

Versatile Link⁺ VTRx⁺ Production Status

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EP-ESE-BE**

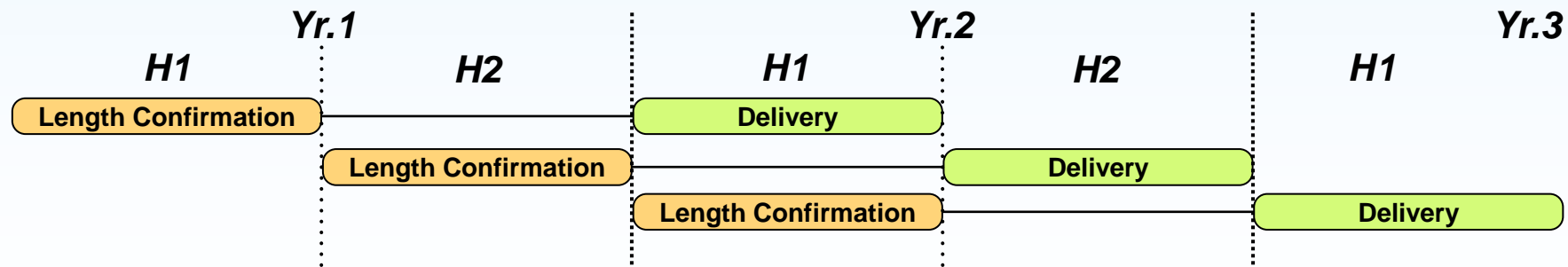
on behalf of the VL⁺ collaboration

Since TWEPP 2022

- Assembly process qualification
 - New gluing process improved the lens alignment
 - However, it failed the temperature cycling
- Lens gluing process had to be further optimized
 - New dual-cure epoxy
 - Optimised UV curing parameters
- CM assembled additional pre-series batches
 - Results confirmed good alignment
 - Successful process qualification
- Series production started in May 2023

Ordering process (Users – CERN)

- Production schedule is being updated according to the requests and the available production capacity
- There will be a sliding window for updating the length distribution planned production
 - Orders in a given six-month period will be delivered 6-12 months after the end of the ordering period
- See Yr.1 schedule in the backup slides



Ordering strategy (CERN – CM)

