ITS3 activities in Bari

NEWS - 02/09/2021

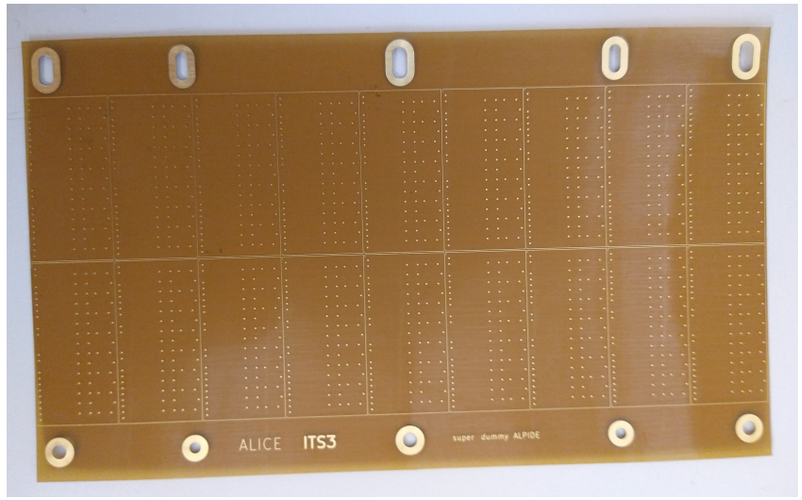
Super-ALPIDE mockup assembly
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

NEWS - 02/09/2021

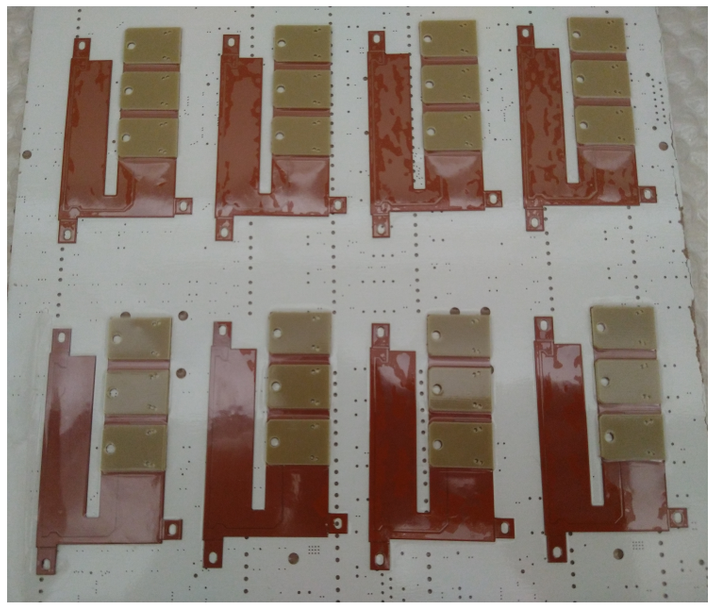
Super-ALPIDE mockup assembly

- Cylindrical bonding tools → **TO BE PRODUCED**
- Dummy-super-ALPIDE → **AVAILABLE**
- Edge-FPC → **AVAILABLE**
- Exoskeleton
- Exo-FPC



Super-ALPIDE assembly

- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

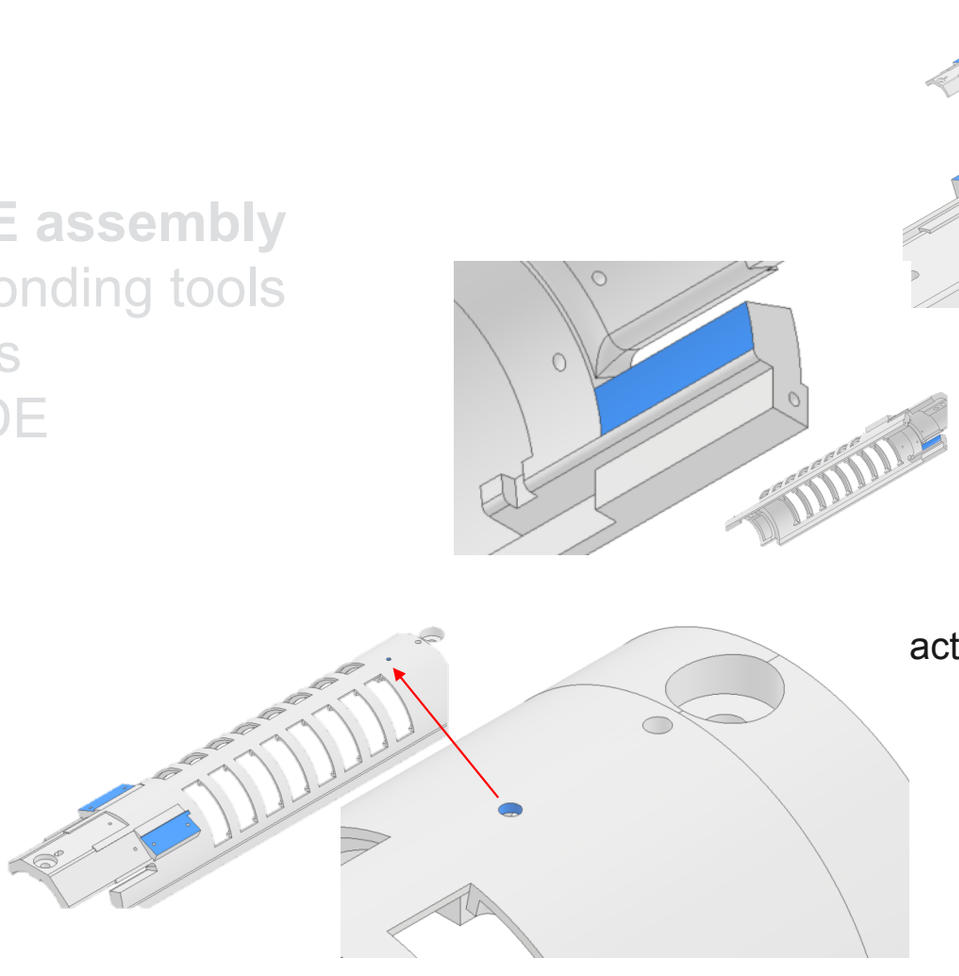


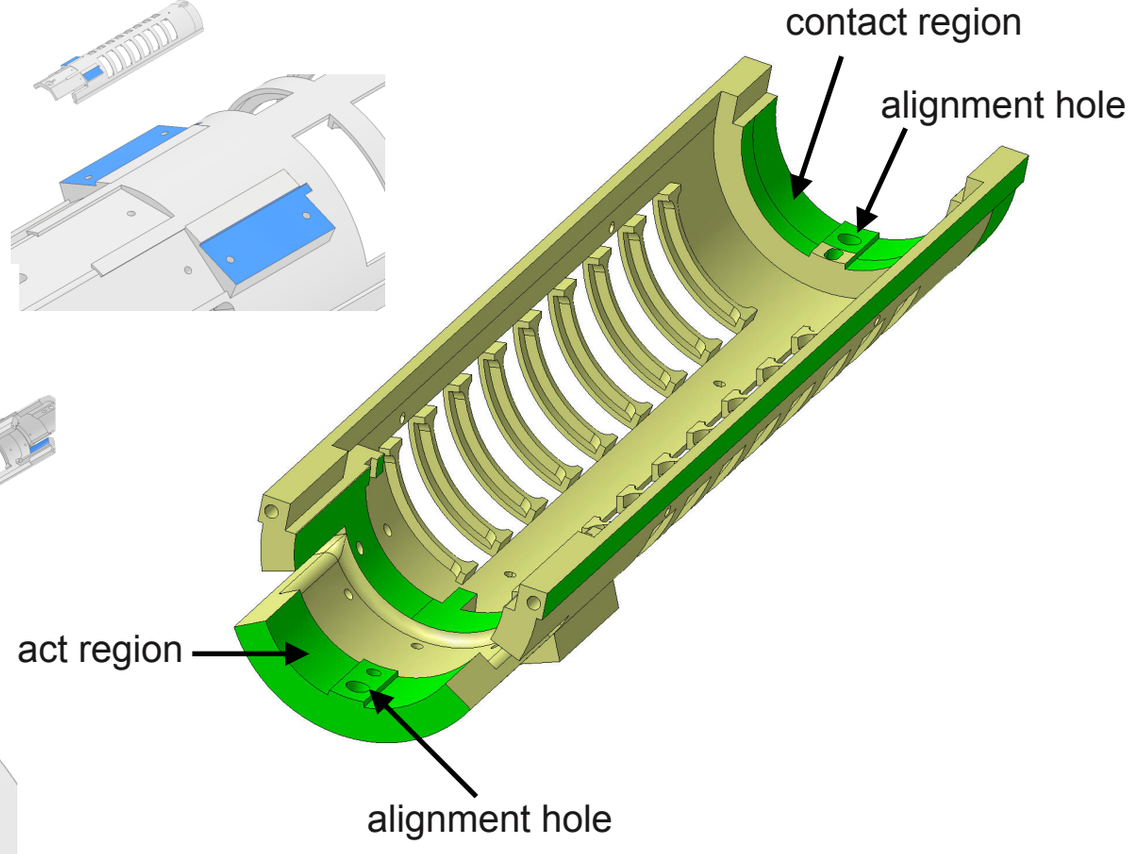
NEWS - 02/09/2021

Super-ALPIDE mockup assembly
- Cylindrical bonding tools → **AVAILABLE**
- Dummy-super-ALPIDE → **AVAILABLE**
- Edge-FPC → **AVAILABLE**
- Exoskeleton
- Exo-FPC

New exoskeleton
- Main changes proposed by CERN
- Implemented and verified in the last version
- Few small additional modification implemented
- Going to print soon (in house or outside)
- It requires longerons and half-rings
  → to be designed and worked/printed
- Exo-FPC gluing procedure/tools to be developed

Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC





NEWS - 02/09/2021

Super-ALPIDE mockup assembly

- Cylindrical bonding tools → **AVAILABLE**
- Dummy-super-ALPIDE → **AVAILABLE**
- Edge-FPC → **AVAILABLE**
- Exoskeleton
- Exo-FPC

What available

- 1 not used v1
- 1 exoskeleton + exo-FPC glued at CERN (old exoskeleton version)
- could detach 1 used exo-FPC

Super-ALPIDE assembly

- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

CONCLUSION

- next assembly test
  - first edge-FPC interference and bonding verification
  - new exoskeleton connection to mandrel verification
- we need to
  - work the new mandrel
  - print the exoskeleton
  - work/print longerons/half-rings
  - define exo-FPC gluing procedure
- I promised this will be done by the end of September

NEWS - 02/09/2021

Super-ALPIDE mockup assembly
- Cylindrical bonding tools
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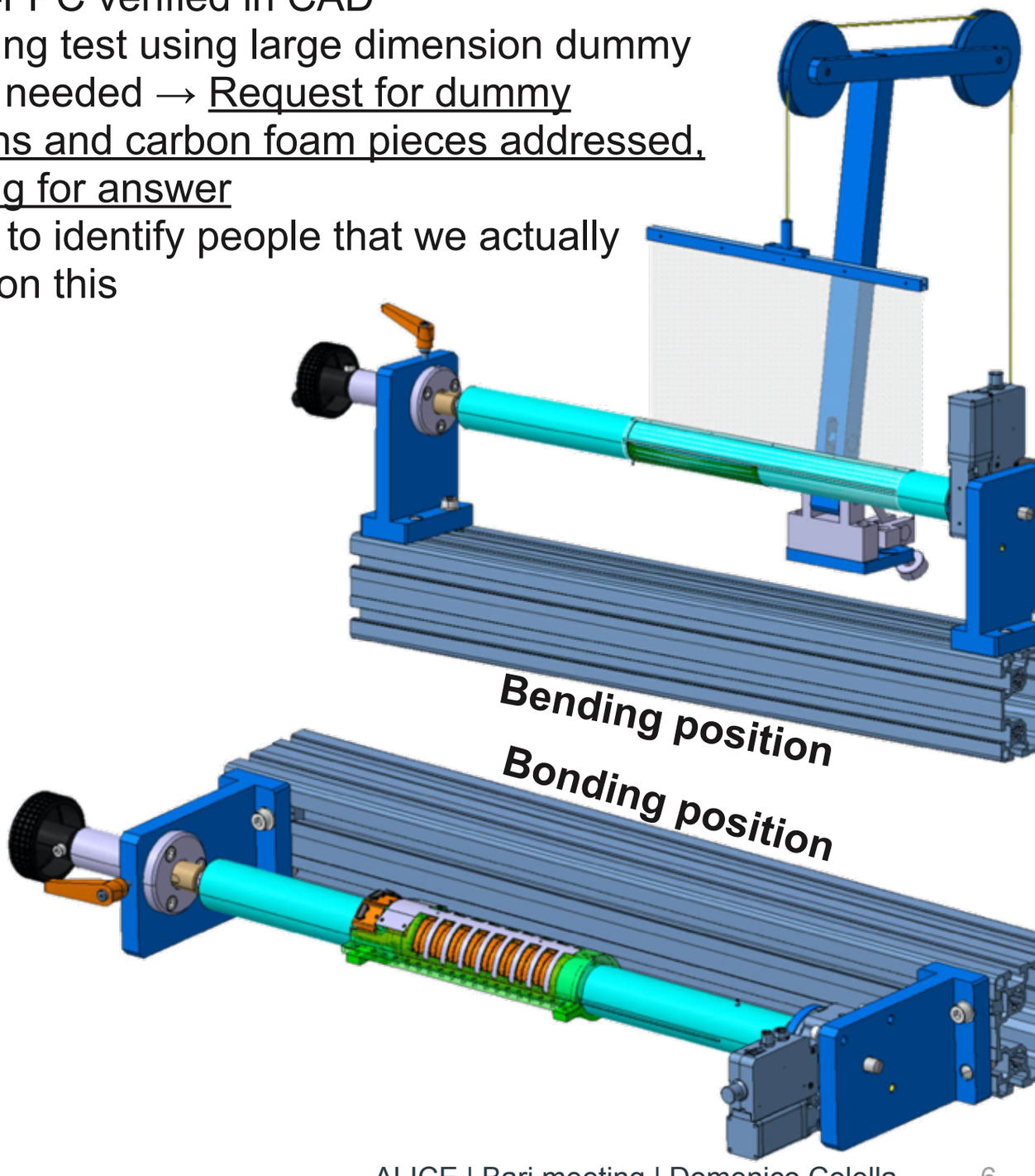
Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

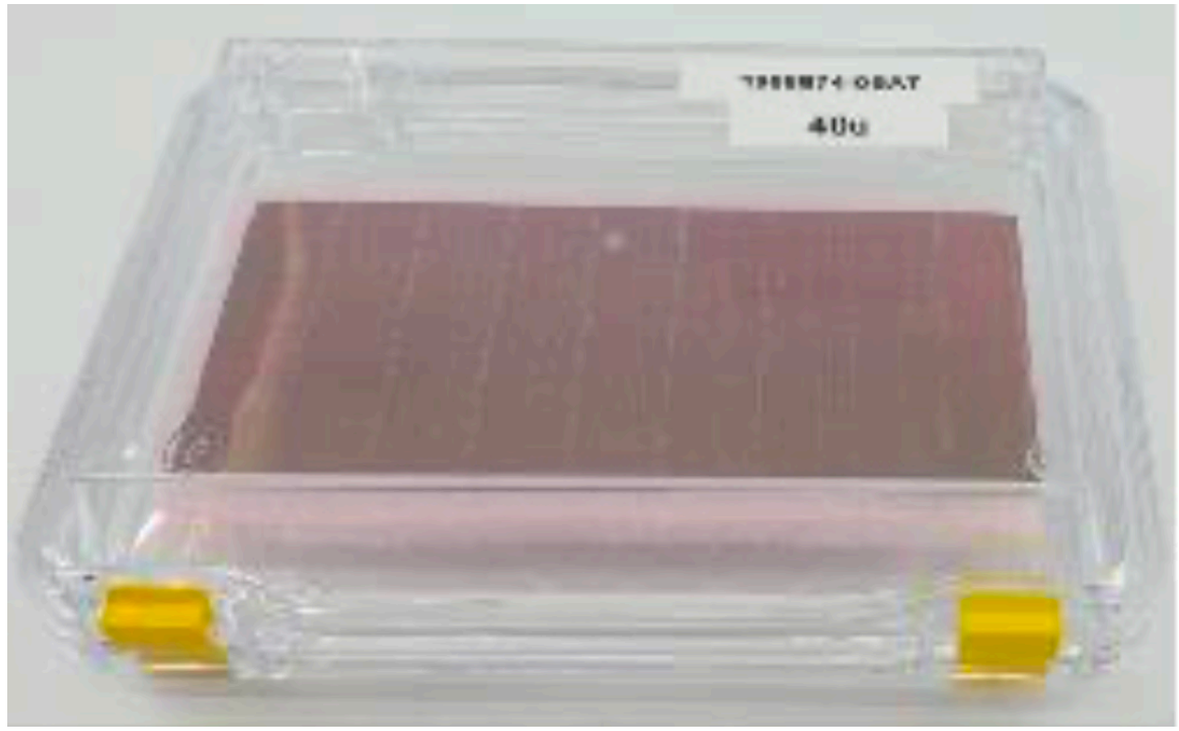
Bending-bonding tool
- Tool developed at CERN
- Compatibility with exoskeleton and edge-FPC verified in CAD
- Bending test using large dimension dummy chips needed → Request for dummy silicons and carbon foam pieces addressed, waiting for answer
- Need to identify people that we actually work on this



NEWS - 02/09/2021

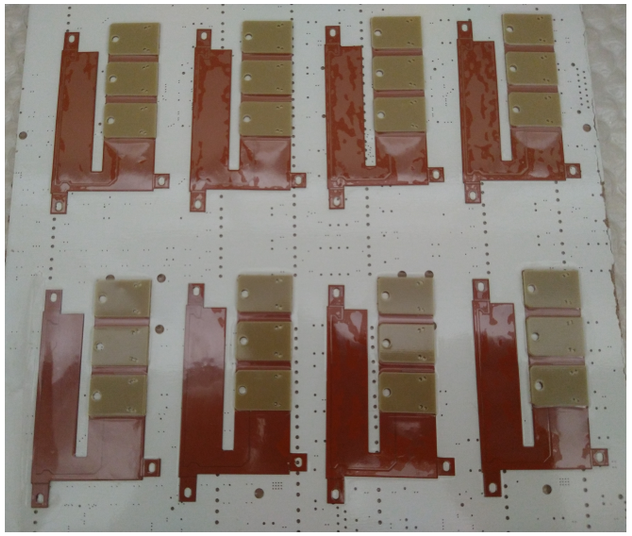
Super-ALPIDE mockup assembly
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

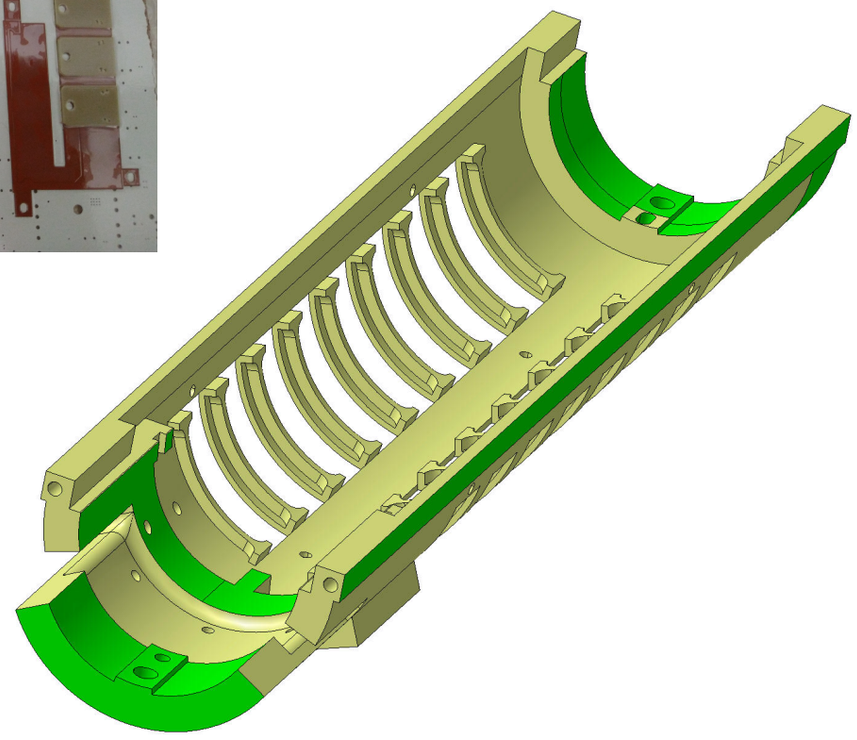
Super-ALPIDE chips already available at CERN



Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE → WILL BE PROVIDED BY CERN
- Edge-FPC
- Exoskeleton
- Exo-FPC

NEWS - 02/09/2021





Super-ALPIDE mockup assembly
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC → **First version available, verification during mockup assembly**
- Exoskeleton → **New version (V4), verification during mockup assembly**
- Exo-FPC

NEWS - 02/09/2021

Super-ALPIDE mockup assembly
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC

New version modifications
- Dimensions adjustment (especially for fingers)
- Few alignment holes/oblong added
- Stiffener under connectors added

