

Linden Photonics
Proprietary Information

Development of Buoyant Optical Fiber

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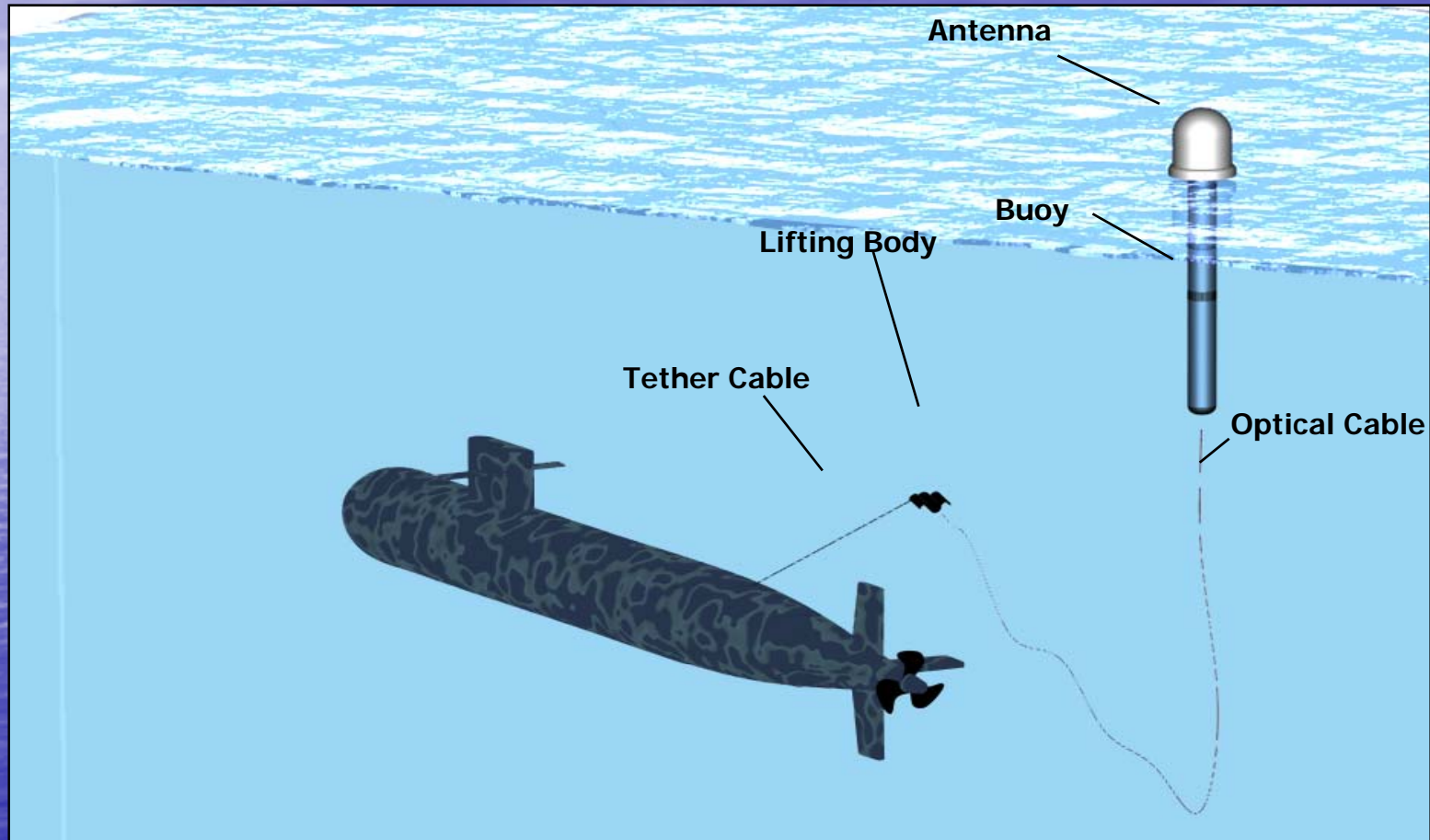
Linden Photonics Inc.

