Space

axon' cables & connectors

BOARD-TO-BOARD INTERCONNECTIONS FOR HIGH DATA RATE APPLICATIONS

ESA CONTRACT NO.4000142275/23/NL/AS/AHH

Chantal Le Graët & Stéphane Hermant

22/10/2026

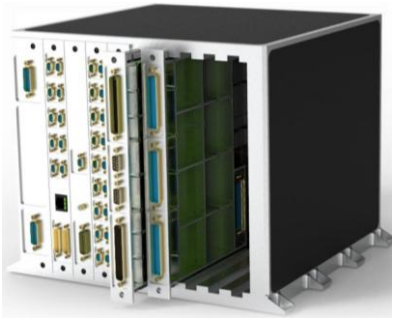


PLAN

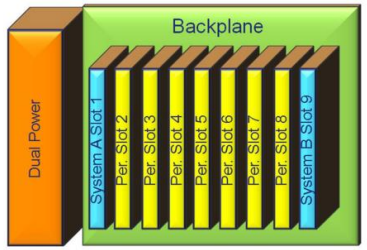
- Specification & Challenges
- On-going Activities
  - Design and manufacture phases
  - HDR variant evaluation results :
    - Mechanical evaluation (pressfit insertion + 500 Cycles mate de-mate)
    - Electrical HDR evaluation
  - Power frame status :
    - Principle design
    - HDR simulation
  - Moulds design
- Next Steps & Future Directions

SPECIFICATIONS & CHALLENGES

ADHA Modules



cPCI Serial Space Architecture



cPCI SS Connectors



MAIN CHALLENGES W.R.T. ADHA SPECIFICATION:

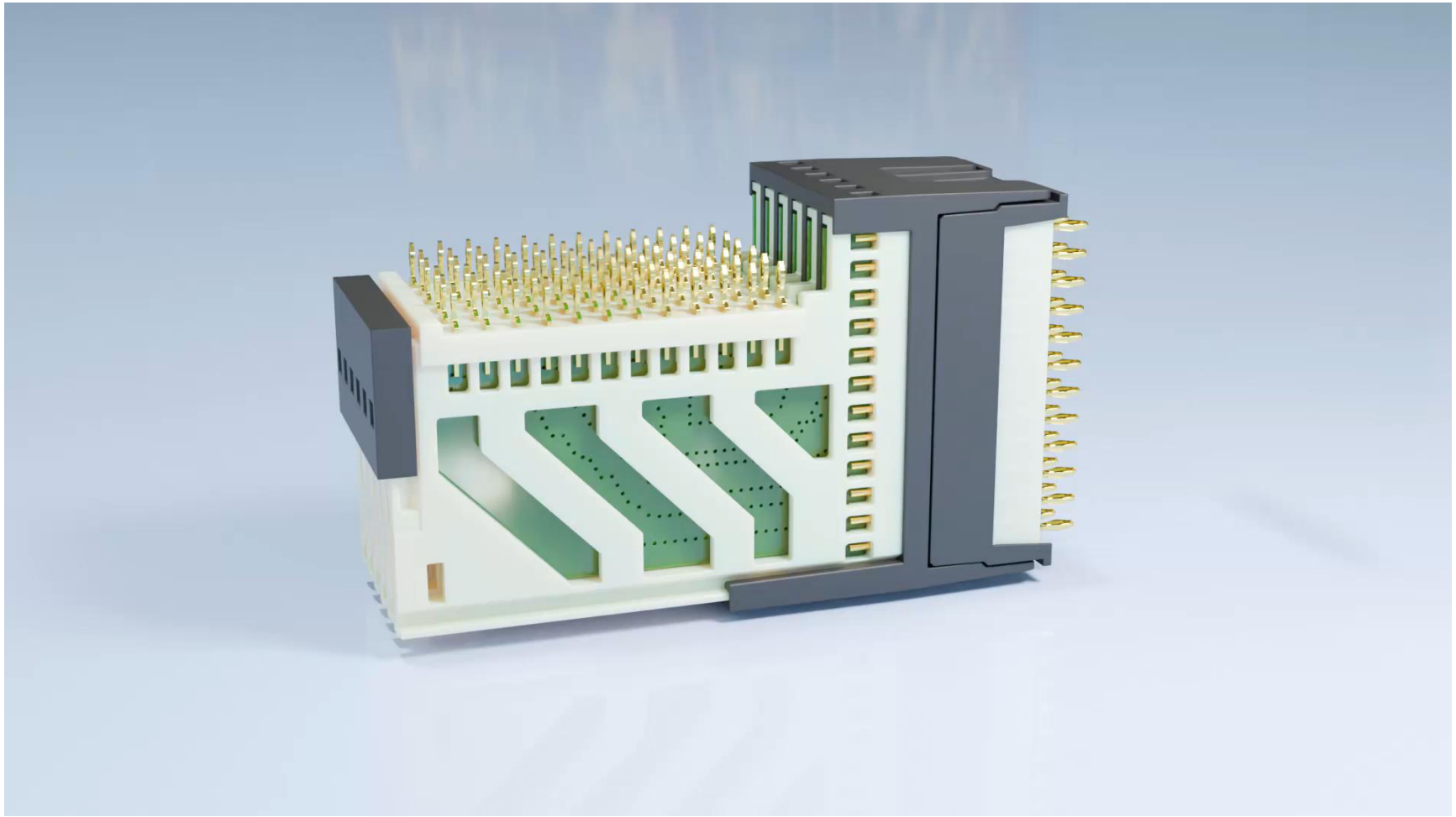
- High Speed up to **25 Gb/s**
- **Solderless** solutions => Press-fit
- Operating Temperature: **-55°C to 125°C**
- Current rating per contact: **2A**
- discontinuity of **1ns** or longer duration during mechanical and thermal tests

