



# Versatile Link Plus

## WP5 – Passive Components

Stefano Meroli

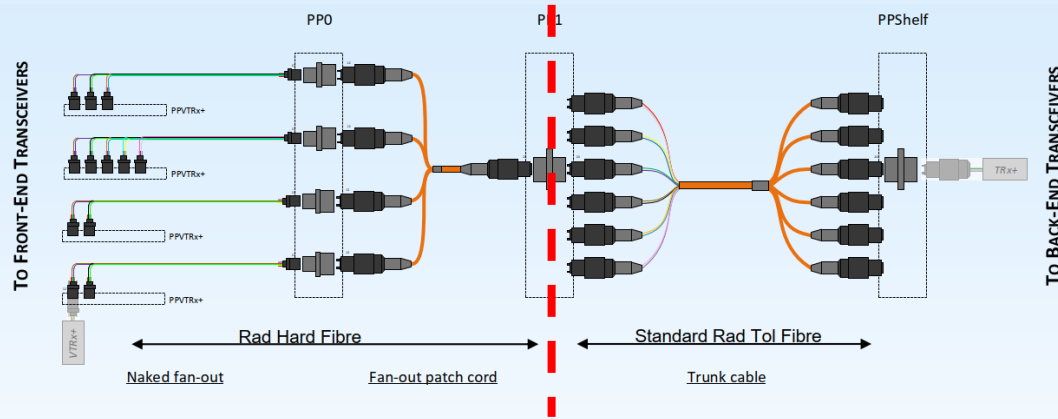
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CERN, Fibre Optics section (EN-EL-FO)



# Introducing the WP5 – Passive Components

- Define and Supply a cabling plant optimized to meet the specific requirements of the CMS and ATLAS subdetectors

