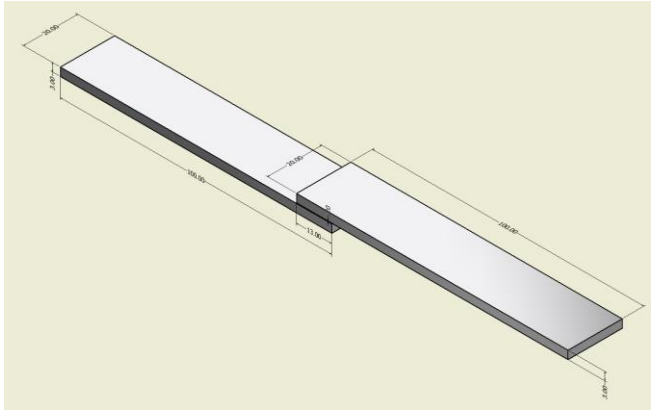
# Status of the material characterization campaign

Nicola Pacifico (EP-DT)

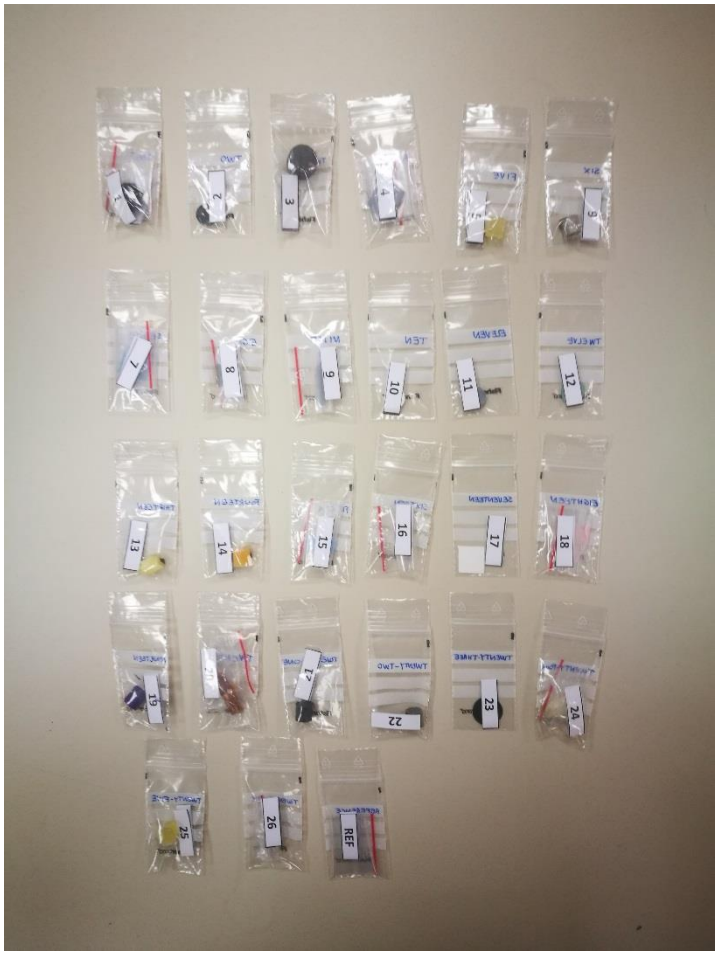
# Campaign scope

- Produce a list of structural/thermal materials suitable for use in a radiation-hard environment
  - Maximum target dose: 15 MGy (2 intermediate dose steps, e.g. 2 and 7 MGy)
  - Testing through one standardized structure (there might be space allowance for other non-standard samples for different tests)
- Irradiation at an industrial facility (dose rates up to 30 kGy/h) equipped with a Co60 source
- In parallel:
  - Neutron activation study (next slide)



