Fiber Optic System Qualification at Goddard Space Flight Center

Cable Assemblies for Space Flight

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Goddard Space Flight Center

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Outline

- Justification
- Goals
- Applications
- Terminology
- Performance Requirements
- Needs
- Lessons Learned
- Available Technologies
- Candidates
- Future Activities

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Justification

- Corning fiber 100/140 discontinued.
- SMA connectors non repeatable performance, discontinued.
- Research and Development being driven by telecommunications.
- Push for COTS parts for projects to cost cut.

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Goals

- NASA wide use.
- Multimode and singlemode applications.
- Cable assembly using Commercial-Off-the-Shelf Technology (COTS).
- Sharing available data.
- Partnerships with vendors.
- Wide variety of products with parameters for usage.

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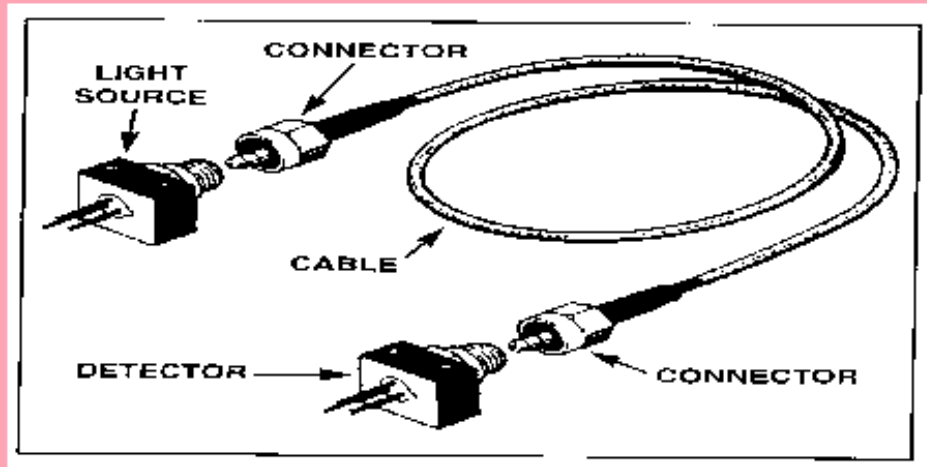
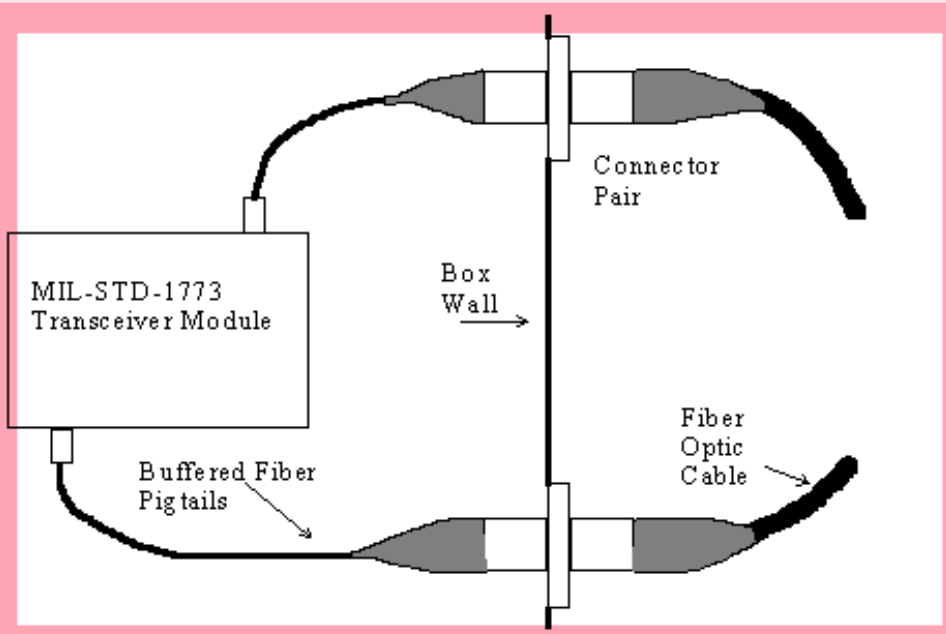
Applications

- Point-to-Point Spacecraft (> 10 meters)



- Sub-Box Jumpers (@ 0.5 m)



