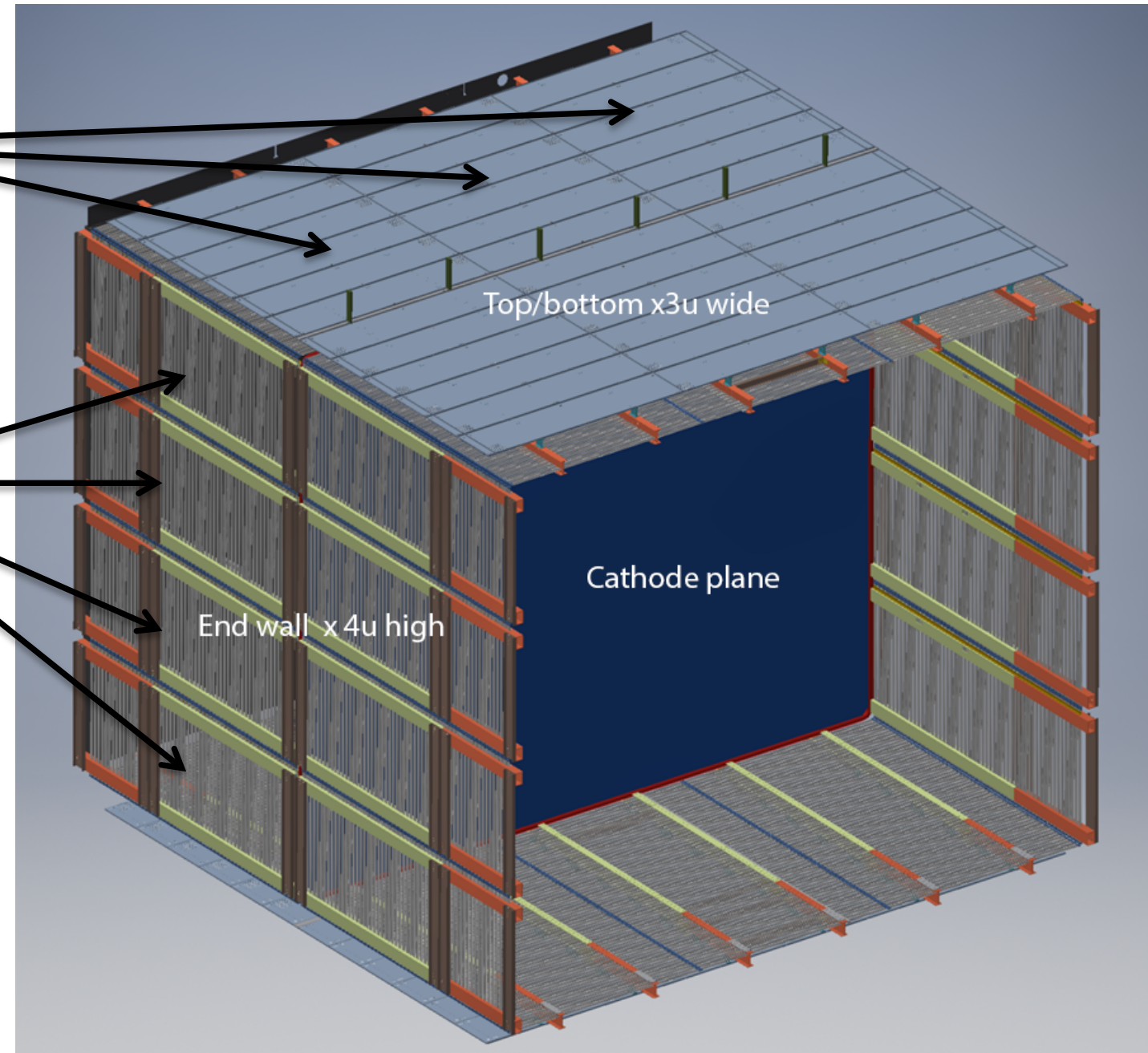


Top & Bottom Field Cage Assembly

Mike Wilking
Stony Brook University
Production Readiness Review
