RD51 Mini-Week@CERN

CERN electronics assembly workshop services

Sylvain Kaufmann
BE-CEM-EPR
Assembly workshop process engineer

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  - From manual assembly to (almost) fully automated; 15 years of improvement
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- Special assembly capability
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  - Deriving standard process for detectors
  - Manual interconnection

INTRODUCTION AND SHORT HISTORY

Introduction

WHO WE ARE

The internal electronics assembly workshop is currently part of the BE-CEM-EPR section which provides several services to the CERN electronics community

WHERE DO WE COME FROM

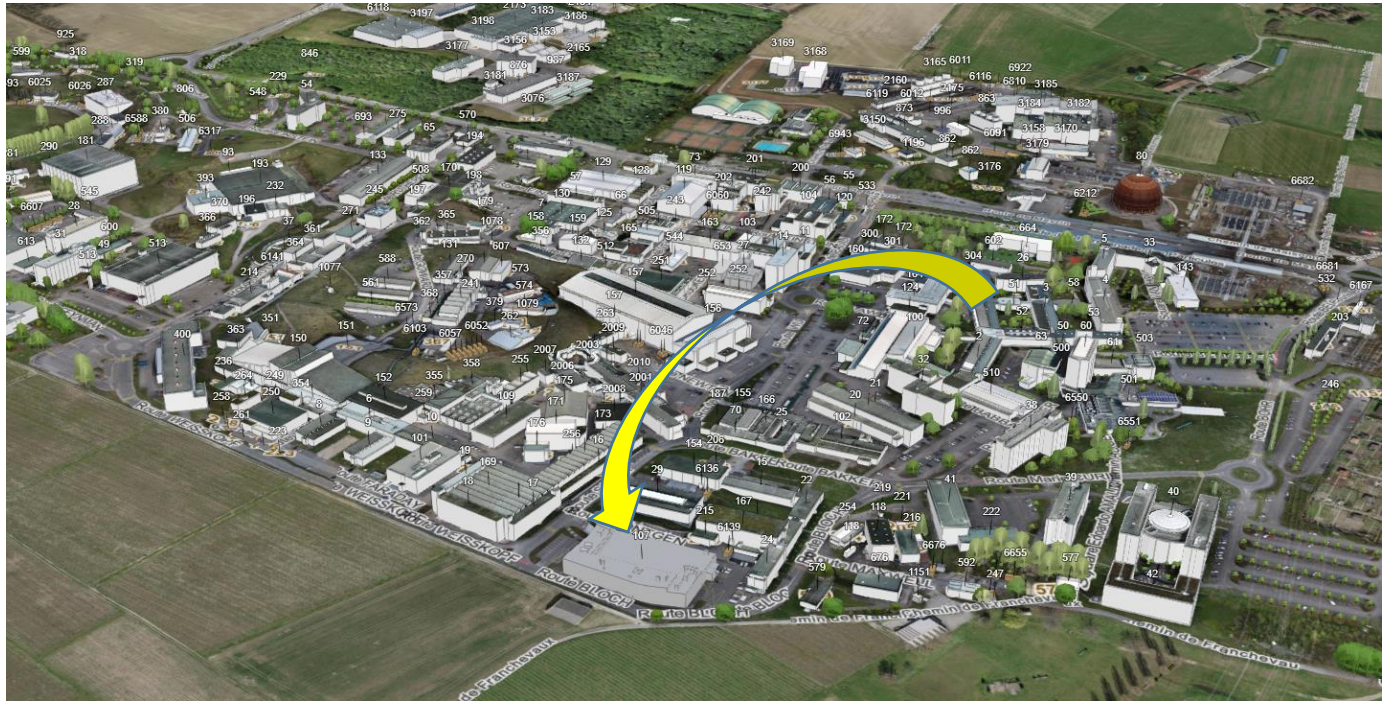
The internal electronics assembly workshop has been part of the overall electronics service which merged during the mid 2000's the PS and PH design offices with the PCB manufacturing workshop from bldg. 102 and the prototype and repair service located in bldg. 1

Introduction

WHERE TO FIND US

In 2018, we hopped from bldg. 1 to the brand new 107 building on CERN Meyrin site

BE-CEM-EPR electronics services are located on “JURA” side of bldg. 107; workshop is on first floor



Short history

BEFORE 2006 : early days

A small team provided manual assembly and rework/repair services on electronics board, as well as crate cabling and small mechanical work

2006-2010 : industrializing processes

While TS-DEM group activity was growing, it was decided to broaden the assembly and repair services offered by deploying industrial processes that cope with SMD assembly requirements

2006: new cleaning machine, solder paste stencil printer, reflow profiler

2008: first pick and place machine

2009: new BGA repair station

2010: new documentation and machine programming software (CAD-to-CAM)

Short history

2011-now : consolidating processes

After the successful implementation of the first “industrial” processes in the workshop, the assembly service turned into an entity capable of fulfilling all assembly requirements from CERN users and worked closely with EP-DT-EF facility for all that relates to detector interconnection

2011: solder paste stencil printing replaced by a jet printing machine, commissioning of a new reflow oven

2016: new cleaning process and machine

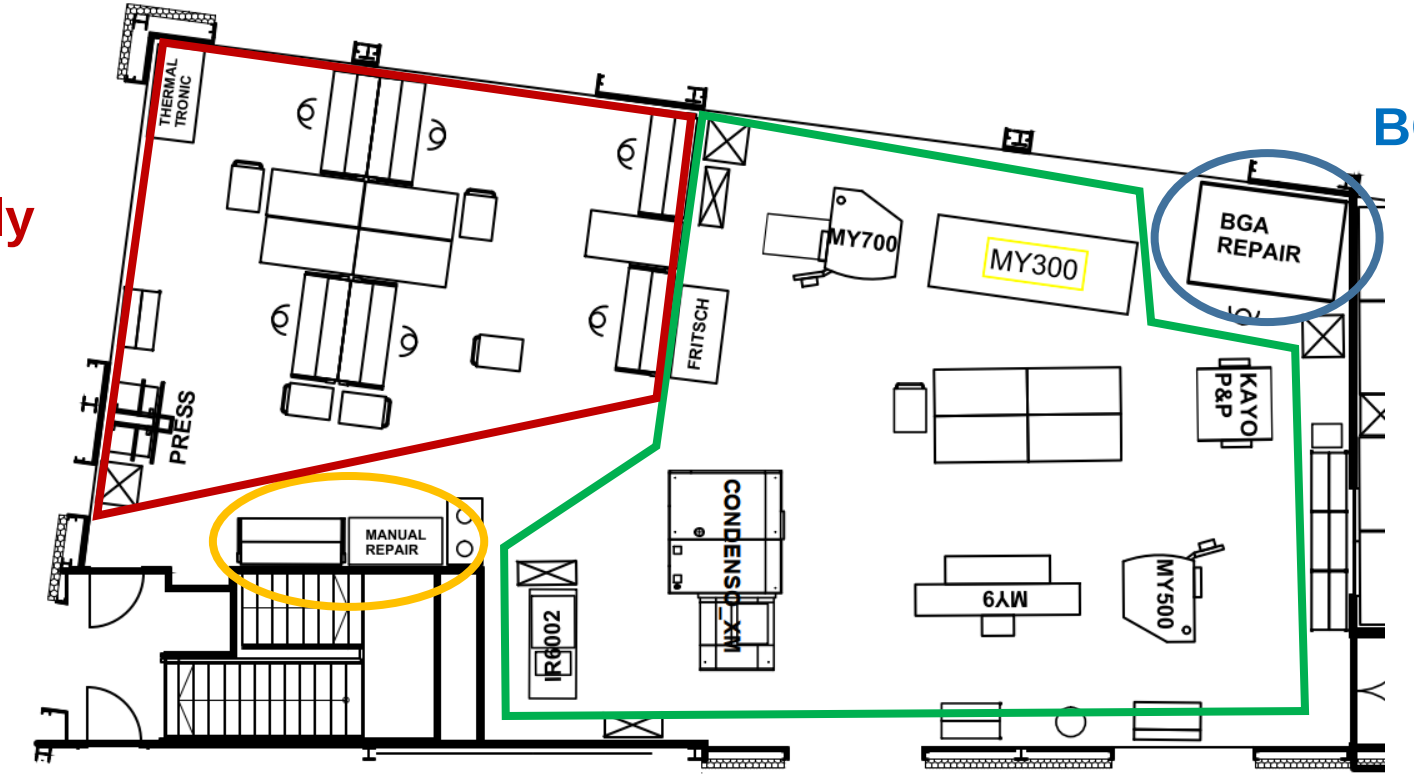
2018: large detectors assembly workplace implemented by EP-DT-EF premises

