

US-Japan Beam Monitor Workshop: XRM - RFSoc based Readout

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U.S. DEPARTMENT OF
ENERGY

Stanford
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ACCELERATOR
LABORATORY

- Successfully demonstrated BOR based on RFSoc technology
 - DOI: [10.1088/1748-0221/19/12/P12026](https://doi.org/10.1088/1748-0221/19/12/P12026)
 - Refer to Riku's talk later today
- Mitsuka-san ask if it would be possible to implement RFSoc technology to XRM application as well.
- This talk to present a **design concept** for a RFSoc readout for the XRM
- RFSoc readout is not the current “baseline” design
 - Matt Andrew presented the baseline design in earlier talk

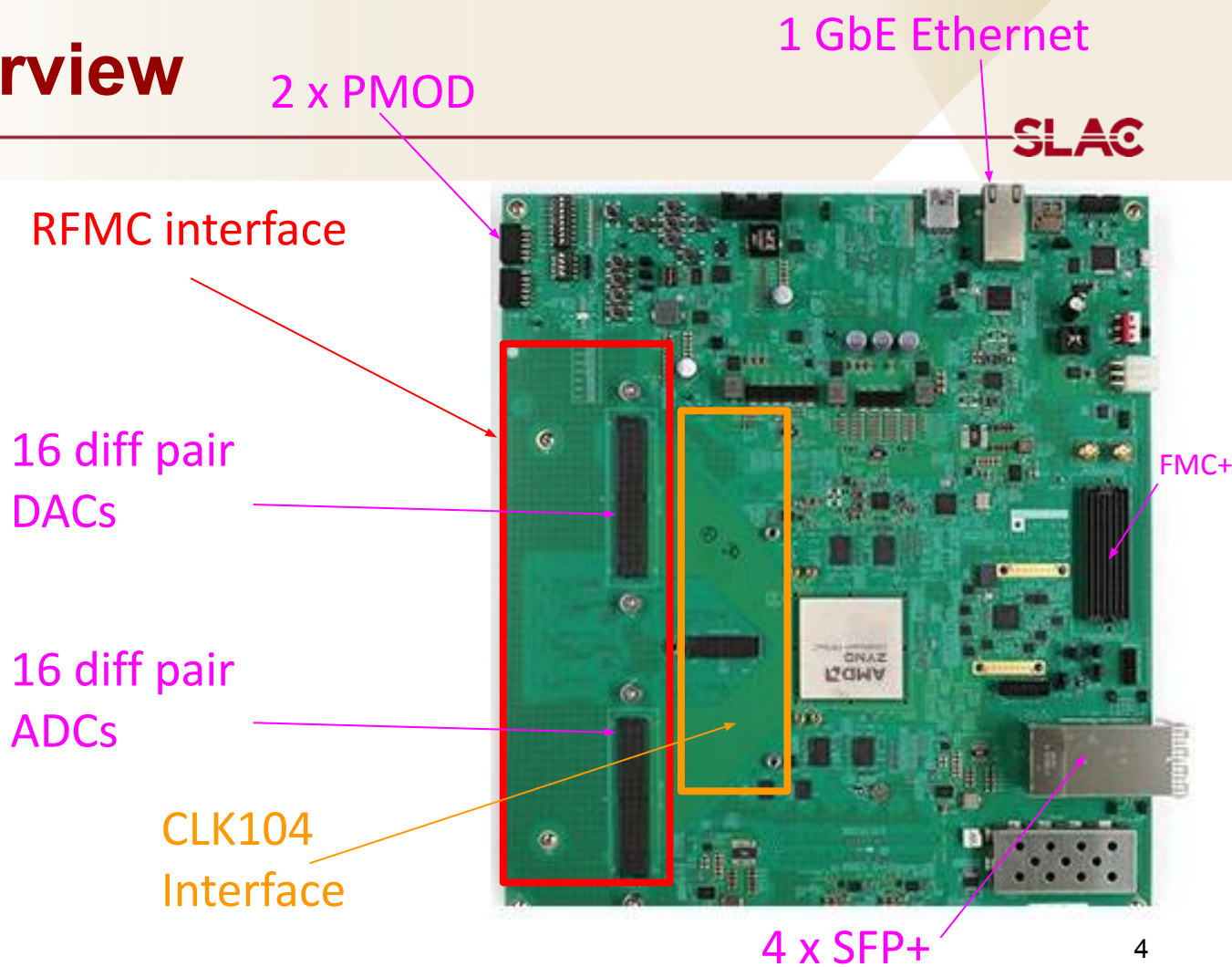
“High Level” XRM Requirements and Constraints