ON-GOING ACTIVITIES: DESIGN PHASE

Modular design

Mutualized elements for 72 & 96

HDR & POWER frames : mix possible

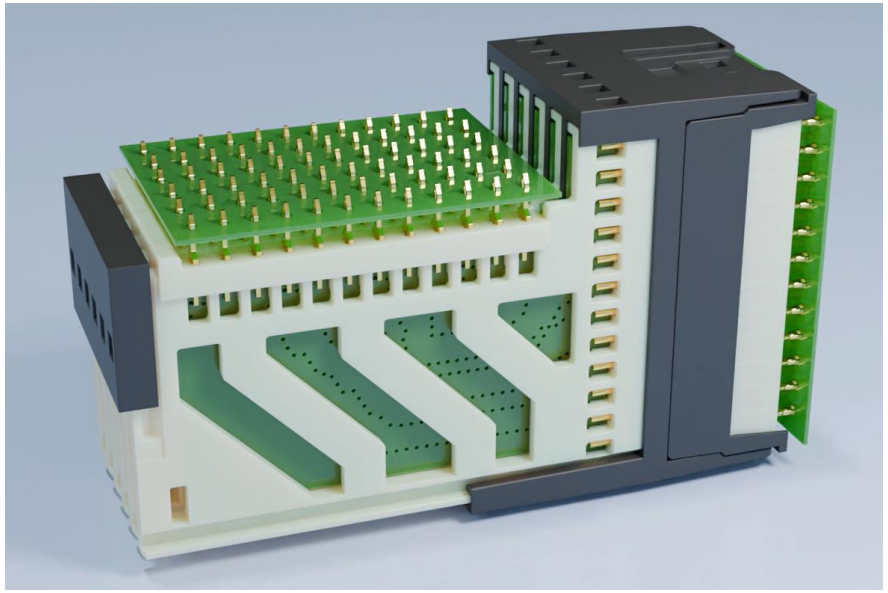


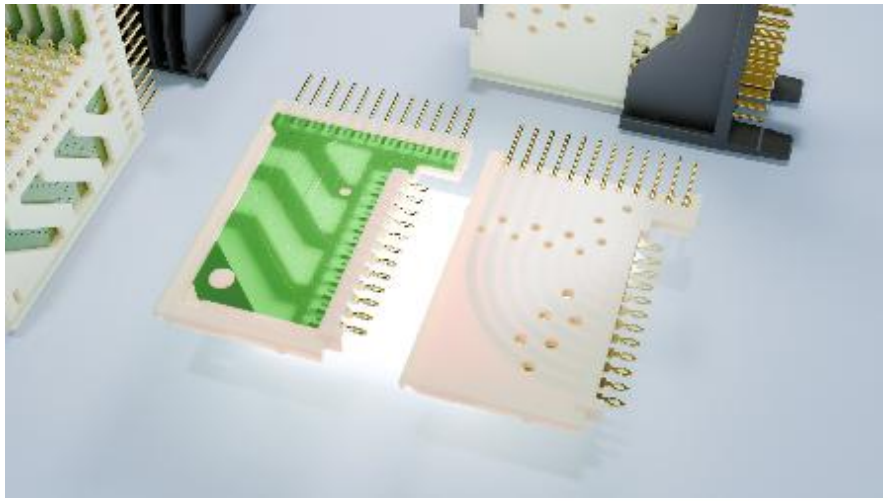
ON-GOING ACTIVITIES: DESIGN PHASE

Modular design

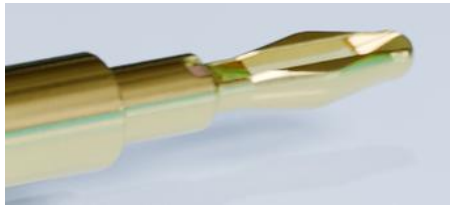
Mutualized elements for 72 & 96pins

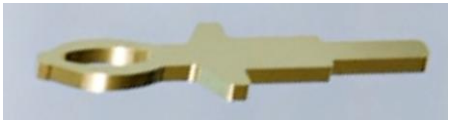
HDR & POWER frames : mix possible



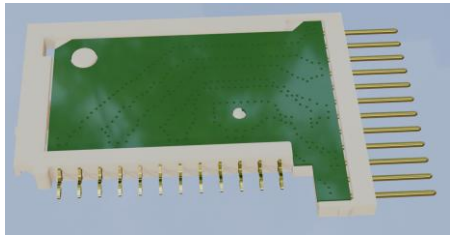


Press-fit : a gas-tight, mechanically robust interconnection





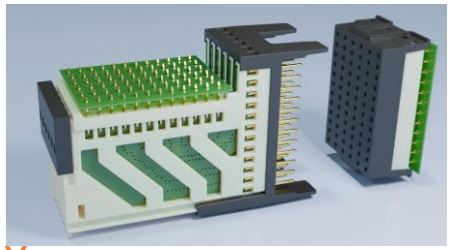
HDR frames Optimised transmission



Mating: round contact

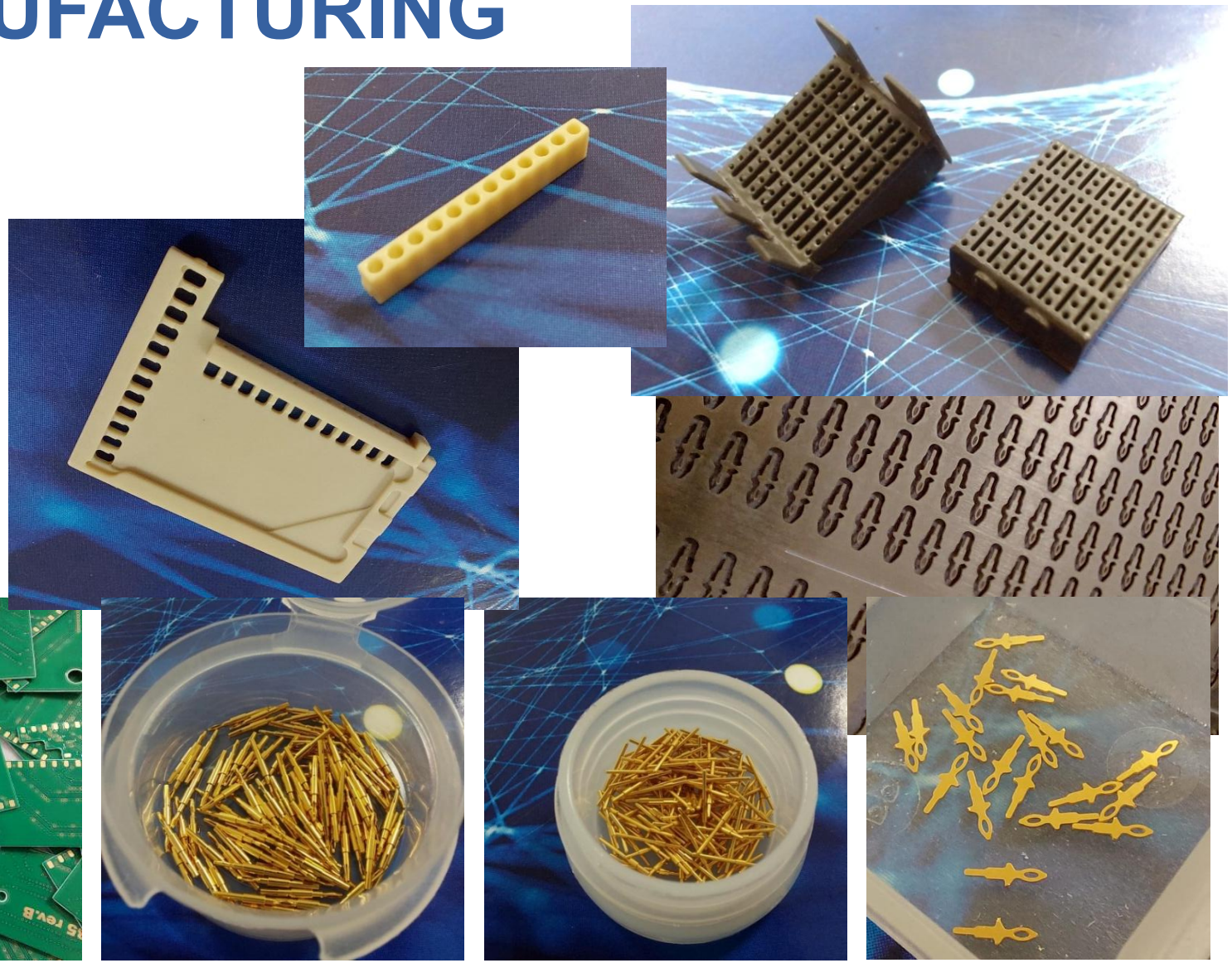


Two connectors X,Y tolerance Mating : +/- 1.0 mm



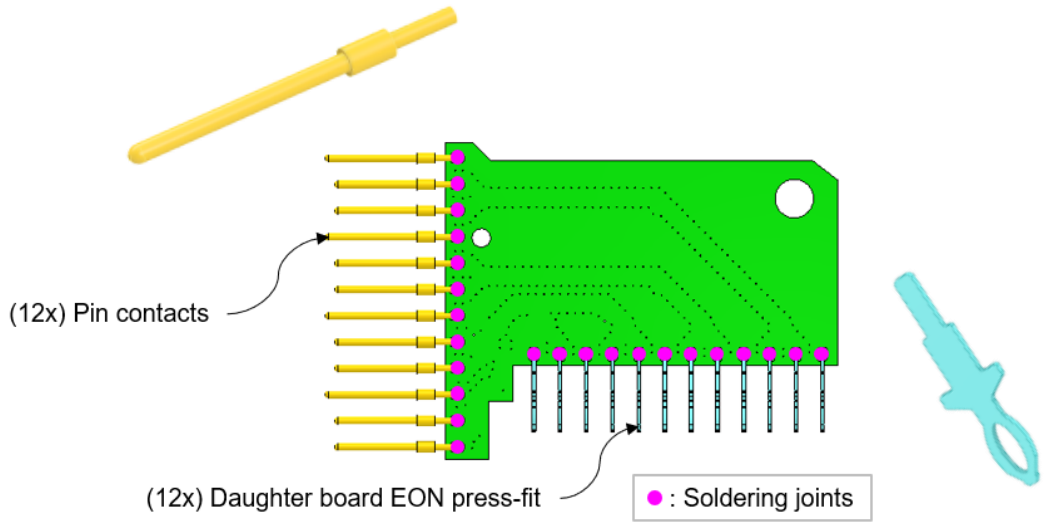
PRODUCT MANUFACTURING

- PEEK Machined frames
- 3D printed housing (photopolymer) **/!\ Fragile**
- Chemical cutting PressFit daughter contact
- Male & Female contacts interface Machining
- PCB (not QPL)

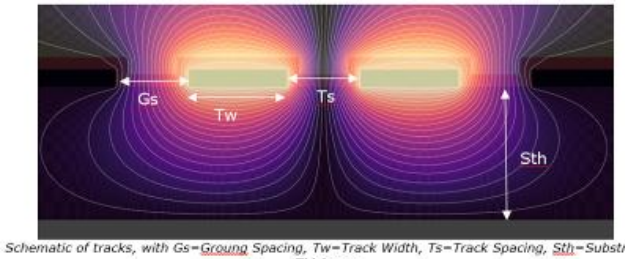


