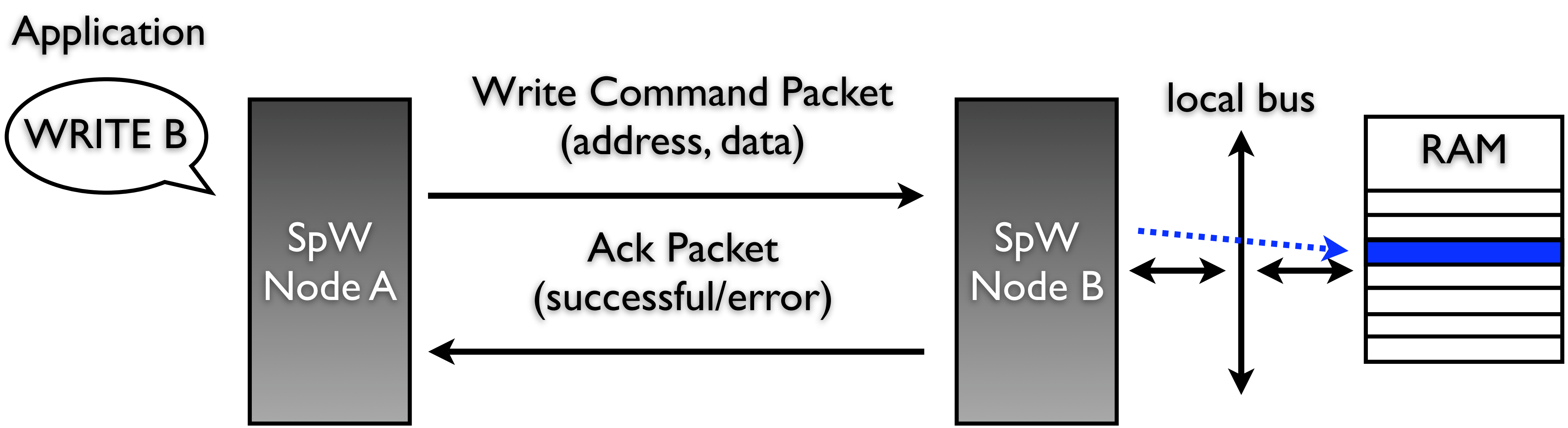


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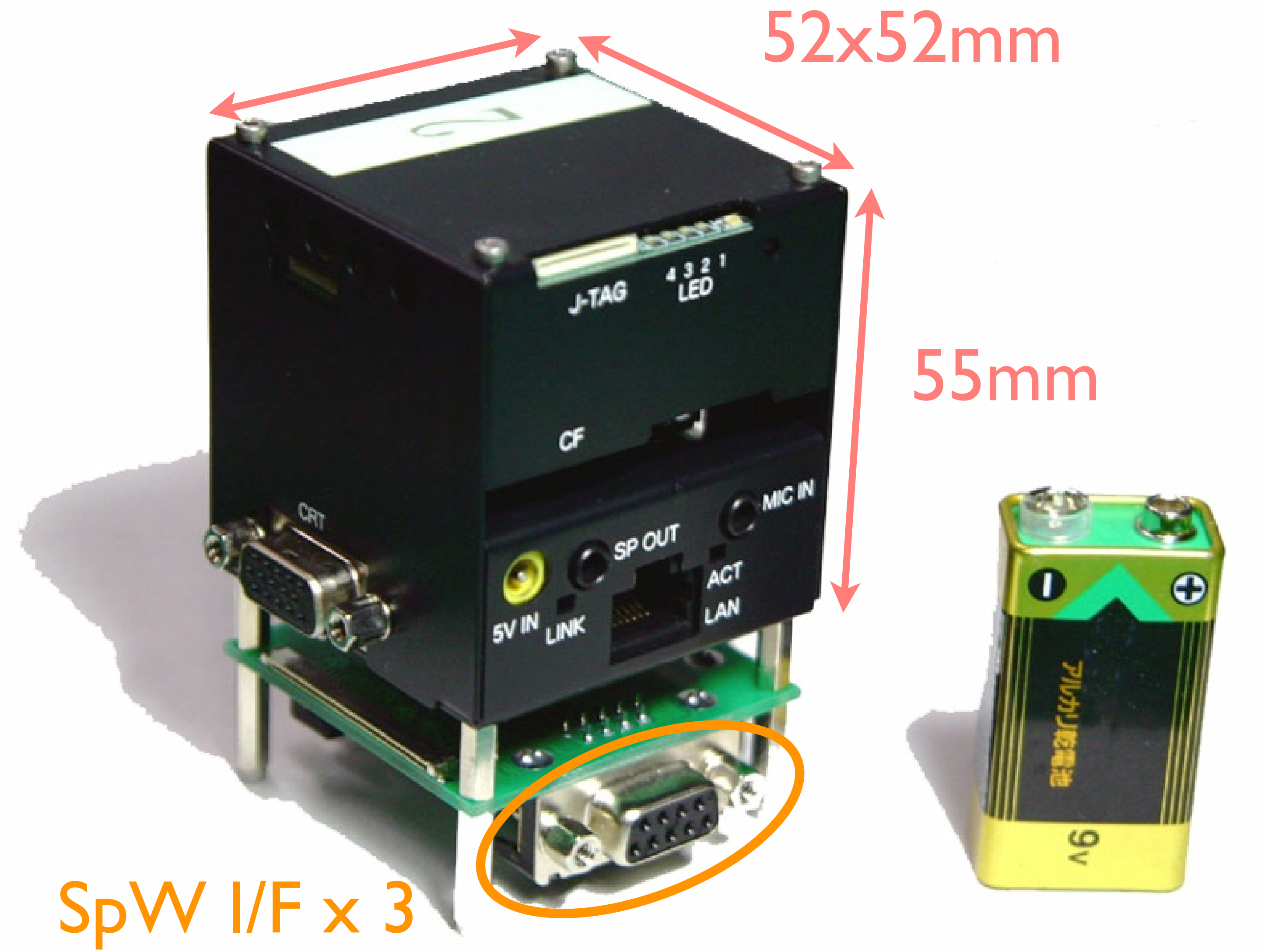
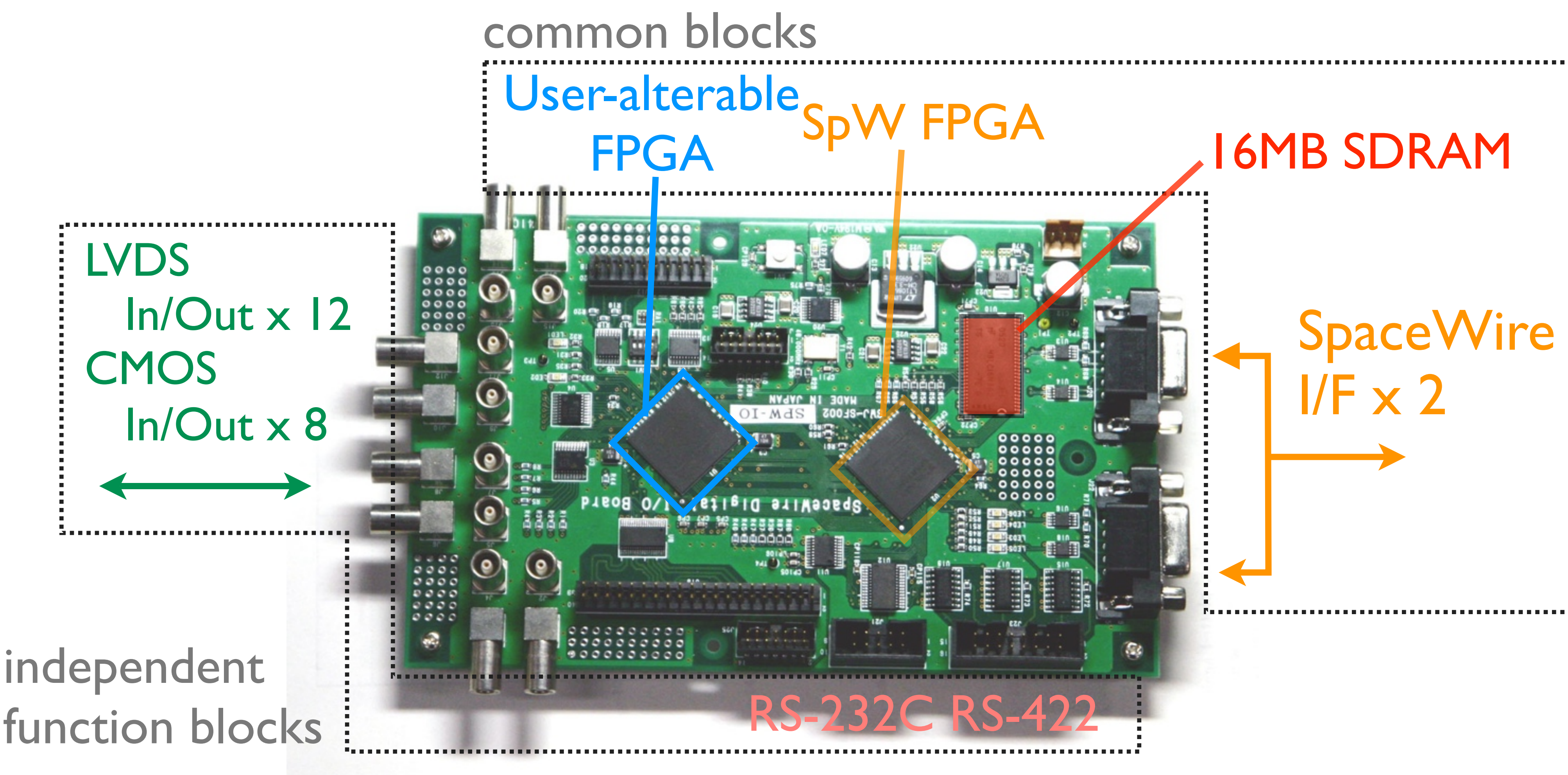
# SpaceCube by Shimafuji



