




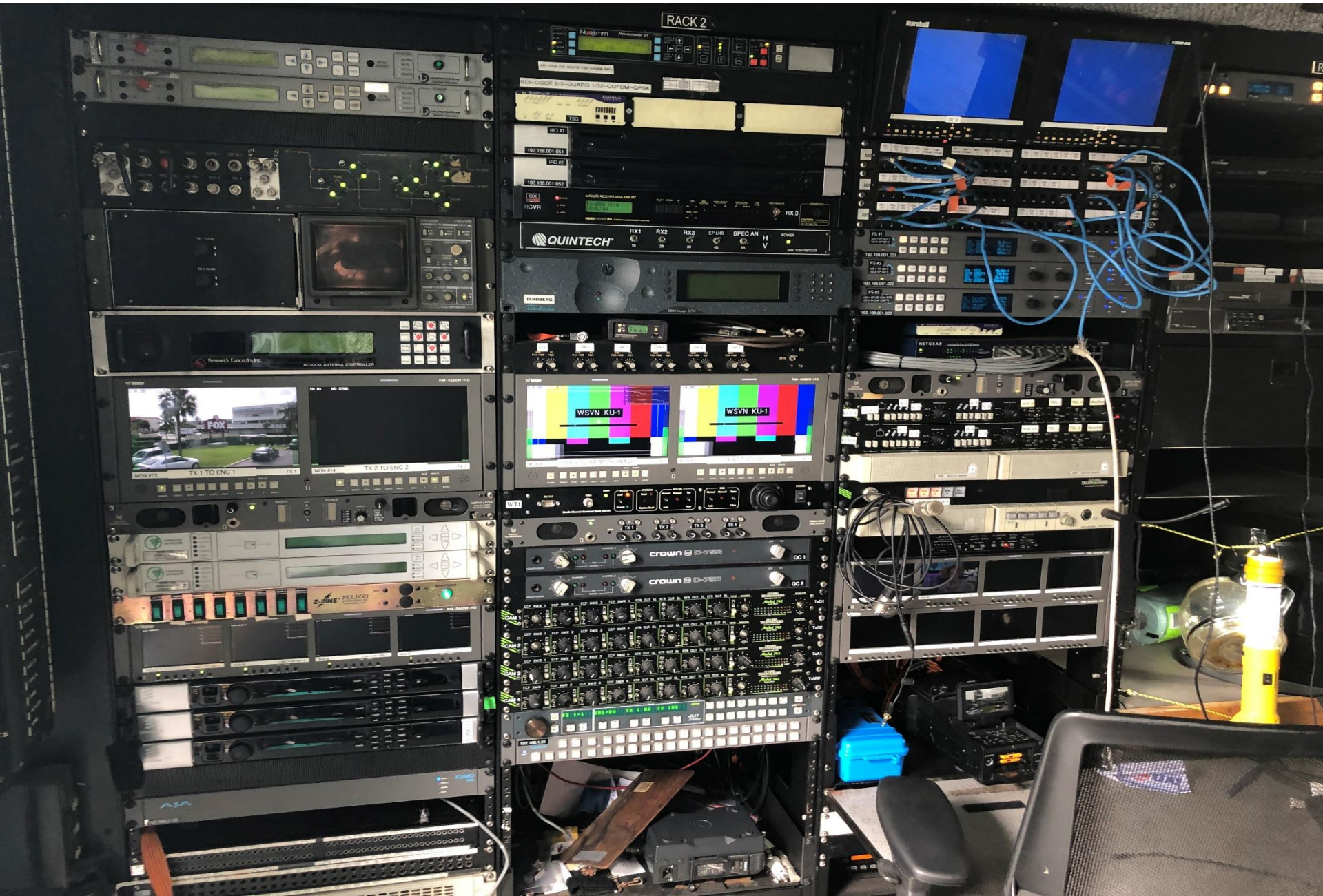
# FIBER OPTICS FOR HD-BROADCAST

# SMPTE Webinar Presentation 2021

## Introduction-Topics of Discussion

1. System Concept Approach in Fiber Design and Installation
  2. From Analog to 24Gb/s-A Brief History of Broadcast Cable Development
  3. Why and Where Do We Use Fiber Optics in AV/Broadcast?
  4. Types of Fiber Optic Cable and Connectors
  5. 4K-8K-Future Standards
  6. Demo-Termination and Troubleshooting
  7. Q&A
- 

# System Approach-Distance +Connection Points





# A BRIEF HISTORY

Transition-Analog-Digital-3D-3G-4K-8K  
HD/3D Mobile Unit at Kennedy Space Center



Shuttle launch filmed in 3-D by AMV Epic  
May 16, 2011  
6.75Gb/s Data Rate

# MAXIMUM\* DISTANCE-COAXIAL CABLES HD-SDI-12G

Data Rate	Cable Family	143 Mb/s	270 Mbs/s	1.5Gb/s	3Gb/s	12Gb/s
		NTSC Composite	Component SD-SDI	HD-SDI	1080p	UHD-TV
Cable Type Belden-Nemal		SMPTE 259M (Meters)	SMPTE 259M (Meters)	SMPTE 292M (Meters)	SMPTE 424M (Meters)	ST2082-1
179DT-1712	Micro	153	116	33	23	-
1855A-1191	Mini RG59	299	240	64	47	-
1505A-1570	RG59	436	339	94	66	
1505F-1570F	RG59 Flx	366	261	69	46	
8281-1185	Analog	436	305	N/A	N/A	
1694A-1580	RG6	544	408	111	76	
1694F-1580F	RG6 Flx	457	326	87	59	
1794A-1585	RG7	740	537	146	100	
7731A-1590	RG11	839	622	166	111	
2191-4855R	Mini 12G	325	244	67	47	45
2570-4505R	RG59-12G	449	329	94	66	63
2580-4694R	RG6-12G	535	407	117	82	89

ALL DISTANCES ARE RECOMMENDED VALUES AND CAN VARY BASED ON PARTICULAR INSTALLATION

Standards: loss @ ½ clock frequency: SMPTE 259=30db SMPTE 292 and 424=20db ST2081=40db. NOTE: BER can vary dramatically as calculated limits are approached





# TRIAx v. FIBER

## PAL TO NTSC ADAPTERS-WORLD CUP 2015

- \*Dimensional Tolerances
- \*Materials-Insulation and Separator
- \*High Frequency Performance



# HD VIDEO CONNECTORS

MINI DIN



BNC/ 12G BNC/HD-BNC



# WHERE DO WE USE FIBER OPTICS?

## Audio and Video Systems

- Camera Boom
- Instrumentation
- Control
- Mixers & Synthesizers
- TV Studios
- Recording Studios
- Sound Systems
- Microphones
- Lighting Controls