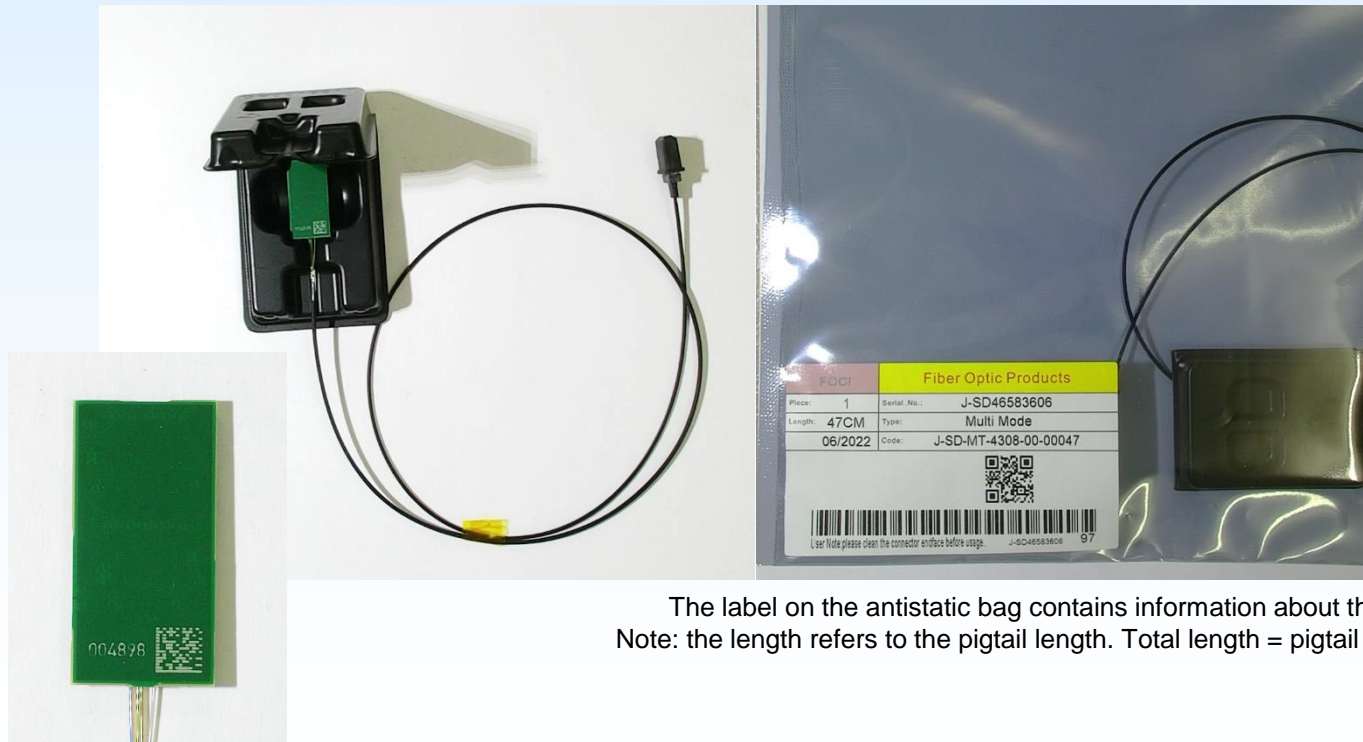
- Following the first few production months we adjusted the ordering strategy according to the feed-back received from the CM
- Number of variants per month
 - Assembly company has indicated the desire to reduce the number of variants, and/or increase the number of modules of a given variant in a given batch
- Number of components to be ordered
 - The assembly house is currently facing logistics issues in delivering exactly the number of components orders
- CERN optimised the schedule and increased the quantities per variants to include spare modules for QA, as well as to have more flexibility

Delivery procedure (CERN – Users)

- Modules are produced in monthly batches
 - Not every production month necessarily yields parts for any particular end user
- When batches are delivered to CERN, the contact person for a particular user team gets informed
- After the completion of the Inter Departmental Transfer (TID) document, the modules are delivered to one CERN-based contact per sub-detector
- The VTRx+ contains “dual-use” components. It is the user’s responsibility to follow the specific export rules
 - <https://ep-ese.web.cern.ch/exportcontrol>

Package

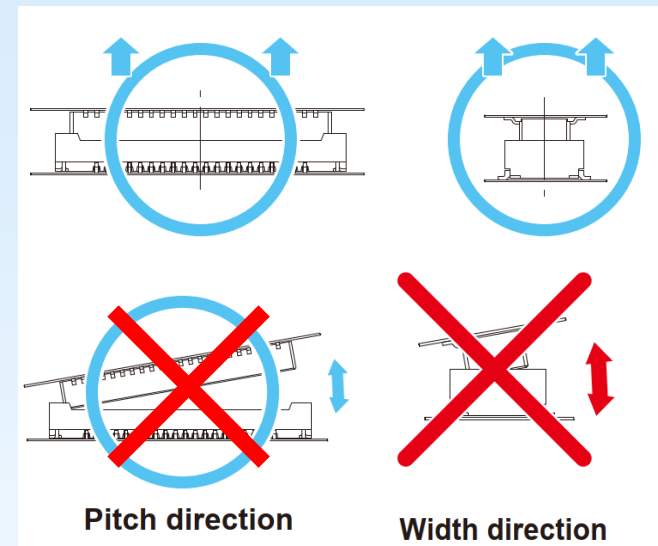
- Modules are placed in an ESD-safe blister package, which in turn are put in individual antistatic bags
- The bags are delivered in carton boxes
- The serial numbers of the delivered modules can be provided in a file



