



NOvA Module Design

(WBS 1.5 / 2.5)

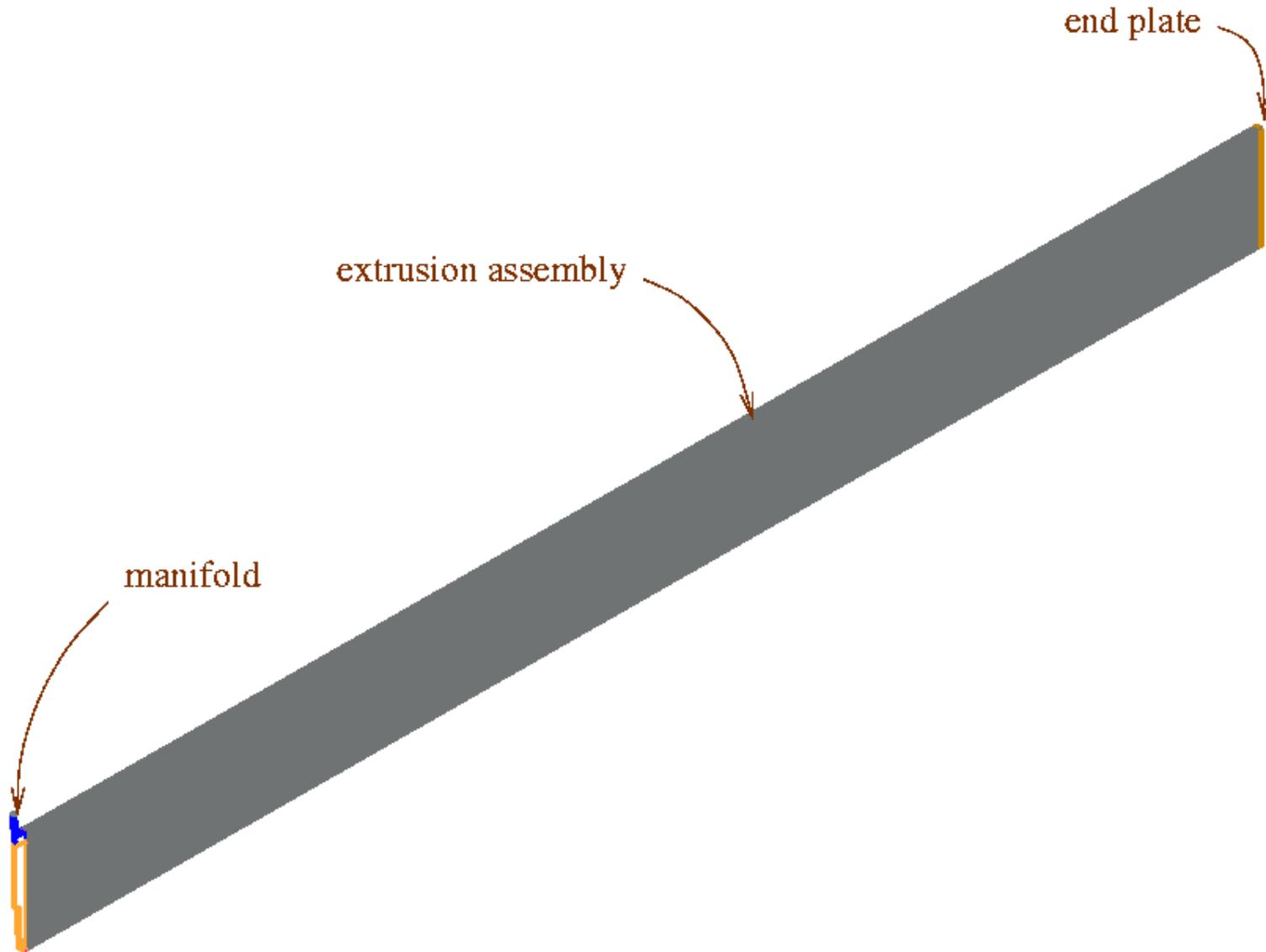
June 5, 2007

Tom Chase

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A. Smith



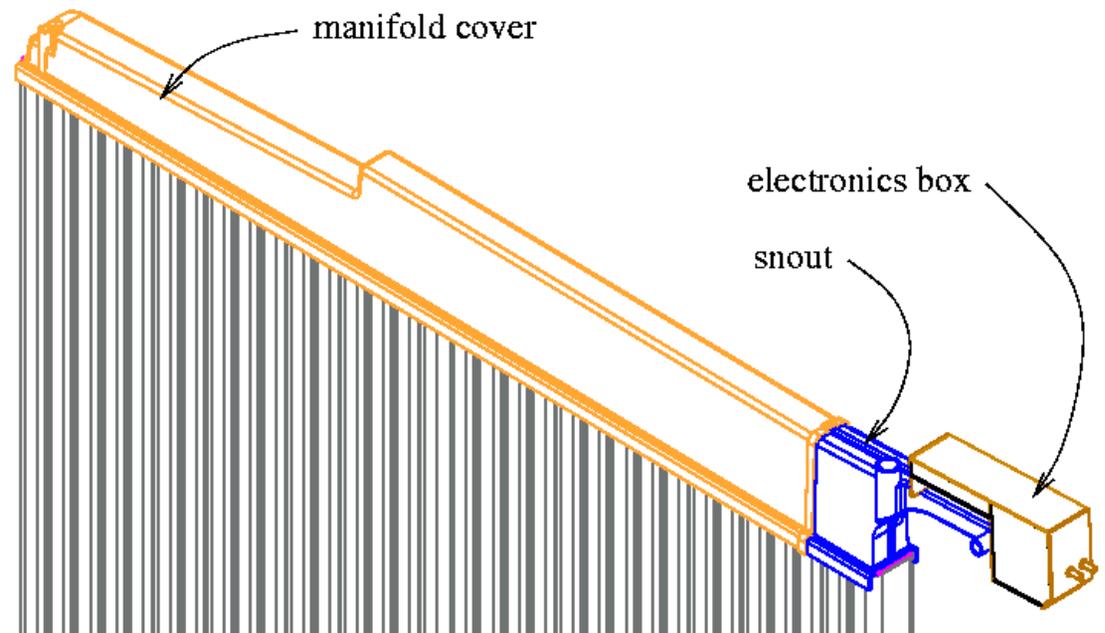
Module Architecture





Overview

- End plate design
- Module adhesive testing
- Manifold design



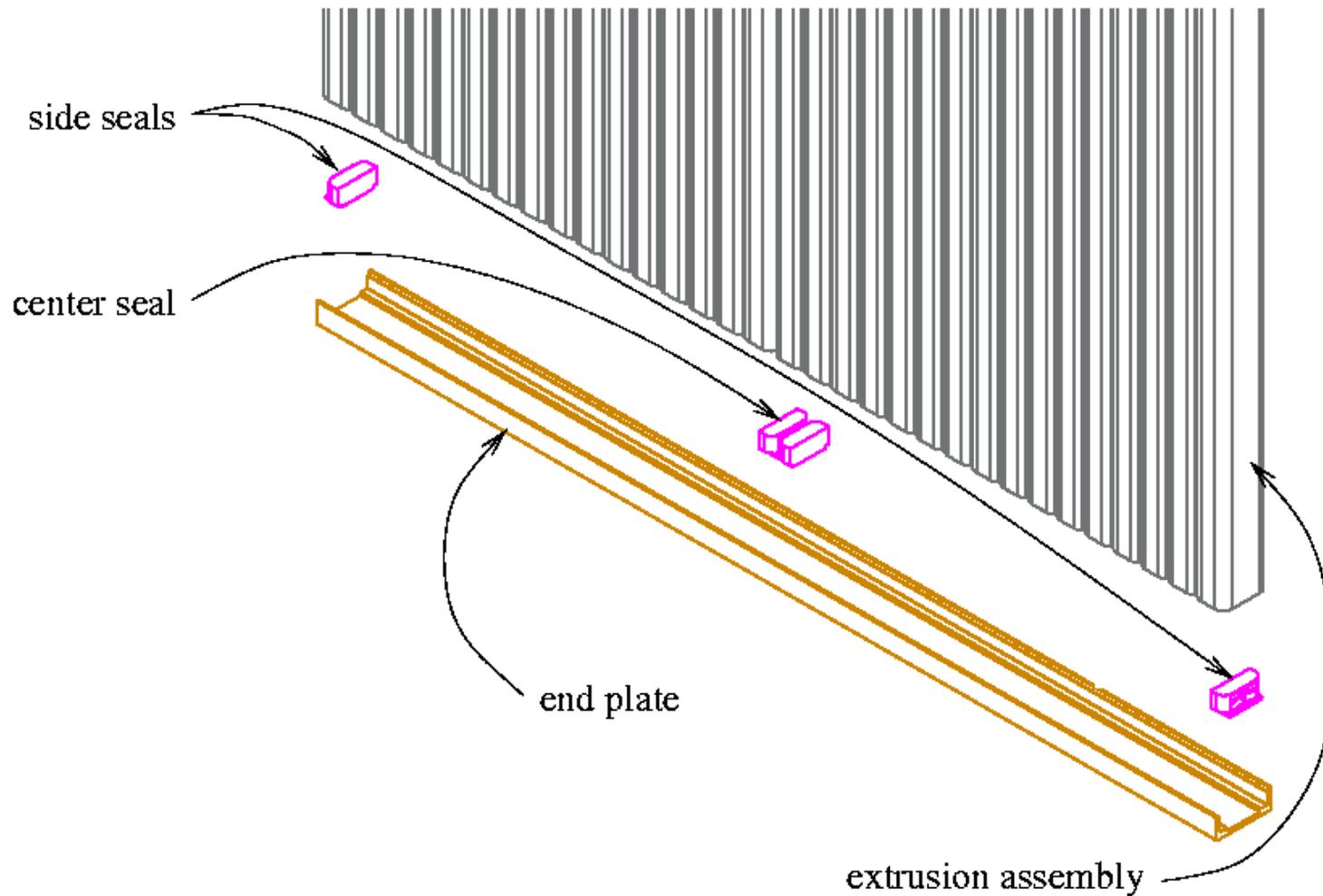


End Plate Requirements

Metric	Units	Value
Extrusion assembly width tolerance	mm	± 6
Extrusion assembly depth tolerance	mm	± 1
Fluid pressure	kPa	131
Crush force	kN	> 22
Length beyond extrusion assembly	mm	< 10
Extent of adhesive seal	mm	> 20
Fluid transfer area	mm ²	180
Installation time	min	30
Modification of main extrusion	binary	No