Optical μ packaging

270 Littleton Road, Unit # 29, Westford, MA 01886. Tel.: 978-392-7985; Fax: 413-714-5084

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Fiber Optic Tethered Buoy

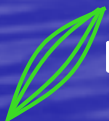
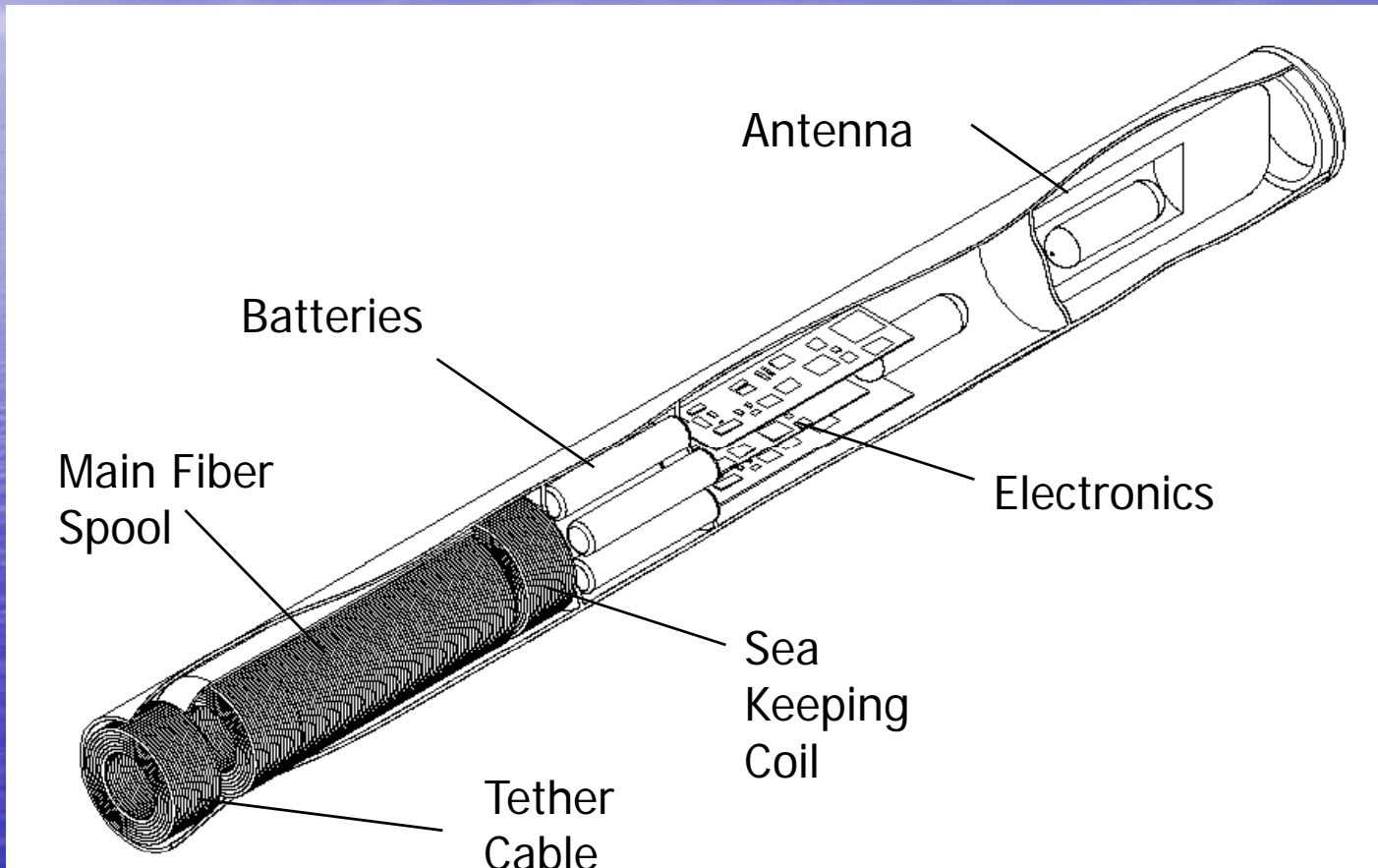