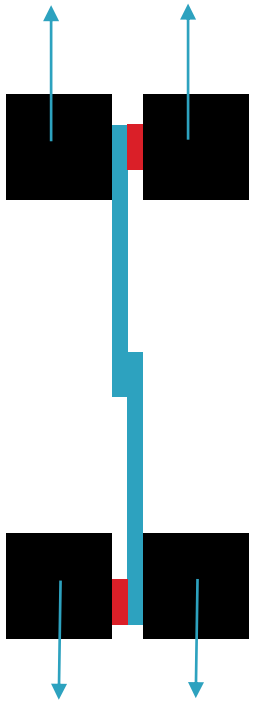
# Status of neutron irradiation

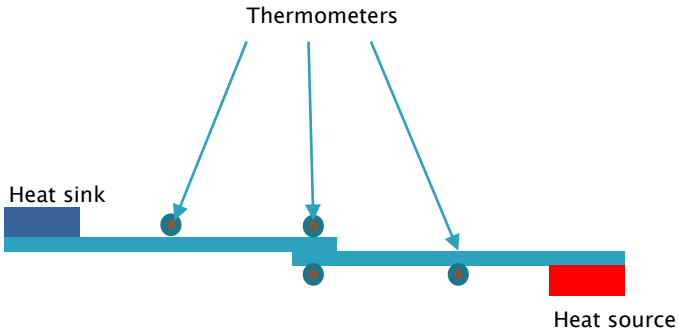
- Samples have been irradiated
- Few samples have melted due to high neutron absorption X-section
- Samples are being shipped to CERN for detailed spectrometry.
- Active samples (after ~ weeks):
  - AMEC Thermasol MPC25: 3 uSv/h
  - LAIRD TPCM 583: 8 uSv/h
  - Electrolube ER2074: 4 uSv/h
  - Electrolube ER2220: 5 uSv/h
  - Araldite 2012: 1 uSv/h
  - Gap-pad 3000S30: 6 uSv/h



# Testing procedure

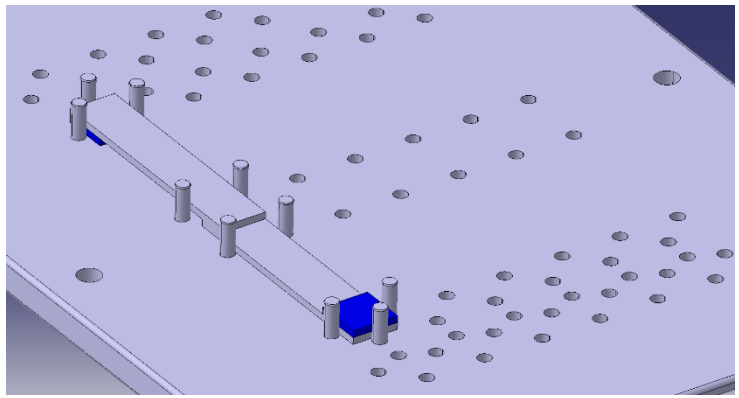
- For each material/dose step
  - Tensile machine tests
  - Thermal tests (using available TFM setups or others)
- Sample multiplicity:
  - 3/dose for mech. tests
  - 2/dose for therm. tests
  - 2/material for reference





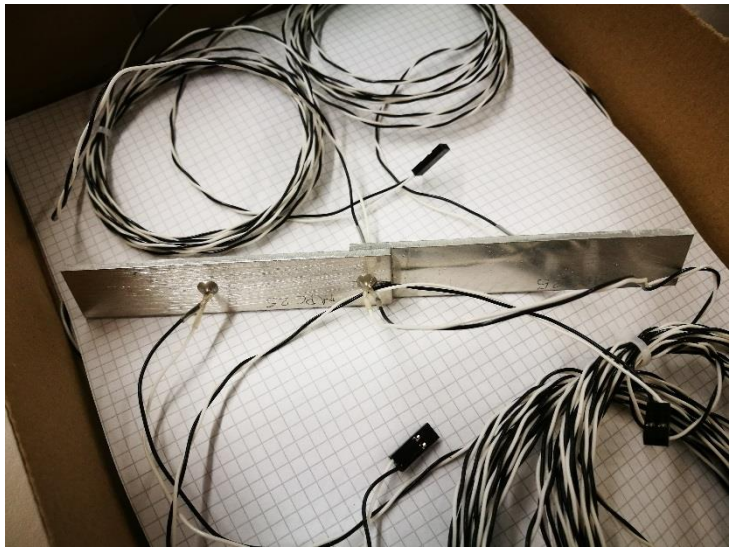
# Samples preparation

- JIG design is ready and tested
  - Glue thickness control (where needed) through ~100 um fishing wire
  - Curing of full jig in the oven at the required temperature
  - Pressure on top plate to be applied either with calibrated weights or autoclave (if available)
  - Due to good manufacturing quality of the aluminium plates, acetone cleaning is enough.
- First samples have been successfully assembled at CERN – preliminary mechanical and thermal testing in progress
- Please ask for the drawings in case you would like to produce a similar jig in-house.
- 400 aluminium pieces (for 200 lap joints) already ordered.



