



XARAPUCA Production Process, QA/QC, Lessons Learned

DUNE FD2 FINAL DESIGN REVIEW, APRIL 2023

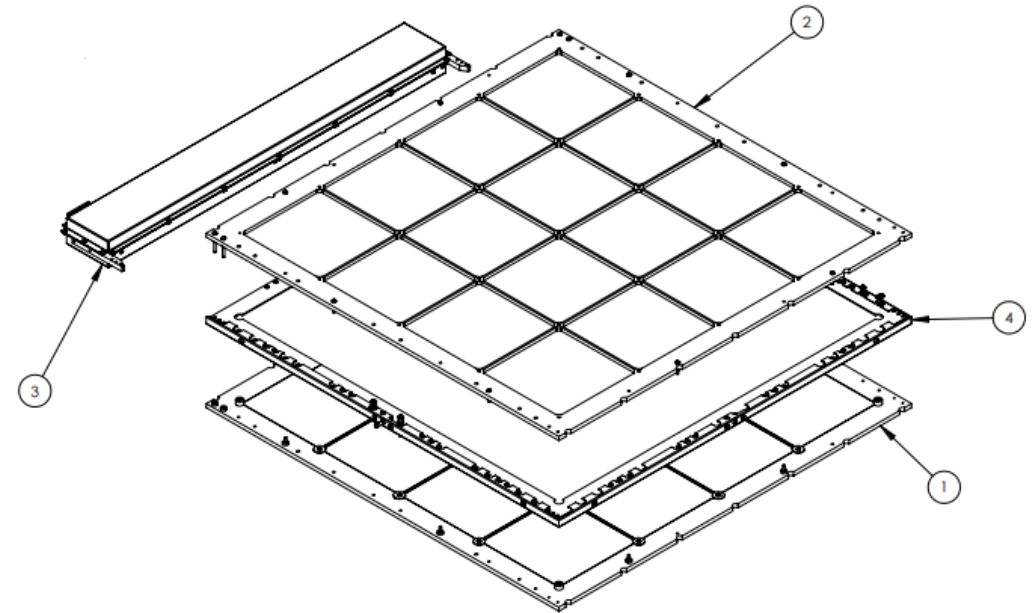
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Outline

- Design and assembly overview
 - Modular design, to allow fabrication and test of subcomponents
 - Minimize time and labor at SURF
- Design lesson's learned during Coldbox runs and Module 0 preparations
- Fabrication and shipping lessons learned
- Fabrication & QC plans for DUNE
- Conclusion