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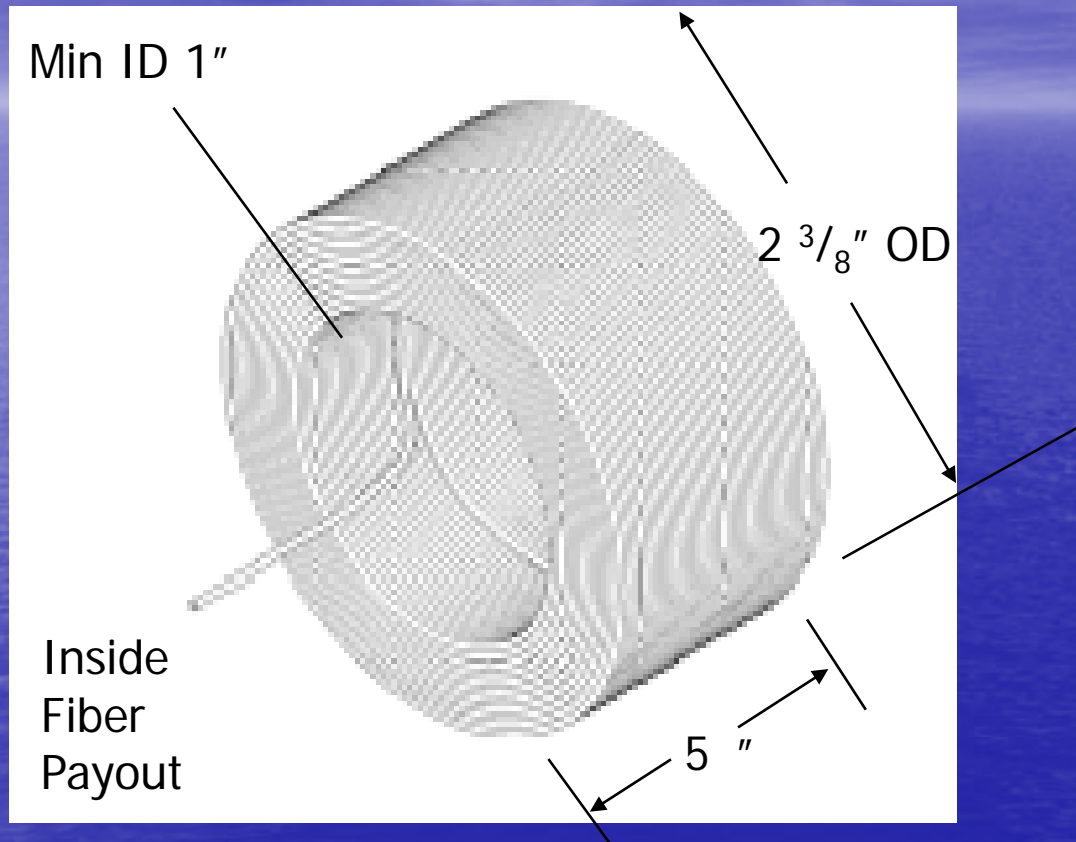
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SSXBT BUOY CONSTRUCTION