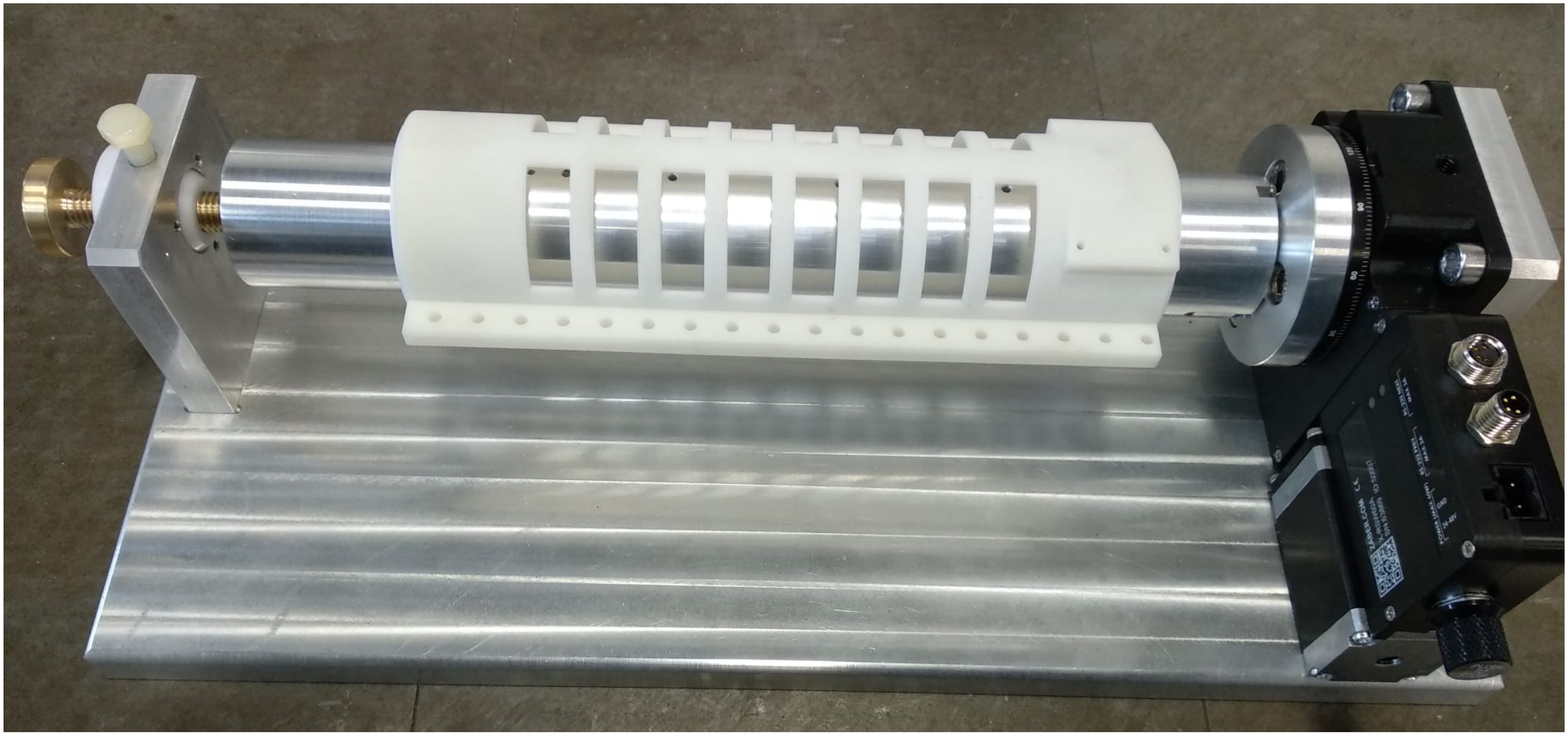
Super-ALPIDE assembly
- Cylindrical bonding tools
- Bending tools
- Super-ALPIDE
- Edge-FPC
- Exoskeleton
- Exo-FPC → **New version (V2), provided by Magnus. Looking for production in Bari**

NEXT SLIDES ARE FROM PREVIOUS MEETINGS

NEWS - 11/06/2021

Super-ALPIDE mockup assembly

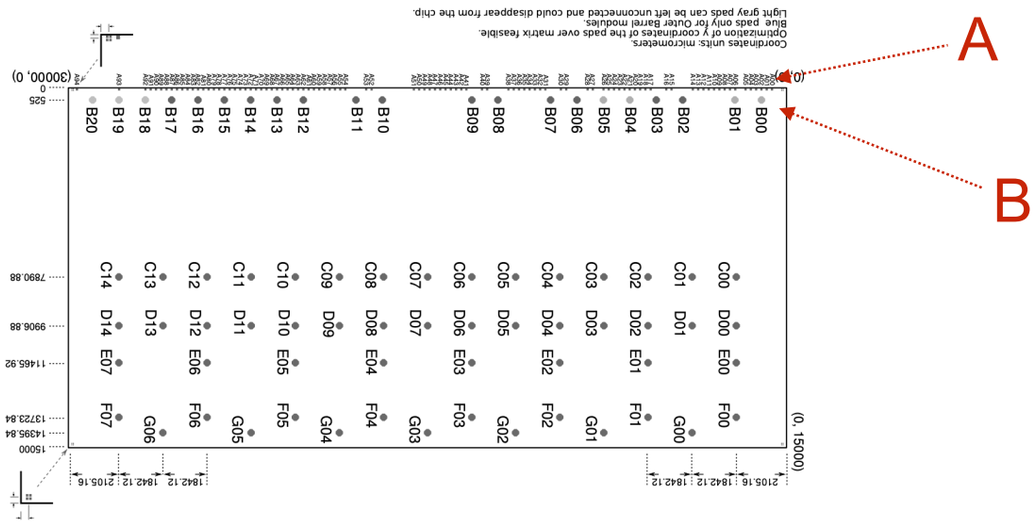
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus)
- Exo-FPC



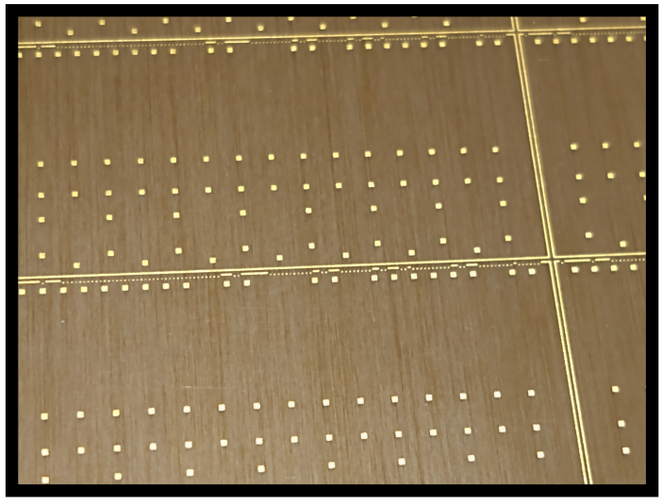
NEWS - 11/06/2021

Super-ALPIDE mockup assembly

- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus)
- Exo-FPC

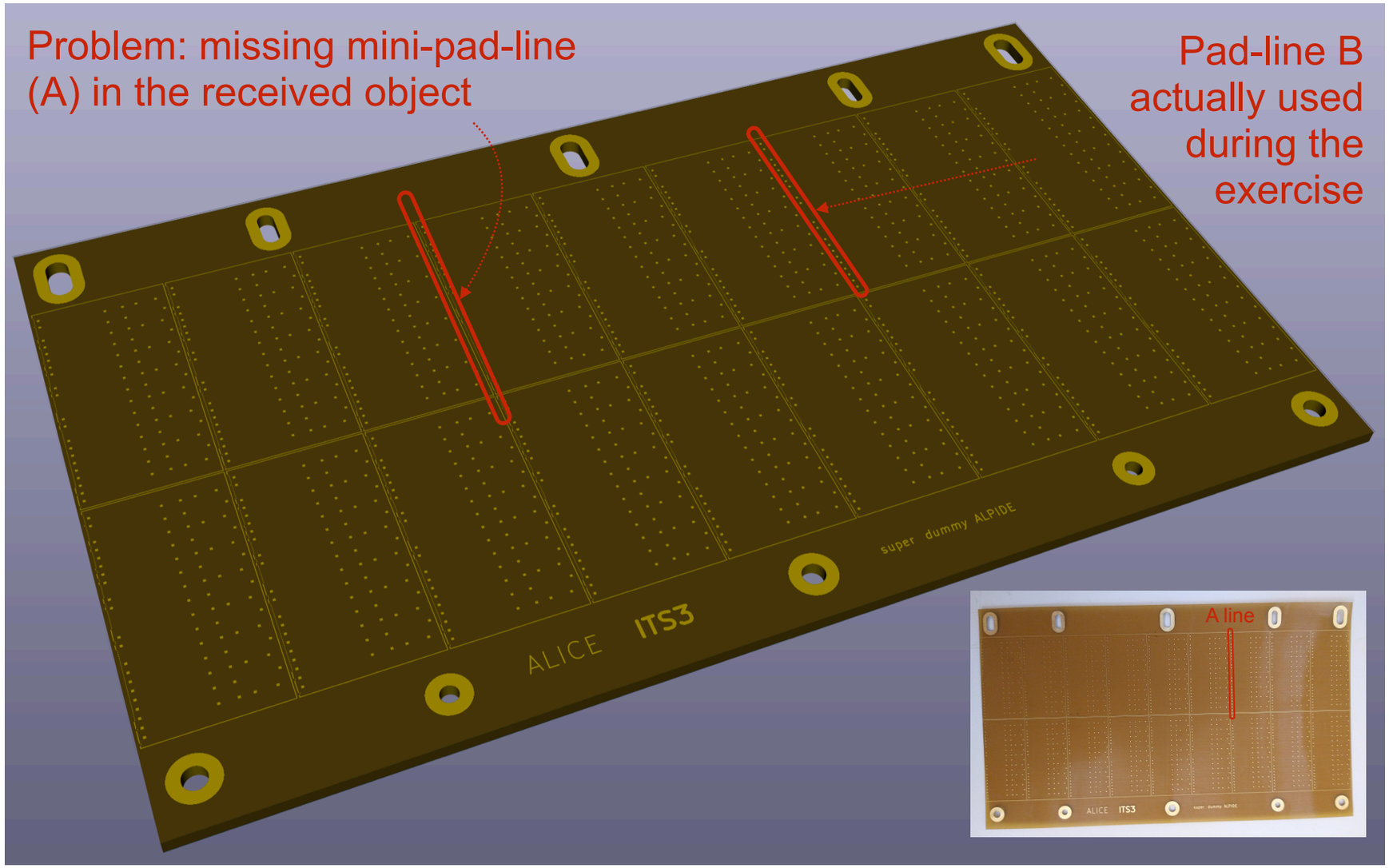


Problem solved in second production (received yesterday)



Problem: missing mini-pad-line (A) in the received object

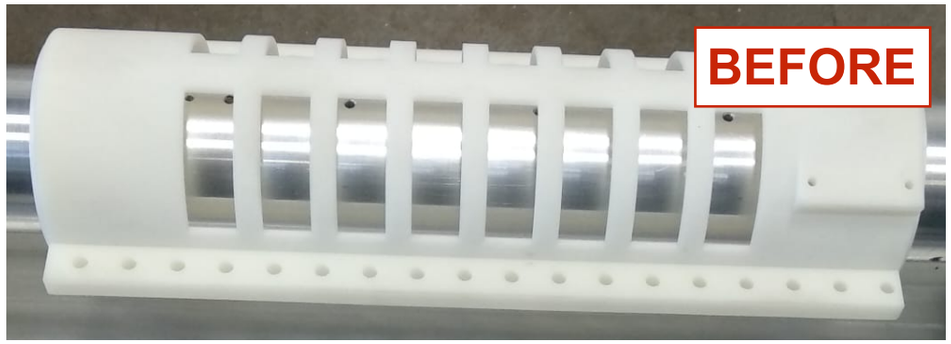
Pad-line B actually used during the exercise

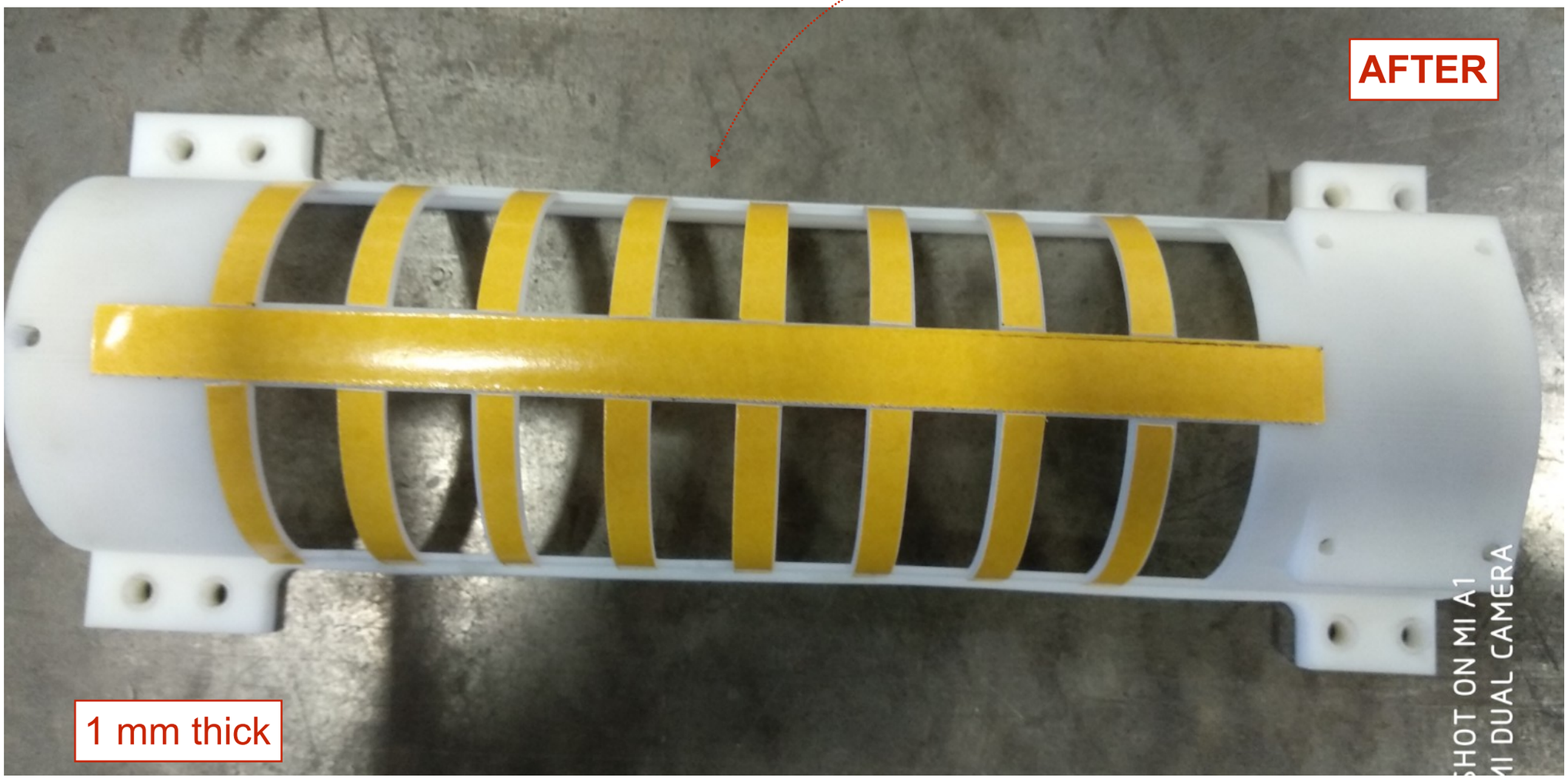


NEWS - 11/06/2021

Super-ALPIDE mockup assembly

- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus)
- Exo-FPC



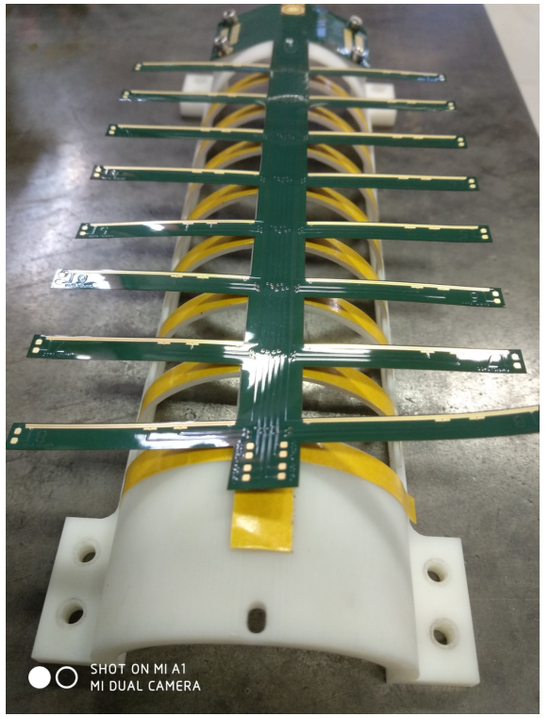


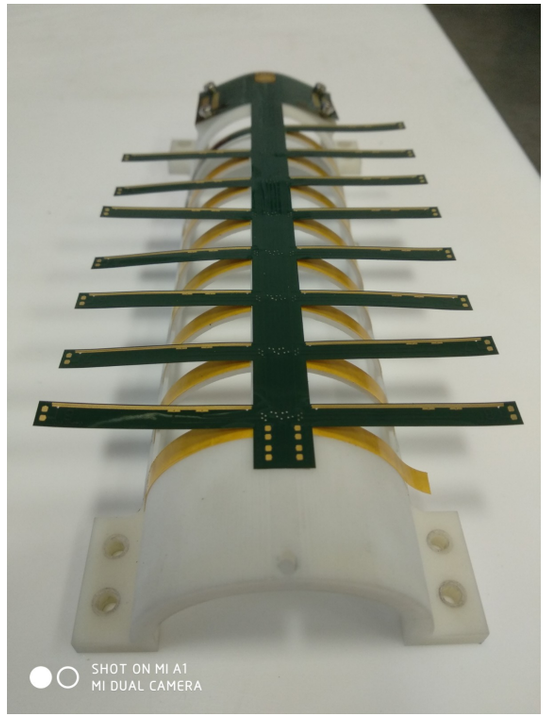
NEWS - 11/06/2021

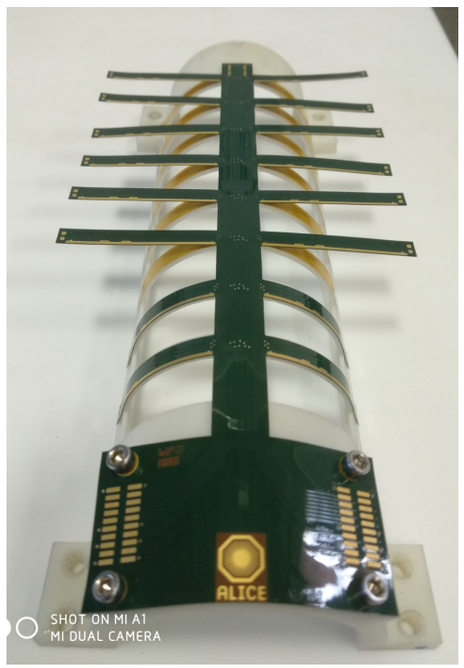
Super-ALPIDE mockup assembly

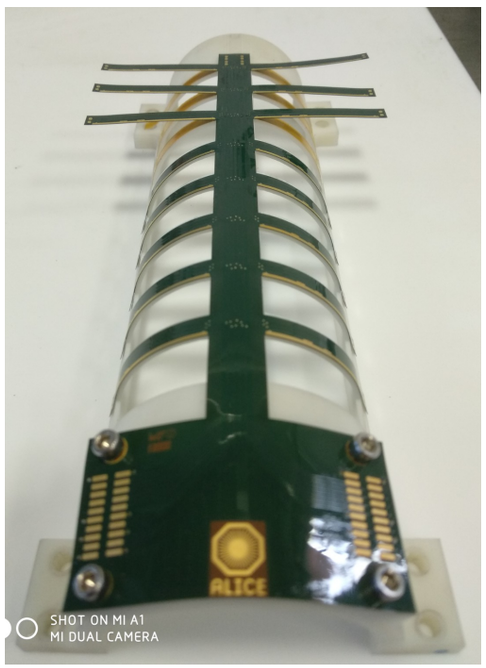
- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus)
- Exo-FPC

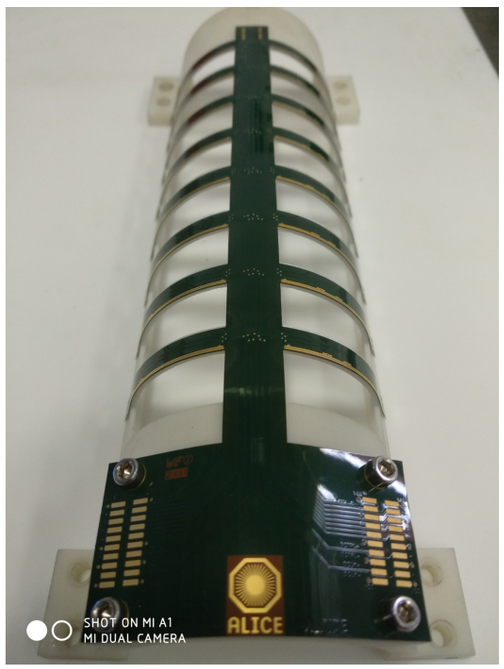
- Double-side adesive tape (100 μm)
- Placement procedure
  1. Connector side fixed with screws
  2. Spine placement starting from the connector side
  3. One-by-one rib placement starting from the connector side
- Quite good result: smooth FPC surface.
- Screws in the connector head, actually fix the position of the FPC-ribs with respect to the exo-ribs → to be evaluated the possibility to replace hales for screw with asole