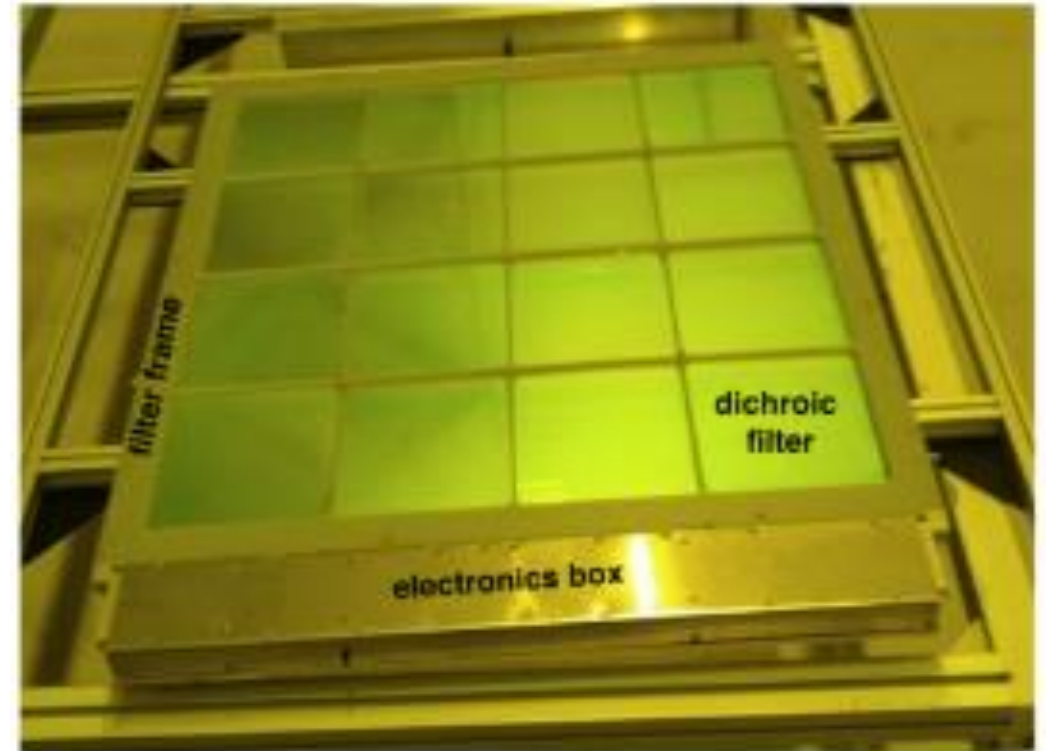
XARAPUCA Design and Assembly

- Design for manufacturability
- To produce subassemblies that are easy to assemble at SURF
- These are the:
 - Module core which houses the WLS plate, photosensors, and electronics
