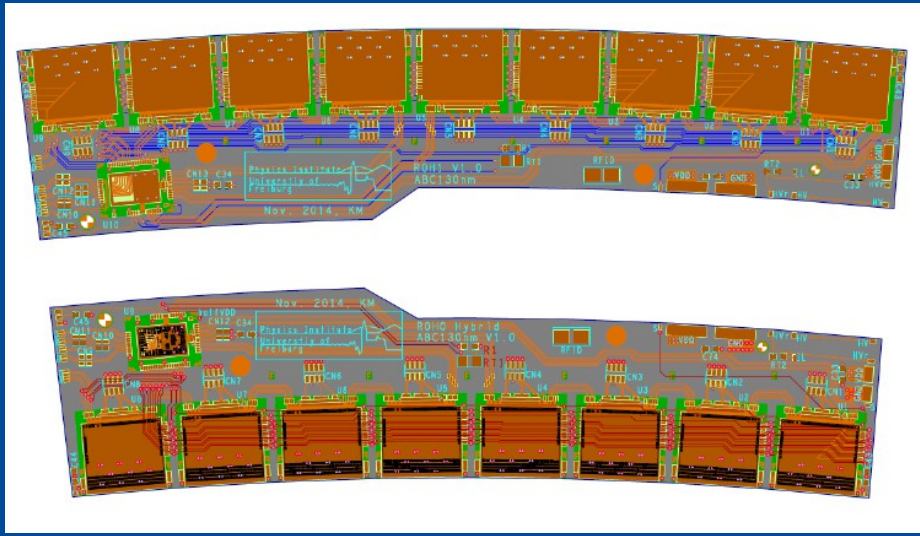
ATLAS strip-endcap production preparation meeting

ABC130 Petal Hybrids – Status



DESY Zeuthen

March 2017

Albert-Ludwigs-Universität Freiburg

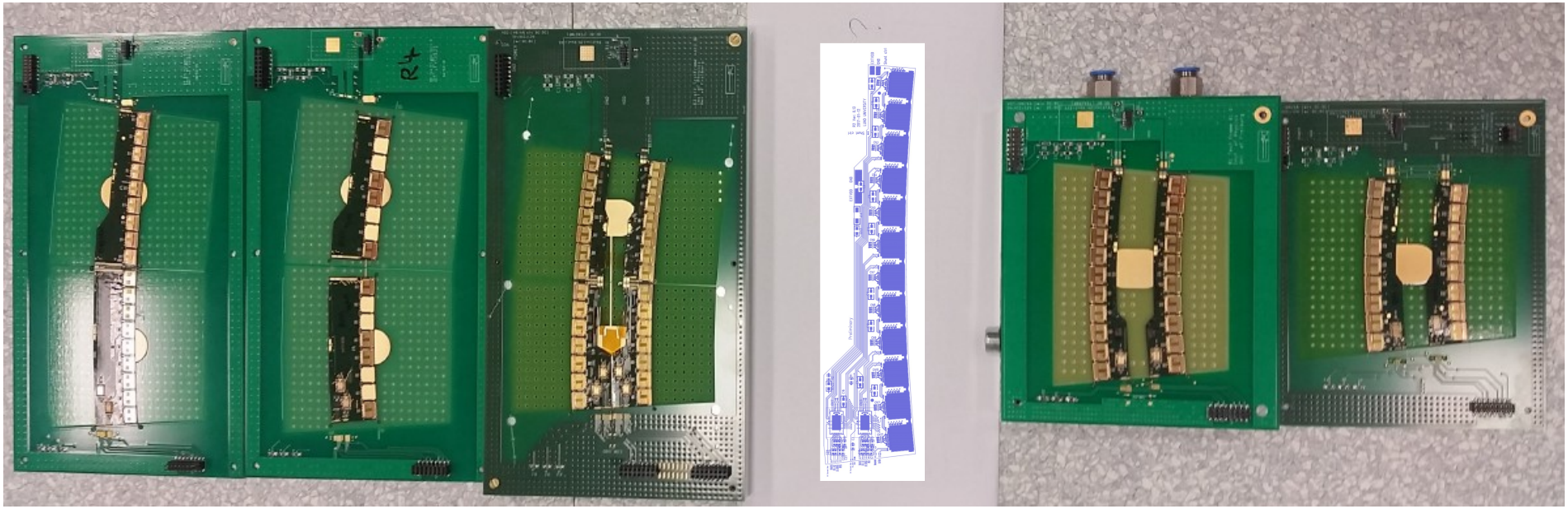
Marc Hauser on behalf of the Freiburg Group

(Carlos Garcia Argos, Kambiz Mahboubi, Ulrich Parzefall)

UNI FREIBURG

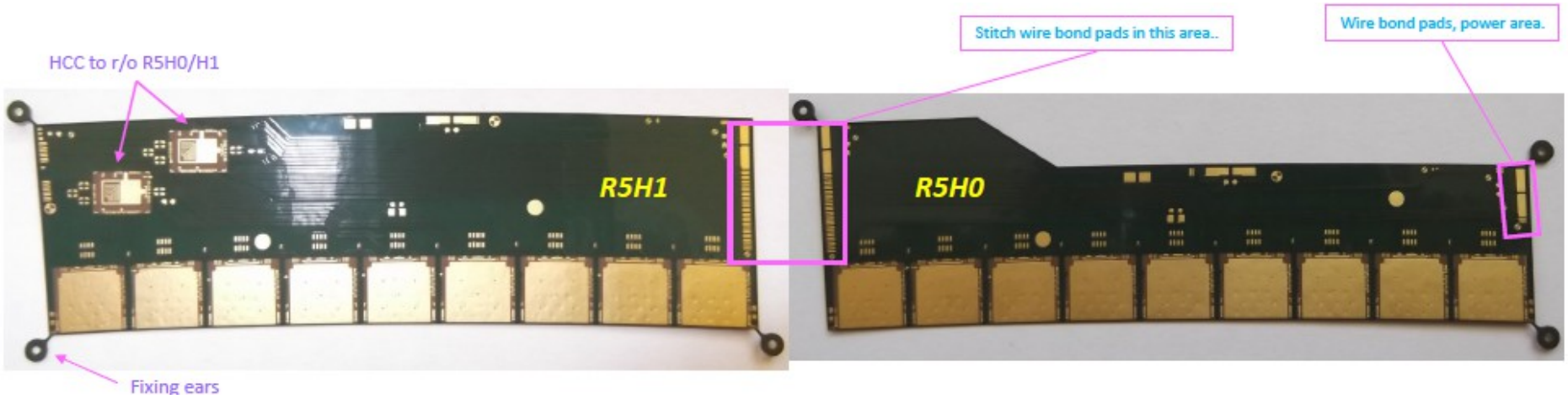
Petal Hybrids

- Where we are:
  - Design of all Petal hybrids is finished (R2?)
  - Freiburg has produced, assemled and tested a full set of hybrids (except for the missing R2, which is designed by Lund)
  - Testframes (designs) for all rings available



Petal Hybrid - General

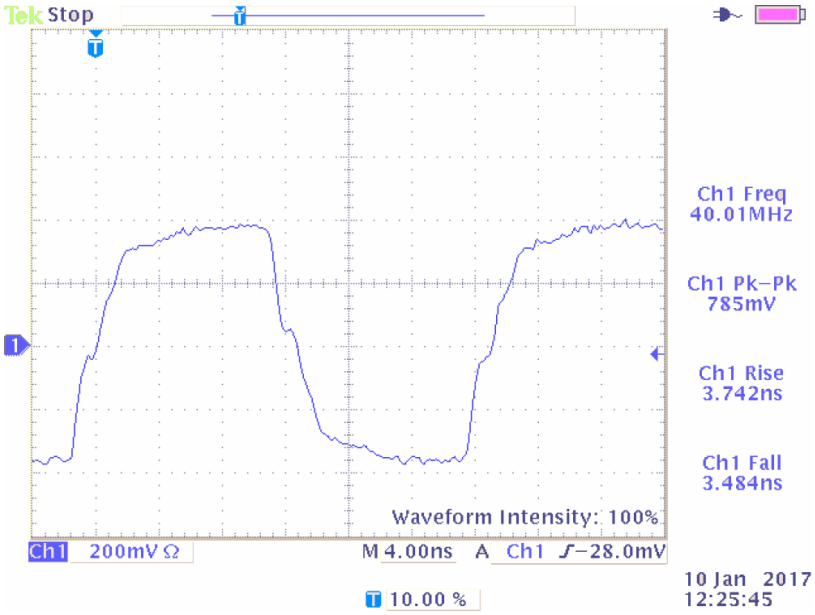
- Curved hybrids, four-layer build, flexible-PCB
- 100um trace pitch and width, only blind vias, no through-vias (but filled or staggered)
- Extra polyamide foil on bottom (mechanical stiffener)
- Manufactured by Wuerth Electronics, populated with passive SMDs in house (Uni Freiburg)
- Split scheme, means power from one side and data from the other
- Data/power needs to be connected (with bonds) between the hybrids for the three outer rings (R3,R4,R5), see picture of R5 below!
- HCCs are always on the left hybrids to keep the input traces short