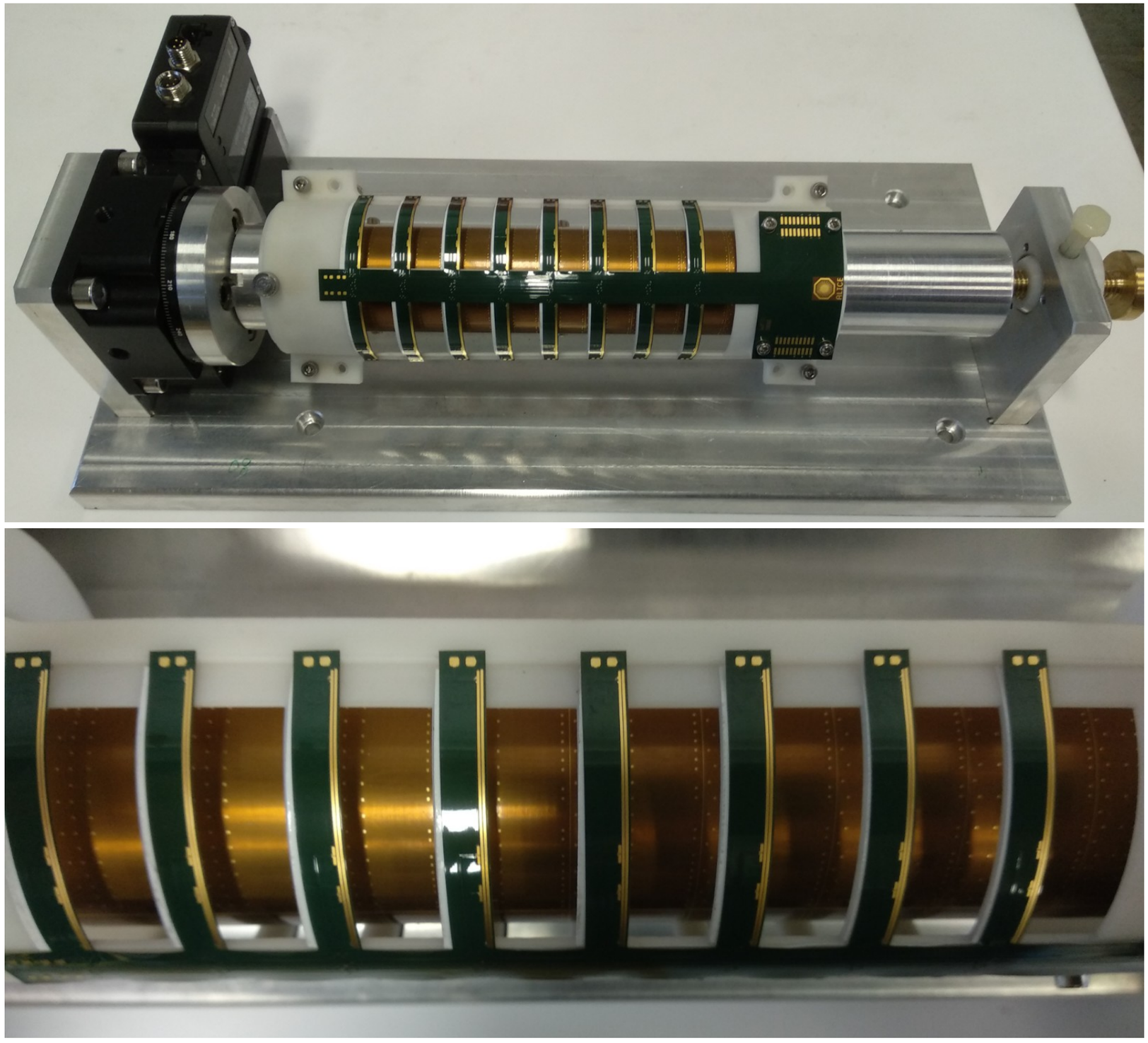


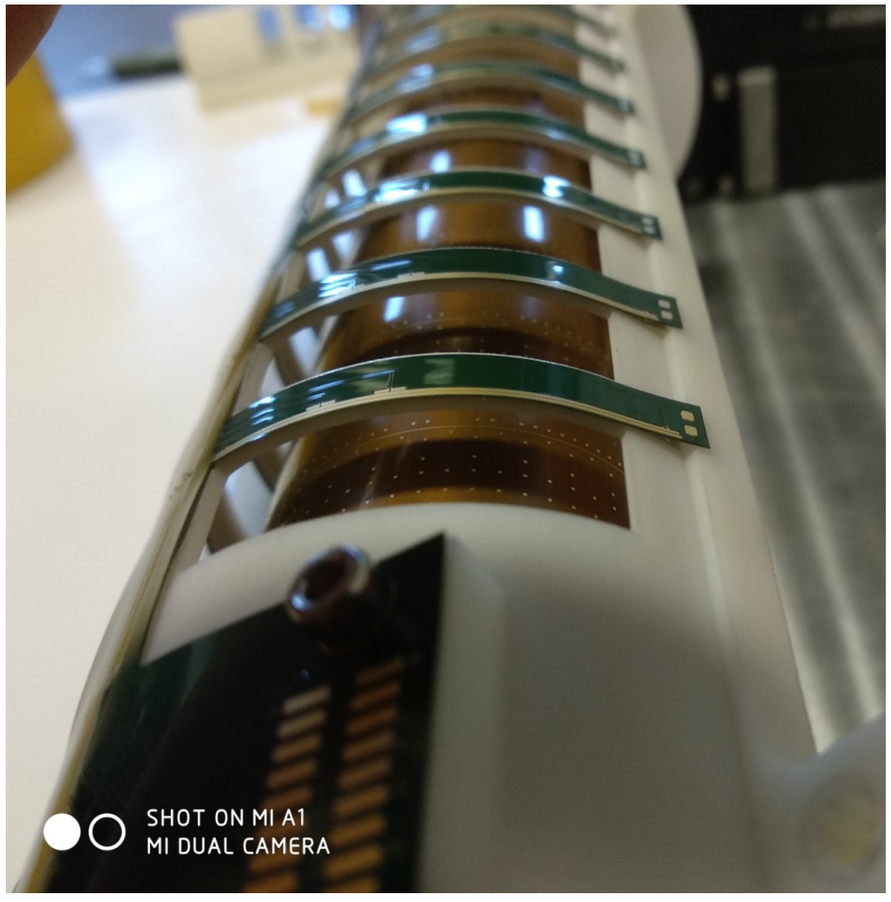
One more exo-FPC available → detailed later

NEWS - 11/06/2021

Super-ALPIDE mockup assembly

- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus)
- Exo-FPC

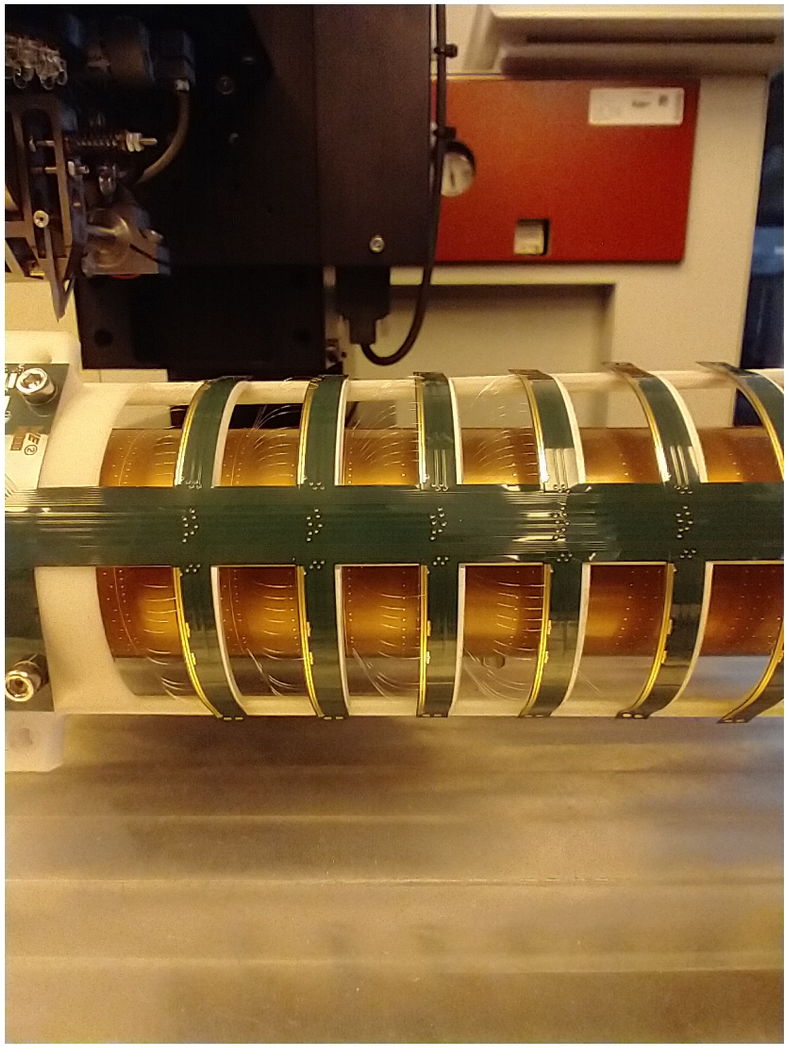


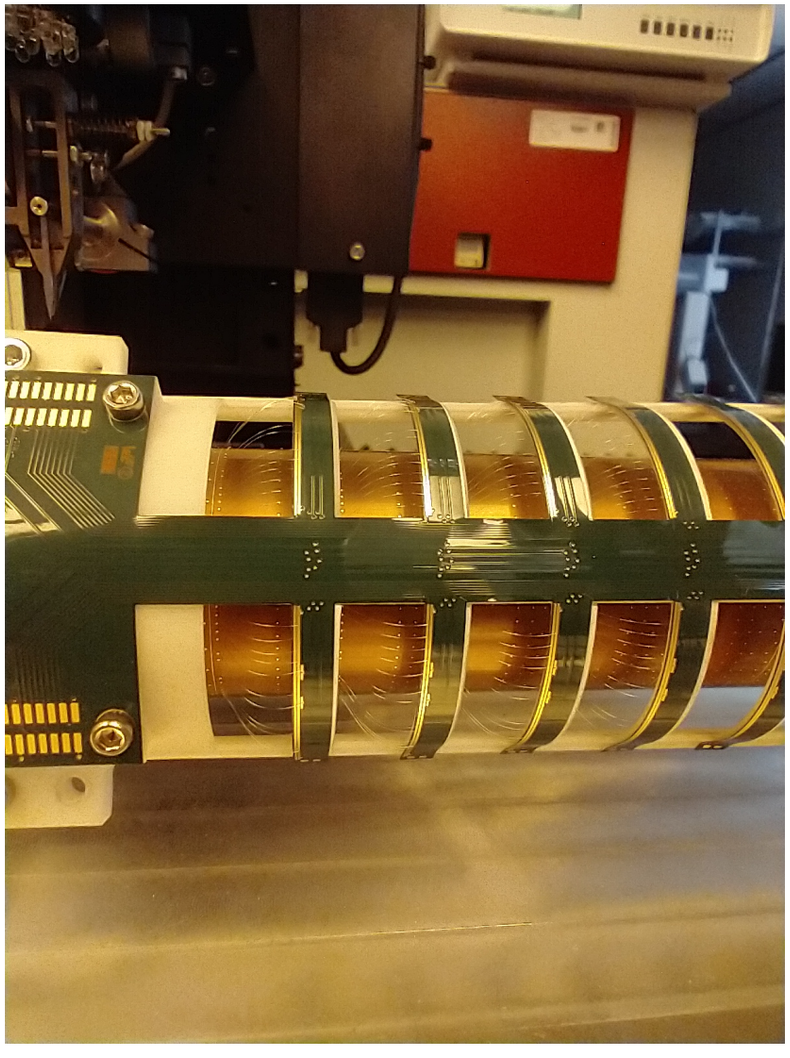


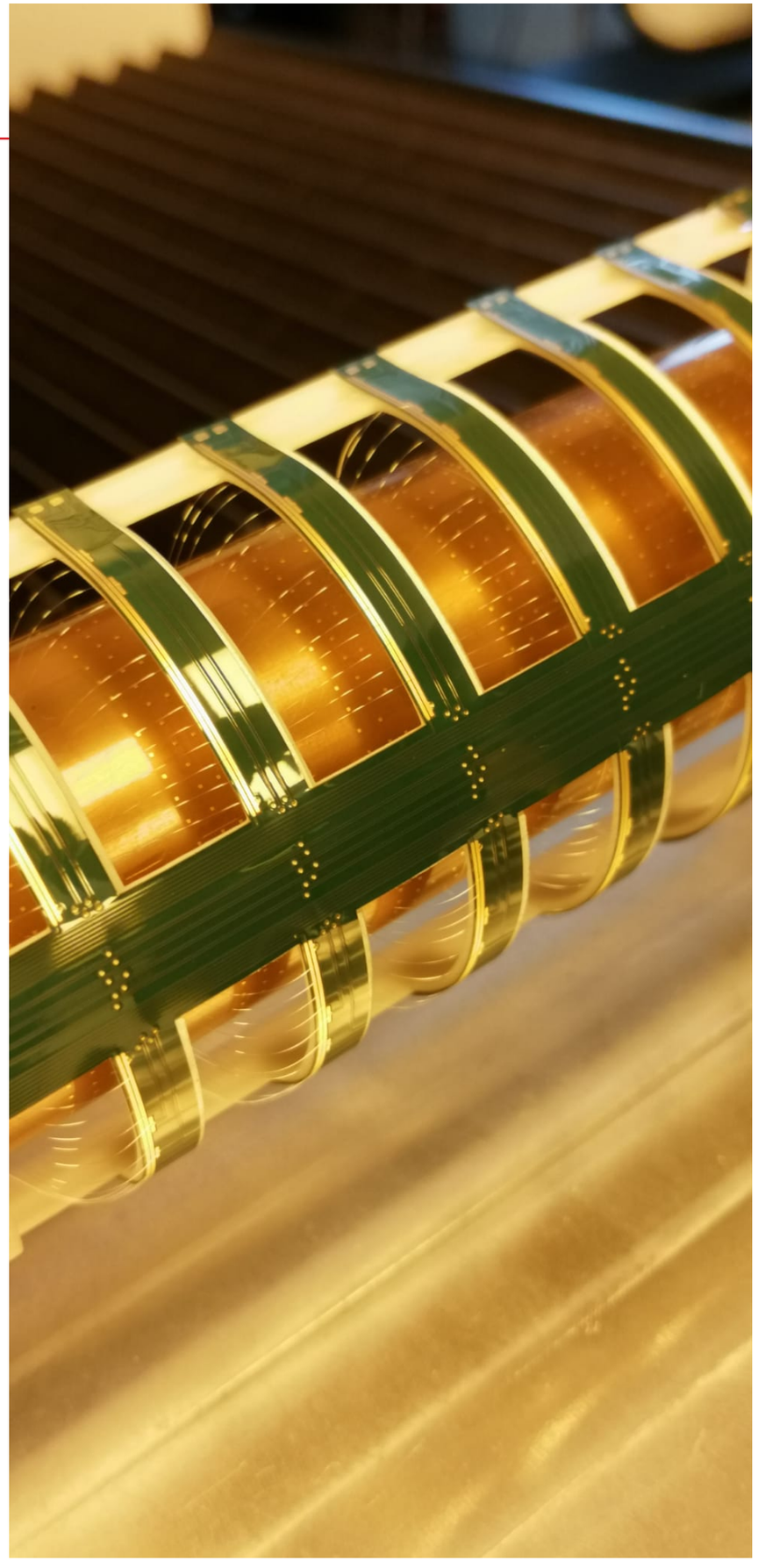
NEWS - 11/06/2021

Super-ALPIDE mockup assembly

- Cylindrical bonding tools
- Dummy-super-ALPIDE
- Exoskeleton (v1, by Magnus), 1mm
- Exo-FPC





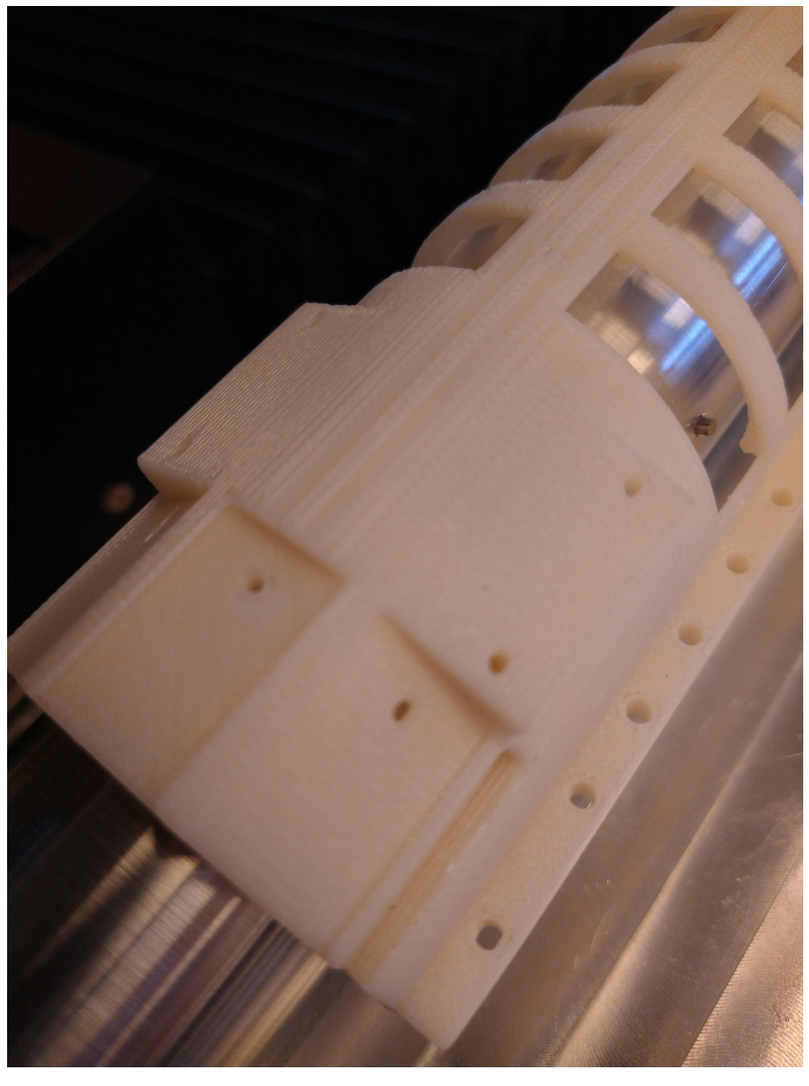


NEWS - 11/06/2021

Exoskeleton v2 printing

- Large improvement in the dimensional precision
  - Total length: (v1) ~500 μm (v2) ~10 μm
- Surface very rough
  - Depends on the thickness of the wire used in the printing machine

In this new design, lateral bars simply reduced (not removed) to avoid interference with bonding machine head.

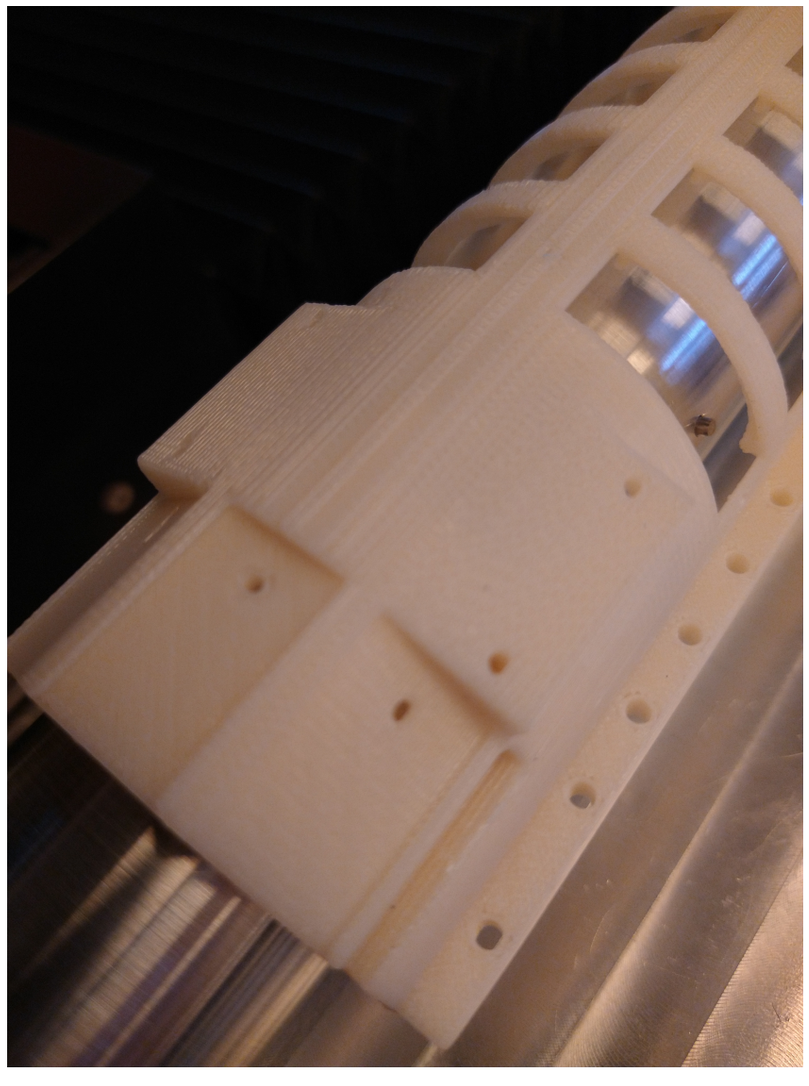


NEWS - 11/06/2021

Exoskeleton v2 printing

- Large improvement in the dimensional precision
  - Total length: (v1) ~500 μm (v2) ~10 μm
- Surface very rough
  - Depends on the thickness of the wire used in the printing machine

One more exo-FPC available
→ Use it with the new exoskeleton
→ Still thinking about gluing procedure: glue or adesive tape
- Rough surface could be better for glue



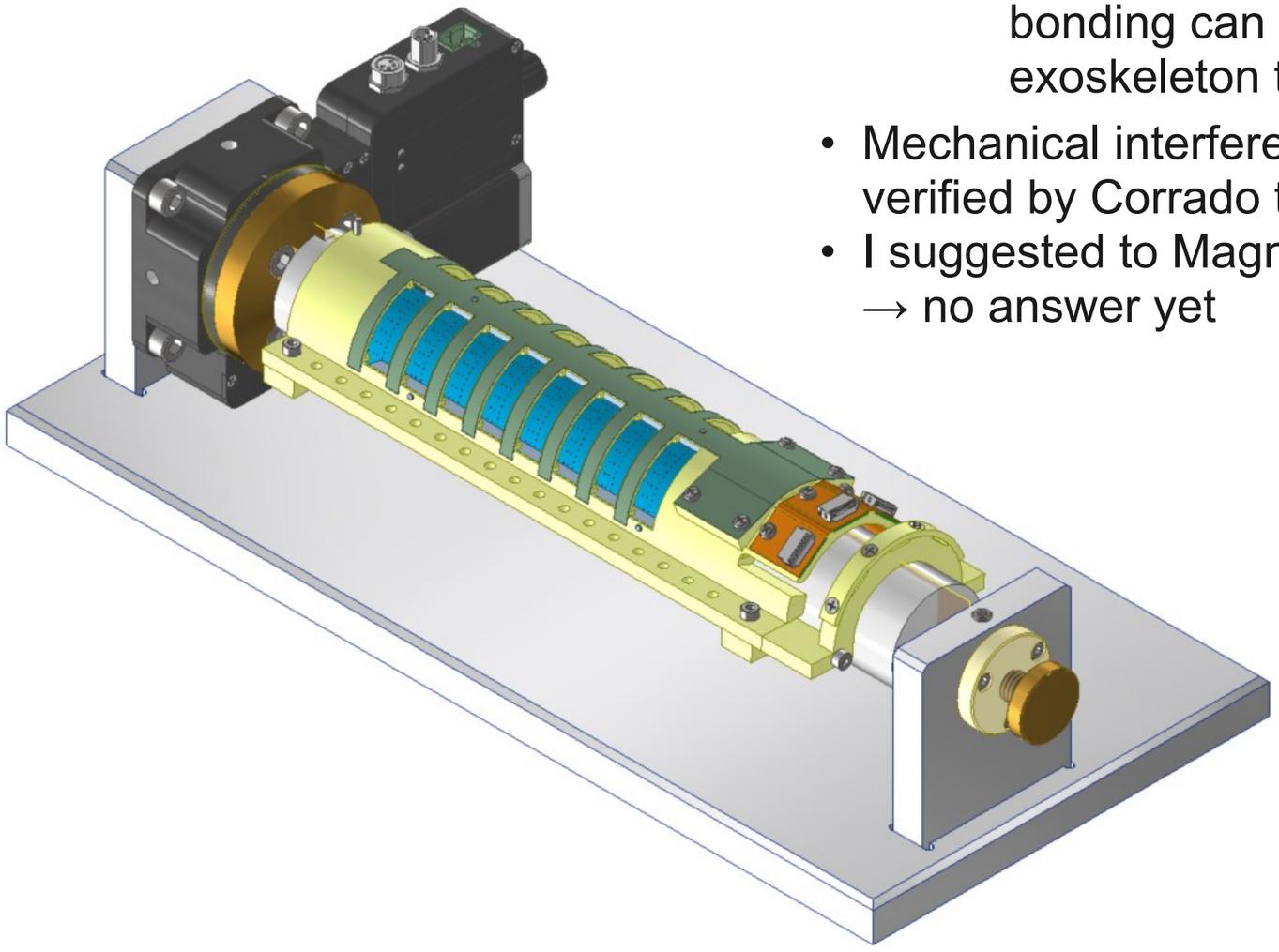
NEWS - 11/06/2021

Component production status

- Dummy super-ALPIDE → Available
- Edge-FPC → Submission completed, starting production
- Exo-FPC → No news
- Exoskeleton (v2) → One produced in Bari