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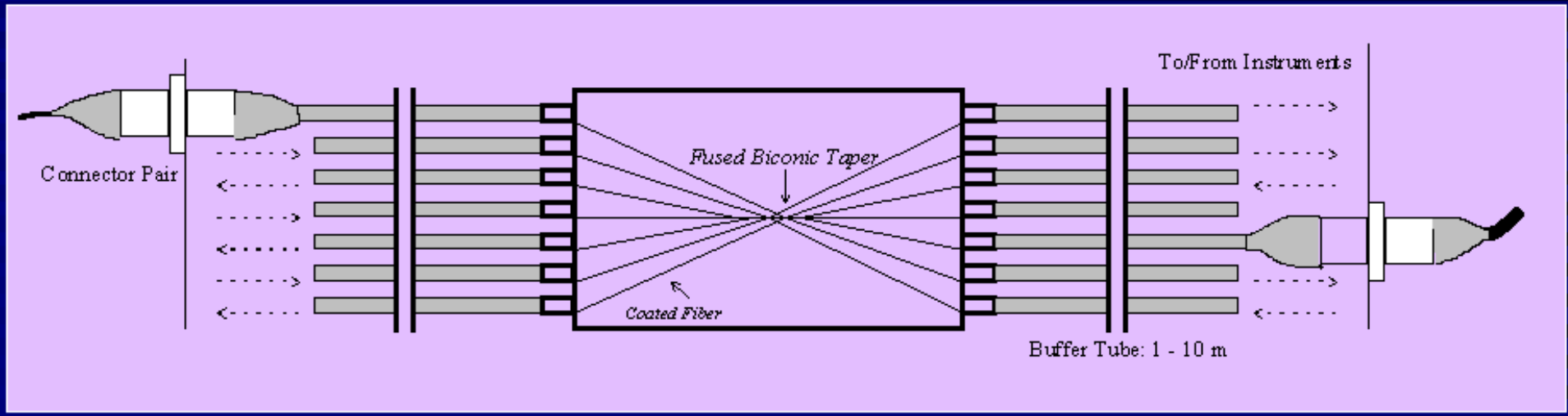
Applications

- Extra Vehicular Harness
- Singlemode and Multimode



- Couplers
  - –coated fiber inside coupler
  - –external packaging

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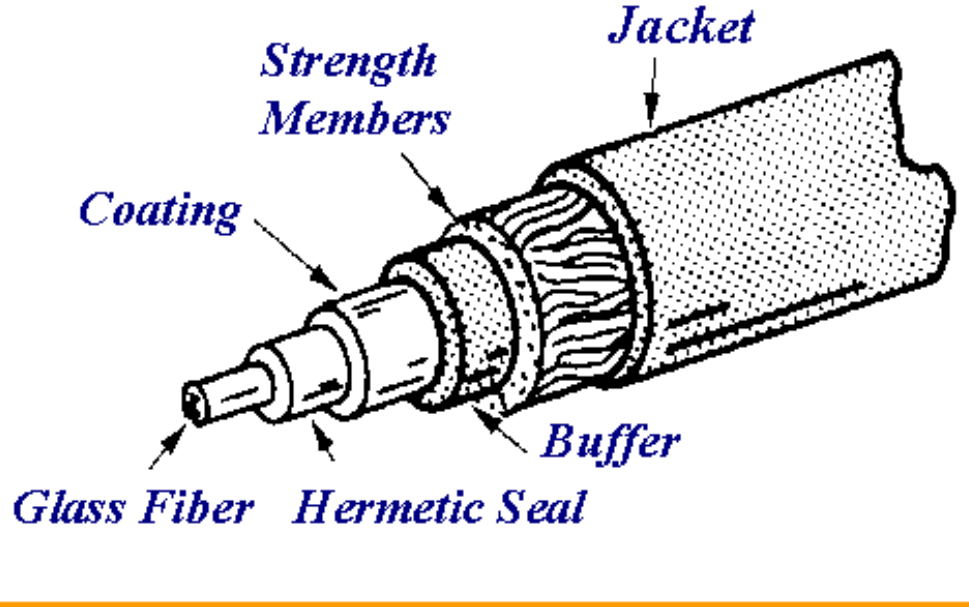
Terminology of Cable

- Glass Fiber
  - –core and cladding
- Hermetic Seal layer
- Coating
- Buffer
  - –loose tube, tight tube
- Strength Members
- Jacket