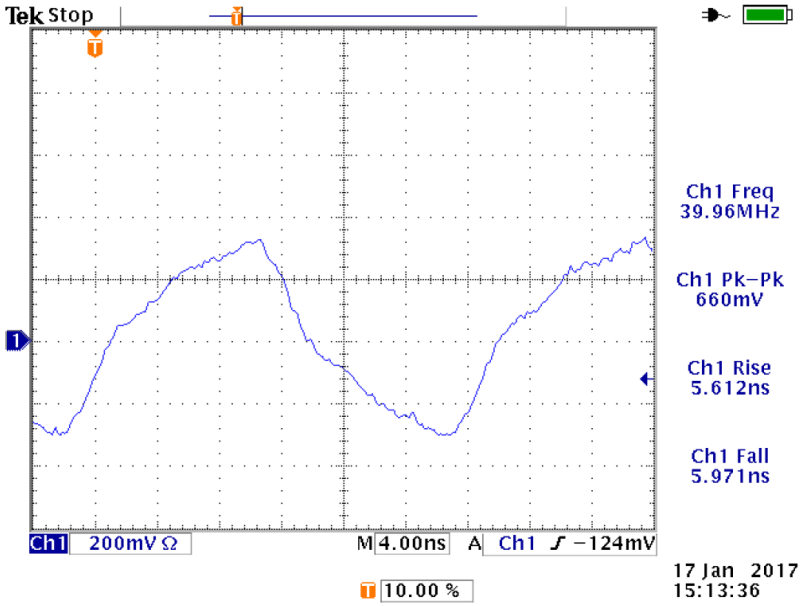
Issues with Capacitor Arrays (AC coupled signals)

- Capacitor arrays at the HCC input degrade the signals on the bus (~25pF capacitance in parallel on the differential pairs)

capacitor arrays with 1 HCC on bus



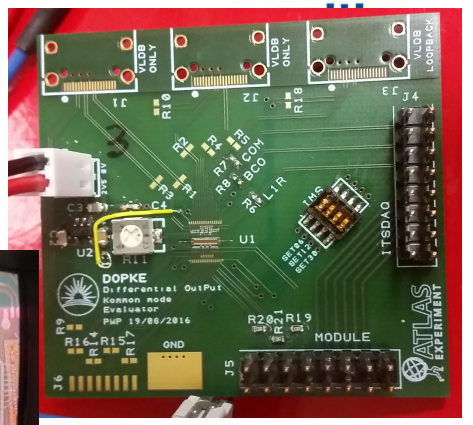
capacitor arrays with 4 HCCs

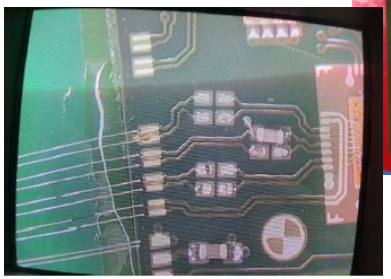


Issues with CapacitorArrays (AC coupled signals)

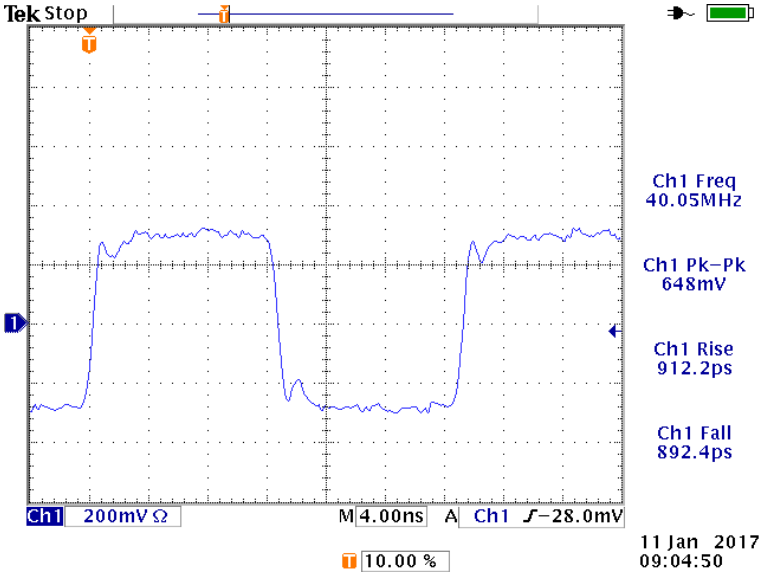
- Running with DOPKE (Differential OutPut Kommon mode Evaluator) board and DC-coupled bus results in good results

- Replacing the capacitor arrays by discrete capacitors (luckily fitting in 0402) gives also good results for TTC signals