May 4th, 2017

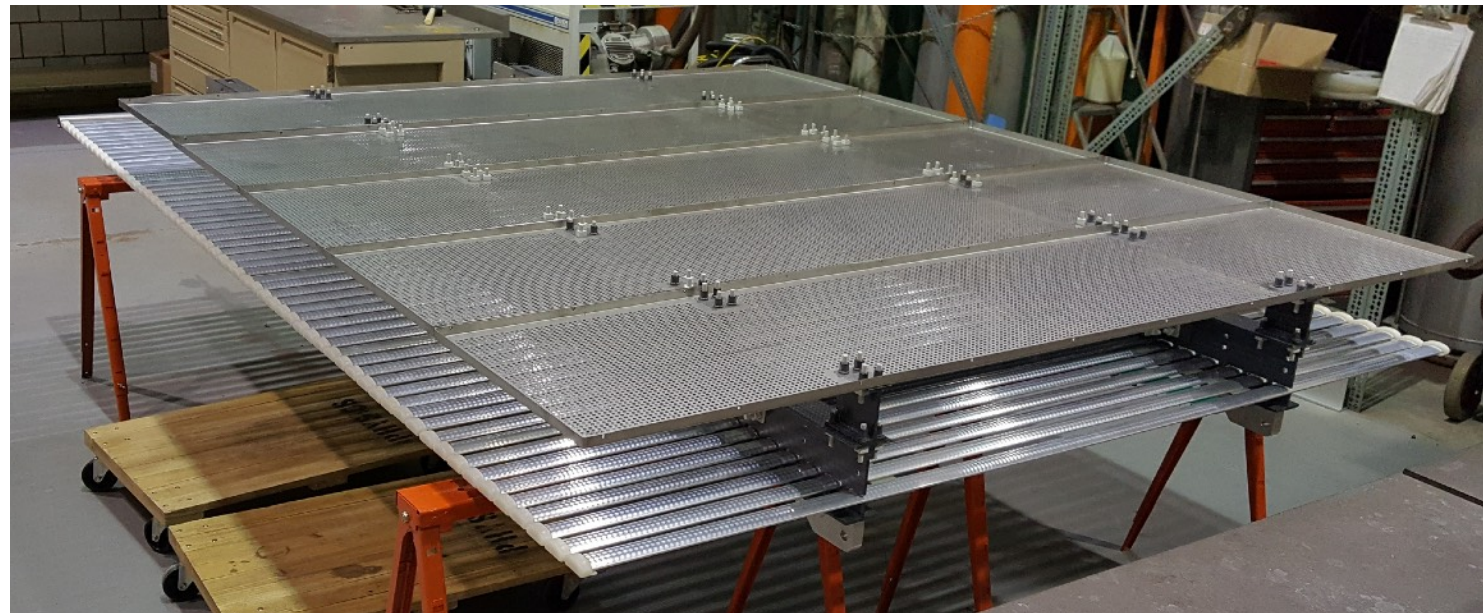
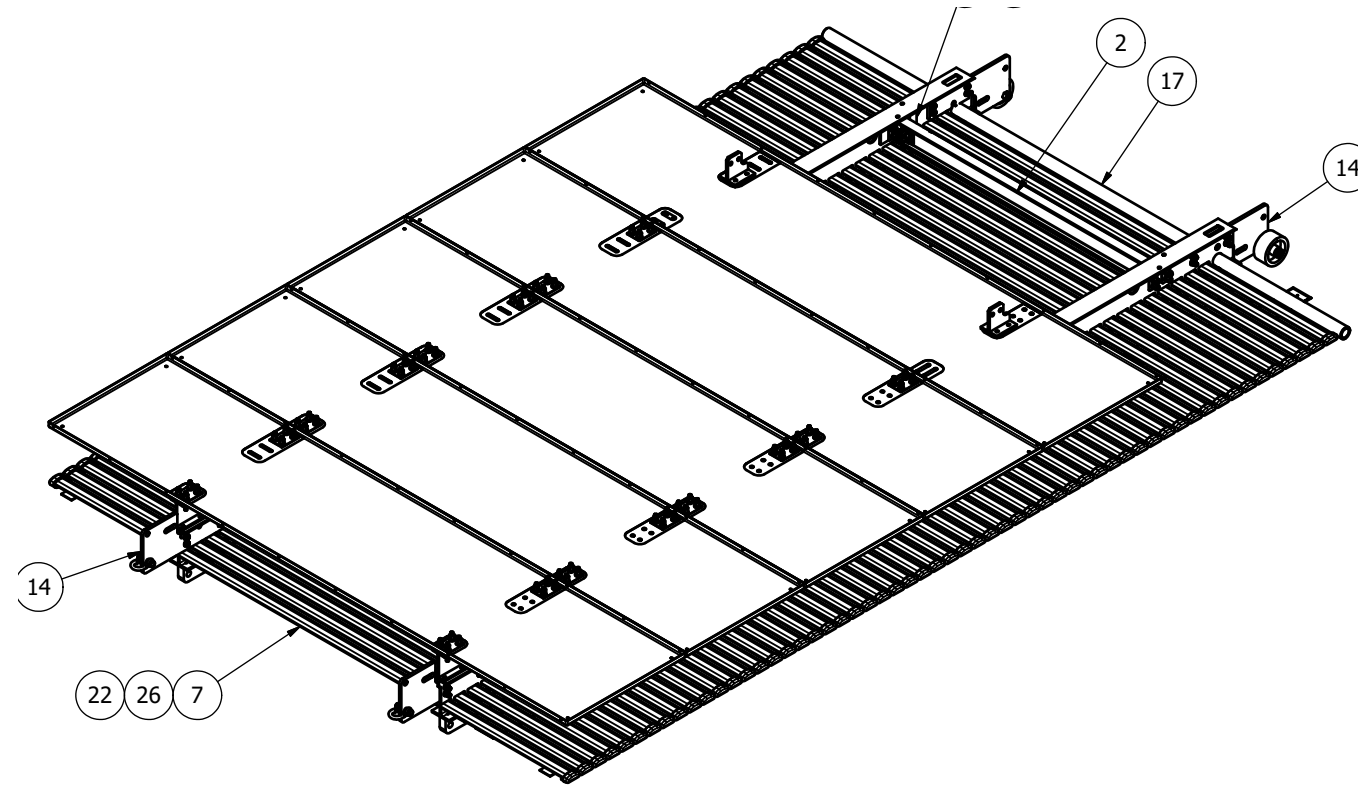
ProtoDUNE Field Cage Modules