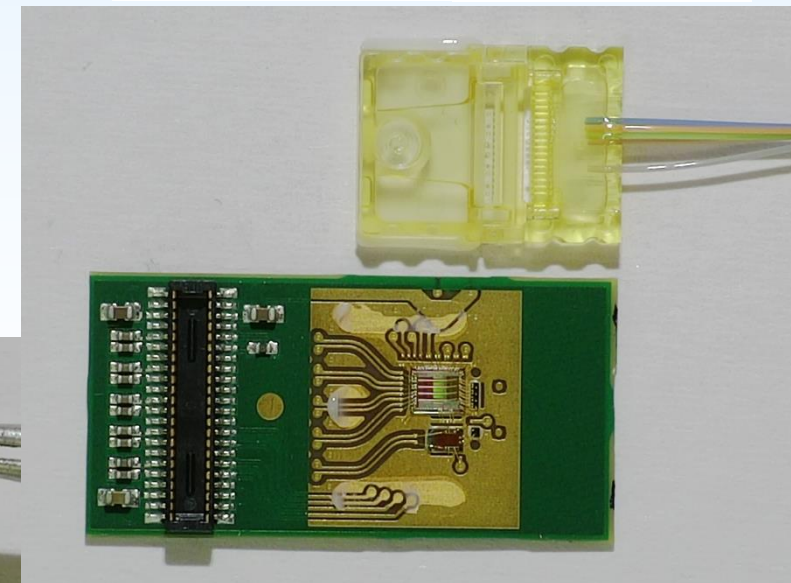
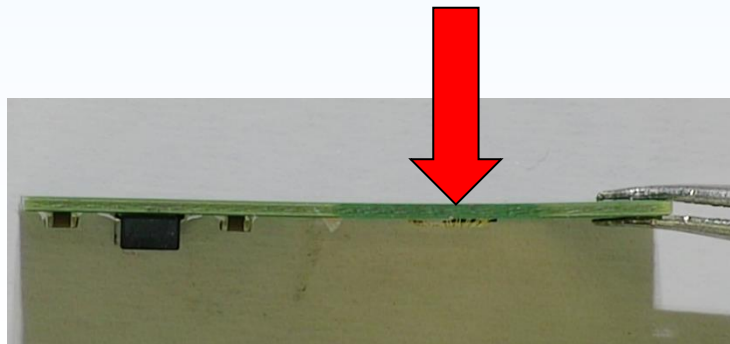
The label on the antistatic bag contains information about the pigtail.
Note: the length refers to the pigtail length. Total length = pigtail length + 3cm

Serial number in human-readable format
and as 2D matrix code

- Interface connector handling
 - To unmate the module, lift evenly across the header, making sure that each side stays parallel to each other
 - Do not tilt the connector during mating and unmating, because it may damage the contacts

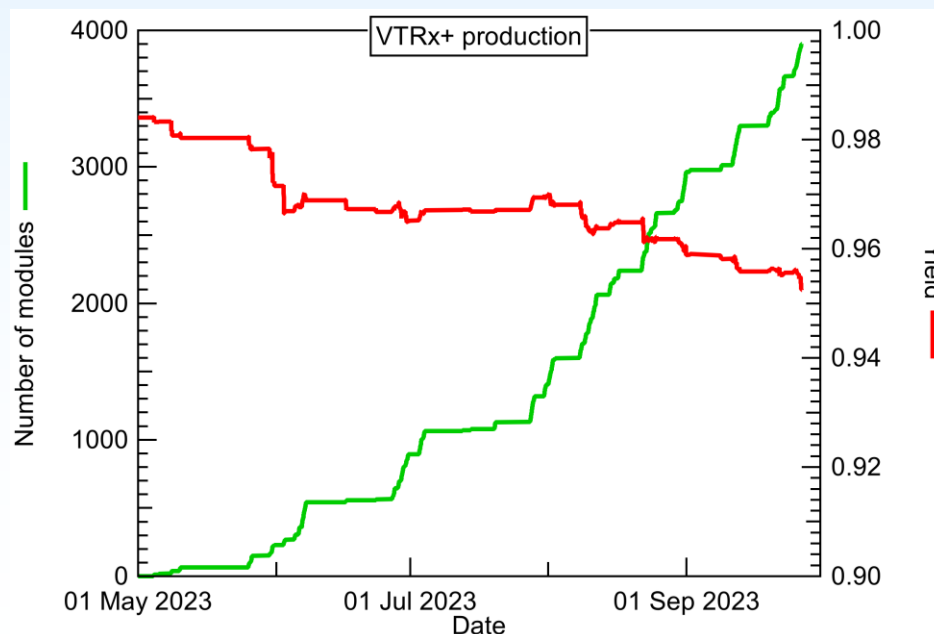


- The modules are assembled on a thin PCB, which must NOT be bent. Bending the PCB may lead to permanent damage.