## Video Walls

## Data

## HDMI Extenders

## HD Cameras (SMPTE)

- Mobile Units
- Remote Camera





# WHAT ARE THE ADVANTAGES OF OPTICAL FIBERS?



**Increased bandwidth - more information** ✓

**Lower losses - longer distances** ✓

**Smaller size & lighter weight - easier to handle** ✓

**Interference immunity - no EMI** ✓

**Transmission security - very difficult to tap** ✓

**Open circuit failure mode-no short circuits** ✓

**Inexpensive abundant raw materials** ✓

# Relative Max Distance-Copper v. Fiber

SINGLE  
MODE

RG11

RG6

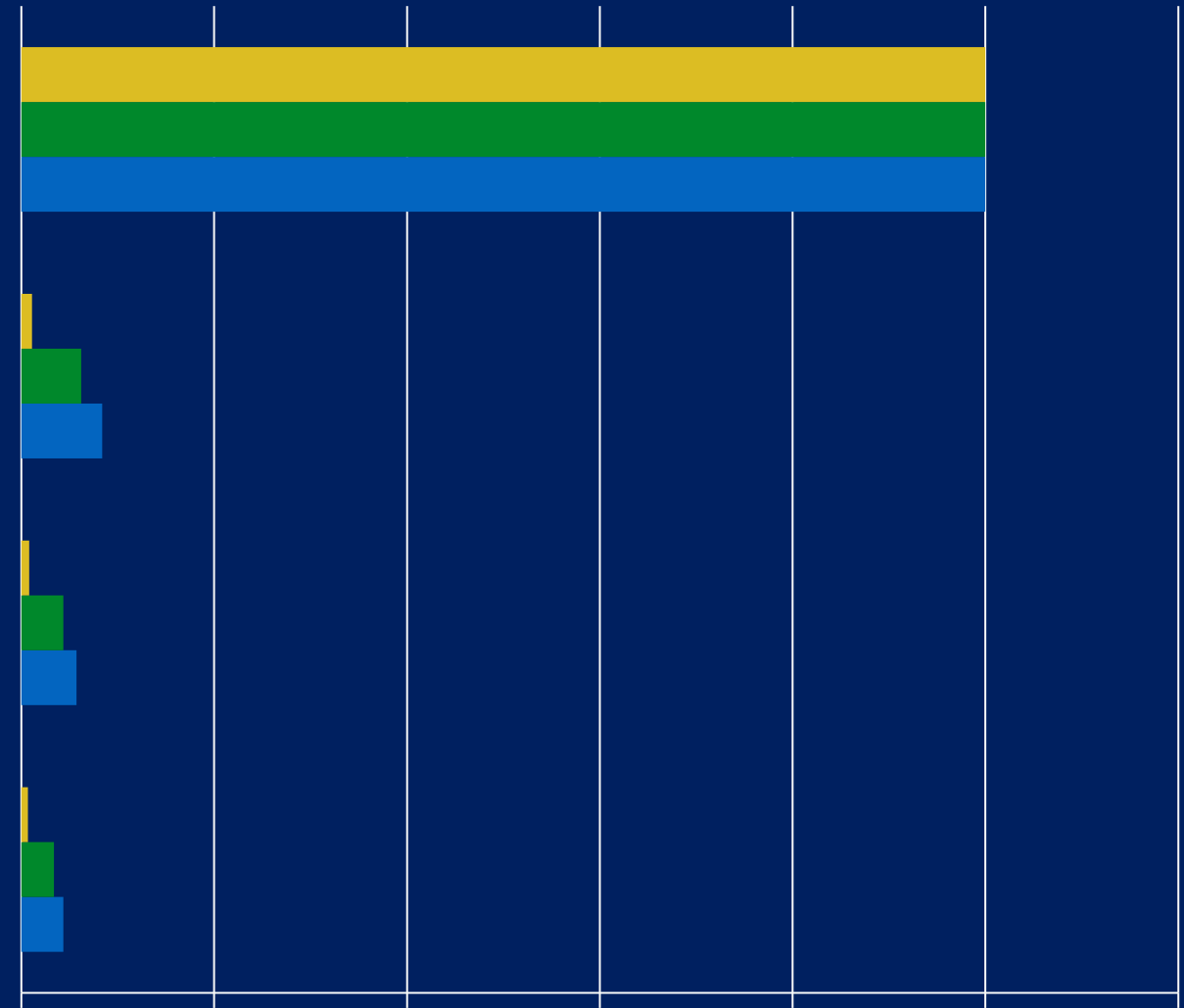
RG59

■ SMPTE 311 HD

■ SMPTE 259M Component

■ SMPTE 259M Composite

0 2000 4000 6000 8000 10000 12000





# SIZE COMPARISON: FIBER VS COPPER

To transmit the same information

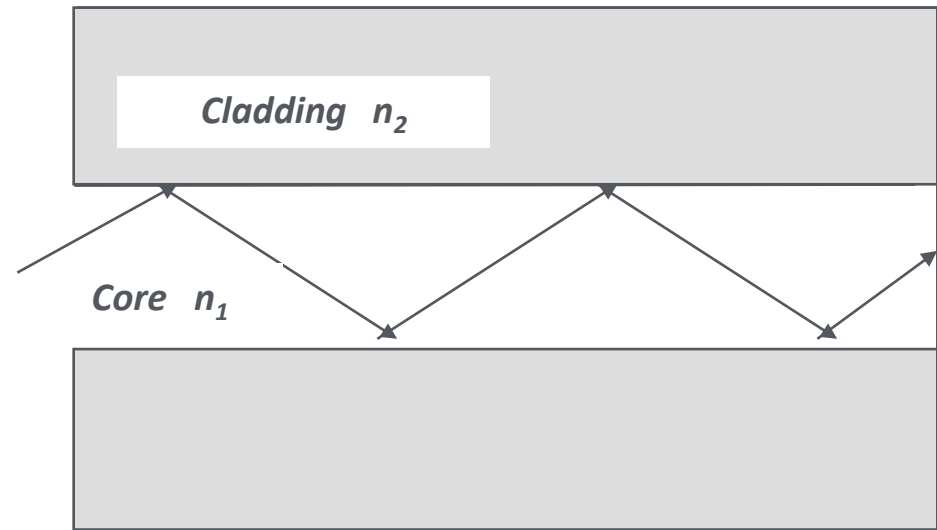
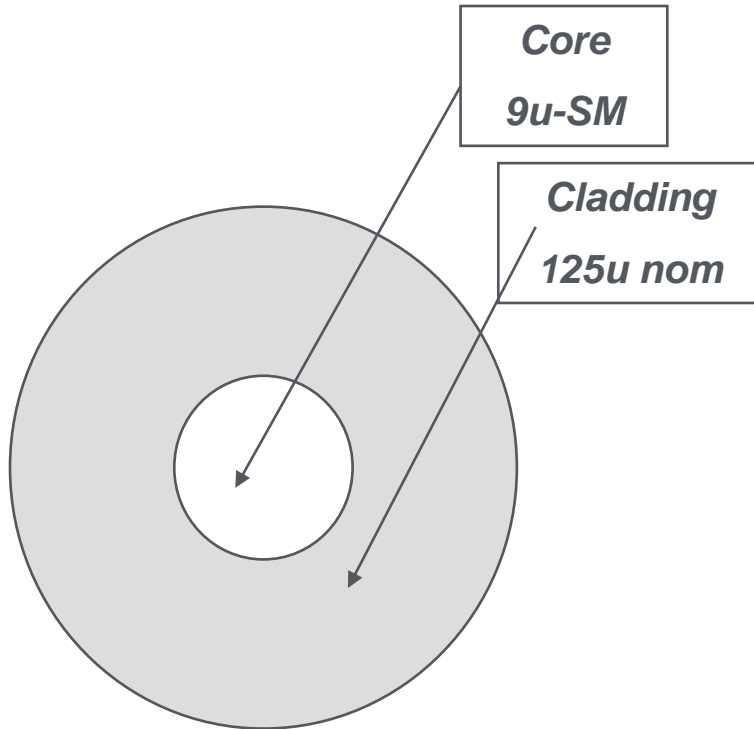


Digital audio cable  
Diameter: 29mm  
Weight: 89kg/km



Singlemode (1 fiber)  
Diameter: 2.6mm  
Weight 4kg/km

# CONSTRUCTION OF FIBER CABLE



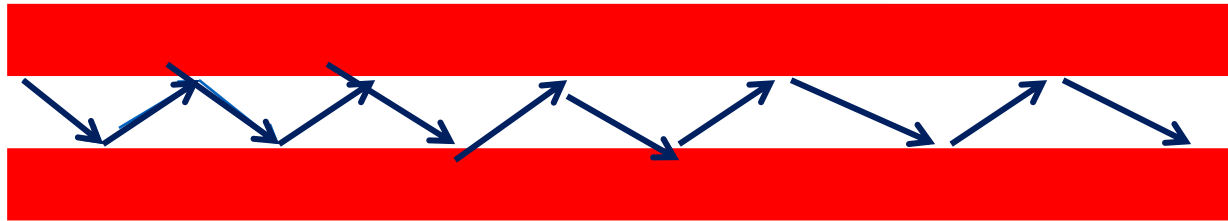
**Total Internal Reflection in an optical fiber**

Fibers consist of centric elements of either plastic or glass. Light is guided through the fiber by Total Internal Reflection at the interface between the core and the cladding, where the core has a slightly higher index of refraction.



# SINGLE MODE vs MULTIMODE

Multimode-Multiple signal paths



Singlemode-1 path-no reflections

# OPTICAL CHARACTERISTICS

Fiber Type	OS2 Singlemode	OM1	OM3	OM4
Diameter core/cladding (buffer)	9/125μm (900μm)	62.5/125μm (900μm)	50/125μm (900μm)	50/125μm (900μm)
Wavelength (typical)	1310/1550nm	850/1300nm	850/1300nm	850/1300nm
Max Attenuation	0.5db/km	3.5db/km	3.5db/km	2.3db/km
Bandwidth	100THZ	200MHZ@850	1500MHZ@850	3500MHZ@850
Distance Limit (10Gb/s)	80km	30meters	300meters	550meters