2020: solder paste jet printer upgrade and new CAD-to-CAM software

2021: pick and place upgrade and complete assembly workshop reorganization

107/1-A10 assembly workshop

Manual assembly



BGA rework station

Manual repair and inspection

SMD assembly area

107/1-A10 assembly workshop

Have a glimpse at the workshop

STANDARD ASSEMBLY AND REWORK

Standard assembly capability

Board size and parts

Automated processes are tailored to accommodate boards/objects with dimensions starting from 50x50mm up to 500x500mm

Passive parts can be handled down to 0201 size and pitches down to 0.4mm

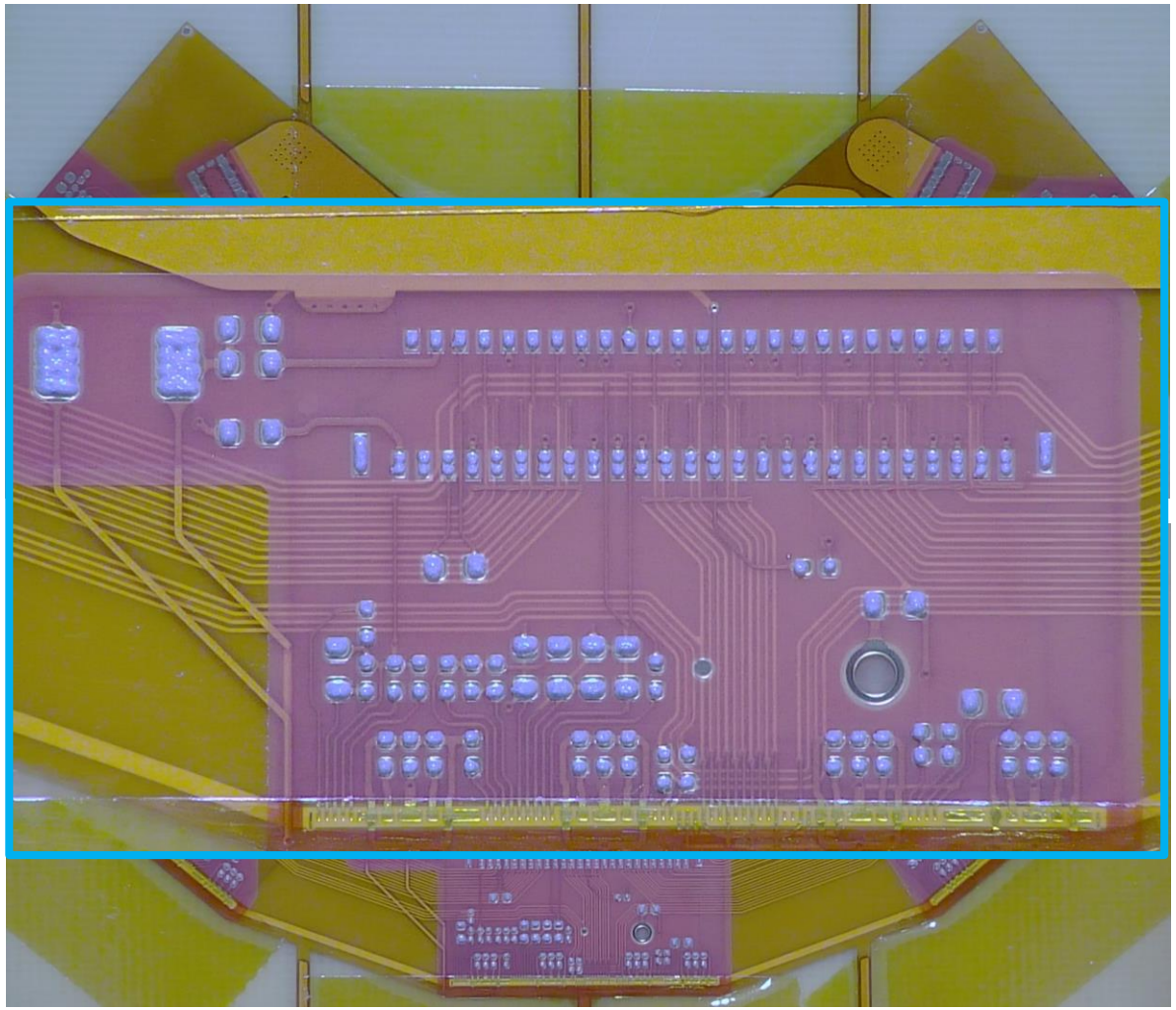
Most parts can be reworked or replaced; currently, the only limitation on the rework is associated with leadless parts that have a pitch below 0.5mm or a really exotic footprint