NEWS - 14/05/2021

SUPER-ALPIDE SETUP



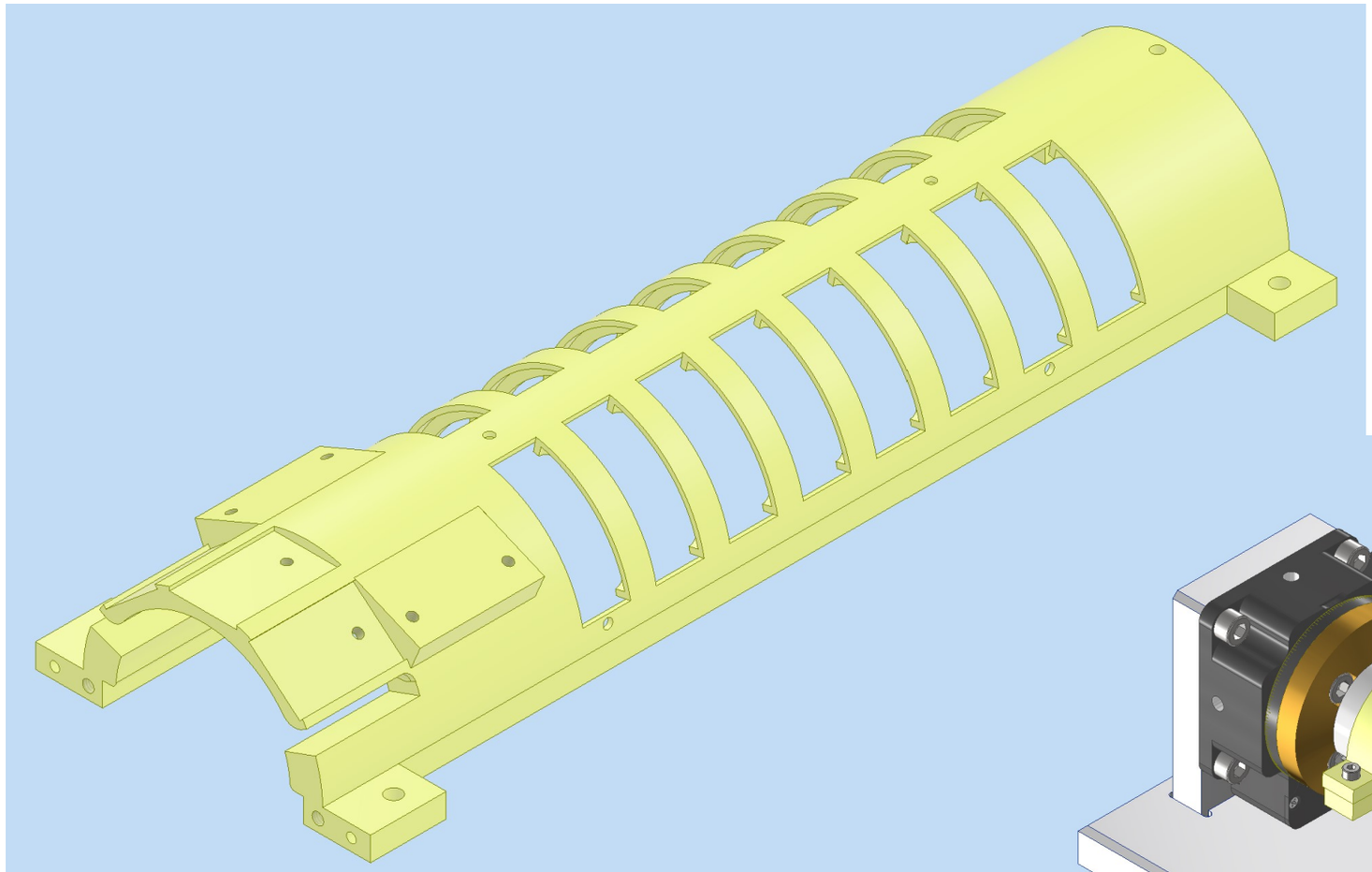
Status

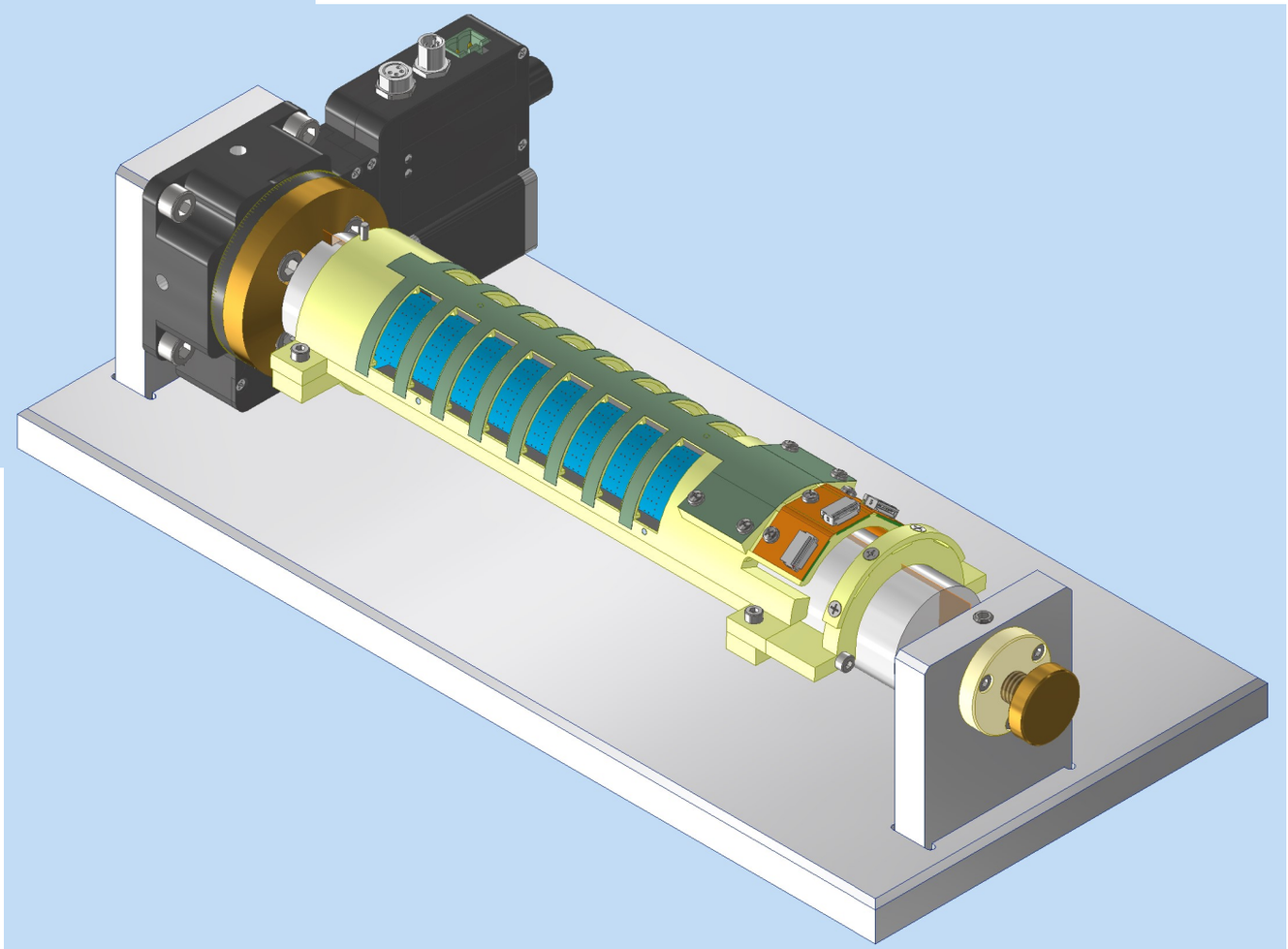
- Cylindrical bonding tools ready
- Setup assembled using single ALPIDE chip on the cylinder and single-ALPDE-FPC as bonding surface on the exoskeleton
- Bonding test performed by Pasquale using a 1.5 mm thick exoskeleton (still old one, designed by Magnus)
    - Lateral bars create mechanical interference with the bonding head → must be removed
    - With such an distance between the two soldering points, bonding can be performed but we are at the limit → reduce exoskeleton thickness to 1 mm
- Mechanical interference with bending tool are expected to be verified by Corrado team at CERN → No reply after two weeks
- I suggested to Magnus to proceed with exoskeleton production → no answer yet

- Dummy-super-ALPIDE production launched
    - ordine spedito 23/04
    - tempo consegna: 15 giorni
    - conferma ordine 6/05
- Edge-FPC offer search launched

NEWS - 14/05/2021

SUPER-ALPIDE SETUP

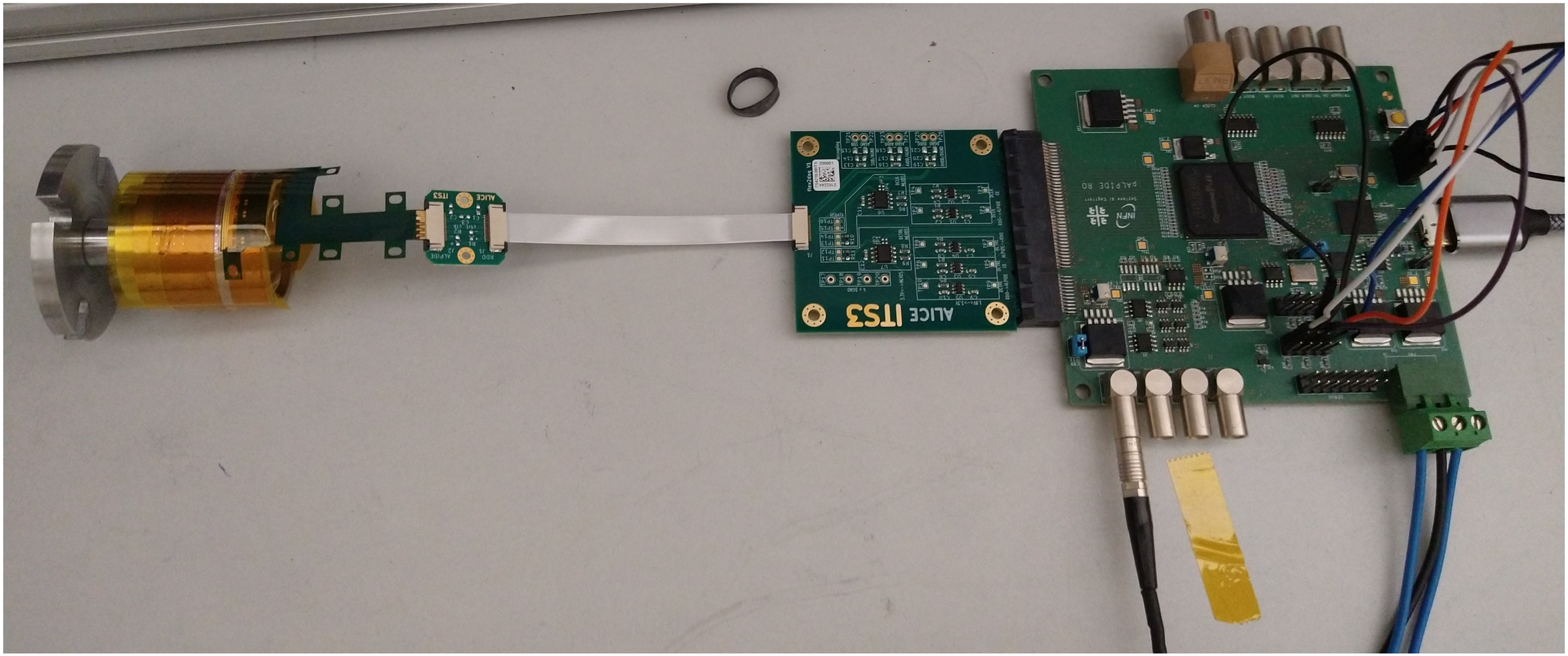




NEWS - 14/05/2021

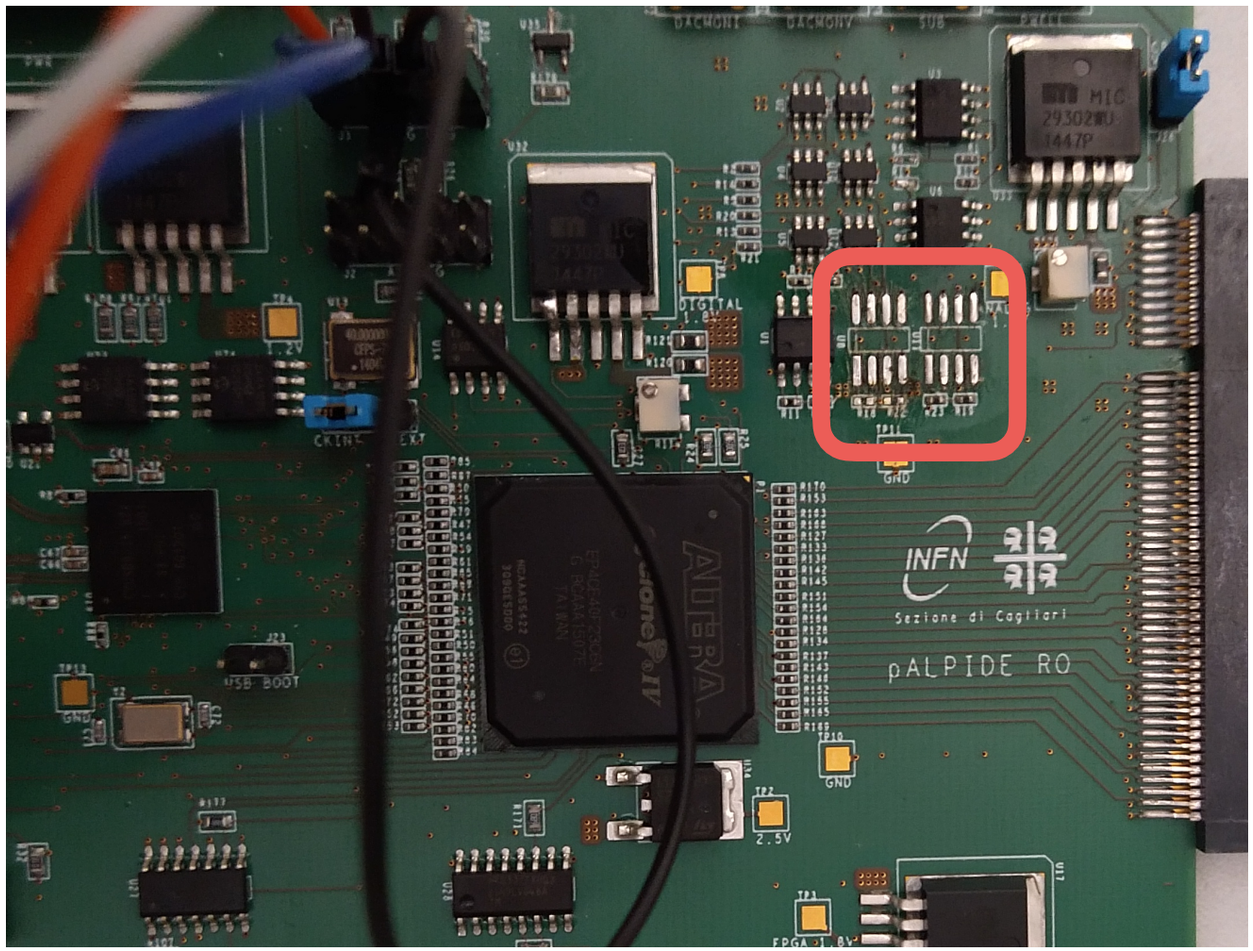
SINGLE ALPIDE SETUP

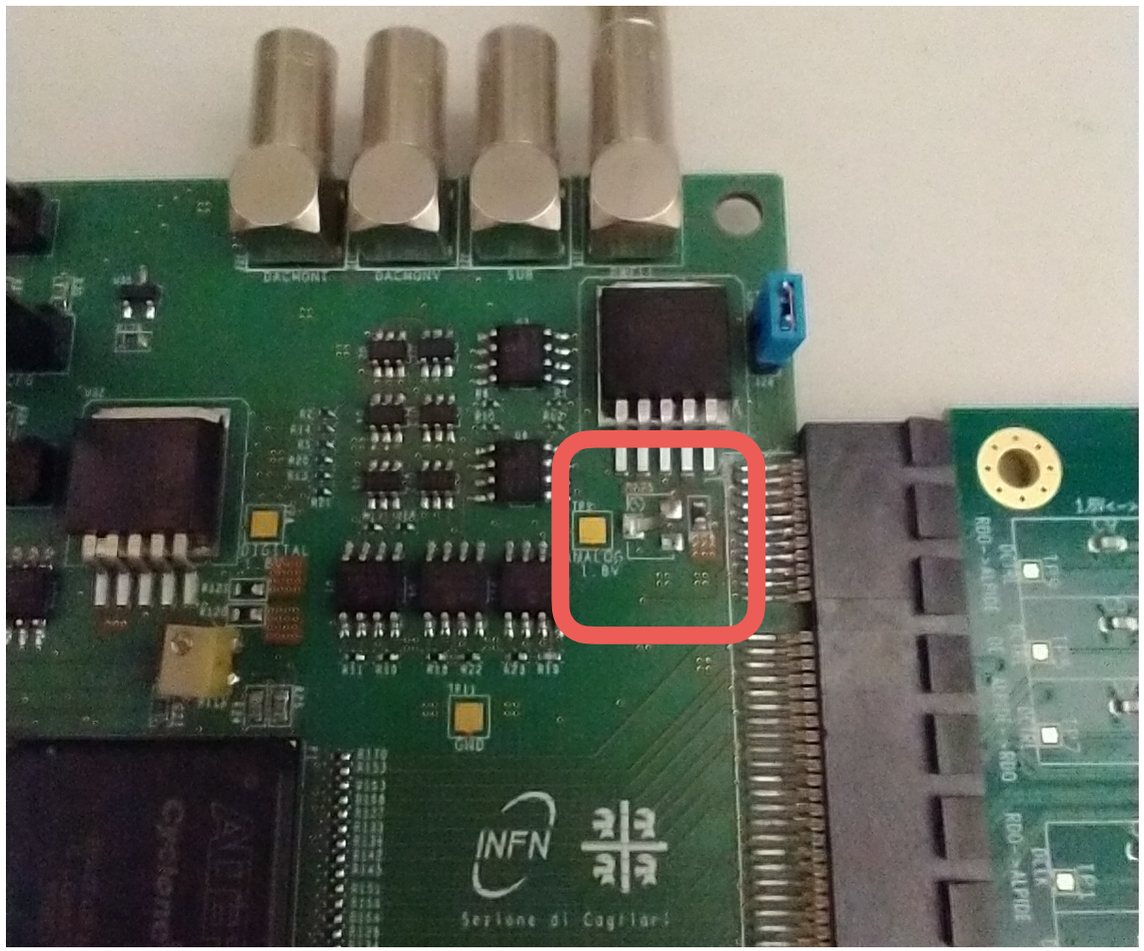
- Assembly with working chip by Cosimo and Vincenzo
- Bonding done by Pasquale
- First powering test on Friday 7/5
  - Board requires new fixing



NEWS - 14/05/2021

- 5 problematic DAQ boards shipped to Bari for reparation (by Michele)
  - Intervention successful for two boards (remaining cannot be fixed)
  - FW can be loaded in these two boards but other components are missing
    - New intervention on Monday



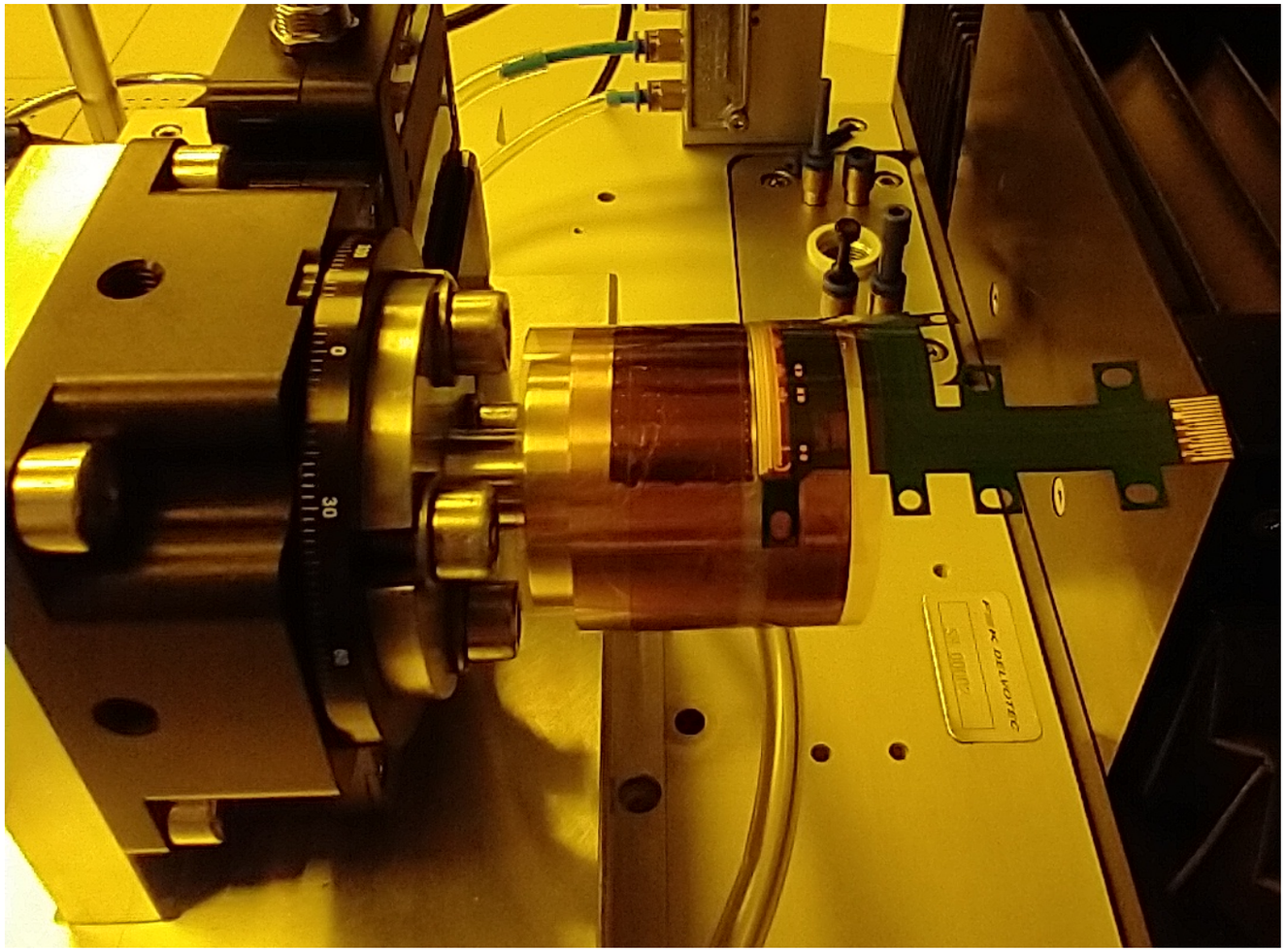


NEWS - 23/04/2021

SINGLE ALPIDE SETUP

Status

- Chips available
  - First assembly using NOT working chip done [Cosimo, Vincenzo]
  - Bonding test next week [Pasquale]
- DAQ system
  - Available board not compatible with FW
  - 5 boards in Bari for reparation [Michele]
    ➔ we will keep one
  - Other cables and boards available