- Top and bottom modules
 - 12 total: 6 top & 6 bottom
 - Stony Brook
- End wall modules
 - 16 total
 - LSU



Top/Bottom Modules

- Frame consists of fire-resistant FRP I-beams
- Aluminum profiles are inserted into the 2 primary, 6" I-beams
 - Resistor boards are attached to the profiles to supply appropriate voltage
- 5 ground planes are also attached, via 4" I-beam spacers
- Removable aluminum plates (with optional wheels) can be attached at either end for craning and handling



Assembly Overview

- Stony Brook University is responsible for providing (and QC) of all field cage components, other than:
 - Aluminum profiles - provided by CERN
 - Ground planes - provided by CERN
 - Resistor boards - provided by LSU
- At Stony Brook, we will procure all components and perform a test assembly of the FRP frame
 - Any acceptable surface damage will be repaired with epoxy
- We will then disassemble the frame, and clean, wrap, and crate the components (3 modules per shipment)
- At CERN, the frame will be reassembled, and aluminum profiles, ground planes, and electronics boards will be attached

Stony Brook Personnel

- 1 Faculty Member
- 3 Postdocs
 - 1 to travel to CERN this summer
- 5 Graduate Students
 - 1 to move to CERN for 1.5 years beginning in June
- 1 Full-time Group Technician
- 4 Full-time Machinists
 - Replacement search for 5th machinist is underway