Standard assembly: solder paste printing

Jetprinting

Max board size: 580 x 1’200mm

Min pattern print: 0.3 x 0.3mm



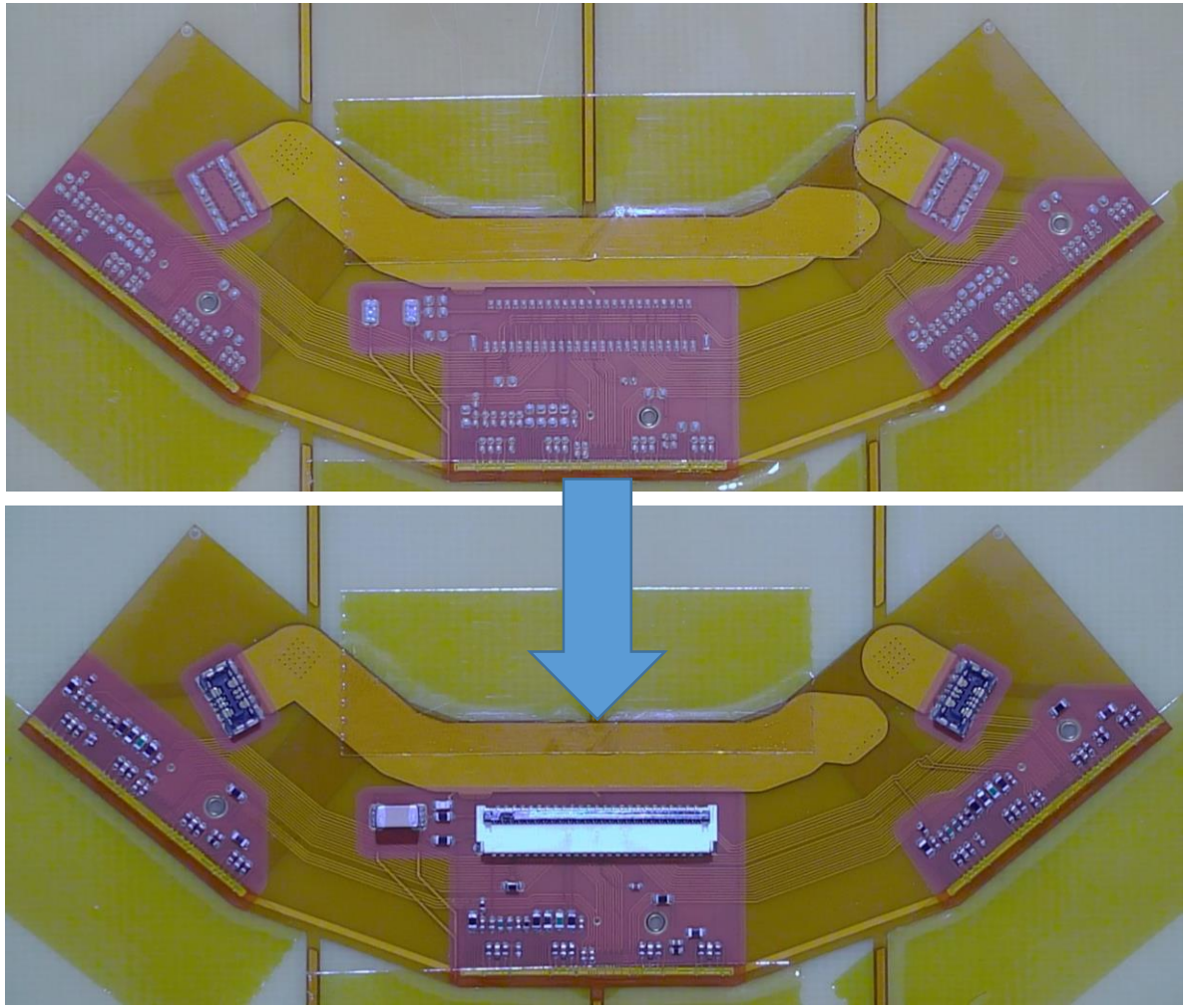
Standard assembly: pick and place

Pick and place

Max board size: 640 x 510mm

Smaller passives: 0201 case

Capacity: ~160 different parts in one setup

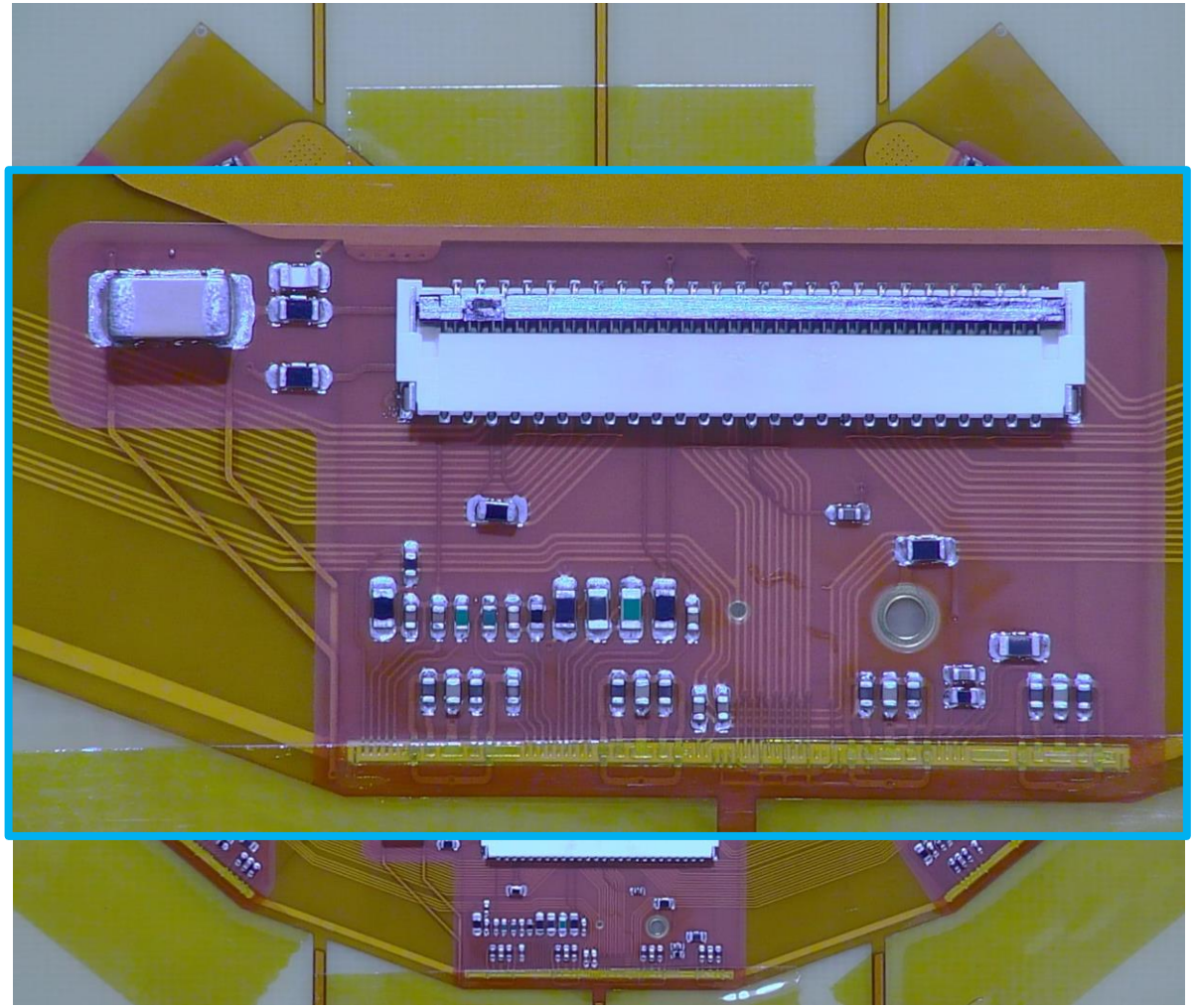


Standard assembly: reflow

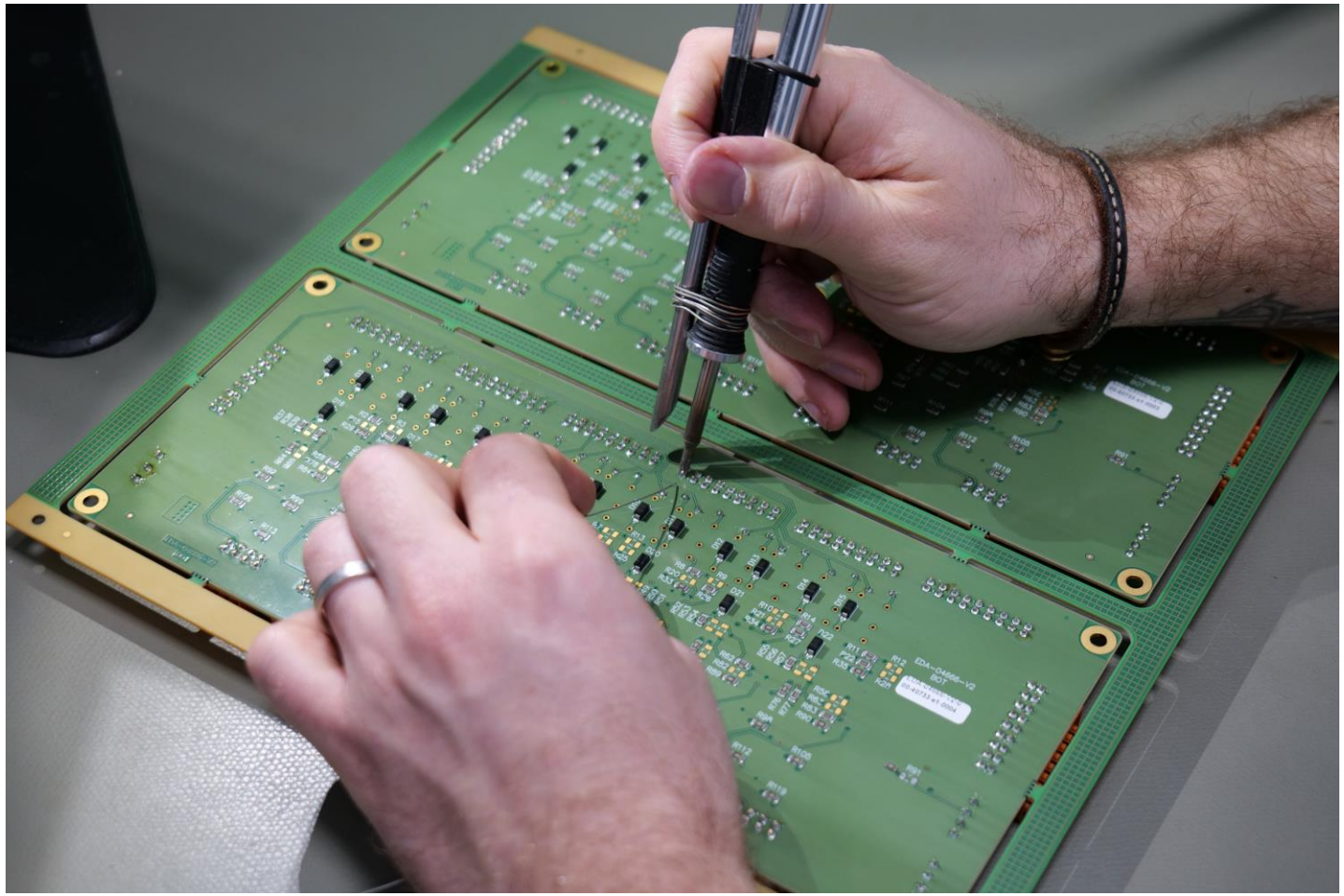
Reflow oven

Process: vapor phase

Max board size: 650 x 650mm



Standard assembly: through hole parts



Through hole soldering

Process: manual

Heavy thermal mass: infrared preheater device

Standard assembly: cleaning

Cleaning

Process: spray in air