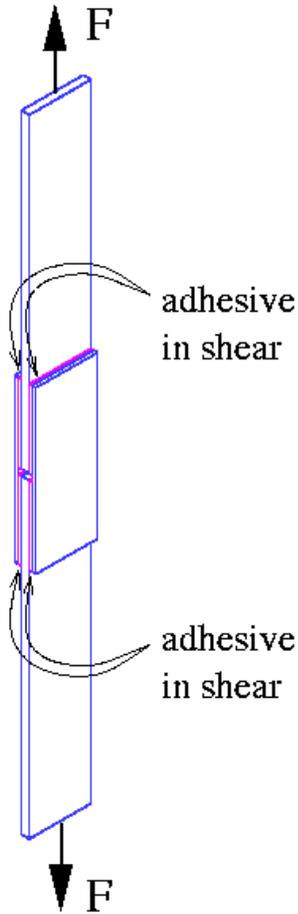


End Plate Architecture

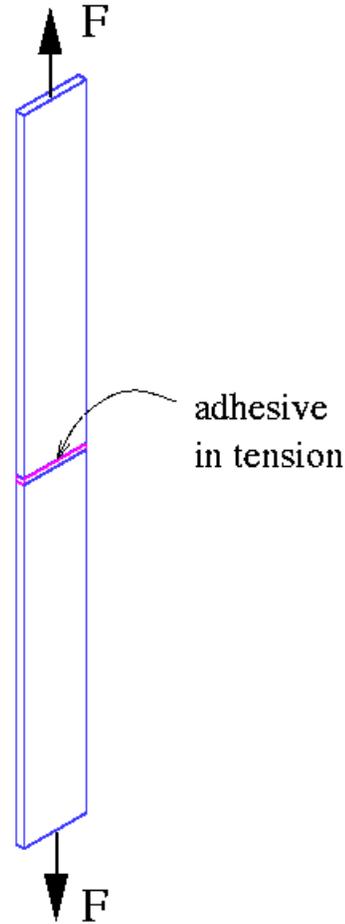




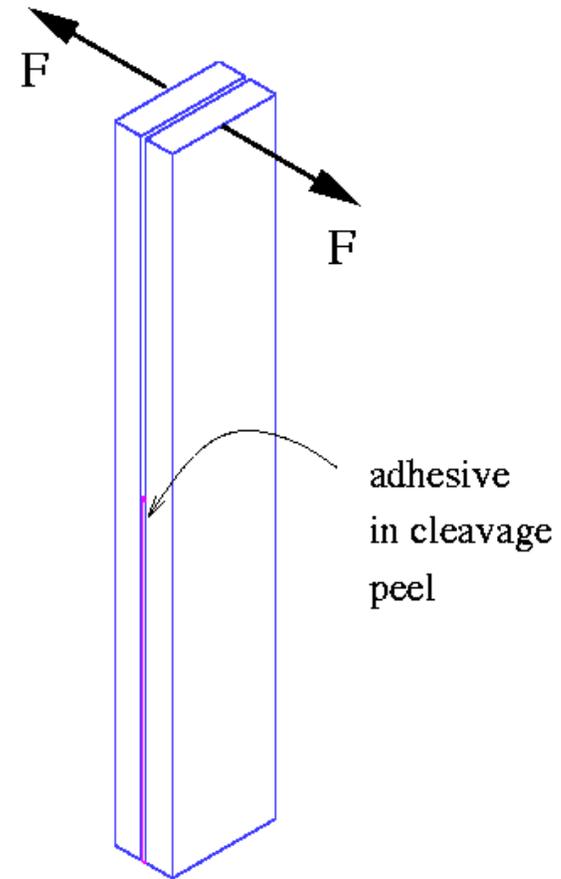
Adhesive Failure Modes



Shear



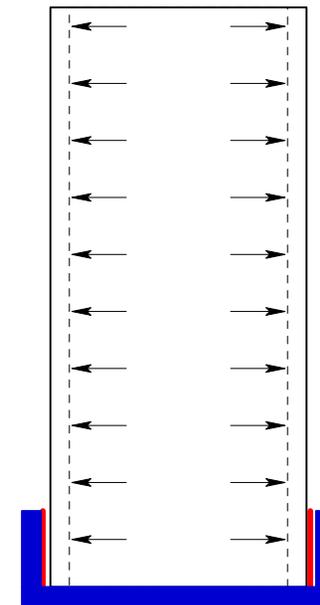
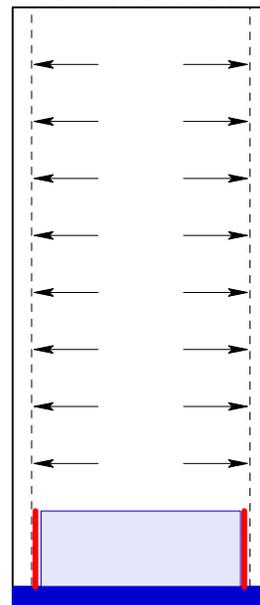
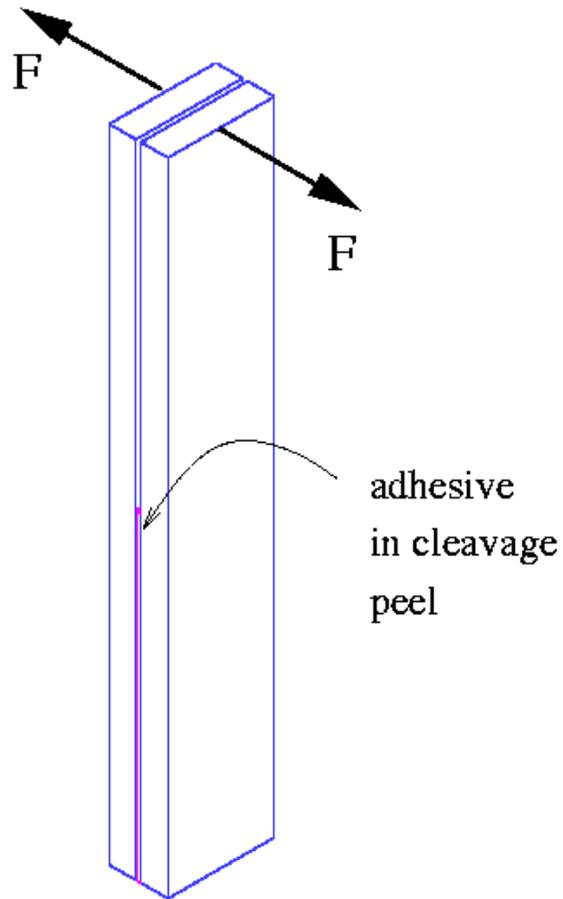
Tension



Cleavage Peel



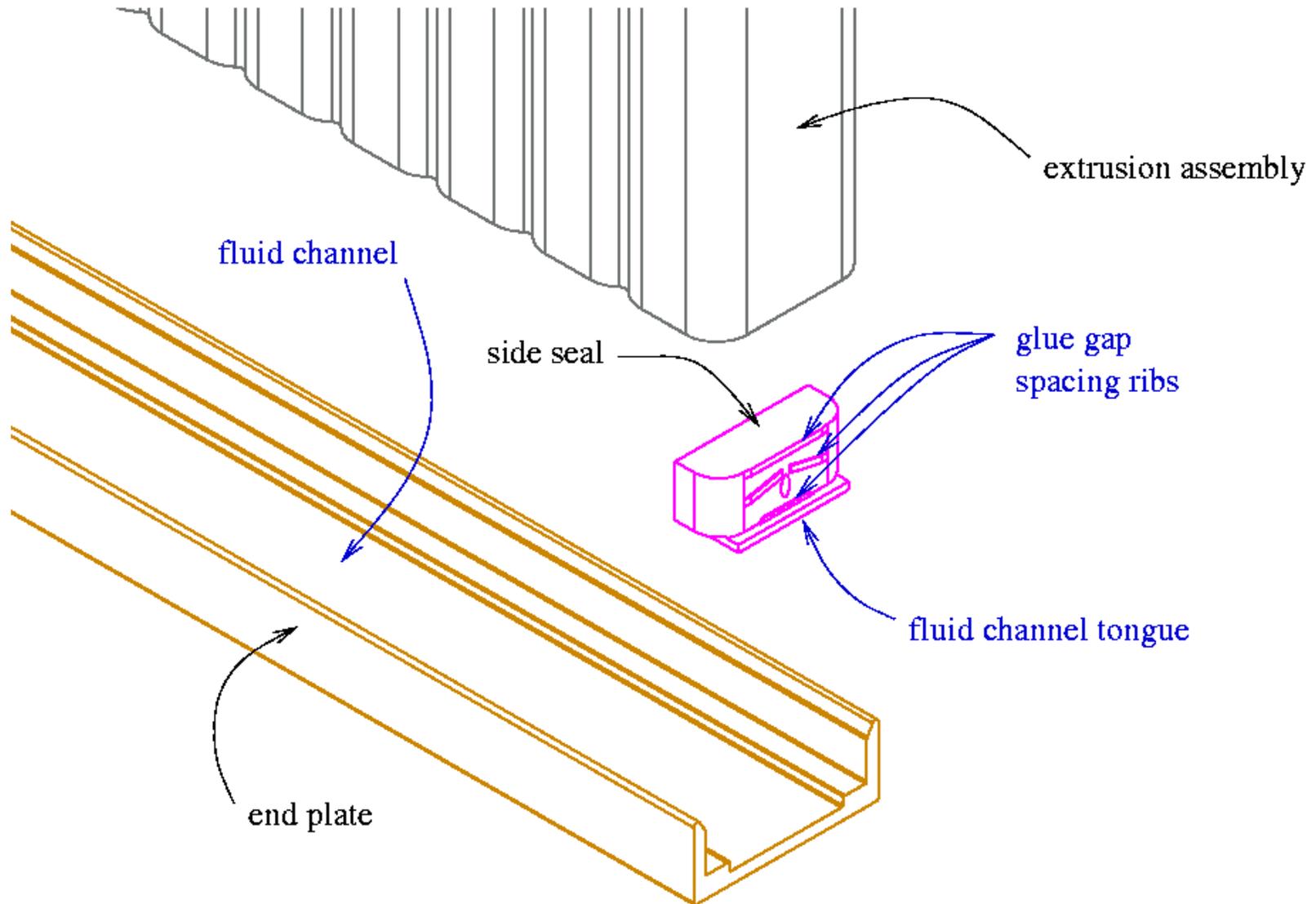
End Plate Design



Avoid cleavage peel!