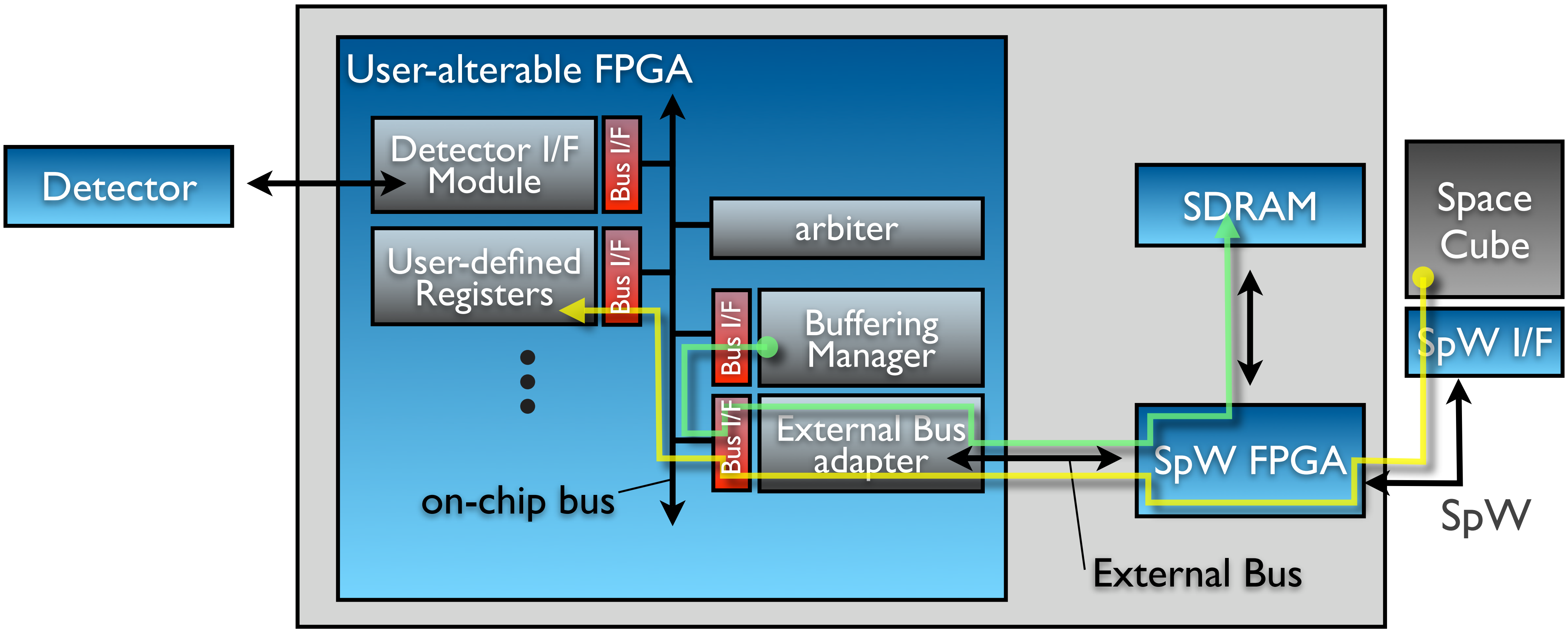
# SpaceWire IF board



# Internal block diagram of a User-alterable FPGA

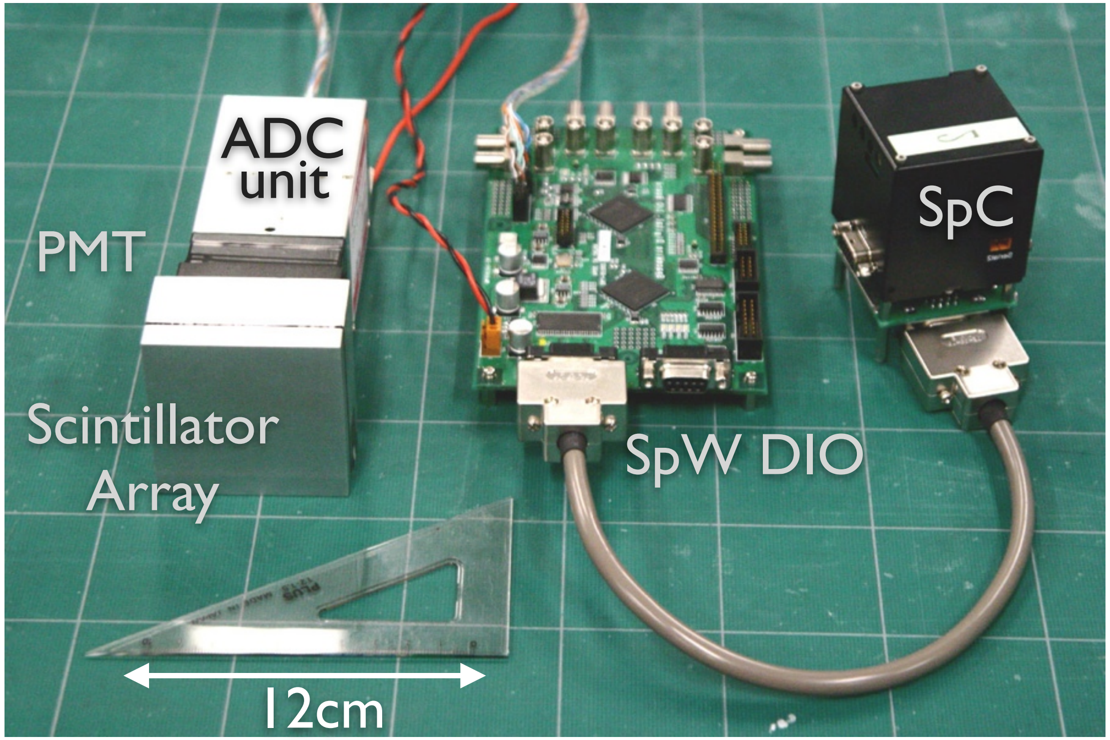
- Simple on-chip bus and External Bus for data transfer
- on-chip bus arbiter, bus i/f, External Bus adapter are prepared

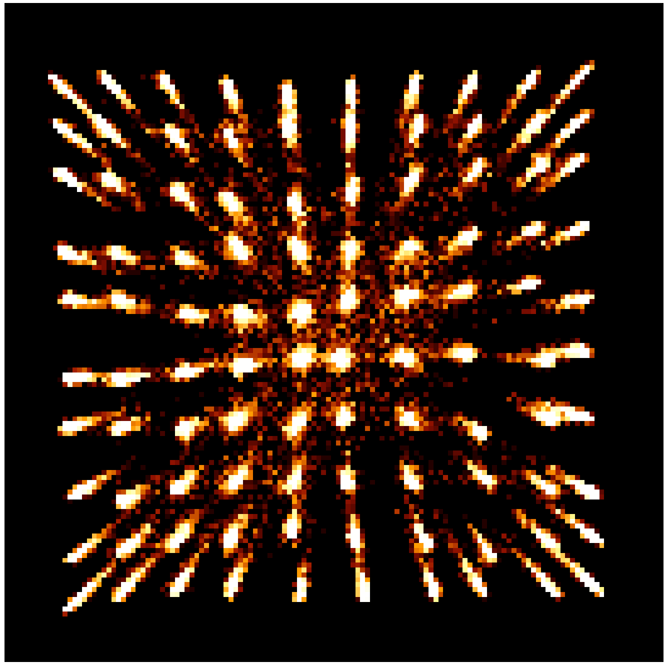
- on-chip bus : ~10Mbps@50MHz clock
- External Bus : ~64Mbps@50MHz clock