Max board size: 500 x 500mm

Cleaning agent: Zestron Vigon PE-180

Capability: flux and other process pollutants removal, wire bonding pads cleaning/preparation, copper oxides removal prior or after soldering

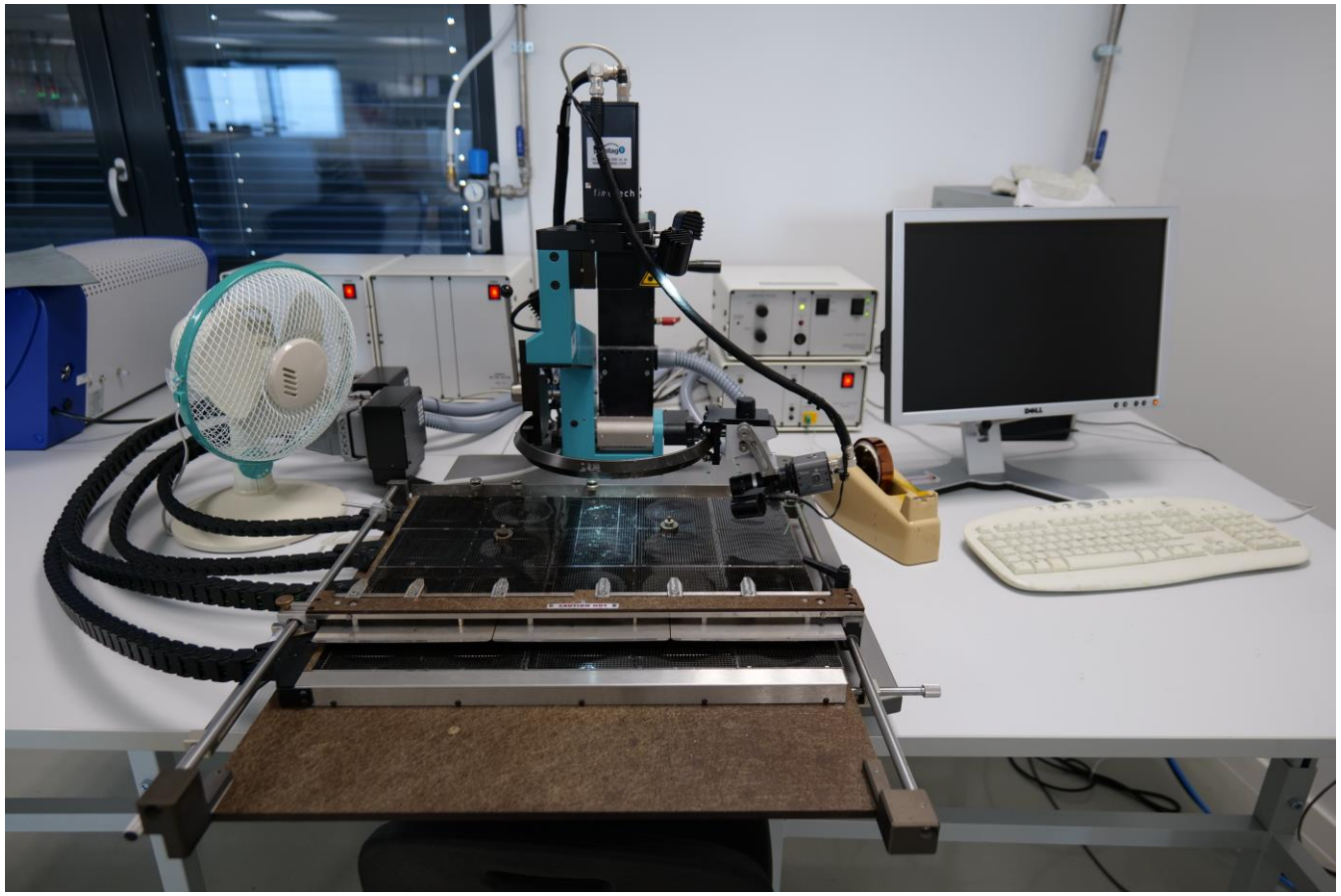
Rework: manual processes

Manual rework

Processes: hot air gun, heated tweezers, desoldering pump, solder paste dispensing

Capability: most standard parts can be removed using one of these tools, except BGA and some leadless connectors

Rework: semi-automated processes



Semi-automated rework

Process: hot air bottom pre-heating, hot air top heating, real time monitoring thanks thermocouple live measurement