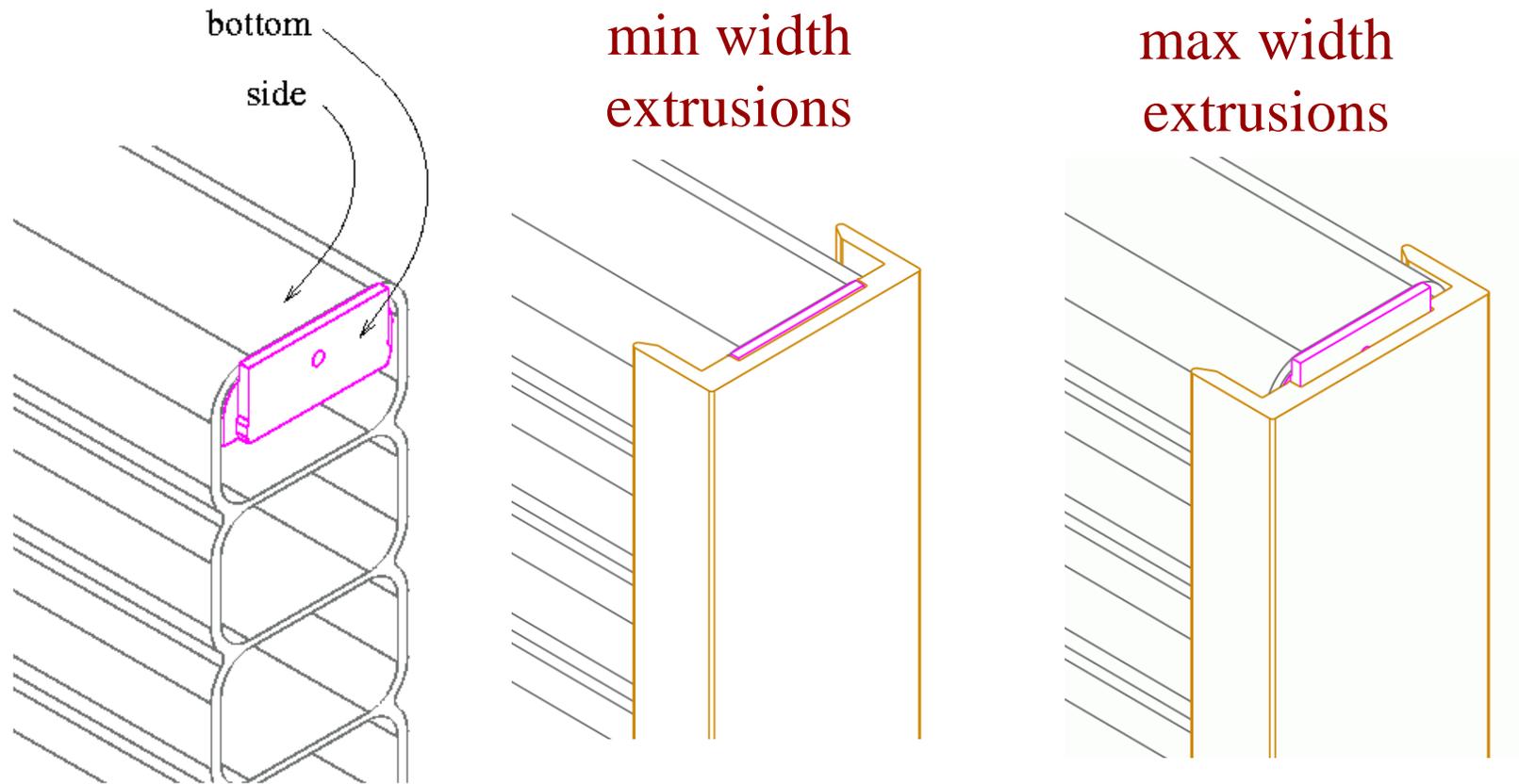


Close-Up of Side Seal





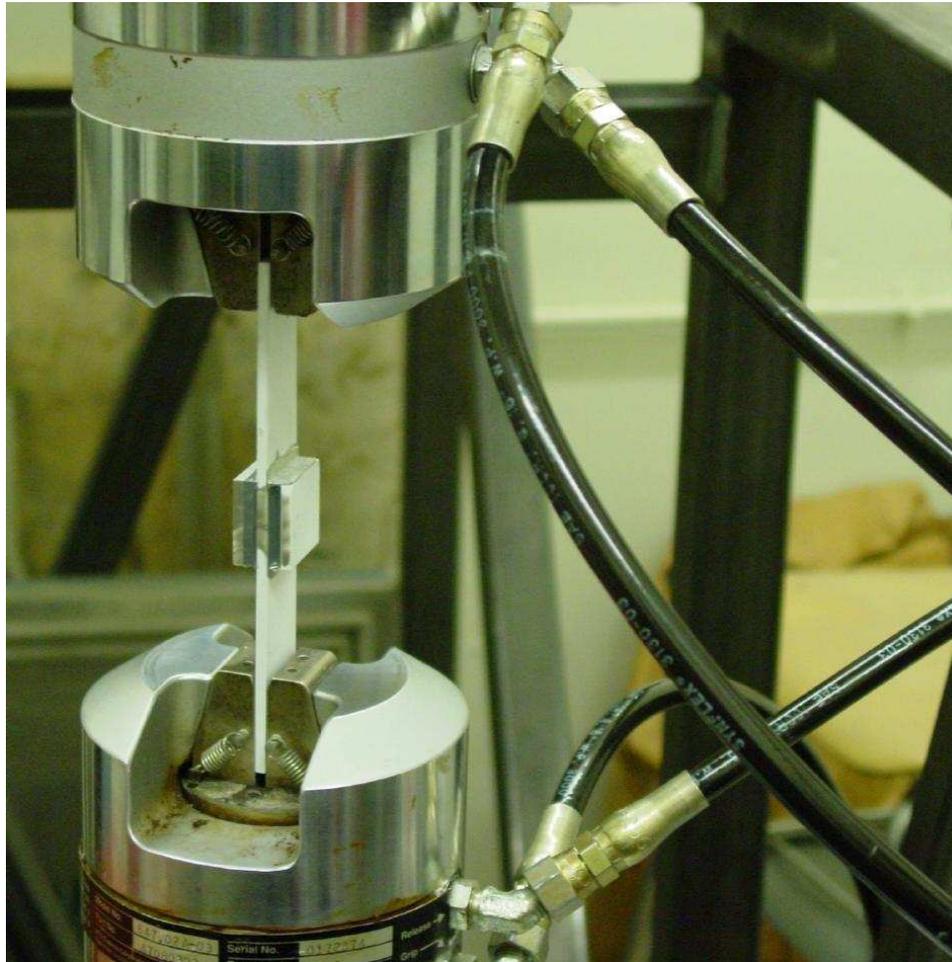
Side Seal Functionality



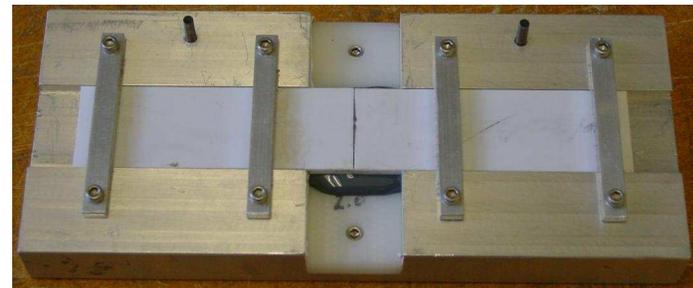
Side seal moves sealing surface from side of module to bottom of module



Adhesive Testing Program



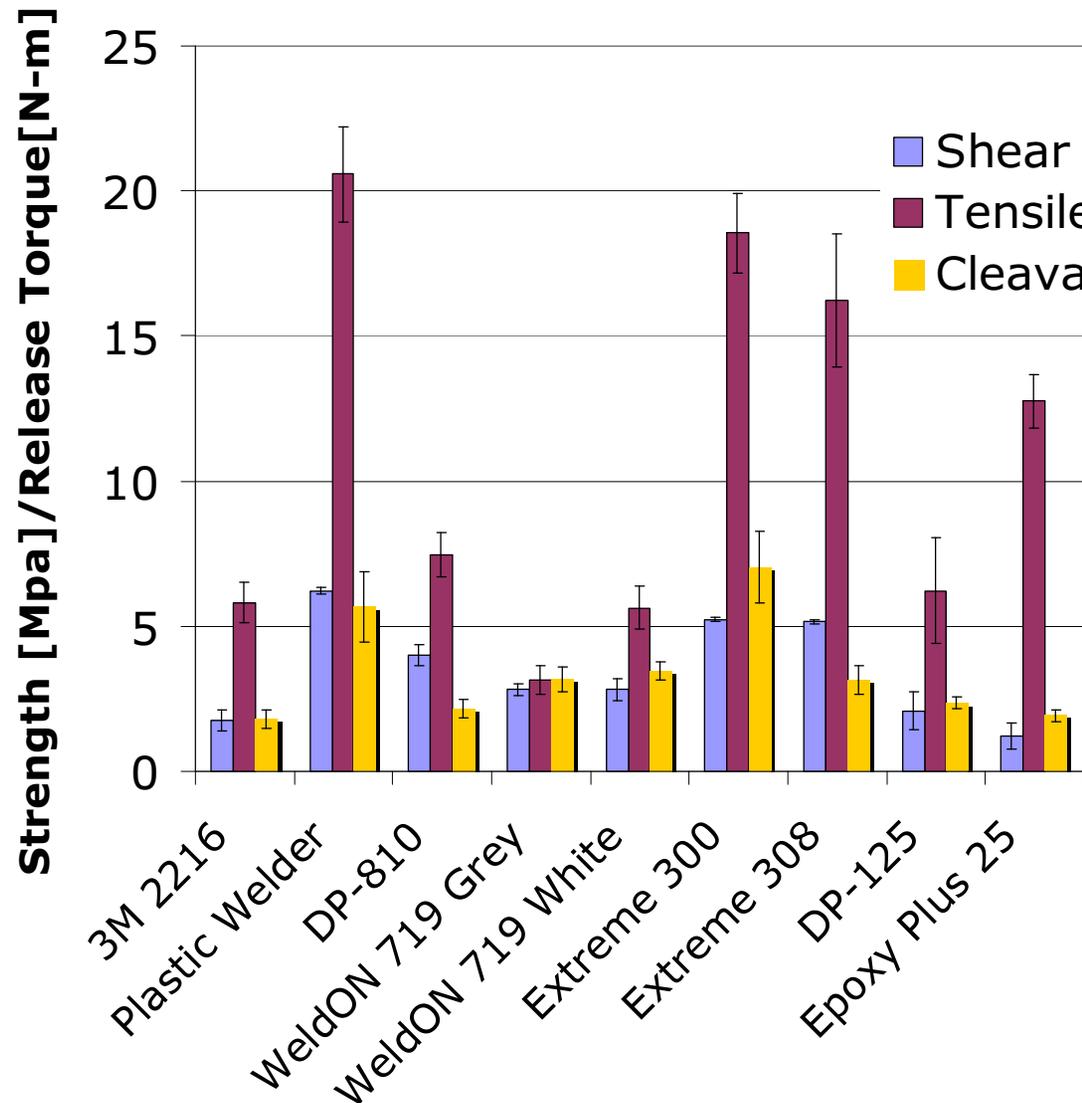
*Testing a shear specimen,
3M 2216, 4 mm thick*



*Fixturing for
fabricating specimens*



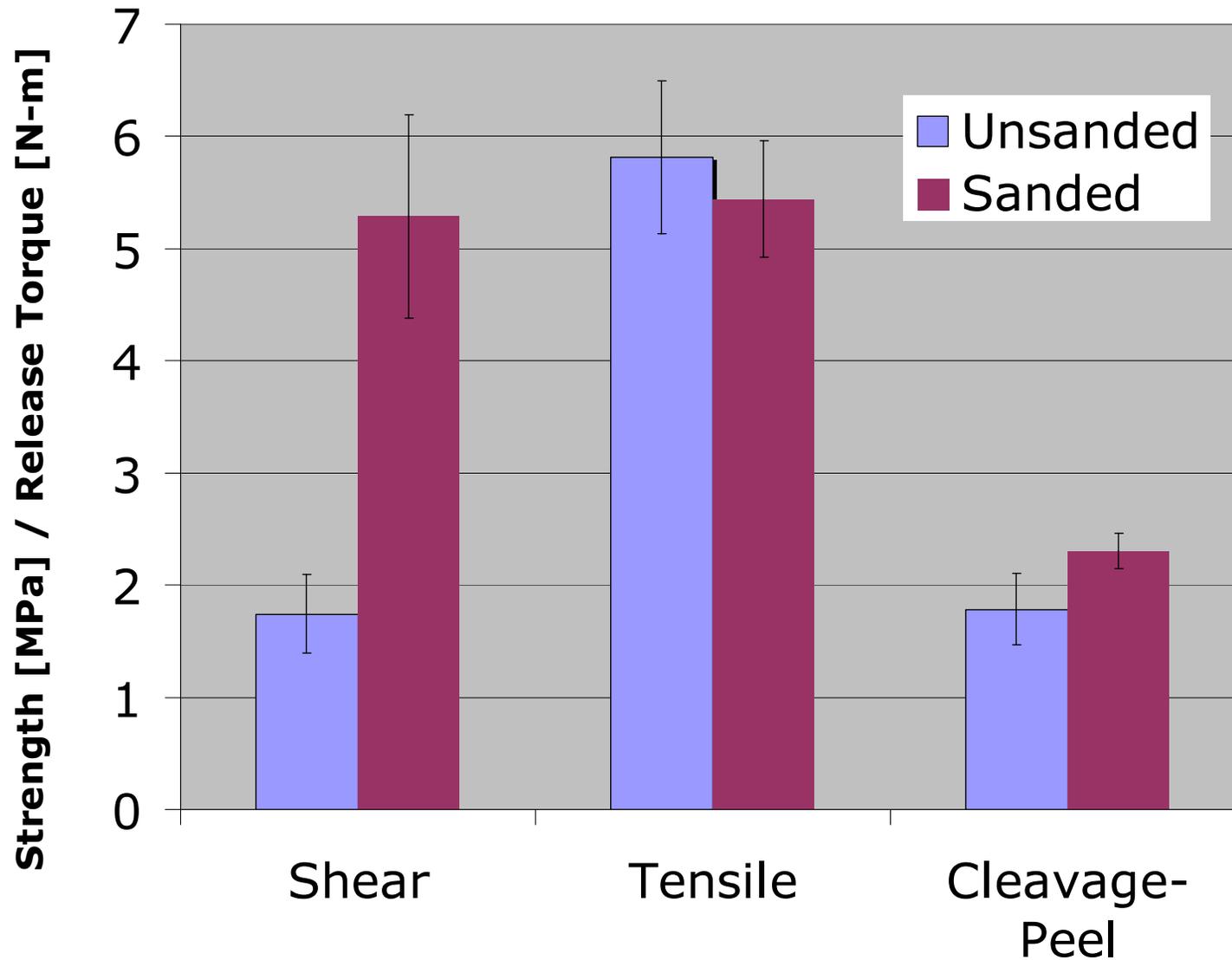
Module Adhesives Tested



- Plastic Welder is strongest
- 3M 2216 is 100% compatible with both the scintillator as well as the PVC