Circuit board with SpaceWire I/F

# Test implementation of the framework





# Eliminated Slides

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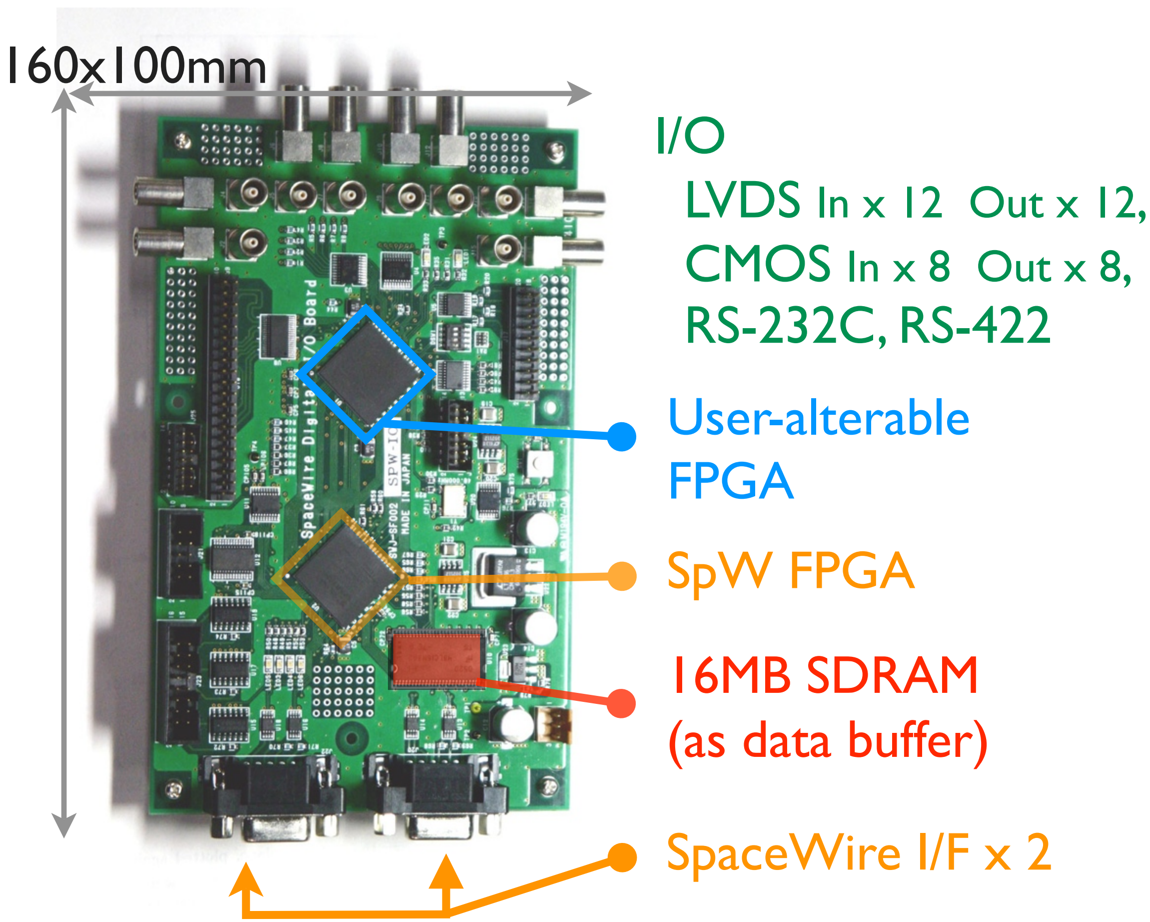


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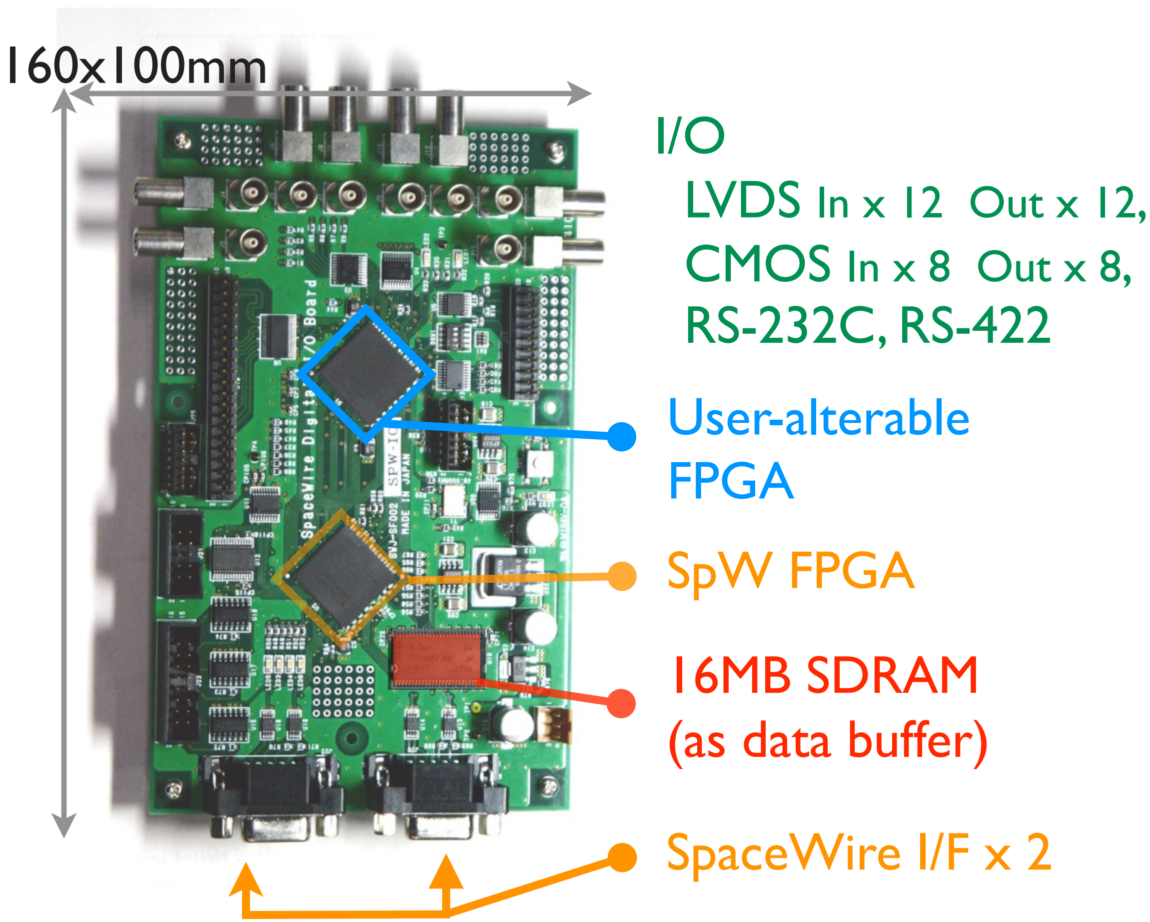


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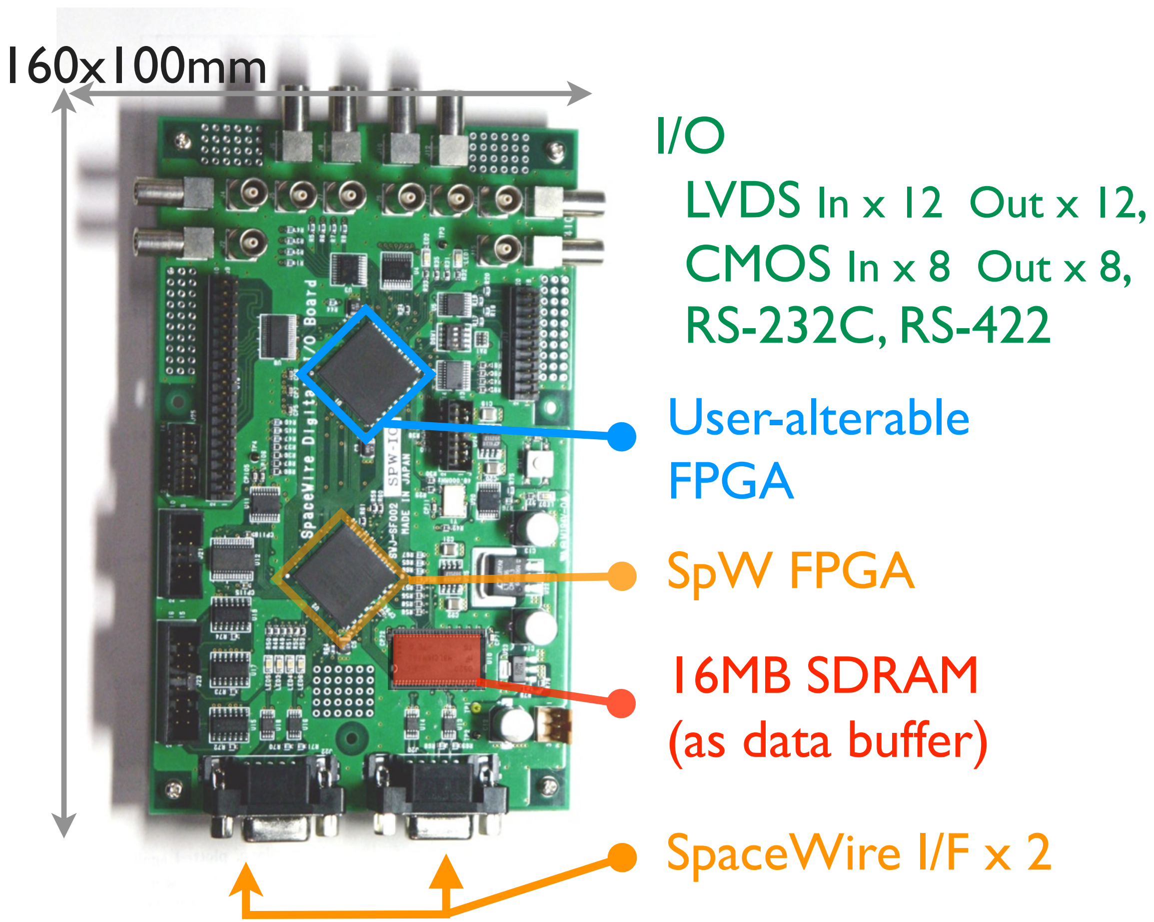


