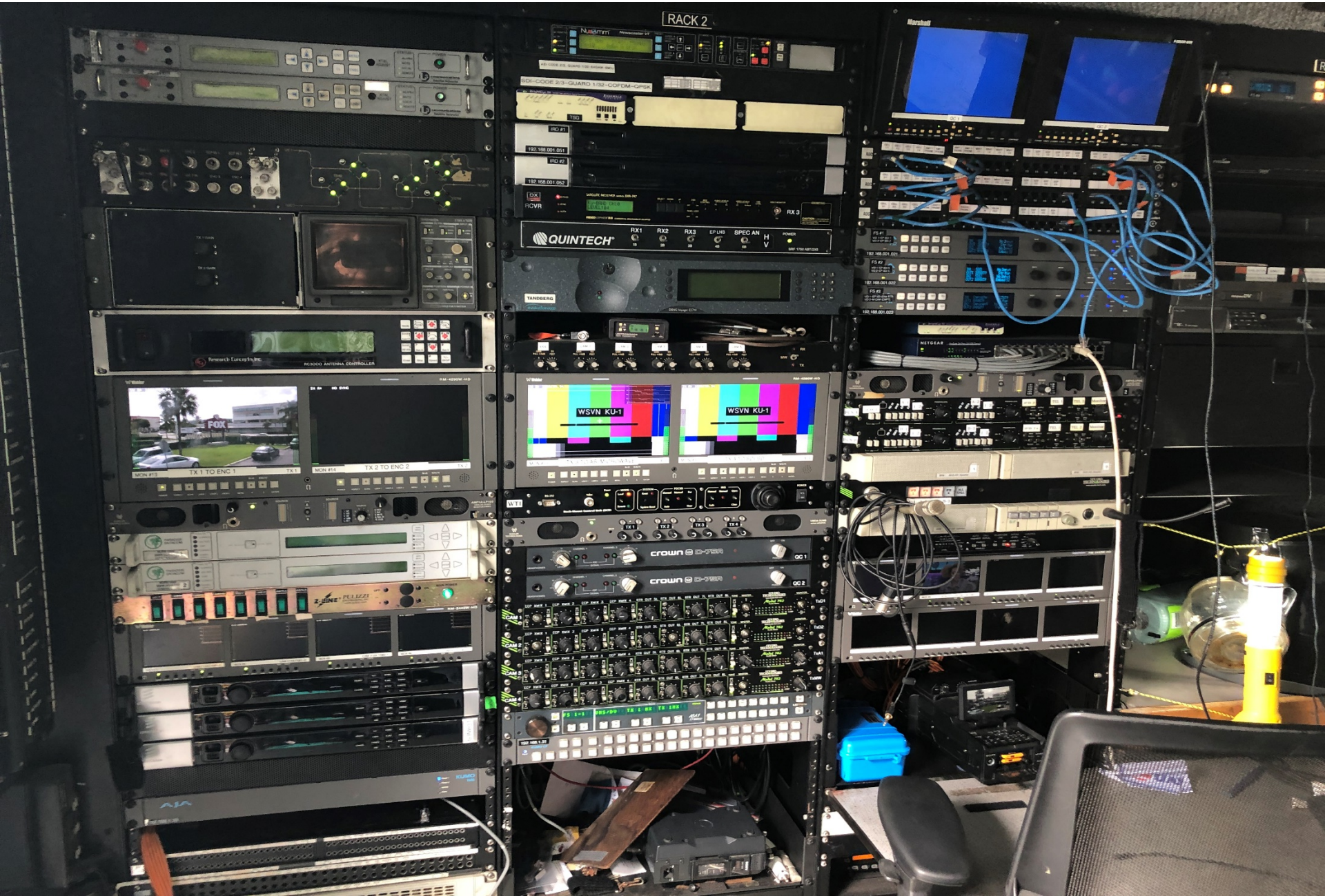
FIBER OPTICS FOR HD-BROADCAST

WBA Live 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

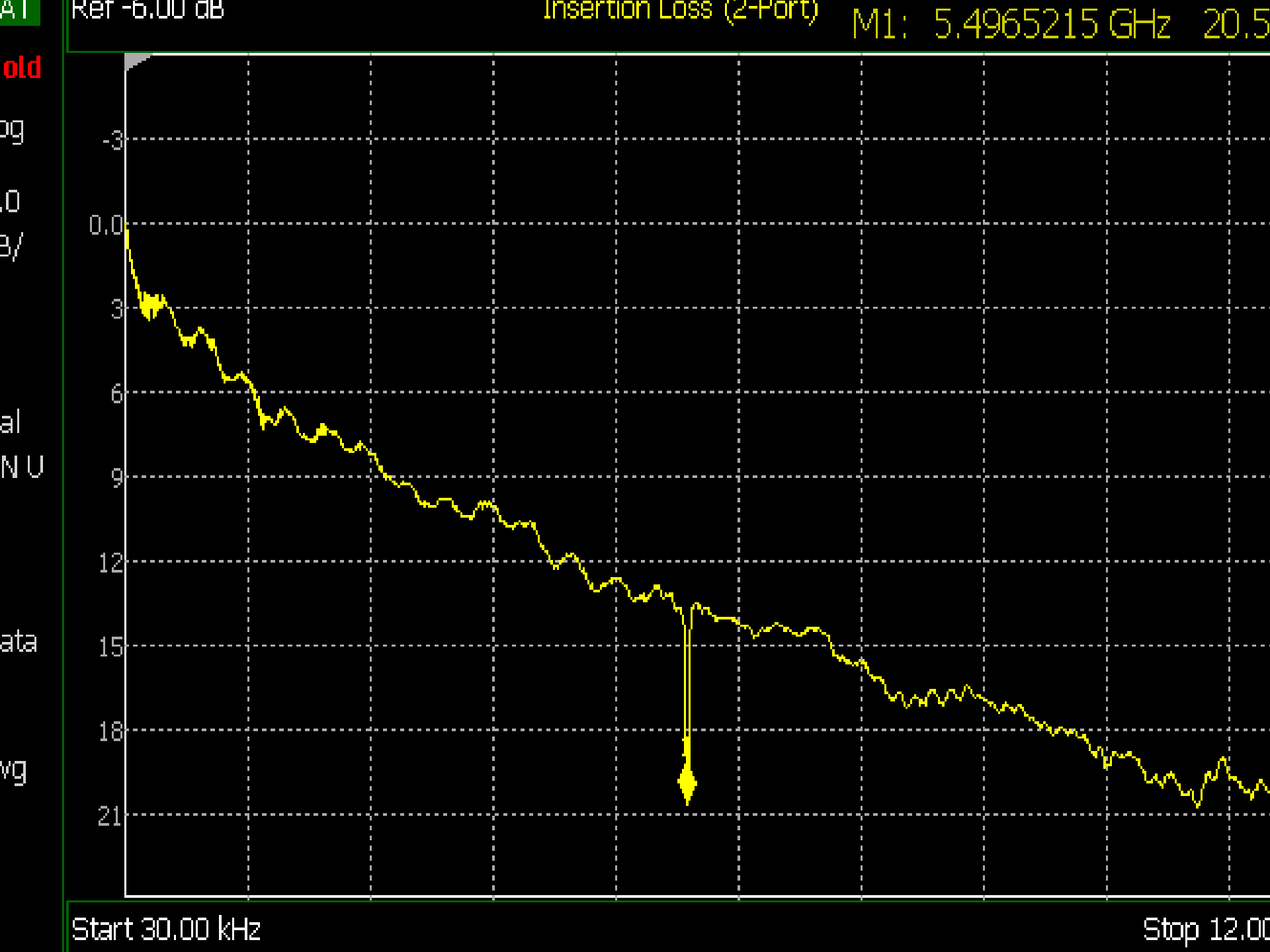
Data Rate	Cable Family	143 Mb/s	270 Mbs/s	1.5Gb/s	3Gb/s	12Gb/s
		NTSC Composite	Component SD-SDI	HD-SDI	1080p	UHD-TV
Cable Type Belden-Nemal		SMPTE 259M (Meters)	SMPTE 259M (Meters)	SMPTE 292M (Meters)	SMPTE 424M (Meters)	ST2082-1
179DT-1712	Micro	153	116	33	23	-
1855A-1191	Mini RG59	299	240	64	47	-
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


Ref -6.00 dB
Insertion Loss (2-Port)
M1: 5.4965215 GHz 20.5
-3
0.0
3
6
9
12
15
18
21
Start 30.00 kHz
Stop 12.00

HD VIDEO CONNECTORS

MINI DIN

BNC

BNC/ 12G

HD VIDEO CONNECTORS-2
75 Ohm
HIGH DENSITY BNC (HD-BNC) FOR 12G

Parameter	12G Standard BNC	12G HD-BNC
Frequency Range	DC-12GHZ	DC-18GHZ
Return Loss	>30dB @ DC-6GHz	>15dB @ DC-12GHz
Dielectric Withstand V	1500 VRMS	1000VRMS
Temperature Rating	-65C to +165C	-65C to +165C

Performance of Category Cables

Cable Type	Max Freq (MHZ)	Trans Speed (GB)	Max atten (db/100m)	Delay Skew (ns)	Network Type	Return Loss (db)	Max Distance (M)
CAT5E	100	.350-1	22	45	1000BASE-T	20.1	100
CAT6	250	1 to 10	19.8	45	1000BASE-TX	20.1	100
CAT6A	500	10	19.3	35	10GBASE-T	22.5	100
CAT7	600-1000	10	20.8	20	10GBASE-T+	21	200
CAT8	1600-2000	25 to 40	17.5	25	40GBASE-T	24	30

HD Base T

Global standard for distribution of Ultra-High Definition video and audio. Ethernet, Controls, USB and up to 100W of power over a single cable for up to 100 meters