# FREQUENCY vs WAVELENGTH

## FREQUENCY

## WAVELENGTH

1 MHZ

300 Meters

100 MHZ

3 Meters

1 GHZ

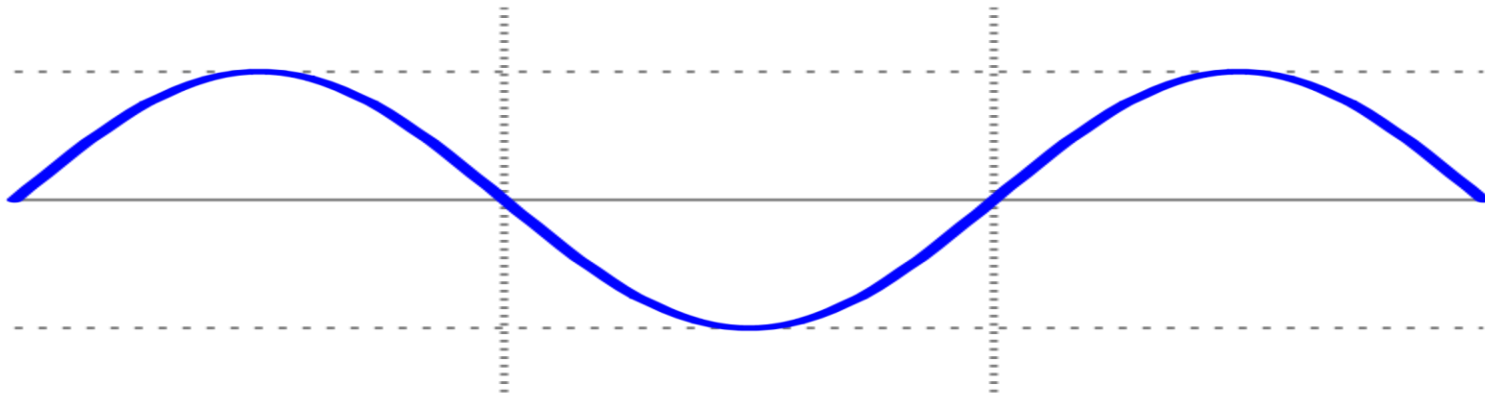
30 CM

100 GHZ

3mm

$3 \times 10^{14}$  Hz

$1 \mu (10^{-4} \text{ Meter})$



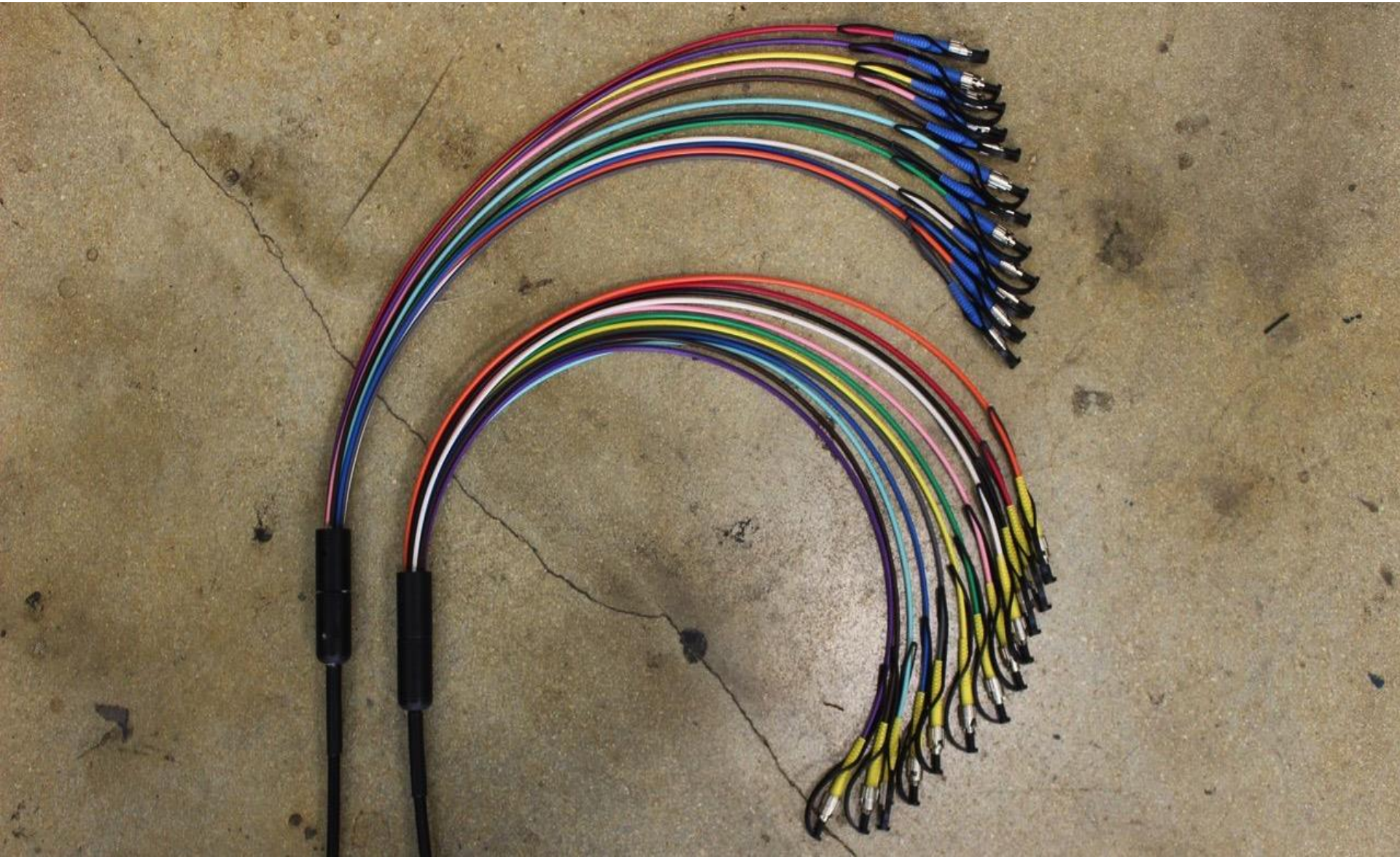
# DISTRIBUTION FIBER



No individual jacket  
Requires breakout kit or direct  
connection to a panel  
Lightweight-Reduced Diameter