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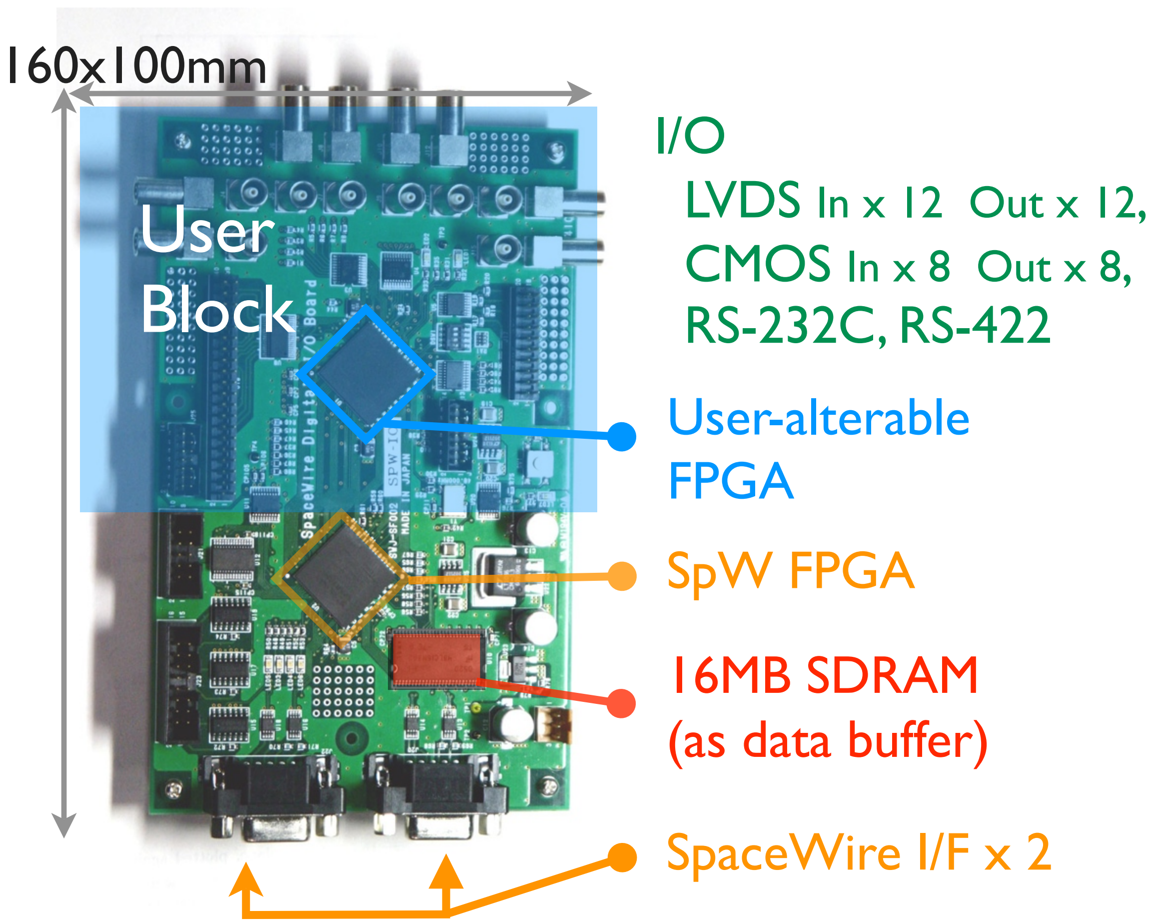


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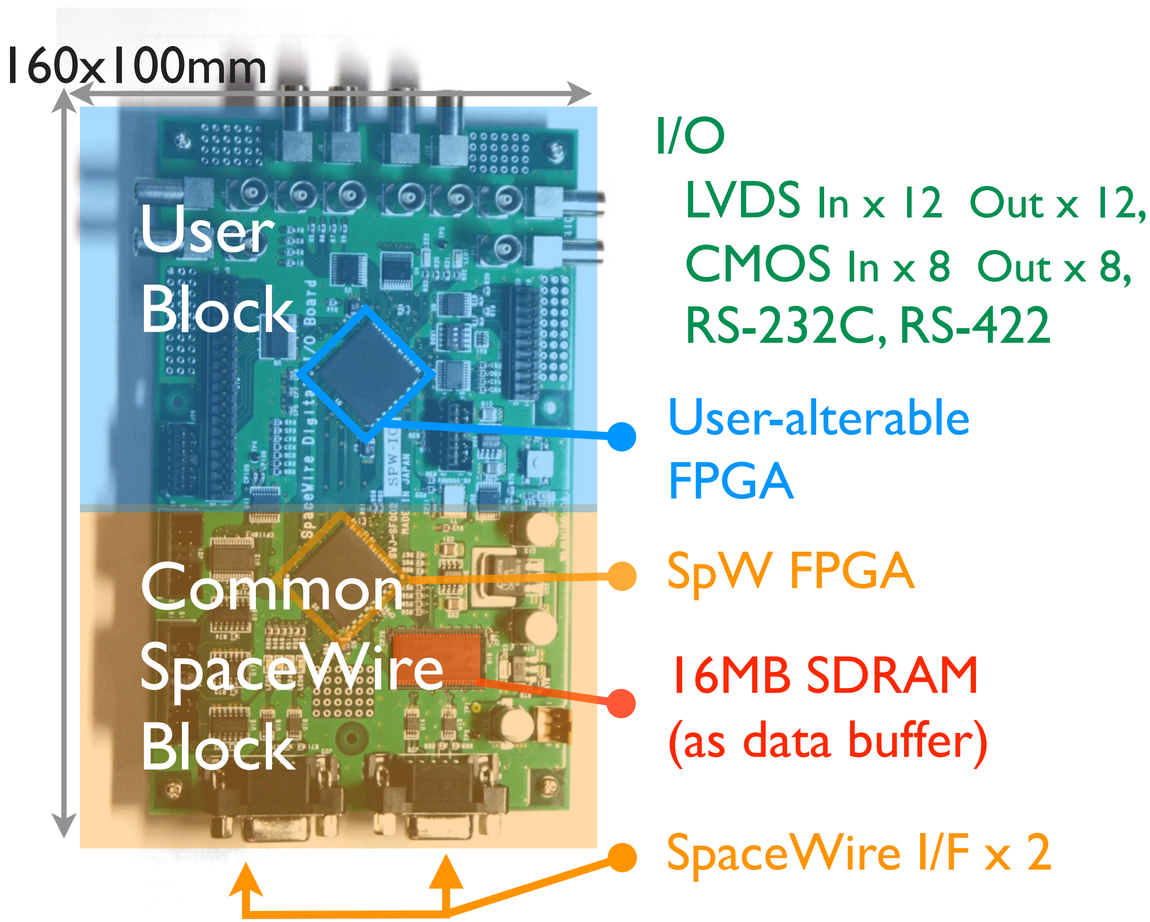