 - 1 or 2 filter frames
 - A backplate for the Membrane Mounted XARAPUCAs
- Each can be prepared and assembled and shipped separately for final assembly at SURF



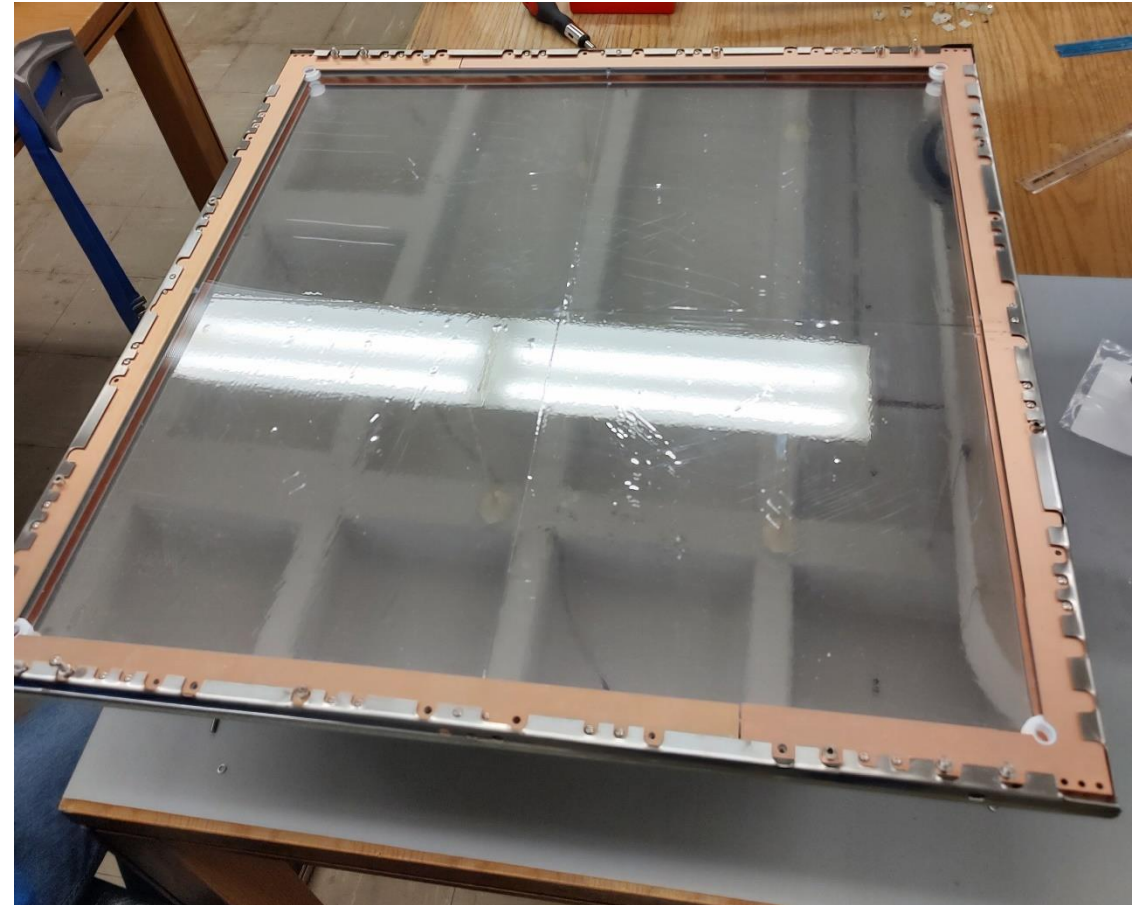
X-ARAPUCA Module 0 Design Lessons Learned