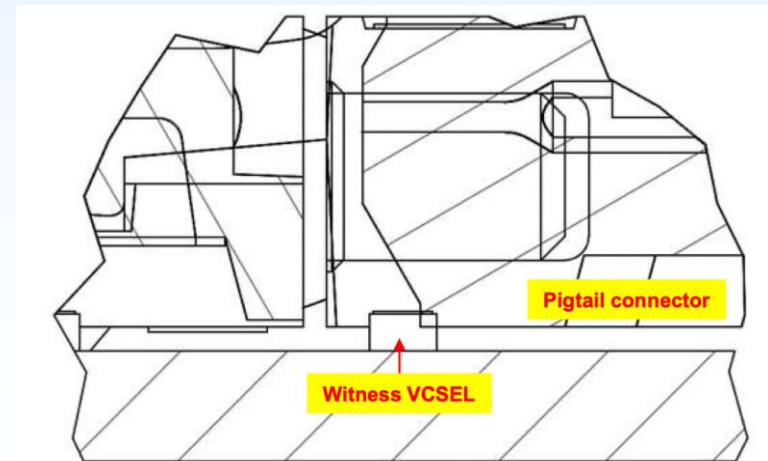
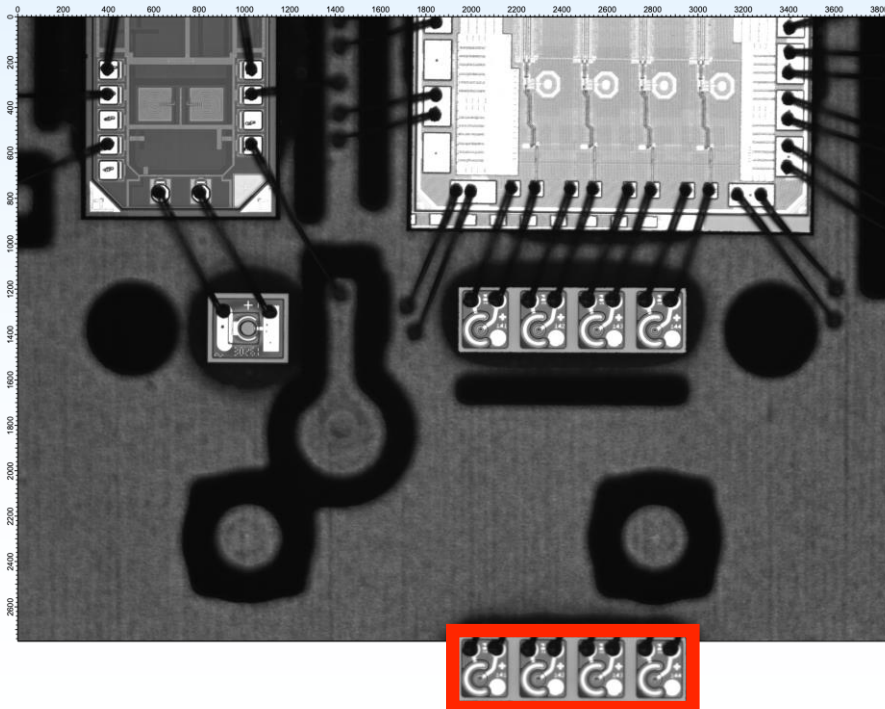
Production status

- Received 5 production batches so far
 - Batches 1-3: 500 modules/batch
 - Batch 4-5: 1000 modules/batch
- Batches 1-3 have been tested and distribution to users has started
- Batch 4 is being tested; functional testing complete, temperature testing is in progress
- Batch 5 arrived this week, reception process starts soon