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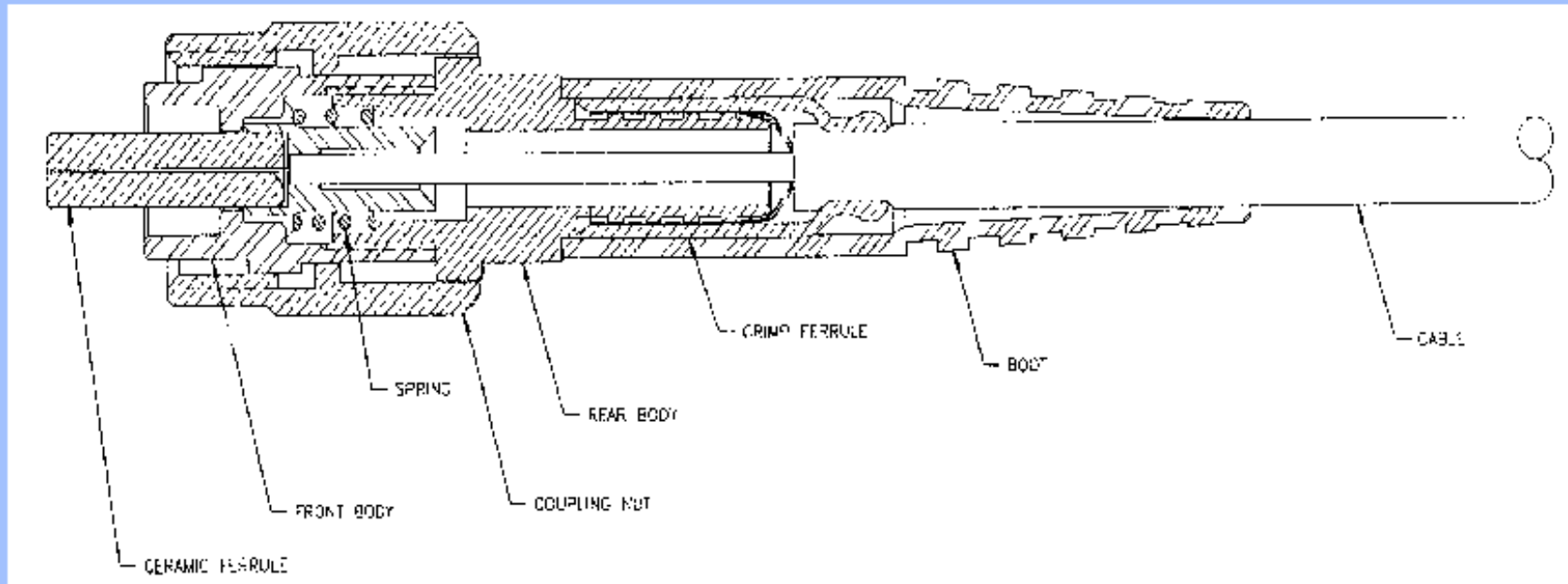

Connector Cross-Section

- **Ferrule**
- **Boot**
- **Coupling Nut**

Terminology of Connector

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Performance Requirements

- Maximum Insertion Loss:
  - singlemode: 0.5 dB multimode: 1.0 dB
- Maximum Delta for Insertion Loss:
  - singlemode: 0.4 dB multimode: 0.7 dB
- Connection Repeatability: 0.1 dB
- Pull-Proof

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Needs

Will Develop into Requirements as the Design Matures:

- Total Dose Radiation Tolerance.
- Atomic Oxygen Resistance.
- Crush Resistance.
- Thermal Vacuum & Thermal Stability.
- Outgassing.
- Bend Radius.

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Lessons Learned

- Shrinkage of Fluoropolymers: Teflon & Tefzel (TFE, ETFE, PFA, FEP) - causes optical losses.
- Hygroscopic Behavior of Kevlar.
- Strippability of Polyimide Coating.
- Processing Control of Acrylate Material (affect on stripping).
- Outgassing of Acrylate Fiber Coating.
- Contacting Fiber Connection : Pull-Proof.
- Dimensional Compatibilities.
- Hermetic Coating Fabrication.