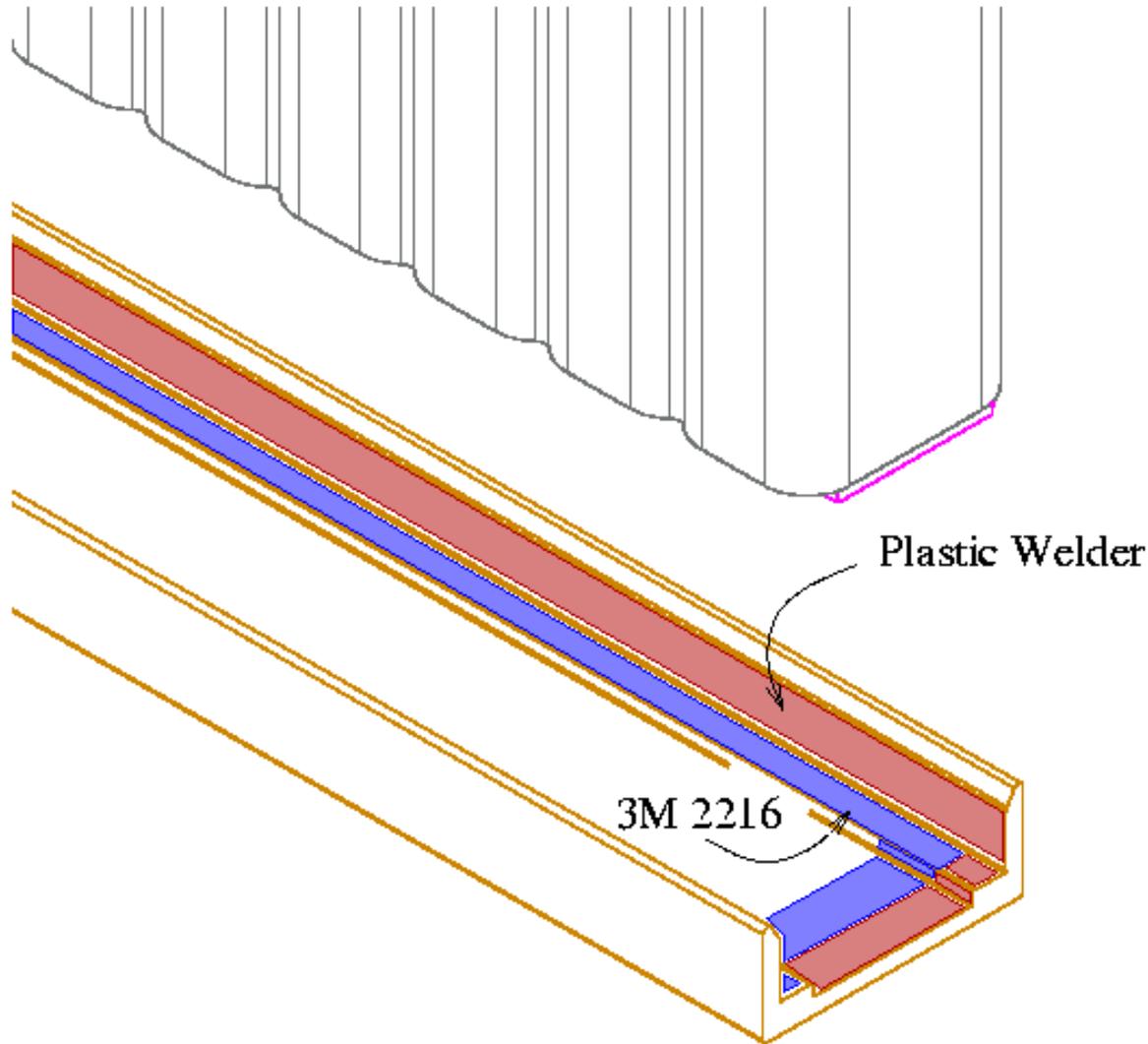


Effect of Surface Finish on 3M 2216





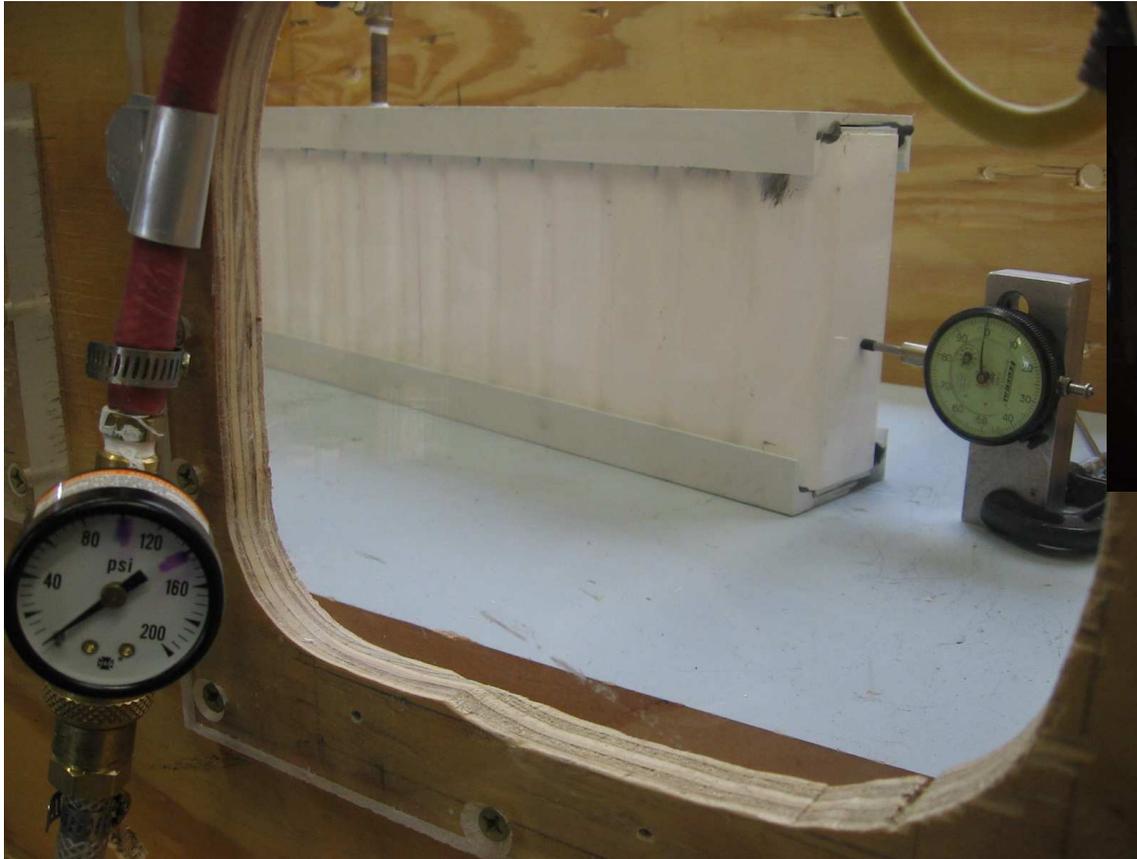
Utilizing Benefits of Both Adhesives



*Utilize 3M 2216
for sealing &
Plastic Welder
for structure!*



Testing actual joint geometry to failure

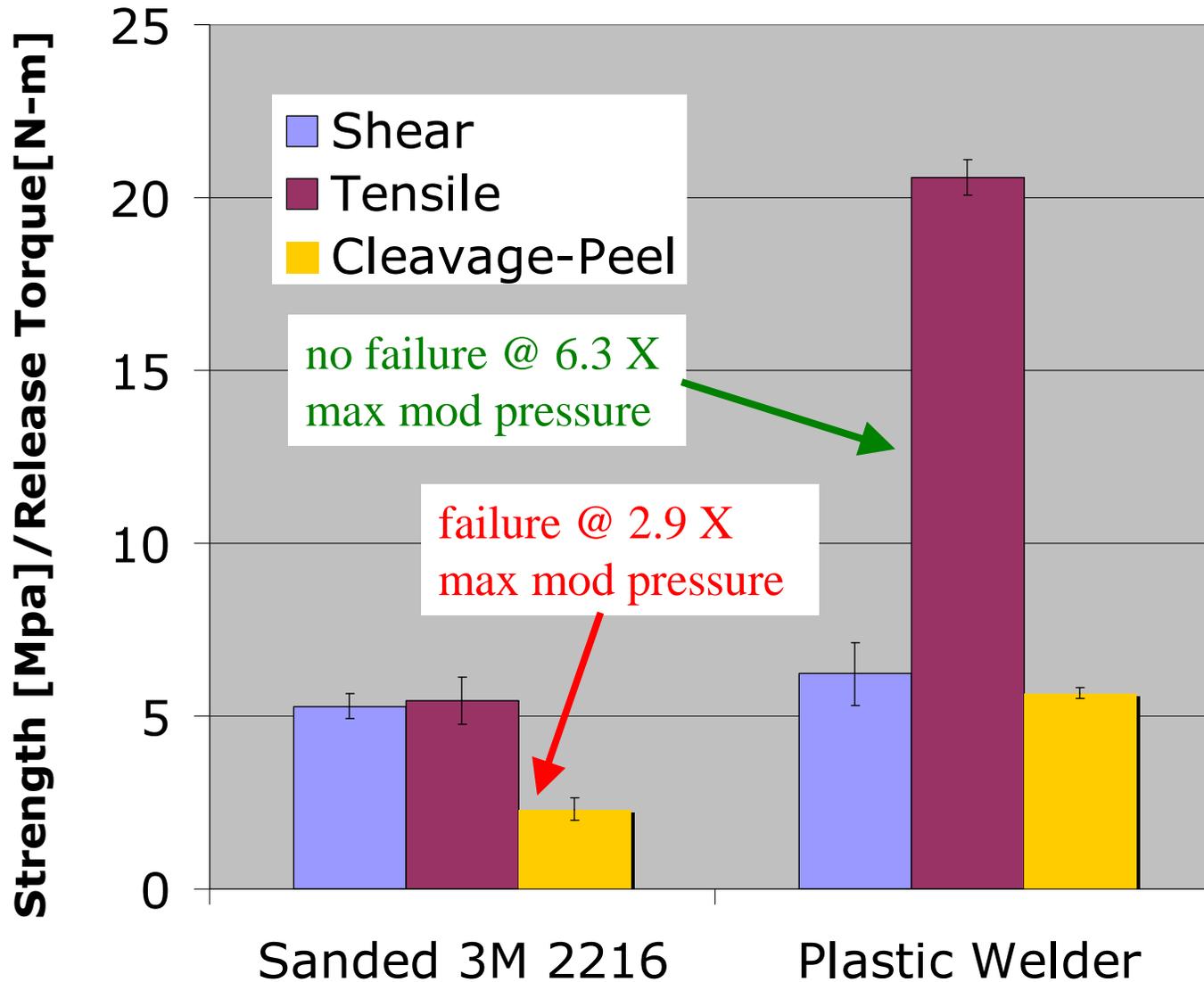


*Failure of
3M 2216 @
414 KPa*

Test chamber set-up



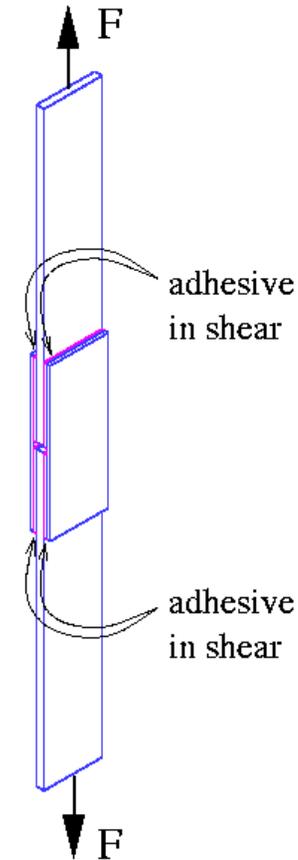
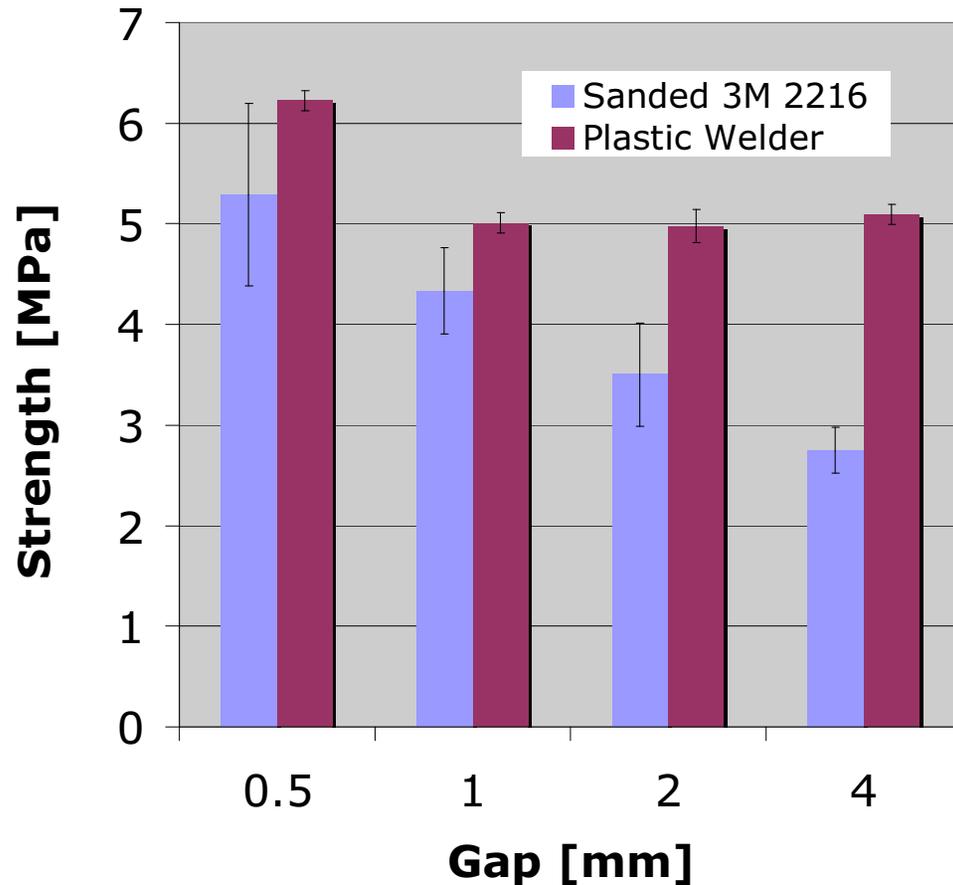
Module Adhesive Strength



Dual bond
factor of