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- Due to **export restrictions** of RFSoc (**ECCN = 5A002.A.4**) and lack of funds to build custom RFSoc PCB, need the ability to buy the RFSoc using standard AMD/Xilinx development boards from a standard distributor
 - Dev boards: ZCU208, ZCU216, etc
- For these AMD/Xilinx development boards, the existing AMD/Xilinx RFMC balun board and AMD/Xilinx CLK104 (“clocking”) board do not meet requirements for applications
 - Not enough balun channels, wrong VCO frequency on CLK104 board, etc
- RFSoc dev board solution need to support 64 XRM channels (or more)
 - Targeting multiple AMD/Xilinx ZCU216 development board
 - ZCU216 has 16 input analog channels per board
- Need to synchronize multiple RFSoc dev boards to each other

ZCU216 Overview

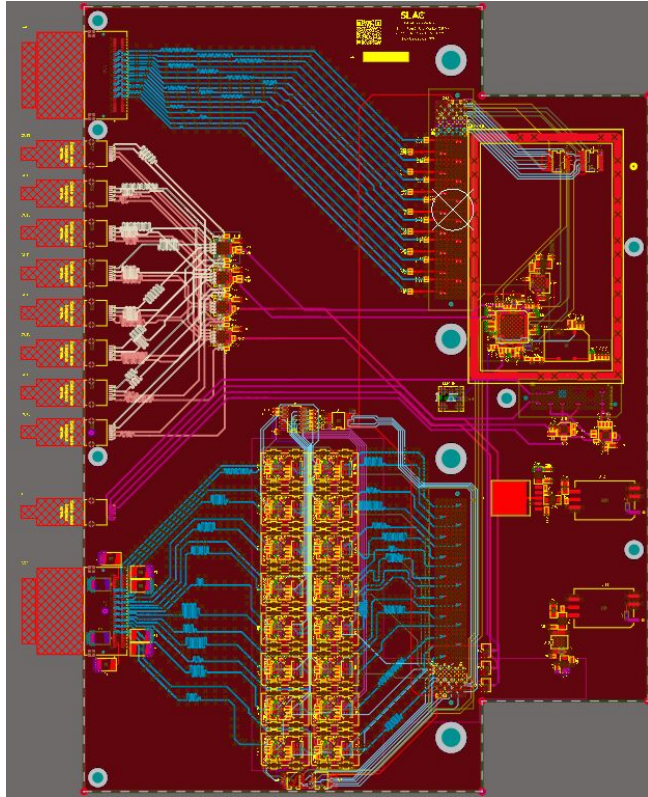
14-bit, 2.5GSPS RF-ADC	16
14-bit, 9.85GSPS RF-DAC	16
Max. RF input Frequency (GHz)	6
System Logic Cells (K)	930
Memory (Mb)	60.5
DSP Slices	4,272
33G Transceivers	16
Maximum I/O Pins	408



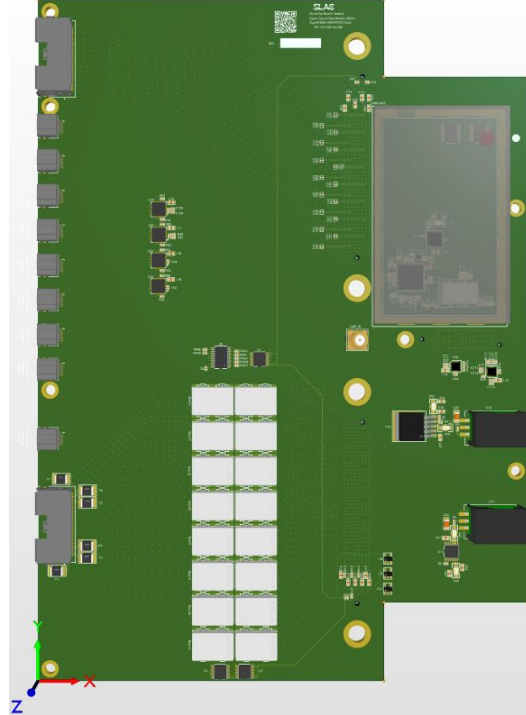
SLAC has developed a Custom RFMC/CLK Daughter card