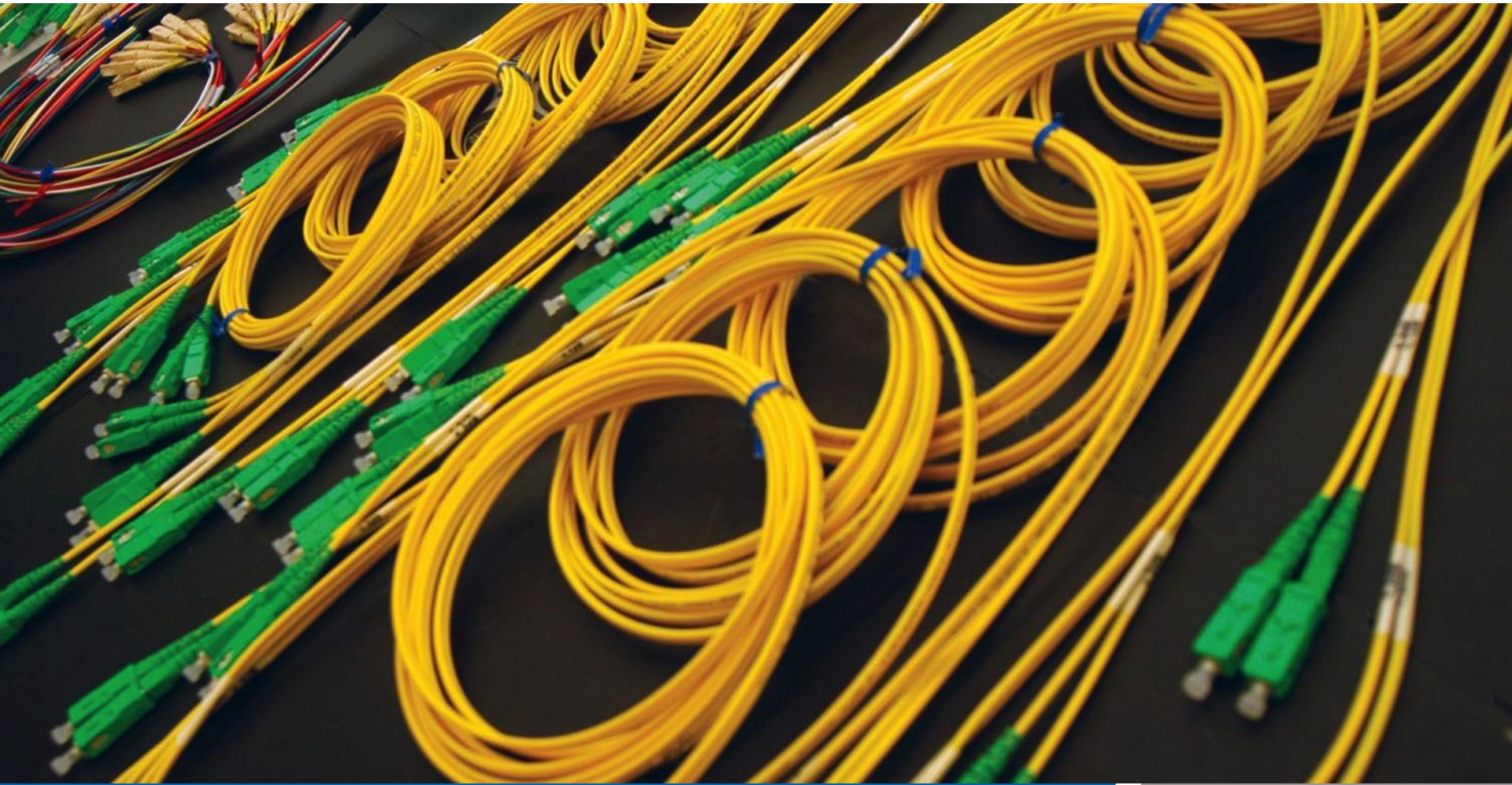


# BREAKOUT KIT v. BREAKOUT FIBER CABLE





# FIBER PATCH CORDS – 1.6mm, 2mm, 3mm Which is best for YOUR needs?



# TACTICAL FIBER CABLE

## Characteristics:

### Distribution 900u

- Single-mode
- Multimode
- 2-12 Fibers
- Lightweight

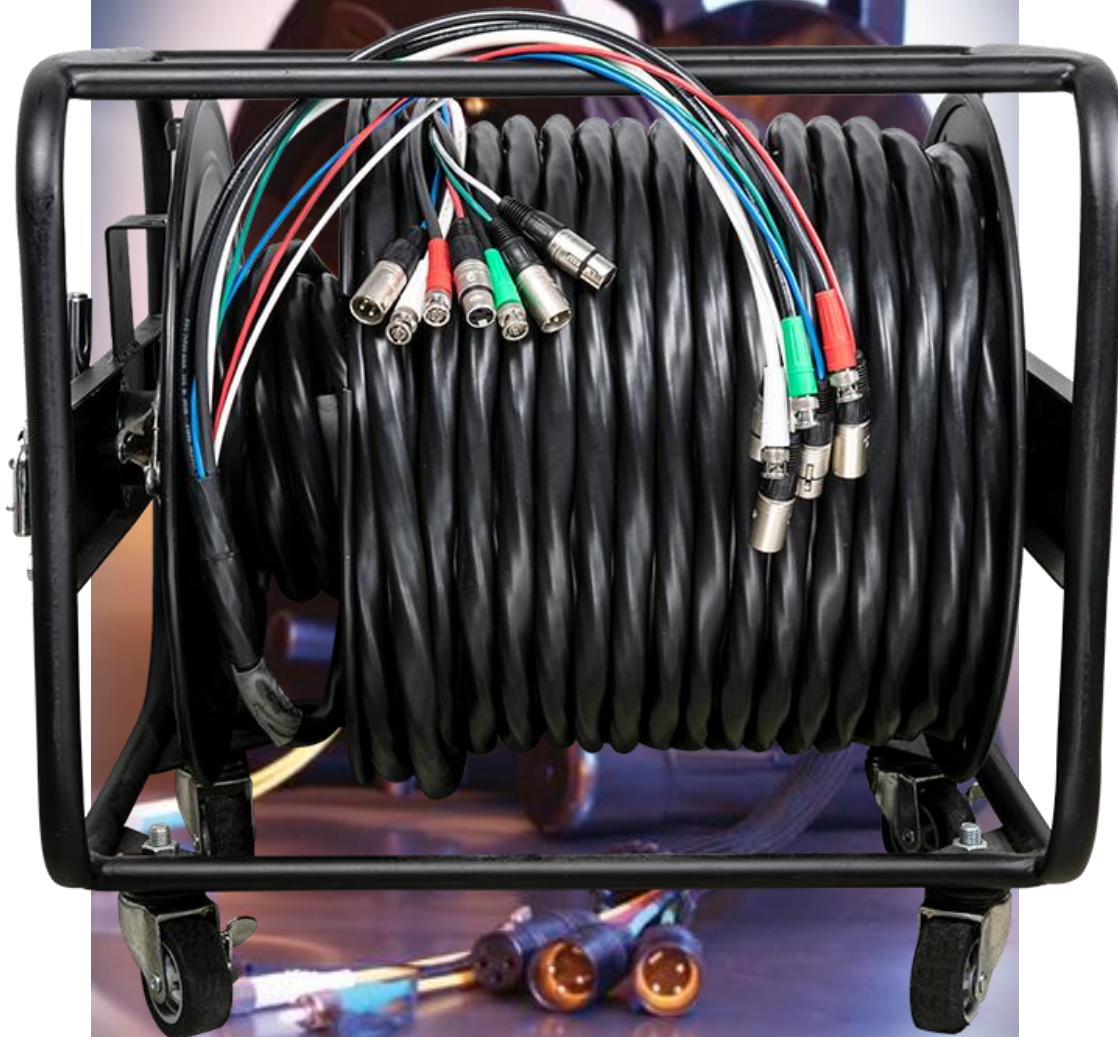
### Temperature Range:

- -50 a +105C
- Excellent Environmental Resistance
- For use in Harsh Environments
- Use expanded beam, TFOCA, opticalCON, other multi-contact connectors





# HYBRID CABLE



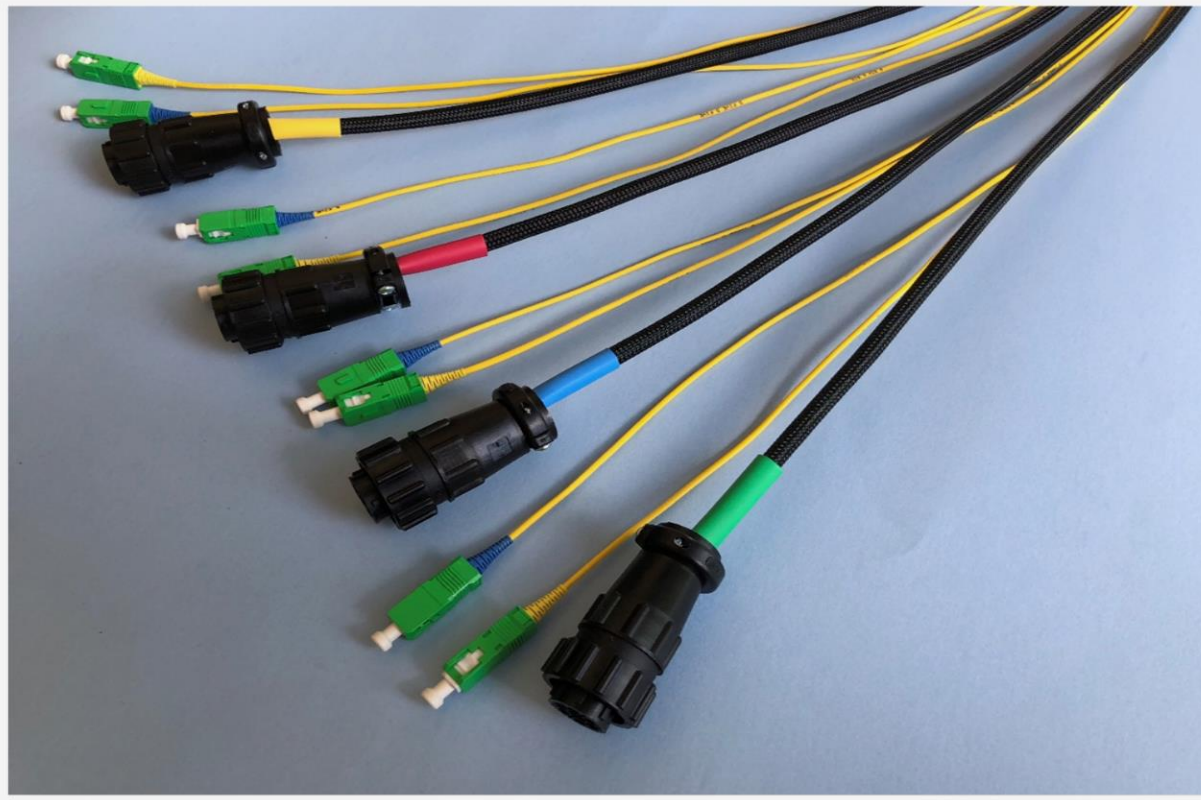
- ST (Fiber)
- XLR (Audio)
- Power RJ45
- CAT 5/6





# “STADIUM CABLE” 1-4 Channel

For use in Stadiums and other fixed installations to connect Multiple SMPTE cameras with a single cable



- \*Groups of 2 fiber (SM)

- \*Individually shielded groups of copper (4 conductor shielded)

## TYPICAL DISCRETE CONNECTORS-1.25mm and 2.5mm



The image displays four different types of discrete fiber optic connectors arranged horizontally. From left to right: an ST connector with a black jacket and a metal bayonet mount; an SC connector with a tan plastic housing and a push-on latch; an FC connector with a black jacket and a metal threaded mount; and an LC connector with a white jacket and a blue plastic housing. In the background, a bundle of multi-colored fiber optic cables is visible. The labels 'ST', 'SC', 'FC', and 'LC' are printed in white below their respective connectors.

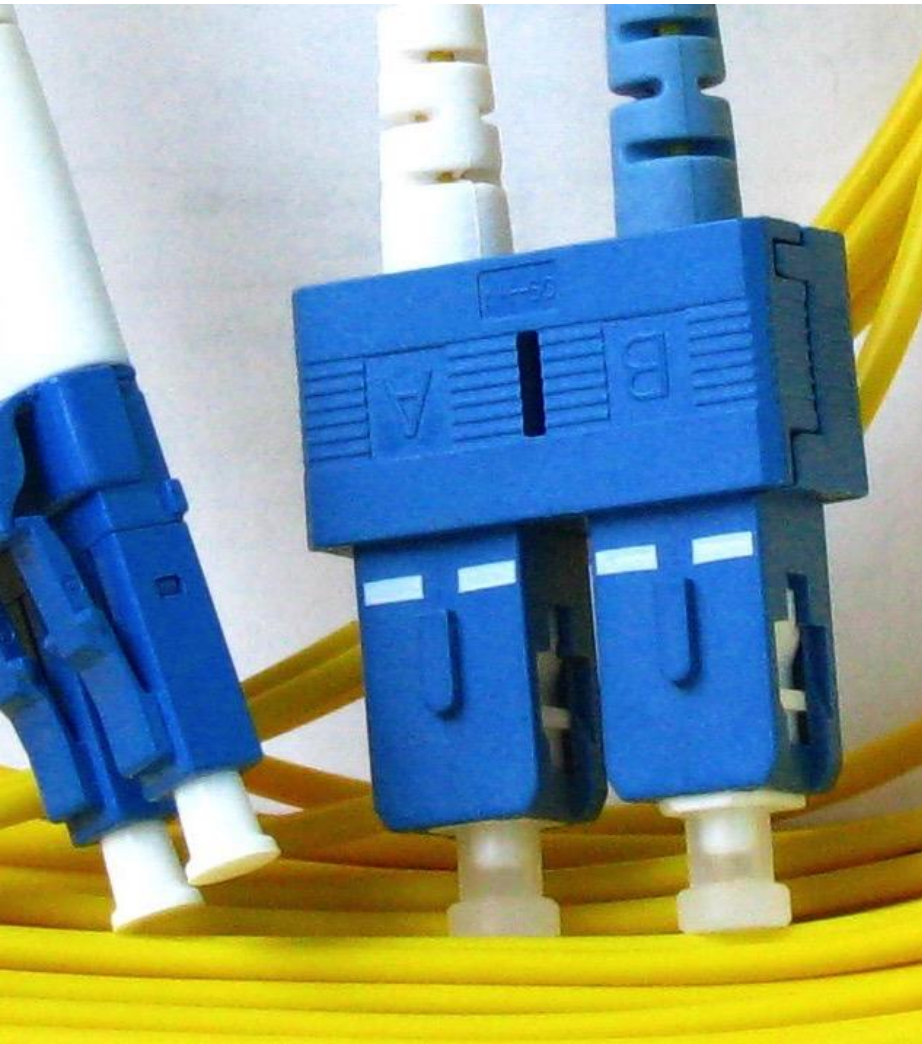
ST

SC

FC

LC

# CONNECTOR TYPE LC DUPLEX



Small Form Factor  
2-Fibers (A and B)  
Common in IT environment  
Can separate into 2 individual  
connectors\*