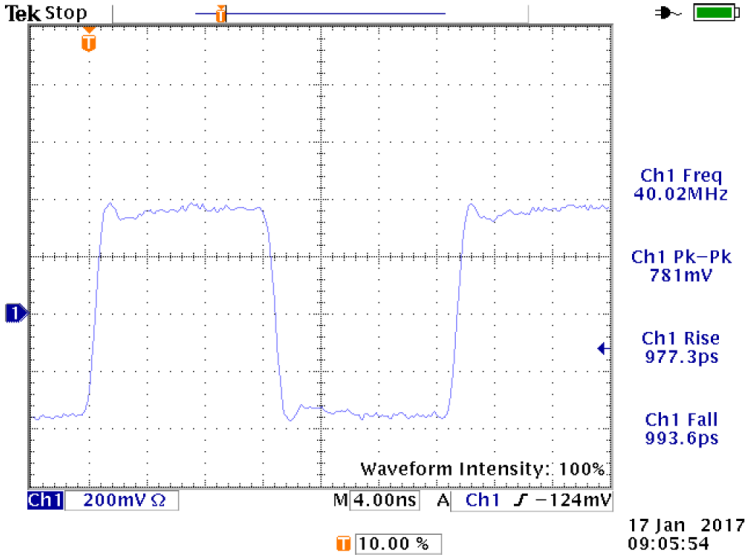




DOPKE without caps & with 2 HCC

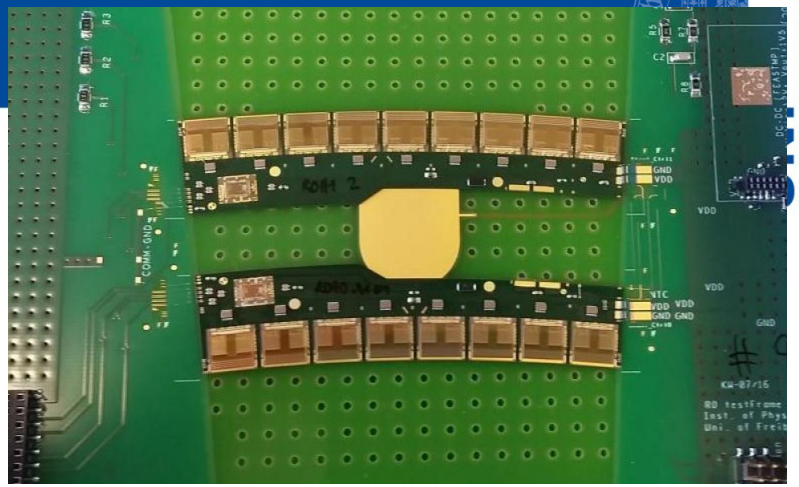


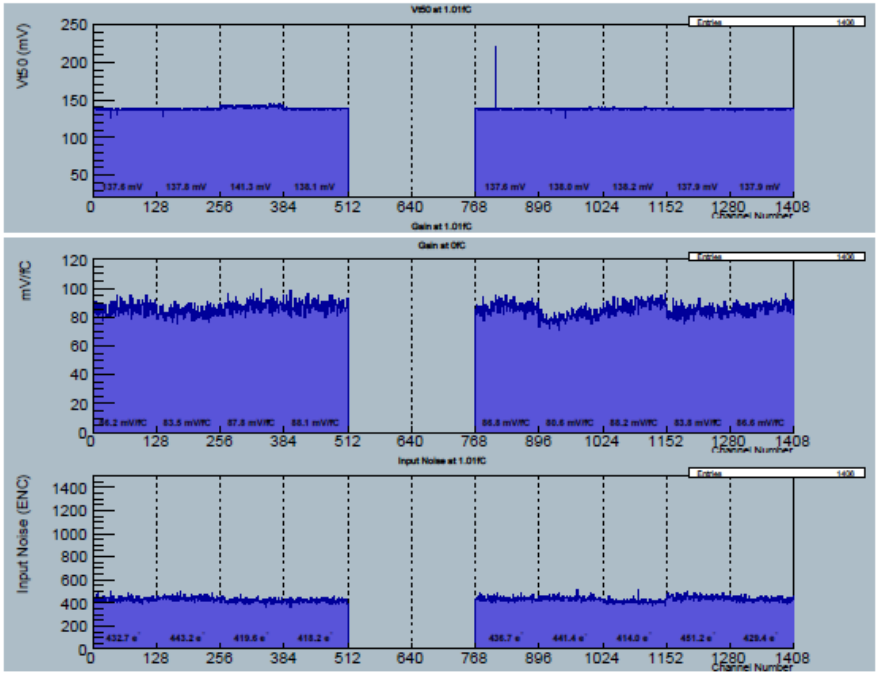
discrete capacitors with 1 HCC



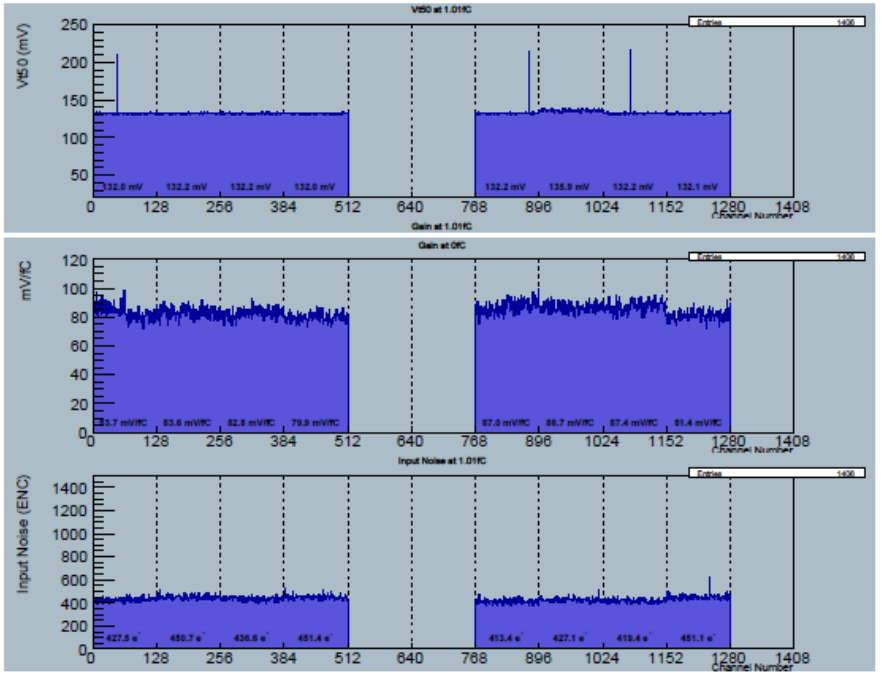
R0 Hybrids

- R0 hybrids work fine (also with discrete caps)
- tooling done and in use already (in FR)
- different versions of testframes (e.g. for daqloads or testbeam) designed
- reverse readout of streams sucessfully (after setting the right registers of the HCC)





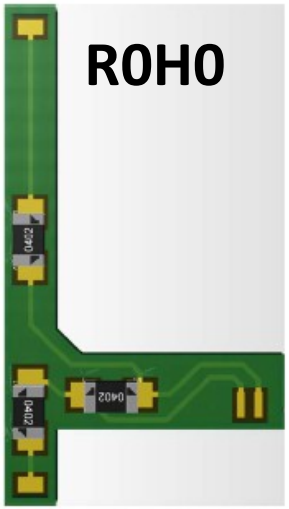
R0H1 (top hybrid)

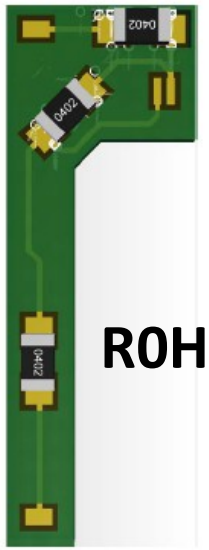


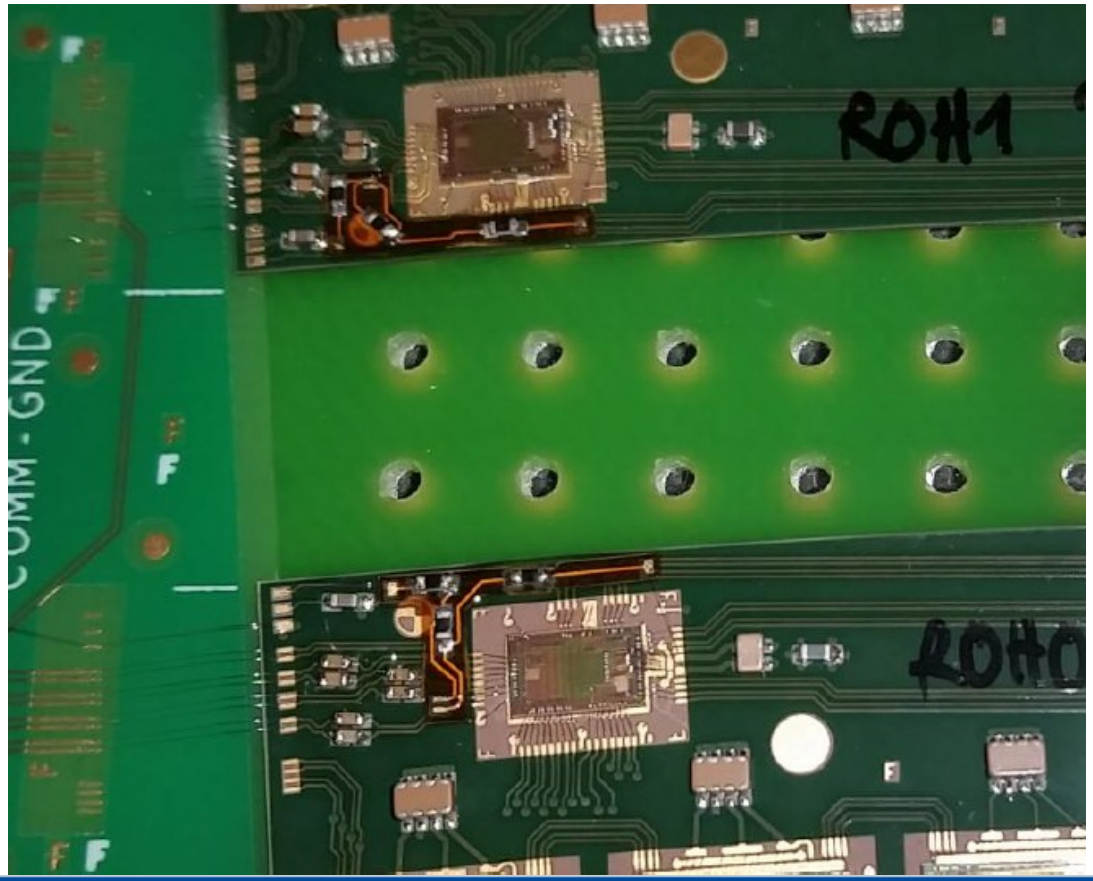
R0H0 (bottom hybrid)

R0 Hybrids - BCO Fix

- R0 BCO common mode fixture for both R0 hybrids available (three 0402 resistors & one layer on thin flexible Kapton foil)
- tested (after bonding) and improving the signals, but didn't change the test results for the R0 (which was working fine anyway)
- R3 fix design finalized, manufactured as well and at the moment waiting for the population of the SMDs
- design is not easy to fit in, but continuing with R5 and so on...