DESIGN PHASE

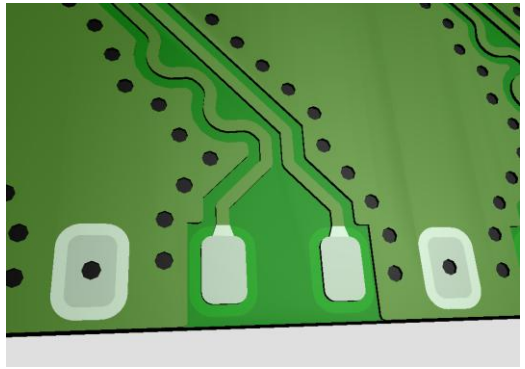
- Daughter connector : interface contacts soldered on frames PCB.
  - Copper alloys
  - Pin contacts
    - Short & long length
    - Dedicated End shape for Insertion force reduction
  - “Eye Of the Needle” press-fit



- Design with HDR frames (priority)
  - transmission lines made with differential coplanar waveguides
  - Zc=100Ω diff.
  - GSSG sequence connection
  - Zero intrapair Skew (length compensations)



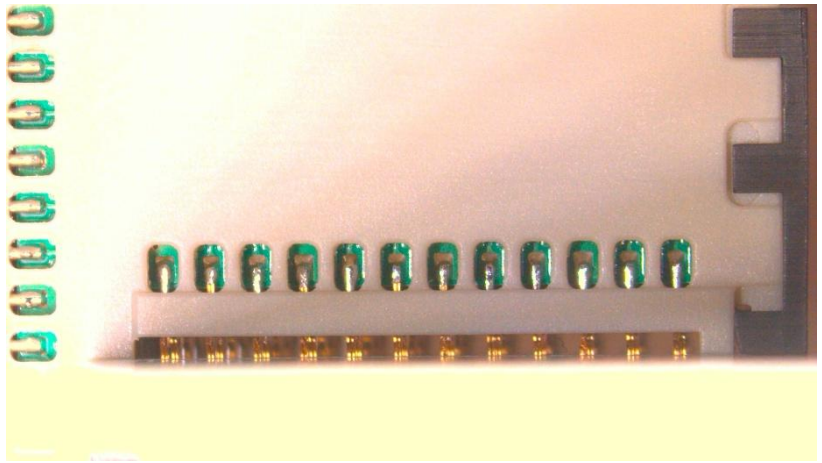
Schematic of tracks, with Gs=Ground Spacing, Tw=Track Width, Ts=Track Spacing, Sth=Substrate Thickness

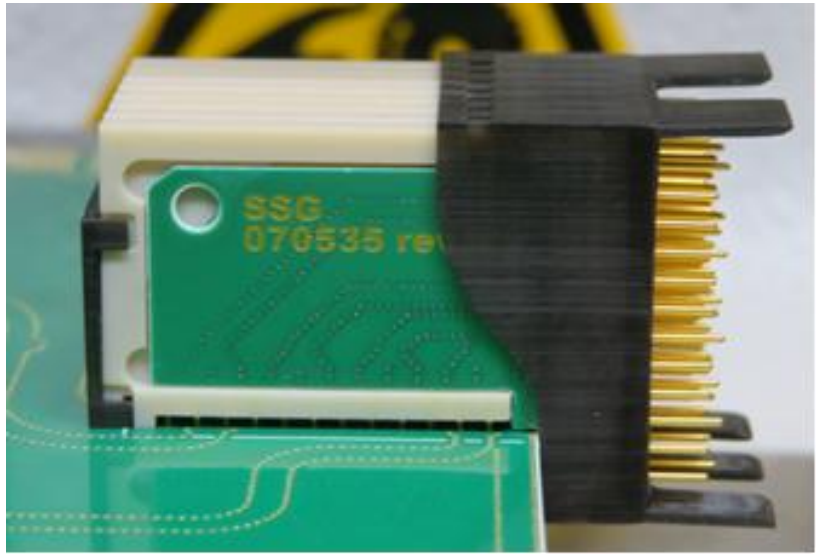


TEST VEHICLES MANUFACTURING

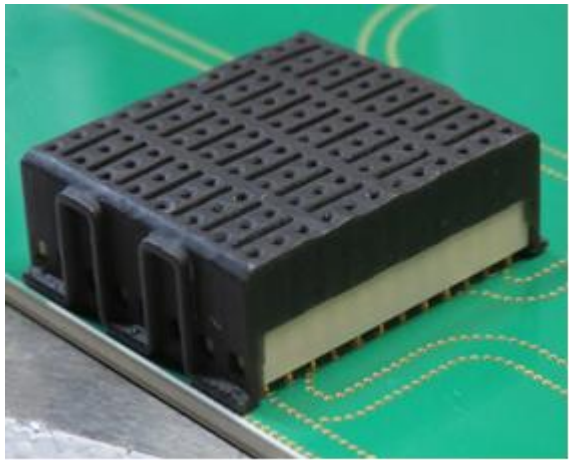
sequences

- Male contacts & PressFit soldering on daughter PCB
  - Dedicated jig
  - Manual process
- Frame insertion in housing
  - Manual process
- Contacts insertion in backplane frame
  - Manual process
- PressFit insertion in PCB
  - Dedicated tooling