# Samples preparation

- First lap joints produced and tested (F. Boyer and R. Gomez)
- More lap joints produced for PPI and UHU Endfest (S. Kuehn)
- Updated tables – *input needed (see next slides)*



# Todo: fill in the gaps

https://docs.google.com/spreadsheets/d/1Xd1SWfz0UO2caJr1HirvmpbHe4plTNXs9grWGGTxaAM/edit#gid=0

| Brand | Product code | Description | Link to datasheet | Date av | Requested | Comments | Curing | Requestor |
|---|---|---|---|---|---|---|---|---|
| - | - | Composite resi | - | - | | Used for truss structure | - | Diego EP-DT |
| - | - | Composite resi | - | - | | Used for truss structure | - | Diego EP-DT |
| 3M | 5515 | Thermo-silicon | http://multimedia.3m.c | - | | No supplier found | None | Rubén EP-DT |
| 3M | Scotchweld DP 190 grey | (structural glue | http://multimedia.3m.c | - | | | 2hrs@93C | |
| 3M | Scotchweld DP 110 | (quick setting g | http://multimedia.3m.c | - | | | 2hrs@93C | |
| 3M | VHB 5909 | thin foam tapes | https://cdn2.hubspot.n | - | | available, sample tested up to 5e15 neqcm-1 , 1e16 | None | Susanne ADE-ID, Julien MPP |
| Adhere | IRS2125 | | http://www.intertronics | - | | | 2hrs@85C | |
| All comp | K9 | carbon foam | | - | | assembly with foam + composite for inclined structu | - | Ludovic LPSC |
| AMEC Thermasol | MPC315 | Phase-change | http://uk.farnell.com/a | 09/12/20 | | Some stock available. Product discontinued | None | Rubén EP-DT |
| AMEC Thermasol | MPC25 | Phase-change | http://amecthermasol.c | - | | Samples requested | None | Rubén EP-DT |
| Andover | new Epolite | Epoxy | https://www.andoverc | - | | for module assembly | None | |
| Arctic Silver | Arctic Silver | | http://www.arcticsilver | - | | | - | |
| Dow Corning | SE4445 | Thermally conc | http://www.ellsworth.c | 09/12/20 | 20 MGy | | 45min@125C | Rubén EP-DT |
| Dow Corning | TC 5022 | replaced by TC | http://www.dowcorning | - | | | None | |
| Dow Corning | TC 5622 | (thermal interfa | http://www.dowcorning | - | | | None | |
| Electrolube | ER2074 | | http://www.electrolube | - | | | 1hr@100C | |
| Electrolube | ER2220 | Epoxy | http://www.electrolube | - | | | 1hr@100C | |
| Hexion | Epon 828/Epikur 3055 100:4 | (structural glue | http://www.hexion.com | - | | | 2hrs@93C | |
| Huntsman | Araldite 2011 | Epoxy | http://www.farnell.com | - | | | 10min@100C | Susanne ADE-ID |
| Huntsman | Araldite 2013 | (component mc | http://www.intertronics | - | | | 6min@100C | |
| Huntsman | TDR 1100 | (silicon compat | http://krayden.com/tec | - | | | 15min@82C | |
| Huntsman | Araldite AV/HV1580 | Epoxy | http://aralditeadhesive | - | | | 5min@100C | |
| Huntsman | Araldite 2022 | Epoxy | http://docs-europe.ele | - | | | 20min@40C | |
| Huntsman | Araldite 2012 | Epoxy | https://www.exdron.co | - | | | 20min@100C | |
| Isoltronic | Gap-Pad 3000S30 | Thermal pad - | https://isoltronic.ch/as | 09/12/20 | | Readily available | None | Rubén EP-DT |
| Isoltronic | Gap-Pad V0 Ultra Soft | Thermal pad - | https://isoltronic.ch/as | 09/12/20 | | Readily available | None | Rubén EP-DT |
| Kunze | KU-BGDX | Thermo-silicon | https://www.aavid-kun | 09/12/20 | | Samples received | None | Rubén EP-DT |
| Laird | TPCM 583 | (thermal interfa | https://assets.lairdtecl | - | | | None | |
| Melcor | TCE-004 | Reworkable ep | http://www.knap.at/dat | - | | No supplier found | 60min@85C | Rubén EP-DT |
| Parker Chomerics | T725 | Phase change | https://www.chomerics | - | | | None | |
| Parker Chomerics | T557 | Phase-change | https://www.chomerics | - | | Small quantity ordered, contains solder | None | Rubén EP-DT |
| Parker Chomerics | T777 | Phase-change | https://www.chomerics | - | | Not available in small quantities, min. order > 10 kC | None | Rubén EP-DT |
| Parker Chomerics | Gel 30 | Pre-cured gel, | https://www.chomerics | - | | Small quantity ordered | None | Rubén EP-DT |
| Polytec | TC423 | | http://www.polytec-pt.c | - | | | 1hr@100C | |
| PPI | 7011 DS | POLYIMIDE FI | http://www.polydecup | - | | available, sample tested up to 5e15 neqcm-1 , 1e16 | None | Susanne ADE-ID, Julien MPP |
| PPI | RD-577F | polyimide film | http://www.ppitapes.co | - | | available will be shipped from Bonn, for module assembly | | Susanne ADE, |
| Prima-bond | EG7655 | Reworkable ep | https://www.aitechnolo | - | | No supplier found | 2hrs@100C | Rubén EP-DT |
| Prima-bond | EG7658 | Reworkable ep | https://www.aitechnolo | - | | No supplier found | 2hrs@100C | Rubén EP-DT |
| Stycast+Catalist 9 | 2850FT | POTTING CON | https://tds.us.henkel.c | 12/01/17, will be sent | | | 2hrs@65C | Ludovic LPSC |
| Tesa | tesafix 4962 | double-sided ta | http://www.tesa.com/fi | 12/01/17, will be sen | | available, sample tested up to 5e15 neqcm-1 , 1e16 | None | Susanne ADE-ID, Julien MPP |
| UHU | UHU Endfest 300 | Epoxy | www.uhu-profishop.de/ | 12/12/2016, will be s | | for module assembly | 12hrs@RT | Susanne ADE-ID |