# MTP CONNECTOR – 12 OR 24 FIBER SM or MM, Standard “D” Size Receptacle



# CONNECTOR TERMINATION TYPES



1. Polish-Hand or Machine  
\*Many options

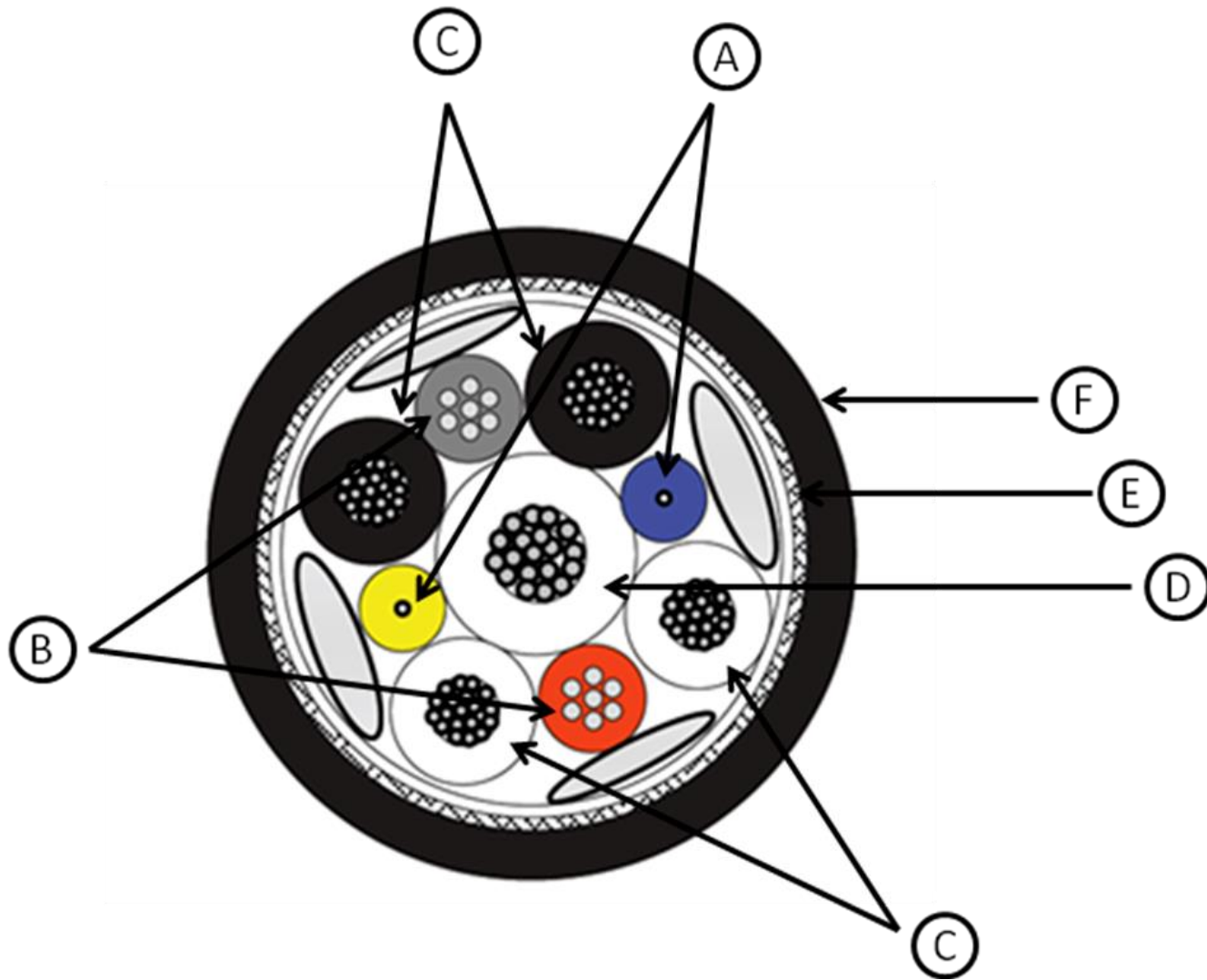
2. Mechanical Crimp  
\*Fast and Easy  
\*Simple Tooling  
\*Low Cost



3. Splice On (Fusion)  
High Performance  
Fast

4. Crimp On  
(Matching Gel)  
Fast  
Good performance  
Higher cost

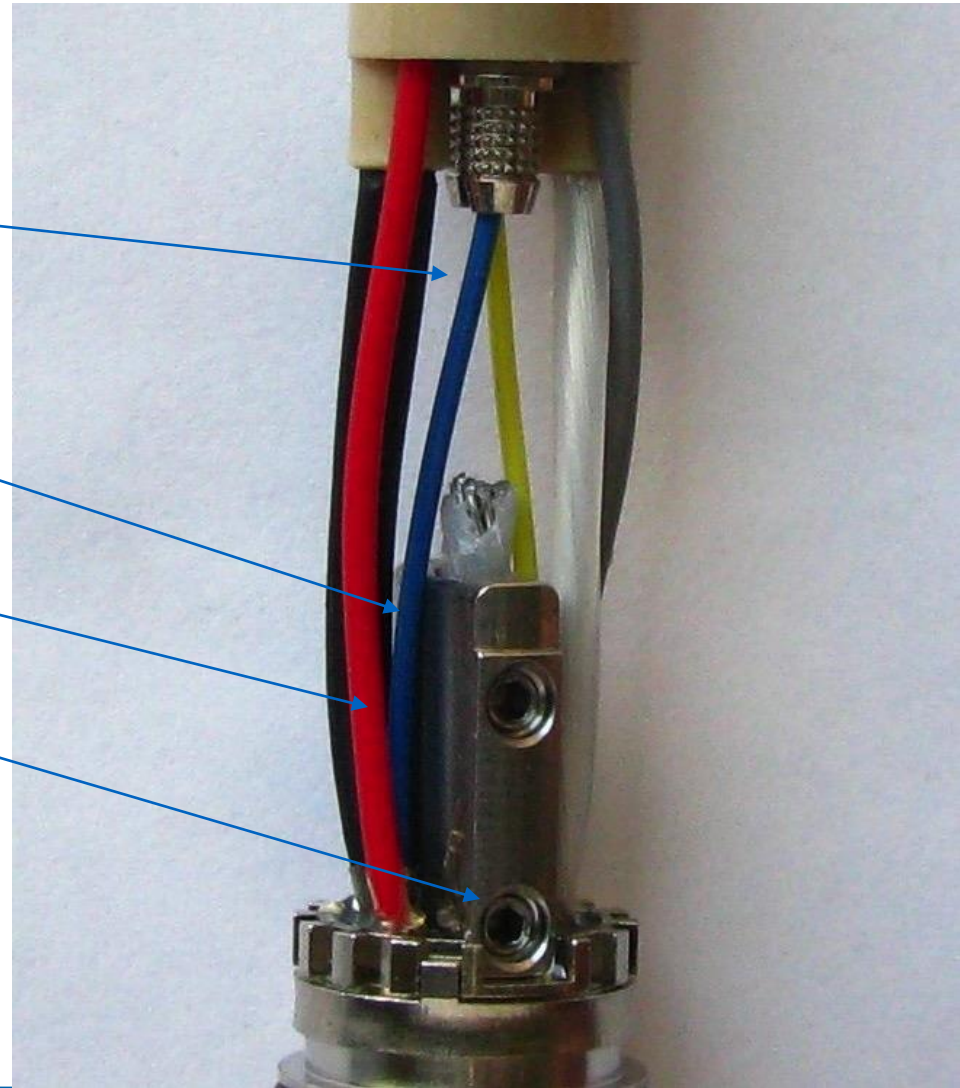
# SMPTE CONNECTOR FOR HD CAMERAS





# SMPTE STANDARD CONNECTOR (internal view)

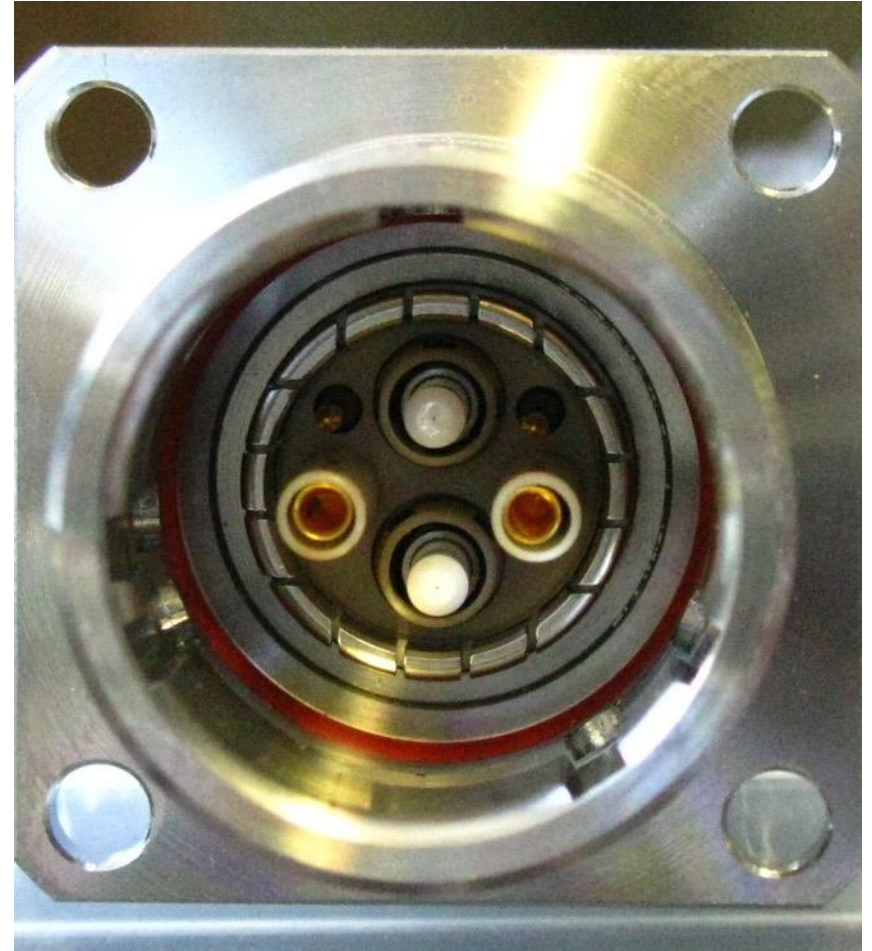
- 2-Fiber  
(Yellow and Blue)
- 2 pair copper 20awg (use as 2  
conductors-black-white)
- 2 cond copper 24awg (signal-red-  
grey)
- 1-Steel (strength member)