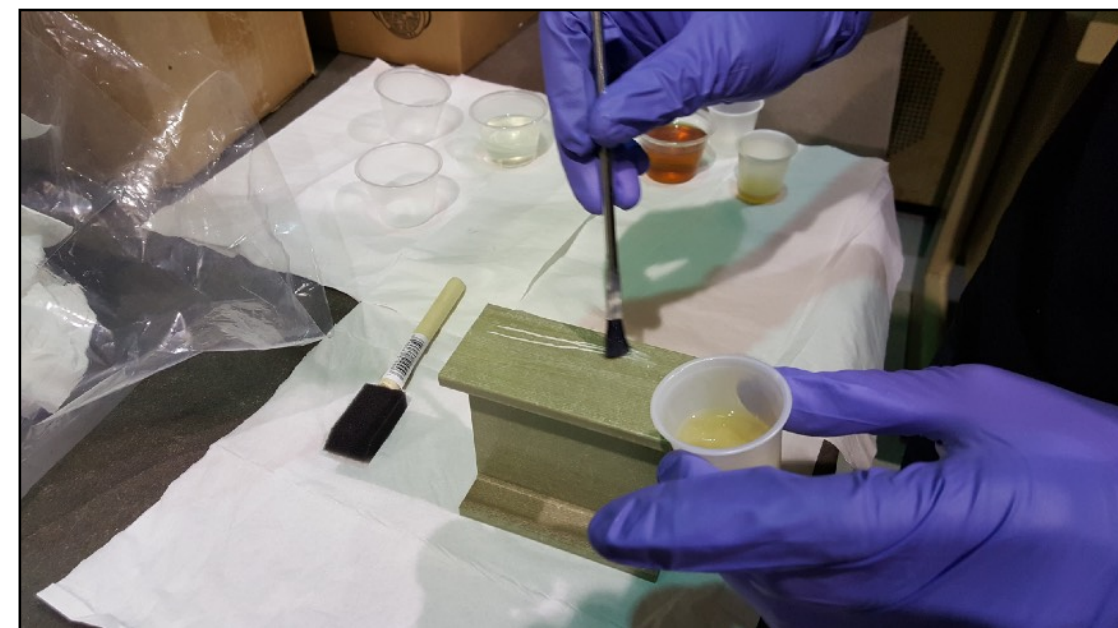
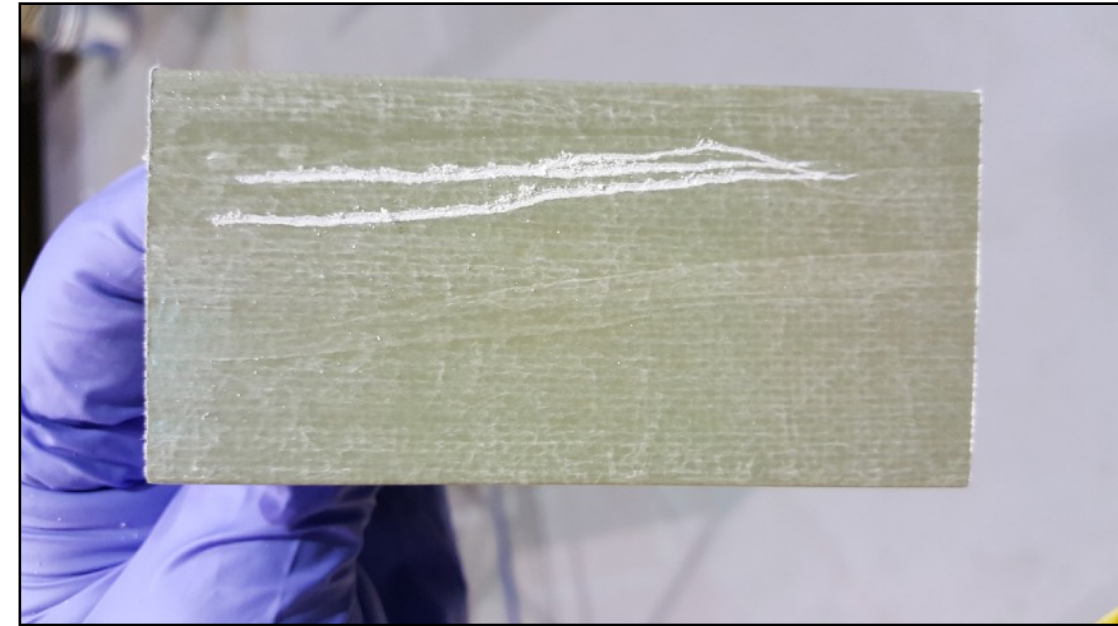
FRP Frame

- I-beams are machined off-site at FPI Industries
 - No water is used at any stage of the manufacturing or assembly
- Components are assembled using durostone (epoxy + glass fiber) threaded rods and FRP nuts
- Components are cleaned with denatured ethanol and wrapped with plastic prior to shipping