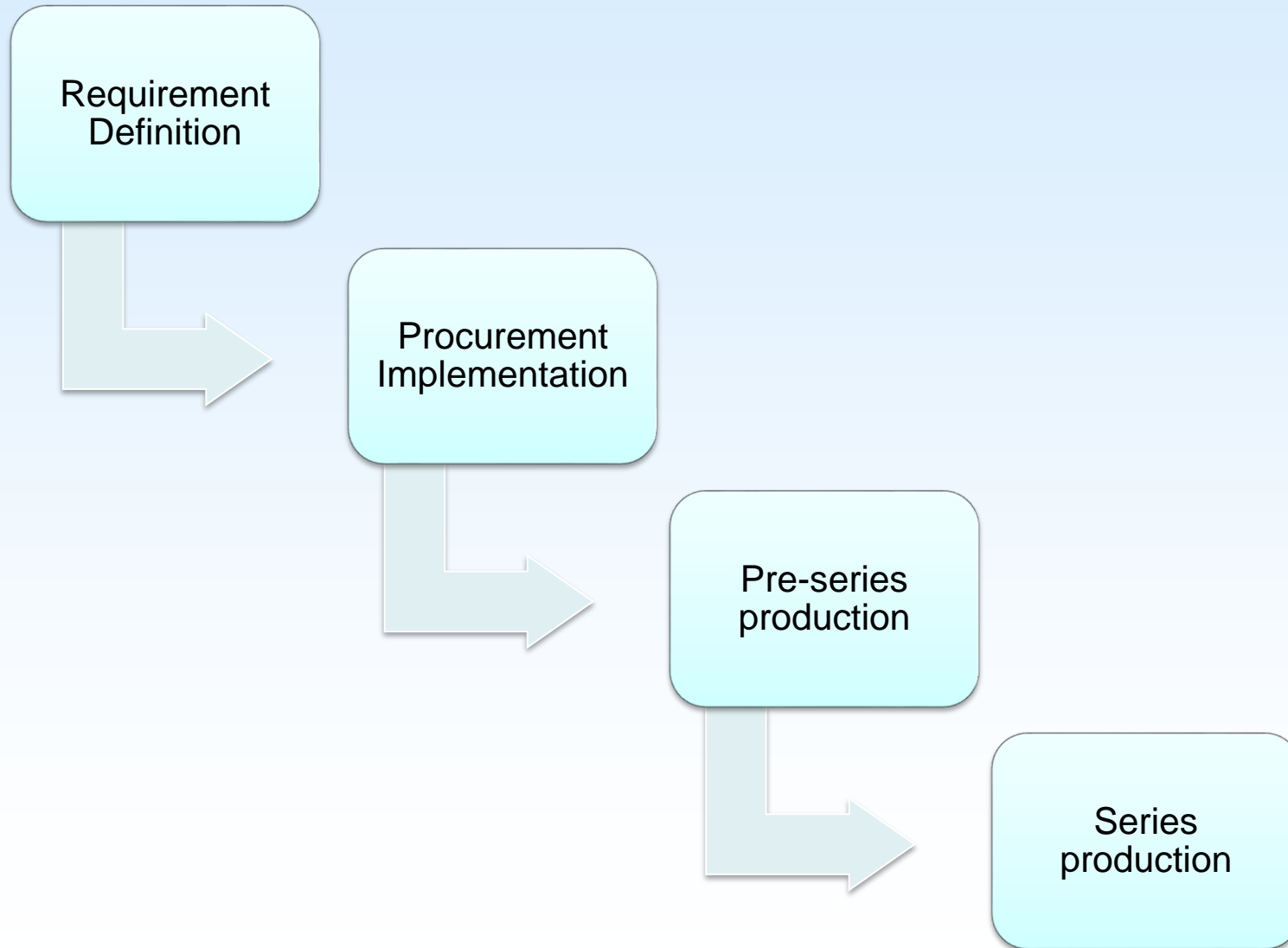


- Harsh environment
  - Temperature down to -35C
  - Magnetic field up to 4T
  - Radiation dose up to 1 MGy
- Standard industrial environment

- Versatile Link Plus project requires the development of a radiation resistant data link:

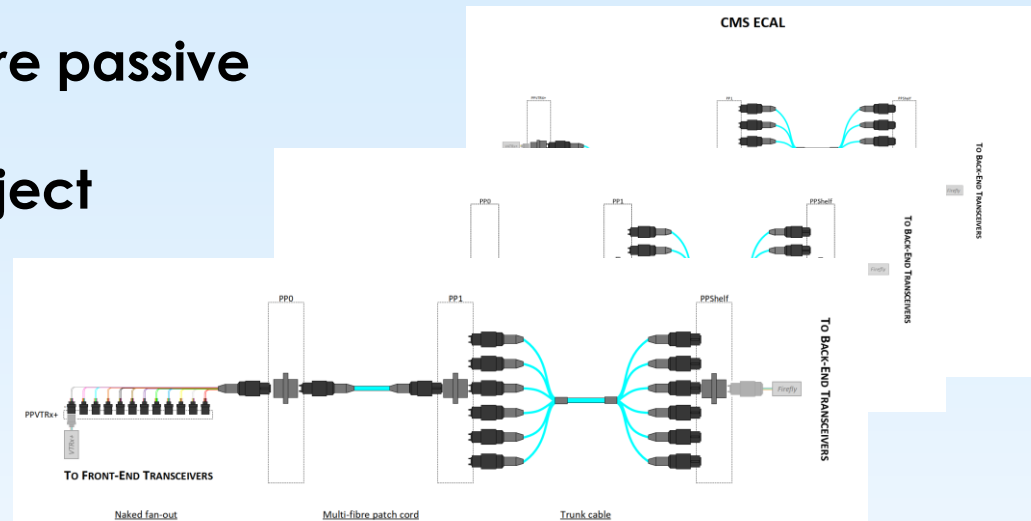
- Up to 10 Gb/s data rate upstream and 2.5 Gb/s downstream over ~100m
- Based on Multi-Mode Fibres (MMF) operating with a centre wavelength of 850 nm
- Concatenation of different types of fibres and cables suited for different radiation levels, ruggedness and routing constraints

# The Workflow



# Requirement Definition

- **Objective: Define the optical fibre passive needs of the 14 CMS and ATLAS subdetectors part of the VL+ project**
  - Cable Plant
  - Flavours and quantity
  - Schedule and Logistic



Subdetector	Cable plant	Quantity	Rad Hard Fiber	Quantity	RAD. Fibre length
ATLAS HGTD	-	-	ok	-	25
ATLAS ITK Pixel	ok	ok	ok	374	0.0
ATLAS ITK Strip (Barrel)	ok	ok	ok	148	9.1
ATLAS ITK Strip (End Caps)	ok	ok	ok	70	2.1
ATLAS Lar	ok	ok	ok	638	0.0
ATLAS Muon	-	-	-	-	-
ATLAS TDAQ	-	-	-	-	-
CMS ETL	ok	ok	ok	320	23.0
CMS BTL	ok	ok	ok	171	13.8
CMS ECAL	ok	ok	ok	258	48.3
CMS HGCAL	ok	ok	no	2340	192.2
CMS IT Pixel	ok	ok	ok	408	39.2
CMS Muons	-	-	-	-	-
CMS OT Barrel (TB2S)	ok	ok	ok	739	63.6
CMS OT Barrel (TBPS flat)	ok	ok	ok	196	20.5
CMS OT Barrel (TBPS tilted)	ok	ok	ok	338	29.9
CMS OT TEDD	ok	ok	ok	3046	93.9
<b>TOTAL</b>				<b>9076</b>	<b>561</b>