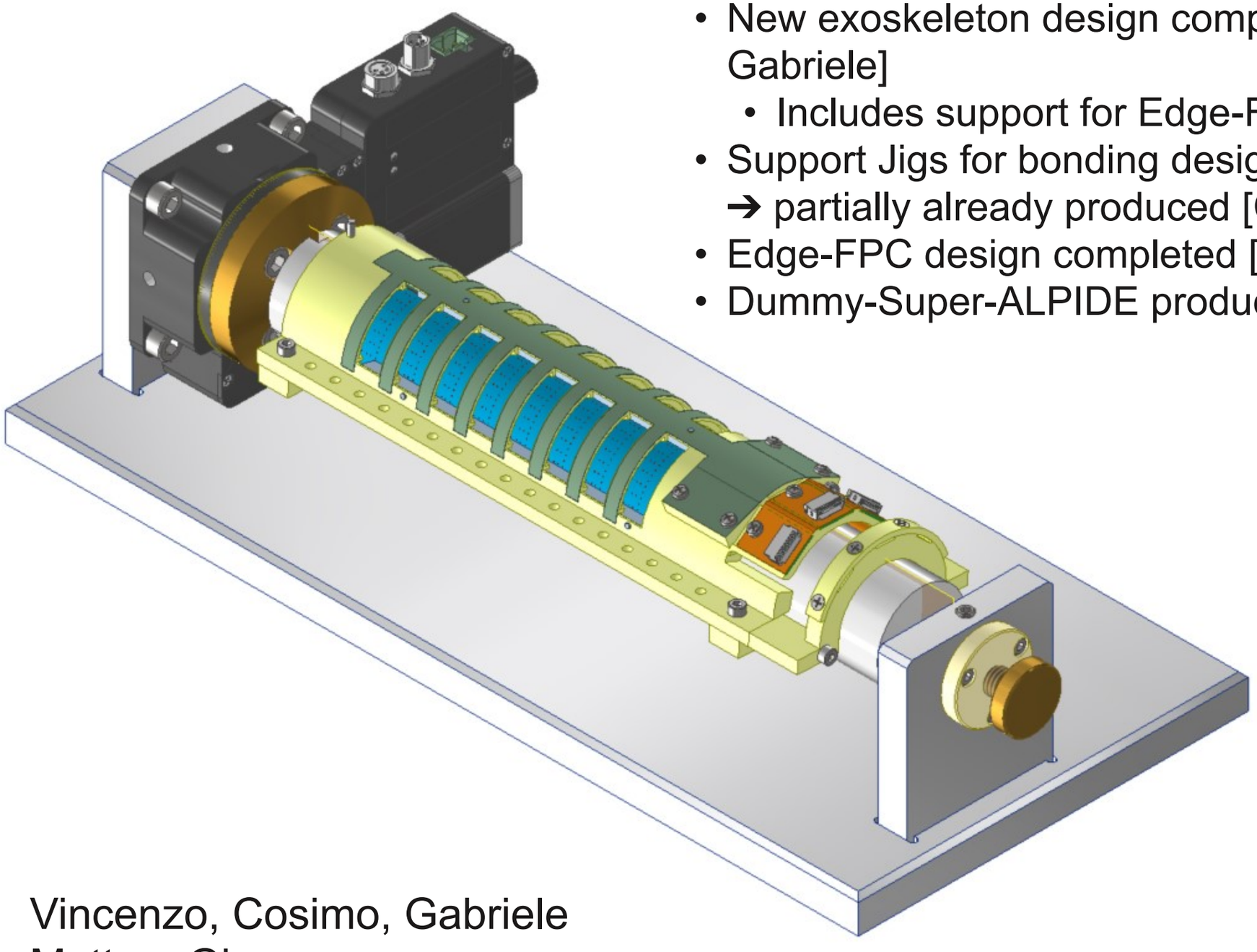


Next steps

- Push for DAQ board reparation
- Assembly of working chip setup
- Start with measurements…

NEWS - 23/04/2021

SUPER-ALPIDE SETUP

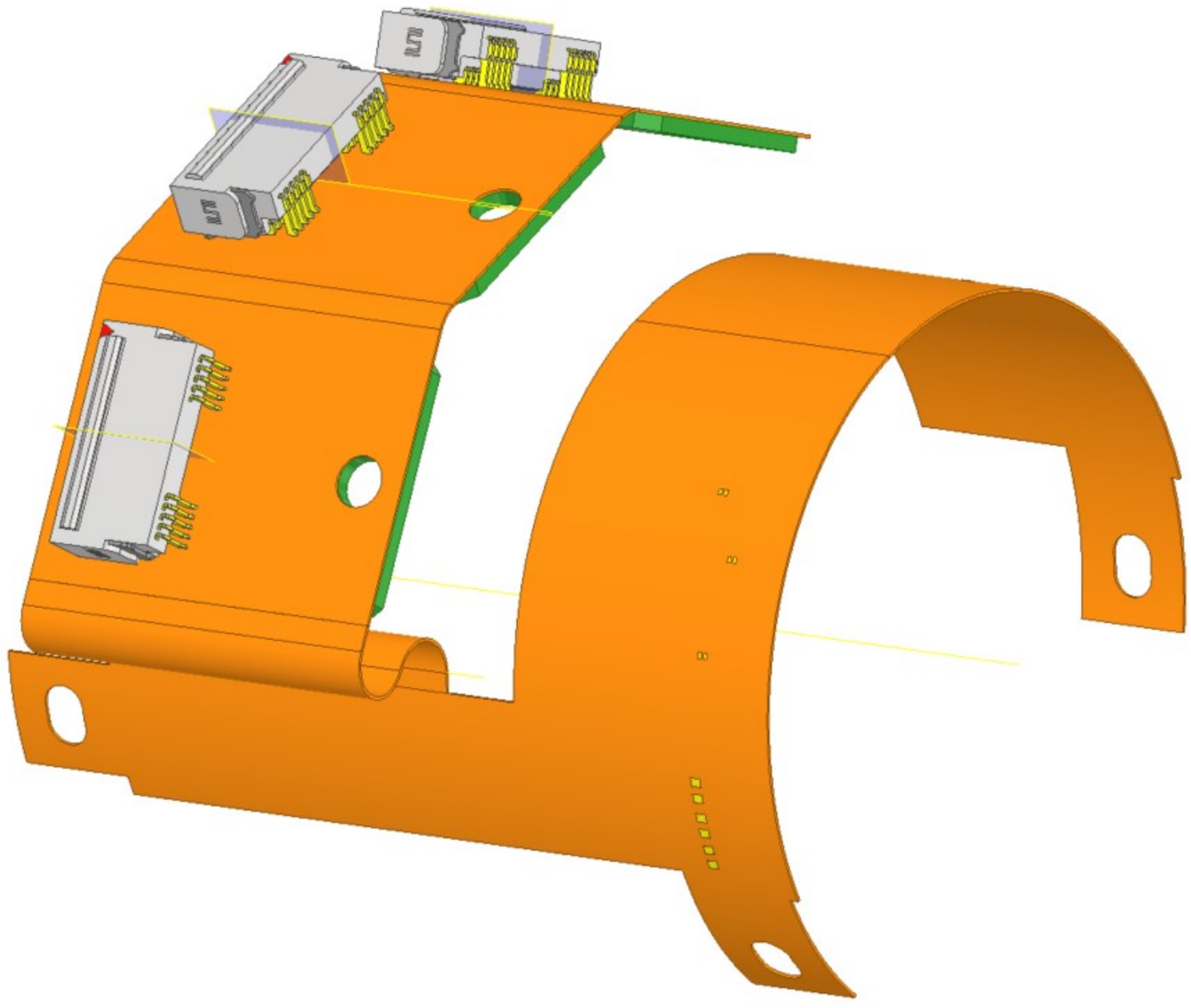


Vincenzo, Cosimo, Gabriele
Matteo, Giuseppe

Status

- Exo-FPC and exoskeleton received
  - Dimensional inspection [Pasquale]
- New exoskeleton design completed [Cosimo, Vincenzo, Gabriele]
  - Includes support for Edge-FPC
- Support Jigs for bonding design completed [Vincenzo]
  ➔ partially already produced [Cosimo, Michele F.]
- Edge-FPC design completed [Matteo, Giuseppe]
- Dummy-Super-ALPIDE production launched

NEWS - 23/04/2021

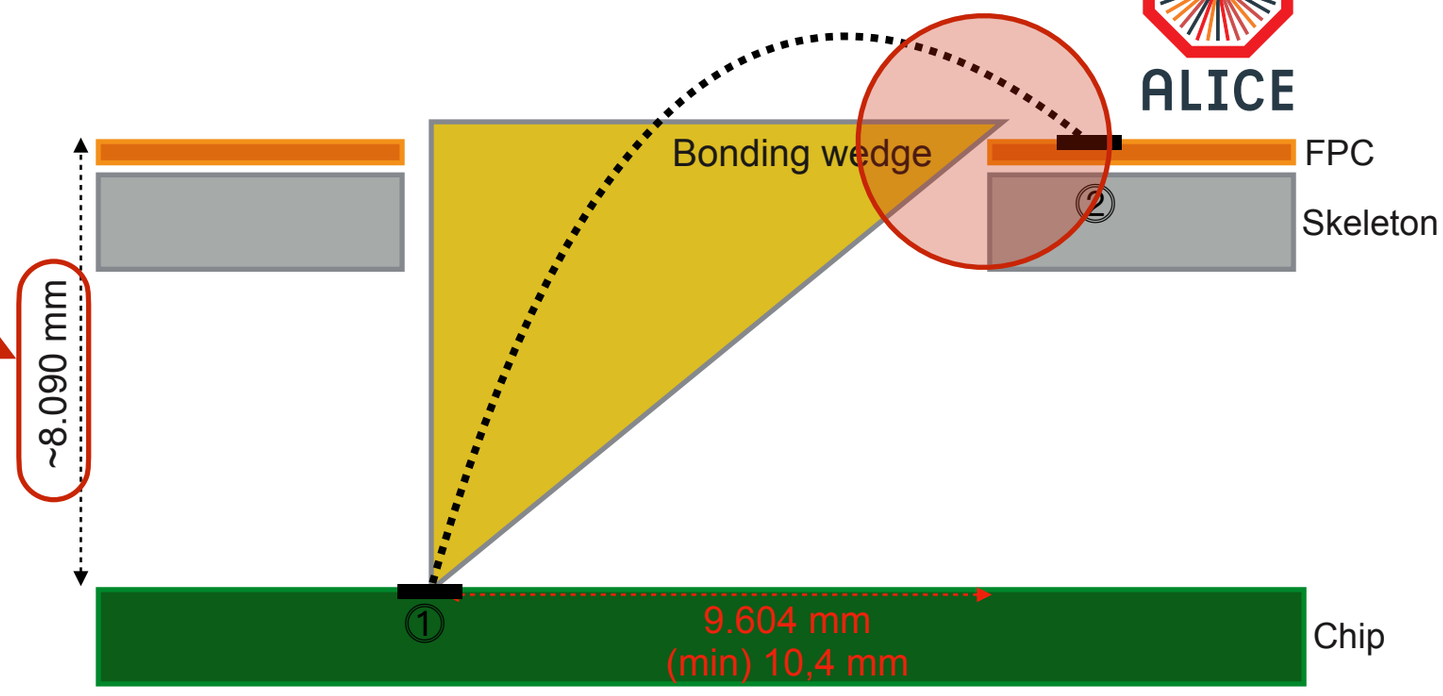


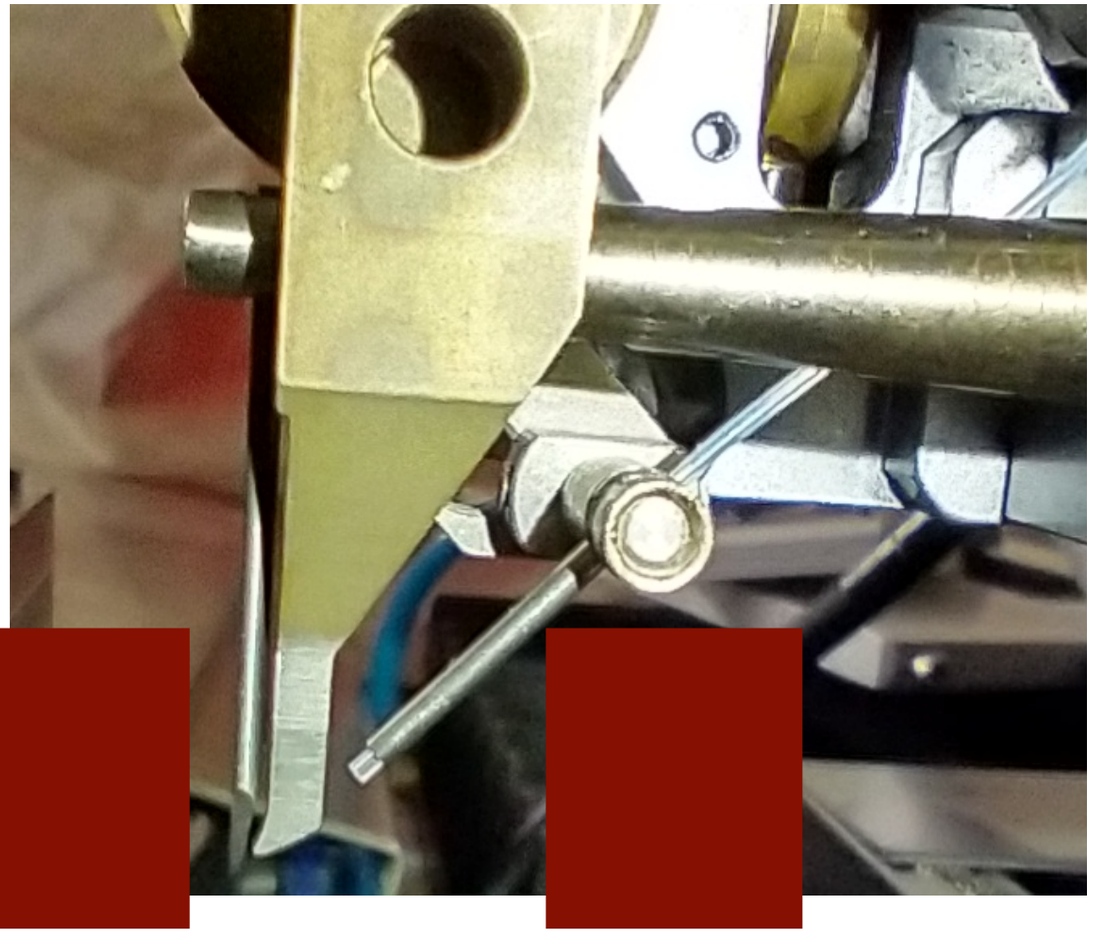
Matteo, Giuseppe

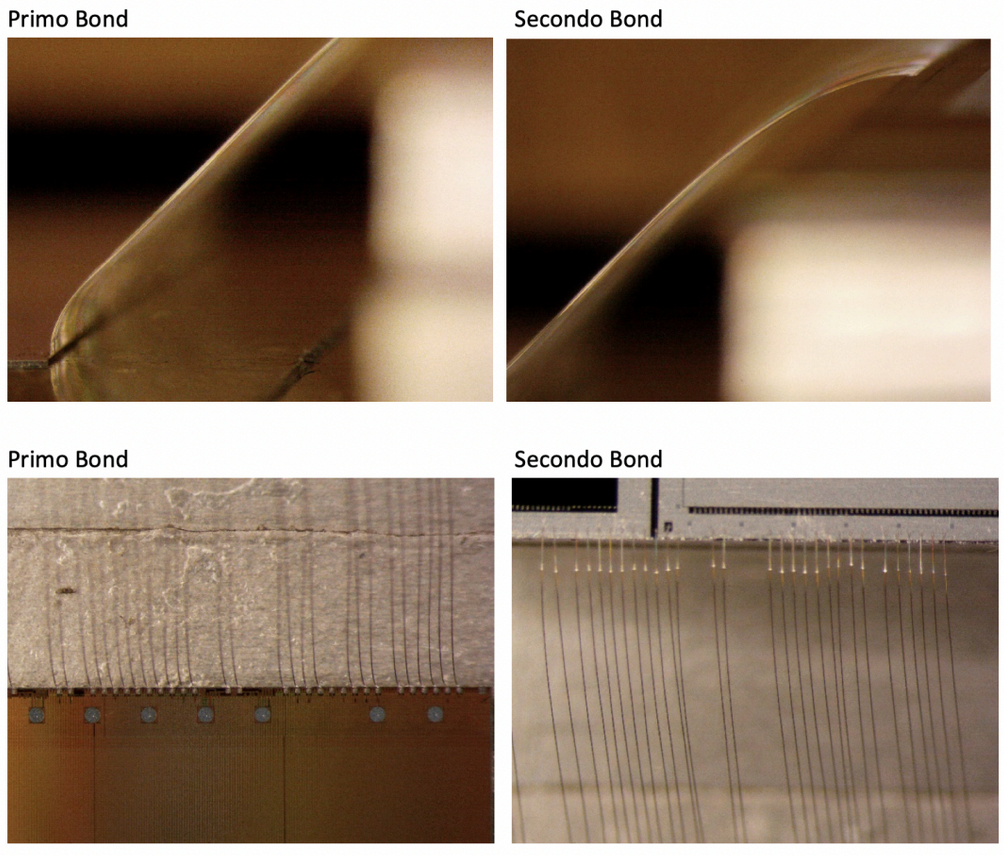
NEWS - 23/04/2021

Pasquale

Moving to the target height







NEWS - 23/04/2021

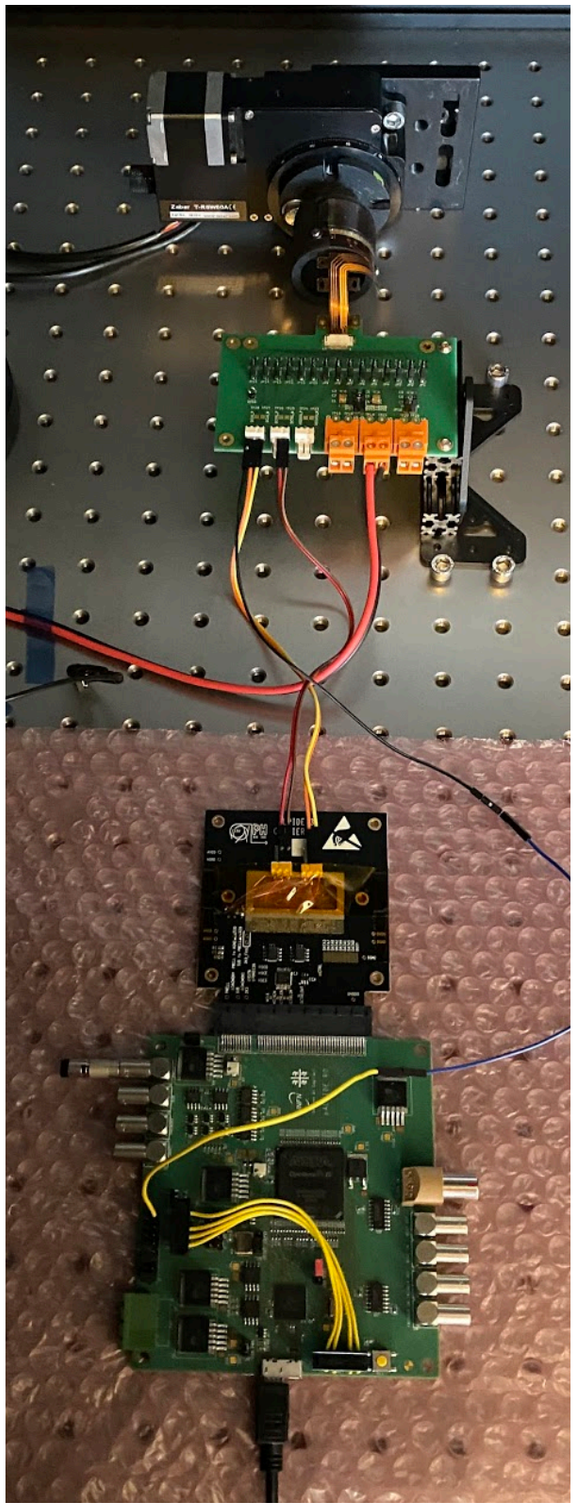
Next steps

- Assembly the super-ALPIDE bonding jigs and try bonding with present exoskeleton version
- Proceed with new exoskeleton version production
- Proceed with Edge-FPC production