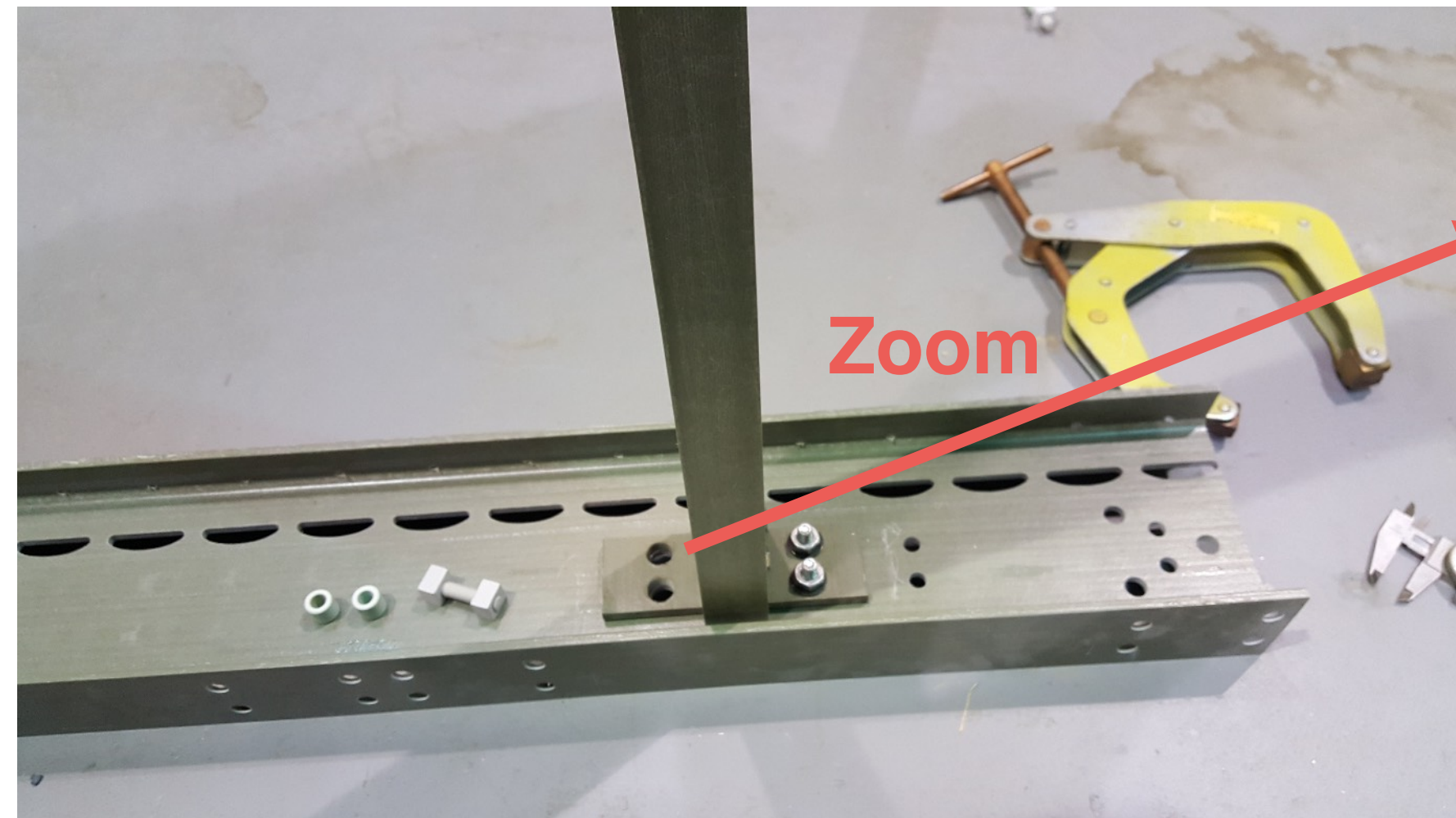