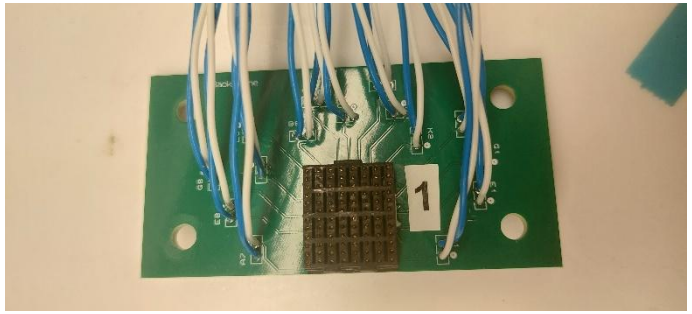


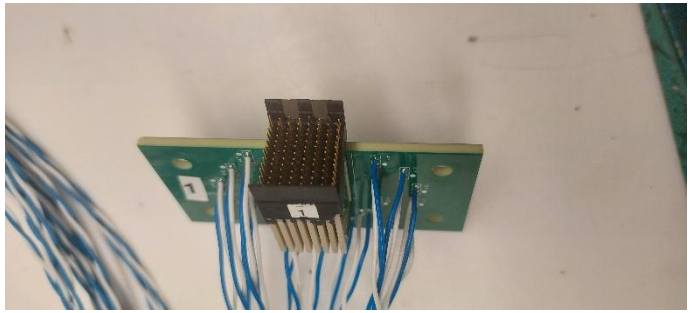


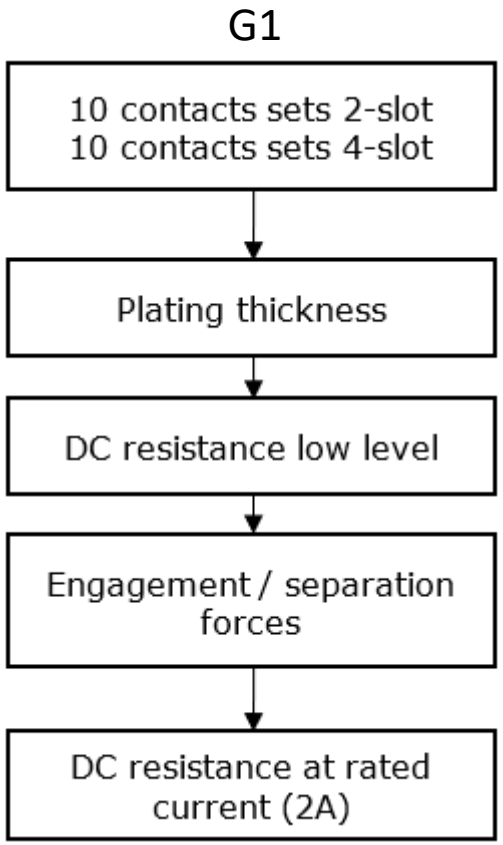


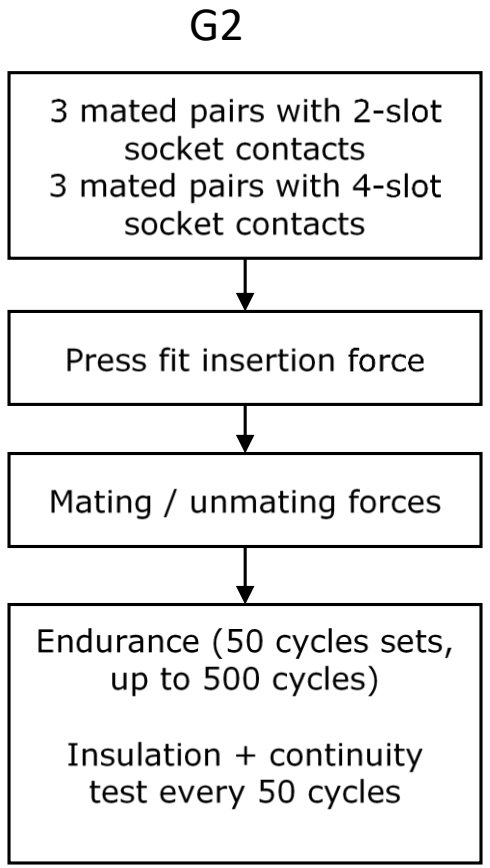
MECHANICAL EVALUATION ON TVS

- 2 groups were manufactured :
  - Group1: for contacts alone
  - Group2: for mated connector pairs









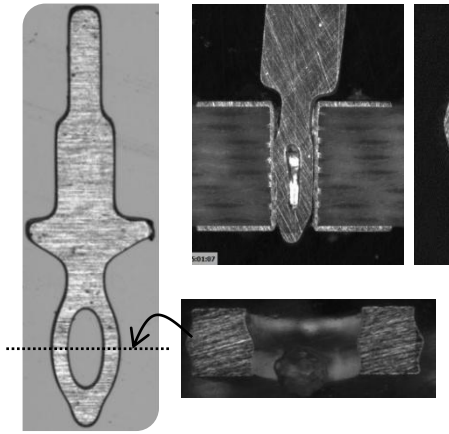
ON-GOING ACTIVITIES : PRESSFIT STATUS

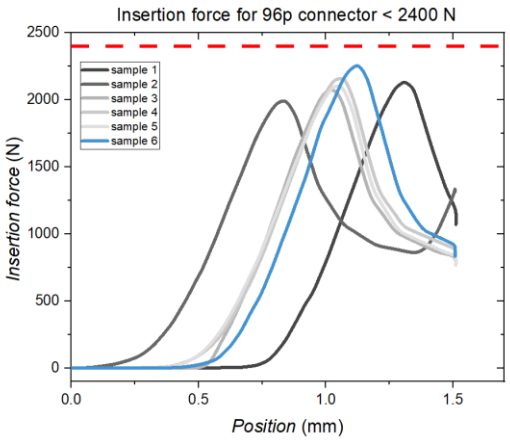
For via diameter range 0.45-0.55 mm

Daughter Flat PressFit within the specifications

- Insertion: 18 N $^{+/-\ 9\ N}$ < 25 N
- Extraction: 6 N $^{+/-\ 3\ N}$ > 5 N
- Contact resistance 0.06 mΩ $^{+/-\ 0.04\ m\Omega}$

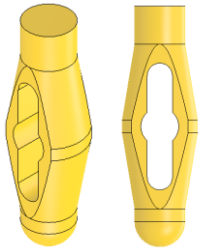
⇒Qualification sequence following IEC60352-5 & IPC9797 in progress

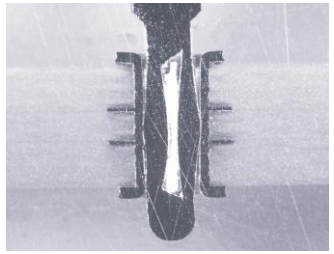




Backplane Machined PressFit within the specifications

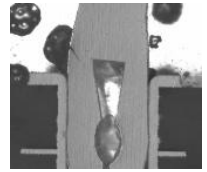
- Insertion: 21 N $^{+/-\ 5\ N}$ < 25 N
- Extraction: 9 N $^{+/-\ 3\ N}$ > 5 N
- Contact resistance 0.05 mΩ $^{+/-\ 0.04\ m\Omega}$



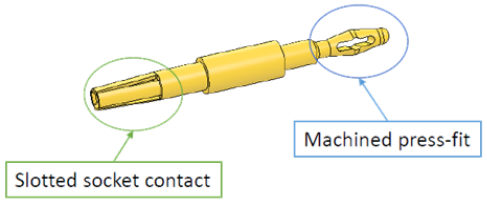


The results are within the specifications, nonetheless quality risk detected on lower tolerances PTH sizes /!\