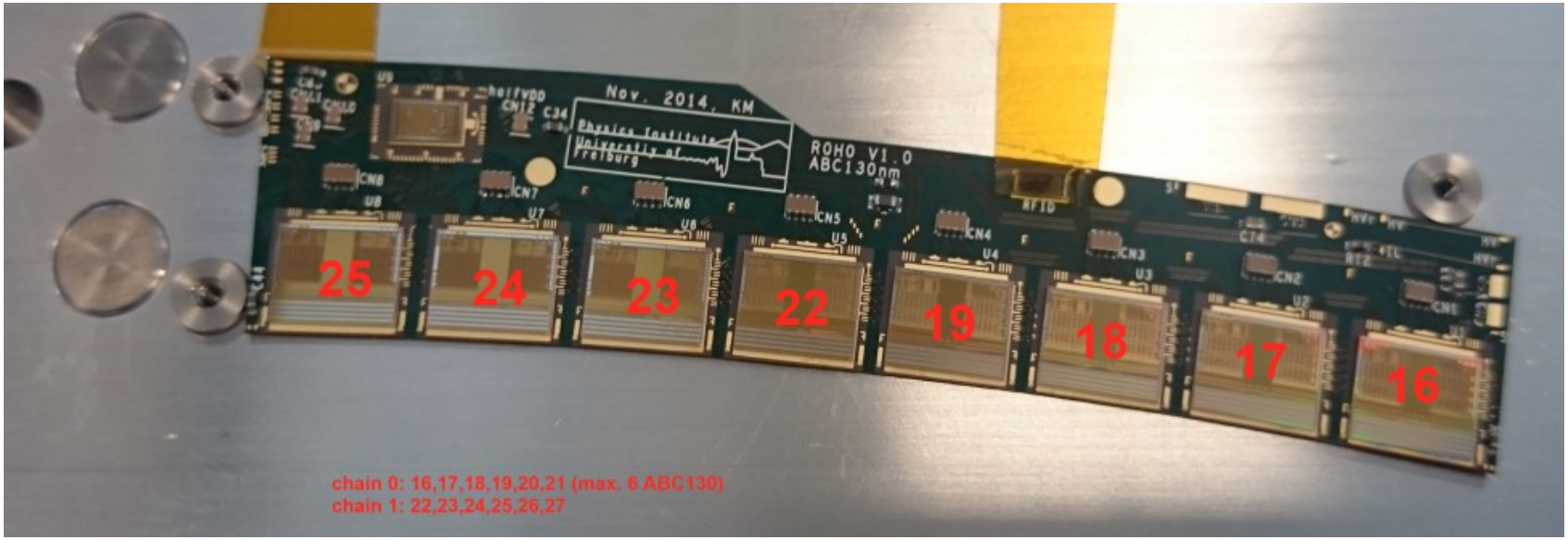




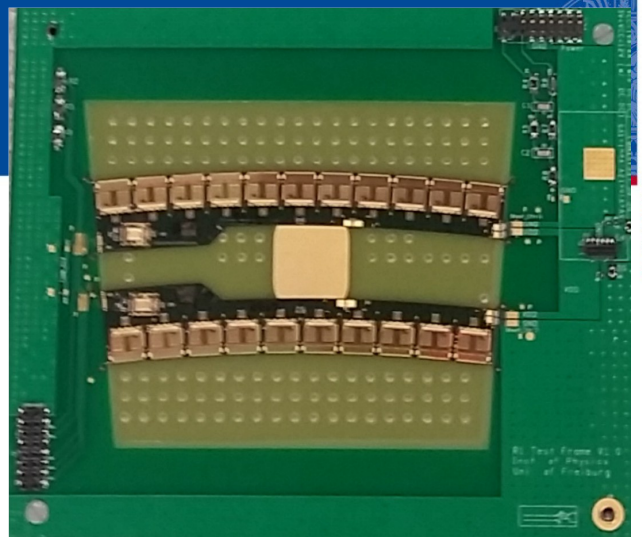


R0H0 Hybrid Alternative - CONTAG

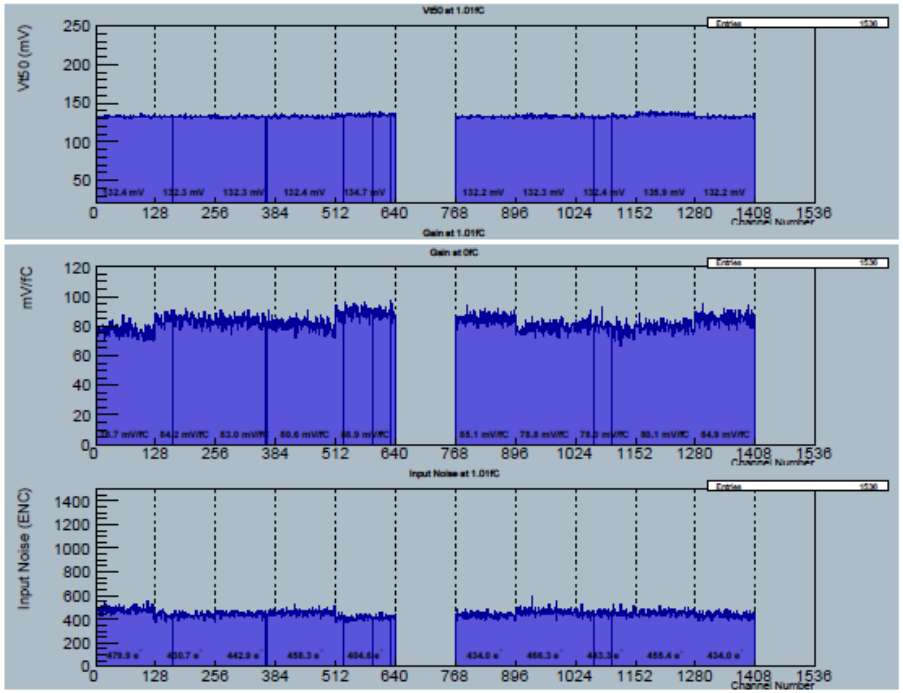
- tried a 2nd vendor (CONTAG) for manufacturing the endcap hybrids
- R0H0 hybrid was fully populated and working fine
- After some time more and more chips were not responding anymore
- Still under investigation:
  - Hybrids are quite twisted, pulling them flat during population of ABCs could have damaged the lines/vias
  - some degradation on top surface (maybe also on other layers, could as well lead to broken vias and connections)
- Outlook: as soon as there are more ABC available, build and test another one or try to remove and re-use the ABCs from that one



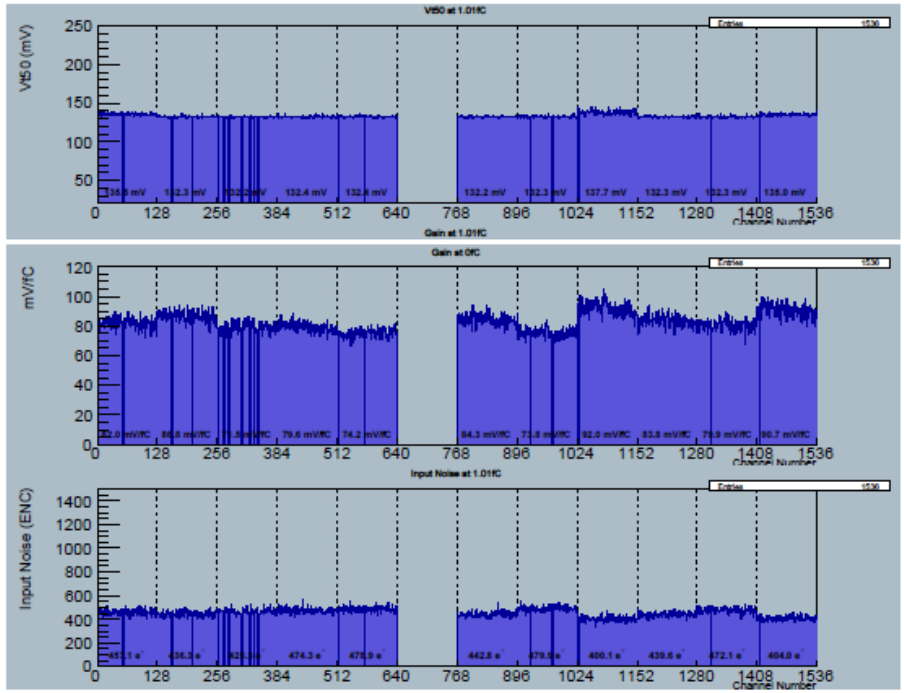
R1 Hybrids



- R1 hybrids are working (together)
- cap. arrays removed and replaced by discrete ones
- tested DC-coupled (no caps) as well
  - giving similar results
- testframe was designed and is in hand



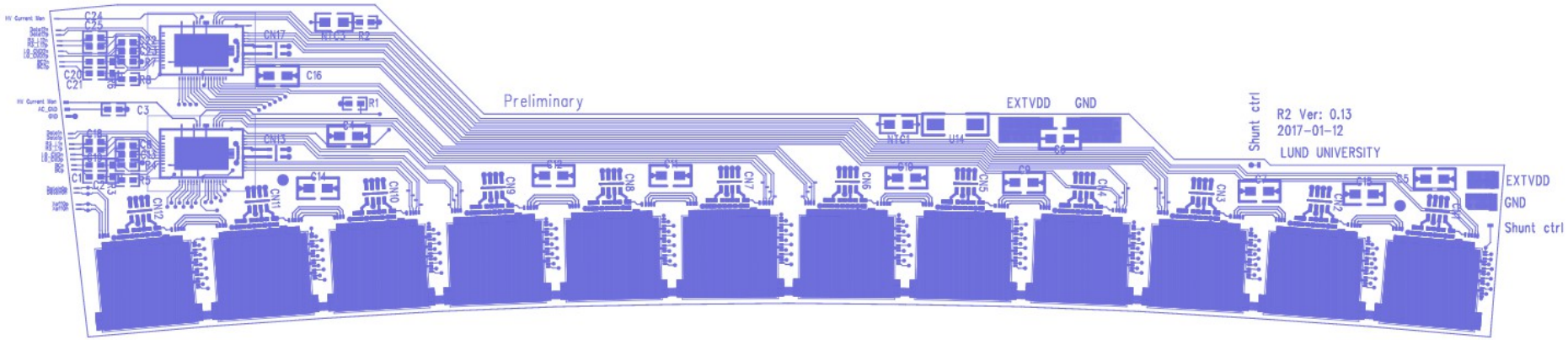
R1H0 (bottom hybrid)



R1H1 (top hybrid)

R2 Hybrids – Status Update

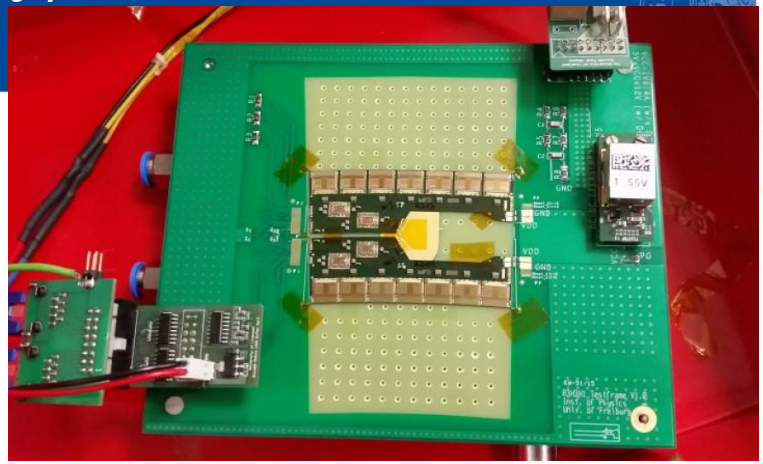
- New layout (Jan 2017) with modifications, e.g. removing the arrays and use discrete capacitors for the HCC inputs, no fixed IDs for ABCs and HCCs, decoupling capacitors at larger distances from the bondpads,...