## Component

**Naked fan-out**

**Fan-out patch cord**

**Shuffle patch cord**

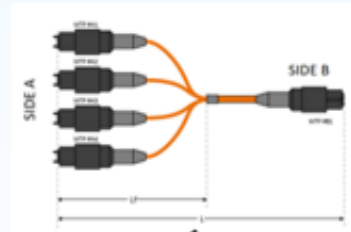
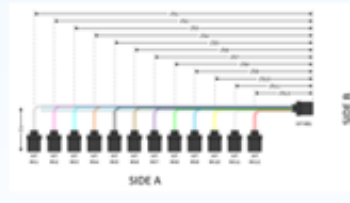
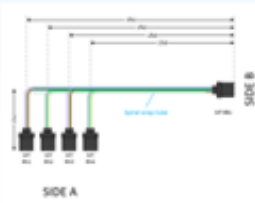
## Family

Connector type (MT12/24 or MTP12/24) and number of connectors on both sides fixed

NK 1 NK 2 **NK 3** ... **NK 10** NK n

FN 1 FN 2 **FN 3** FN n

SH 1 SH 2 **SH 3** SH 4 SH 5 SH n



## Type

$n_1$  fibres in each connector ...  $n_q$  fibres in each connector

$n_1$  fibres in each connector ...  $n_q$  fibres in each connector

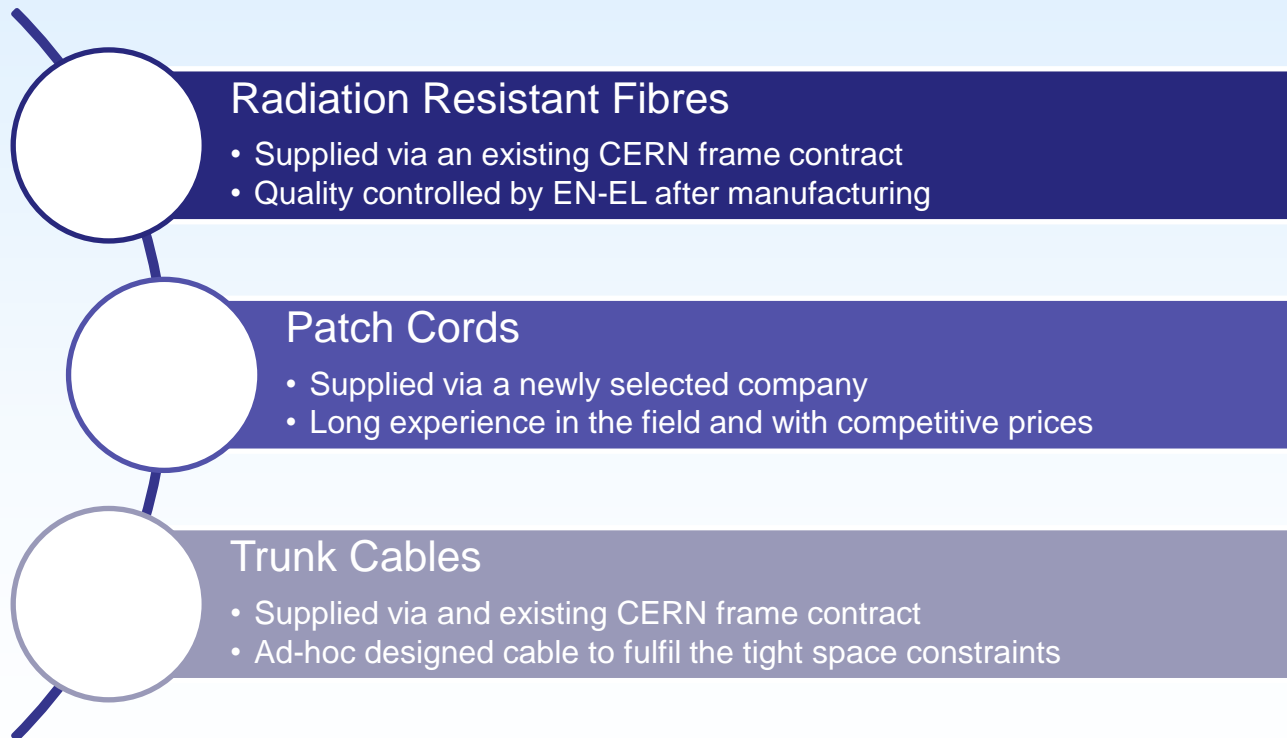
$n_1$  fibres in each connector ...  $n_q$  fibres in each connector