⇒Further study on conception & material definition in progress



CONTACTS AT CONNECTORS INTERFACE





Backplane connector: one part, two terminations

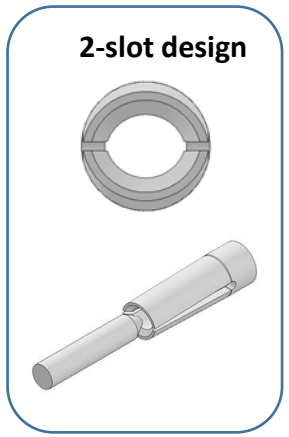
- Copper alloy
- Socket contact: Multiple contact points (ESA requirement)

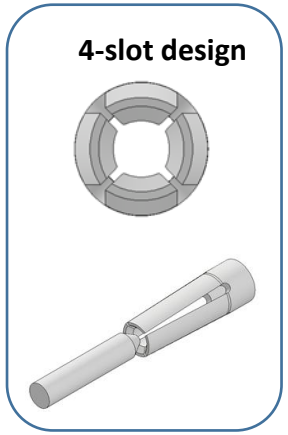
GROUP1

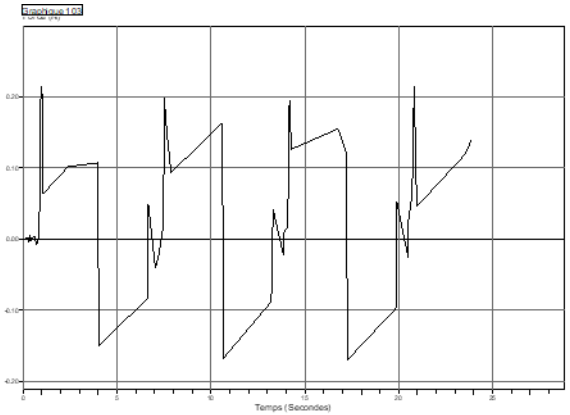
Mate force target <0.45N, Demate force target >0.15N

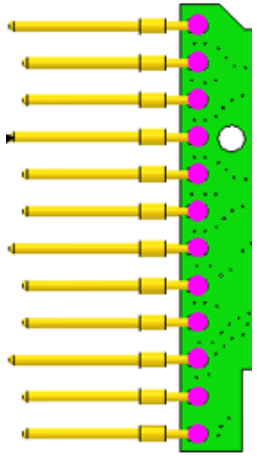
<u>Evaluation done with 2 & 4 slots:</u>











<u>2 slots contacts:</u>

F_{mate}=0.27 to 0.37N : 100% PASS

F_{demate} >0.09 to 0.2 : 40% PASS

<u>4 slots contacts:</u>

$F_{insertion}$ =0.37 to 0.51N : 60% PASS

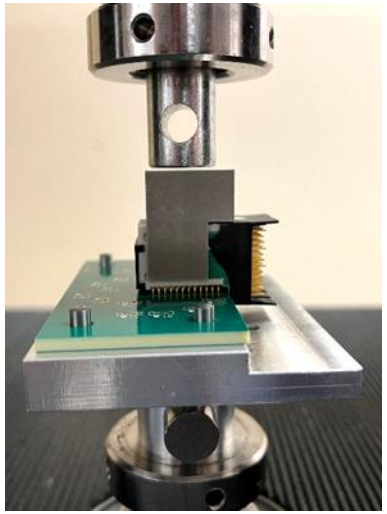
F_{demate} =0.12 to 0.21N : 90% PASS

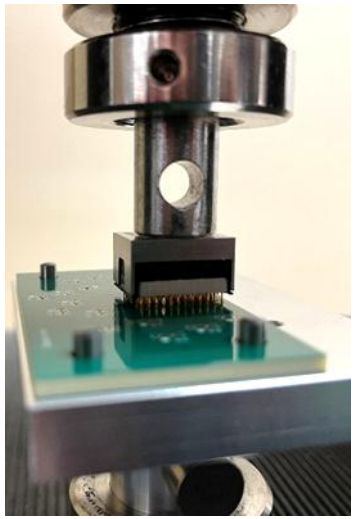
MECHANICAL EVALUATION

GROUP2

Pressfit insertion force on TV (6 backplane + 6 daughter)

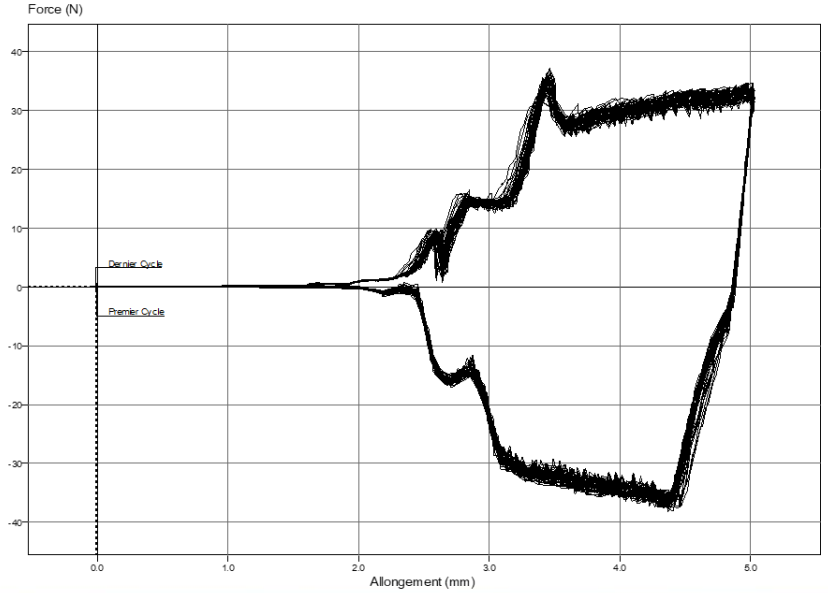
- ❑with dedicated toolings
- ❑<2400N for all TV (25N/contact): 100 % PASS

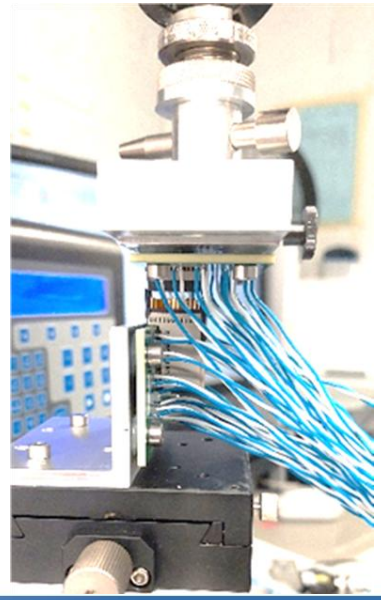




500 cycles Mate/demate

- ❑Maximum mating F (<43N) 100 % PASS
- ❑Minimum unmating F (>14.5N) 100 % PASS
- ❑Low dispersion force value (see graph)





MECHANICAL EVALUATION

Electrical measurement

- On **Group1**
  - Contact resistance (M/F contact only):
    - @Low Level current <6 mΩ, PASS
    - @Rated level current <5 mΩ PASS

- On **Group2**
  - Continuity (M/F contacts + PCB + pressfit) : PASS
    - Resistance dispersion from PCB to PCB due to metallization dispersion (not QPL) → corrected with new QPL PCB
    - Resistance values : 60mΩ < R0< 140mΩ → improved with QPL PCB
  - Insulation 500Vdc : PASS
  - DWV 600Vac : PASS

ELECTRICAL EVALUATION (HDR)

Lines under test

- Lines J1, K1, K2, and L2 are longest lines on PCB connector.
- Lines A1, B1, B2 and C2 are the shortest lines on PCB connector.