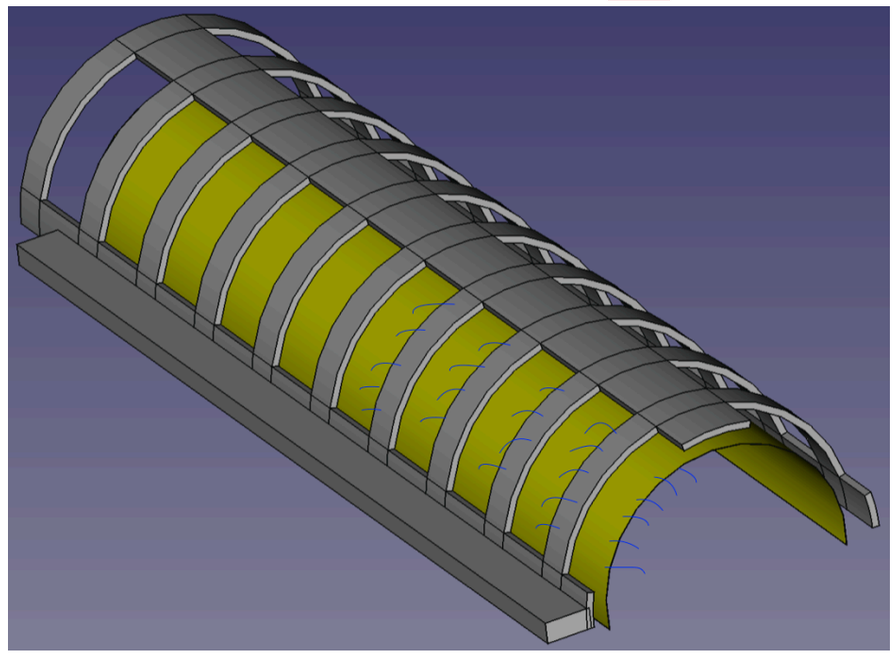
NEWS - 12/03/2021

SINGLE CHIP TEST

1. ALPIDE 50 um received
2. FPC single chip production request submitted
   - Order submitted on March 1
   - Delivery time 10 working days
   - Expected March 15
3. Rotary motor adapter under design (Vincenzo)
   - Connect the rotary motor to the cylinder hosting the bended chip
   - Needed to perform the bonding over bent chip
4. Bending procedure
   - Simplify as much as possible → No tool development
   - Use Mylar foil sandwich to keep side-by-side chip and FPC
5. DAQ board
   - Connector fixed
   - Instructions for FW loading available
6. FPC to DAQ connection
   - Flex2DAQ connector in production (two weeks more for delivery) → One could be sent to Bari
   - Alternatively, adaptor+carrier board → To be requested at CERN



NEWS - 12/03/2021



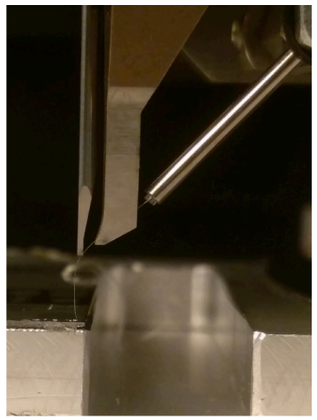
SUPER-CHIP

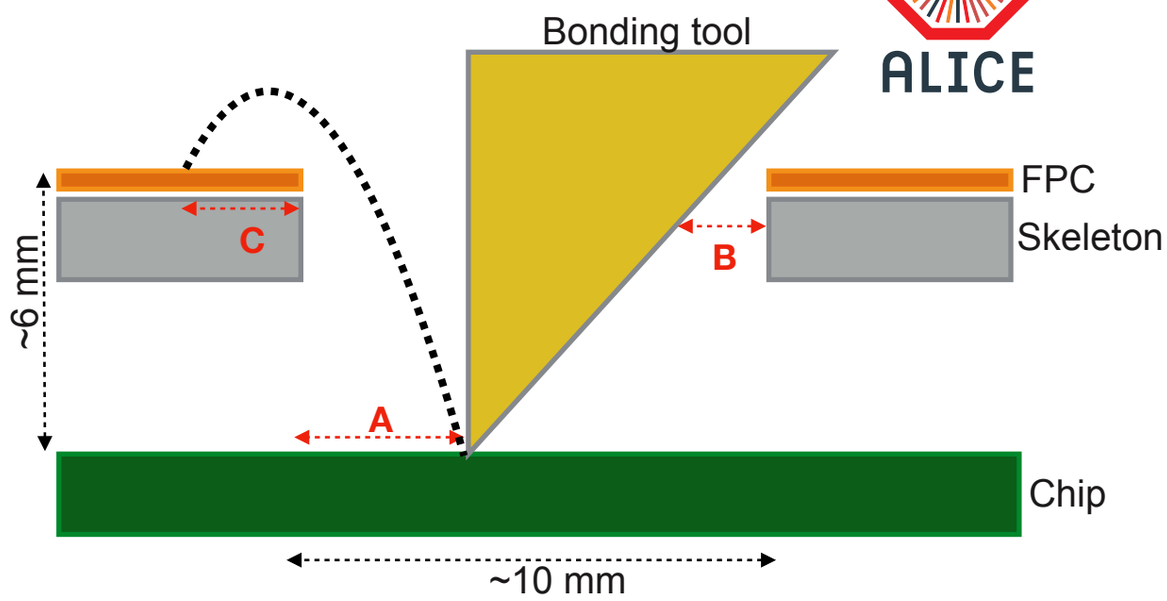
1. Skeleton FPC
   - Skeleton
     - Scalable design by Magnus
     - Good material for the production to be identified
   - Wire-bonding
     - First tests performed by Pasquale (next slide)
     - More tests during next week
   - FPC
     - designed by Magnus, under G. De Robertis revision

2. Edge FPC
   - FPC design requires minimal geometrical limitations from mechanical support → Vincenzo and G. De Robertis
   - Mechanical support design requires actual dimensions of the full detector mechanical support → Gabriele and Vincenzo
   - Mechanical support design also requires to take into account the full object assembly sequence → Gabriele and Vincenzo

3. General observation
   - Magnus agreed that a mockup of the chip bending tool is needed in Bari to exercise the bonding and actually study the mechanics for the edge FPC support → Gabriele, Vincenzo and Cosimo

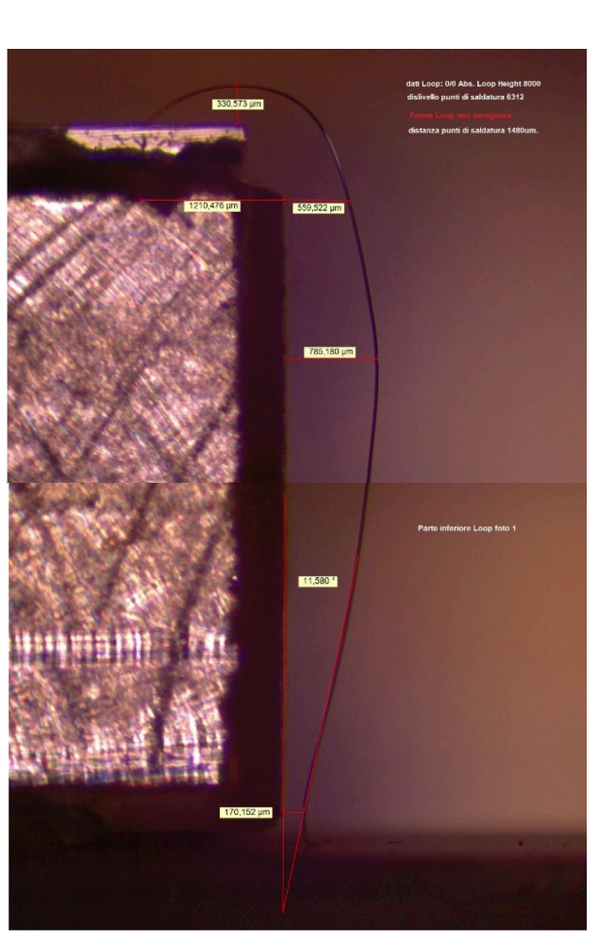
NEWS - 12/03/2021

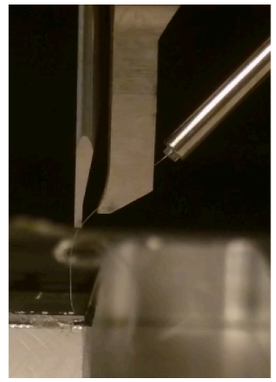


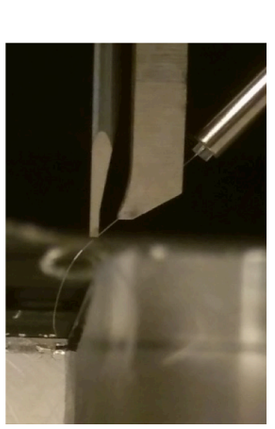


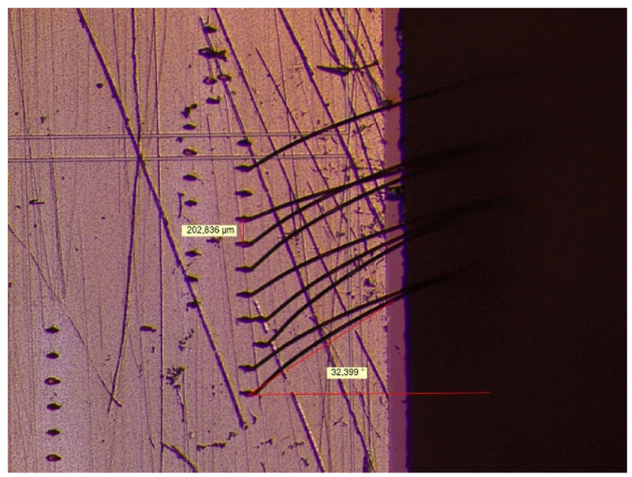
Two configurations explored

1. **FIRST CONFIGURATION**
   - h = ~6,3 mm and C+A = ~2.5 mm
   - bonding from top to bottom
   - Results
     - Very low pull-force: 3,5 grams
     - Deviation angle ~32 degrees
     - High wires touching probability
     - Not homogenous loop shape
2. SECOND CONFIGURATION
   - h = ~6,6 mm and C+A = ~4.6 mm
   - bonding from top to bottom
   - Results
     - Decent pull-force: 8,55 grams
     - Deviation angle ~2 degrees
     - Reduced wires touching probability
     - Loop shape improved

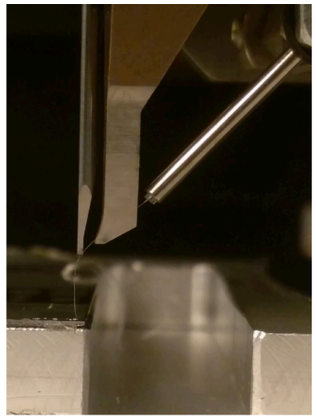


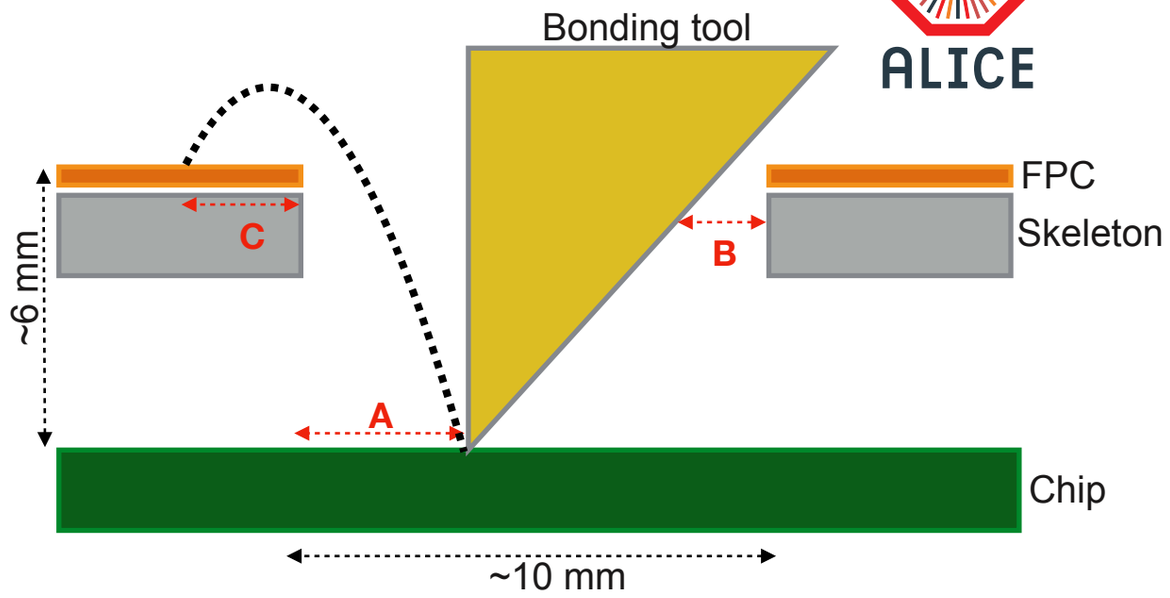






NEWS - 12/03/2021





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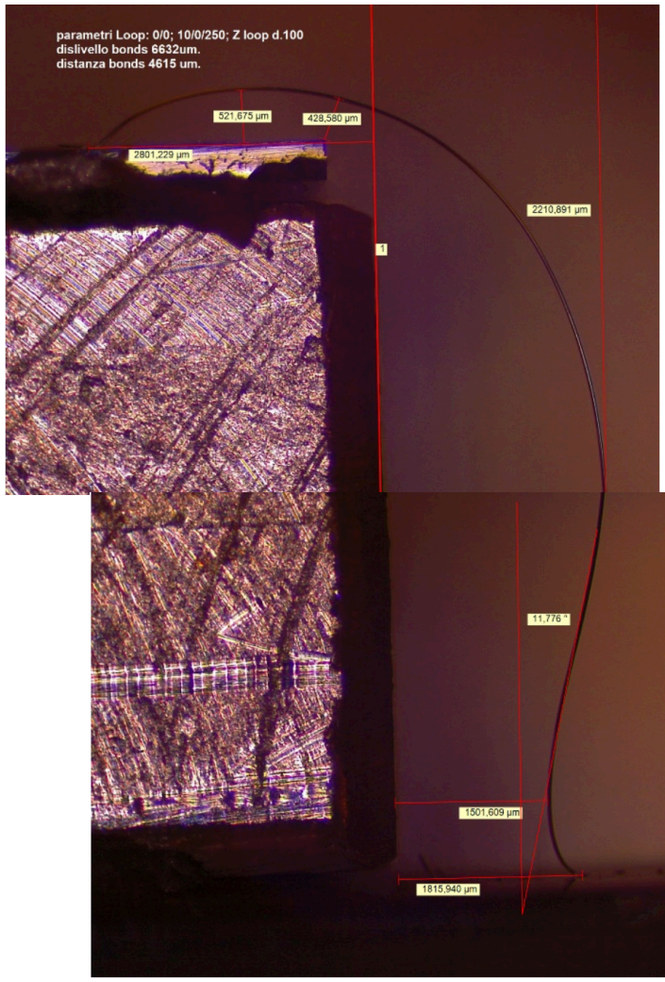
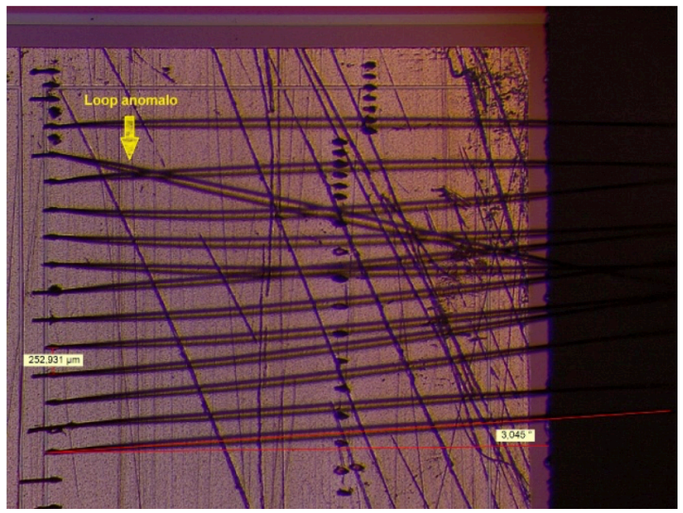
2. **SECOND CONFIGURATION**
   - h = ~6,6 mm and C+A = ~4.6 mm
   - bonding from top to bottom
   - Results
     - Decent pull-force: 8,55 grams
     - Deviation angle ~2 degrees
     - Reduced wires touching probability
     - Loop shape improved

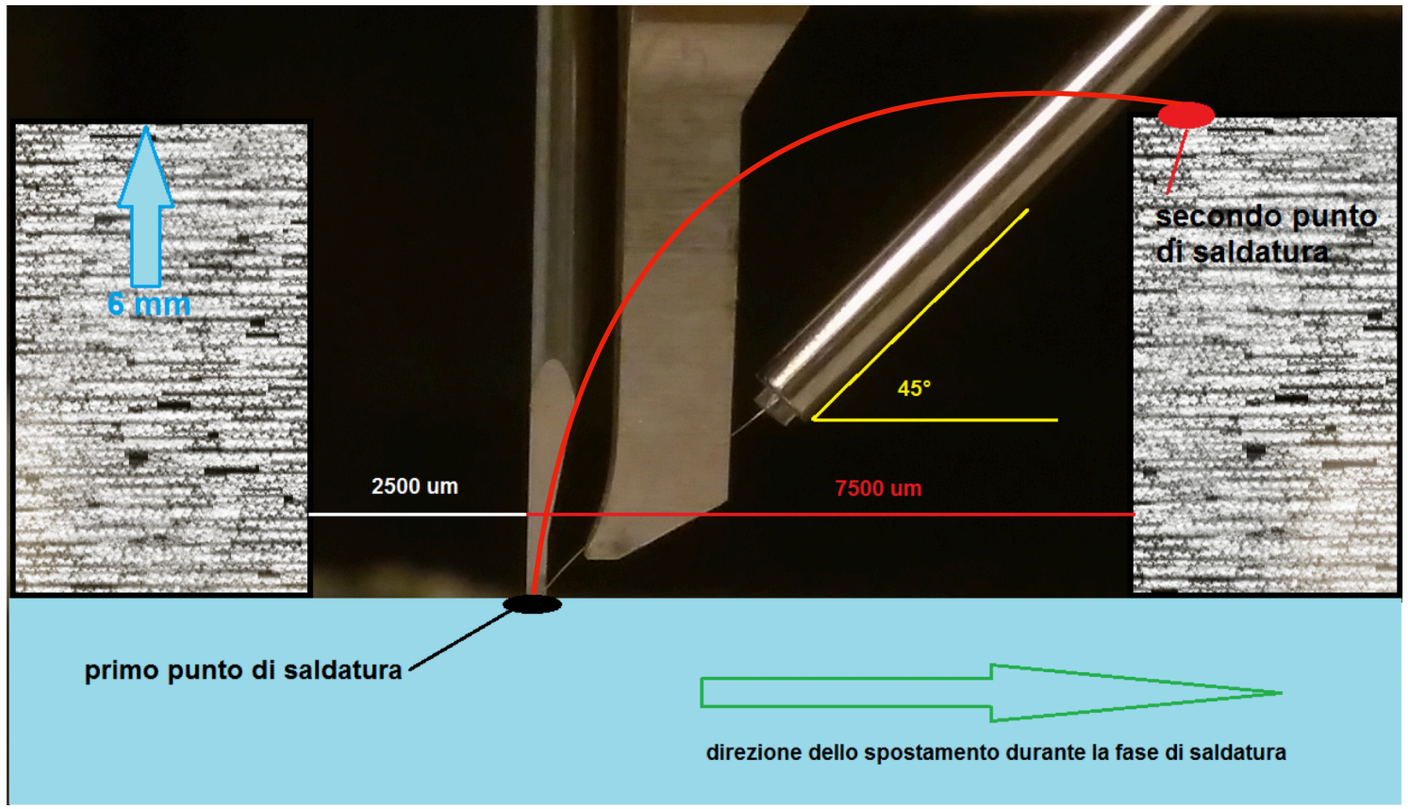




NEWS - 12/03/2021

Next tests

1. Try bonding from bottom to top with large distance from skeleton edge
   - the 45 degrees wire dispenser tool allow a minimal distance from the skeleton edge of ~7,5 mm
   - here the wire is released while the head is moving reducing uncertainty on the wire positioning and reducing the stress on the bonding feet
   - limitation from the maximal wire extension of 10 mm (is this still true??)
2. Procure a 60 degrees wire dispenser tool
   - would allow to reduce the minimal distance from the edge
3. Try to increase the height to ~8 mm
   - Magnus desire to stay as close as possible to the real detector mechanical support dimensions



NEWS - 25/02/2021

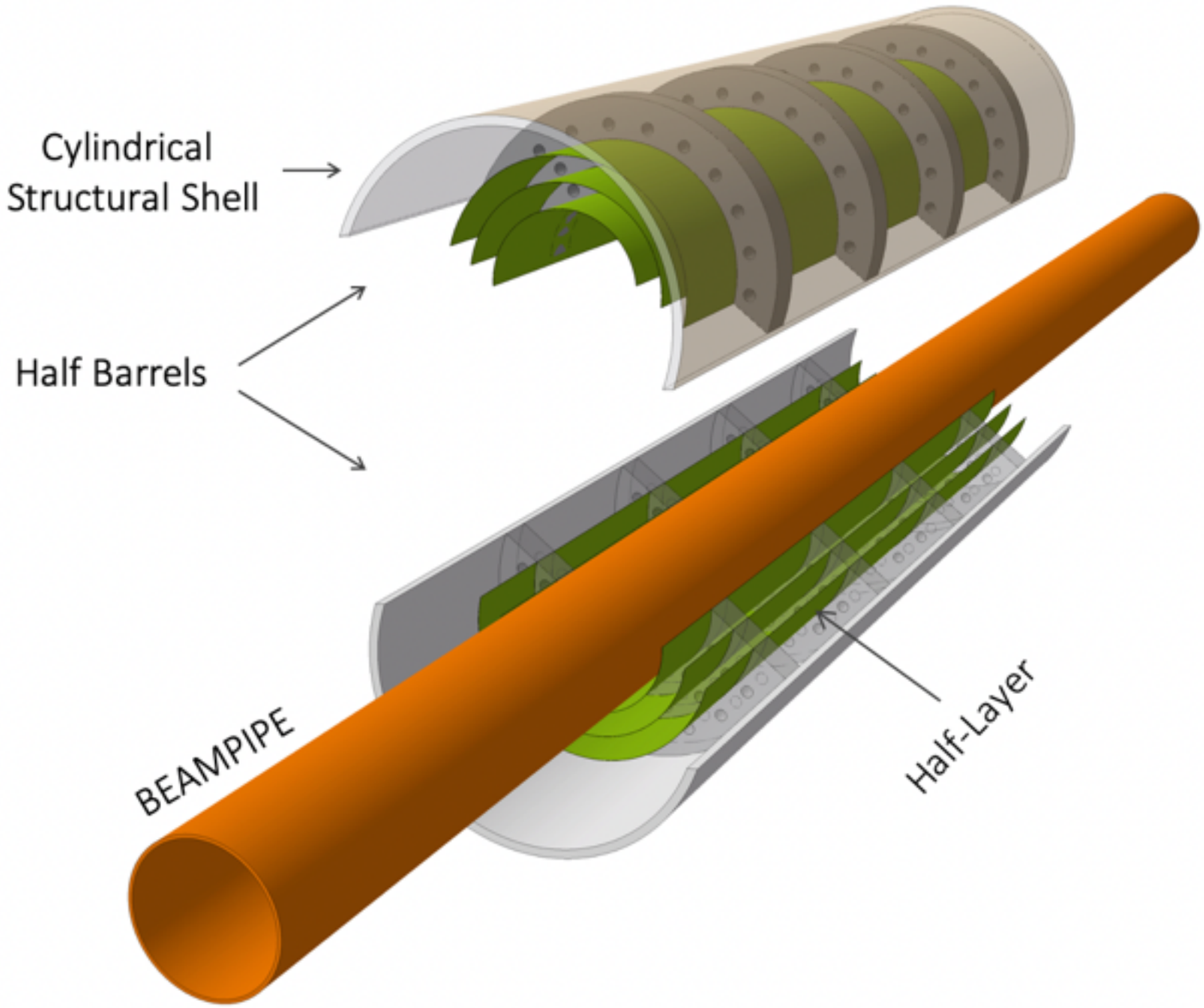
<u>SINGLE CHIP TEST</u>

1. ALPIDE 50 um received
2. FPC single chip production request submitted
3. Cylinder for bending under design (Vincenzo)
4. No specify tool for bending, but Mylar foil as done in Strasbourg
5. DAQ board connector purchase submitted