Main Coil Dimensions

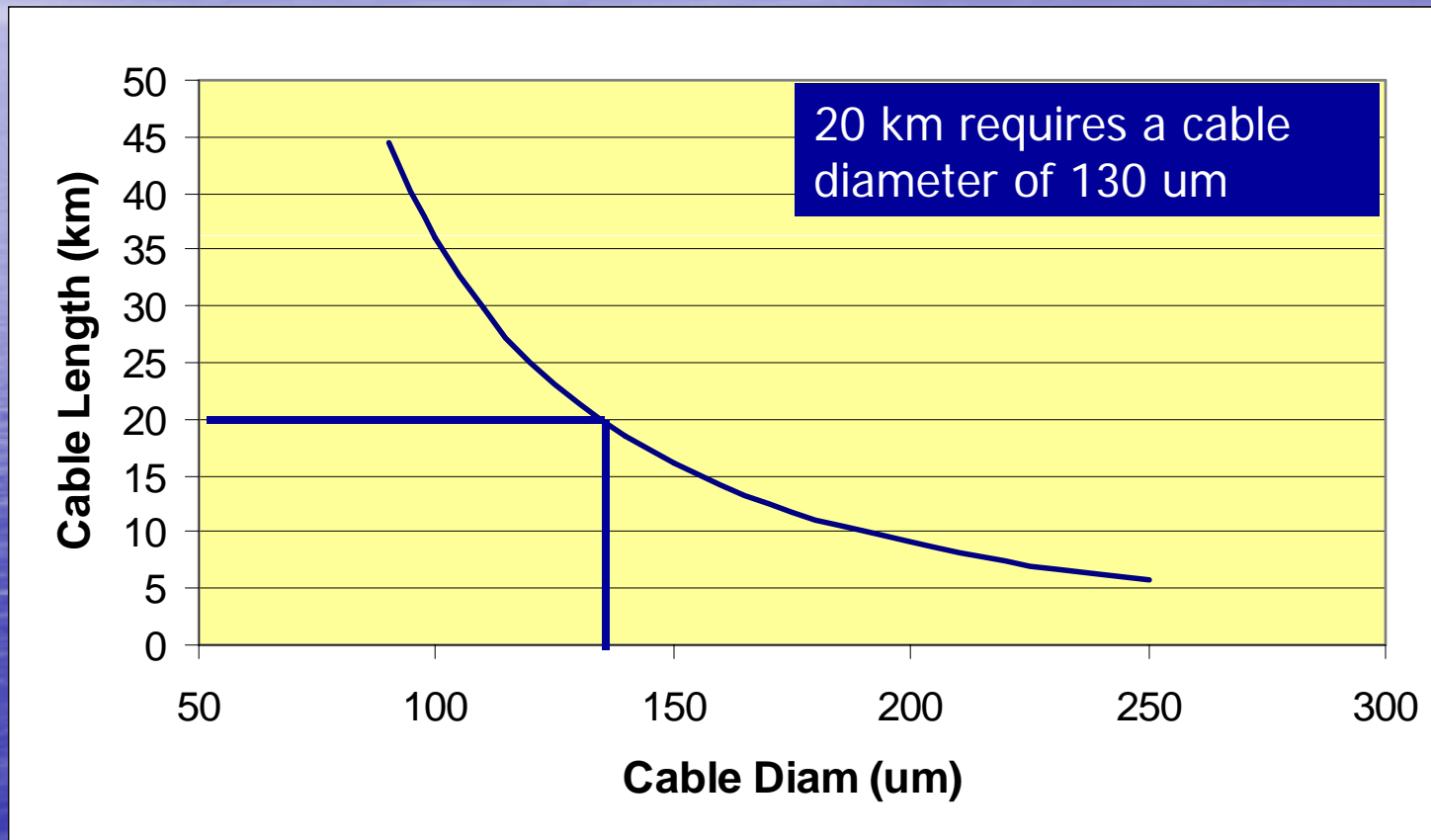


Basic System Requirements

- Long Length 20+ km
- Positive or neutral buoyancy
- Low Optical Loss 8.6 dB
- High deployment speed 15 + kts



Cable Length as a Function of Diameter



Achieving Neutral Buoyancy

Design Options Investigated

- Low density Jacket
 - Intrinsic
 - With Filler (micro-spheres)