Check info in the table for the glues you have added. Orphans (glues without a requestor) won't go to irradiation!

Check availability information for "your" glues. Mark if available, if not mark the availability date.

Check curing time: I have taken this one from datasheets, but you might know better from experience (important for planning)

# Todo: planning of samples manufacturing/testing

https://docs.google.com/spreadsheets/d/1Xd1SWfz0UO2caJr1HirvmpbHe4plTNXs9grWGGTxaAM/edit#gid=0
(sheet 2)

| Brand | Product code | Description | Thermal LJ | Mechanical LJ | Non-irr lap joints | Dose Steps | Total lap joints | Curing time (hrs) | Supplying institute | Institute for assembly | Lap-joints delivery est. date | Institute for thermal testing | Institute for mechanical testing | Time for assembly (hrs) | (days) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | Composite resin - Type 1 | 0 | 0 | | 3 | 0 | - | | | | | | 0 | 0 |
| - | - | Composite resin - Type 2 | 0 | 0 | | 3 | 0 | - | | | | | | 0 | 0 |
| 3M | 5515 | Thermo-silicone | 2 | 0 | | 3 | 6 | None | | | | | | 2 | 1 |
| 3M | Scotchweld DP 190 grey | (structural glue) | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| 3M | Scotchweld DP 110 | (quick setting glue) | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| 3M | VHB 5909 | thin foam tapes with pressure sensit | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| Adhere | IRS2125 | | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| All comp | K9 | carbon foam | 0 | 0 | 2 | 3 | 2 | - | | | | | | 2 | 1 |
| AMEC Thermas | MPC315 | Phase-change material, wax based | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| AMEC Thermas | MPC25 | Phase-change material, wax based | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Andover | new Epolite | Epoxy | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| ~~Arctic Silver~~ | ~~Arctic Silver~~ | | 0 | 0 | | 0 | 0 | - | | | | | | 0 | 0 |
| Dow Corning | SE4445 | Thermally conductive adhesive | 2 | 3 | 2 | 3 | 17 | 0.75 | | | | | | 8.25 | 2 |
| Dow Corning | TC 5022 | replaced by TC5622 | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Dow Corning | TC 5622 | (thermal interface paste, planned us | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Electrolube | ER2074 | | 2 | 3 | 2 | 3 | 17 | 1 | | | | | | 9 | 2 |
| Electrolube | ER2220 | Epoxy | 2 | 3 | 2 | 3 | 17 | 1 | | | | | | 9 | 2 |
| Hexion | Epon 828/Epikur 3055 100:40 | (structural glue) | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| Huntsman | Araldite 2011 | Epoxy | 2 | 3 | 2 | 3 | 17 | 0.1666666667 | | | | | | 6.5 | 1 |
| Huntsman | Araldite 2013 | (component mounting glue) | 2 | 3 | 2 | 3 | 17 | 0.1 | | | | | | 6.3 | 1 |
| Huntsman | TDR 1100 | (silicon compatible glue) | 2 | 3 | 2 | 3 | 17 | 0.25 | | | | | | 6.75 | 1 |
| Huntsman | Araldite AV/HV1580 | Epoxy | 2 | 3 | 2 | 3 | 17 | 0.08333333333 | | | | | | 6.25 | 1 |
| Huntsman | Araldite 2022 | Epoxy | 2 | 3 | 2 | 3 | 17 | 0.33 | | | | | | 6.99 | 1 |
| Huntsman | Araldite 2012 | Epoxy | 2 | 3 | 2 | 3 | 17 | 0.33 | | | | | | 6.99 | 1 |