safety ~6



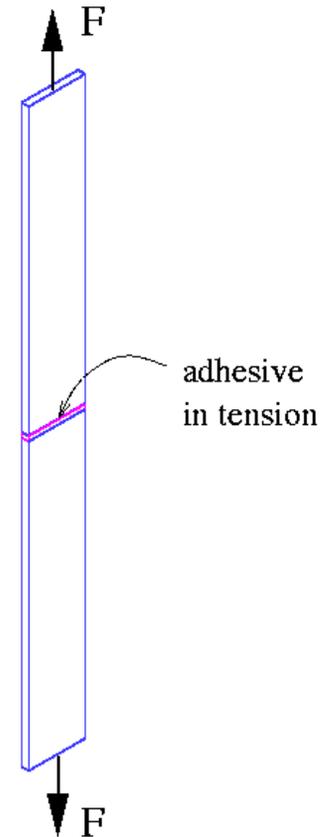
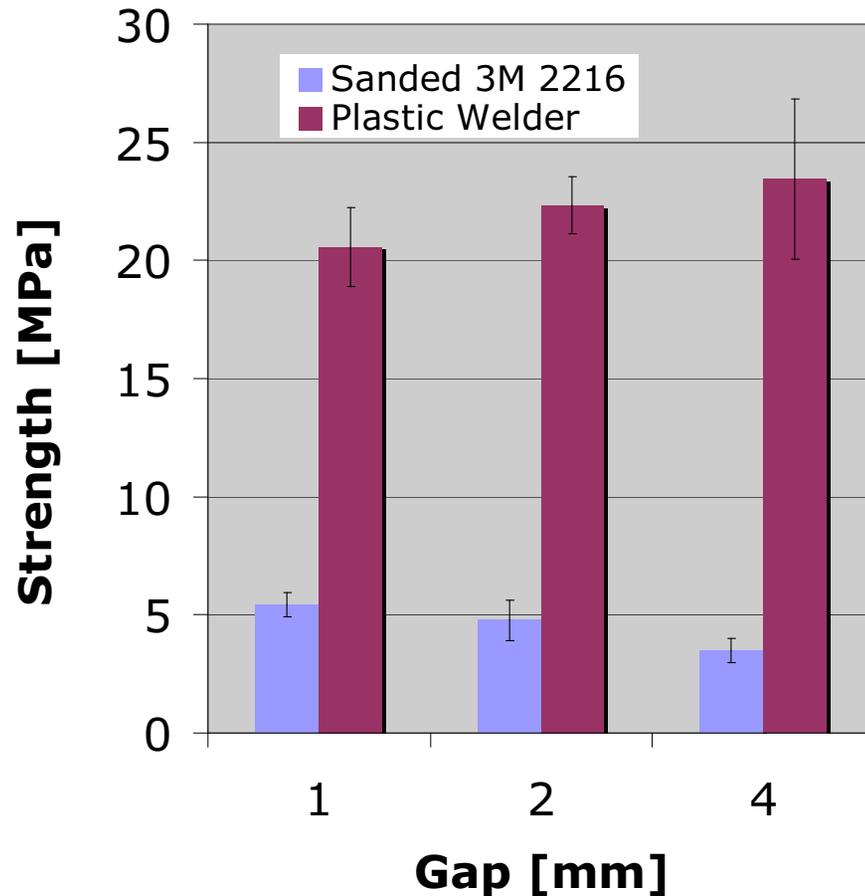
Adhesive Shear Strength vs. Thickness



- Plastic Welder maintains ~80% max strength
- 3M 2216 drops ~50% at 4 mm



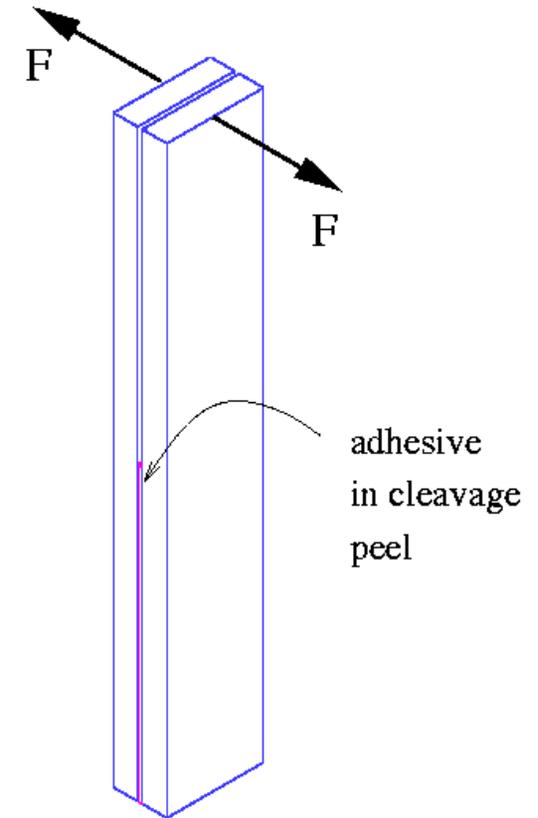
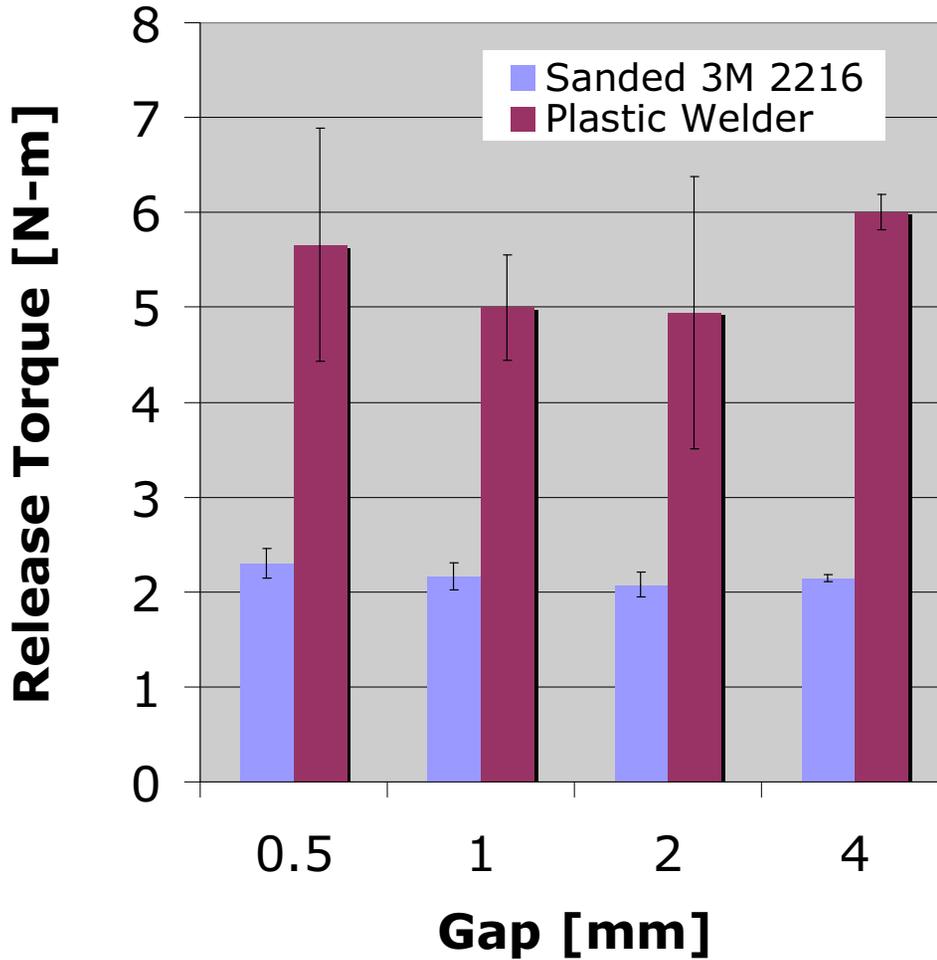
Adhesive Tensile Strength vs. Thickness



- Plastic Welder gets stronger with thickness!
- 3M 2216 drops ~30% at 4 mm



Adhesive Peel Strength vs. Thickness



Peel strength ~ constant for both adhesives!