+ for each component type, protection details may vary

# Procurement

- **Objective: select capable suppliers able to produce the fibre components with the quality, schedule (and price) requested by the project and subdetectors**
  - Implementation of a world-wide supply chain that includes 3 different suppliers



- **Objective: get ready to the series production**

- Validate the cable plant of each subdetectors
- Generate datasheets to be used for production
- Allow the subdetectors to test the components in their own systems, demonstrating the validity of the proposed solutions to fulfil their requirements
- Get a cost estimate of each component
- Test the supplier capabilities and improve the process in view of the series orders

**Patch cord type:**  
NK, FN or SH

**MTP boot:**  
Standard, Flex, Angled, Short

**Fan-out length side A**

**Fan-out or bundle length side B**

**Number of fibre links**

**Fibre type:**  
radiation resistant, conventional

**NK:**  
Loose tube thickness 0.5mm  
Wrap outer diameter:  
- For 1 or 2 fibres: 2mm  
- From 3 to 12 fibres: 3mm  
- From 13 to 24 fibres: 7mm

**NK:**  
Standard -  $\phi$ +2 cm  
Special -  $\phi$ +1 cm

**FN or SH:**  
Standard -  $\phi$ +5 cm  
Special -  $\phi$ +2 cm

CONNECTION TABLE												
SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
01	03	05	06	08	09	10	12	15	16	18	20	24
1	8											
2	7	0										
3	7	0										
4	7	0										
5	7	0										
6	7	0										
7	7	0										
8	7	0										
9	7	0										
10	7	0										
11												
12												
13												
14												
15												
16												
18												
19												

**NK6**  
NK PCORD 20 MM-RRF A 1XMT(24) | 4XMT(12) 0.14m - AT Px  
ATLAS ITK Pixel  
XPMR001

Side A								Side B				Fibre/Cable			
Nb of connectors	Type of connector	Type of boot	Nb of used fibres per connector	Ua1 (cm)	Ua2 (cm)	Ua3 (cm)	Ua4 (cm)	Nb of connectors	Type of connector	Type of boot	Nb of used fibres	Lb (cm)	Fibre Type	Length (cm)	Fibre Protection
4	MTP12	STANDARD	5-5-5-5	12.5	11	9.5	8	1	MTP24	STANDARD	20	2.5	RL FIBRE	STANDARD	WRAP TUBE

**Channels in MTP RA3 to RA4**

**Channels in MTP RB1**

**Comments:**  
The spiral wrap tube protection shall stop before the first splitting point.

Design by:  
Design date:  
Version: 1.0

# Pre-Series Results

- Twenty pre-series orders were placed, quality controlled and distributed to the subdetectors
  - All the components passed the supplier and CERN quality control
  - Minor comments and corrections were provided to the supplier

Caller	Product	Order Status	Orders	Quantity
ATLAS HGTD	Patch Cord	Collected	1	13
	Trunk Cable	Collected	1	1
ATLAS ITK Pixel	Patch Cord	Collected	1	10
	Trunk Cable	Collected	1	1
ATLAS ITK Strip (Barrel)	Patch Cord	Collected	1	15
	Trunk Cable	Collected	1	1
ATLAS ITK Strip (End Caps)	Patch Cord	Collected	1	4
CMS BTL	Patch Cord	Collected	1	11
	Patch Cord	Collected	1	11
CMS ECAL	Patch Cord	Collected	1	6
	Trunk Cable	Collected	1	4
CMS ETL	Patch Cord	Collected	1	7
	Trunk Cable	Collected	1	1
CMS IT Pixel	Patch Cord	Collected	1	12
	Trunk Cable	Collected	1	2
CMS OT Barrel (TB2S)	Patch Cord	Collected	1	8
CMS OT Barrel (TBPS flat)	Patch Cord	Completed	1	24
	Trunk Cable	Completed	1	2
CMS OT Barrel (TBPS tilted)	Patch Cord	Collected	1	6
	Trunk Cable	Collected	1	1
CMS OT TEDD	Patch Cord	Collected	1	24
<b>Grand Total</b>			<b>20</b>	<b>153</b>

- **What's next now with the pre-series**
  - Subdetectors to test the products
    - ❖ Validate the pre-series
    - ❖ Requested changes will need to go through a new round of pre-series
    - An excel file was made available in the Sharepoint ([link here](#)) to collect subdetectors' feedback ... but still empty
  - In either cases, provide a feedback by mail by 30/10/2023