- Module 0 Design guided by feedback from coldbox
- Iterative improvements based on feedback from coldbox runs
- For ProtoDUNE II FD2 partial assembly was done at NIU
- Final assembly, testing and installation done at CERN (including WLS, cables, flex circuits and dichroic filters)



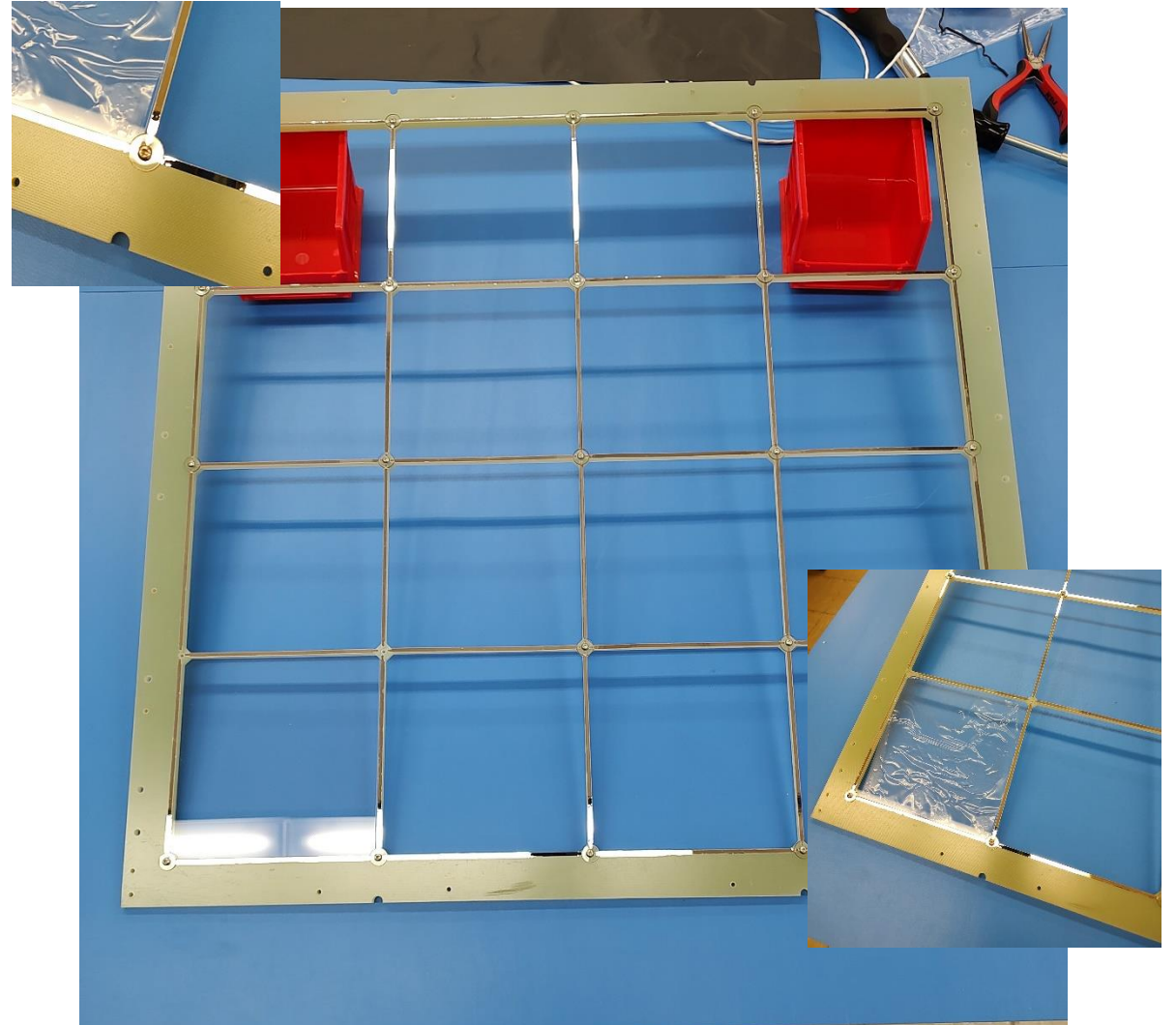
Module Core

- The core and frame pieces designed to be able to be fabricated and shipped separately
- The module core is built around WLS plate, copper clad G10 pieces and spring loaded SIPM backbone, perimeter board, and pocket strips
 - C-channels and electronics box to hold cables and cold electronics
- Original design had the springs on standoffs that were screwed into the backbone with lockwashers - switched to using loctite to fix the standoffs in place (AA326 + SF7649 recommended by FD1 experience)
- Pocket strip added with slot for resistors and capacitors on back of flex circuit
- Needed to add Vikuiti between the SIPMs on the Flex Circuits