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Available Technologies

Fiber Development

- Use of available rad tolerant technologies:
  - Spectran 100/140 micron Corning 9/125 micron
- Hermetic Coating:
  - Amorphous Carbon (200 A)
- Silicone
  - Contamination
- Primary Coating:
  - Acrylate:
    - Consistent Strippability - Process Control
    - Outgassing
    - Spectran's Formulation Limited to Max of 85C
  - Polyimide
    - Strippability (sulfuric acid)
    - Max of 125C

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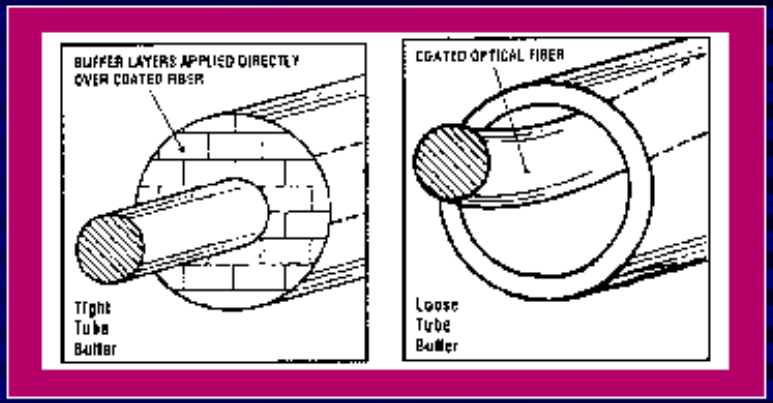
Available Technologies

Cable Development

- Buffers
  - –Tight vs Loose
- Strength Members
  - – Teflon Impregnated Fiberglass
    - • bondability
    - • Not an industry standard
  - – Kevlar
    - • industry standard
    - • water vapor retained
- Woven vs Spiral

  (allow 1mm movement w/ pull-proof)



- Jacket
  - – Shrinkage

    Preconditioning
  - – Radiation Shielding

    Metal infusion

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Available Technologies

Connector Types

ST

- Entire body spring loaded.
- No ferrule isolation from connector body.
- Bayonet coupling.

SMA

- Threaded, no key (inconsistent mating).
- Non-PC (physical contact).
- No spring mechanism.
- Being obsoleted.

FC

- Keyed and threaded, consistent mating.
- PC polish ferrule.
- Spring loaded ferrules.
- Pull proof (isolation of ferrule from body.

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Available Technologies

Cable Candidates

- Spectran Flightguide
- Spectran Redesign of Heritage Design
- Gore Single Mode
- Gore Multimode
- Brand-Rex Space Station

Connector Candidates

- Johanson
- Amphenol-Bendix
- Diamond, (FC, DIN)

Assemblies

- Rifocs
- Spectran

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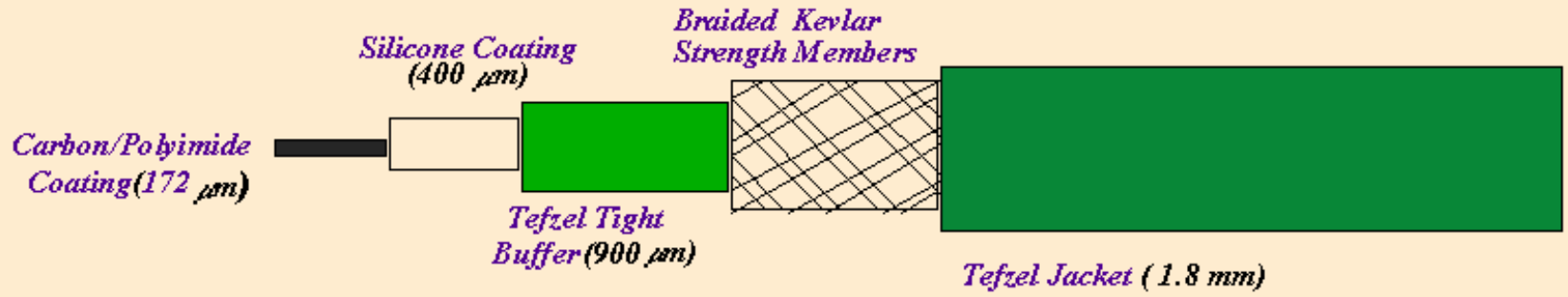
Available Technologies

Spectran Flightguide



Advantages

- Qualification heritage through military.
- Commercially available.
- Rad tolerant to gamma burst.
- Hermetic carbon coating.
- High temp, non-flammable Tefzel.

Disadvantages

- Thermal vacuum stability unknown.
- Polyimide very hard to strip.
- Tefzel highly susceptible to shrinking.
- Low dose space radiation tolerance unknown.
- Too tight for pull-proof connectors.