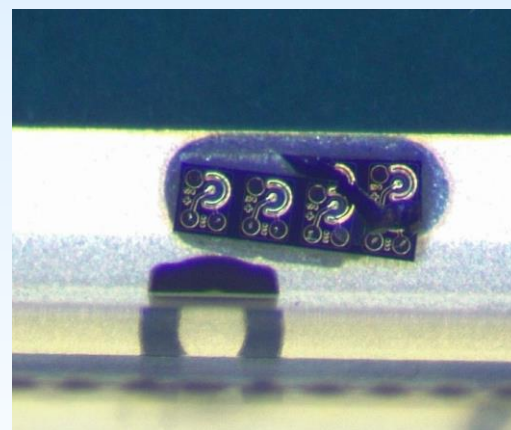
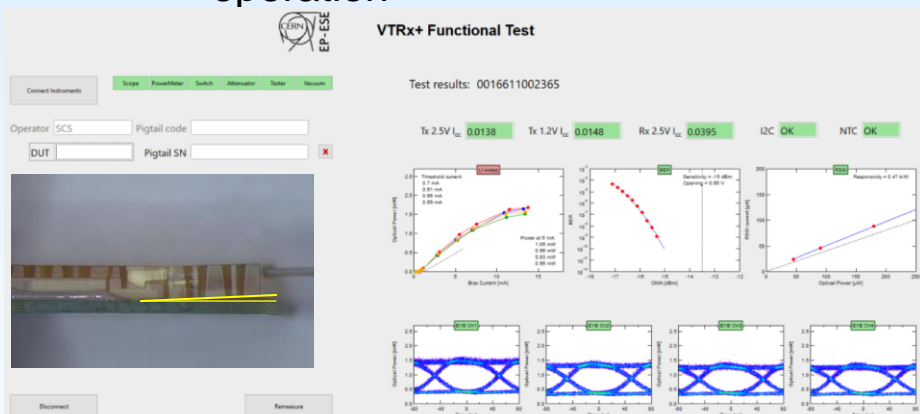
Batch #1 non-conformity

- During the last prototyping round before production start an additional “witness” VCSEL was mounted in order to be able to measure the position of the coupling block after it is assembled
- Turns out that placement might collide with pigtail once plugged into the coupling block
 - Unfortunately not noticed during prototyping

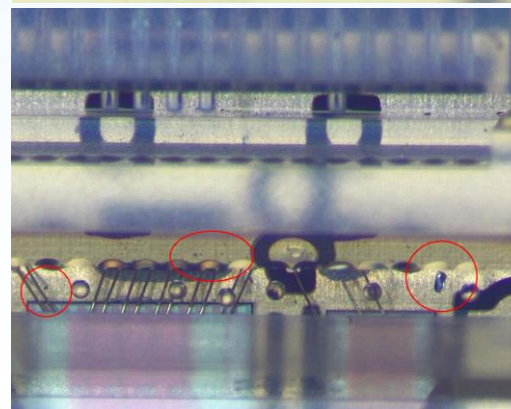
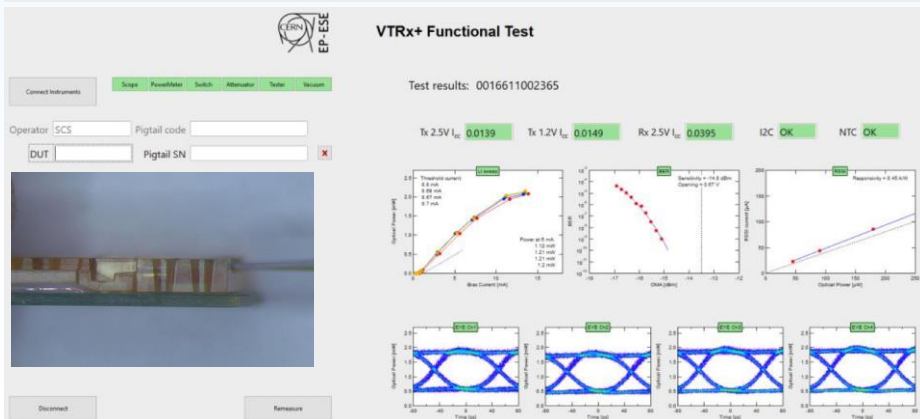