IEEE 1911.3

Ideal for use with CAT6A

Supports Full HDMI, HD/3D, and 4K uncompressed video

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

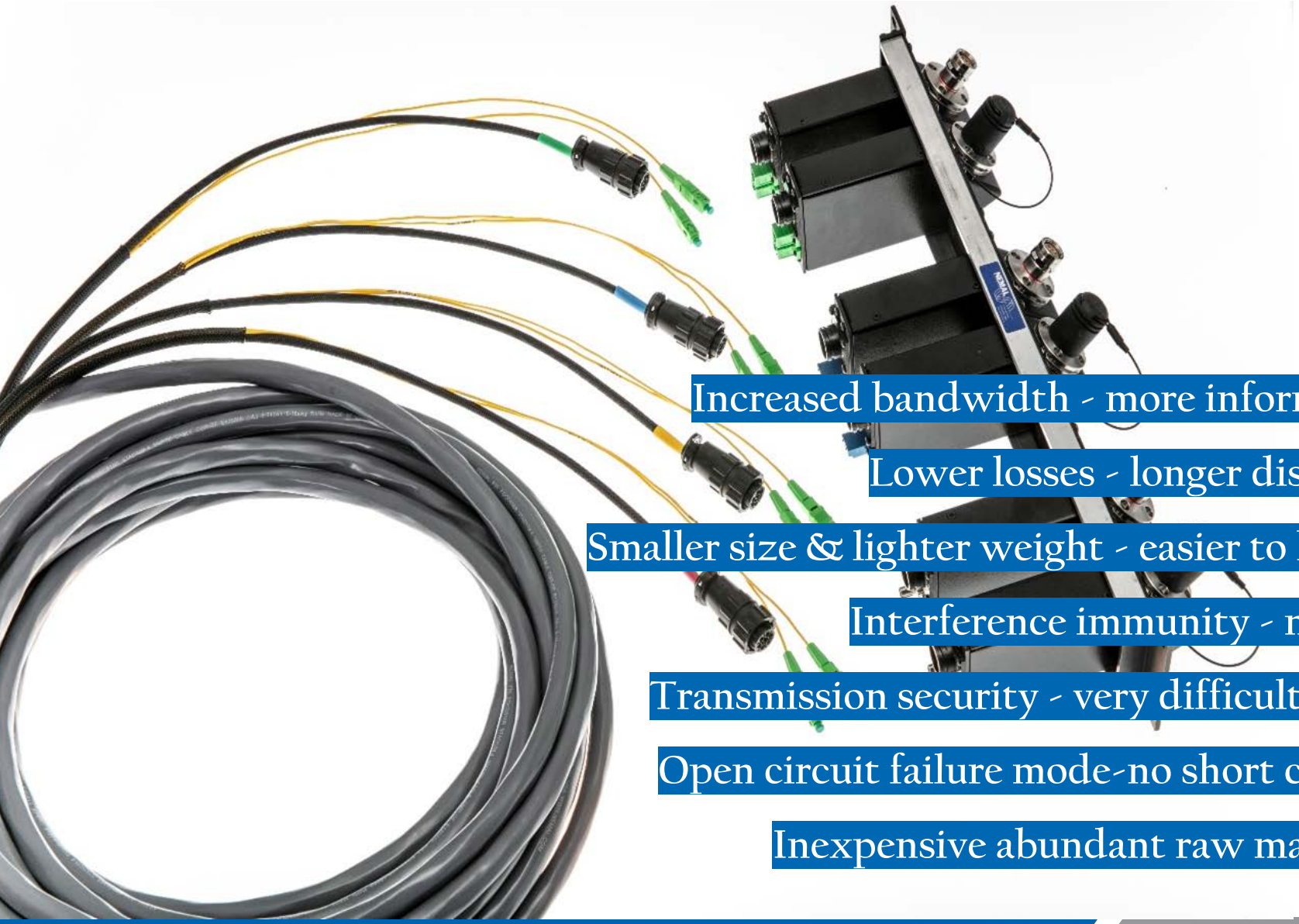
Data

HDMI Extenders

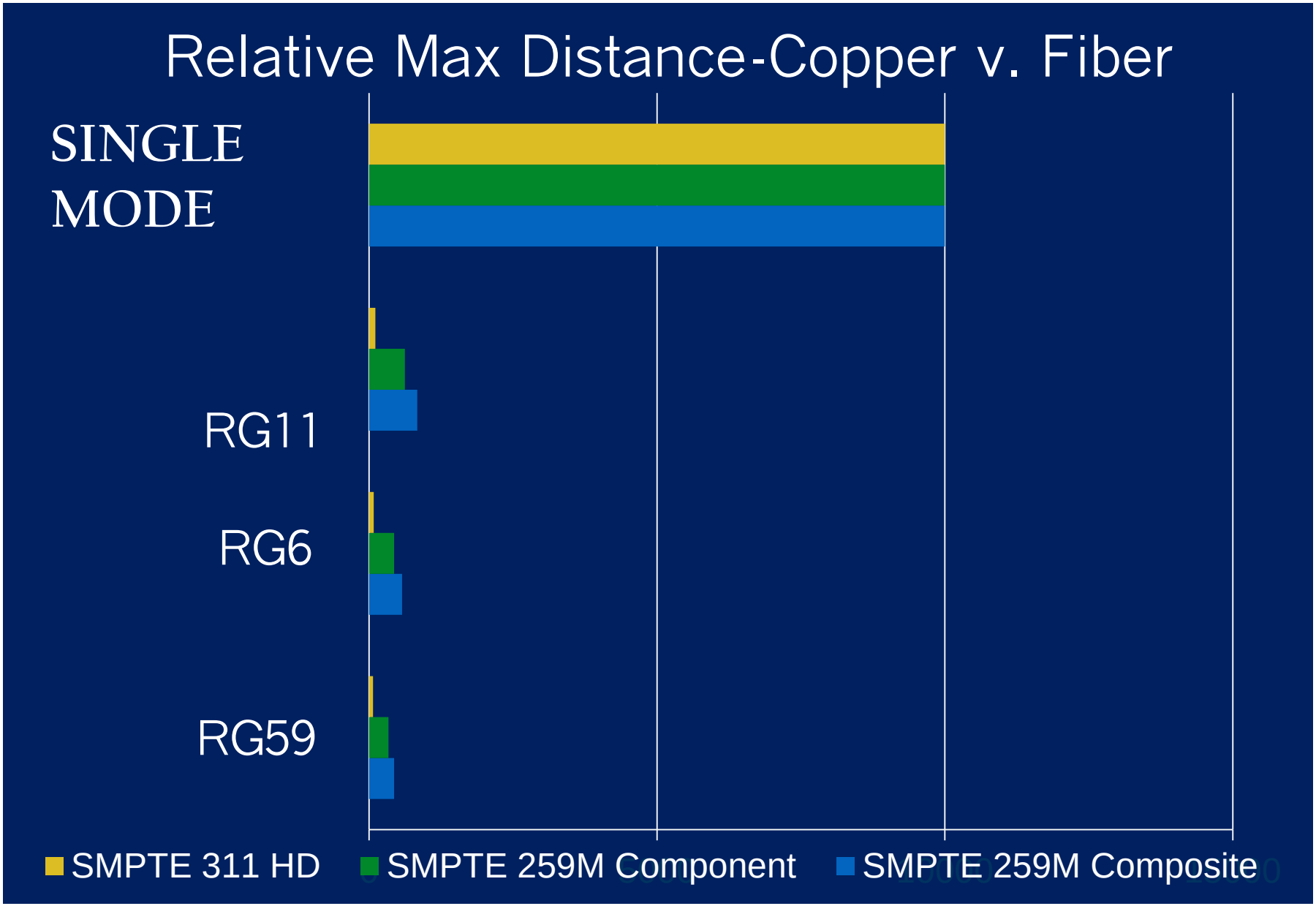
HD Cameras (SMPTE)

- Mobile Units
- Remote Camera

WHAT ARE THE ADVANTAGES OF OPTICAL FIBERS?



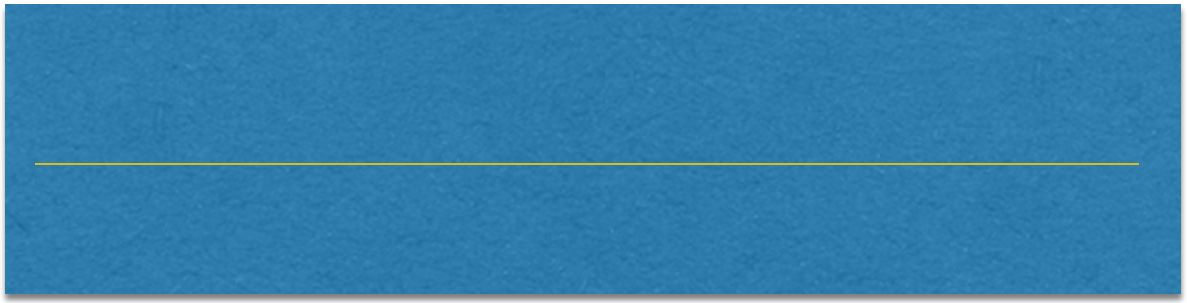
- Increased bandwidth - more information ☑
- Lower losses - longer distances ☑
- Smaller size & lighter weight - easier to handle ☑
- Interference immunity - no EMI ☑
- Transmission security - very difficult to tap ☑
- Open circuit failure mode-no short circuits ☑
- Inexpensive abundant raw materials ☑


Relative Max Distance-Copper v. Fiber
SINGLE MODE
RG11
RG6
RG59
SMPTE 311 HD
SMPTE 259M Component
SMPTE 259M Composite

SIZE COMPARISON: FIBER VS COPPER

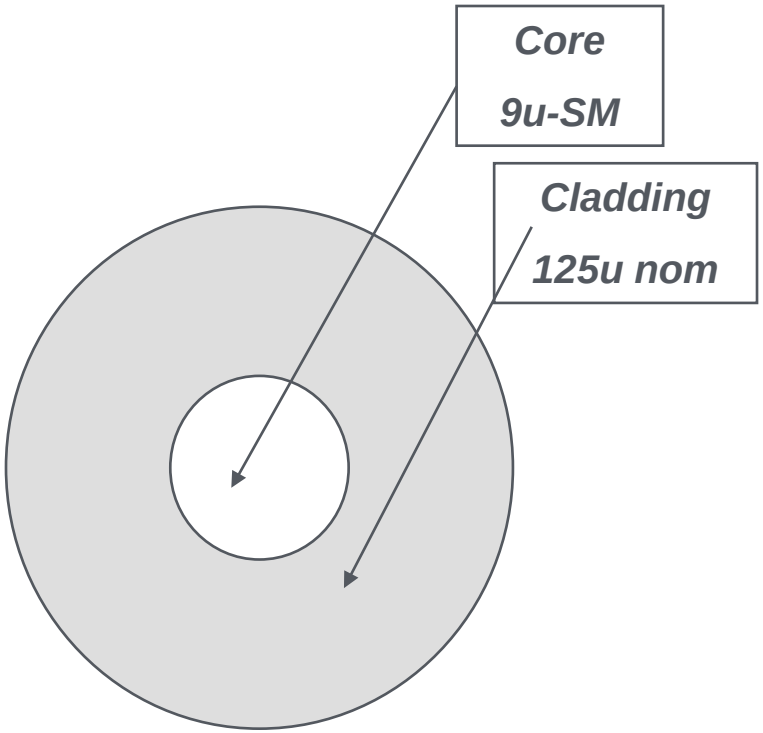
To transmit the same information

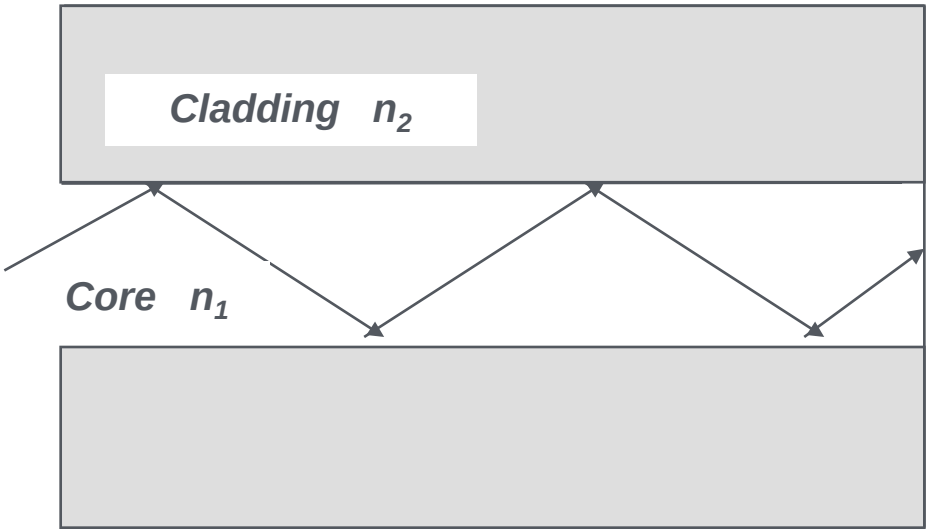
Digital audio cable
Diameter: 29mm
Weight: 89kg/km