Max board size: 450 x 450mm

Capability: BGAs, leadless connectors, other large leadless parts

Also used for some specific process steps where a local reflow only is desirable

SPECIAL ASSEMBLY

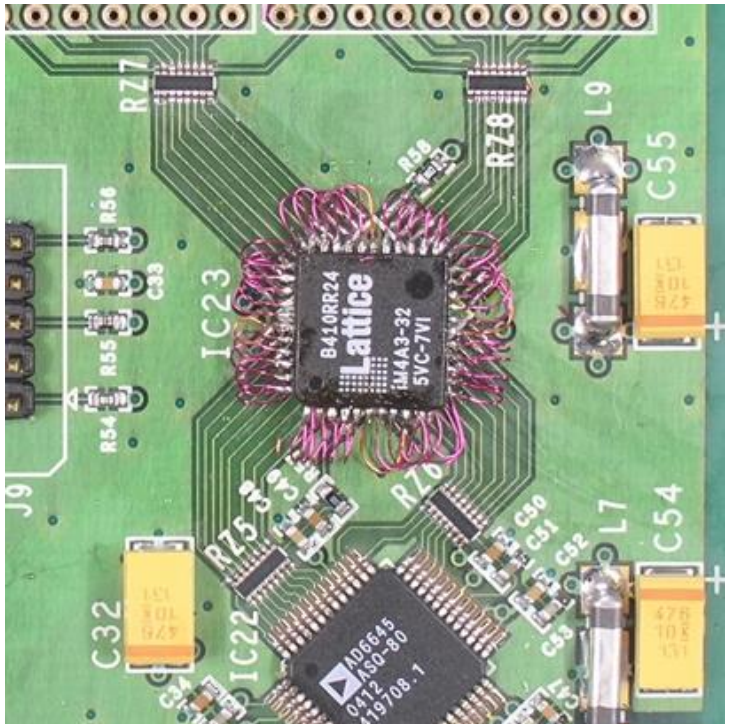
Special assembly capability

Ask anything… we'll give it a try if we can

Over the course of our collaboration with EP-DT-EF, and physics community in general, we have had the chance to derive, adapt, push our process beyond their "official" limits in order to interconnect various species of wire, flex cables or even resistors on 3D objects, on heat sensitive substrates, etc

We have been given the chance to think outside of the box and reconsider what industry calls standard

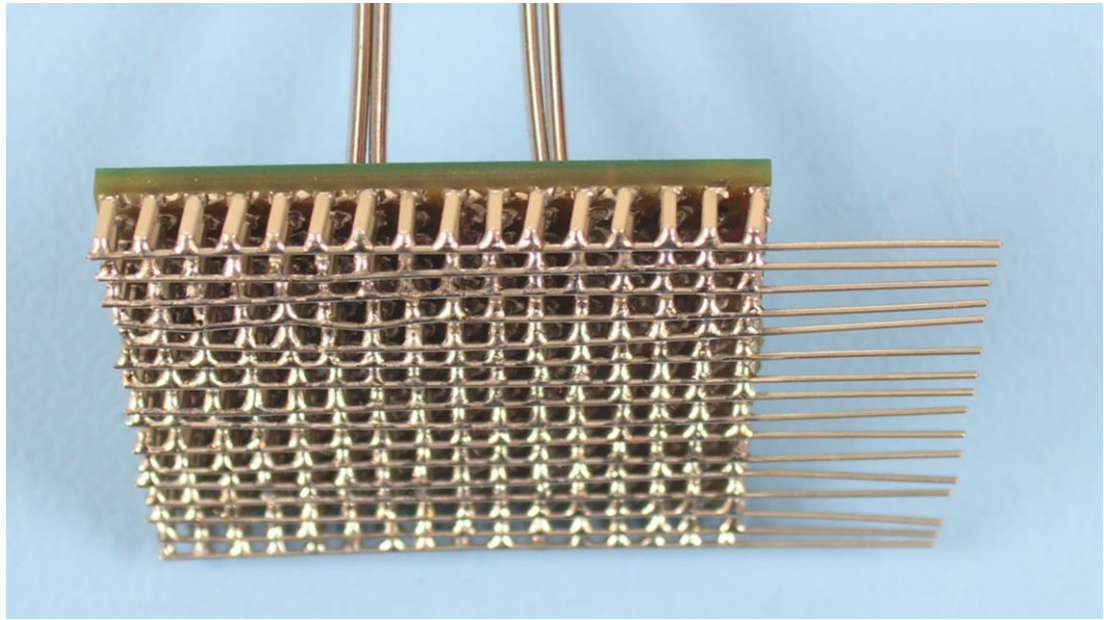
Special assembly examples



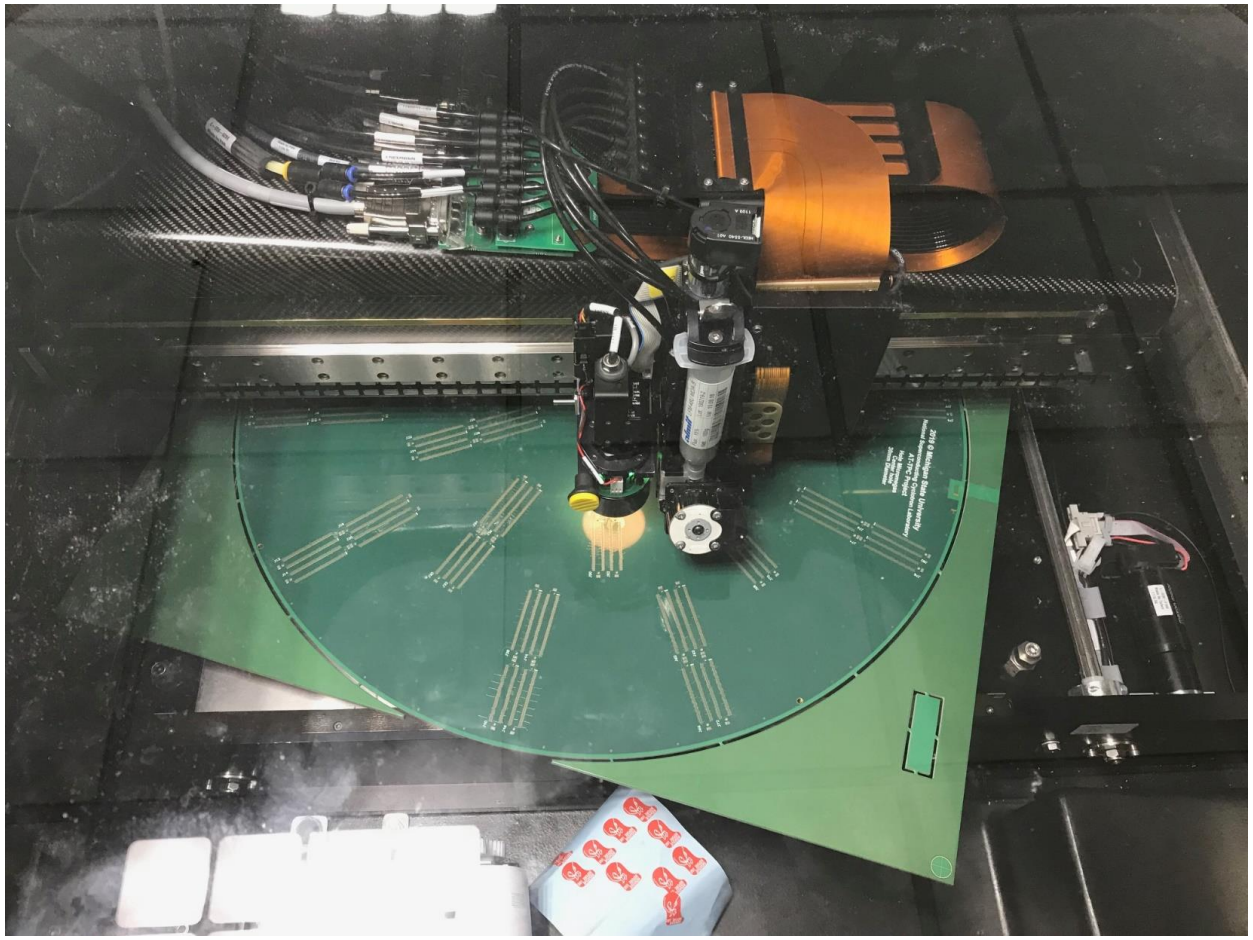
Wrong part footprint? No problem…

“I’d like to have a simple adapter on which capacitors should be soldered vertically and shorted with a wire for a quick test on our experiment. Could you do that?”