Batch #1 non-conformity

- Witness VCSEL may incline the pigtail, causing coupling loss (left)
- Witness VCSEL may shear off and/or disintegrate, causing contamination and/or loss of optical power (right)
 - This could happen during later handling, or during thermal cycling that will occur during operation



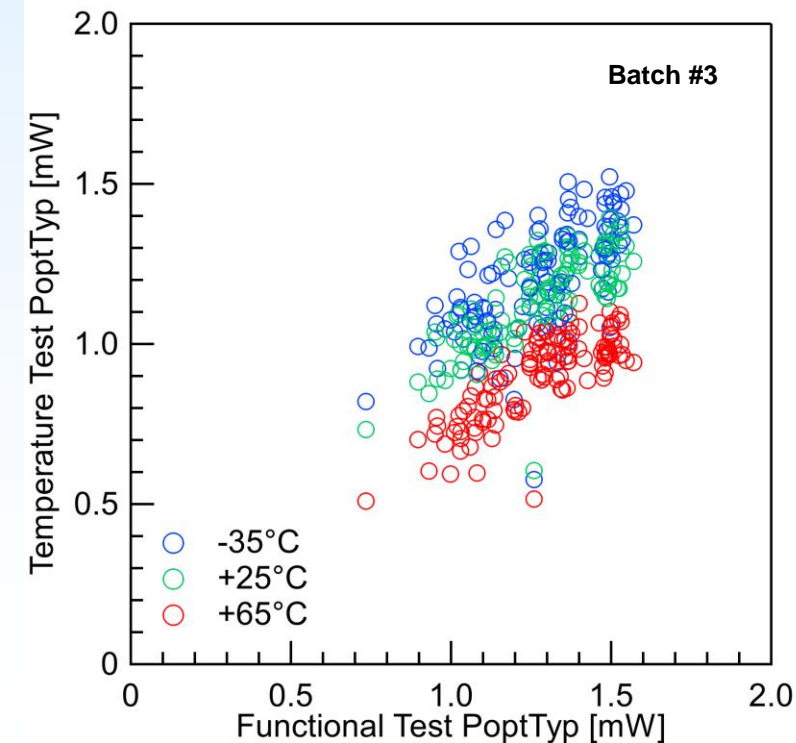