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

CONSTRUCTION OF FIBER CABLE



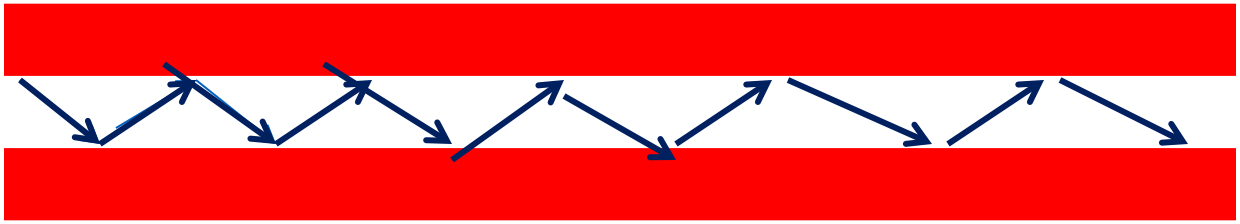


Total Internal Reflection in an optical fiber

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



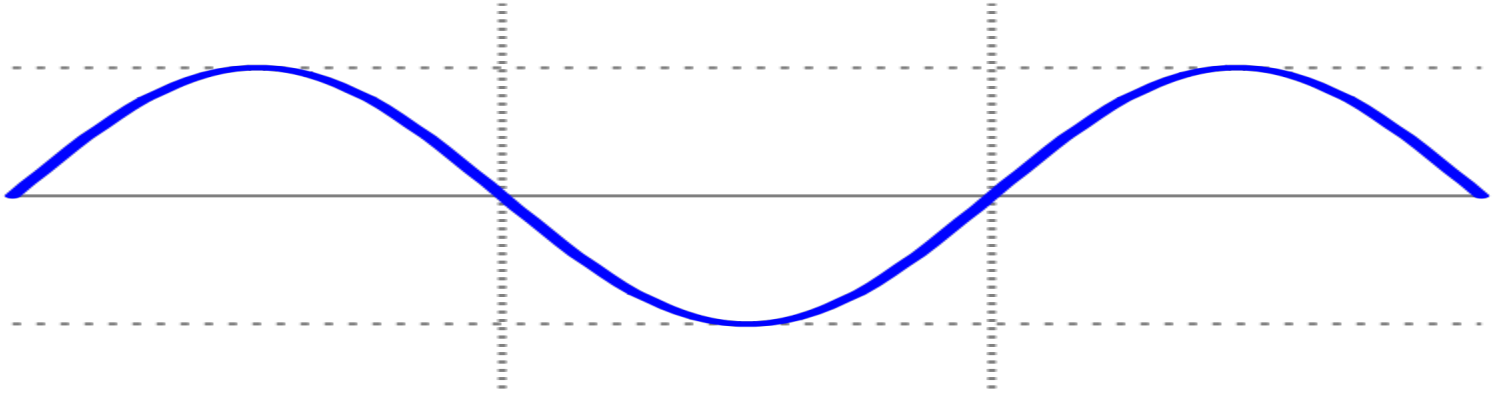
Singlemode-1 path-no reflections

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
3×10^{14} Hz	1 μ (10^{-4} Meter)

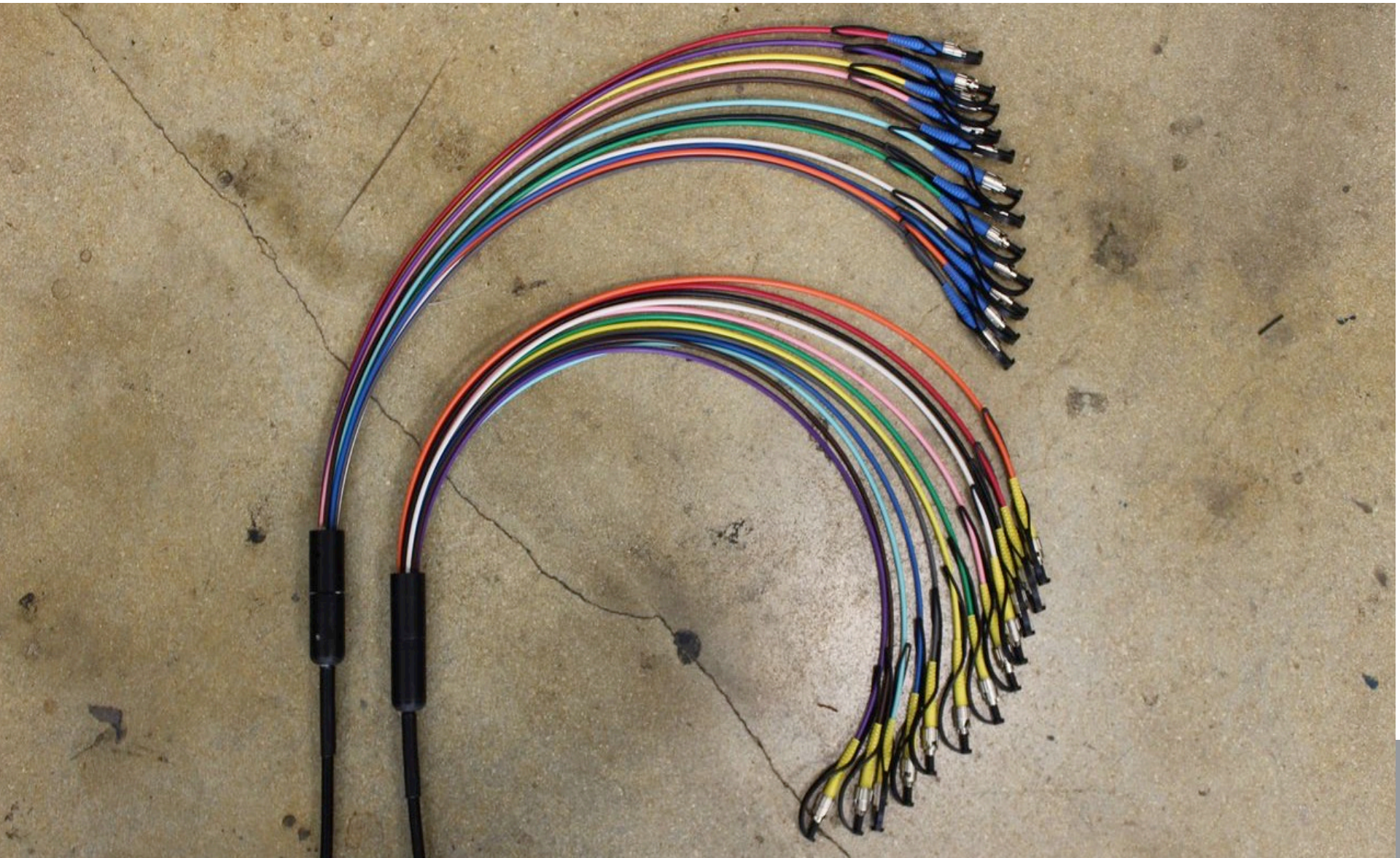


Fiber Cable Construction Types
DISTRIBUTION OR BREAKOUT

Distribution (shown): No individual jacket
Requires breakout kit or direct connection to a panel
Lightweight-Reduced Diameter

Breakout
Individually Jacketed Fibers
Much Larger and Heavier
More Expensive
Crimp-On Connectors

BREAKOUT KIT
Use With Distribution Fiber



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

TACTICAL FIBER CABLE

Characteristics:

Distribution 900u
- Single-mode
- Multimode
- 2-12 Fibers
- Lightweight

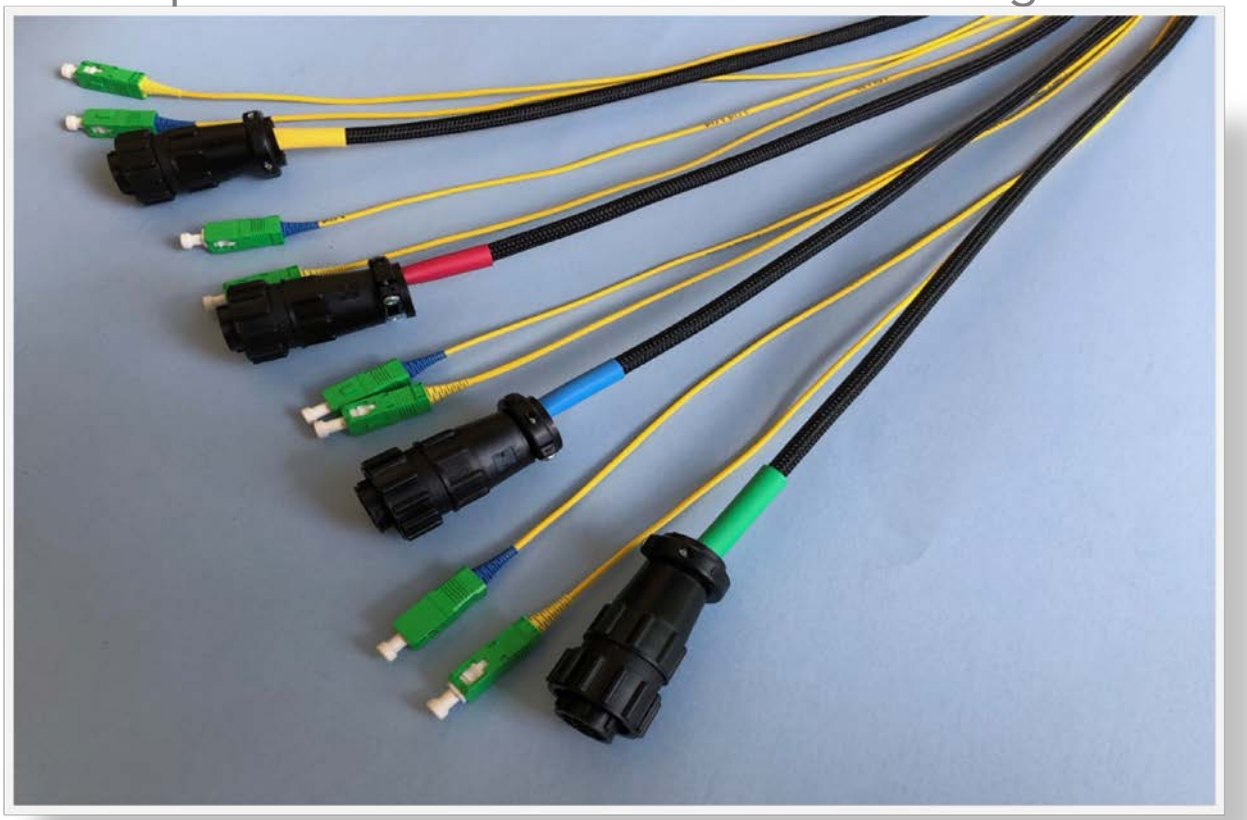
Temperature Range:
- -50 a +105C
- Excellent Environmental Resistance
- For use in Harsh Environments
- Use expanded beam, TFOCA, opticalCON, other multi-contact connectors