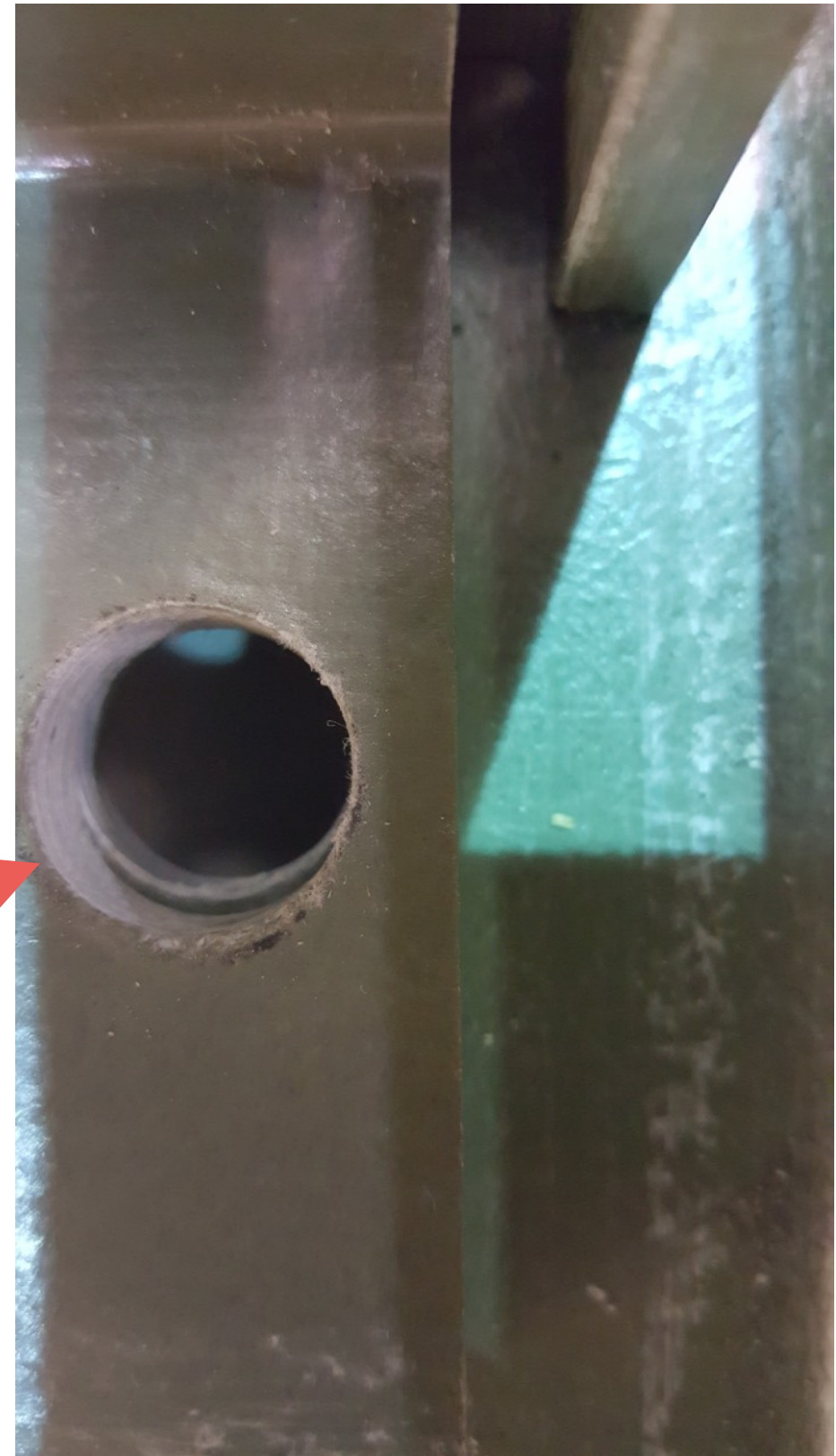
FRP Surface Remediation