# SMPTE 311 CHASSIS CONNECTORS



Male – Type FMW

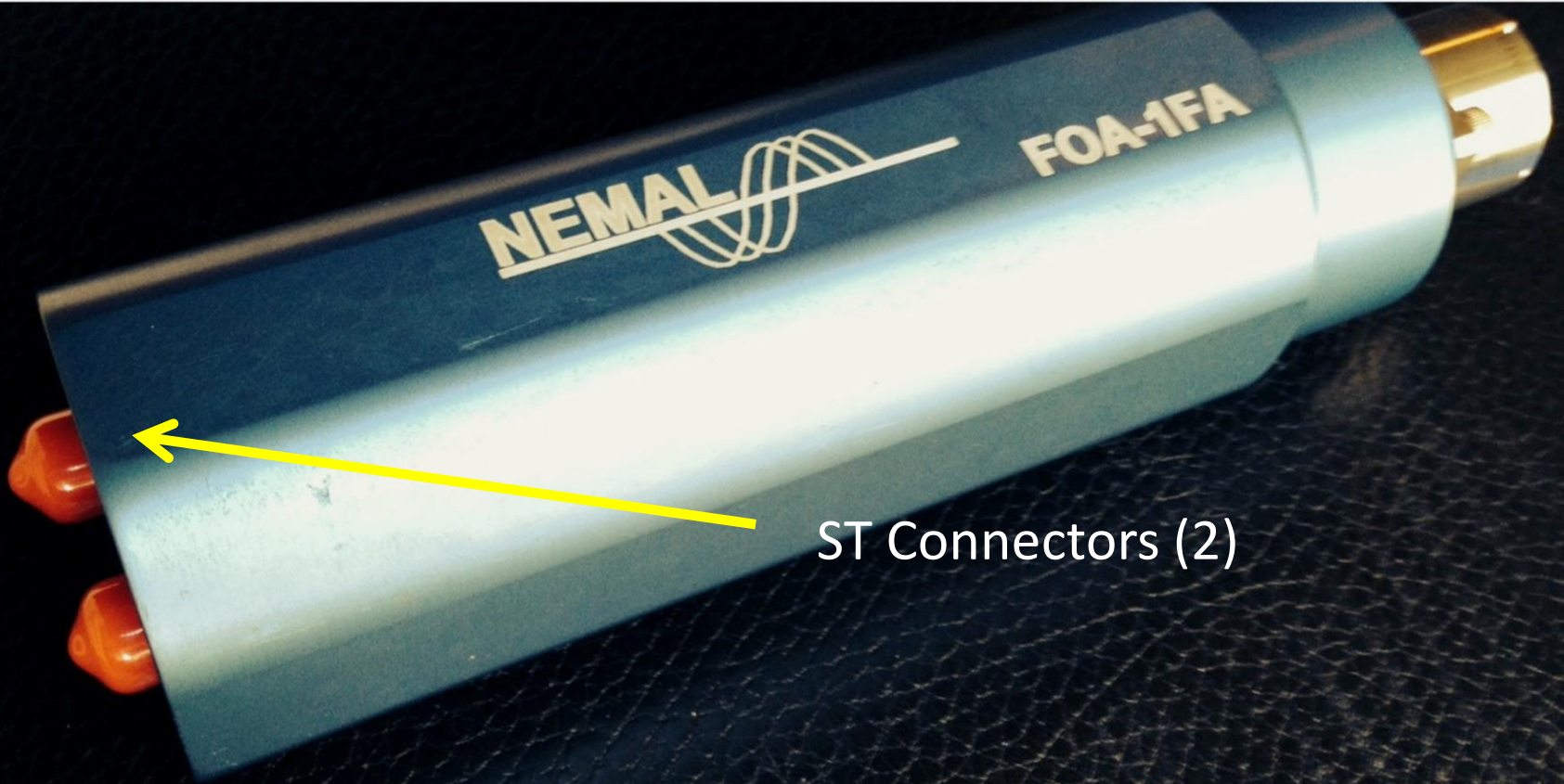


Female – Type PBW



# SMPTE FIBER ADAPTERS AND PANELS

FOA-1FA



Either active or passive  
Male or female SMPTE connector



# PANELS including multiple fiber types LEMO SMPTE, opticalCON, MTP, ST



# MODULAR PANELS opticalCON-SMPTE

## Wide Range of Options





# FIXED PANELS (pigtail construction)

Easy to replace or add channels





## opticalCON TO LEMO ADAPTER CABLE



# SMPTE FEMALE PIGTAILS TO ST



# MULTI-CONTACT CONNECTORS FOR TACTICAL FIBER CABLES

Hermaphroditic up  
to 36 contact



Mixed contact  
fiber-copper



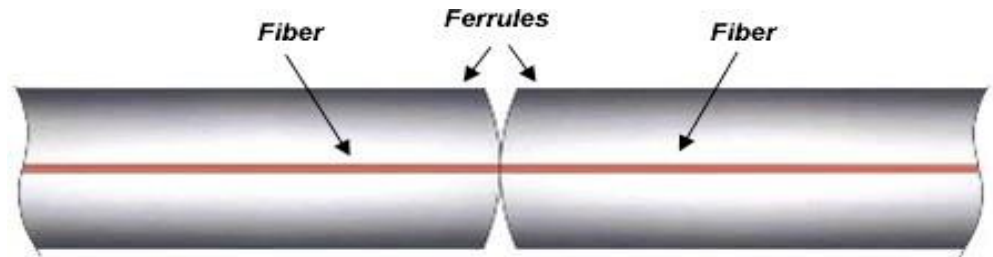
TFOCA  
(common-military)



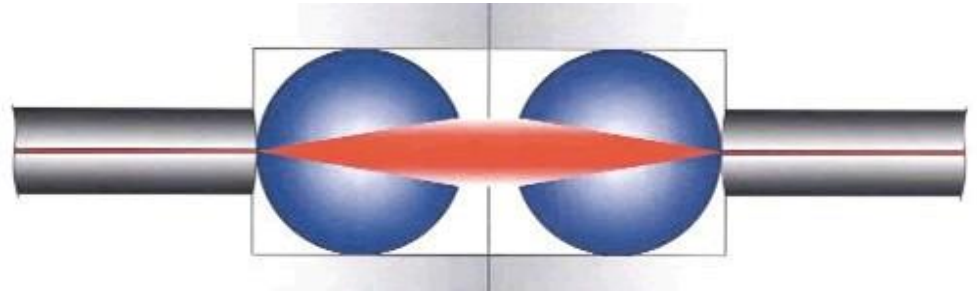


# EXPANDED BEAM

Direct Physical Contact



Expanded Beam (mirror)

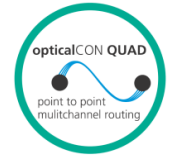


Typical Connector - MX



# Neutrik opticalCON Family

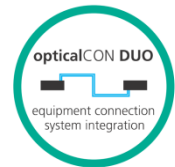
- Durable – suitable for use in mobile broadcast, sports, field
- Low maintenance
- Interface with low cost standard LC connector
- Versatile – 2-4 fiber, either SM or MM
- MTP Versions 12 or 24 fiber
- DUO-LV 2 fiber+ 4-copper



# opticalCON DUO

## 2 Fiber with or without power - SMPTE

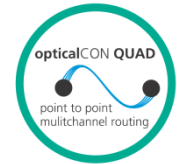
- Robust Construction-Easy maintenance, Common in Mobile Broadcast
- Easy Integration– LC Interface-Economical
- Compatible with LC (front)
- Suitable for use with Tactical or Hybrid Cables





# opticalCON QUAD (4 Fiber)

- Robust IP Contruction, Auto Shutter
- Low maintenance cost
- Easy Integration– LC Interface-Economical
- Compatible with LC (front)
- Versatile – multi-channel 4 fiber



NKO4S-A\*

## ADAPTER opticalCON DUO to ST



Other Constructions include Box to Pigtail, Connector to Pigtail, Connector to Box.  
Fiber Connectors may be ST, LC, or SC.