HYBRID CABLE

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

“STADIUM CABLE” 1-4 Channel

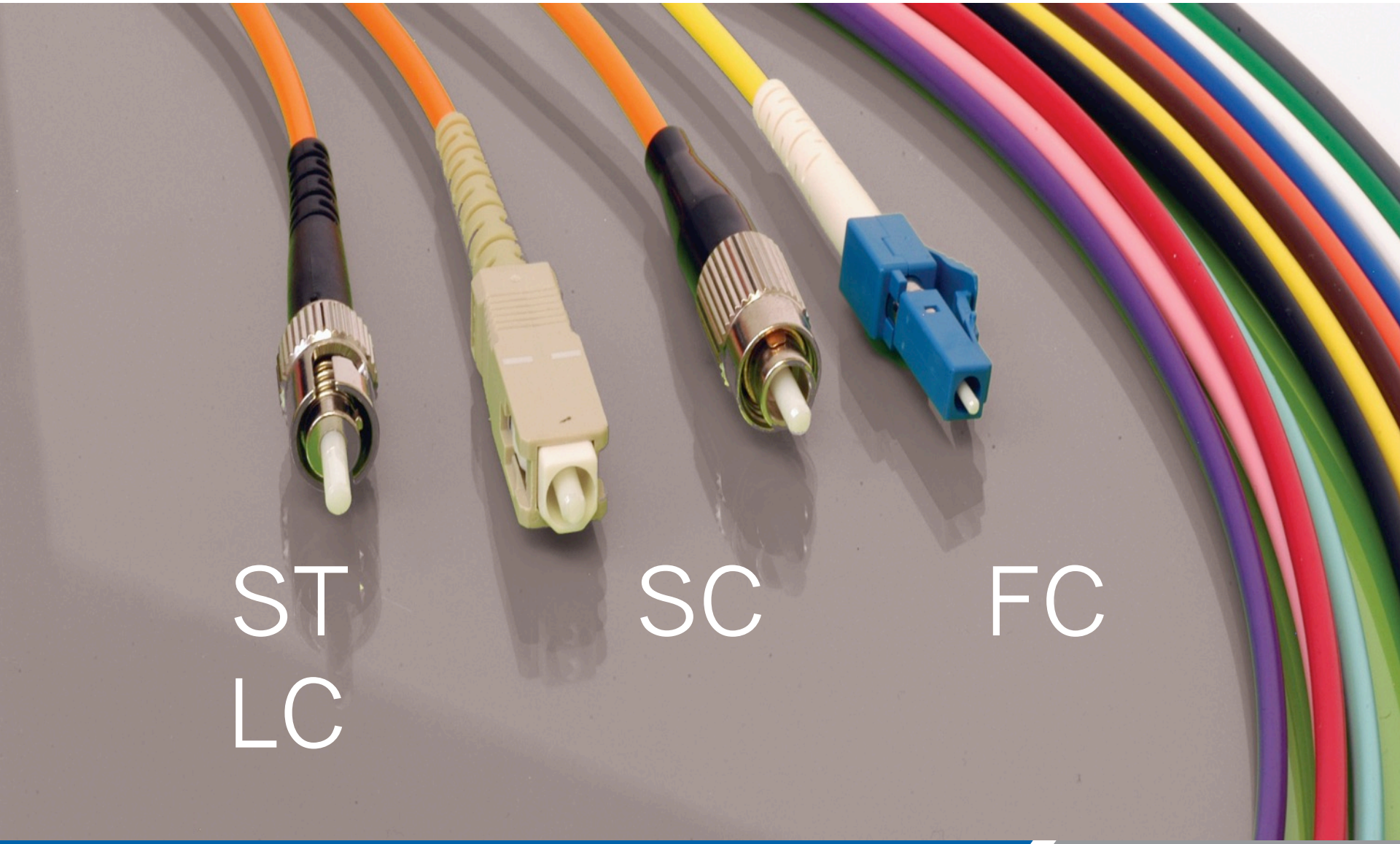
For use in Stadiums and other fixed installations to connect Multiple SMPTE cameras with a single cable



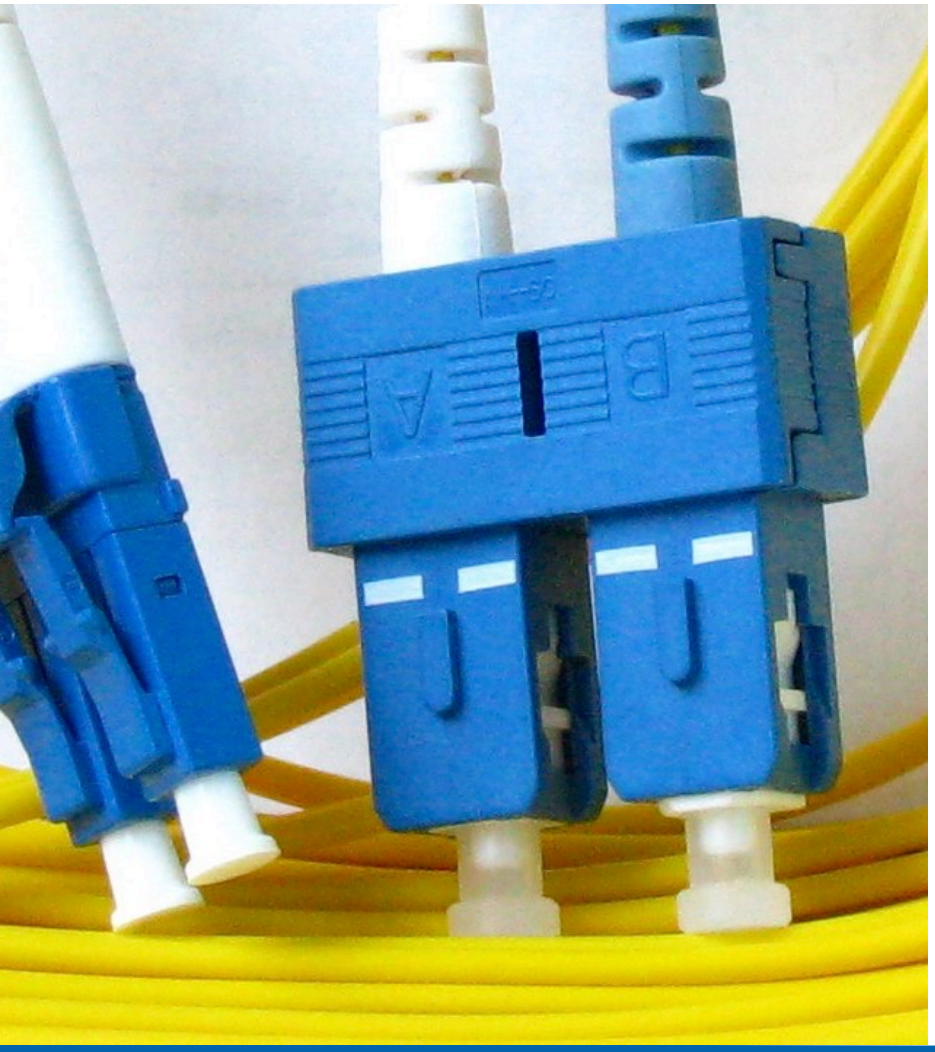
*Groups of 2 fiber (SM)

*Individually shielded groups of copper (4 conductor shielded)

and 2.5mm



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

MULTI-CONTACT CONNECTORS FOR TACTICAL FIBER CABLES

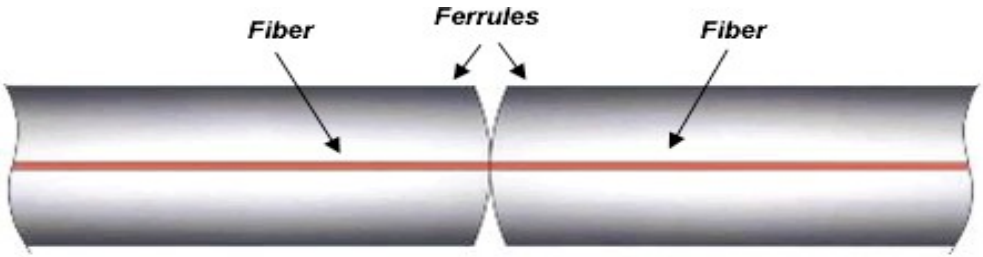
Hermaphroditic
up to 36 contact

Mixed contact
fiber-copper

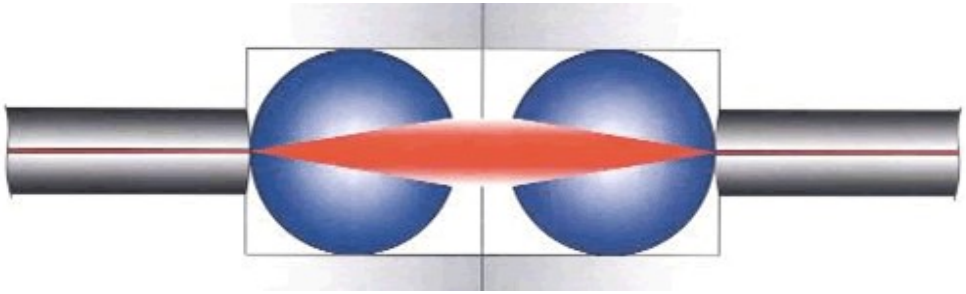
TFOCA
(common-military)

EXPANDED BEAM

Direct Physical Contact

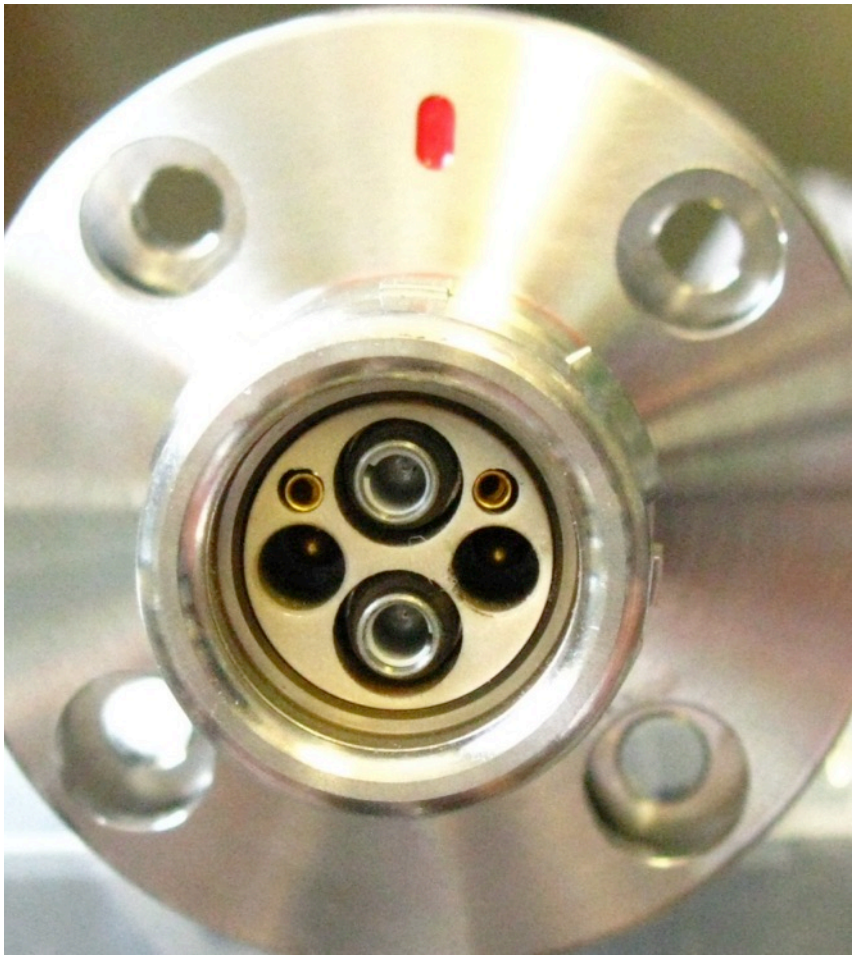


Expanded Beam (mirror)