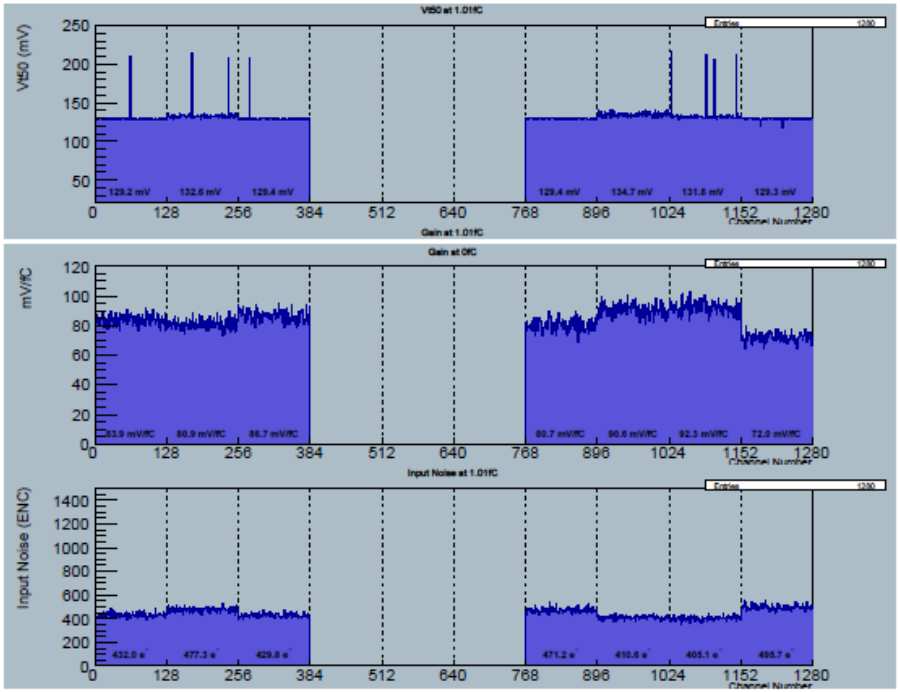


- Next steps:
  - Upload to twiki & collect feedback from community
  - Send request for quote to Würth Elektronik GmbH & Co. KG
  - Finish the test frame PCB for the hybrid
  - Same footprint (ABC&HCC bondpads) for star layout

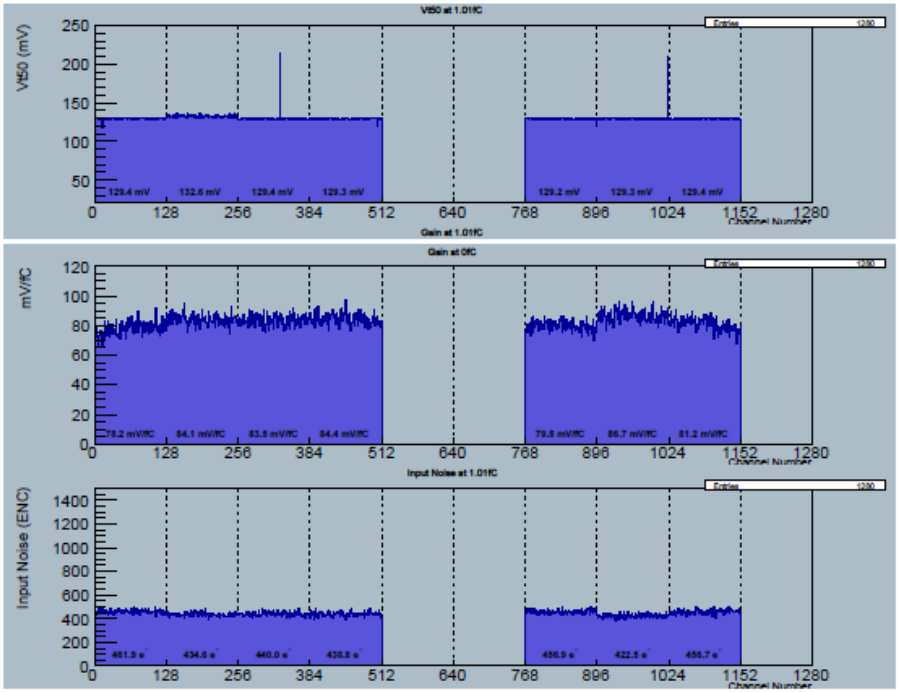
R3 Hybrids (left side frame only)

- the two left side R3 hybrids (R3H1 & R3H3) are working
- design of R3 left side testframe only capable of reading out two data streams (vs. 4 HCCs)
- area of four HCCs is getting quite hot



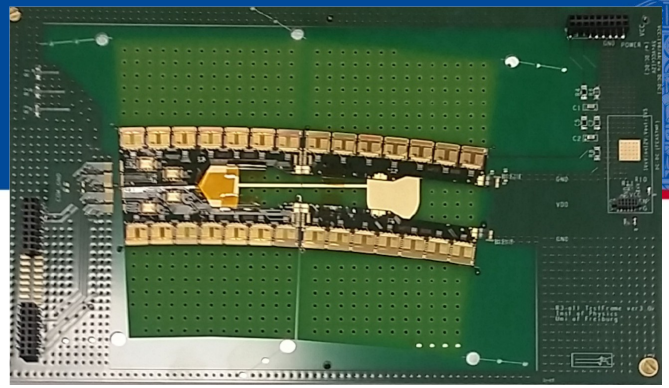


R3H3 (top hybrid left)

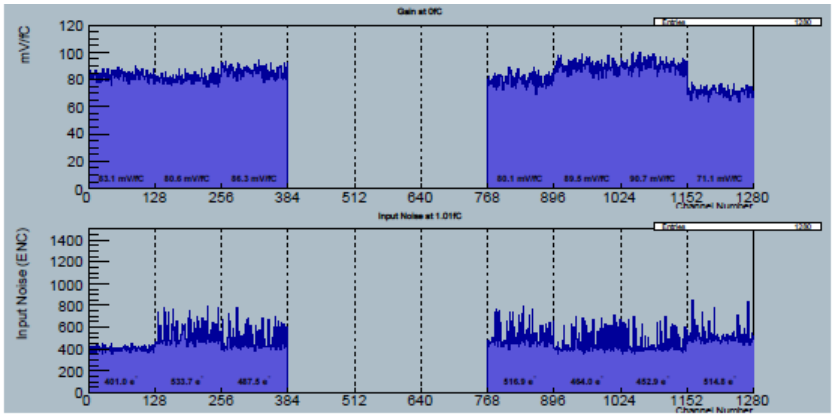


R3H1 (bottom hybrid left)

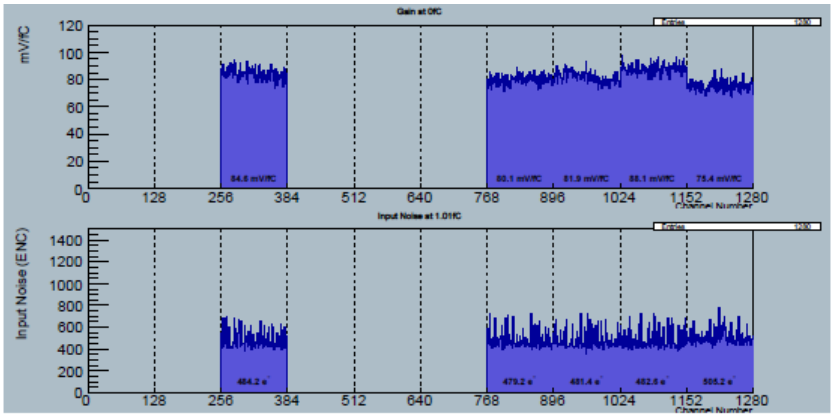
R3 Hybrids



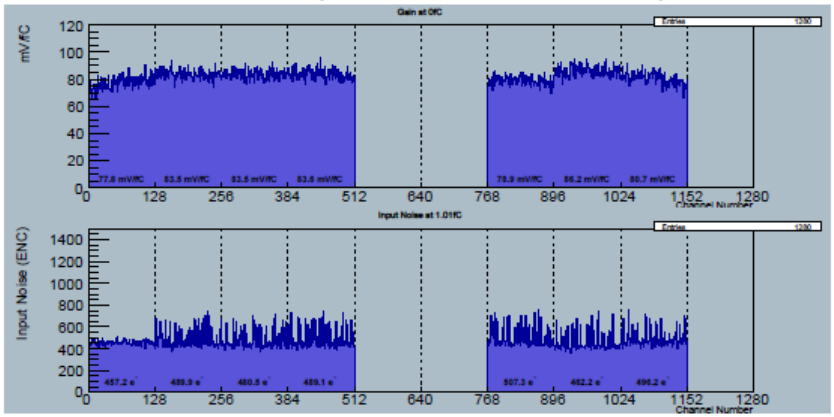
- All four R3 hybrids are working together as well
- Stitching bonds in two rows are no problem
- Full R3 testframe in hand (two data connectors)