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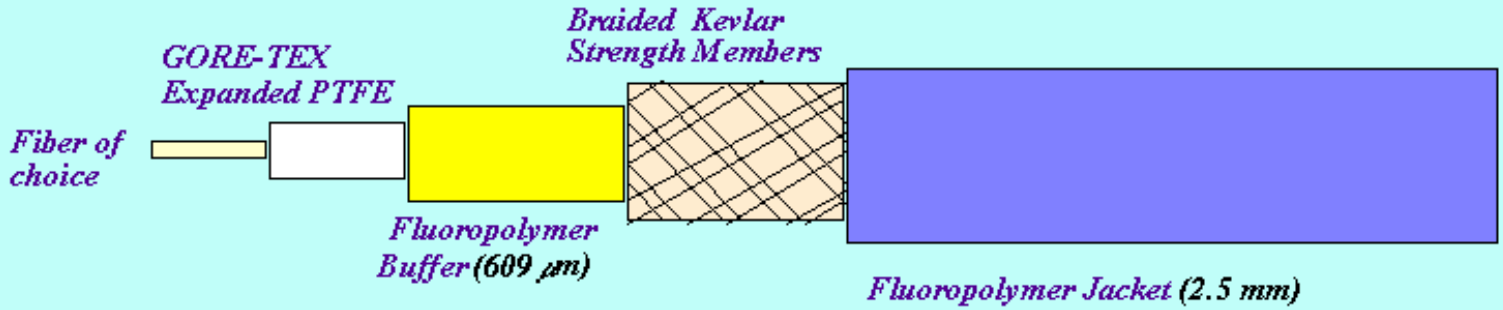
Available Technologies

W. L. Gore, NASA Vacuum Chamber Cable



Advantages

- Available in 12/96.
- Commercially available.
- Designed with input from Lockheed-Martin & NASA.
- Lockheed-Martin choice.
- Any size fiber, versatile.
- Will work with pull-proof FC's

Disadvantages

- No experience terminating wrapped buffer.
- No data on materials yet.
- Gore does not make fiber.

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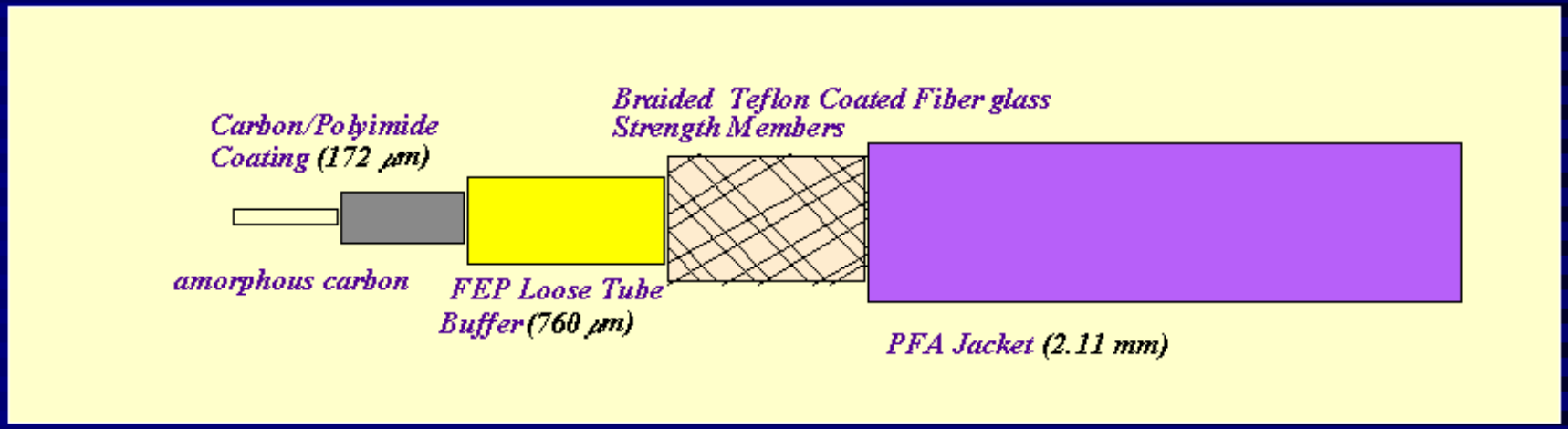
Available Technologies

Brand Rex, Space Station



Advantages

- Heritage.
- Rad hard gamma burst.
- Preconditioning Information.
- Hermetic.

Disadvantages

- Strippability, polyimide.
- Shrinkage.
- Incompatible with pull-proof FC's.

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Future Activities

- Procure final candidates of connectors and cable.
- Finalize test plan, based on construction.
- Testing and evaluation.
- Specification for series of parts.
- Publish results.

Sponsor of this work: Advanced Packaging Interconnect Program, Photonics Applications for Small Spacecraft

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