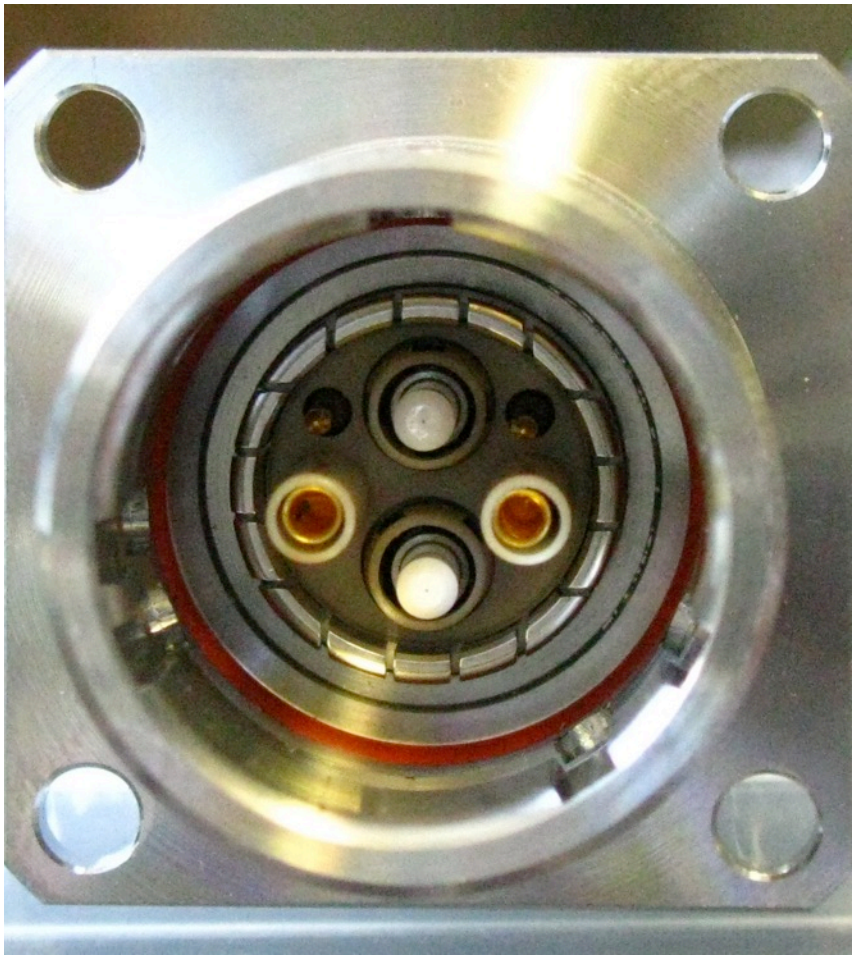


Typical Connector - MX

SMPTE 311 CHASSIS CONNECTORS



Male – Type FMW



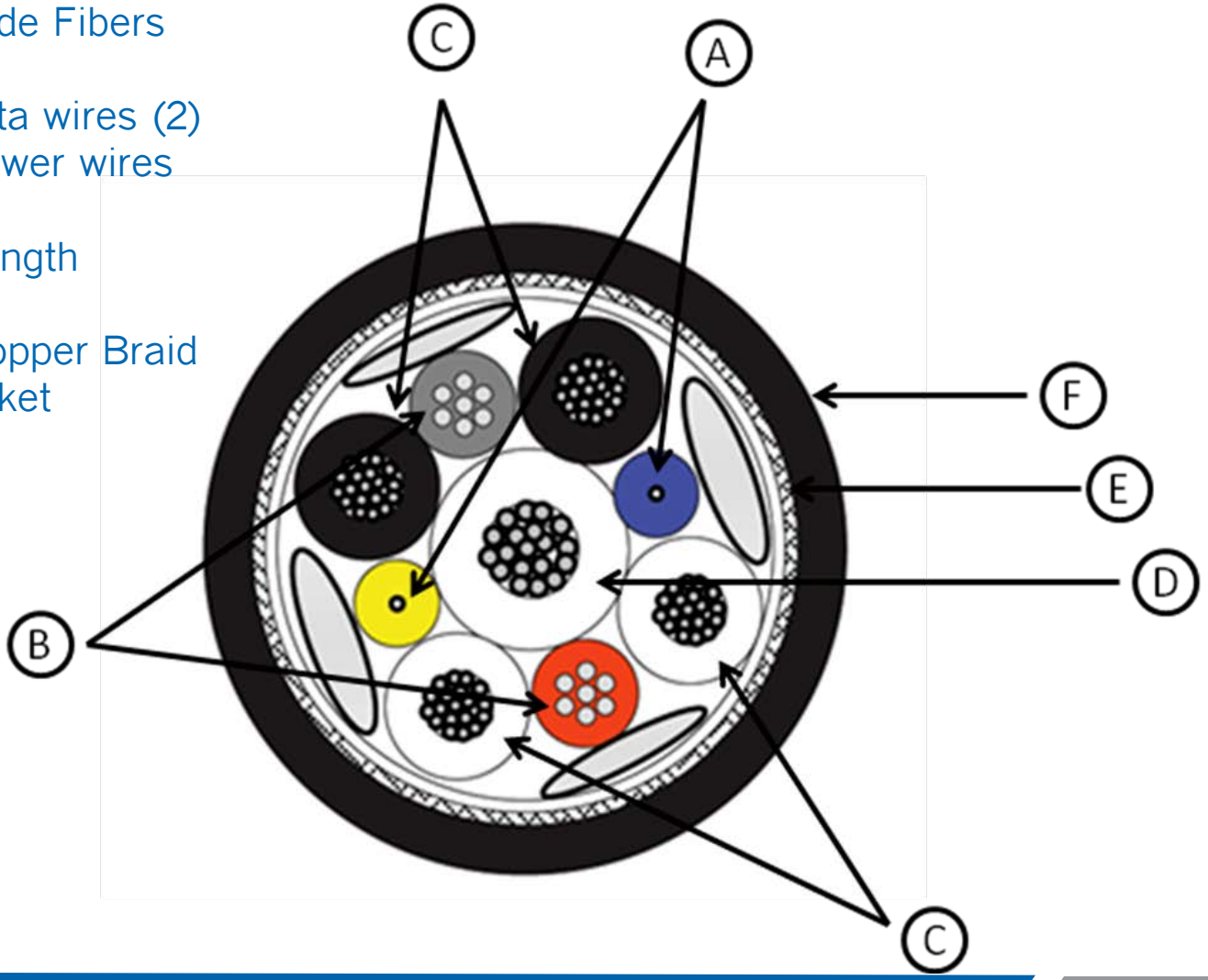
Female – Type PBW

SMPTE HDTV CAMERA CABLES

LEMO OR NEUTRIK opticalCON
Always Use Part Numbers to Specify Gender

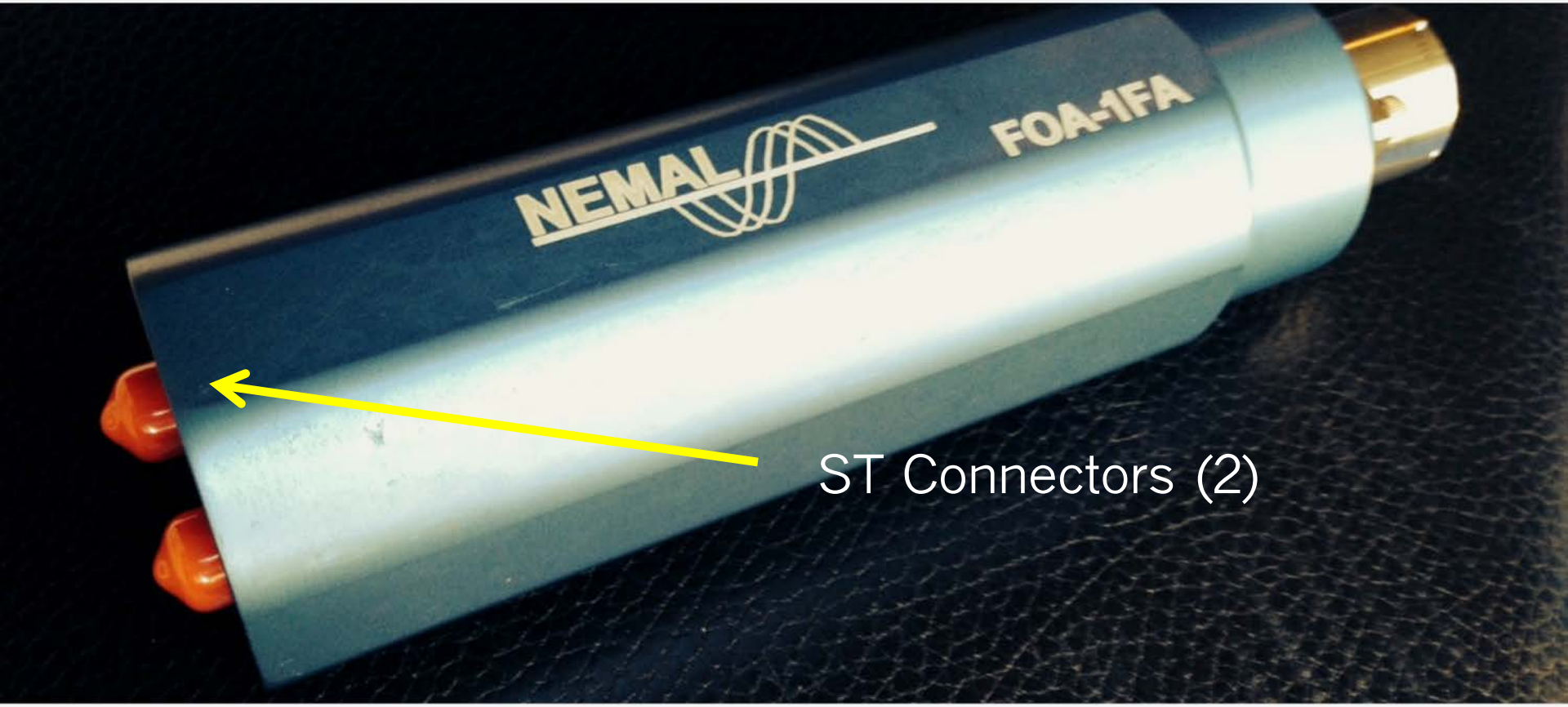
HYBRID SMPTE CABLE FOR HDTV CAMERAS
Inside View

A Singlemode Fibers (2)
B 24awg data wires (2)
C 20awg power wires (4)
D Steel Strength Member
E Tinned Copper Braid
F Outer Jacket