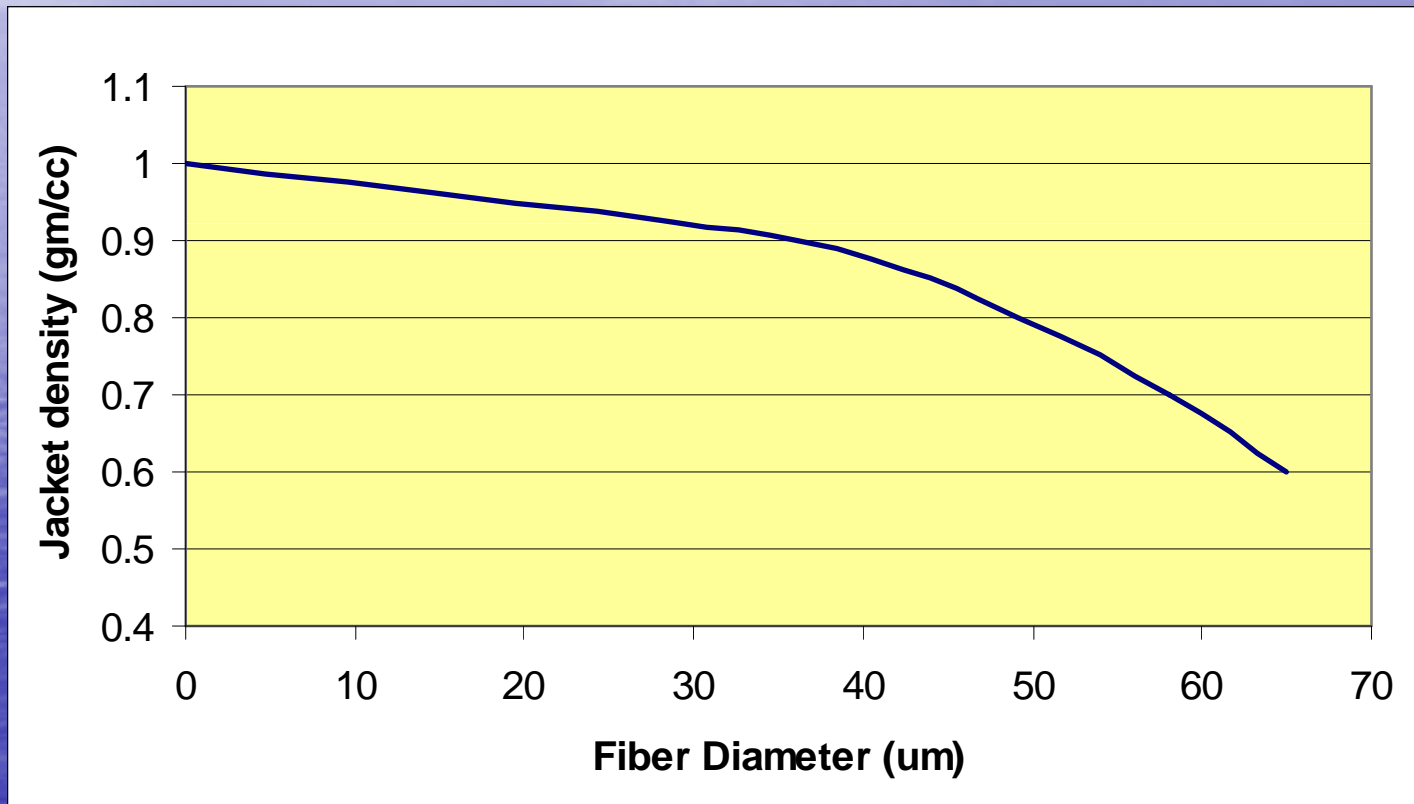


Low Density, Tight Buffer Coating

- Only viable option for 130 um OD Cable
- Requires low density polymer.
- Coating must be applied during fiber draw to maintain strength.
 - Requires special fiber drawing equipment

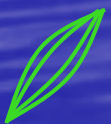


Fiber (glass) Diameter as a function of Jacket Density Tight Buffered Cable



Low density Polymer Jacket Candidate Materials

Polymer	Density gm/cc	Modulus (kpsi)	Strength (kpsi)
TPX MX002	0.835	114	2.9
TPX MX004	0.834	255	2.9
TPX RT31	0.833	270	2.9
Nylon 6	1.1	420	5.8
LCP	1.4	4000	100
LDPE	0.92	28	1.5