# Series Production

- Only subdetectors that have validated the pre-series will be able to place series orders. Validation to be completed by 2023.
- A tentative schedule for series production shall be provided as well and confirmed to meet the capacity plan of the suppliers
- Orders to the suppliers are placed every three months (Jan-Apr- Jul-Oct).
- Each subdetector manages its production independently, provided the schedule fits an approved common capacity plan

# Series Production: FAQ

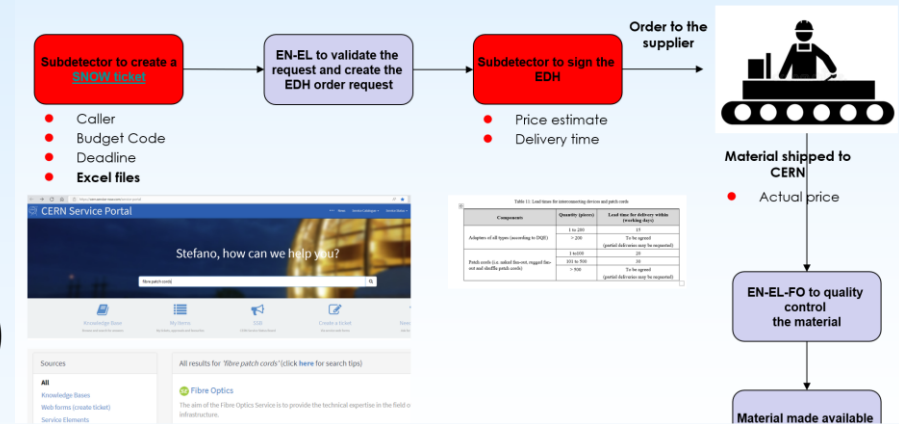
- **When can a subdetector move to series production?**

As soon as the subdetector validated the pre-series (no more changes are required) and provided the tentative schedule

- **How can a series order be sent?**

In the same way as with the pre-series

- Fill in a new excel file
- Attach the excel file to a ticket (link [here](#))



- **Who can send a series order?**

The subdetector contact person

Subdetector	Contact person
ATLAS HGTD	Sergei Malyukov
ATLAS ITK Pixel	Aaron Paul O'Neill
ATLAS ITK Strip (Barrel)	Tony Weidberg
ATLAS ITK Strip (End Caps)	Pepe Bernabue
ATLAS Lar	Luis Hervas
ATLAS Muon	-
ATLAS TDAQ	-
CMS ETL	Natalia Koss
CMS BTL	Joao Varela
CMS ECAL	Werner Lustermann
CMS HGCAL	Jan Troska
CMS IT Pixel	Stella Orfanelli
CMS Muons	Domenico Dattola
CMS OT Barrel (TB2S)	Antti Onnela
CMS OT Barrel (TBPS flat)	Nicola Bacchetta
CMS OT Barrel (TBPS tilted)	Antti Onnela
CMS OT TEDD	Christophe Delaere

# Series Production: FAQ (2)

- **Will the WP5 team quality control the supply**

Yes, visual and optical inspection will be performed on the supply.

!! Each subdetector is responsible for testing the final links after installation on-site

The diagram illustrates the quality control process for series production. It is divided into two main sections: Visual inspection and Optical inspection. Each section lists specific inspection criteria and includes a callout for the sample rate.

- Visual inspection:**
  - Packing
  - Article type
  - Quantity
  - Termination quality (e.g. silicone wrap tube, fan-out kits)
  - Supplier test report check

Callout: 100% sample rate
- Optical inspection:**
  - Optical performance (i.e. insertion loss)
  - End face inspection
  - Physical and optical length
  - Pin-out and key orientation

Callout: 10% min. sample rate

The diagram also includes a small table with columns for 'Analysis image' and 'Analysis data'.

- **What is the lead time for series orders?**

Orders are placed every three months (Jan-Apr- Jul-Oct). The typical lead time is 10 weeks.

!! Provide us with your tentative schedule as soon as possible so that we can book the supplier facility

- **Who will store the components?**

Each subdetector shall provide adequate storage place.

!! Trunk cables are extremely bulky (around 0.5 m3 each)

## Conclusions and Next Steps

- The subdetectors' requirements have been defined. Pre-series orders have been launched accordingly
- Enough radiation resistant fibres have been procured and tested
- Suppliers have been selected and tested during the pre-series phase. **So far so good**
- **Next steps for the subdetectors**
  - Validate the pre-series or request changes by 30/10/2023
  - Provide the latest series order schedule to help planning production capacity
  - Series orders following the same process as for the pre-series (excel file, ticket, EDH..)

# Thank you for your attention!

## Questions?