SMPTE FIBER ADAPTERS AND PANELS

FOA-1FA

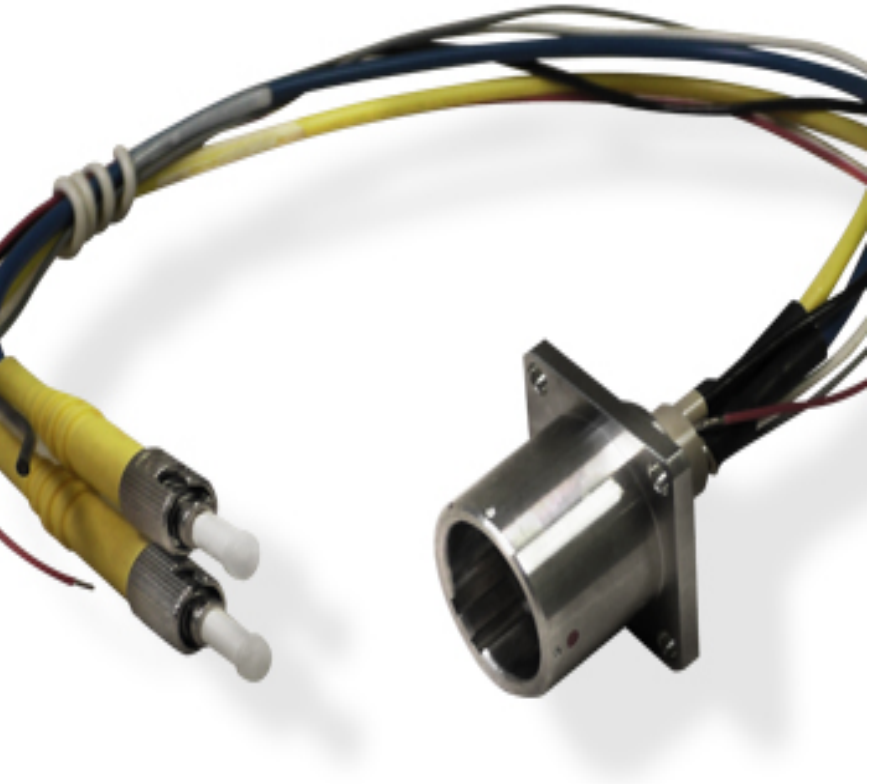


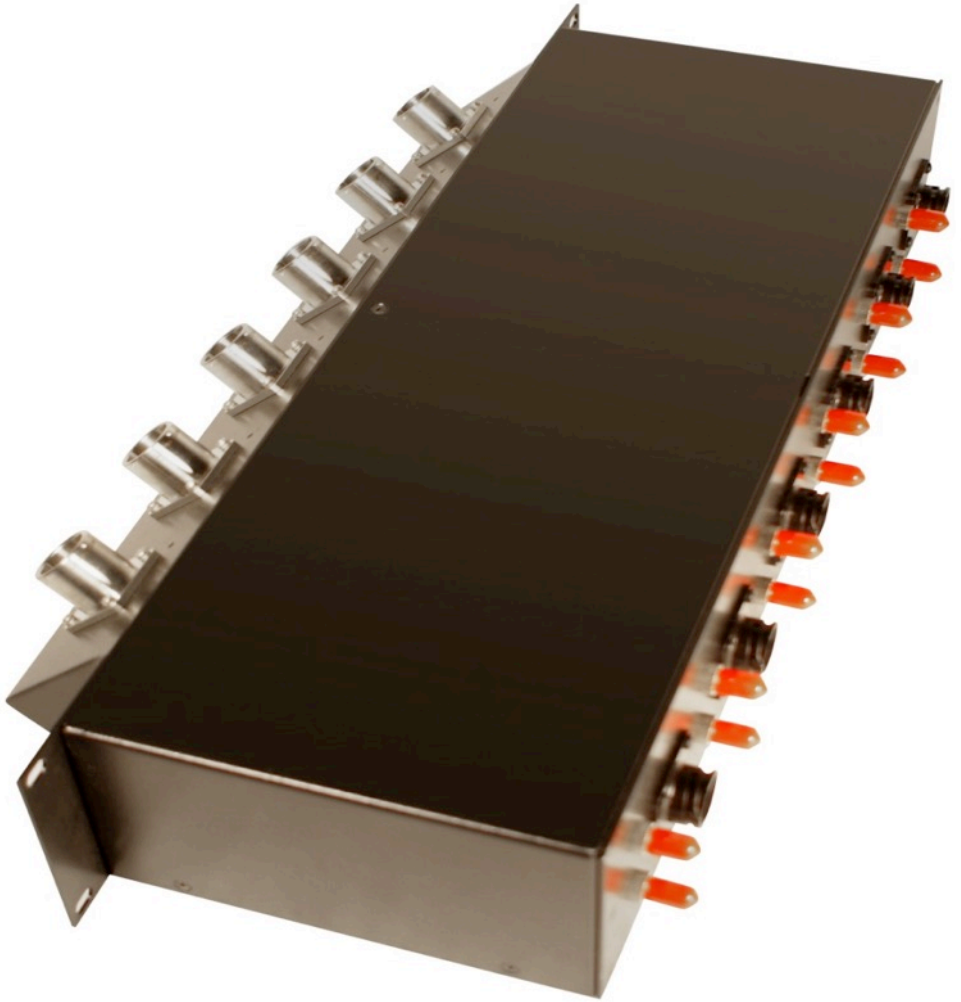
Either active or passive
Male or female SMPTE connector

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





SMPTE FEMALE PIGTAILS TO ST

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 DUO Chassis with transceiver adapter and SFP tranceiver

NKO2S-A*

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

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

MATERIALS USED IN FIBER ABLES

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

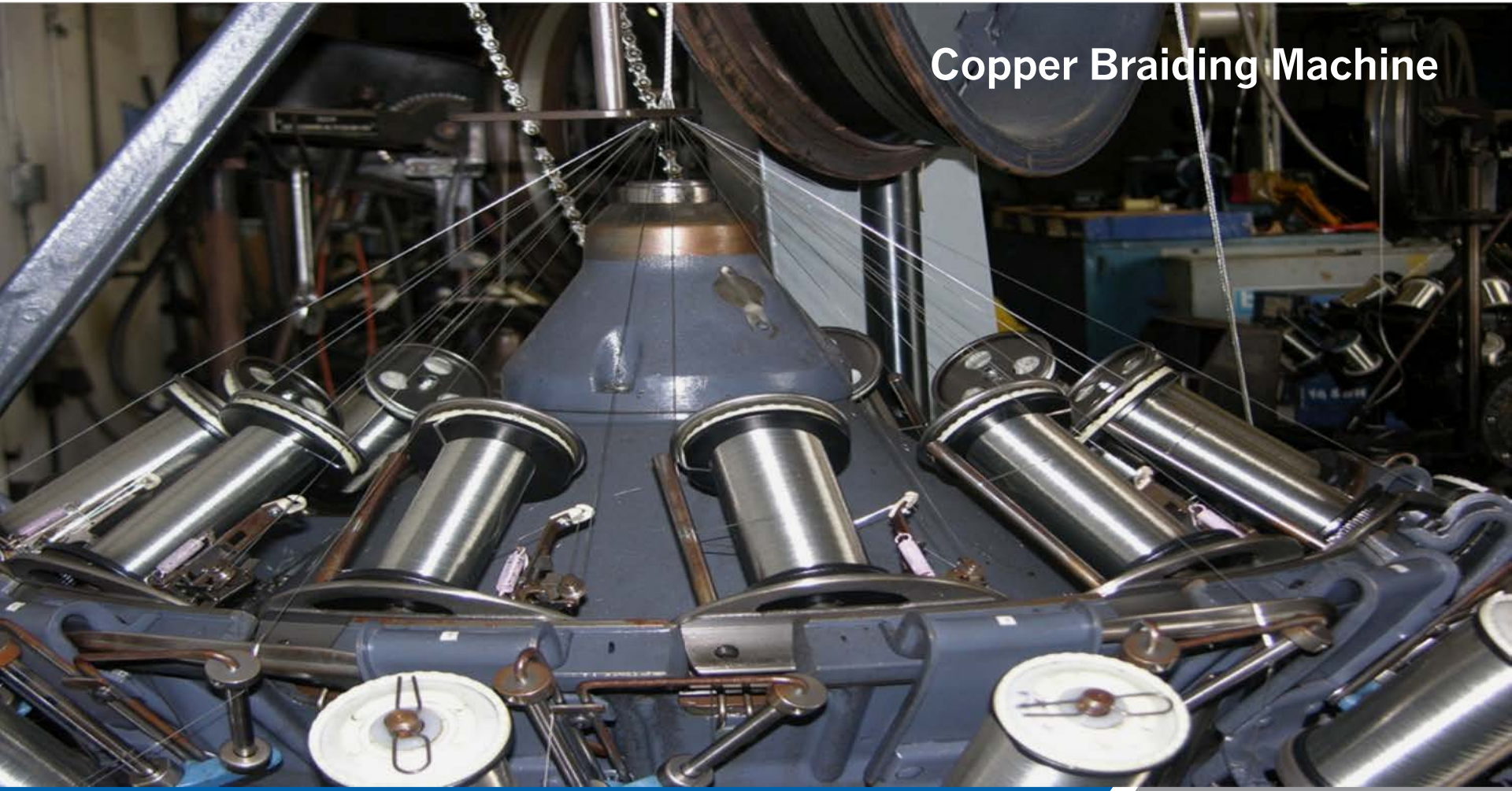
Sunlight Resistance-SR

Resistance to Oil and Gasoline

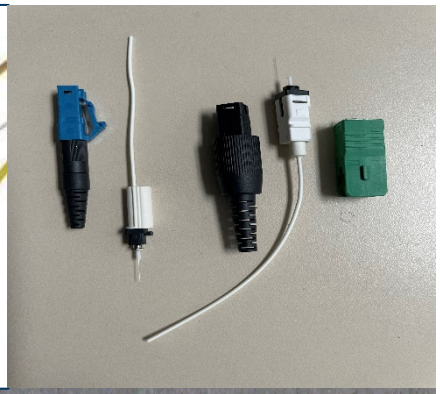
Temperature

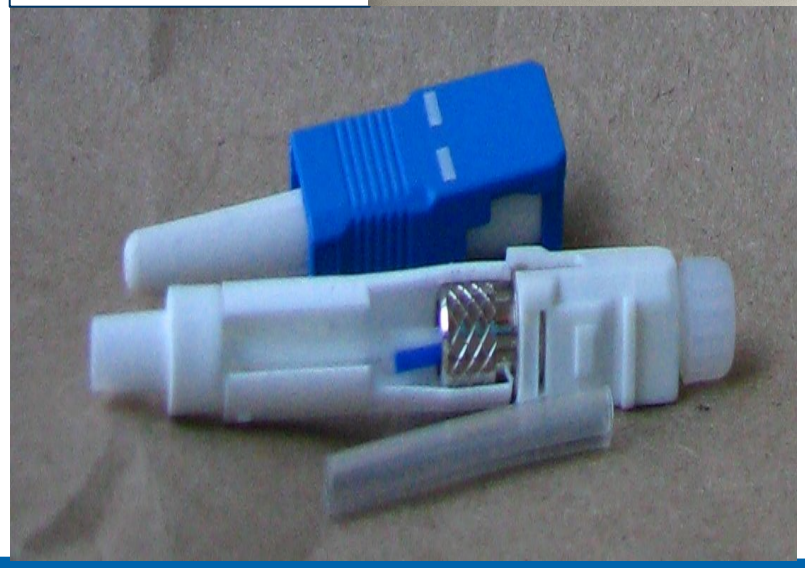
PRODUCTION OF FOCC24 SMPTE CABLE

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



CONNECTOR TERMINATION TYPES





Splice On (Fusion)
High Performance and Fast

Polish-Hand or Machine
*Many options

Mechanical Crimp (No Gel)
Fast and Easy, Simple Tooling
Low Cost, Mediocre Performance

Crimp On (Matching Gel)
Good performance and Fast
Higher cost

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

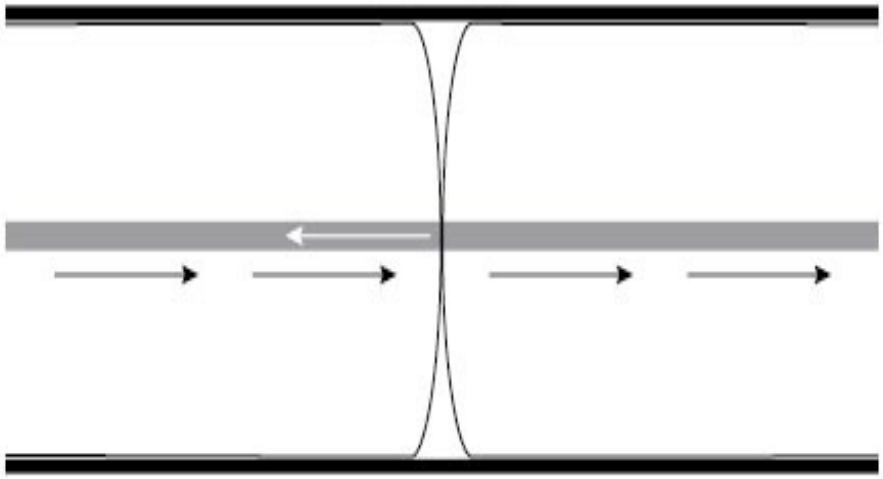
➔

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

➔

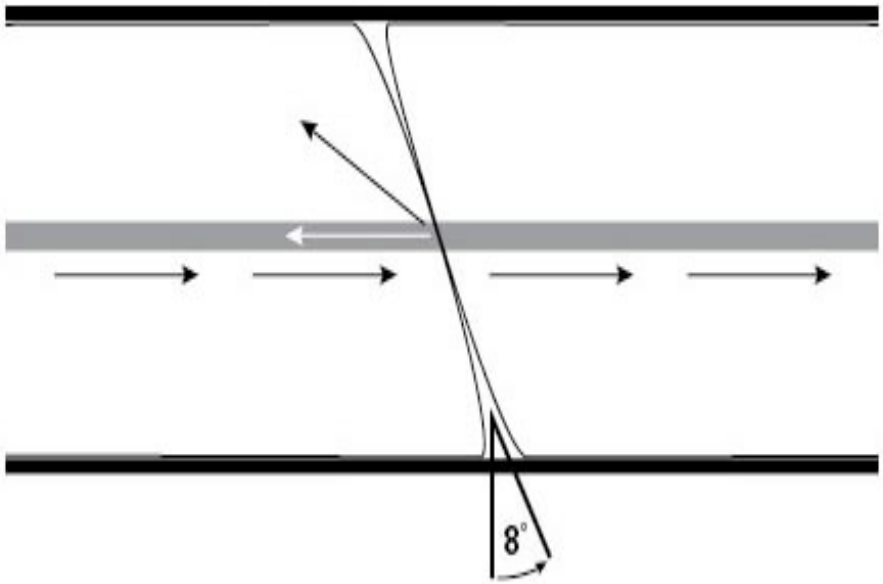
PC Common Polish
(but not so much anymore)
>-30dB de reflexion

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.