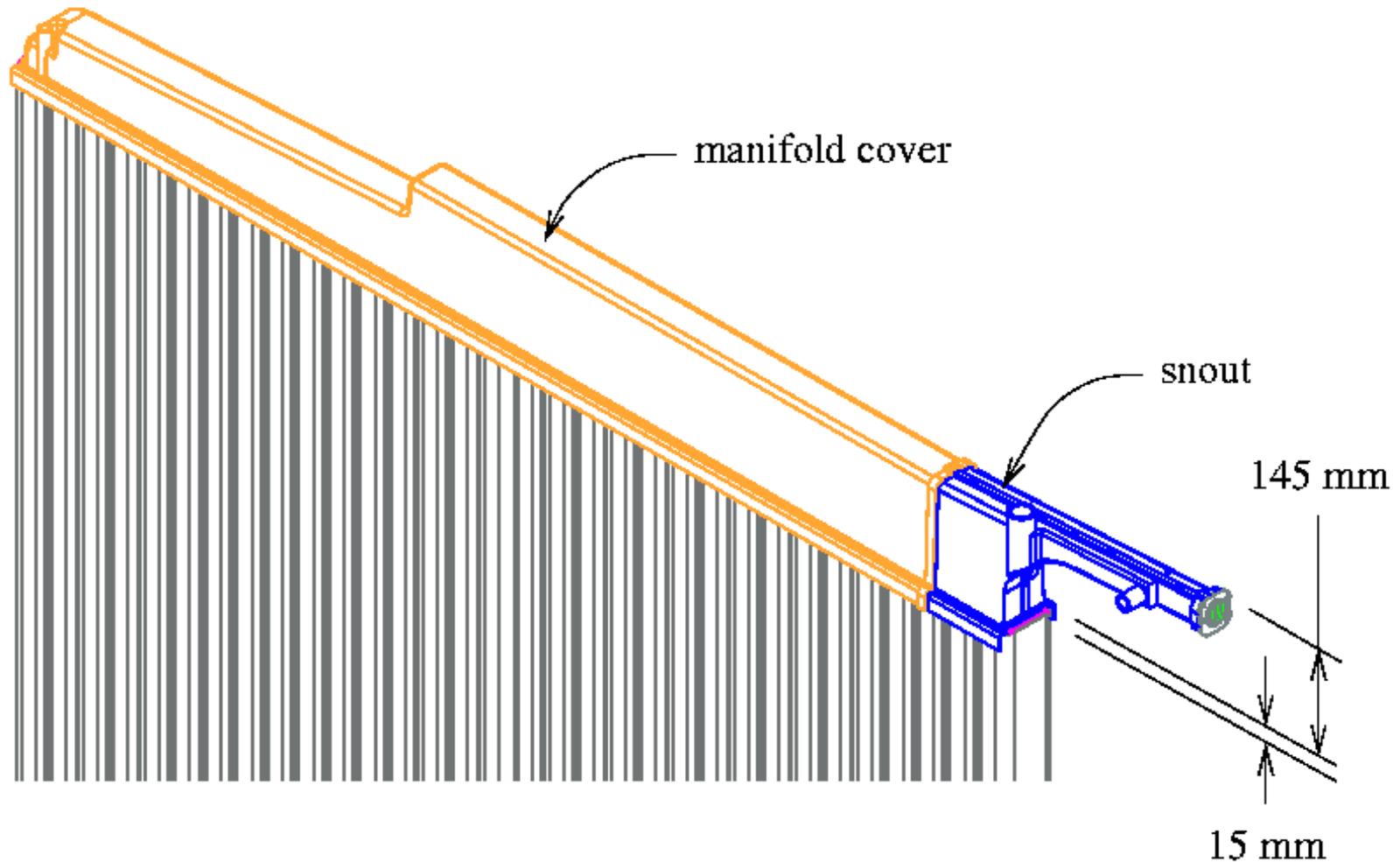


Manifold Requirements

Metric	Units	Value
Extrusion assembly width tolerance	mm	±6
Extrusion assembly depth tolerance	mm	±1
Fluid pressure	kPa	11
Minimum fiber bend radius	mm	> 35
Length beyond extrusion assembly	mm	< 150
Expansion volume	liters	4
Fill tube diameter	NPT (in)	3/4
Vent tube diameter	NPT (in)	3/8
Clearance, fill tube & electronics box	mm	25
Glue seam length (in addition to extrusion assembly seam)	cm	100
Installation time	min	45
Minimum cell clearance for stringing	mm	30
Hermetically seal optical connector	binary	Yes
Modification of main extrusion	binary	No