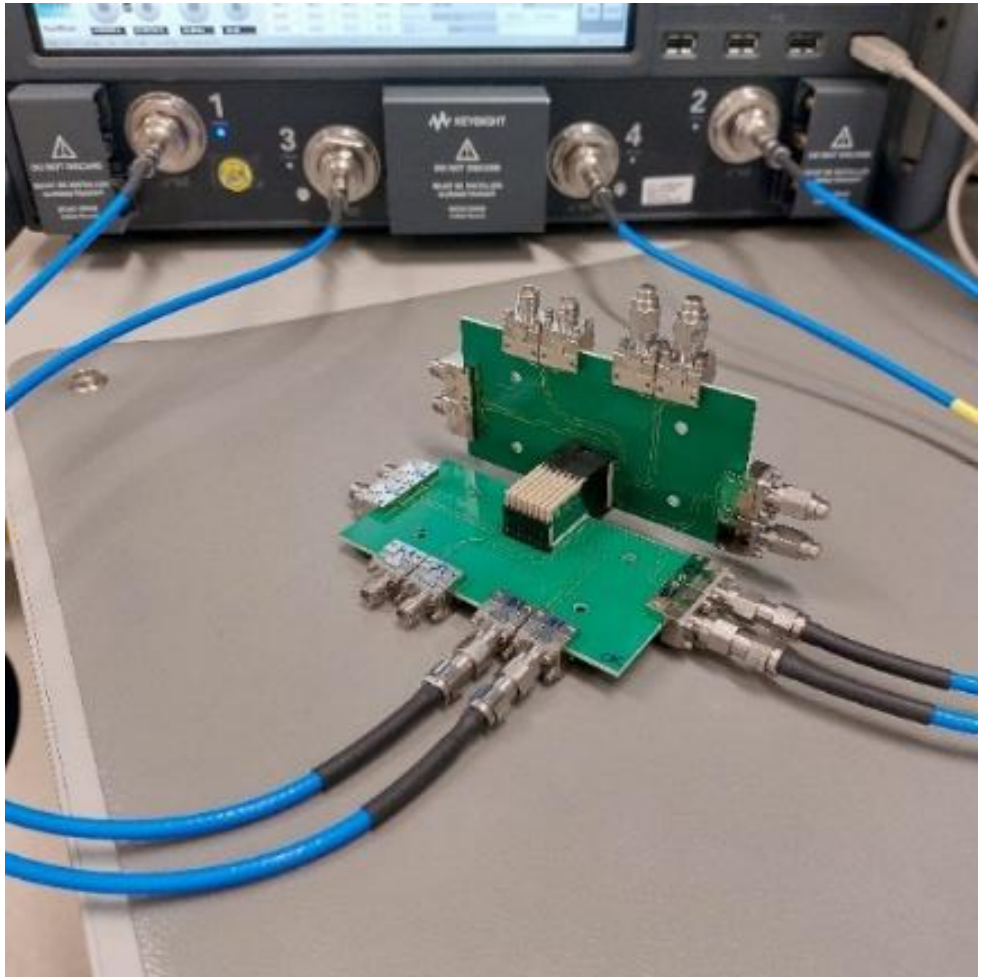


Table 1: Connector cabling

	A	B	C	D	E	F	G	H	I	J	K	L
08	GND	+	-	GND	+	-	GND	+	-	GND	+	-
07	+	-	GND	+	-	GND	+	-	GND	+	-	GND
06	GND	+	-	GND	+	-	GND	+	-	GND	+	-
05	+	-	GND	+	-	GND	+	-	GND	+	-	GND
04	GND	+	-	GND	+	-	GND	+	-	GND	+	-
03	+	-	GND	+	-	GND	+	-	GND	+	-	GND
02	GND	+	-	GND	+	-	GND	+	-	GND	+	-
01	+	-	GND	+	-	GND	+	-	GND	+	-	GND

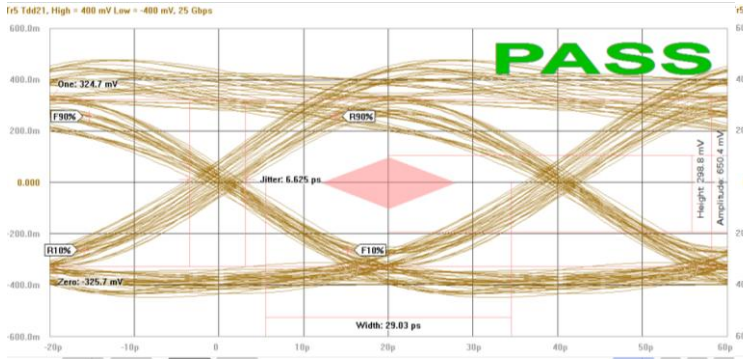
ELECTRICAL EVALUATION (HDR)

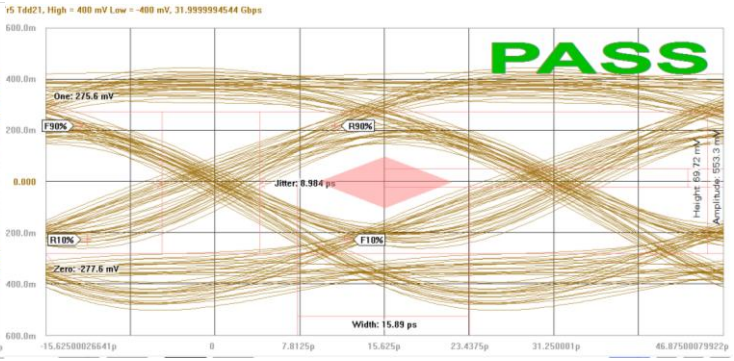
Tests	Targets			Results		
	3.125 GHz	6.25 GHz	12.5 GHz	3.125 GHz	6.25 GHz	12.5 GHz
Insertion losses	-1 dB	-1.5 dB	-2 dB	OK	-2dB / -2.9dB	-2.3dB / -4.18dB
Near end signal crosstalk	-39 dB	-34 dB	-29 dB	OK		
Far end signal crosstalk	-42 dB	-34 dB	-26 dB	OK		
Differential impedance TDR (40GHz BW, rise/fall time ≤ 17.5 ps)	Min 90 Ω		Max 110 Ω	Min 82 Ω (peak)		Max 130 Ω (peak)
High speed data rate (SpaceFibre Mask, input signal 800 mVpp)	SpaceFibre mask 200 mV diff peak-peak			12.5 Gb/s		25 Gb/s
				PASS		PASS
Insulation (500Vdc) & DWV (600 Vrms)	>1000MΩ			PASS		
Continuity	<200mΩ			PASS		

ELECTRICAL EVALUATION (HDR)