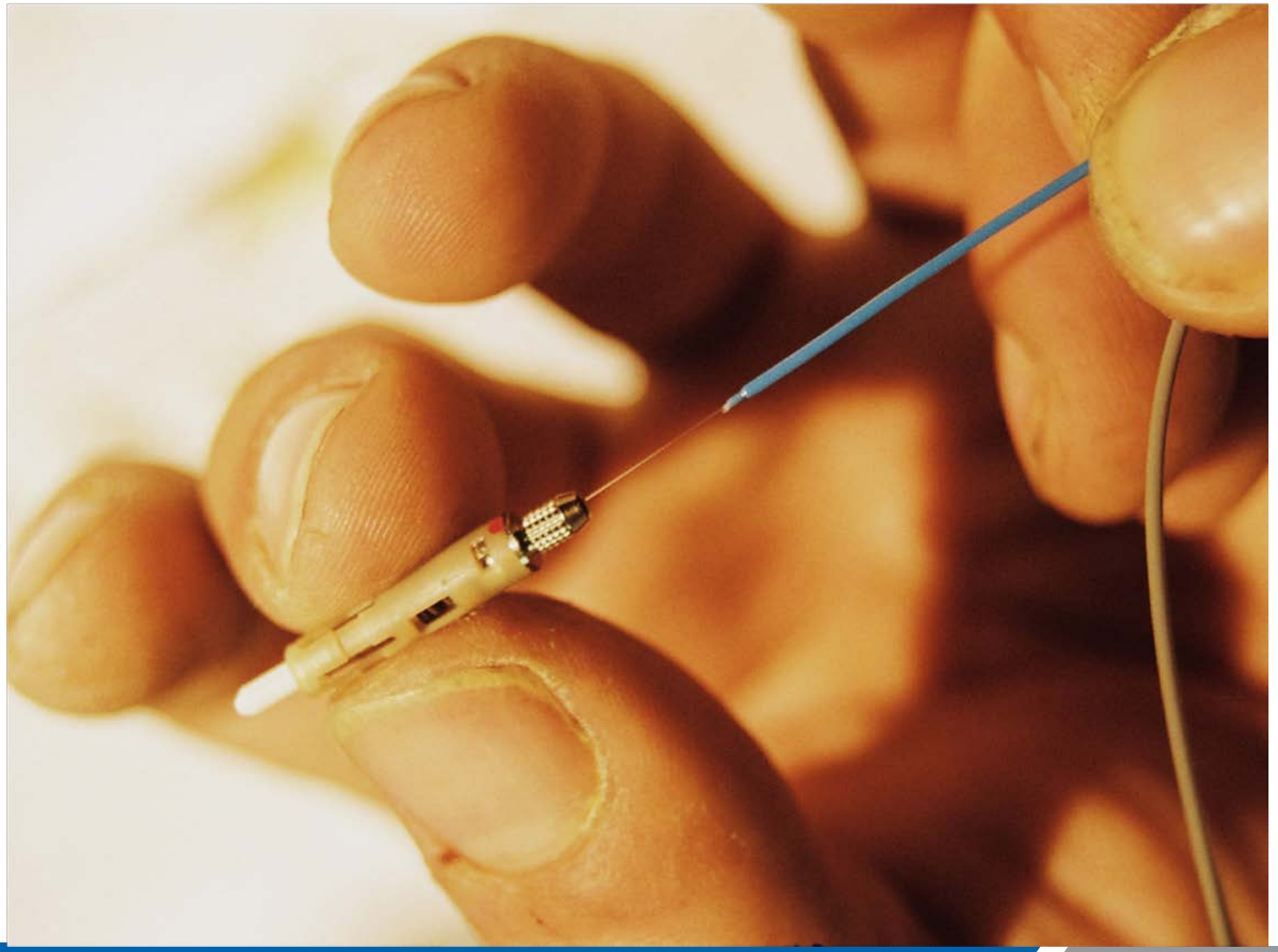


APC POLISH

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/F3 (2.0mm) SMPTE CONTACTS



COMMON FIBER TERMINATION FAULTS

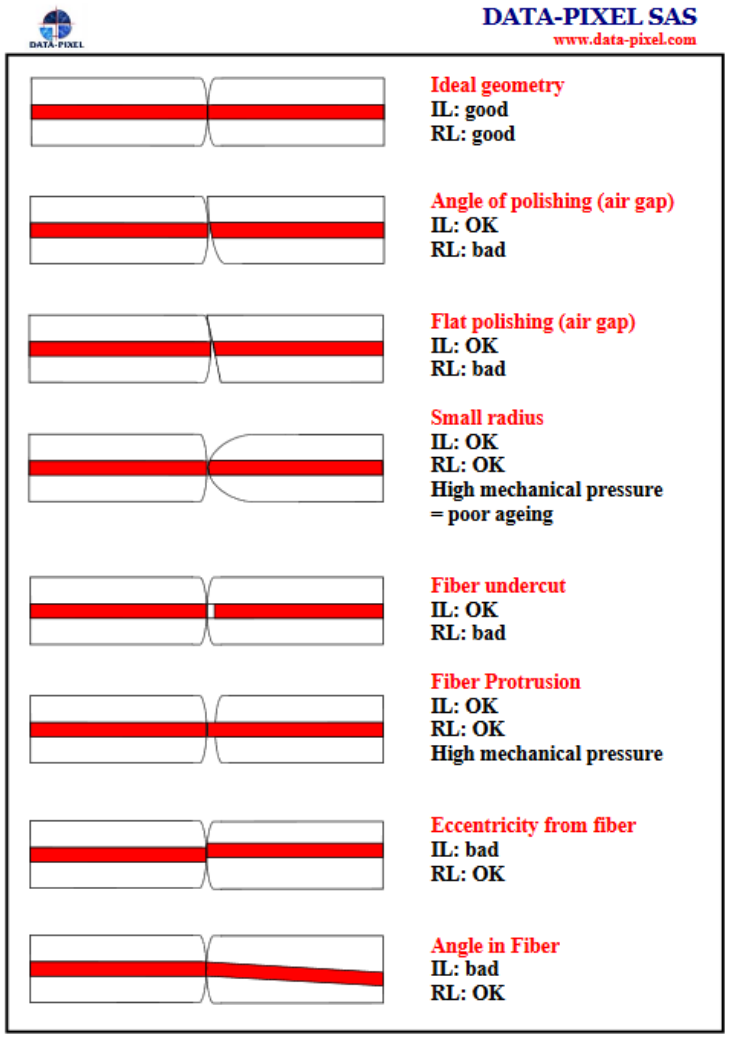
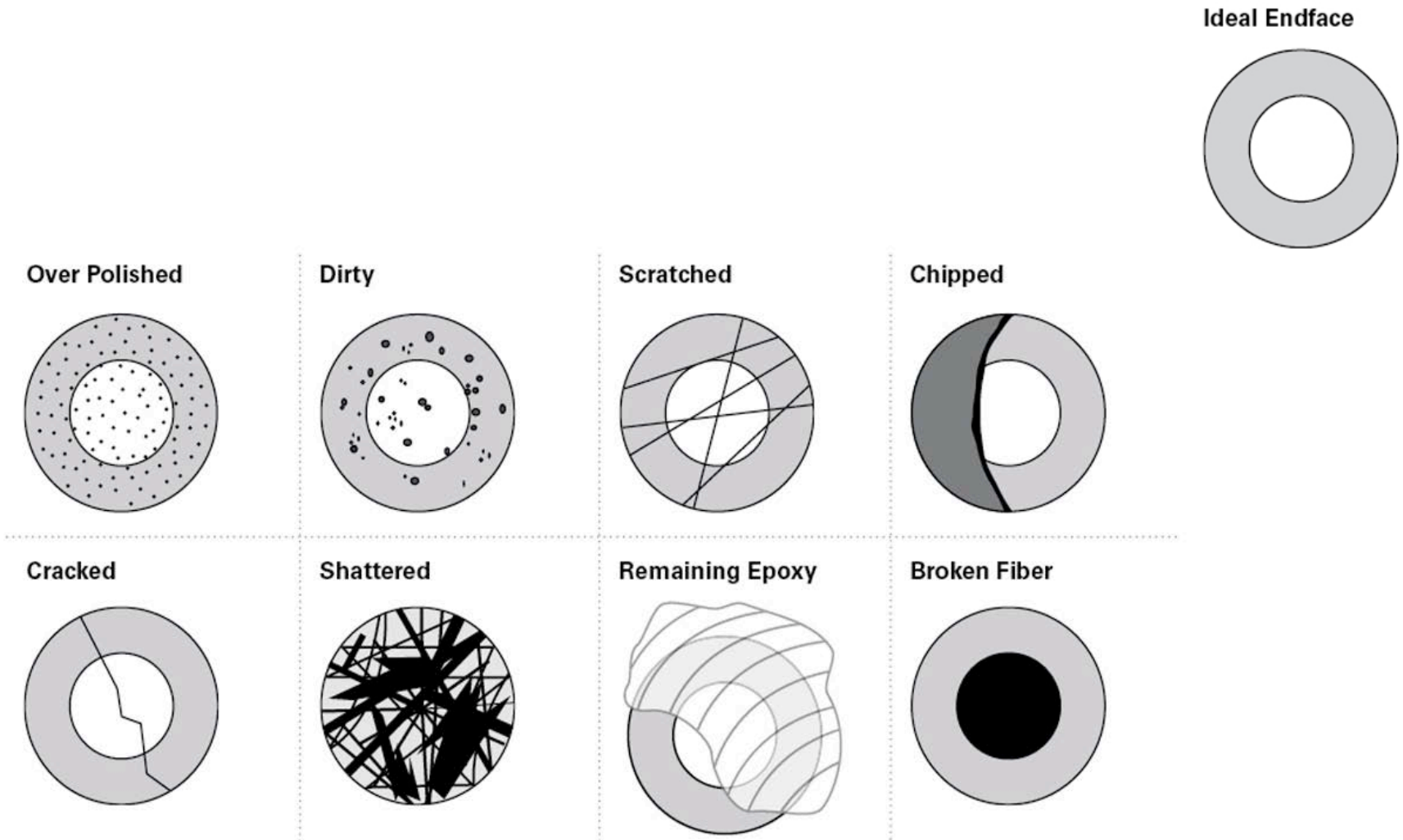
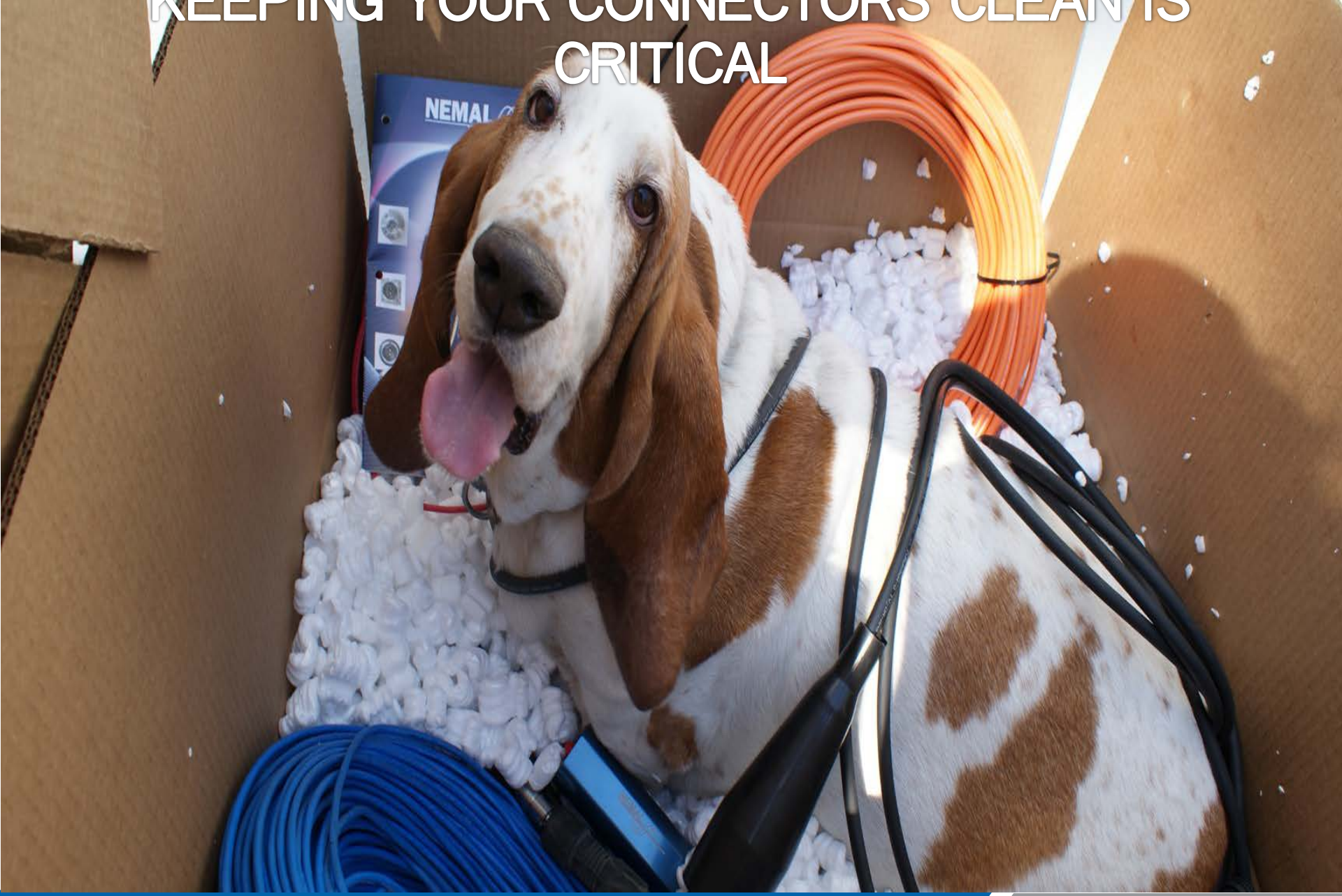