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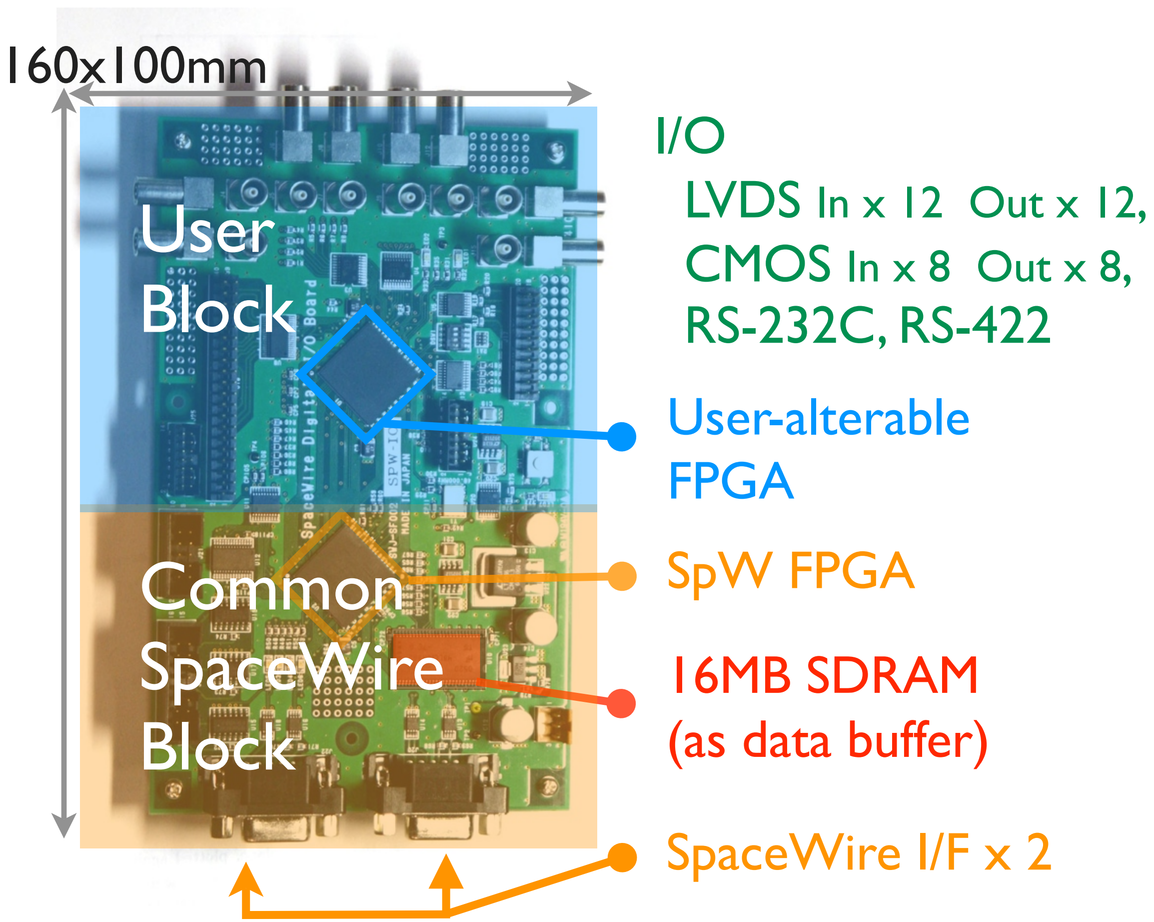


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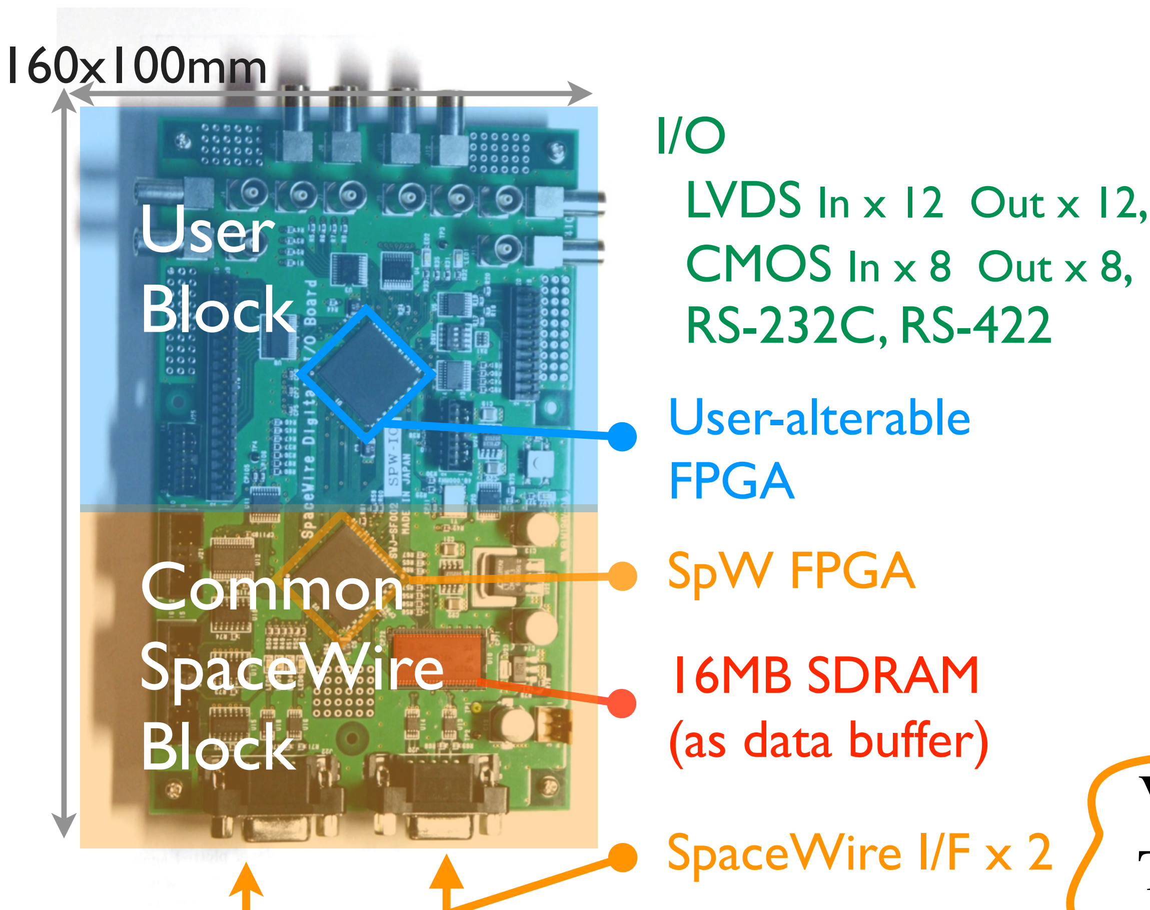


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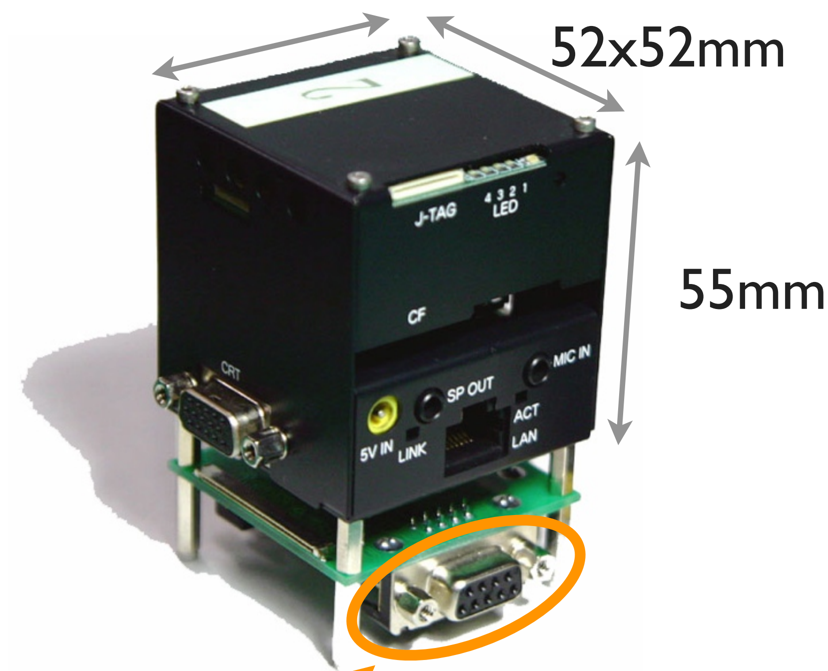


VR5701(MIPS core) 200-300MHz, TRON OS, 64MB RAM, LAN, SpaceWire I/F x3, stereo audio, RS232C

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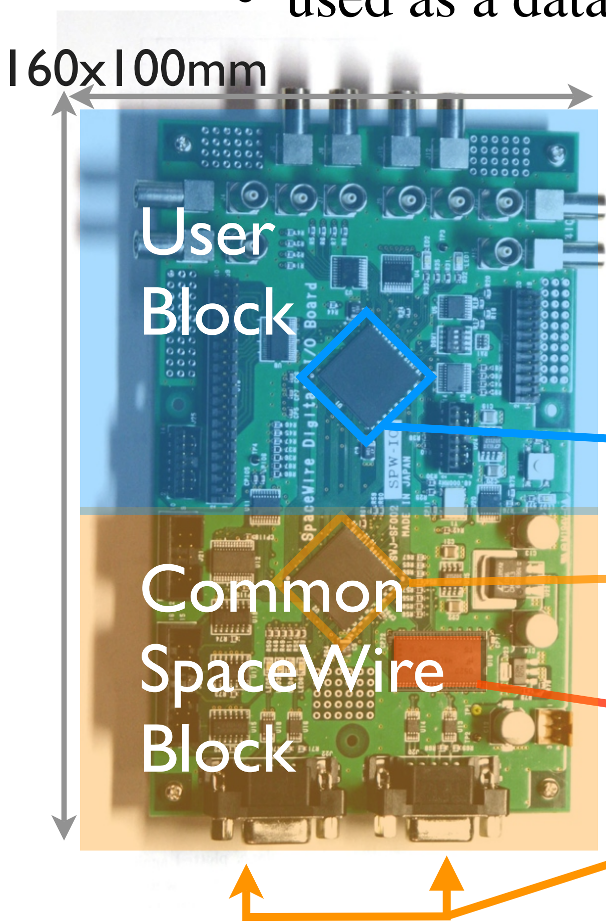
  - used as a data handler and detector controller.