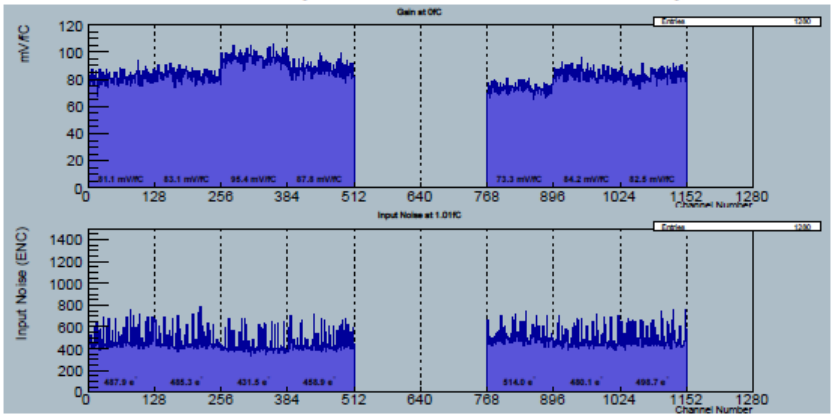
R3H3 (top hybrid left)



R3H2 (top hybrid right)



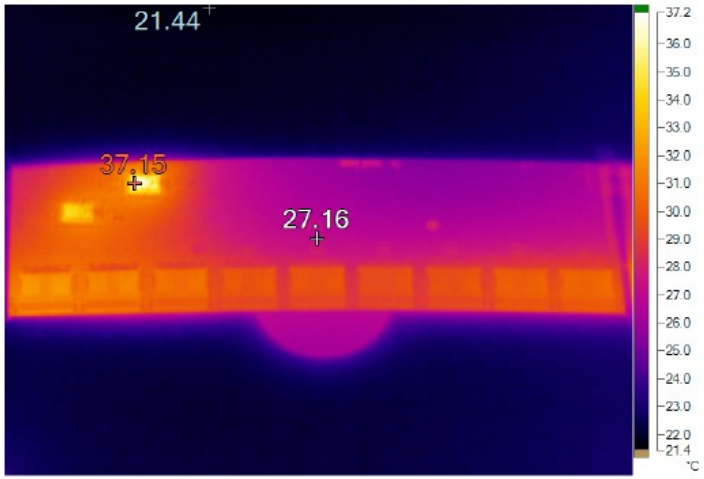
R3H1 (bottom hybrid left)

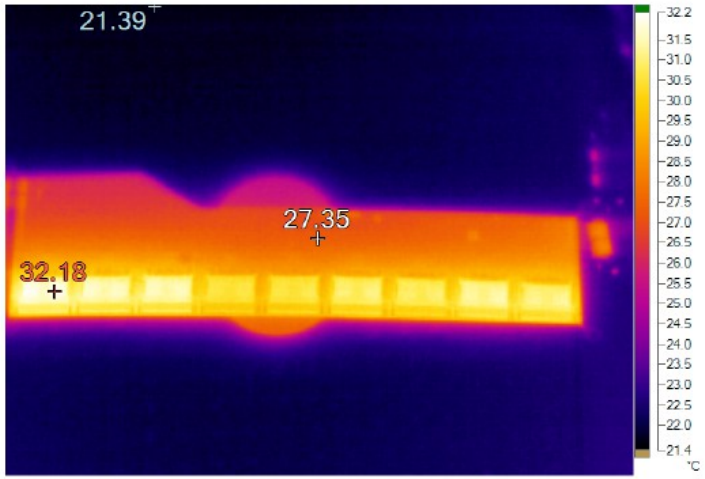


R3H0 (bottom hybrid right)

R5H1 Hybrid - Bad Chip Issues

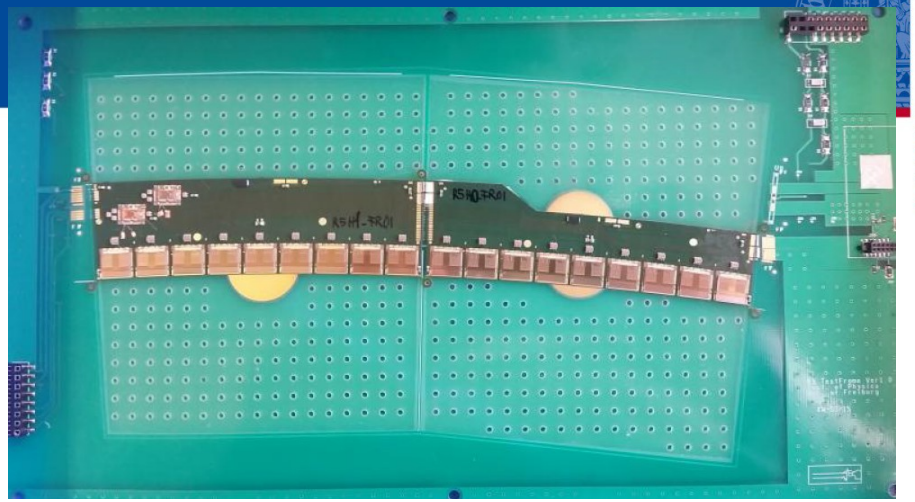
- While the right hand side hybrid was working from the beginning
  - (quite happy, means that the stitching of the power, commands and data works fine),
- the left one wasn't able configure the ABCs (as you can see in the lower picture resulting in a lower temperature)
- Probing the data and clock lines was only possible by adding small Cu-Pads (tape) and bonding them to the HCC pads → option: open vias (no solder resist on top) could help in future designs (like in R4 already realized)
- The DRC signal did show a wrong level of common mode (20 & 120mV)
- Started pulling the corresponding bonds on the ABCs from one side of the hybrid
  - found the problematic/broken chip (id18) and the level was up to 600mV again
- Hybrid worked after removing the chip (with heat and a vacuum tool) and replacing it

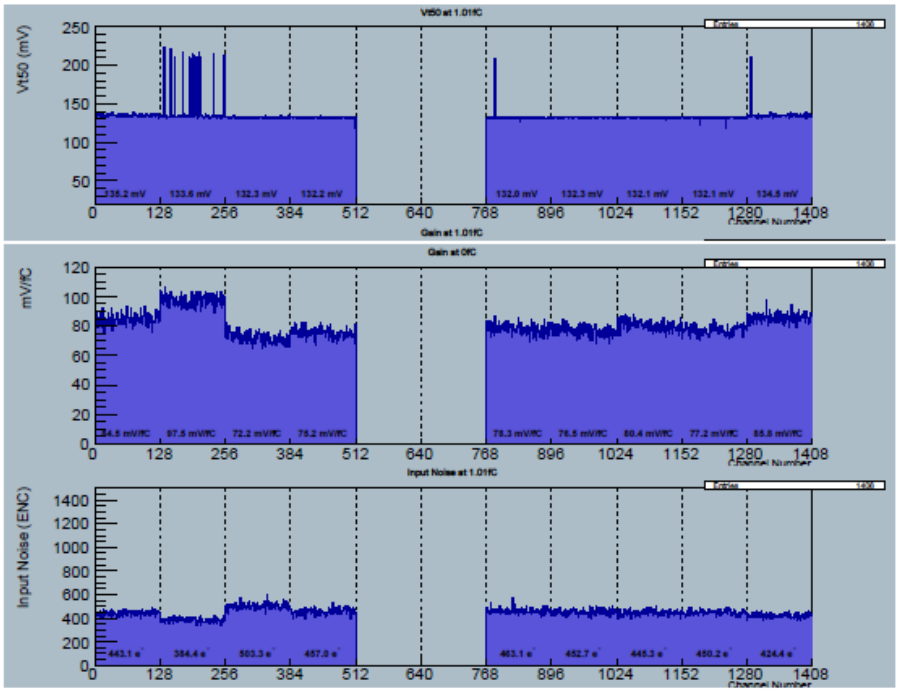




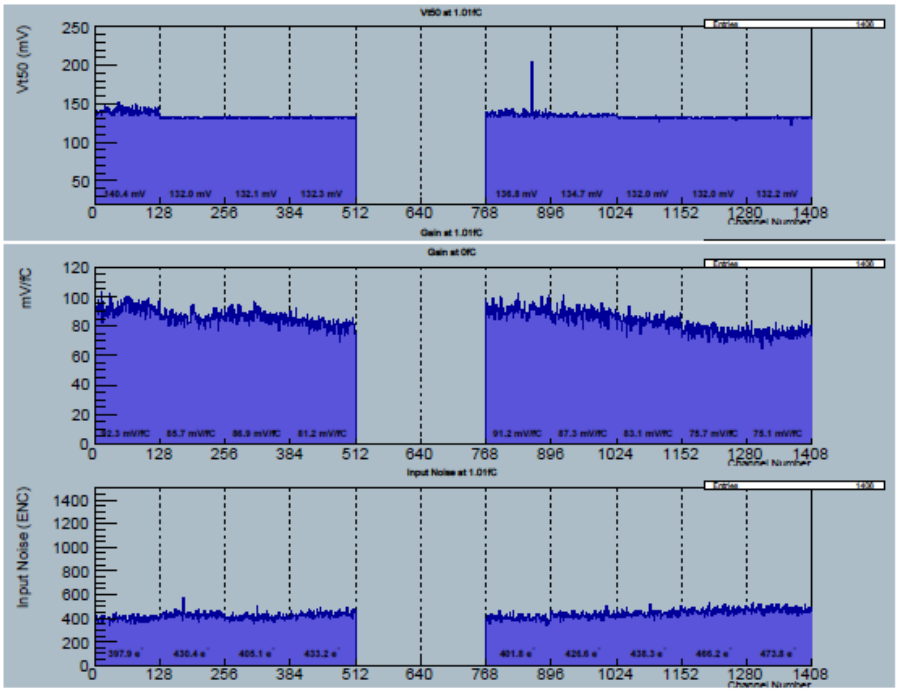
R5 Hybrids

- R5 hybrids are working fine
- Tooling done and in hand (in FR)
  - needs to be tested
- Testframe(s) for left hand side only and full R5 ready and in hand