| Isoltronic | Gap-Pad 3000S30 | Thermal pad - Type 1 | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Isoltronic | Gap-Pad V0 Ultra Soft | Thermal pad - Type 2 | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Kunze | KU-BGDX | Thermo-silicone | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Laird | TPCM 583 | (thermal interface film, planned use | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| Melcor | TCE-004 | Reworkable epoxy | 2 | 3 | 2 | 3 | 17 | 1 | | | | | | 9 | 2 |
| Parker Chomeric | T725 | Phase change material | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| Parker Chomeric | T557 | Phase-change material, polymer bas | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| Parker Chomeric | T777 | Phase-change material, polymer bas | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| Parker Chomeric | Gel 30 | Pre-cured gel, silicone based | 2 | 0 | 2 | 3 | 8 | None | | | | | | 4 | 1 |
| Polytec | TC423 | | 2 | 3 | 2 | 3 | 17 | 1 | | | | | | 9 | 2 |
| PPI | 7011 DS | POLYIMIDE FILM COATED ON BO | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| PPI | RD-577F | polyimide film used in IBL modules | 2 | 3 | 2 | 3 | 17 | | | | | | | 6 | 1 |
| Prima-bond | EG7655 | Reworkable epoxy | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| Prima-bond | EG7658 | Reworkable epoxy | 2 | 3 | 2 | 3 | 17 | 2 | | | | | | 12 | 2 |
| Stycast+Catalist | 2850FT | POTTING COMPOUND | 0 | 3 | 2 | 3 | 11 | 2 | | | | | | 8 | 1 |
| Tesa | tesafix 4962 | double-sided tape consisting of a nc | 2 | 3 | 2 | 3 | 17 | None | | | | | | 6 | 1 |
| UHU | UHU Endfest 300 | Epoxy | 2 | 3 | 2 | 3 | 17 | 12 | | | | | | 42 | 6 |
| | | | | | | | | | | | | | | Total days | 54 |
| | | | | | | | | | | | | | | | |
| | | | | | | | 542 | | | | | | | | |

- Fill in, or check, for “your” glues:
  - Number of mechanical and thermal lap joints (for some samples only mechanical or thermal tests might be needed)
  - Supplying insititutes: who is going to provide the adhesive
  - Institute for assembly, thermal and mechanical testing: specify if you are willing to take on the assembly, mechanical and thermal testing for specific materials
  - When the lap-joints are going to be ready for shipment to the irradiation facility

# Gamma irradiation planning

- Total number of lap joints must be confirmed (after table fill-up).
- The table automatically calculates an estimate on the total production time based on the curing time and number of lap joints
  - To be added: working time per institute (use a consistent name for your institute in order to allow automatic calculation once the feature is implemented)
- At the moment, ~540 lap joints are seemingly to be produced (450 for irradiation, 90 for reference, total of ~54 working days*site)

# Gamma irradiation planning: next steps

- Completion of table =>
  - Estimated number of lap joints
  - Delivery date
- Booking of irradiation slot at irradiation facility (~3-4 weeks)
- Irradiation (~3-4 weeks of source time)
- Testing

- A detailed schedule will be available as soon as the table is filled up.