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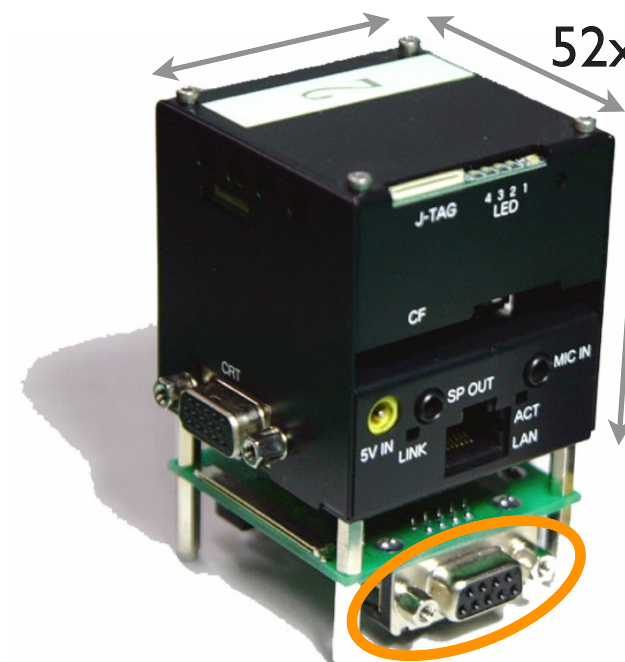


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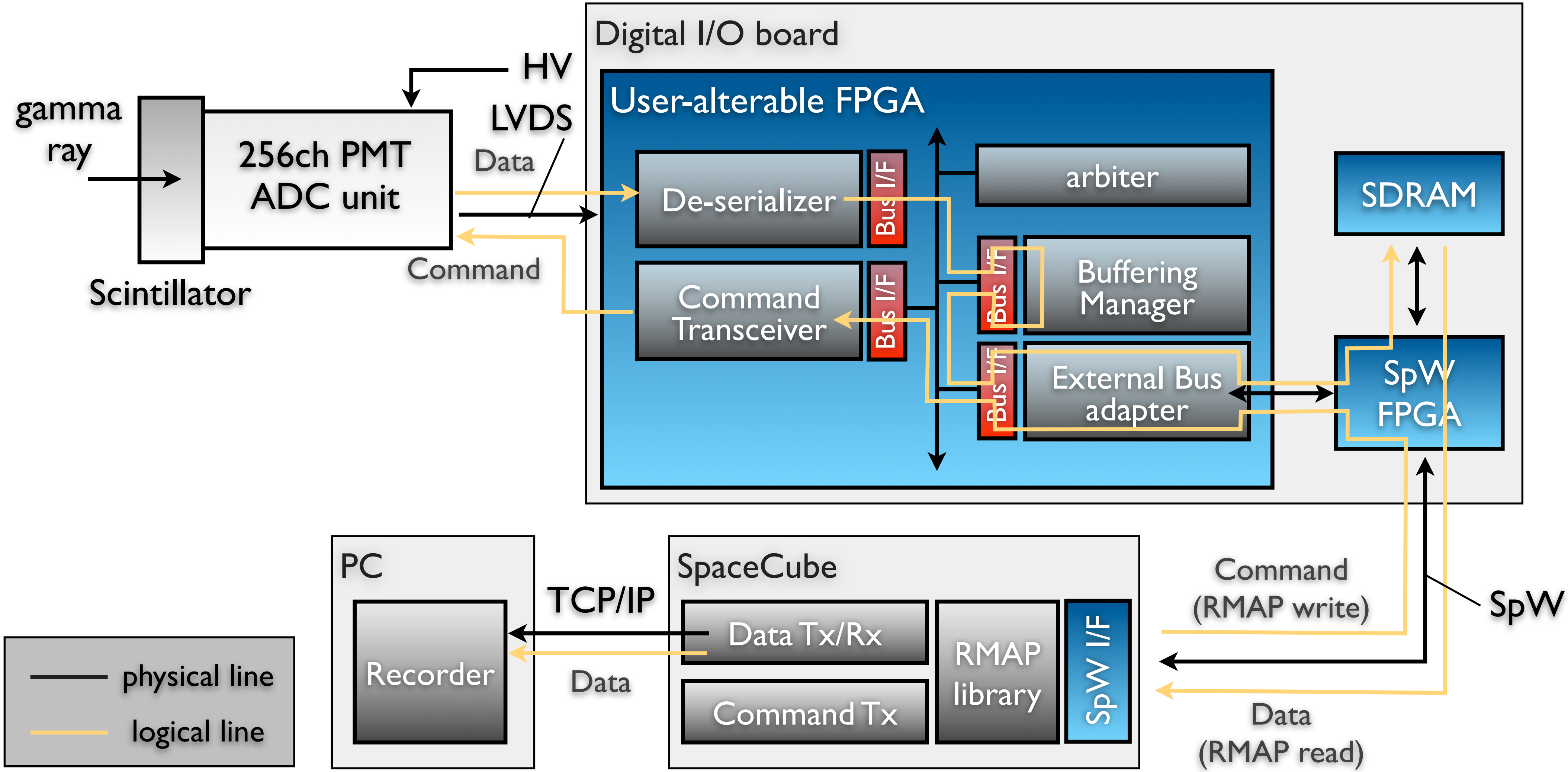
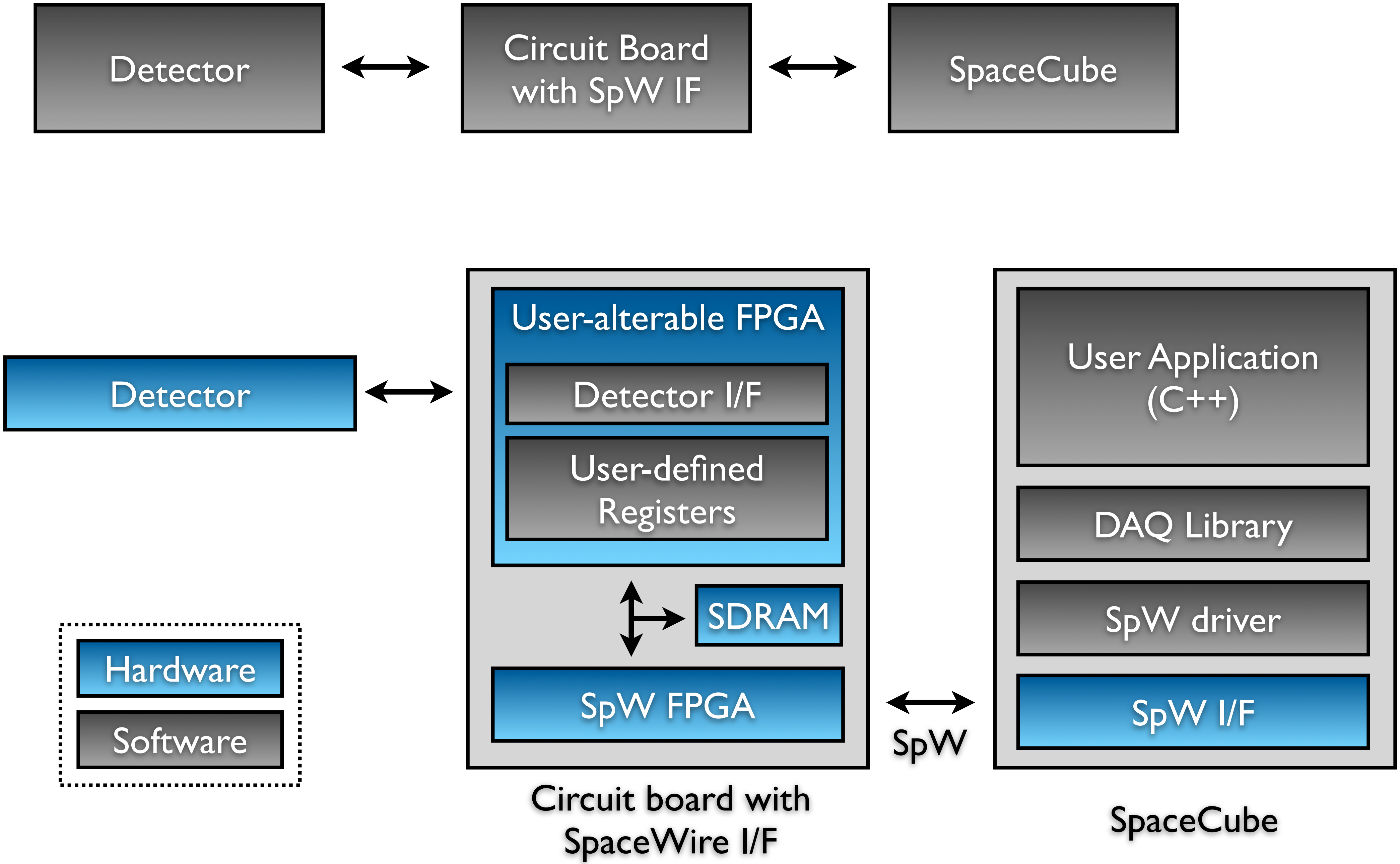
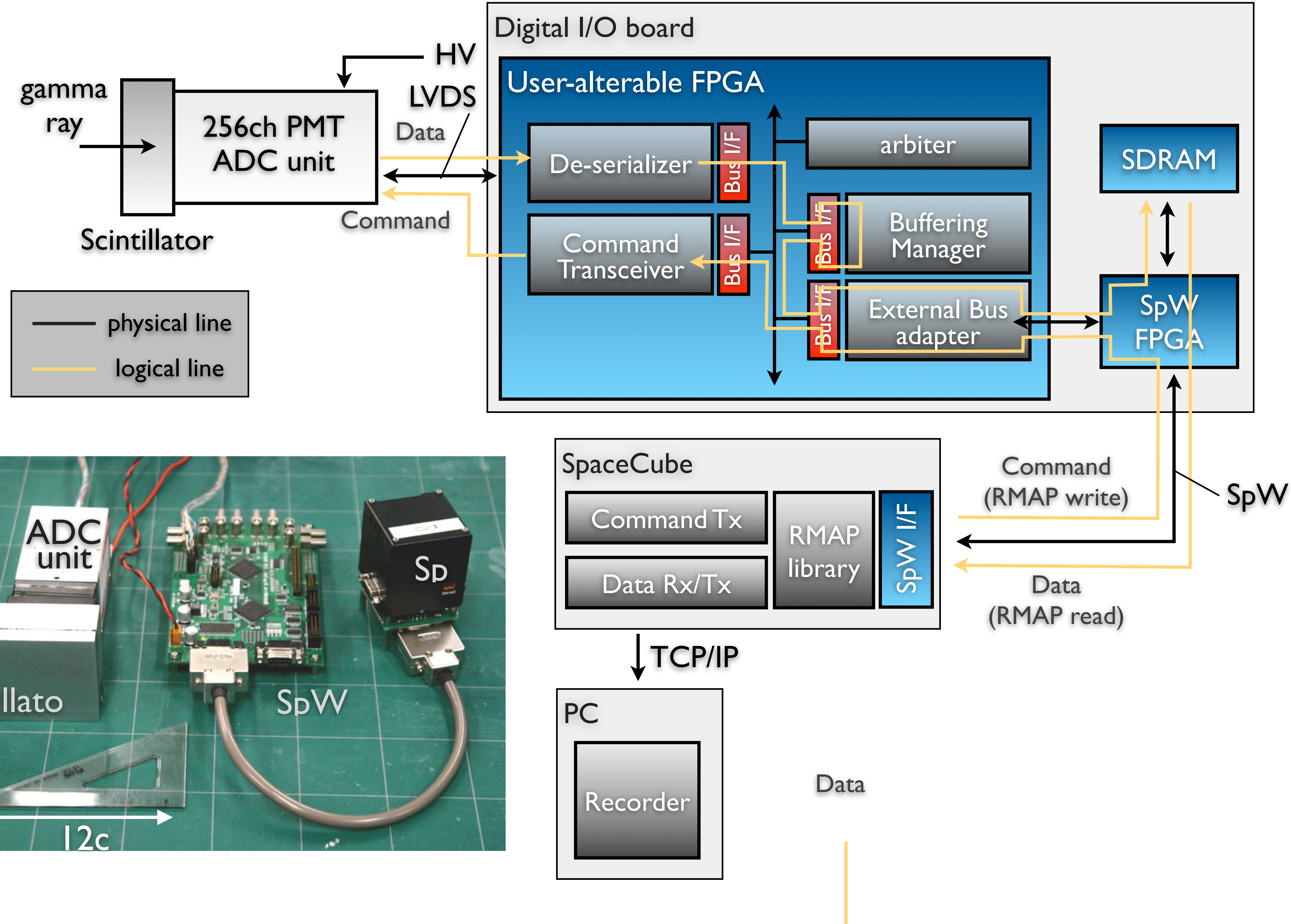