# MEDIA CONVERTERS-CAVU S8 AND 4K



CAVU<sup>S8</sup>  
and  
CAVU<sup>4k</sup>



# MATERIALS USED IN FIBER CABLES

## Insulation/Buffer

PVC

## Jacketing

PVC-Most Common, general purpose

PE-Polyethylene, rugged, less flexible

PUR-Polyurethane, very durable, flexible

TPE-Flexible, good for outdoor use

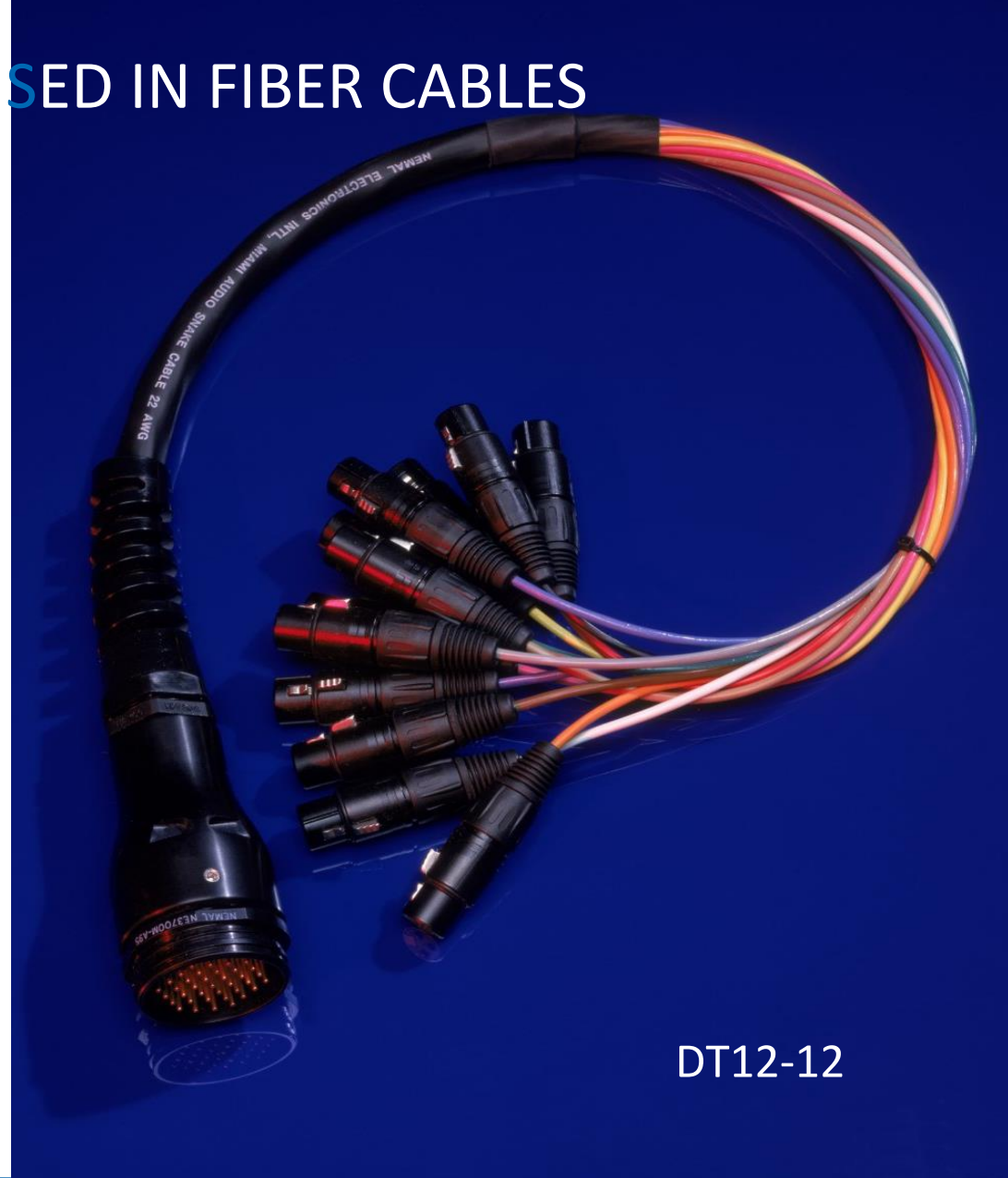
FEP-High Temperature, stiff, expensive

## Fillers

Kevlar (Aramid)-

Polyester

Central Strength Member-Stainless Steel



DT12-12

## UL CONSIDERATIONS

NEC-National Electric Code

Classifications-CL2, CL3, CM, OF

Riser CMR

Plenum CMP

Sunlight Resistance-SR

Resistance to Oil and Gasoline

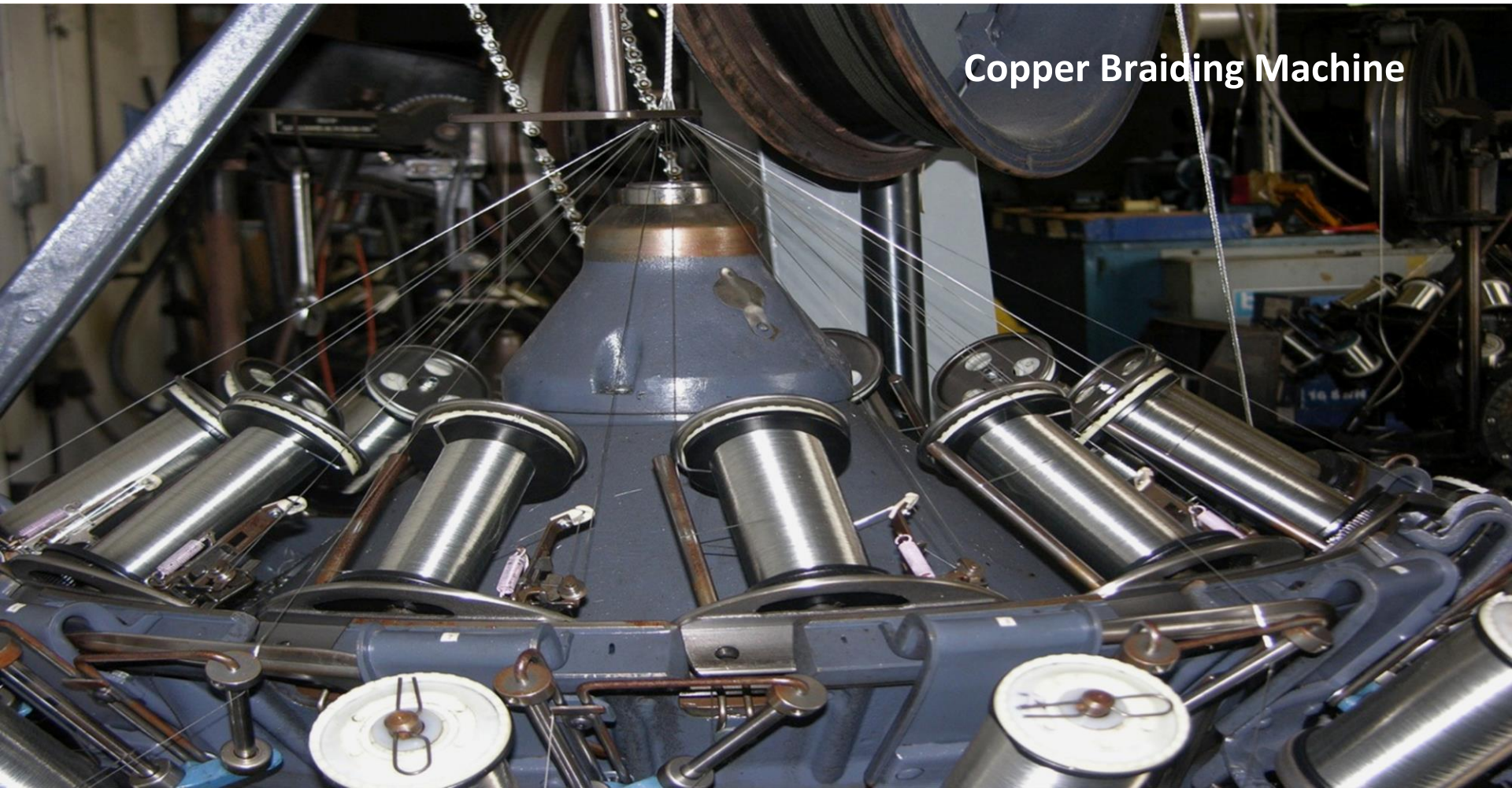
Temperature





# PRODUCTION OF FOCC24 SMPTE CABLE

Even small changes in braid angle impact cable DCR, Weight, OD, and flexibility





# FIBER TERMINATION TOOLING

Polishing Machine

Consider your specific needs



Cleaver

Critical to achieve high performance  
fusion splices



# TYPES OF POLISHING



**UPC (most common)**  
"Ultra PC" ultra polish  
> -50 to -55 dB reflection



**APC- Highest performance**  
Angle Polish (8 deg)  
>-60 a -70 db dB de reflection

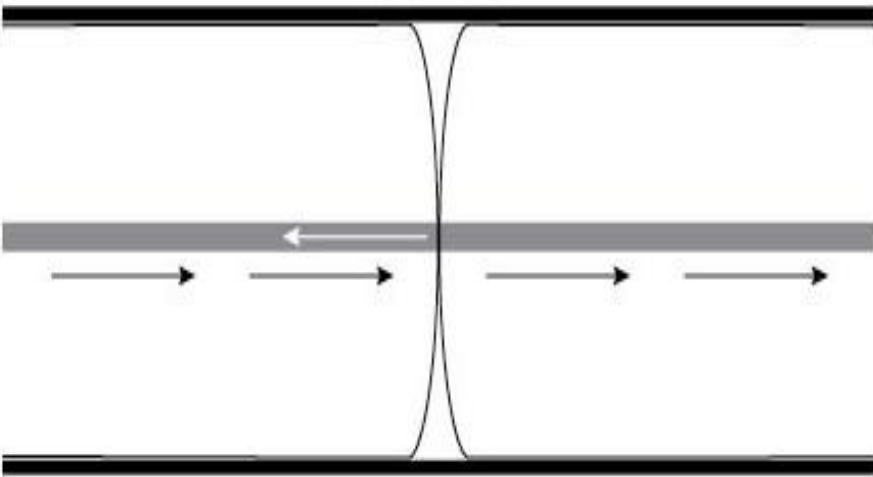


**PC Common Polish**  
(but not so much anymore)  
>-30dB de reflexion

APC  
"Angled PC" 8 degree angled PC Ceramic ferrule  
> -60 to -70 dB back reflection