Witness VCSEL broken but still in place



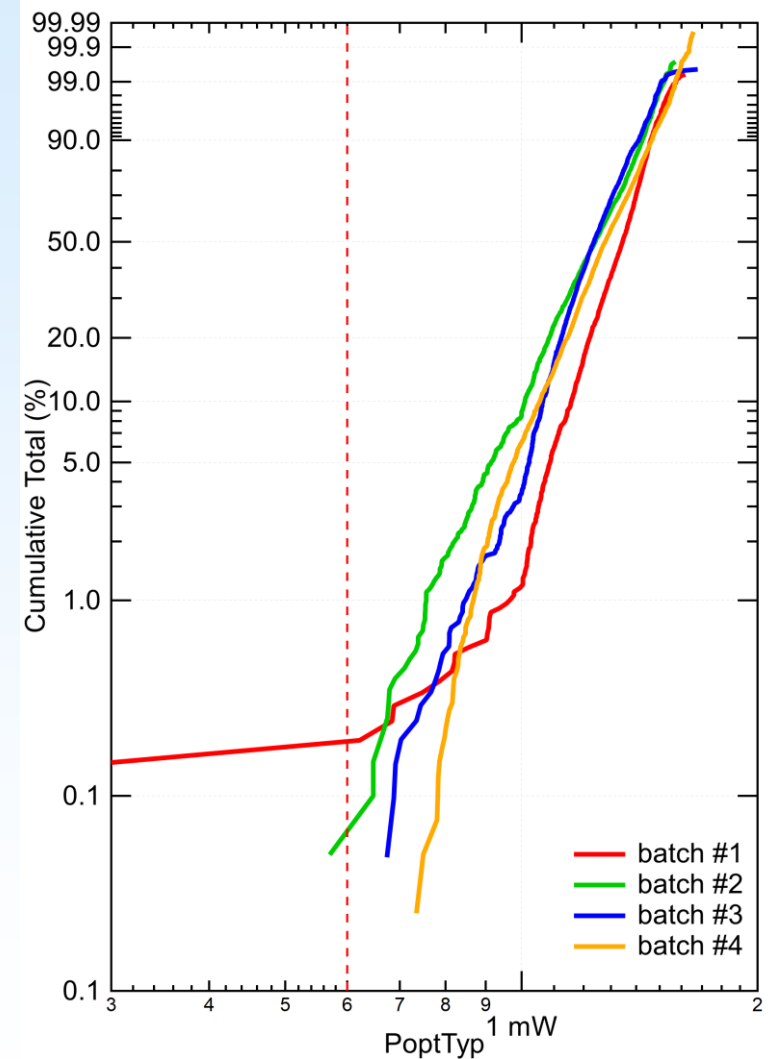
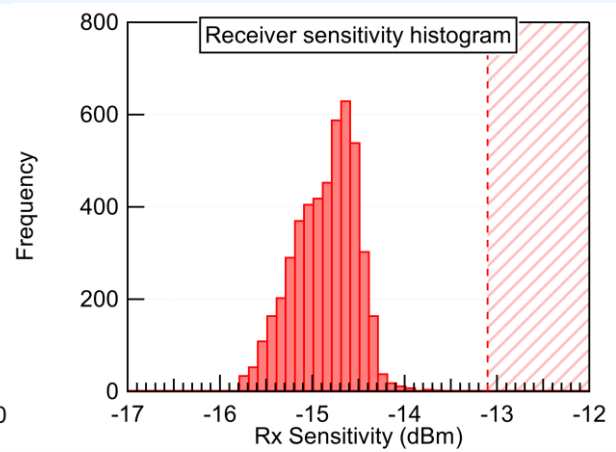
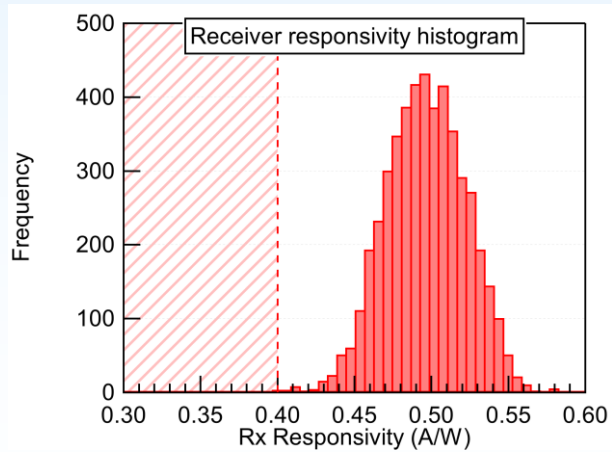
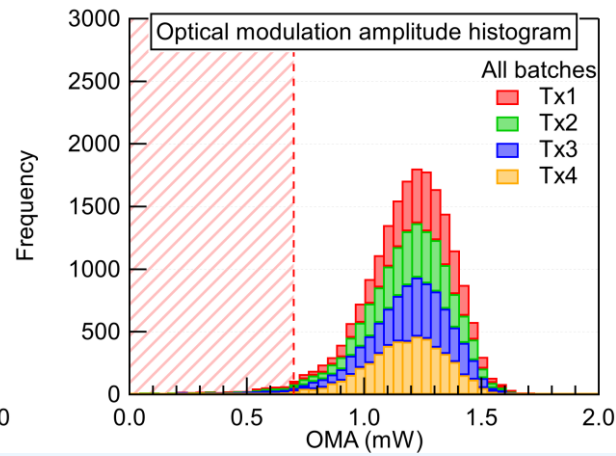
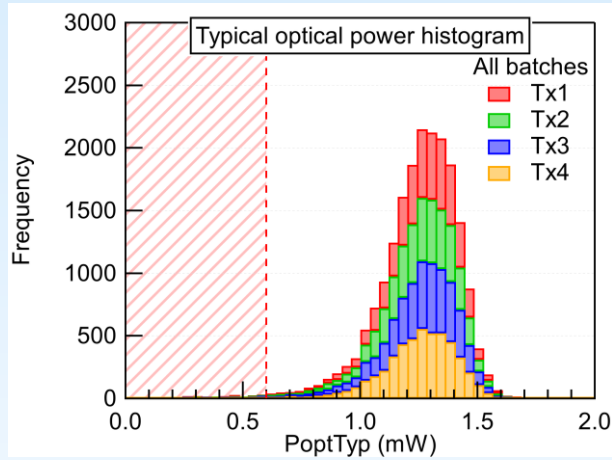
Contamination visible under optical coupling block could later obscure the VCSEL/PD