gamma ray
Scintillator
256ch PMT ADC unit
HV
LVDS
Data
Command
Digital I/O board
User-alterable FPGA
De-serializer
Bus I/F
Command Transceiver
Bus I/F
arbiter
Bus I/F
Buffering Manager
Bus I/F
External Bus adapter
SDRAM
SpW FPGA
PC
Recorder
TCP/IP
Data
SpaceCube
Data Tx/Rx
Command Tx
RMAP library
SpW I/F
Command (RMAP write)
SpW
Data (RMAP read)
physical line
logical line



Detector
Circuit Board with SpW IF
SpaceCube
Detector
User-alterable FPGA
Detector I/F
User-defined Registers
SDRAM
SpW FPGA
SpW
User Application (C++)
DAQ Library
SpW driver
SpW I/F
Hardware
Software
Circuit board with SpaceWire I/F
SpaceCube



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SDRAM
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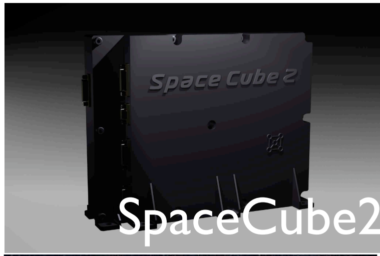
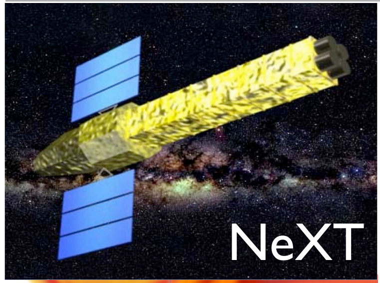
SpaceCube
Command Tx
Data Rx/Tx
RMAP library
SpW I/F
Command (RMAP write)
SpW
Data (RMAP read)
TCP/IP
PC
Recorder
Data
ADC unit
Sp
SpW
llato
12c

# Usage in other experiments

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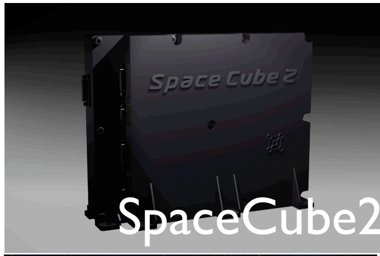


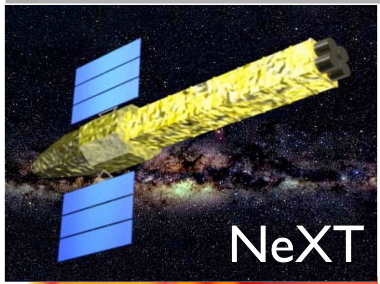


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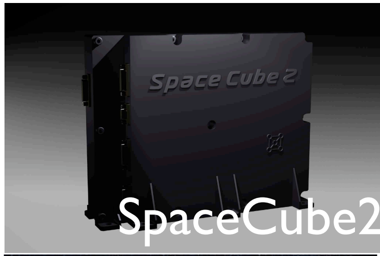


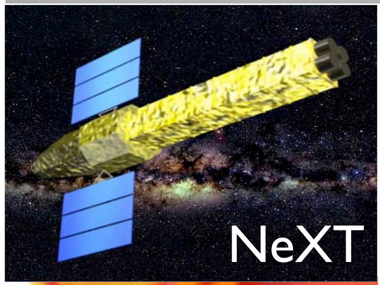


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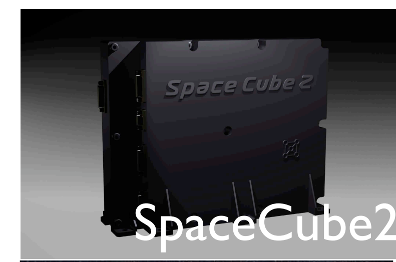


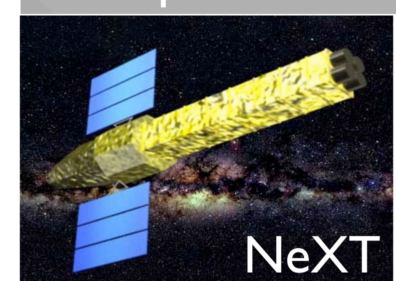


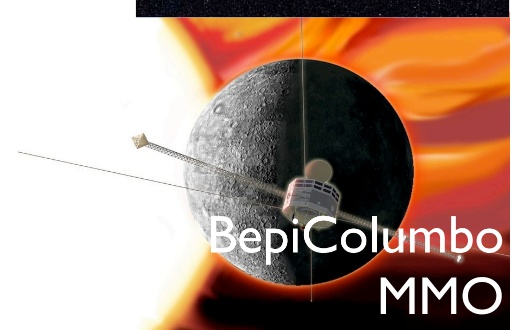

# Usage in other experiments

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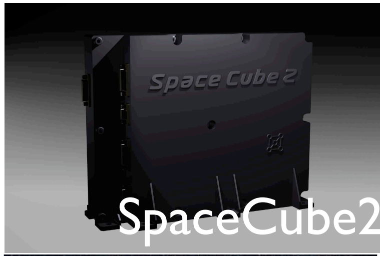