- Surface imperfections can leave exposed fibers
- Fibers can separate from surface when high E-field is applied
- All machined surfaces are coated with epoxy
- Any acceptable damage to the FRP coating is repaired at SBU with epoxy



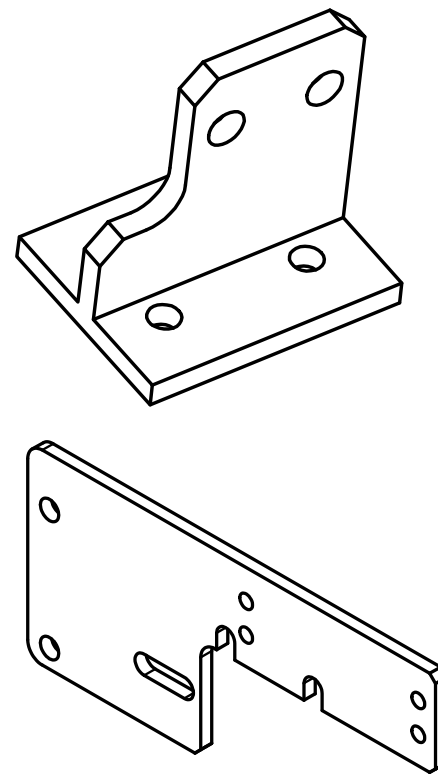
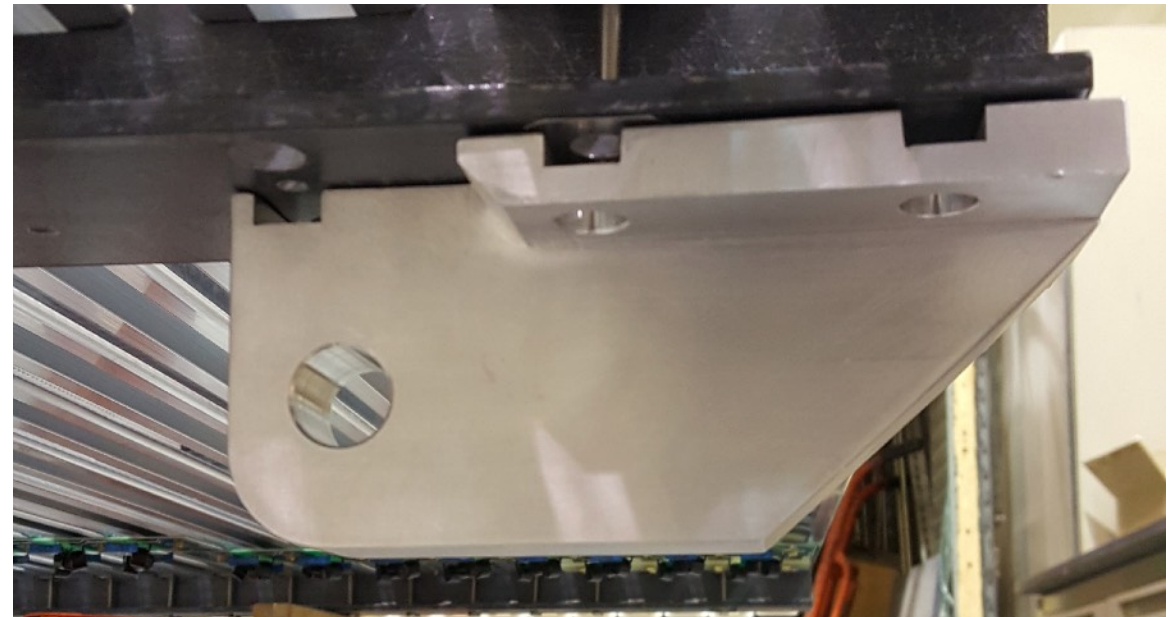
Additional Frame Issues

- Prior versions of field cage modules had several hole misalignments, which inhibited assembly
 - Improvements to initial part shape tolerances and machining practices
- Testing fitting all components at SBU is essential to ensure components meet requirements



Metal Components

- Metal components are machined at SBU or by a local machine shop
 - Slip nuts for profiles
 - Lock nuts for electronics boards
 - lifting fixtures
 - Steel pipe
 - Electrical contact strips
 - Washer plates