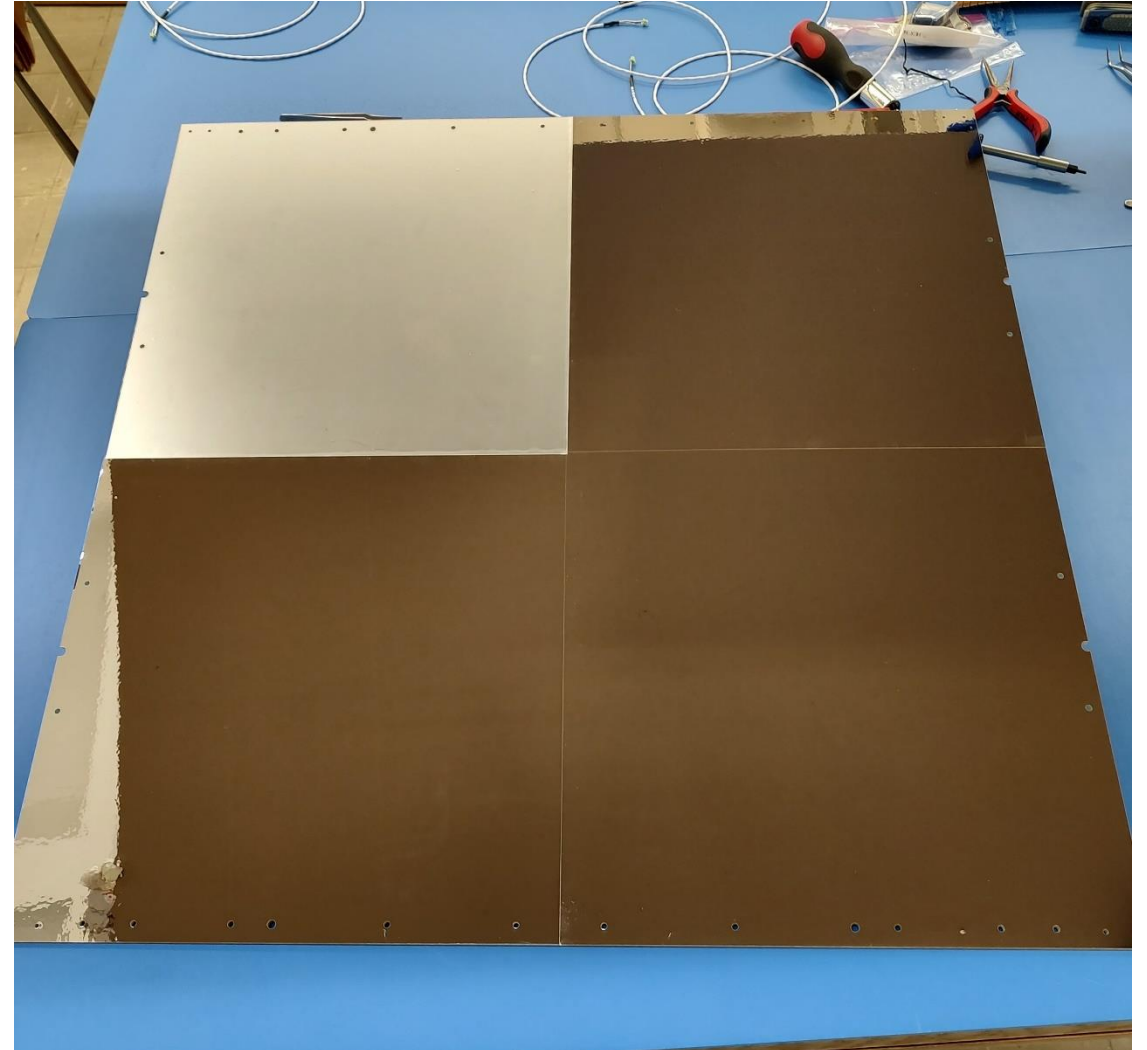
Dichroic Filter Frame

- For Module 0 XARAPUCAs Vikuiti strips were applied to the ribs of the filter frames
- Since Dichroic filters were not available we installed glass blanks in some of the XA to familiarize ourselves with filter installation and to test shipping.
- Most of the XA had screws and washers installed at the corners of the windows to make sure all the holes were threaded correctly



Membrane Mount XA Backplane

- For Membrane mounted xarapucas there is a solid backplane instead of filter frame
- This is covered by vikuiti, currently made out of four separate pieces.
- We had some problems with the Vikuiti delaminating after emersion in liquid Argon
 - Possibly due to too large Vikuiti pieces, overlap of Vikuiti pieces, presence of air bubbles on the Vikuiti, resence of frost when extracting the module due to inadequate warm-up, Too fast cooling down
 - We have ideas for long term solutions, such as vacuum laminating



Fabrication Plans

- All parts converge at assembly facility (NIU):
 - Frames and other G10 parts, WLS plates, Flex circuits, cables, electronics boxes, cold electronics boards
 - Module Core with electronics box will be assembled and tested warm
 - Frames are prepared with Vikuiti and shipped separately
 - It is efficient to assemble two or more XARAPUCA at a time
- Final assembly of frames with dichroic filters to be done inside SURF just before installation



QC Plans

- At NIU we are Constructing a test stand to perform warm testing of assembled Module Core for Cathode mounted XA
 - Use a combination of warm and cold electronics already available (DCEM and possibly Daphne)
 - Allow testing of SIPMs, Flex Circuits, and cables
 - Cold electronics will be tested before installation in electronics box
- Additional cold testing with electronics to be performed at CSU and Fermilab
- A center for fabricating Membrane Mount XA will be established in Europe

Conclusions

- Coldbox runs gave invaluable feedback for design iteration
- ProtoDune 2 Module 0 gave invaluable experience in assembly many XArapucas and real installation issues
- Plans for DUNE
 - Module Core with cold electronics will be fully assembled and warm tested and cold tested before shipping to SURF
 - Frames back panels without Dichroic Filters will be prepared with Vikuiti before shipping to SURF
 - Final assembly with Dichroic filters will be completed in a clean room at SURF