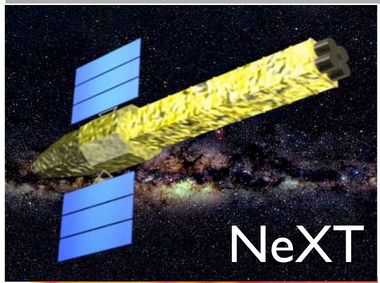

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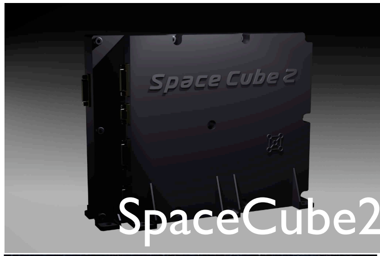


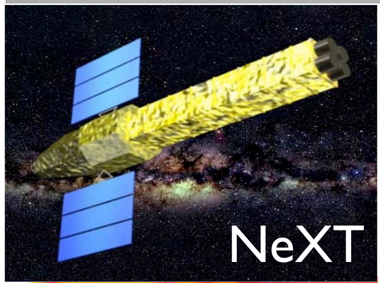


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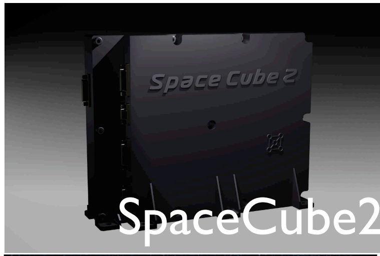


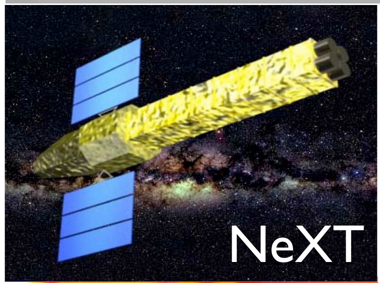


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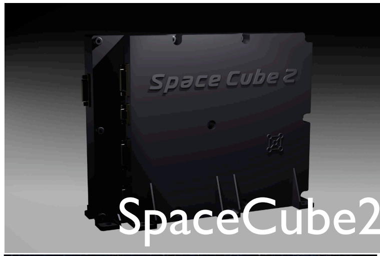


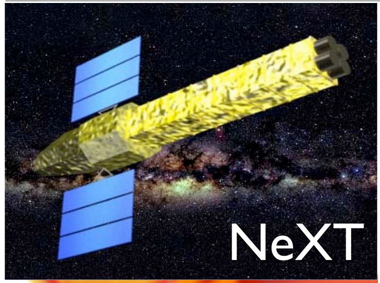


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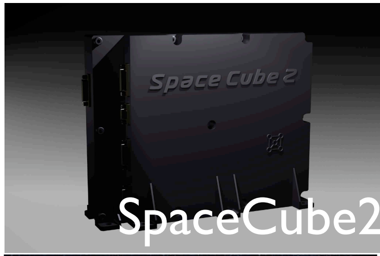


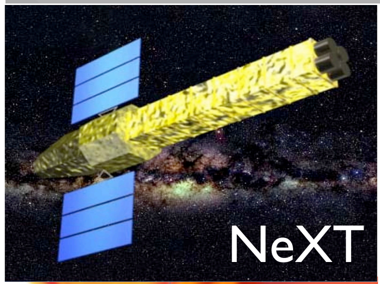


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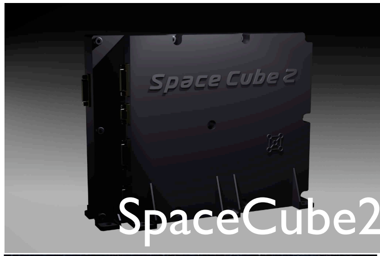


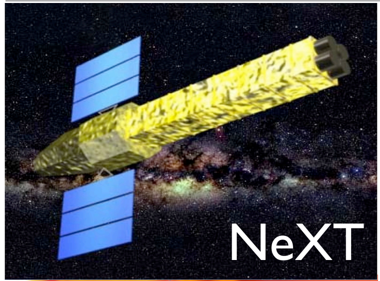


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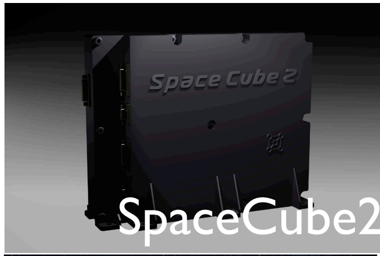

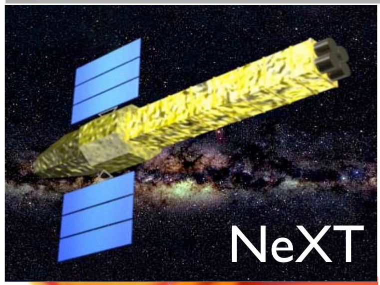

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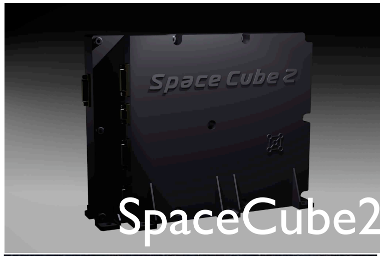
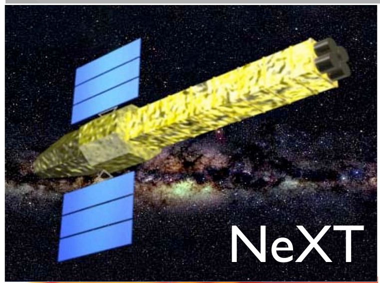
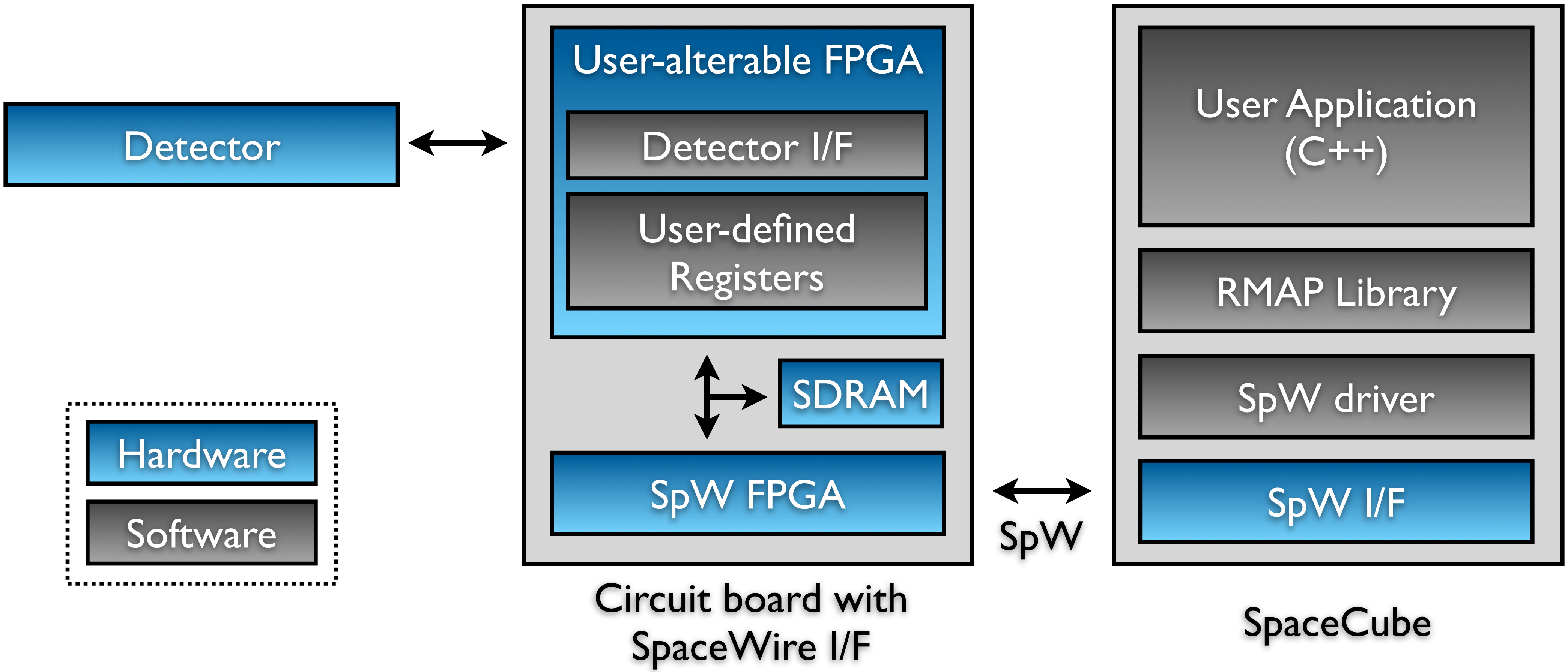
  - Mercury Magnetospheric Orbiter





Detector
User-alterable FPGA
Detector I/F
User-defined Registers
SDRAM
SpW FPGA
SpW
Circuit board with SpaceWire I/F
User Application (C++)
RMAP Library
SpW driver
SpW I/F
SpaceCube
Hardware
Software