Diagram 3: Typical symmetry defects of polished ferrule end faces

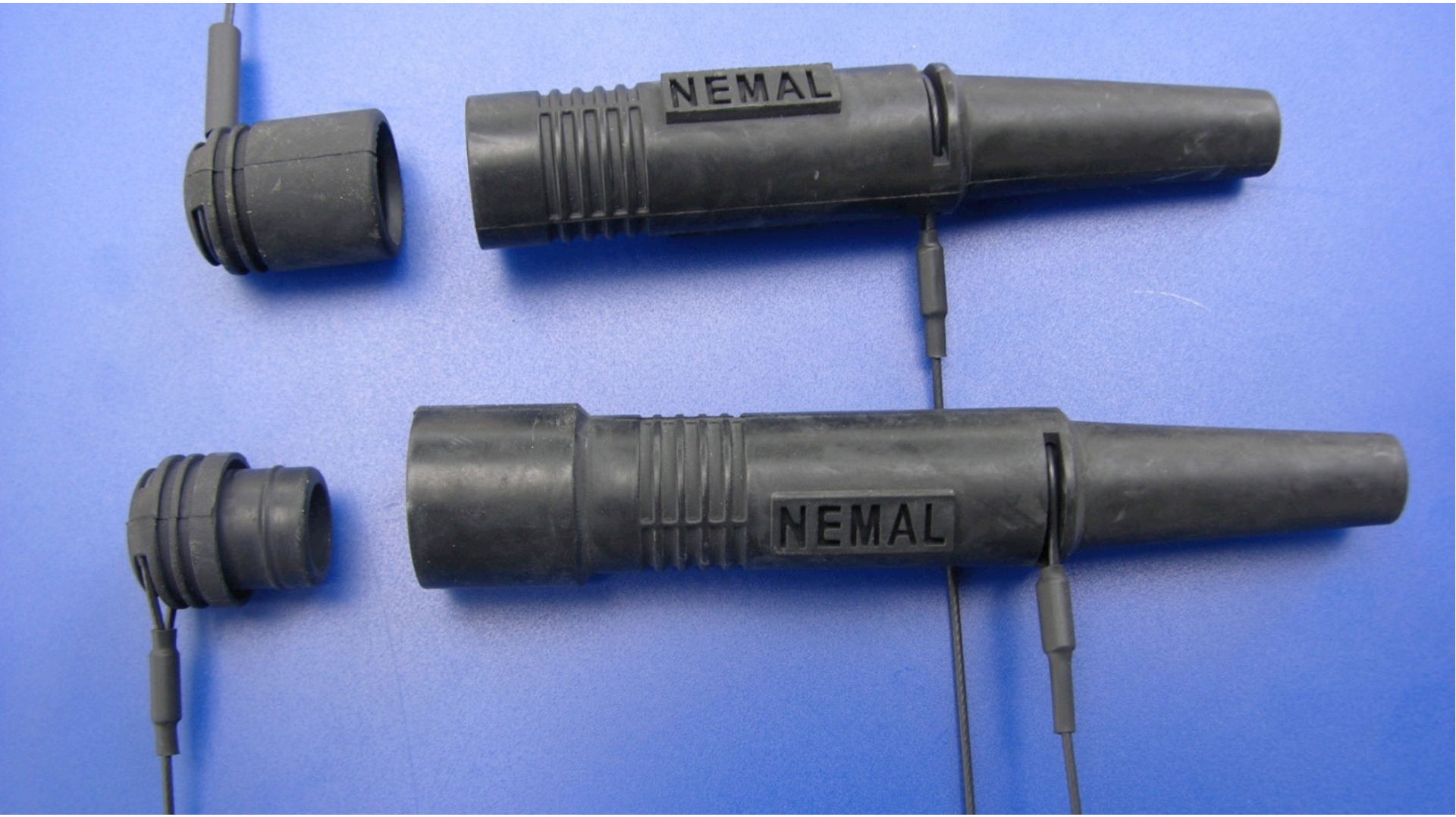
TYPICAL POLISHING DEFECTS AND OTHER FIBER DAMAGE



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

Fiber Cable Testing
Wide Range of Options

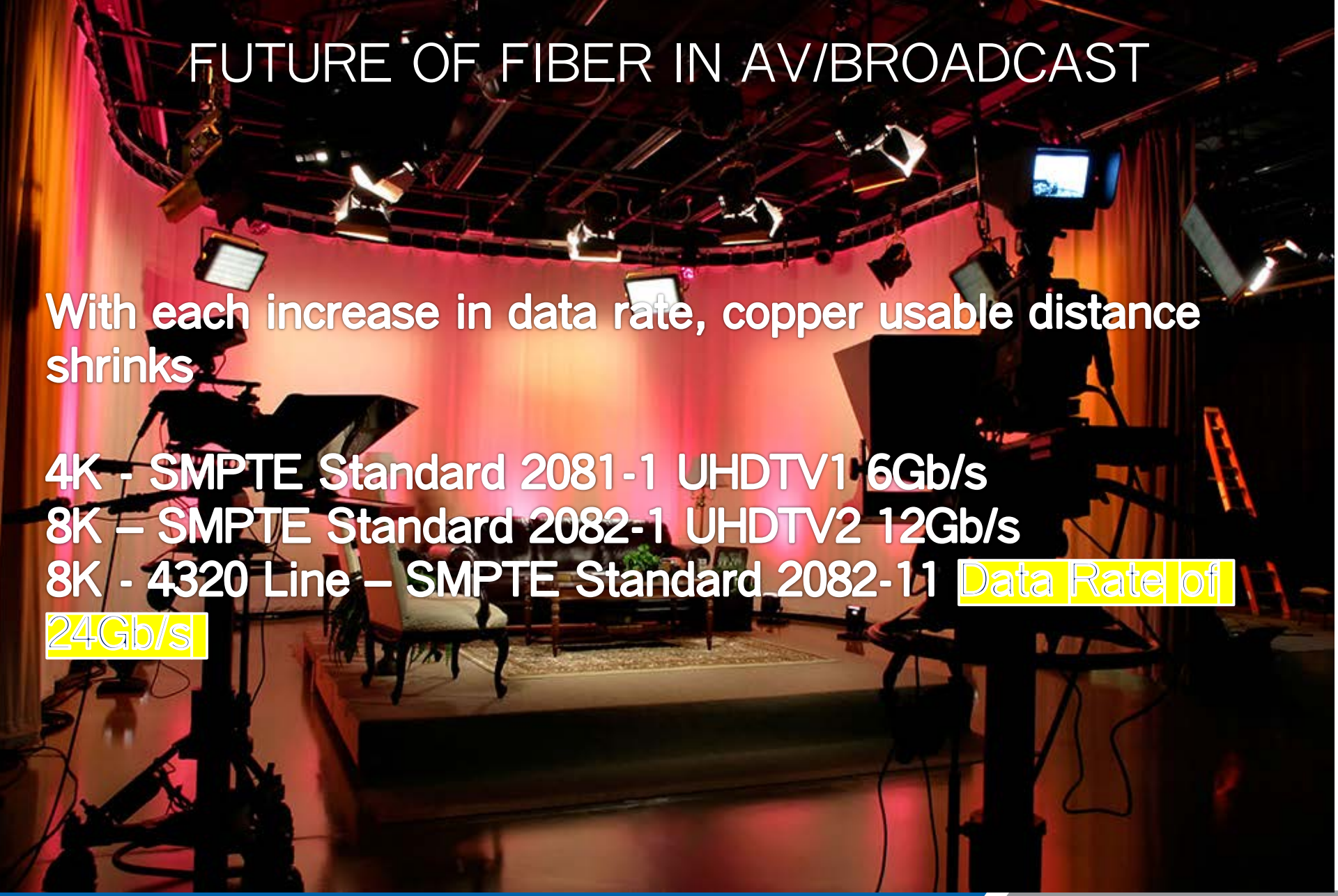
USB Inspection Probe Locator

Visual Fault

Advanced Testing

SMPTE Test Set
OTDR
Interferometry

FUTURE OF FIBER IN AV/BROADCAST



With each increase in data rate, copper usable distance shrinks

4K - SMPTE Standard 2081-1 UHDTV1 6Gb/s
8K – SMPTE Standard 2082-1 UHDTV2 12Gb/s
8K - 4320 Line – SMPTE Standard 2082-11 Data Rate of 24Gb/s

CLEANING AND TEST DEMO