Short lines :
A1B1

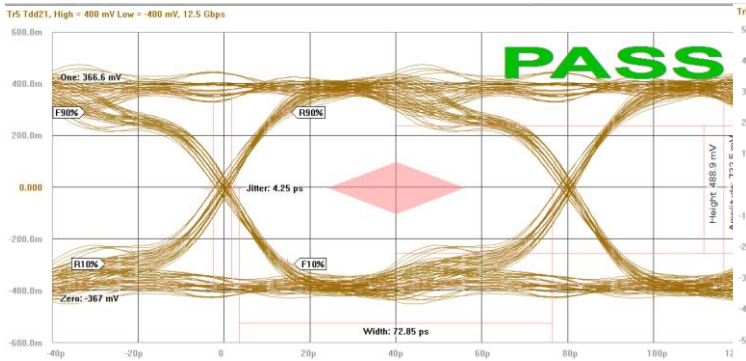


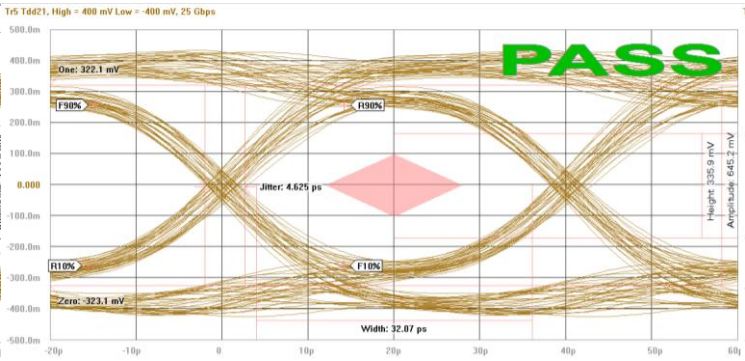


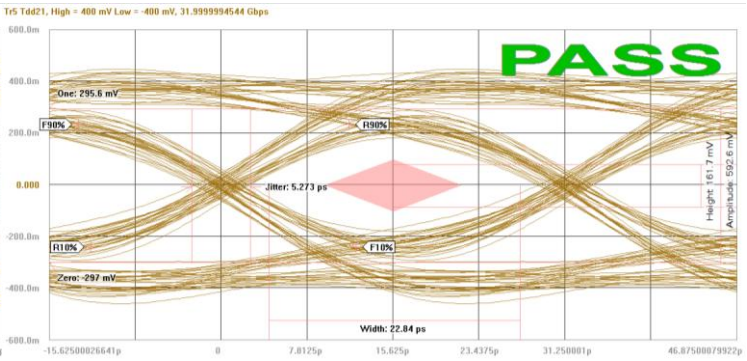


Eye patterns @→ **12.5Gb/s NRZ** **25Gb/s NRZ** **32Gb/s NRZ**

Long lines :
K1J1



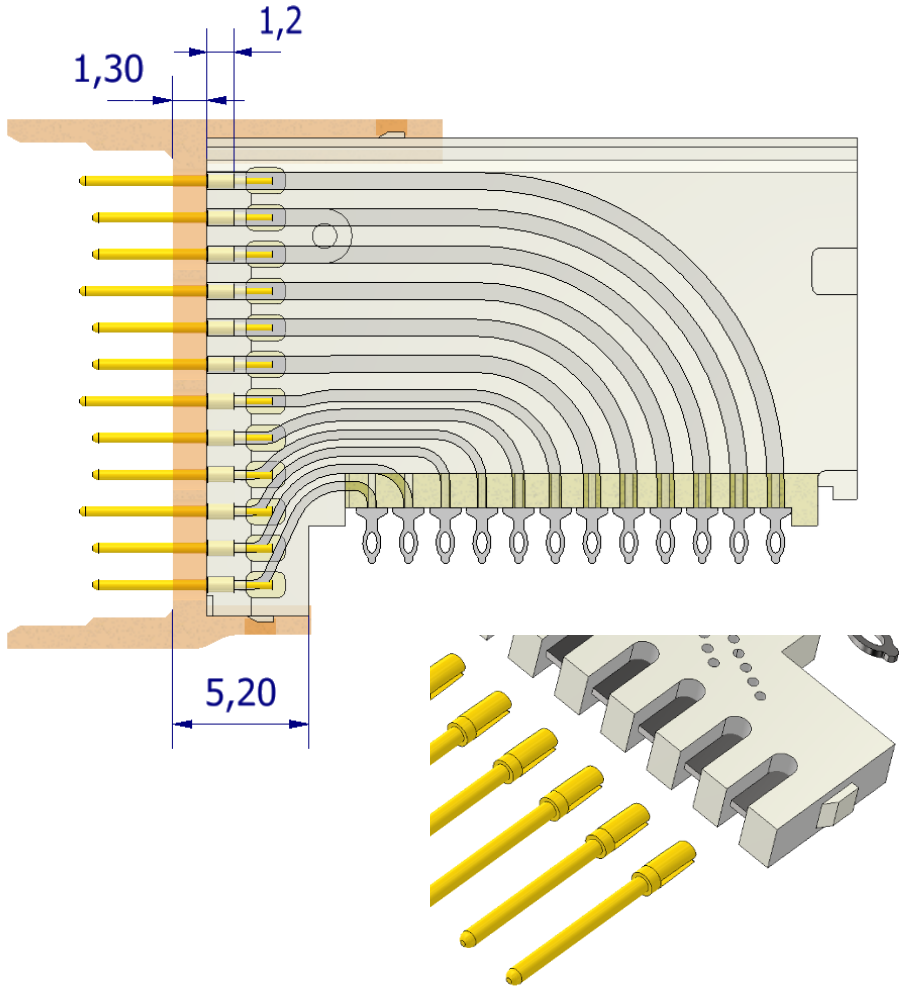




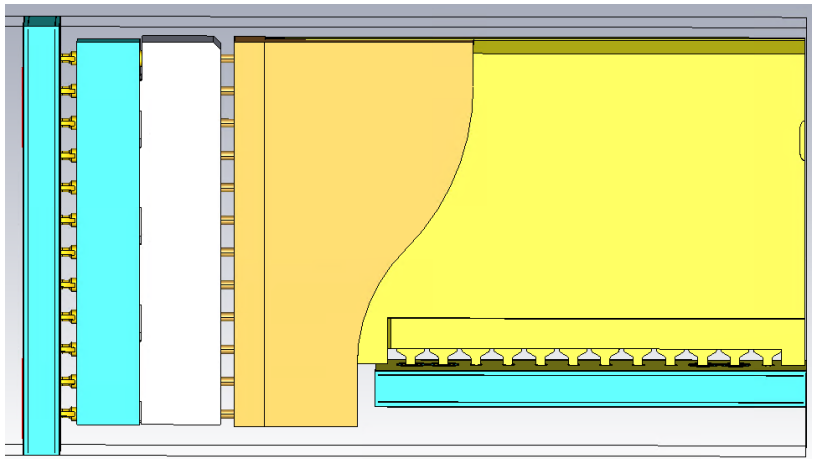
POWER FRAME STATUS

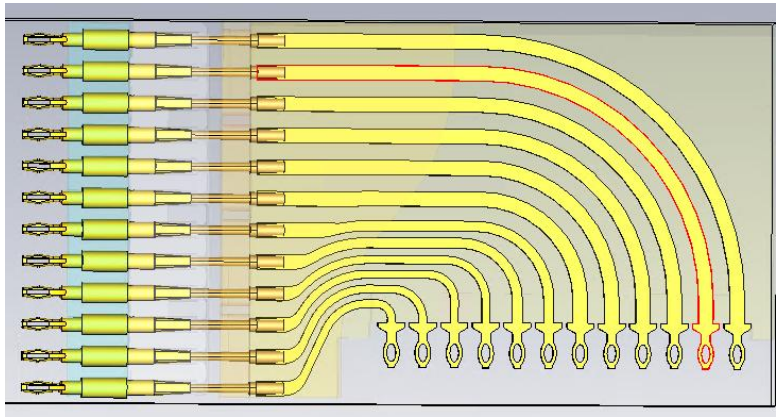
Design on going:

