Novel Capsule Fill Tube and Hydrodynamic Growth Radiography (HGR) Assembly

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Outline

☑️ HGR
  ☑️ Overview
  ❑ Laser Drilling & Divot Ablation
  ❑ Fill Tube Assembly
  ❑ Measurements

❑ Telescoping “Fishing Pole” CFTA
  ❑ Overview
  ❑ Assembly
  ❑ Measurements & Testing

❑ Conclusion
A variety of fill tube modifications including engineered divots on capsules surface showcase the HGR design effort.
A multitude of steps and processes are exchanged during fabrication of a completed HGR target assembly.
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Dissimilar and angled fill holes are laser drilled at specific locations for tube attachment

- 10 and 30 µm fill tube holes are drilled 60 degrees apart at a depth of 200 µm on the Porcupine Plus.
- A 10 µm fill tube hole is drilled at a 45 degree angle for the Sundial.

Dual drill hole UV laser setup for Porcupine Plus and Sundial
Precision laser machined divots are engineered on the capsule surface for implosion reference

- Two 300 nanometer deep by 70 µm diameter divots are laser ablated on a GDP capsule 30 degrees apart from one another.
- Custom CNC rastering programing was developed to achieve uniform divots.

Top view of Sundial fill tube with divots

3D image of divot

10 µm fill tube illuminated

Oral presentation by N. Alfonso on Wed 11:40 for more
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Surrogate fill tubes are purposefully plugged and glued into capsule drill holes for implosion reference.

- **Cut & plugged 10 µm fill tube**
- **UV Glue Plug**
- **Glue dispense to Sundial HGR**
- **CFTA station Sundial 45 degree setup**
UV cure setup was critical in determining shadowing effects caused from the fill tube.

### Fixed UV source setup on CFTA station

#### UV Source

- **Source-to-Capsule Distance**: 34 mm
- **Exposure Time**:
  1. GDP = 45 sec
  2. Be/HDC = 90 sec
- **Source Angle**: 12 deg
- **Measured Output Energy**: 200 mW

Alignment notches are made on the Au Cones and Capsule for assembly reference.

Oral presentations by S. Baxamusa and H. Reynolds on photo oxidation.
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**Measurements**
- Telescoping “Fishing Pole” CFTA
  - Overview
  - Assembly
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**Conclusion**
Radiography and Wyko are used to verify divot shape, fill tube angles, diameters, insertion and exposed lengths.

**Fill Tube Specifications**
- Tip O.D. = 10 µm +/- 0.5 µm
- Length = 1 mm +/- 0.1 mm
- Plug Length = 100 µm +/- 0.1 µm
- Insert Depth = 40 µm +/- 30/-10 µm
- Angle = 20º

**Divot Specifications**
- Diameter = 40 µm +50 -0
- Depth = 300 nm +/- 100 nm PTV
- Angle = 30º

**WYKO Scan of divot depth and diameter**

**Radiography of dual 10 µm fill tube Porcupine**

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  - Overview
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Alternative capsule support was developed due to tenting material seen during implosion.

Tenting material seen during implosion

Telescoping fishing pole CFTA

Photo courtesy of Sean Felker at LLNL
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- Challenges
Assembly construction steps of a telescoping retro-fitted CFTA

**Step #1**
Testing Pre-Tube Assembly
- 150 µm O.D. x 30 µm I.D.

**Step #2**
Retro-fitting 30 µm I.D. to 75 µm I.D
- 350 µm O.D. x 250 µm I.D. Collar

**Step #3**
30 µm O.D. fill tube tip to 75 µm I.D
- 30 µm fill tube insert.

**Step #4**
10 µm O.D. fill tube tip to 22 µm I.D
- 10 µm fill tube insert.

**ACTUAL Telescoping retro-fitted CFTA in transport cradle**
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Fill tube to capsule glue fillets are precisely measured using a 1 µm tip probe.

Glue fillet radius and height measurements are broken into 4 segments then calculated into a mass.

Standard 10 µm fill tube and glue mass

Measurement locations on glue fillet

2.6 ng of glue
Retro-fitted fishing pole CFTA’s have been successfully He leak tested at both ambient and cryogenic conditions.

1. Start of Test

2. CFTA Pump down to background level

3. CFTA Opened to Helium
   Ambient Permeation Rate = 3.0E-7 atm/cc per sec

4. CFTA Begins Cool Down
   25min under LN2 Temp

5. Cryogenic Permeation Rate
   1.0E-11 atm/cc per sec

6. Warm back to Ambient verifying Helium still exists in line
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The HGR target build presented a great number of challenges that were overcome.

- 1mm fill tube positioning and gluing
- Precise located laser ablation of multiple divots with angled drill holes
- Capsule fixture fabrication and transporting devices

The two biggest areas of concern seen during a Target implosion are:

1. Fill Tube
   The HGR builds analyzes fill tube effects.

2. Tenting Material
   The Telescoping CFTA analyzes effects WITHOUT tenting material

During 2016 over 40 HGR assemblies and Telescoping Retro-fitted CFTA’s have been built by GA and delivered to NIF.
Questions?

“Cap Pack” Team