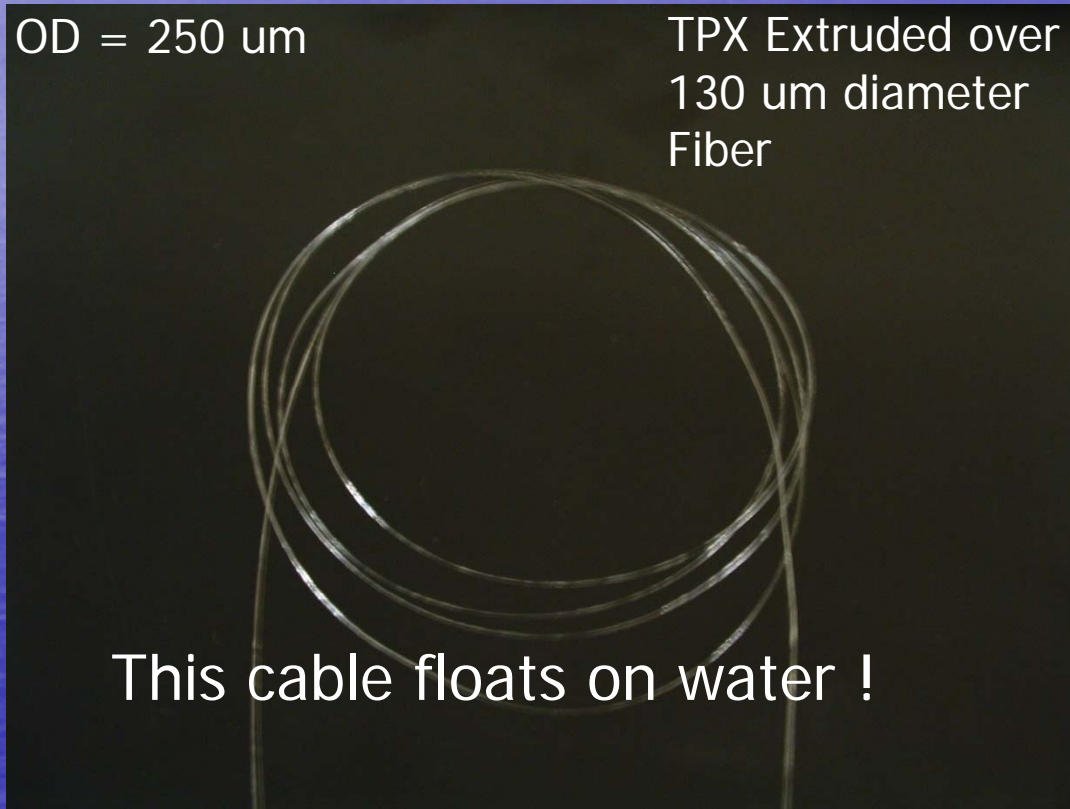


TPX Coated Buoyant optical Fiber

Fabricated under Phase I at Dunn Industries

OD = 250 μm

TPX Extruded over
130 μm diameter
Fiber



This cable floats on water !



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Low Optical Loss

- Attenuation of total cable < 8.6 db
 - Requires < 0.4 db/km for 20 km cable
- Loss due to winding must be minimized by increasing NA of fiber



Coating System

Built Under Navy Contract to explore use of low density filler materials

Curing
Furnace



Capstan



Coating Cup

Fiber Take up



Fiber Requirements

- Reduced Cladding
 - Maximum Cable diameter 130 μm
- Bend insensitive
 - Minimum Bend Radius 10 mm
 - Numerical Aperture 0.17 or higher
- High Proof Test Level
 - Need 200 kpsi minimum
- Low Cost



Specialty Fiber Fabrication

Linden acquires high NA fiber from
StockerYale, Salem, NH

- Have manufactured 25 um dia. Fiber
- Experienced with in-line extruded buffer coatings.
- Have Comprehensive test and characterization facilities



Facilities



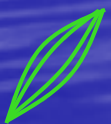
Optical Characterization



In Line Coating



Mechanical Testing



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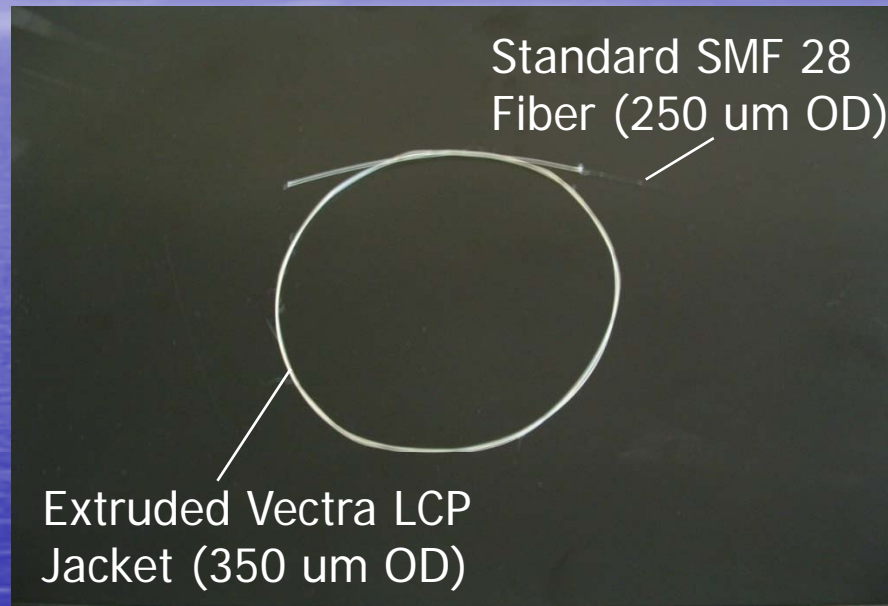
Linden Related Work

Strong Torpedo Fiber Optic Cable (STFOC)

- Utilizes Linden's Proprietary high modulus Liquid Crystal Polymer (LCP) Coating
- Small diameter 0.014" - 0.030"
- High Strength > 100 kpsi
- Low Attenuation 0.25 dB/km @ 1550 nm
- Demonstrated Deployment at 50 ft/sec



Miniature LCP Jacketed Optical Fiber Cable



Linden has extruded multi km lengths of low loss (0.25 db/km) Miniature LCP jacketed cable

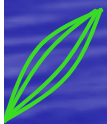


Extrusion

- Linden is working in collaboration with the Plastic Engineering Dept. at UMass Lowell on the development of novel fiber coating techniques.



3/4" Plastic Extruder



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Thank You!



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