“Okay…”



Special assembly examples

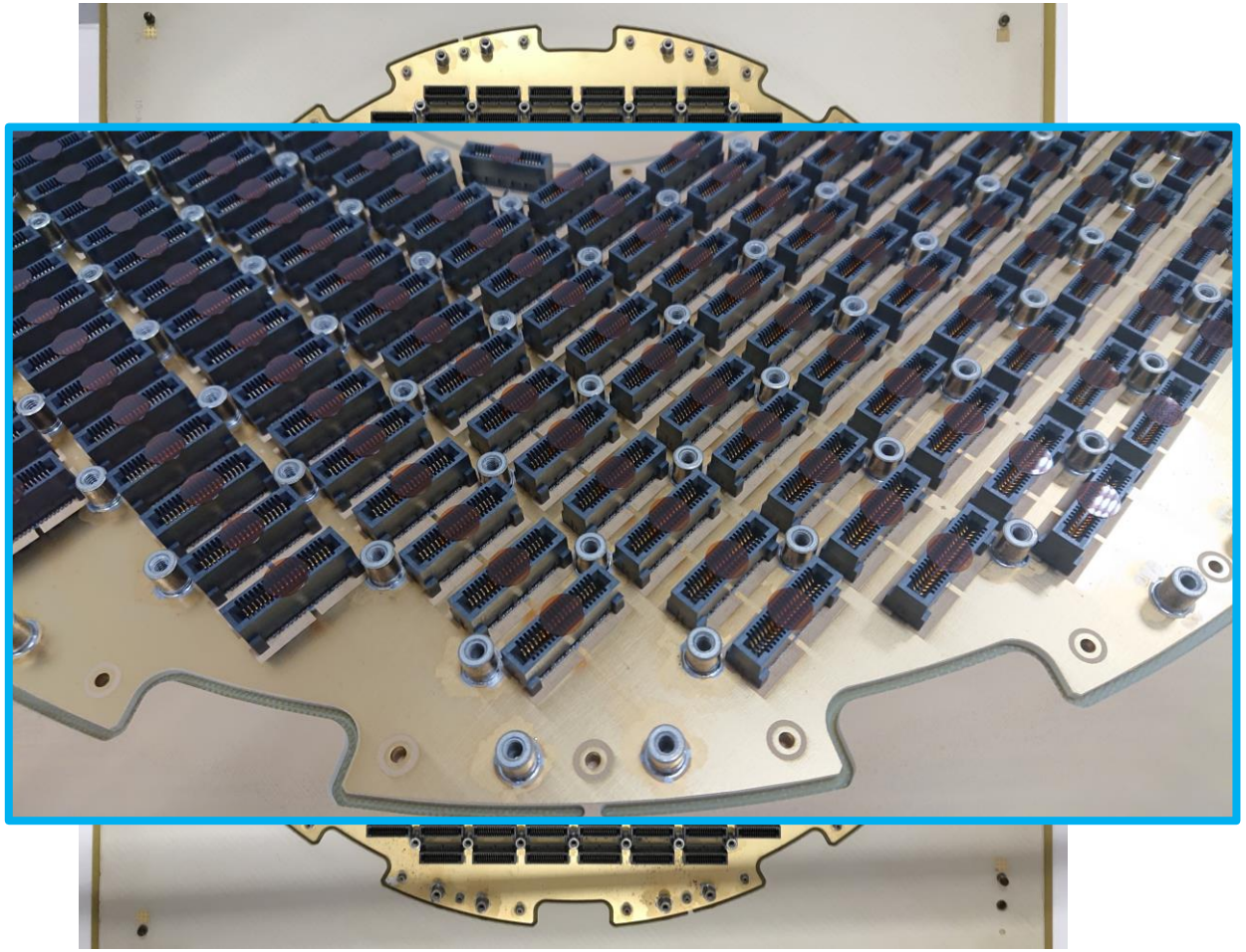


AT-TPC Micromega

Challenge: assembly requiring solder paste printing but too large to fit the conveyor

Workaround: don’t use the conveyor, just sit the assembly on top of it, it should work… (And it did actually work!)

Special assembly examples

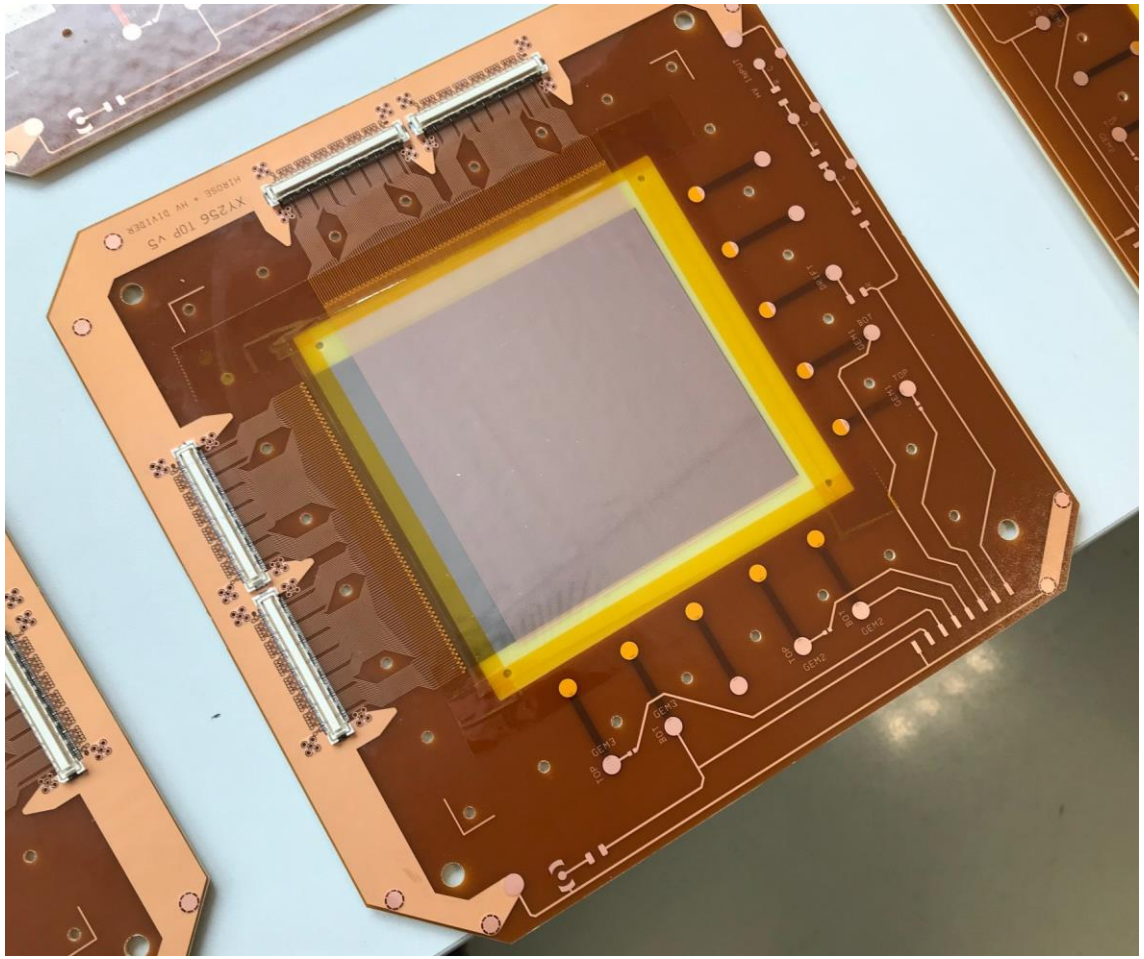


ANODEX2

Challenge: interconnect 12’000+ connector pins with no room for rework (and a bunch of mechanical inserts) on a (very) high value fragile detector

Outcome: longest solder paste printing process for a single board ever done here and two detectors delivered with almost no issue