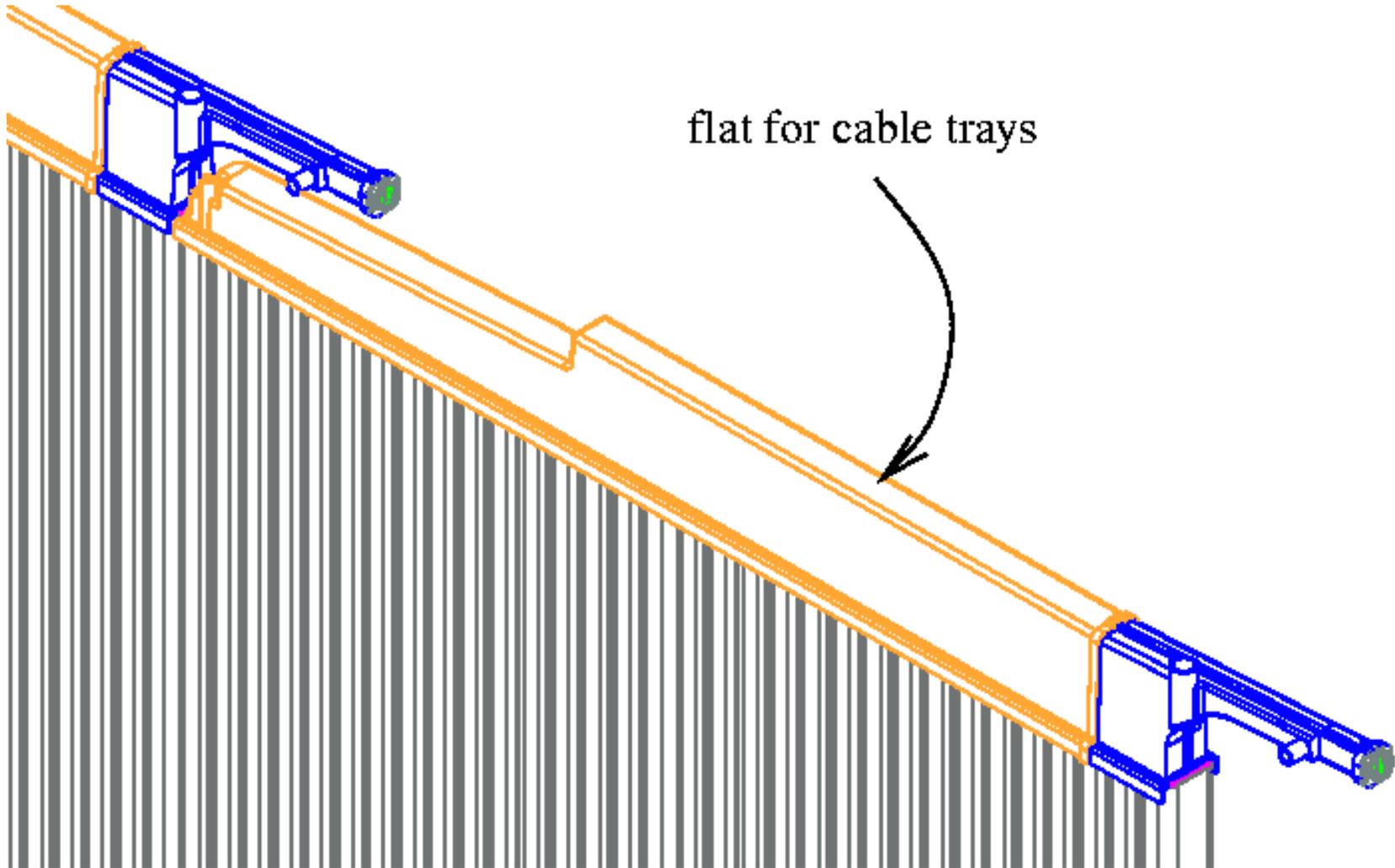
Manifold, Assembled



Glue seam with extrusion is similar to end plate

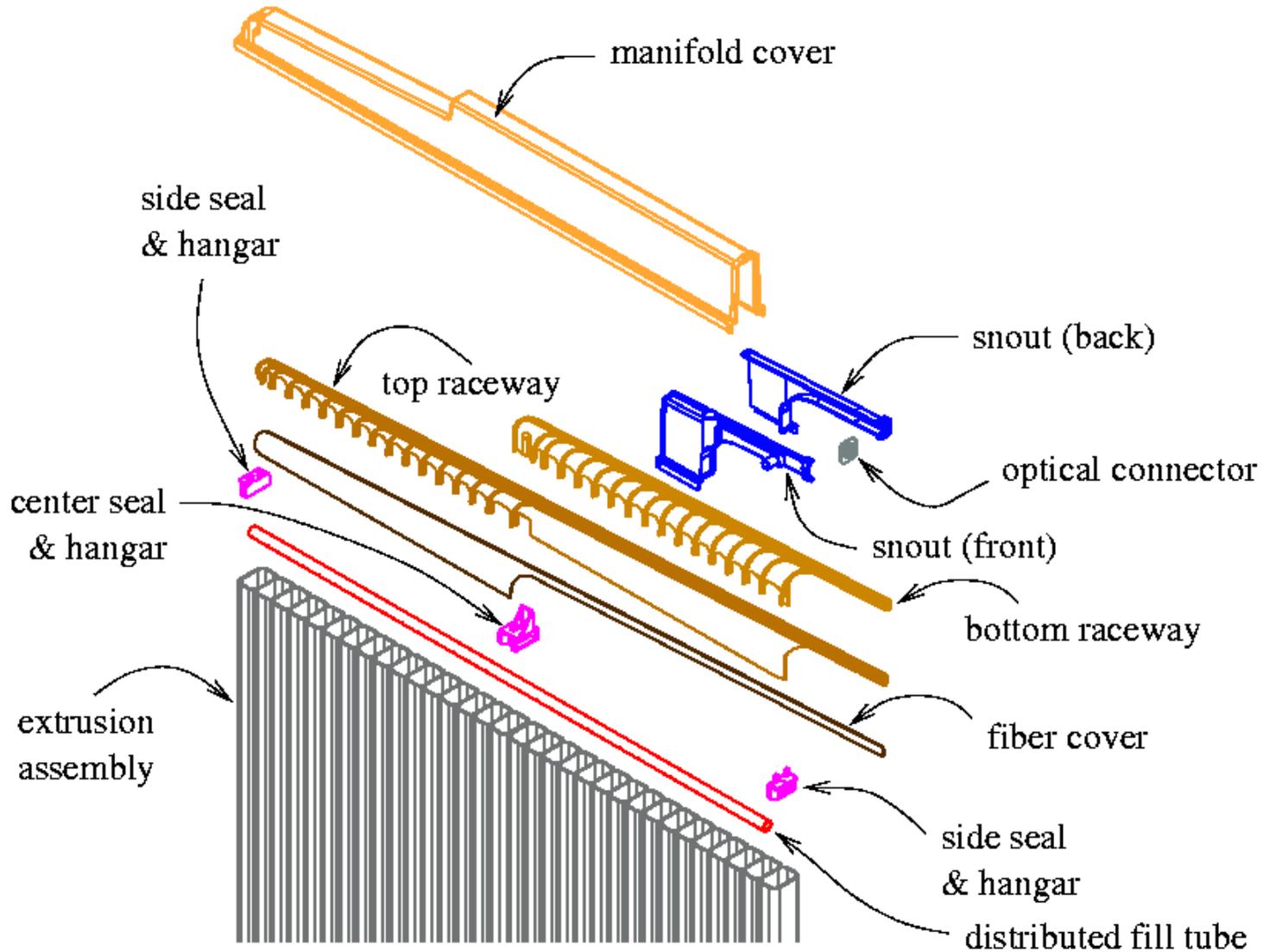


Nesting of 2 Manifolds





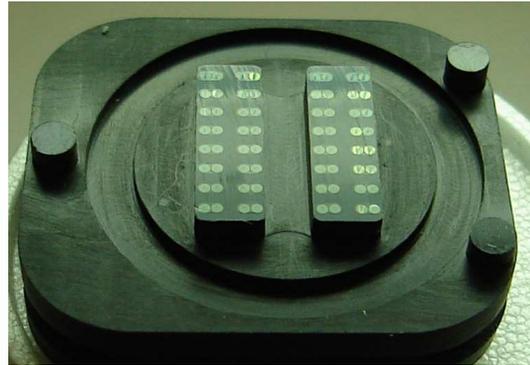
Manifold Architecture



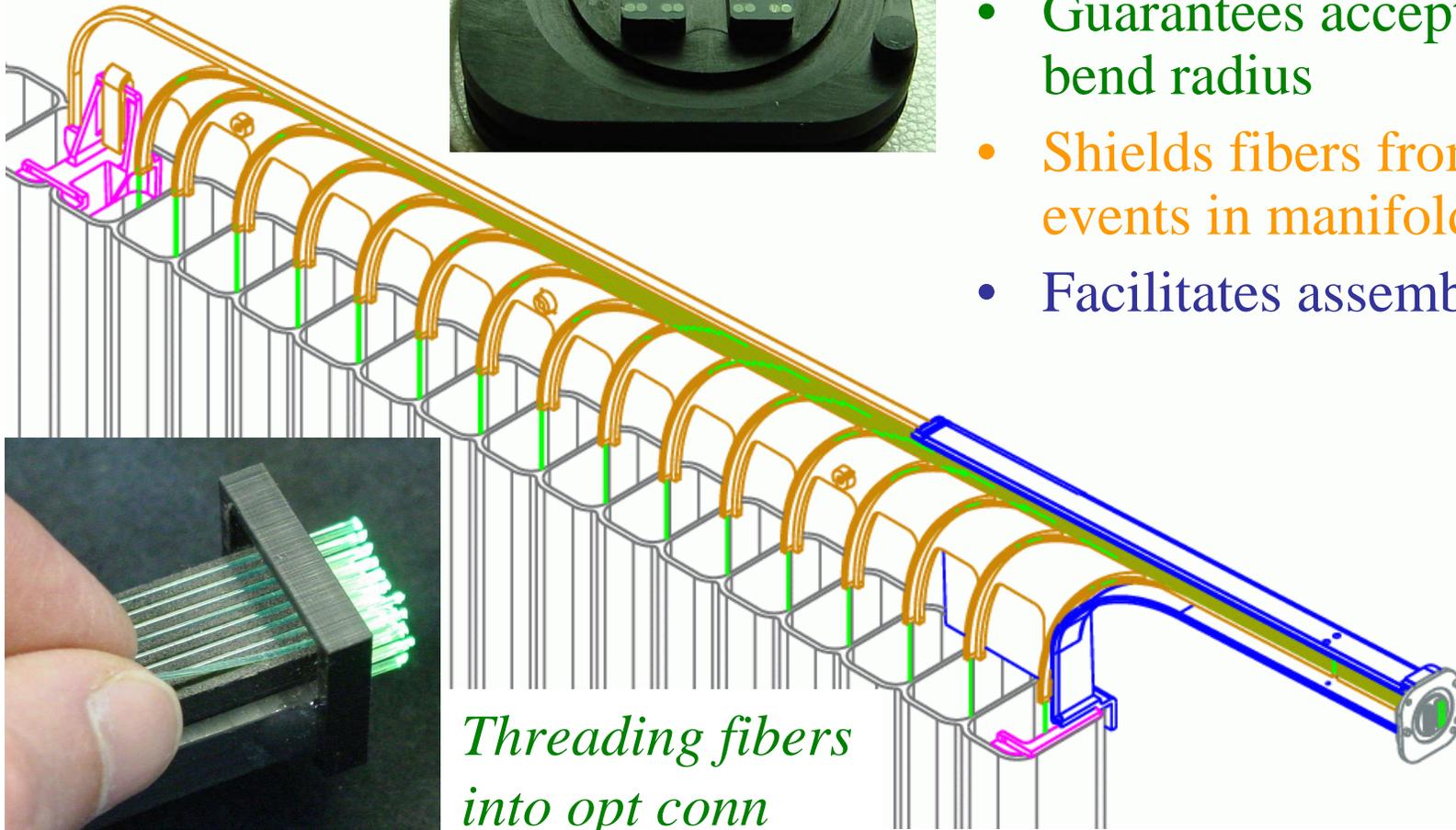


Raceway Functionality

Face of optical connector



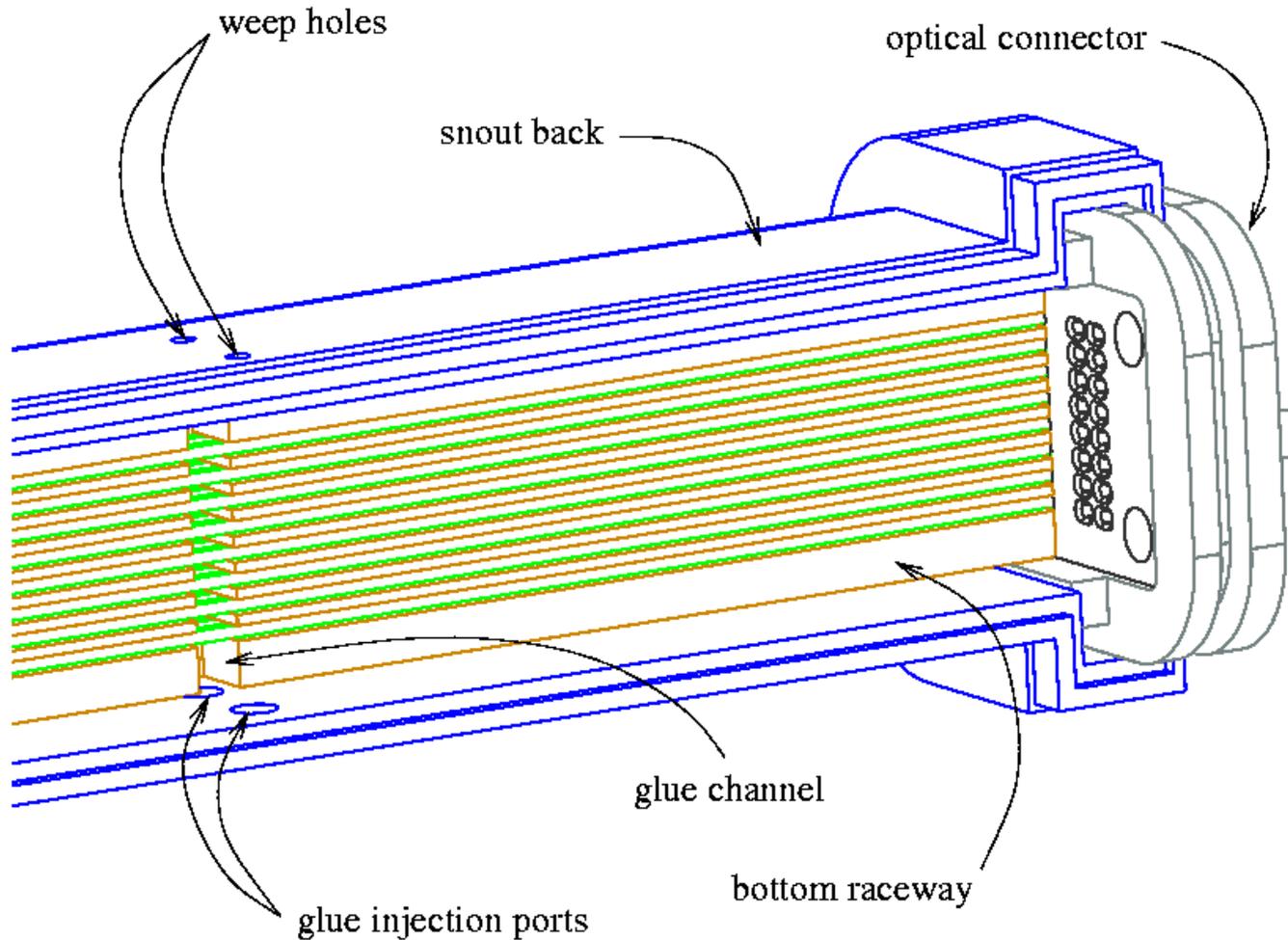
- Registers fibers in optical connector
- Guarantees acceptable bend radius
- Shields fibers from events in manifold
- Facilitates assembly