<u>SUPER-CHIP FPCs</u>

7. First internal meeting on Friday
8. New bonding test from Monday (Pasquale)
9. Skeleton FPC
    A. Large pads usage preferable
    B. Doubts reported to Magnus → No reply
10. Focus more on the edge FPC

NEWS - 16/02/2021



NEWS - 16/02/2021

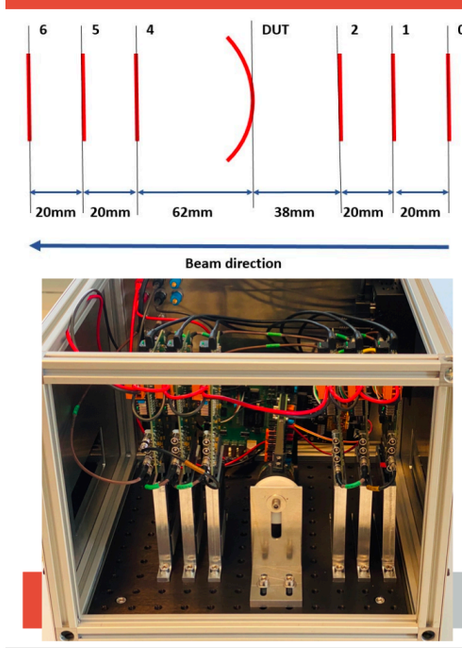
1. WP3
   - August 2020 Test beams data analysis
   - Single chip (ALPIDE 50 um) verification
2. WP4
   - Single chip bendable FPC
   - Pull-force study for wire-bonding
   - Super-chip (ALPIDE) mechanics/FPC design
   - Final chip mechanics/FPC design

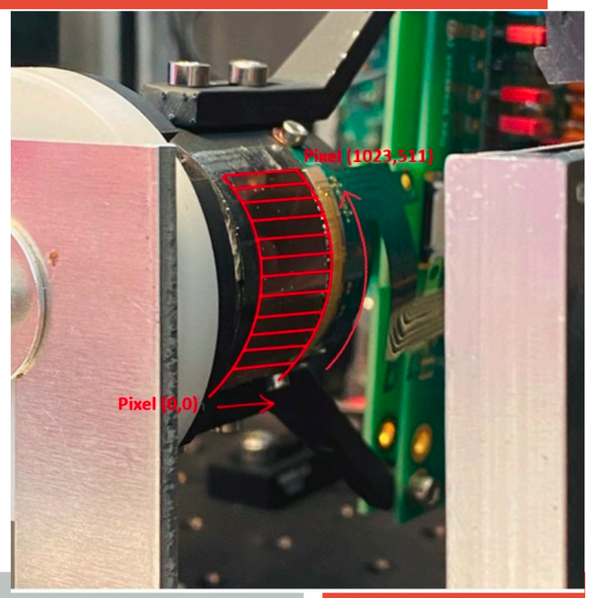
NEWS - 16/02/2021

WP3 - Test beams analysis

Presentation by Arianna at WP3 meeting on 12/01/2021:
https://indico.cern.ch/event/991234/contributions/4175356/attachments/2169191/3662129/preliminary_analysis_v3.pdf

Setup and DUT orientation

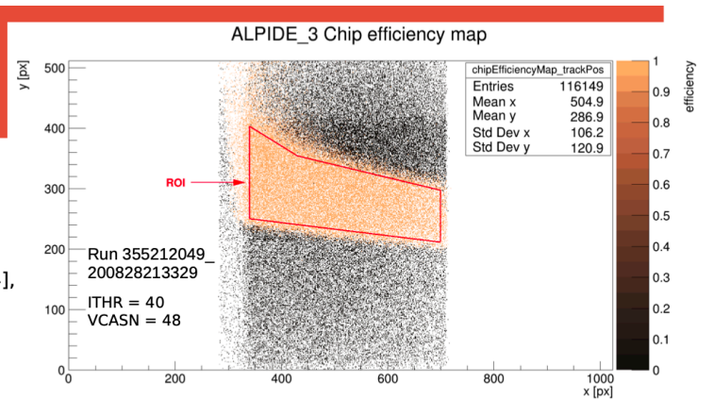


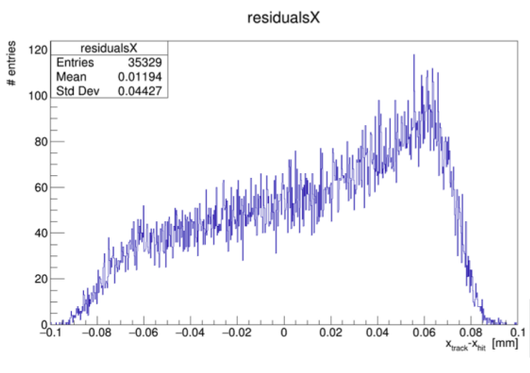


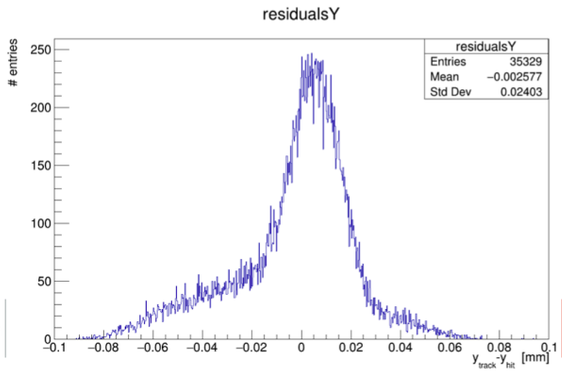
Region of Interest

- Polynomial R.O.I.

3REF-C7-3REF.conf
[ALPIDE_3]
roi = [340, 250], [340, 403], [430, 354], [699, 297], [699, 211]







Conclusions:
– geometry/alignment description not enough good
– software (Corryvreckan) needs modification in the management of the geometry (bent chip)
– CERN/Bologna/GSI team will take care of this

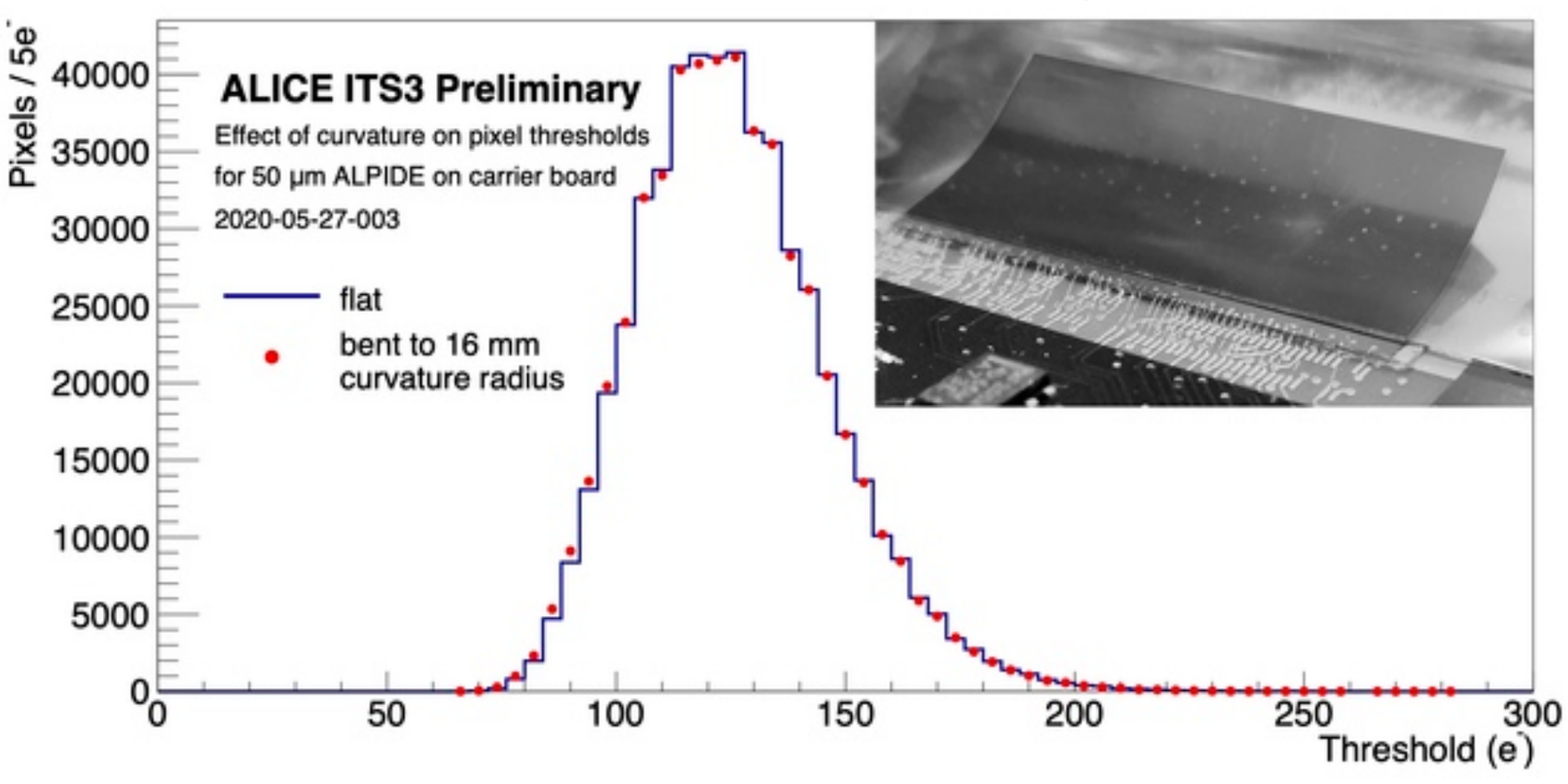
https://twiki.cern.ch/twiki/bin/view/ALICE/ITS3WP3

NEWS - 16/02/2021

WP3 - Single bent ALPIDE characterisation

Goal
– repeat threshold flat/bent chip characterisation
  – useful for Arianna thesis
  – useful for larger chip characterisation

Material
– 50 um ALPIDE chips → Requested
– Bendable FPC → Not available (To be produced, next slide)
– DAQ board (or MOSAIC) → Partially available
– Cables and adaptors → Requested
– Tool for bending + cylinder to hold bent chip → Production in Bari under investigation



NEWS - 16/02/2021

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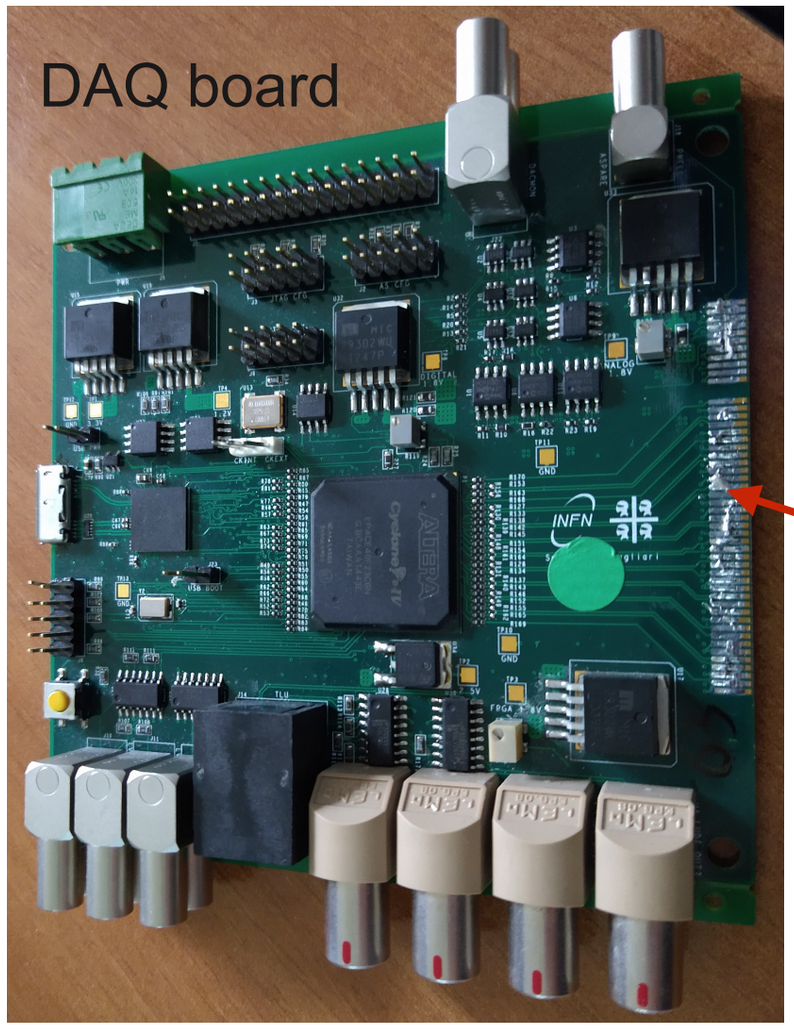
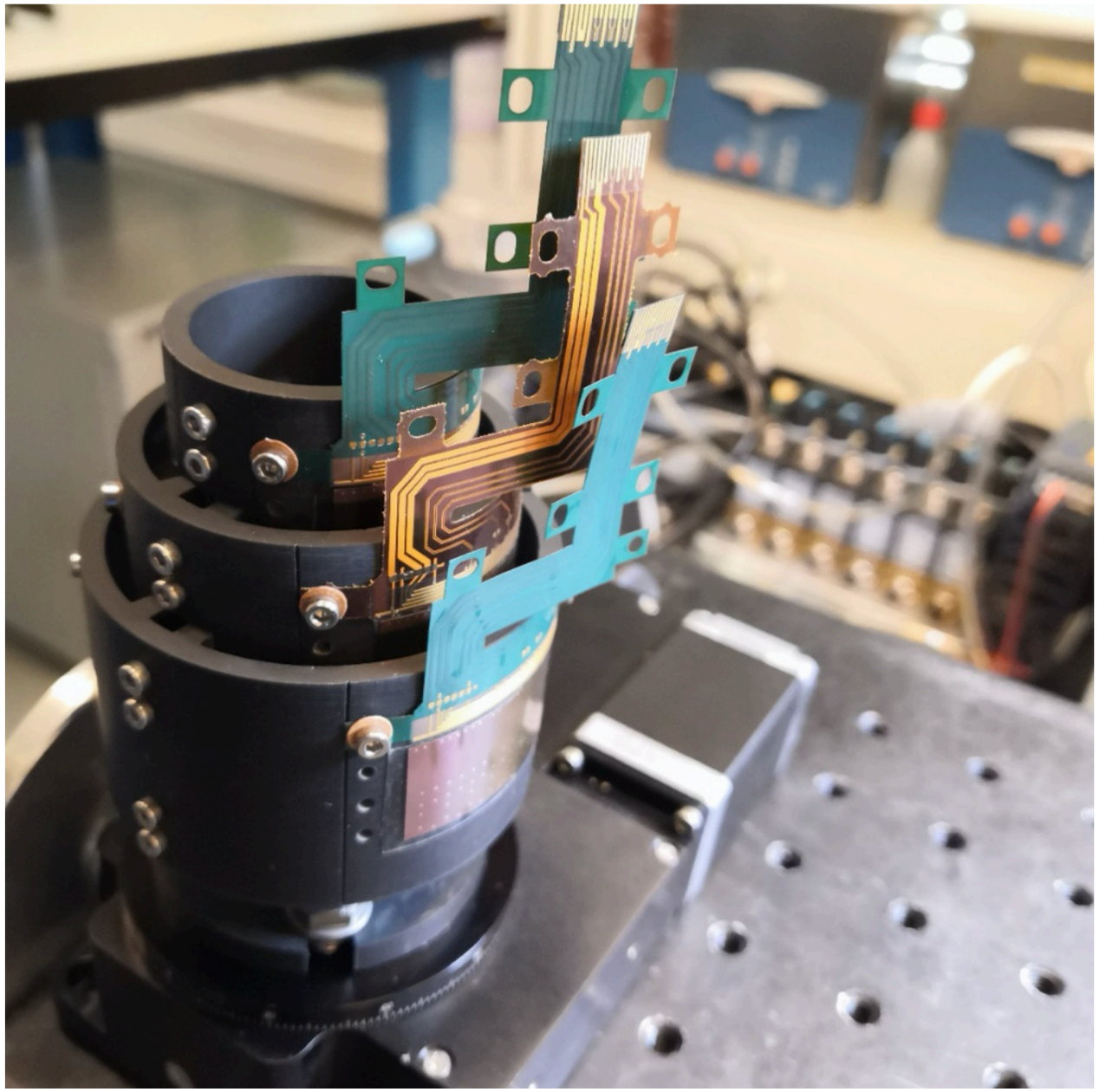


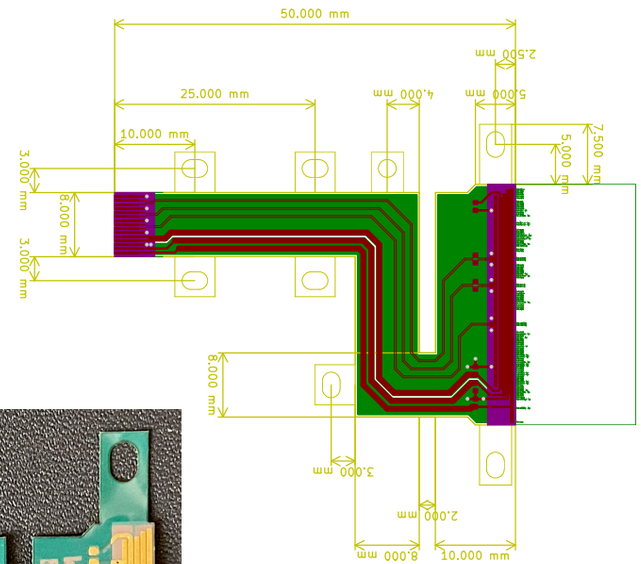
DAQ board:
– Missing connector → G. Usai contacted
– Firmware/Software to be installed
(Alternatively) MOSAIC board:
– Used for single chip usage (Fabio)
– Connectors to be adapted (?)

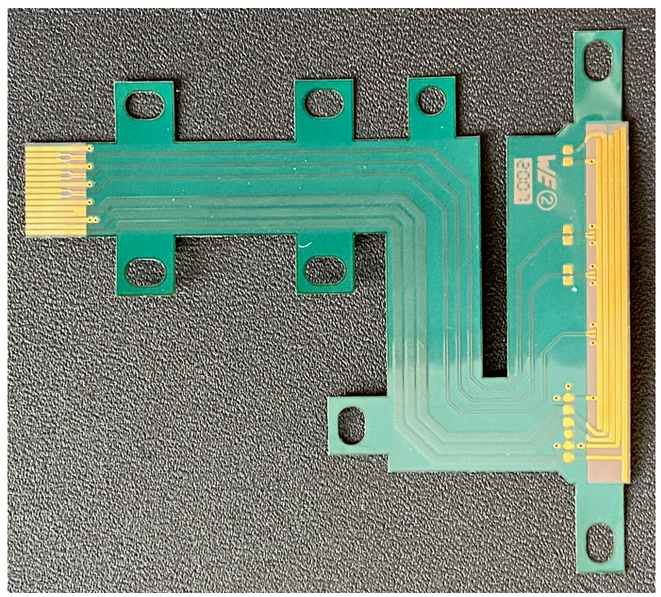
NEWS - 16/02/2021

WP4 - Single chip FPC production



– Used for single chip connection in test beams and lab characterisation
– Not available → to be produced
– Arranging purchase…





NEWS - 16/02/2021

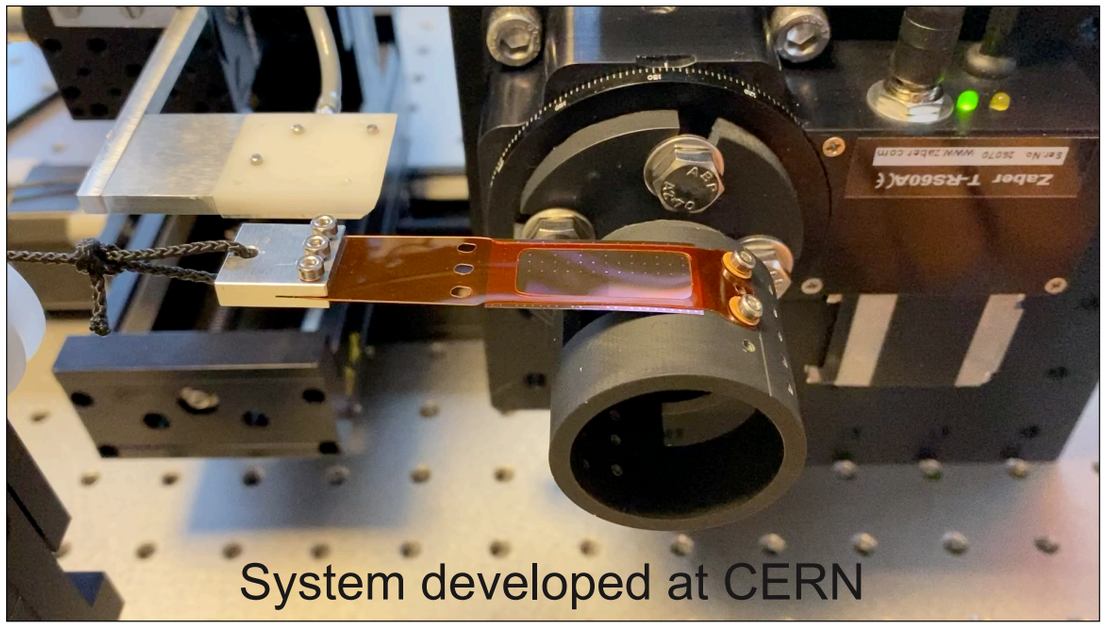
WP4 - Pull force measurement campaign

Goal

1. Systematic study of the wire bonding through pull-force and failure mechanism measurement campaign
   - Bonding after bending
   - Bending after bonding
   - After multiple bending