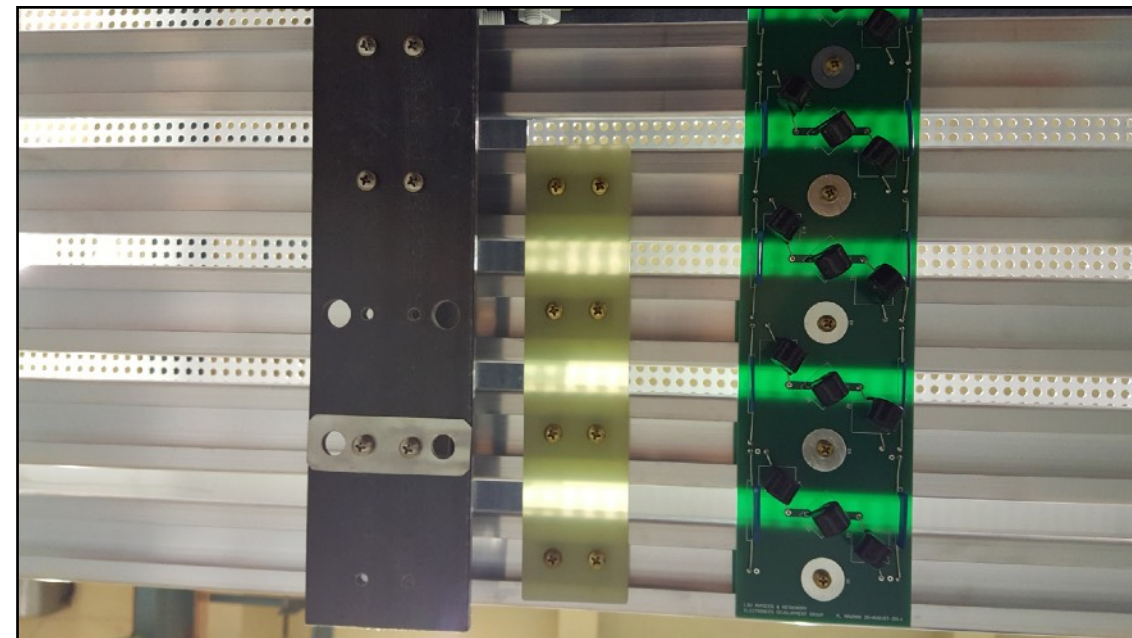
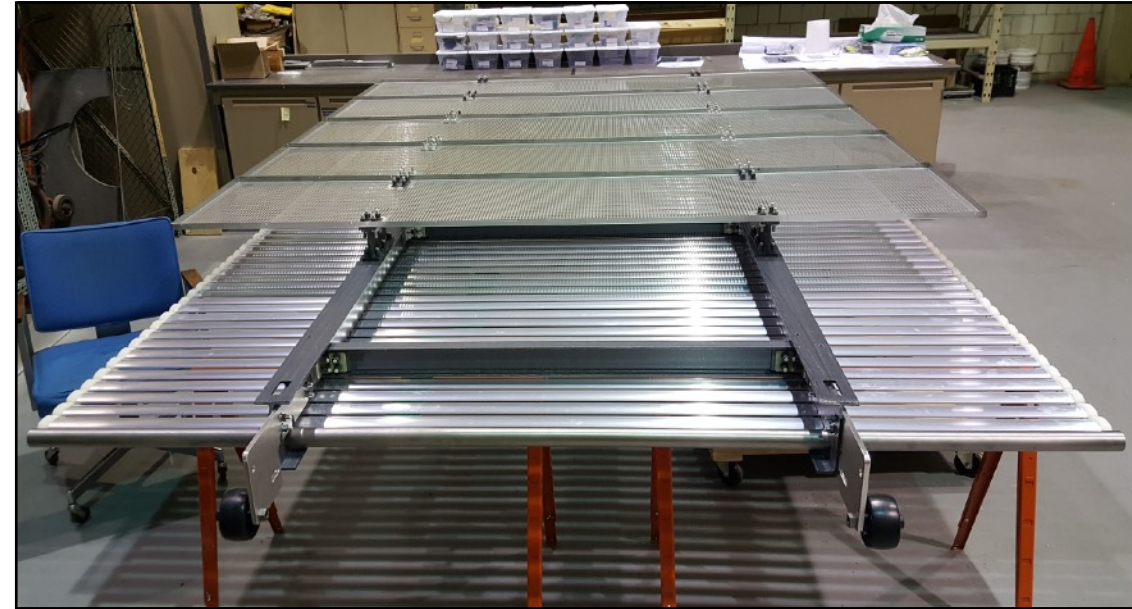
AI Profile Installation

- HDPE endcaps are attached to each end of the profiles
- Profiles are aligned horizontally using a banking plate
- The angle of the profiles is aligned via differential tightening of the 2 screws attached to the slip nut on either side of the I-beam webbing
- A level is used to confirm angle alignment



Full Assembly

- Full assembly will be completed at CERN
- Process has been replicated at SBU (module 0)
- SBU personnel will be onsite to train new personnel on assembly and final QC procedures



Crating / Shipping

- Prior versions were shipped as completed modules
 - Crate designed in conjunction with local company
- New crate design should be finished within the next week
 - Designed to hold components for 3 modules (beams, lifting fixtures, steel pipe, custom washer plates, nuts, etc.)
- Lab is located adjacent to physics loading dock



Schedule

- First shipment to CERN (3 modules) is scheduled for early June
 - 2 week transit time expected
- Subsequent shipments will occur in 2 week intervals
- Assembly of the first modules and training of new personnel (e.g. CERN technicians) will occur in late June / early July
- Current schedule has all 12 top/bottom modules assembled by the end of August