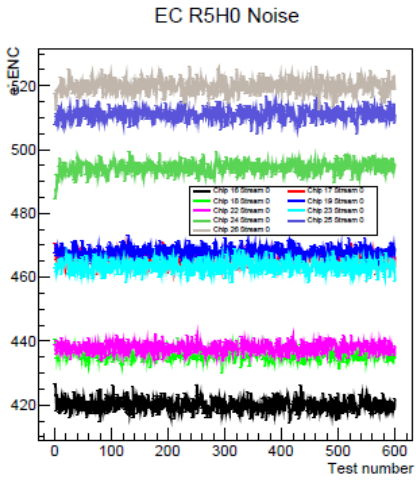
R5H1 (left hybrid)

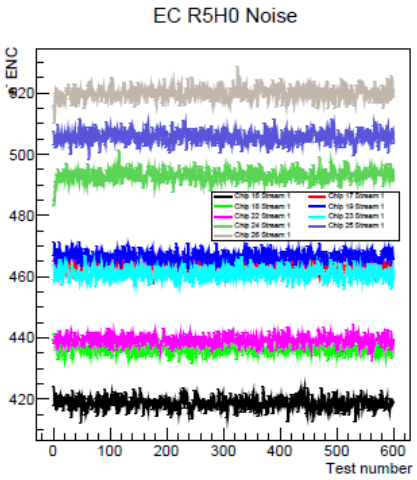


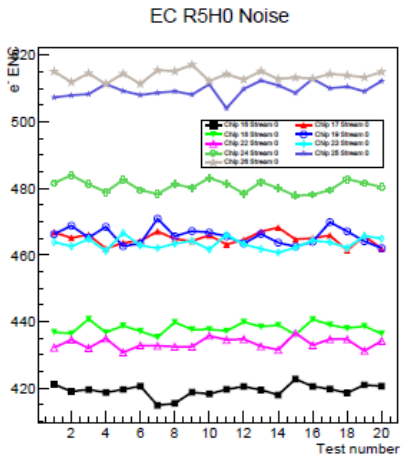
R5H0 (right hybrid)

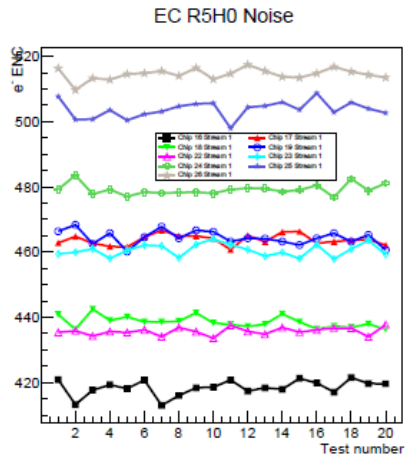
R5 Hybrids - Long-Term Measurements

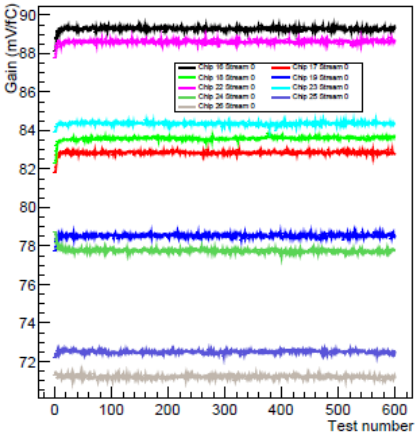
- Stability check with repeating Three-Point-Gain tests:
  stable noise and gain results over long time running (~days)

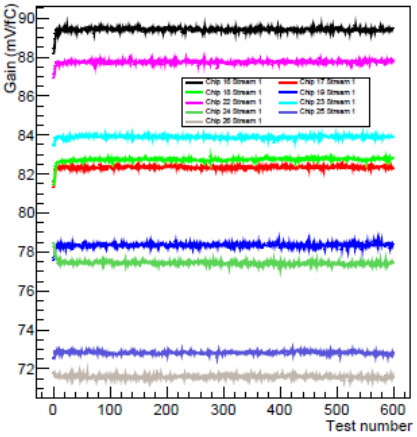


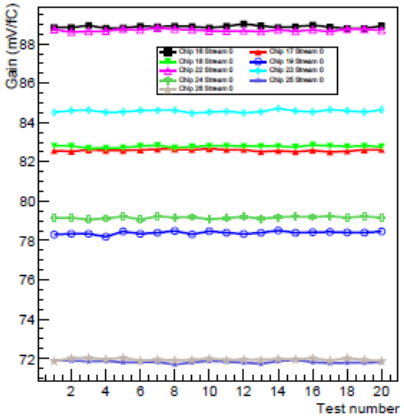


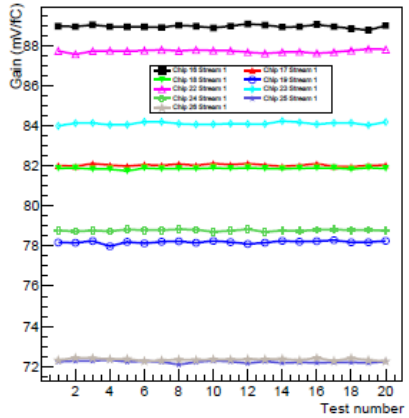






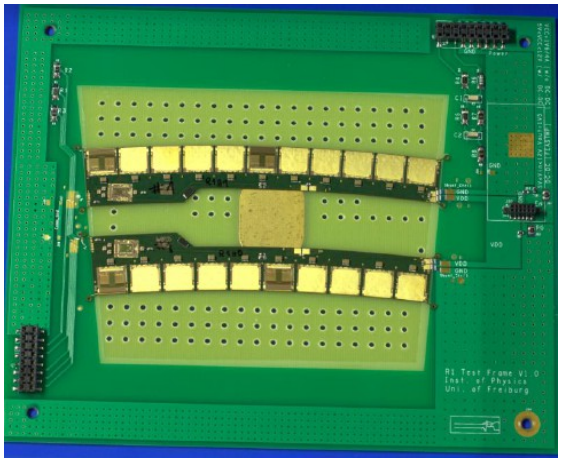


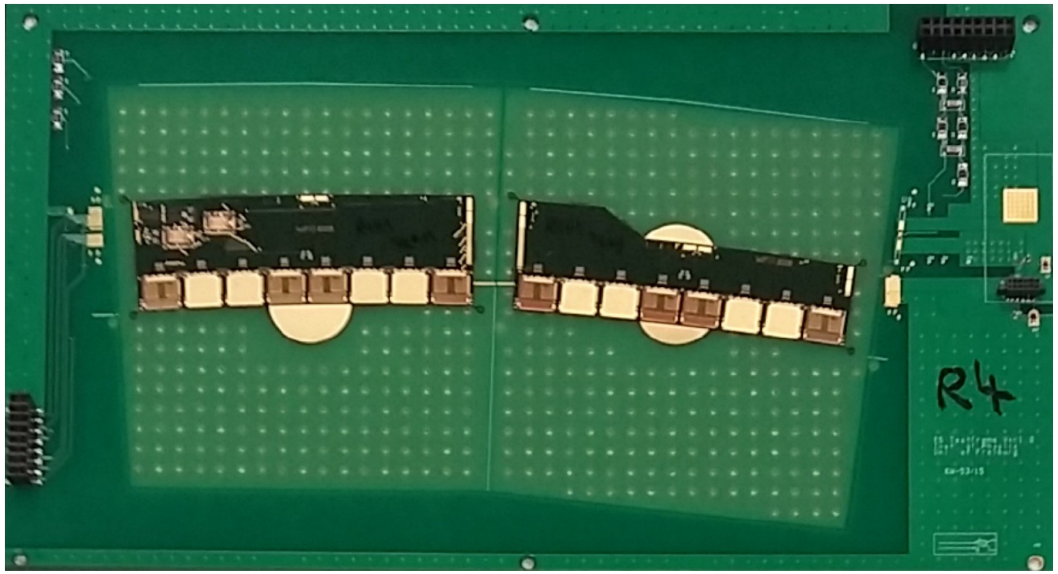




R4 hybrids (not fully populated yet)