Threading fibers into opt conn



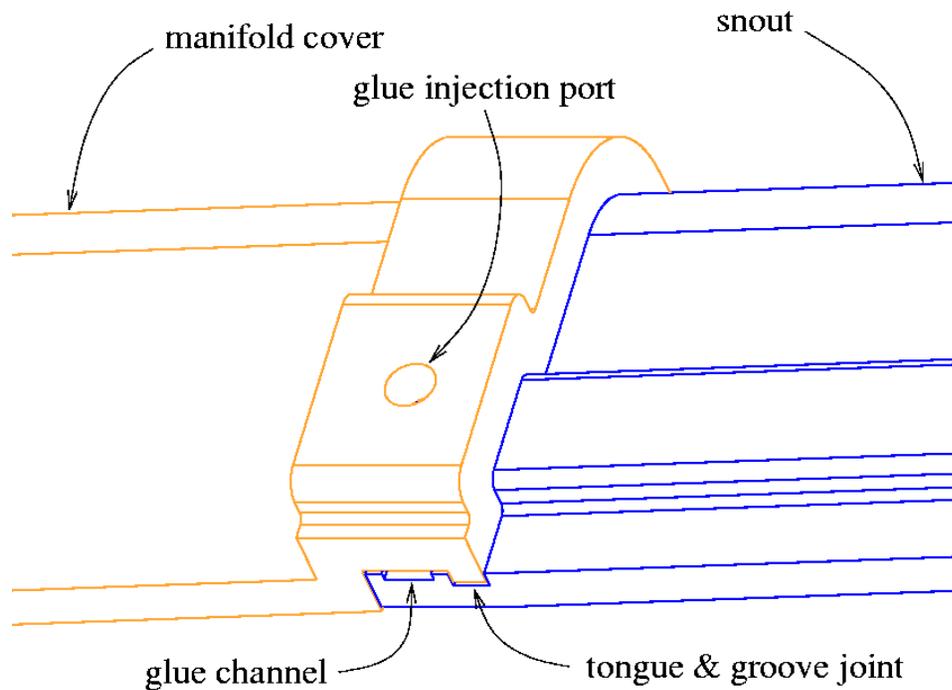
Hermetic seal in back of opt conn



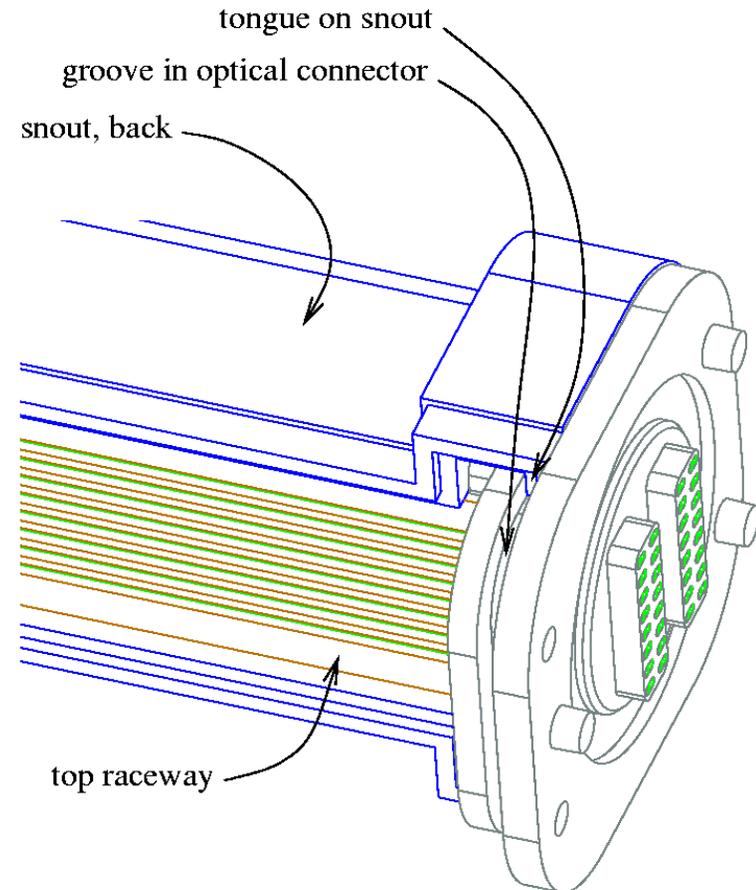
Back of optical connector is cold!



Manifold Glue Seams



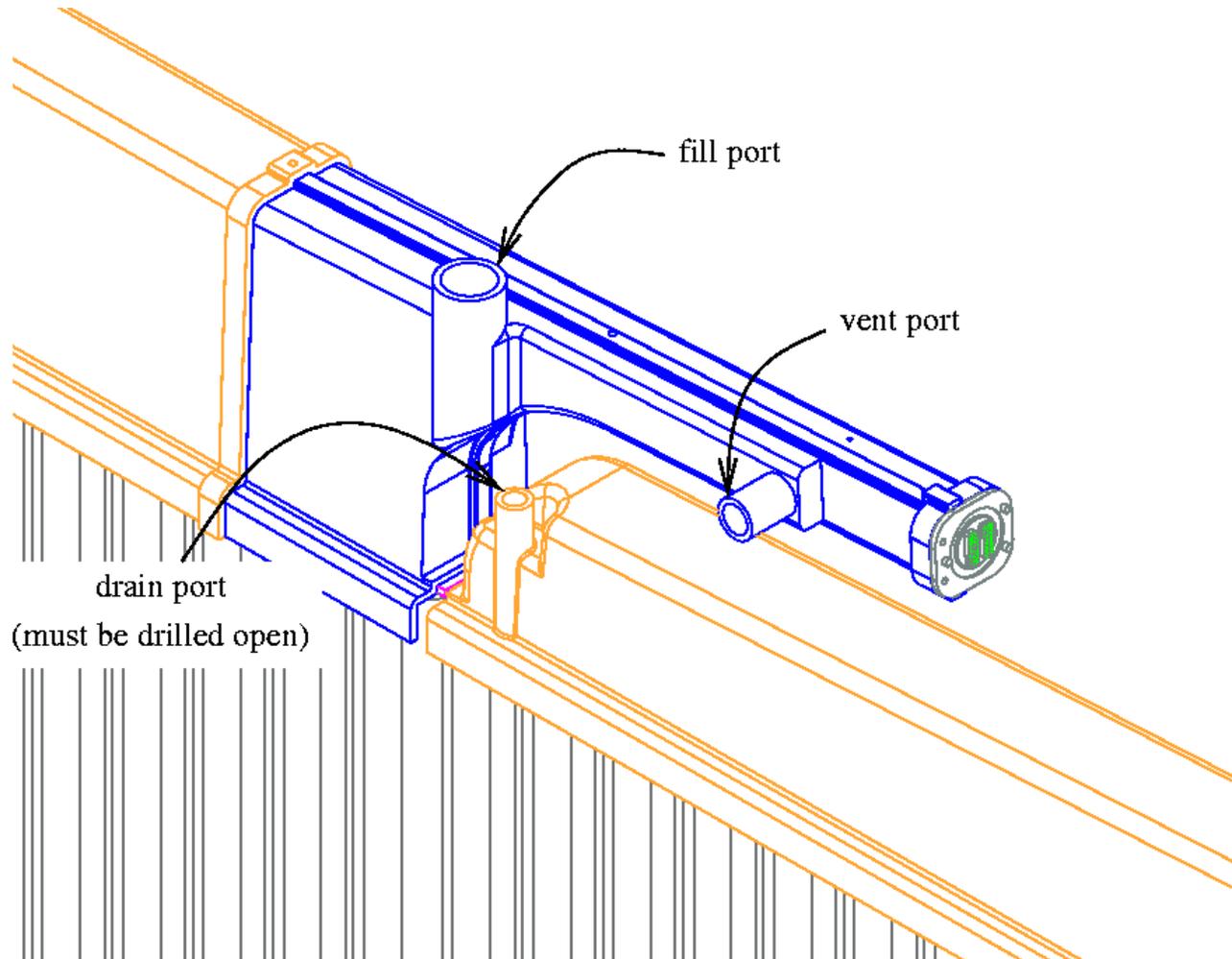
Manifold cover / snout



Snout / optical connector

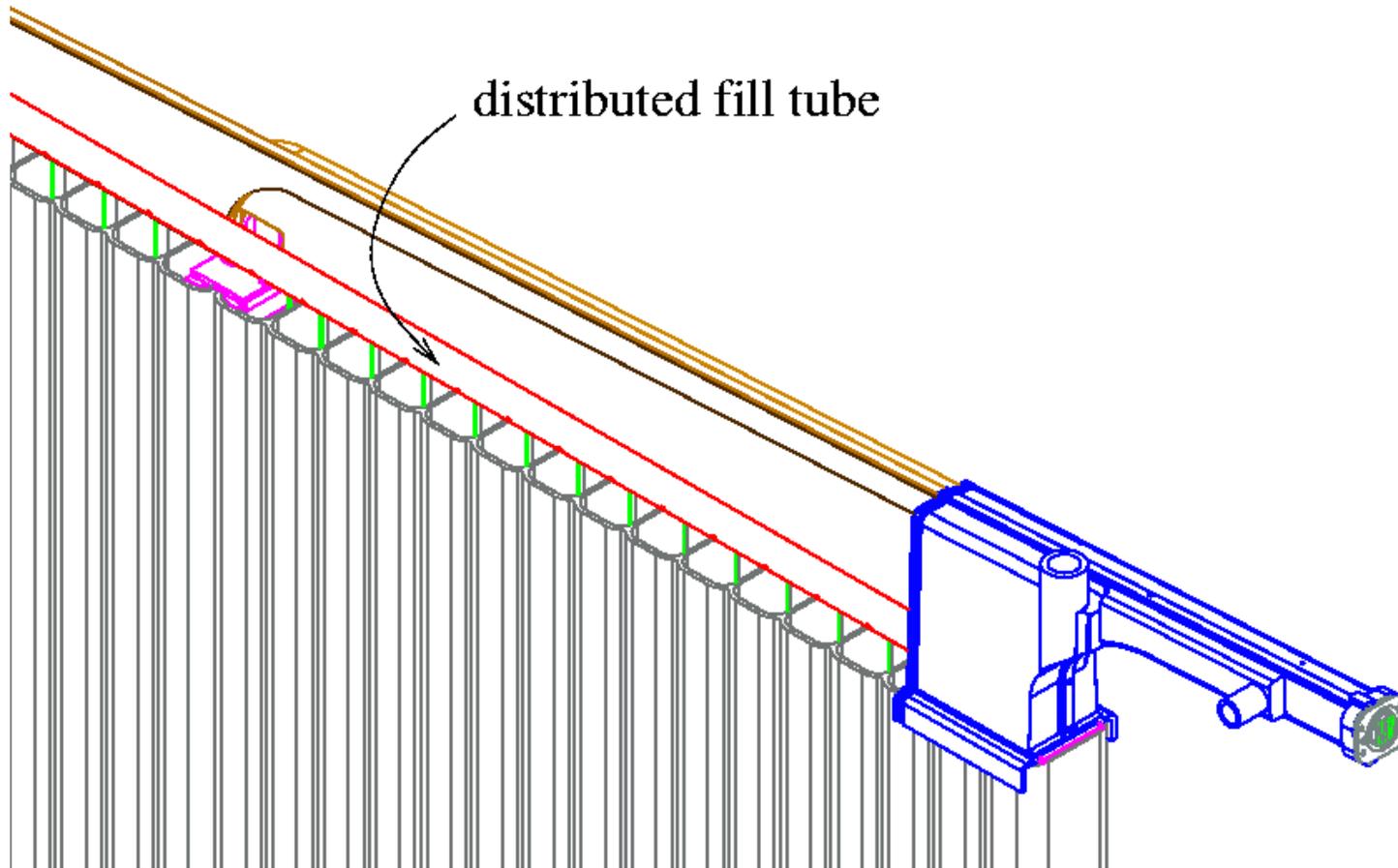


Fill, Vent & Drain Ports





Distributed Fill Tube



Distributes scintillator from fill port to each extrusion cell



Summary: Module Design

- End plate design
 - Minimizes cleavage peel joints
 - Side seals accommodate large width tolerances
 - Low cost extrusions
- Module adhesive testing
 - 3M 2216 for sealing; Plastic Welder for strength
 - Testing validates potentially large gaps
- Manifold design
 - Provides fill, vent & electronics interfaces
 - Robust fiber protection
 - < 15 cm height
 - Tongue-and-groove glue joints