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2D View

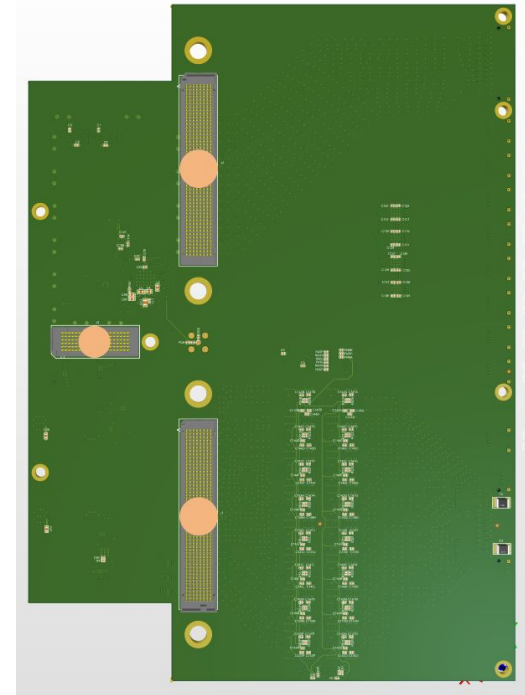


Top View



3D View

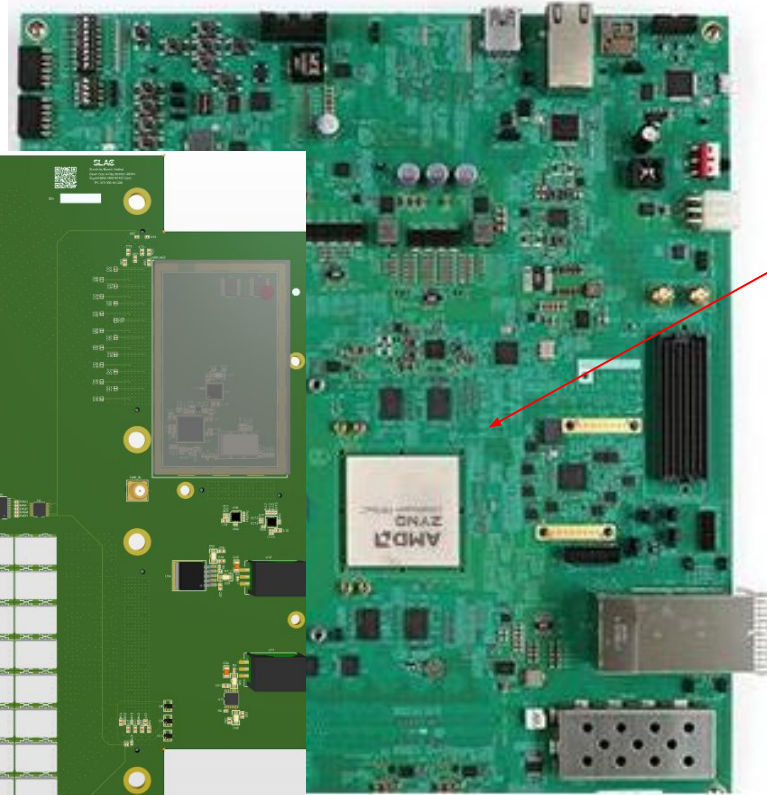
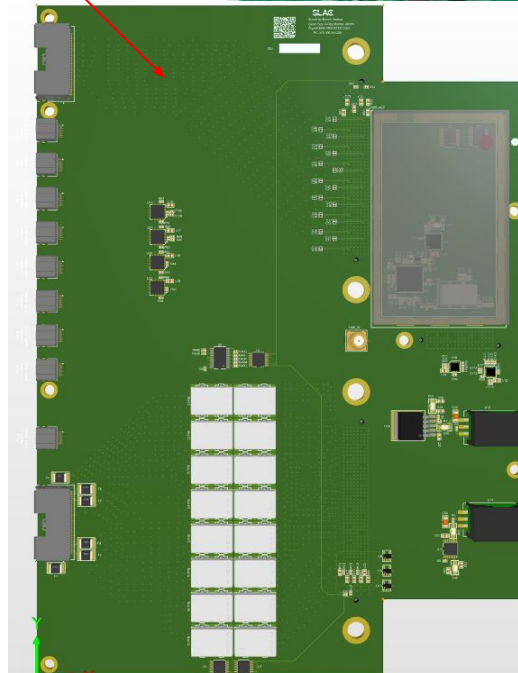
Bottom View