Special assembly examples



MPGDs and GEMs

Challenge: usually too sensitive to be able to survive reflow oven process and very high value; soldering pads on detector are bare copper (oxidation to be managed)

Workflow: manual assembly by specially trained and experienced operator; if the detector is significantly large (>500 x 500mm), we use the dedicated assembly workbench by EP-DT-EF premises in order to avoid unnecessary handling of the object

Contacts

BE-CEM-EPR electronics services contacts

Section leader: Salvatore Danzeca (63227/167579 salvatore.danzeca@cern.ch)

Team leader: Raphaël Berberat (71887/164181 raphael.berberat@cern.ch)

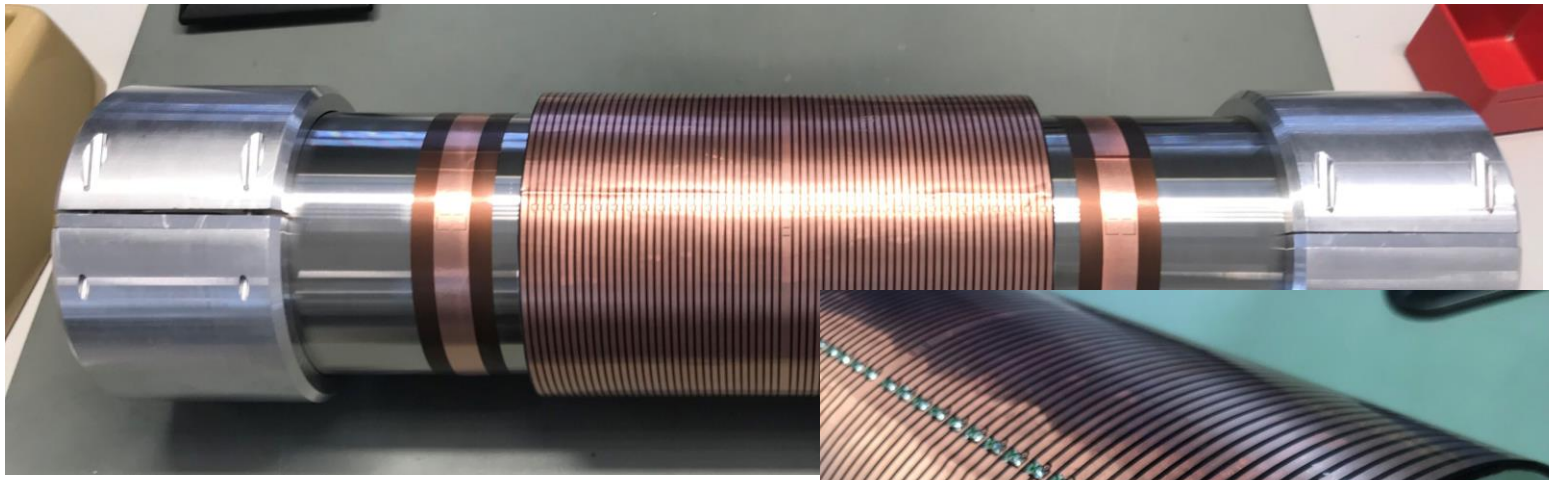
Assembly workshop: Sylvain Kaufmann (73702 sylvain.kaufmann@cern.ch)

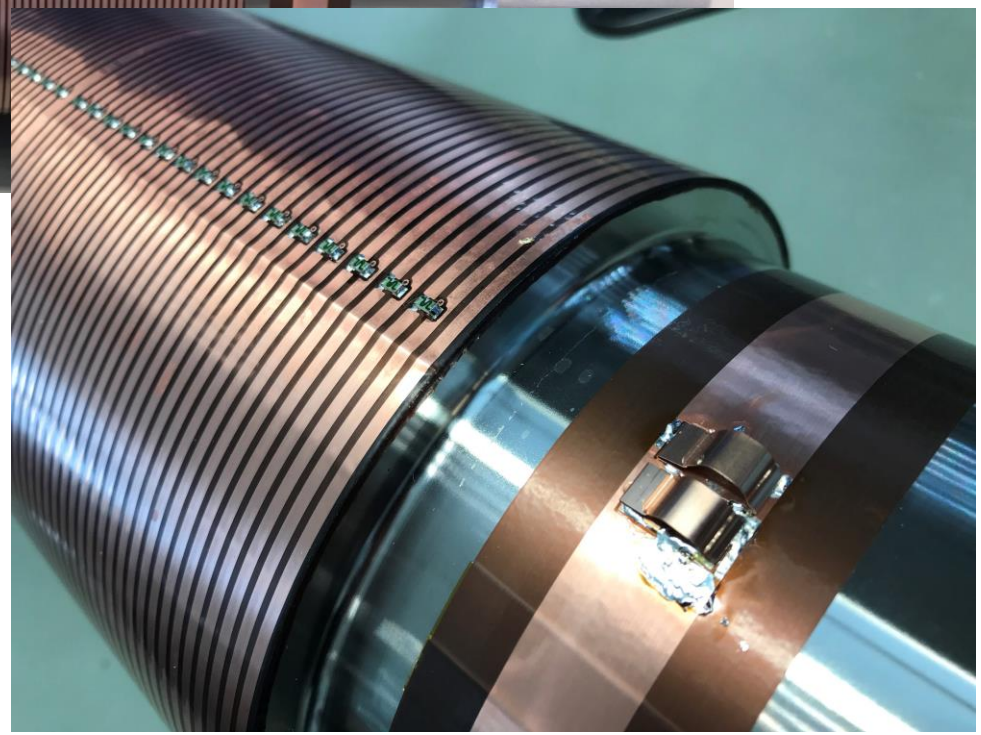
Other resources (CERN login required):

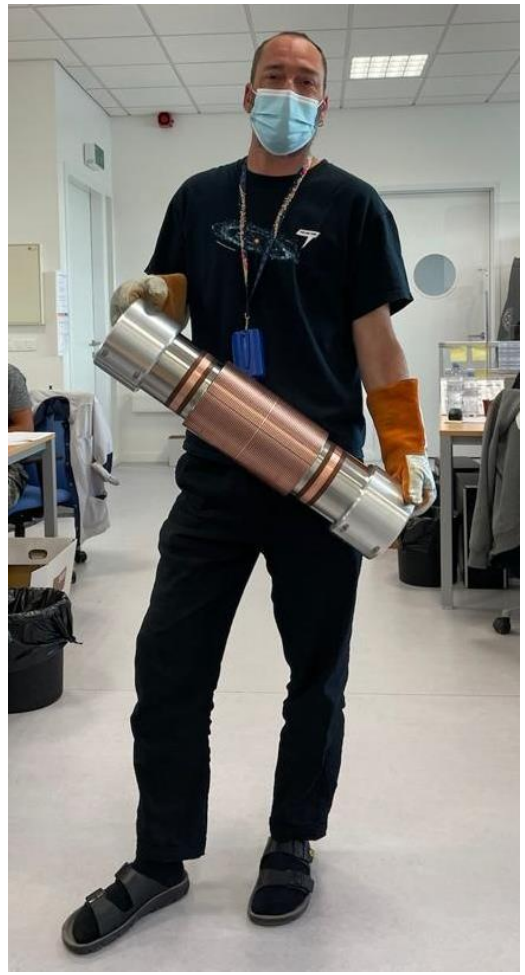
https://twiki.cern.ch/twiki/bin/viewauth/ElectronicModules/WebHome

Thank you for your attention!