Quality assurance

- Incoming scan and visual inspection
- Functional testing (both CM and CERN)
 - All modules tested by CM
 - QA samples (~60 modules) tested by CERN
 - Static and dynamic tests at room temperature
- Environmental testing (only CERN)
 - Only QA samples
 - Static and dynamic tests over the operating temperature range (-35C to +65C)



Functional test results (batches 1-4)



Summary

- After carefully evaluating the performance of the pre-series batches, the assembly process was further optimised
- Following the successful qualification of the improved assembly process, the production started in May 2023
- Since then, CM delivers monthly batches according to the schedule
- QA procedures have been adjusted for better quality control
 - Lot acceptance takes longer than foreseen
- Distribution of production-grade modules has started
 - Some delays due to the longer lot acceptance procedure

Useful links

- VL+ Project: <https://cern.sharepoint.com/sites/project-Versatile-Link-Plus>
- VTRx+ specification: <https://edms.cern.ch/document/1719329/1>
- VL+ application note: <https://edms.cern.ch/document/2149674/1>

Back-up slides

CMS (May 2023 – October 2023)

Detector	Length [cm]	May '23	June '23	July '23	August '23	September '23	October '23
OT	12+20	20	20			60	50
	15+20	20	20				40
	20+20	110	20	50	50		
	25+20	30					
	30+20	50					
BTL	20			100		190	200
ECAL	35				200	250	150
DT	50				100		
	100				100		
	200				70		
ME0	32.5			100			
	49			100			
	65			100			
	84				100		
RPC	10						100
Total		230	60	450	620	500	540

ATLAS (May 2023 – October 2023)

Detector	Length [cm]	May '23	June '23	July '23	August '23	September '23	October '23
ITK Pixel	20		110		150	60	60
ITK Strip	30	50	50				
	40	140	60				
Muon	15	80	220		200	400	400
HGTD	20			50			
BCM	15					20	
	200				30		
LUCID ZDC	25					20	
Total		270	440	50	380	500	460

CMS (November 2023 – April 2024)

Detector	Length [cm]	November '23	December '23	January '24	February '24	Mars '24	April '24
OT	12+20	240		270		380	
	15+20	380		270		350	
	20+20	30		40			
	25+20	60		60			
	30+20	130		60		140	
IT	5.5+20	30				20	
	7.7+20	75				100	
	20+20	50				70	
ETL	5.5+20	150		100		100	
BRIL	5.5+20	50					
BTL	20	140	200	150			70
ECAL	35				270		440
HGCAL	200				200		
DT	21.5		240	100	200	200	200
	50		60		180		60
ME0	32.5		175				
	49		175				
	65		175				
	84		175				
Total		1335	1200	1050	850	1360	770

ATLAS (November 2023 – April 2024)

Detector	Length [cm]	November '23	December '23	January '24	February '24	Mars '24	April '24
ITK Pixel	20				200		
ITK Strip	30	100		100			100
	40	100		100			250
LAr	30	120		250	250		250
	40	225	425	500	530	640	630
MDT	15		200				
HGTD	25				50		
	30	30					
	32.5		20				
DCS	35				120		
	50		10				
	100		45				
Total		575	700	950	1150	640	1230