RFMC/CLK Daughter card + ZCU216

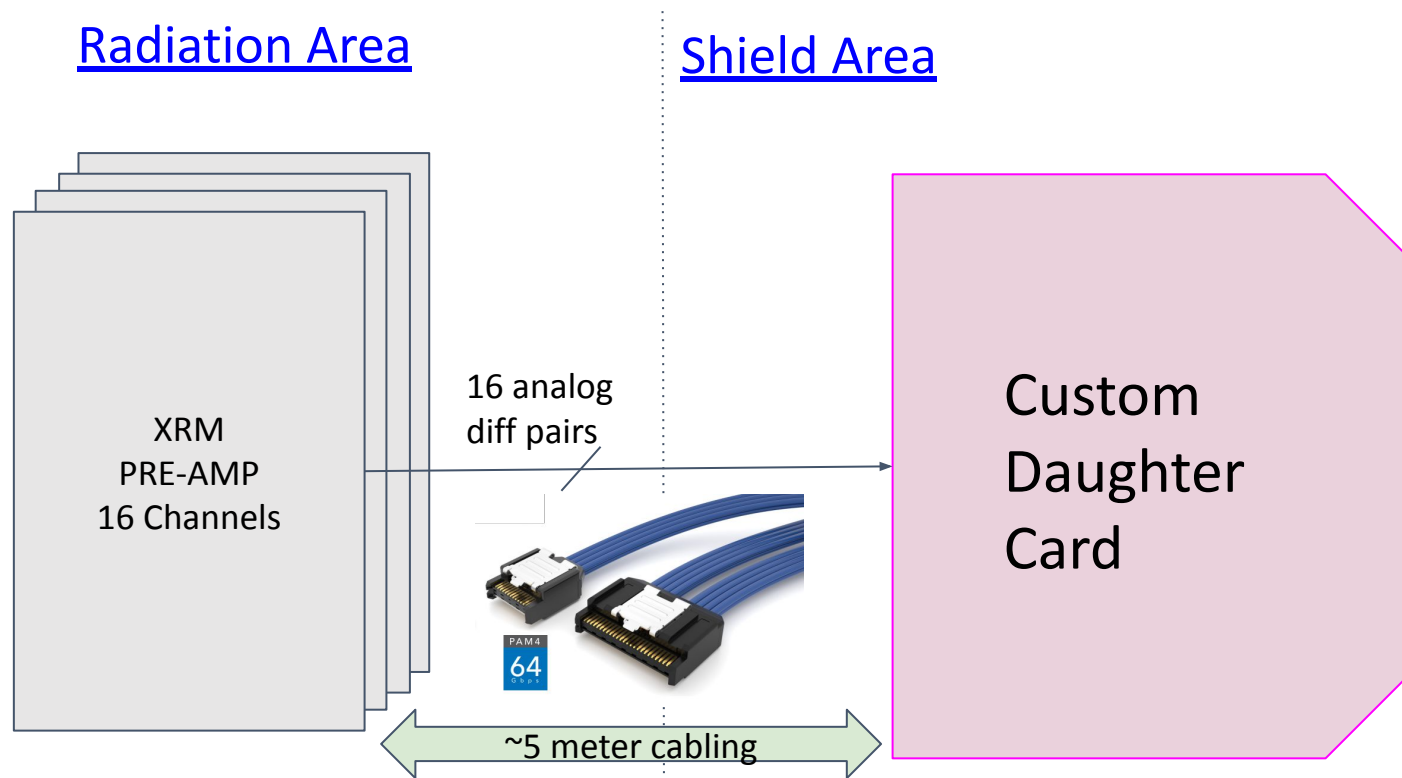
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RFMC/CLK