Tools

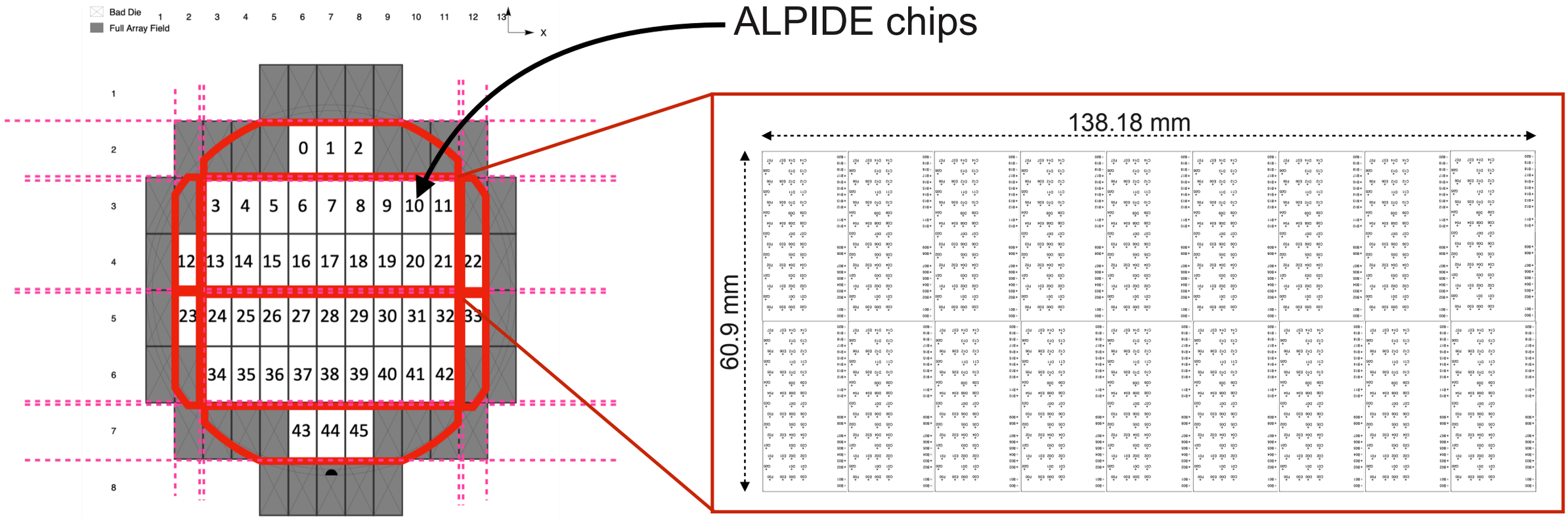
1. Bonding machine → Available
2. Supporting tool for bonding that allow to → Under study
   - bend after bonding
   - bond after bending
   - bend multiple times
3. Pull-test machine → Available
4. Chips (50 μm) [NOT working and working] → Requested
5. FPC → Not available (To be produced, next slide)



System developed at CERN

NEWS - 16/02/2021

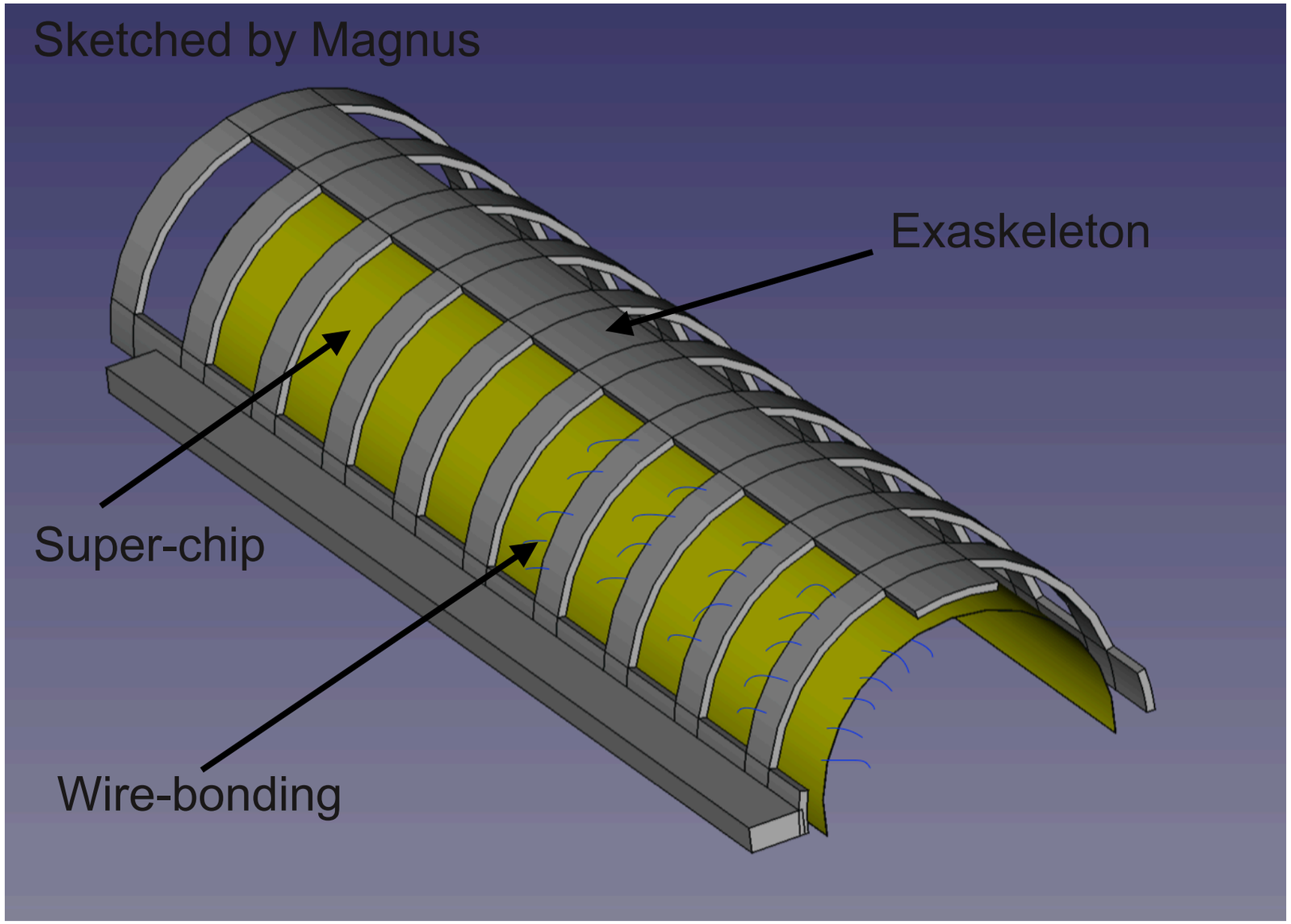
WP4 - Super-chip mechanics/FPC design and production

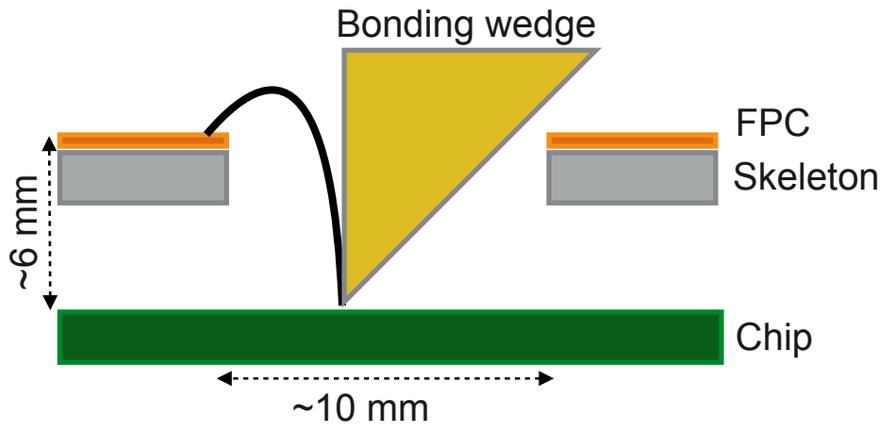


18 ALPIDE chips, as in 2 Inner Barrel ITS2 staves, but different chip orientation

NEWS - 16/02/2021

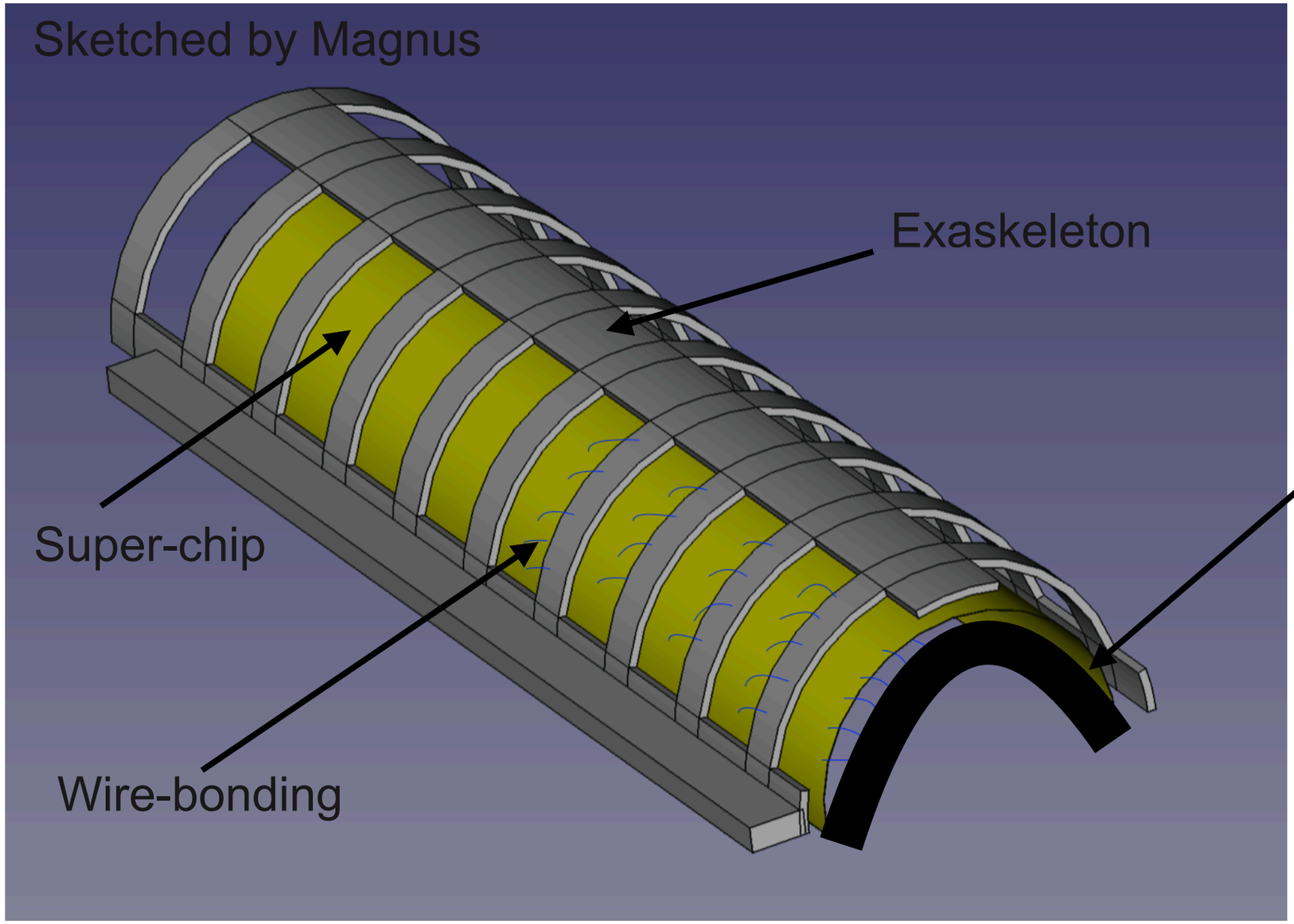
WP4 - Super-chip mechanics/FPC design and production

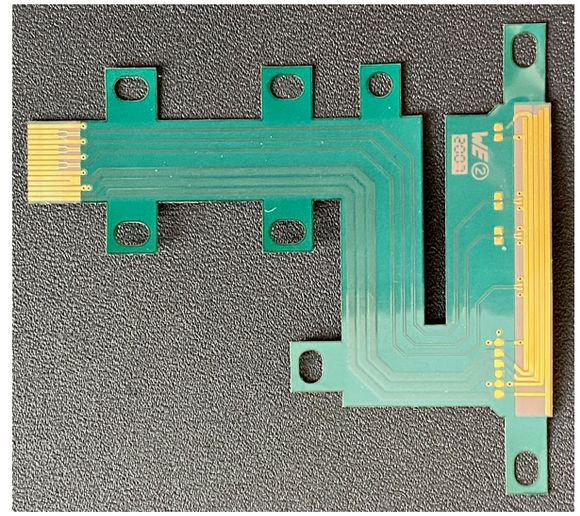




NEWS - 16/02/2021

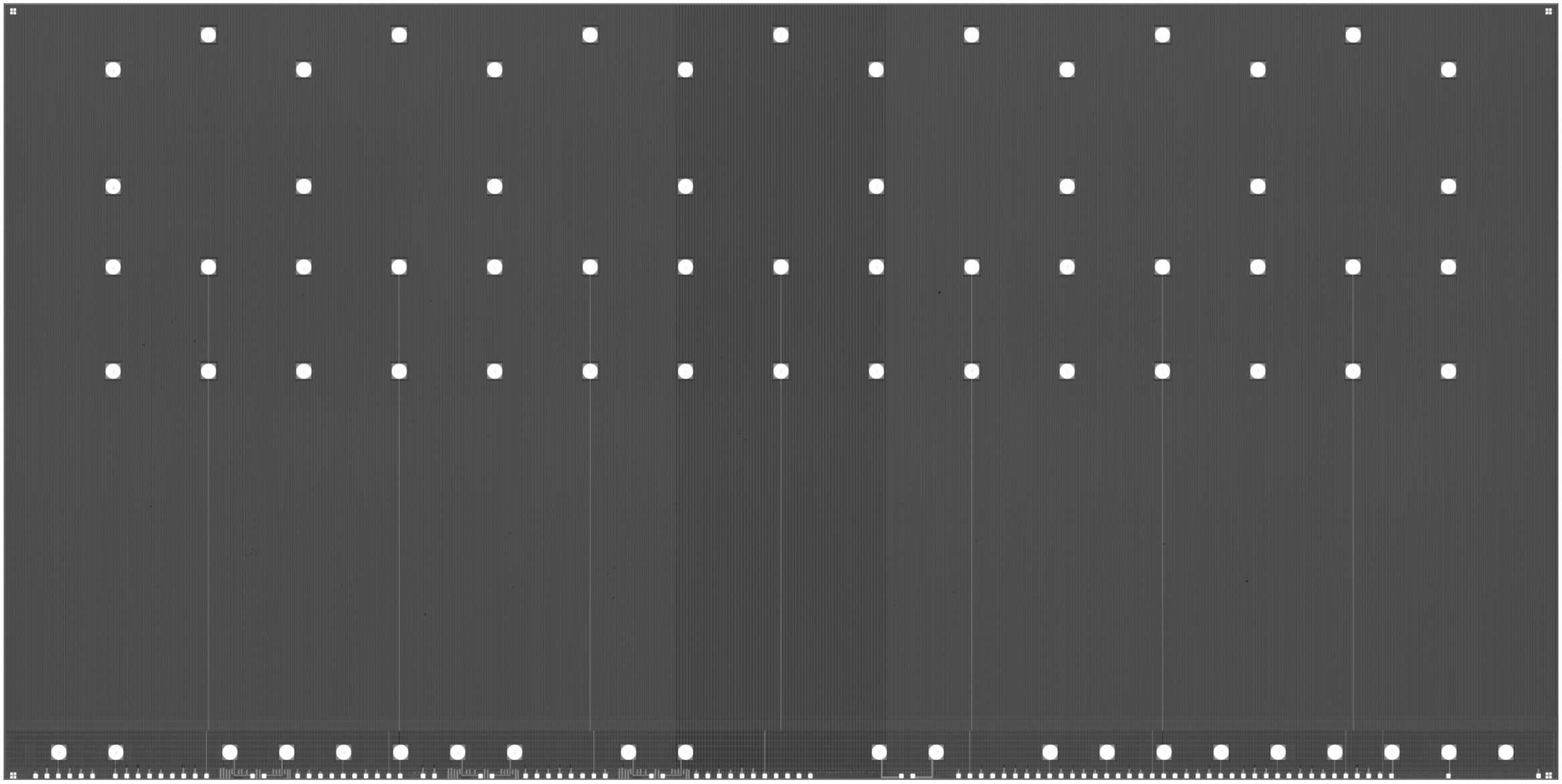
WP4 - Final-chip mechanics/FPC design and production



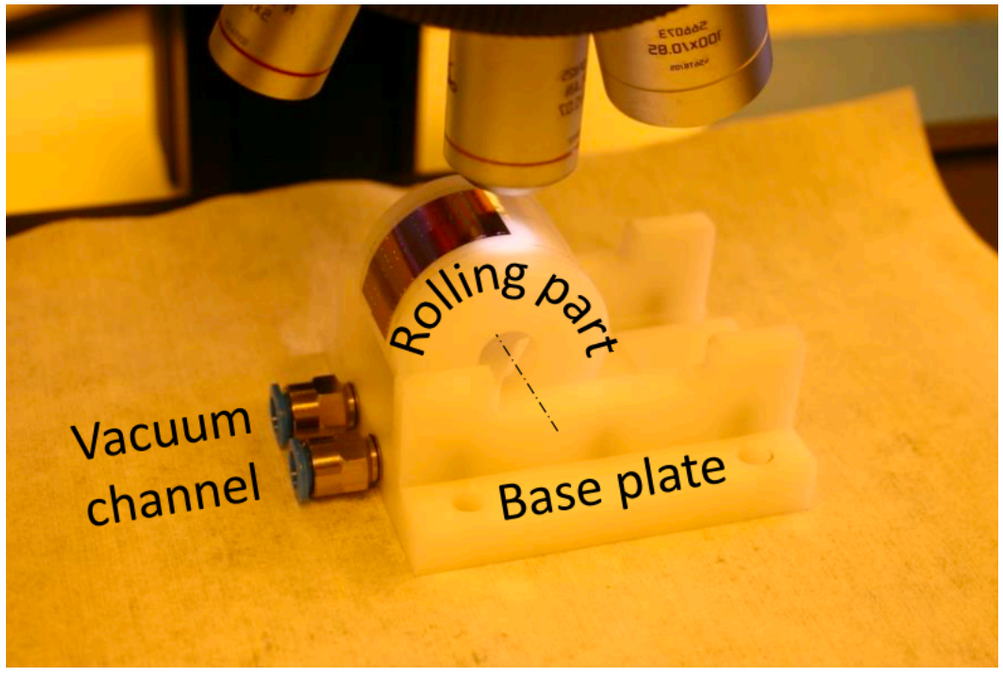


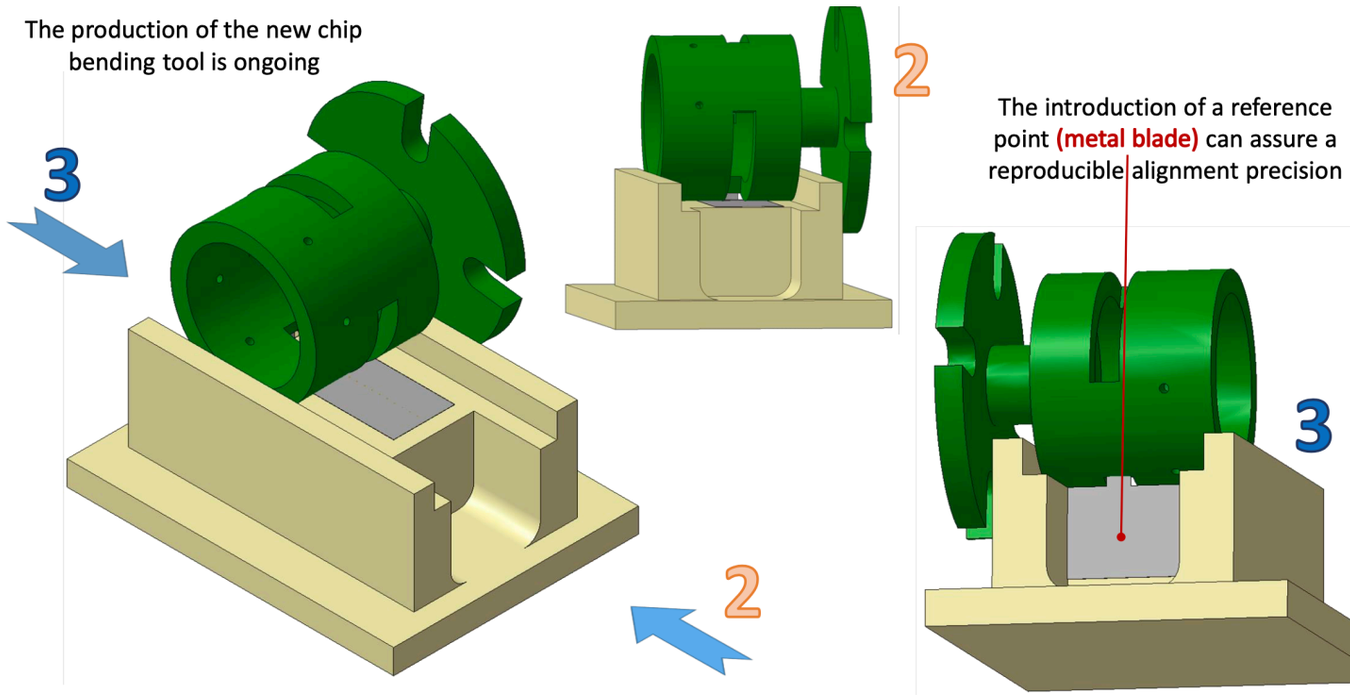
Edge FPC/mechanics
- For the last two chips of the super-chip
- Toward the final chip configuration (only end-of-chip connection)
- Support mechanics design
- Starting design, single-chip FPC

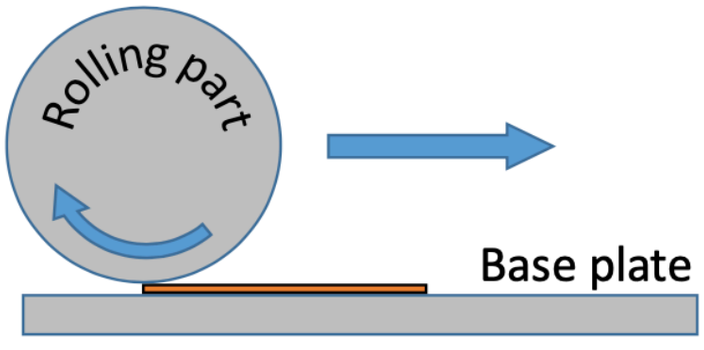
BACKUP



~95 mini-pads


Rolling part
Vacuum channel
Base plate


The production of the new chip bending tool is ongoing
3
2
2
The introduction of a reference point (metal blade) can assure a reproducible alignment precision
3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