Backup slide – TPC





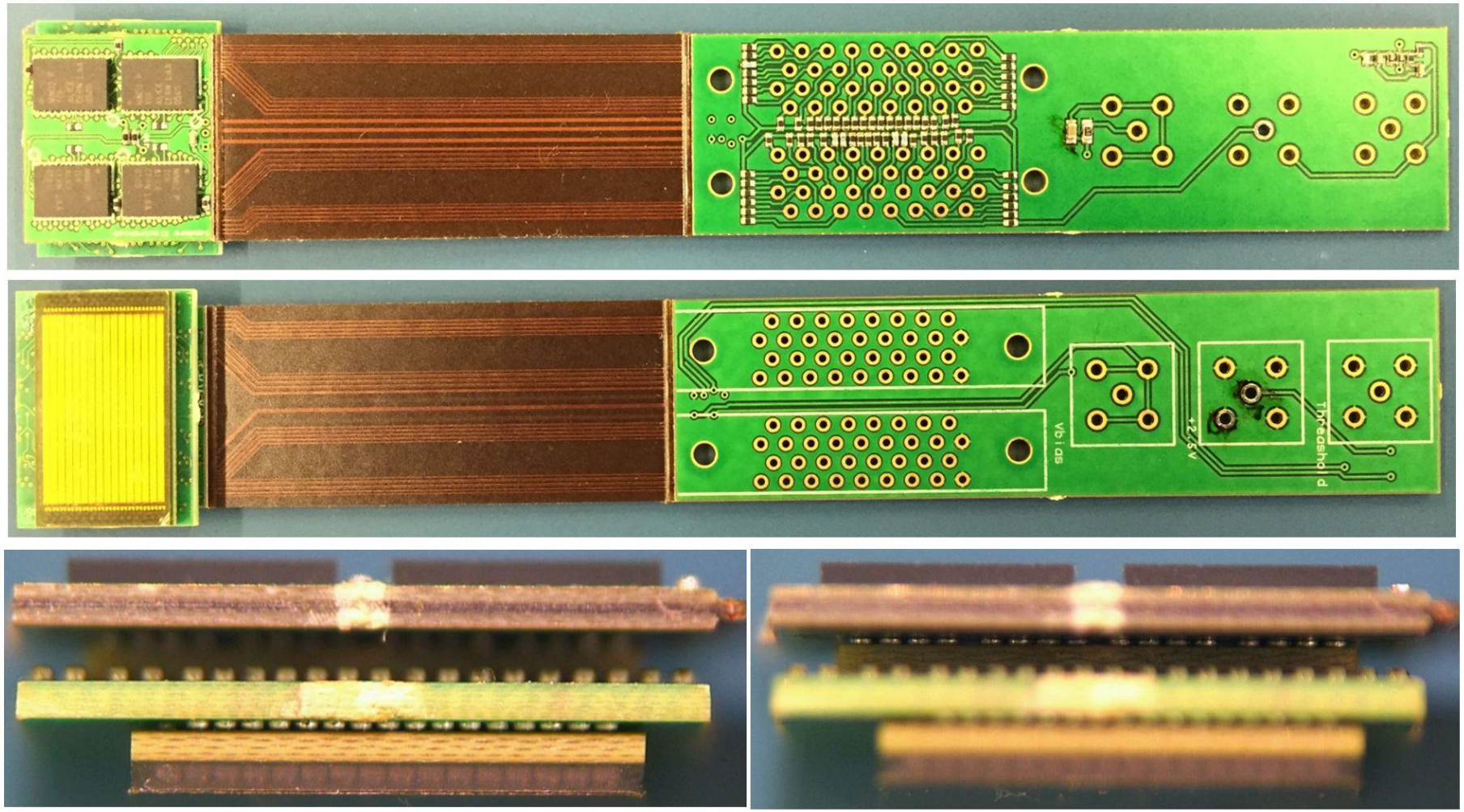


3D objects

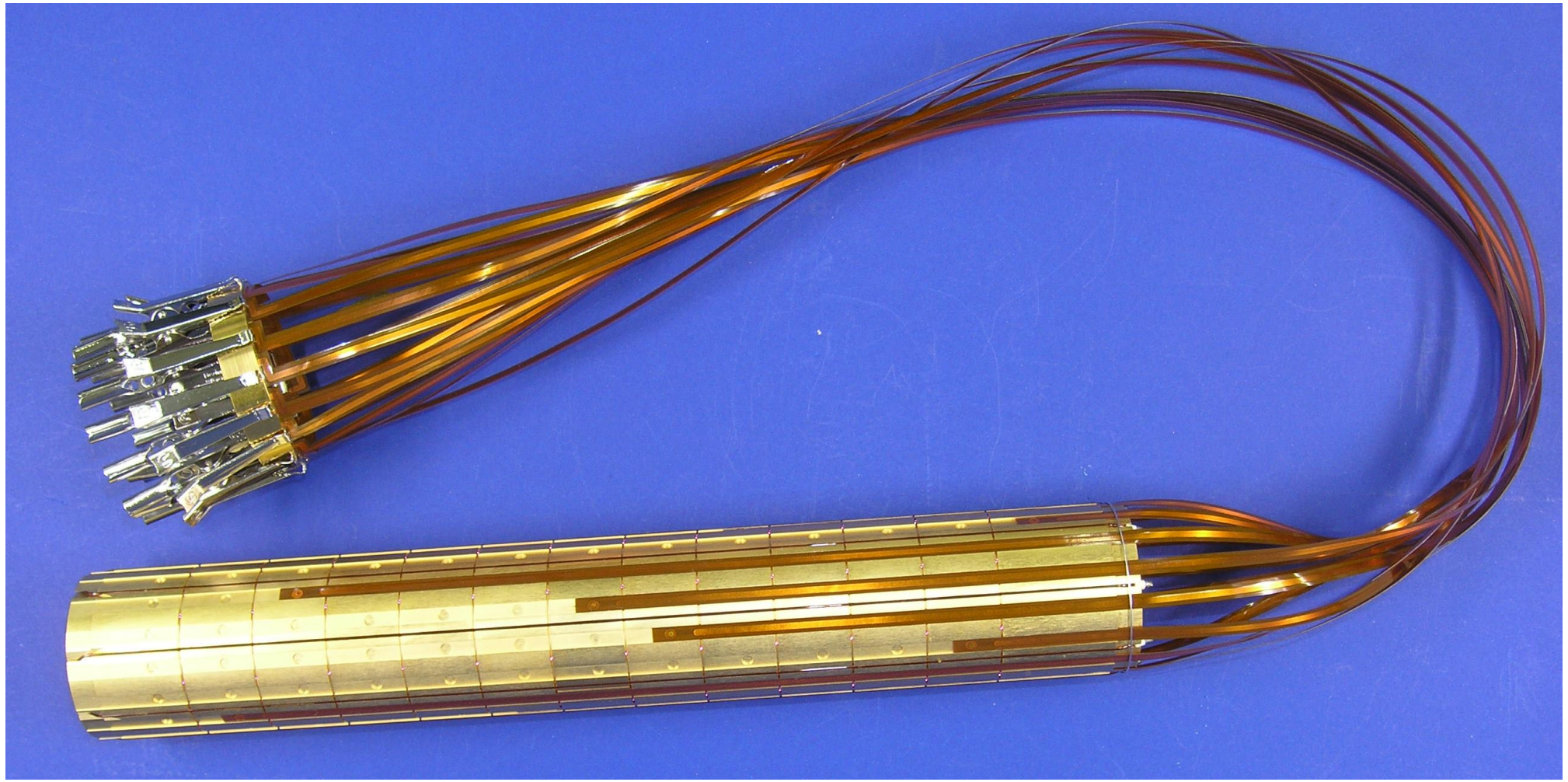
Challenge: assembly of resistors and connecting springs on a 3D very high mass object

Workflow: pre-heat the object in an oven up to 100+°C and use the highest possible temperature soldering tip; use lead based soldering alloy

Backup slide – module on module



Backup slide – penning trap



Backup slide – parts sizes