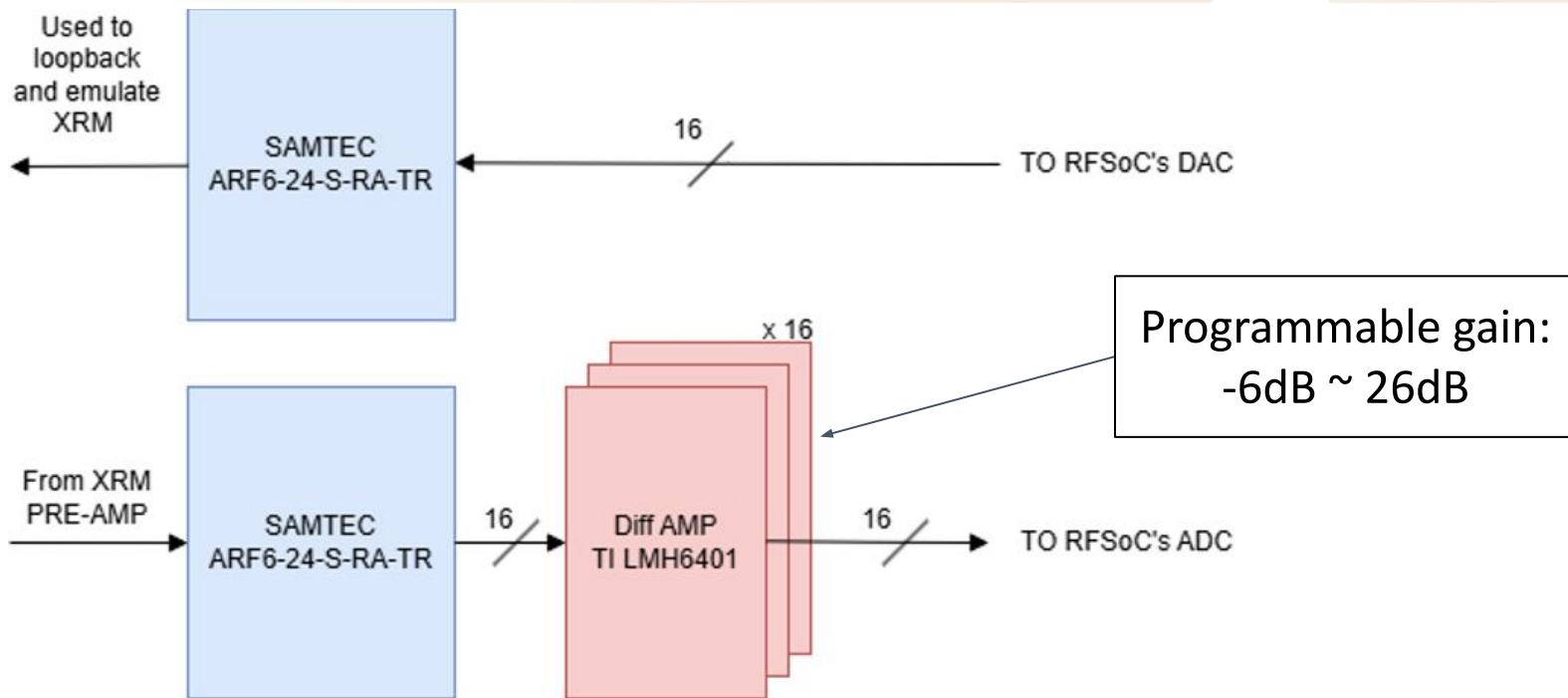


ZCU216

Custom RFMC/CLK Daughter card

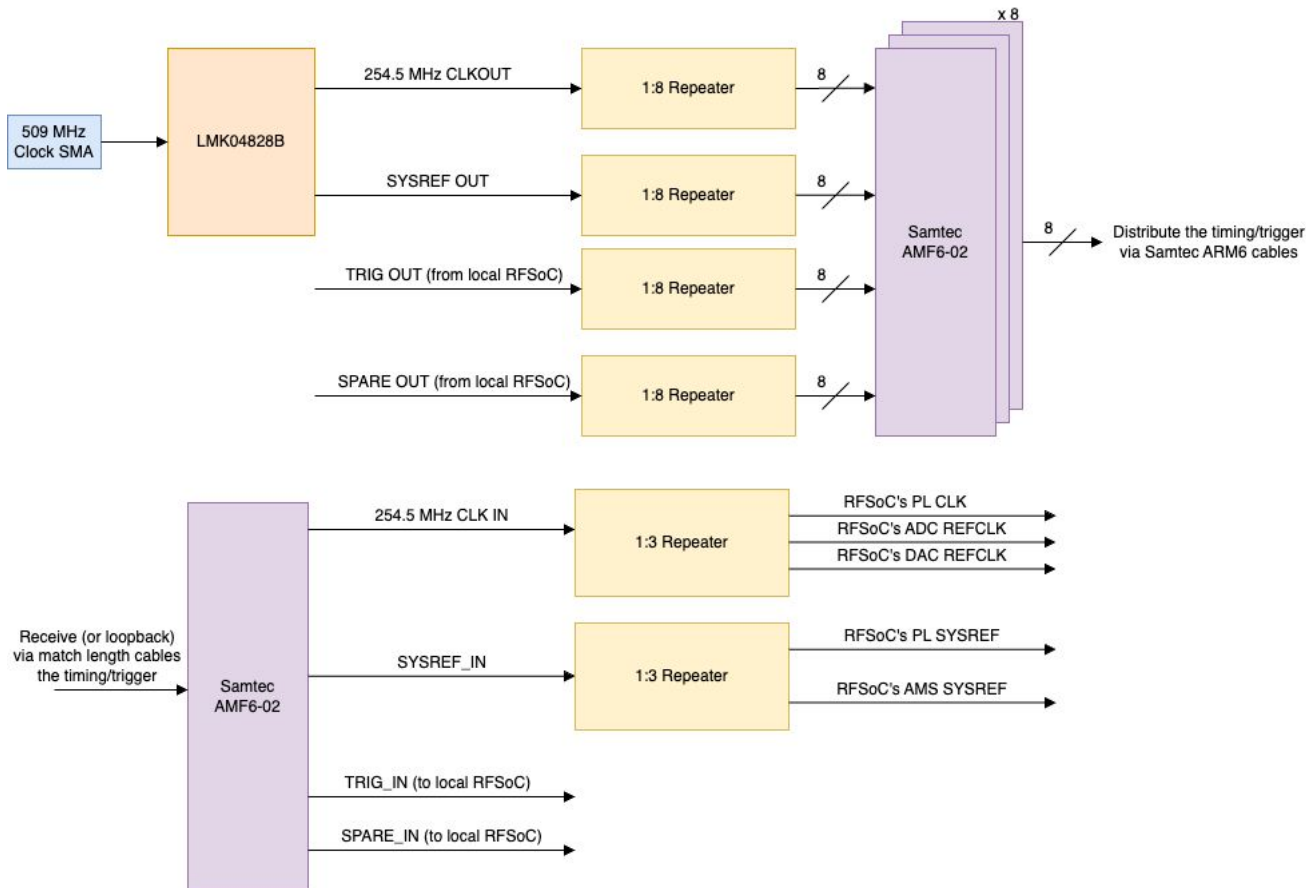


Daughter Card: Analog In/Out



- Use “Samtec ARC6 cable” to connect PRE-AMP to RFMC card
- Confirmed that custom length (e.g. 5m) is possible with Samtec rep

Daughter Card: Timing Distribution



Daughter Card: Timing Distribution Cabling

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Comments/Questions/Discussion (1 of 2)

- Redesign of the PRE-AMP board required to match the Samtec ARF6-24 interface
- RFMC can provide power to PRE-AMP to simplify cabling
- Compatible with ZCU208 in case we learn that 2036 MSPS sampling is not fast enough
 - ZCU208 is half the analog channels but twice as faster (up to 5GSa/s ADCs)
- Compatible with 128 channels using ZCU216 in case we learn 64 channels is not enough
- Design is not “**cost optimized**” yet
 - Possible saving (e.g. use cheaper dielectric material)
- We need to establish a Cooperative Research and Development Agreement (**CRADA**) if we share this PCB design build files with UHM or KEK
 - Confirmed that a CRADA was not established in the US-Japan proposal

Comments/Questions/Discussion (2 of 2)

- A **formal schematics and layout review** of XRM RFMC should be performed before manufacturing
- We can recycle a lot of the firmware/software already developed from BOR effort
 - <https://github.com/slaclab/kek-bpm-rfsoc-dev>
- Do we need to trigger each ZCU216 from an external source (e.g. Belle2Link fiber link, beam abort TTL, etc) or do we need to form triggers locally?
- We can delivery power from the RFSoc to the PRE-AMP board. What voltages should we provide? Or none at all?
- How do we want to proceed?