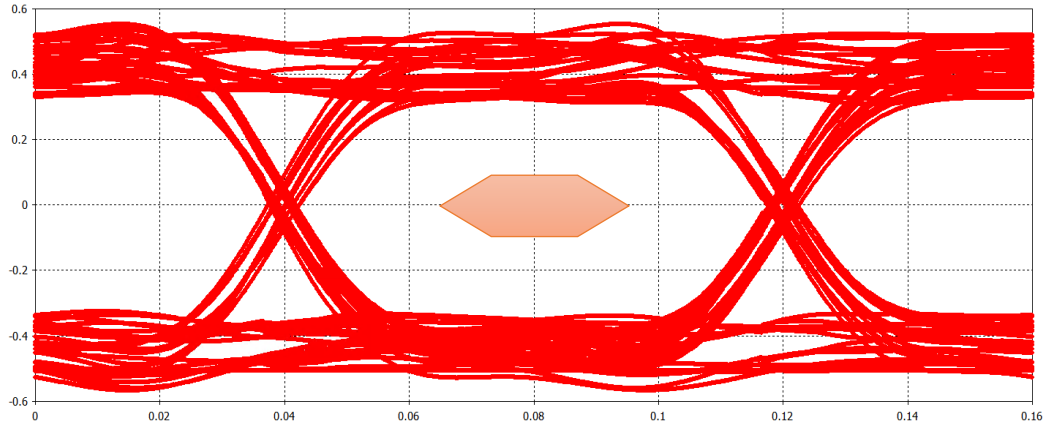
- Overmolded leadframe design without air gaps & integrated press-fit.
- Target :2A max/20mΩ (10mΩ per track +5mΩ per contact)
- Base material: copper alloy
- 100Ω Zc target
- **No impact on backplane connector design, nor in daughter connector housing design**
- **Possibility to mix HDR or Power layer within the same connector**



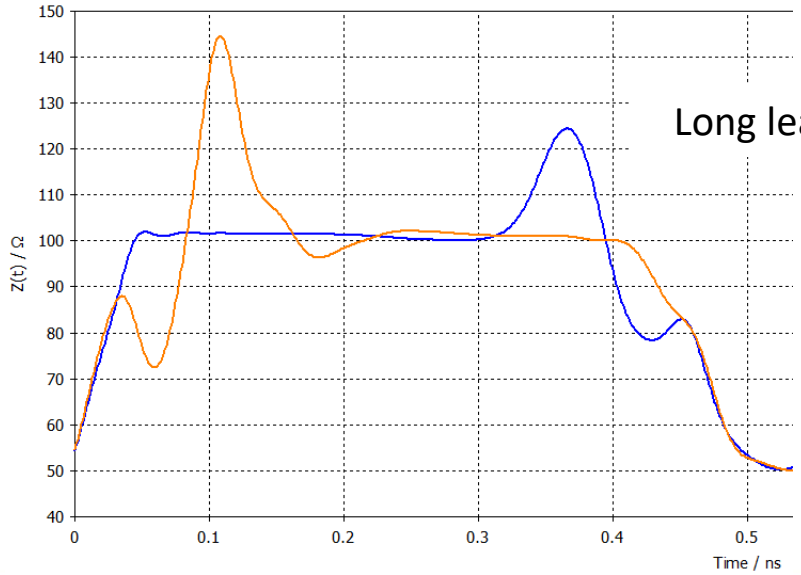
POWER FRAME : HDR SIMULATION







NRZ 12,5 Gb/s



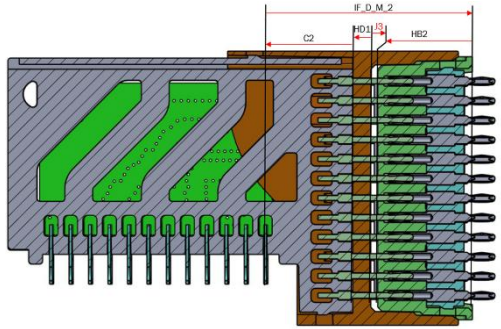
Long leadframe

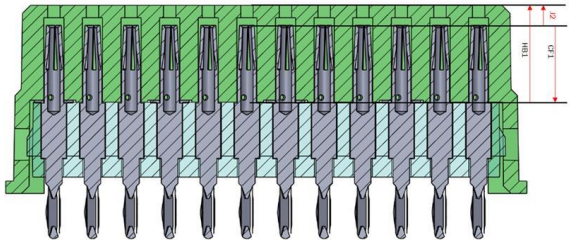
MOULDS DESIGN

Industrialisation phase :

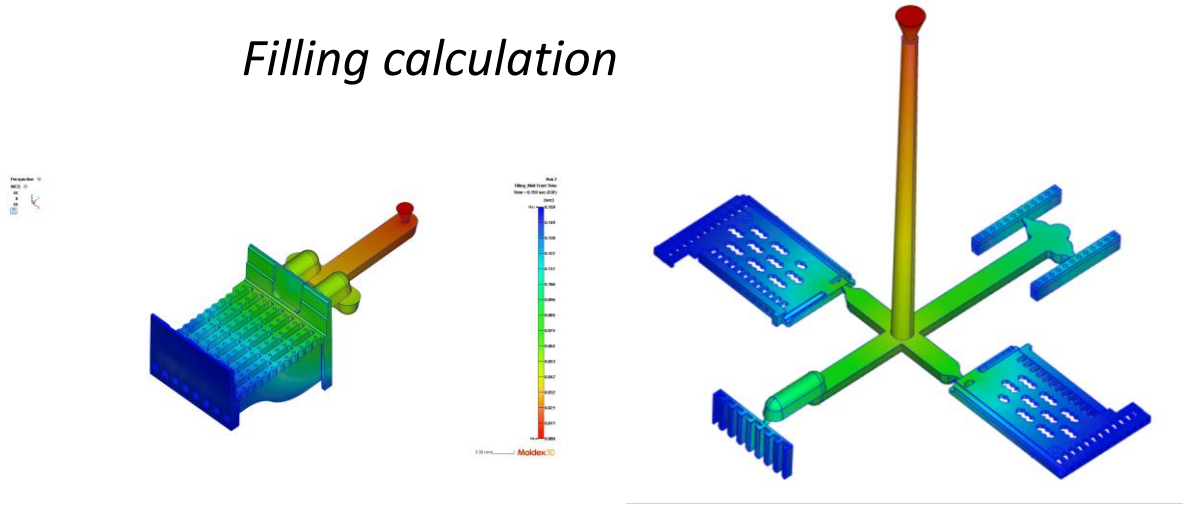
- Tolerance stack up analysis for the HDR connector:
  - Validate the design : chains of dimensions based on ***NFT58000* standard** and others manufacturing tolerances.
  - Ensure the connectors assembly can withstand harsh environment (vibration&thermal)

- Rheology completed on :
  - mold inserts assembled into a shared moldbase
  - No filling issues.
  - Limited deformations.





Filling calculation



NFT58000 tolerances used for calculations for plastic parts



THE NEXT STEPS ARE:

- Integrate new PCB in MEGTRON7 to improve electrical performances
- Test new backplane press-fit to eliminate the risk of cracks (low PTH diameters): mechanical test on-going.
- Launch moulds machining to manufacture injected plastic parts (72p & 96p). Modular moulds, cavities variants.
- Launch **power frame prototype** manufacturing:
  - Contacts already developed (and tested) with the max current and the procurement of parts is done.
  - Machined plastic frame and chemical cutting tracks under investigation to manufacture a prototype.

Next investigations:

- Make the assembly and test the connector with new injected parts, to industrialisation.
- Make a complementary evaluation on electrical and mechanical aspects:
  - Electrical signal integrity.
  - Mechanical & thermal tests (with nanosecond discontinuity monitoring).



Thank you !