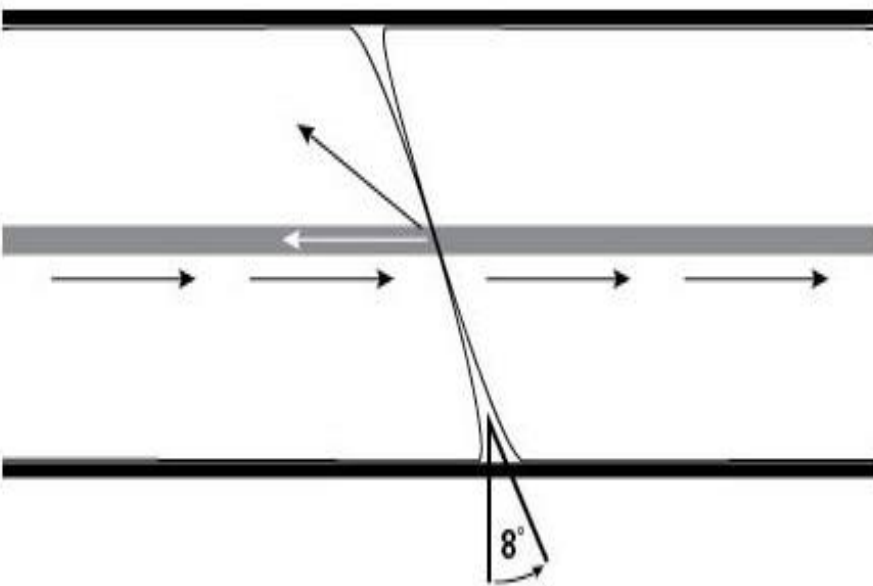
## STANDARD UPC POLISH

Up to 4% of the light can be reflected back towards the source.



## APC POLISH

With “Angled Physical Contact” or “APC” finishes the connector tip is cut to 8°, which directs the light away from the source.





# FUSION SPLICER

## Many options available



# INSTALLATION OF F2/FS (2.0mm) SMPTE CONTACTS



# FIBER TESTING



DATA-PIXEL SAS  
[www.data-pixel.com](http://www.data-pixel.com)

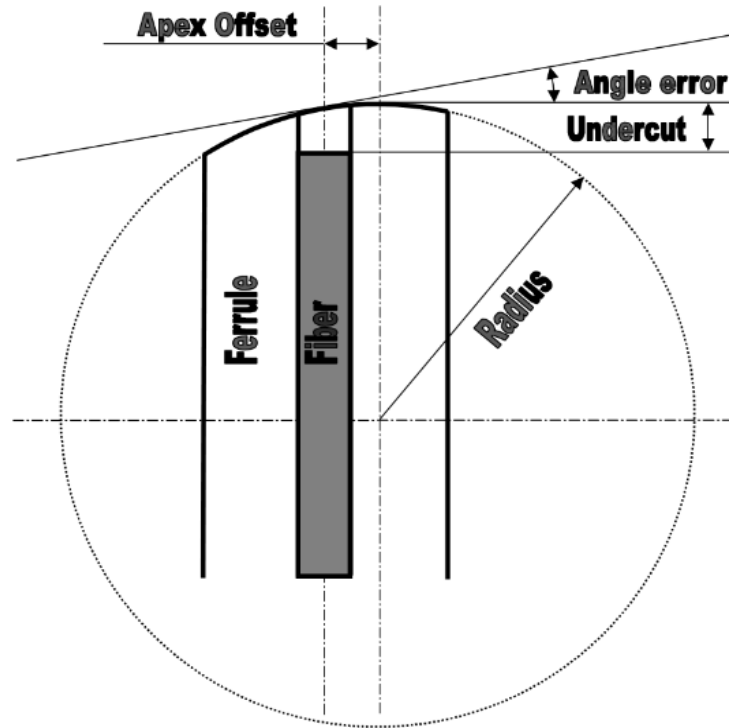


Diagram 2: Critical symmetry parameters of an optical connector end face

Note in graph 1 that the maximum allowed undercut is a function of the radius of polishing of the end face. Future standards will, logically enough, also include the apex-offset in addition to the radius as a parameter for the allowance of the maximum undercut.



# COMMON FIBER TERMINATION FAULTS

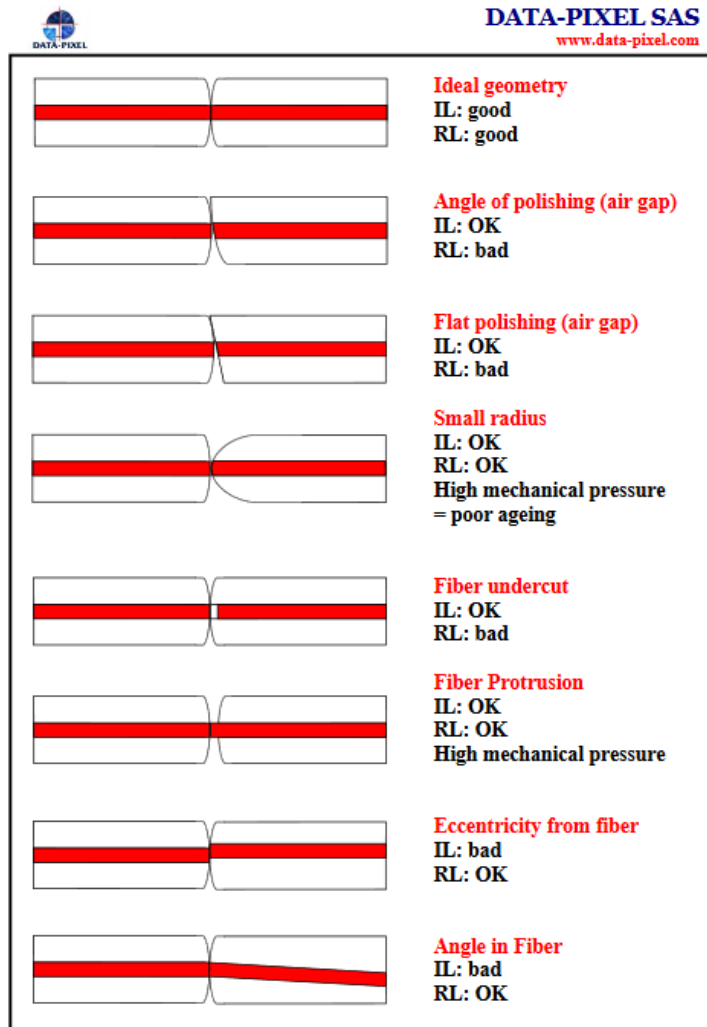
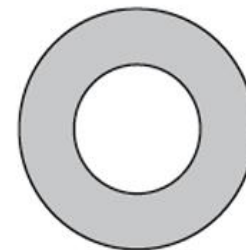


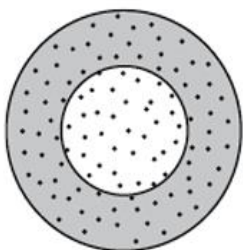
Diagram 3: Typical symmetry defects of polished ferrule end faces

# TYPICAL POLISHING DEFECTS AND OTHER FIBER DAMAGE

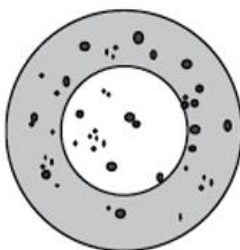
**Ideal Endface**



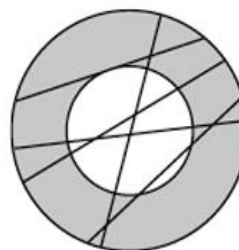
**Over Polished**



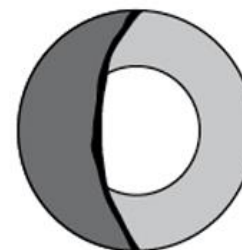
**Dirty**



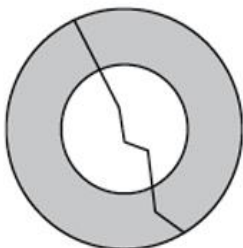
**Scratched**



**Chipped**



**Cracked**



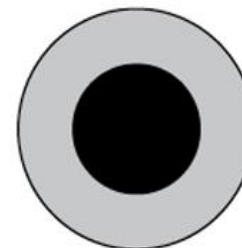
**Shattered**



**Remaining Epoxy**



**Broken Fiber**



**KEEPING YOUR CONNECTORS CLEAN IS CRITICAL**





BOOTS AND CAPS  
KEEP ALL FIBER CONNECTORS CAPPED WHEN NOT IN USE



# FIBER CLEANING KITS-



# CLEANING PEN

Dependent on ferrule size





# SMPTE TEST SETS (insertion loss-electricals)



# FUTURE OF FIBER IN AV/BROADCAST

With each increase in data rate, copper usable distance shrinks

4K - SMPTE Standard 2081-1 UHD TV1 6Gb/s

8K - SMPTE Standard 2082-1 UHD TV2 12Gb/s

8K - 4320 Line - SMPTE Standard 2082-11 Data Rate of 24Gb/s



# CLEANING AND TEST DEMO