- As for the other rings: started populating the hybrids only with chips on the start and end of the streams (to save some chips in case of a hybrid failure and due to limited availability)
- like for the partly populated R1 (see right) and others:
  - chips in the center work fine (if others are masked)
  - left/right ones return their IDs, but stall the readout during tests
- Confident, that R4 works fully when adding the other ABC130s
- But, not done so far for further investigation of the 'failure'
- Bonded to a R5 frame with large gaps (R4 frame designed, but not ordered yet)





DAQ issues

- Reverse readout (only) of the streams (loops) possible when changing the corresponding parameters in the ABC configs and the HCC registers

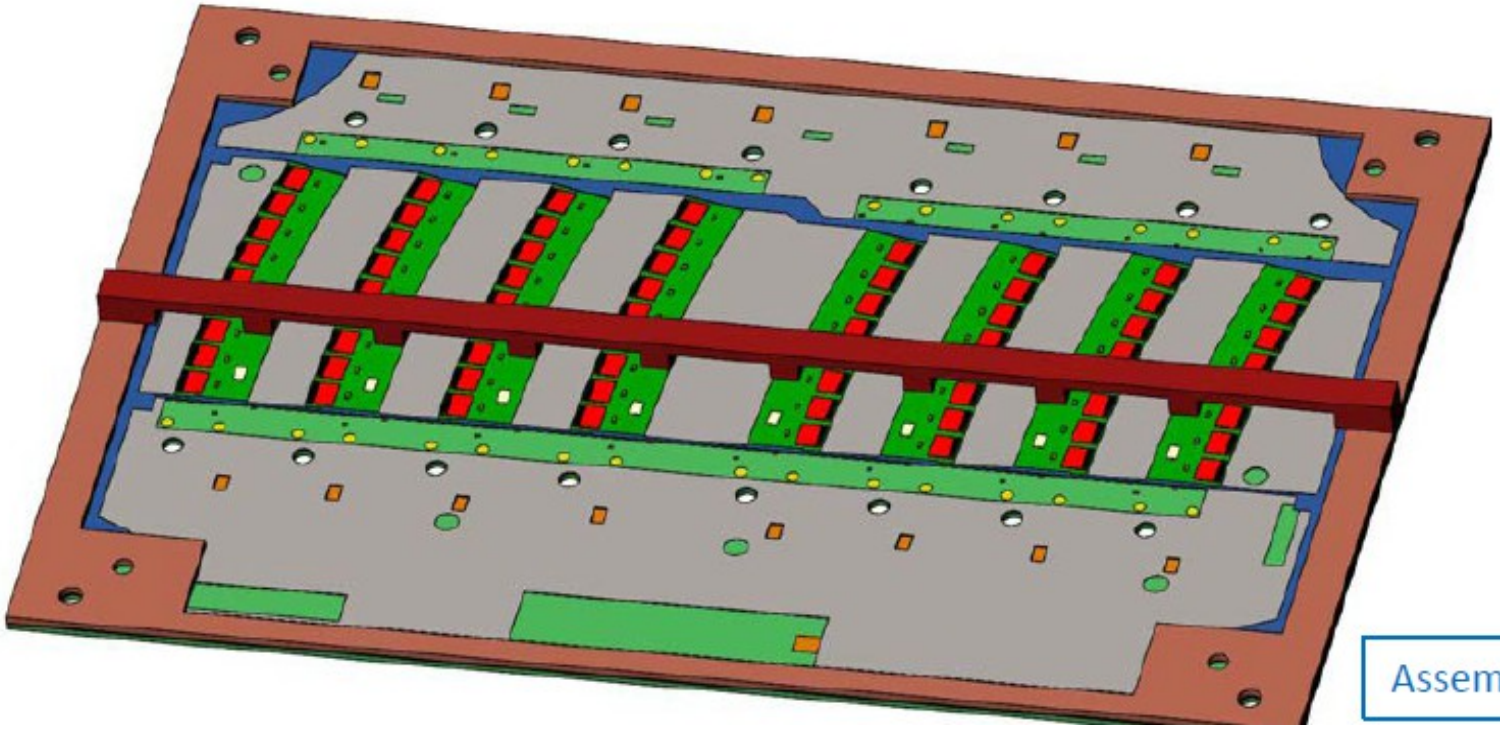
- All newer SCTDAQ revisions allow now reading out more than 10 chips in a stream, which was necessary for R1H1, having eleven chips (Thanks to Bruce!)

- Still (after changing to discrete caps or with DC-coupling) getting timeouts during scans when having 'medium' occupancy (long data packets?)

    - Not occuring for R0 hybrids
    - Next: Check R3 hybrids with the BCO fix applied

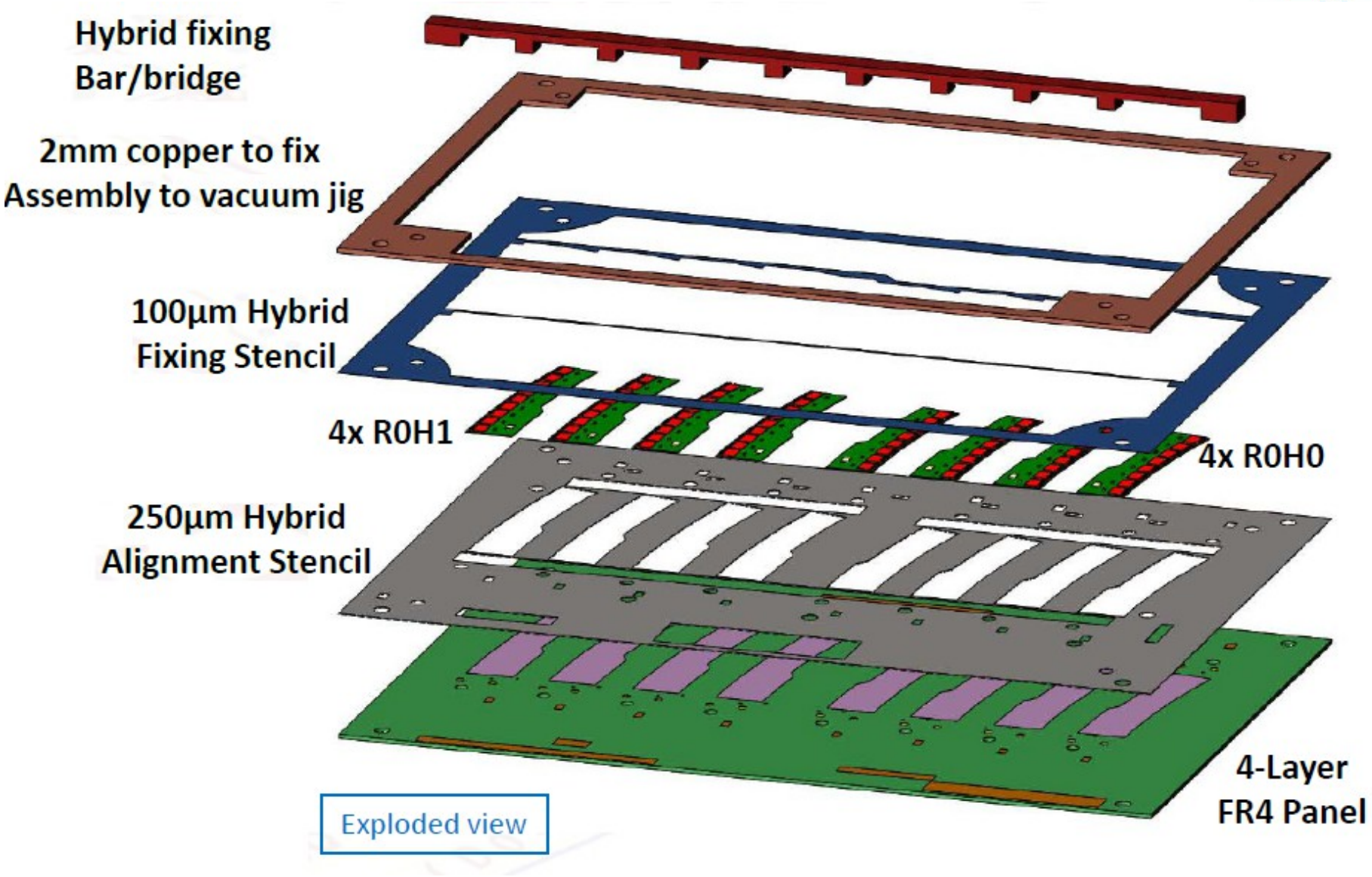
R0 Test&Assembly Panel

- Started with the design of a test&assembly panel to move towards a faster production and testing procedure
- Idea: hybrids get (still) produced in the same way, but then will be tested and assembled together, reducing the time for glueing and testing while keeping the costs at a reasonable level (using the full area of the production panel and re-using the test&assembly panels after the hybrids are glued to modules)
- First mixed R0 panel, stencils & jigs are in hand and will be tested soon...



Assembled view

R0 Test&Assembly Panel

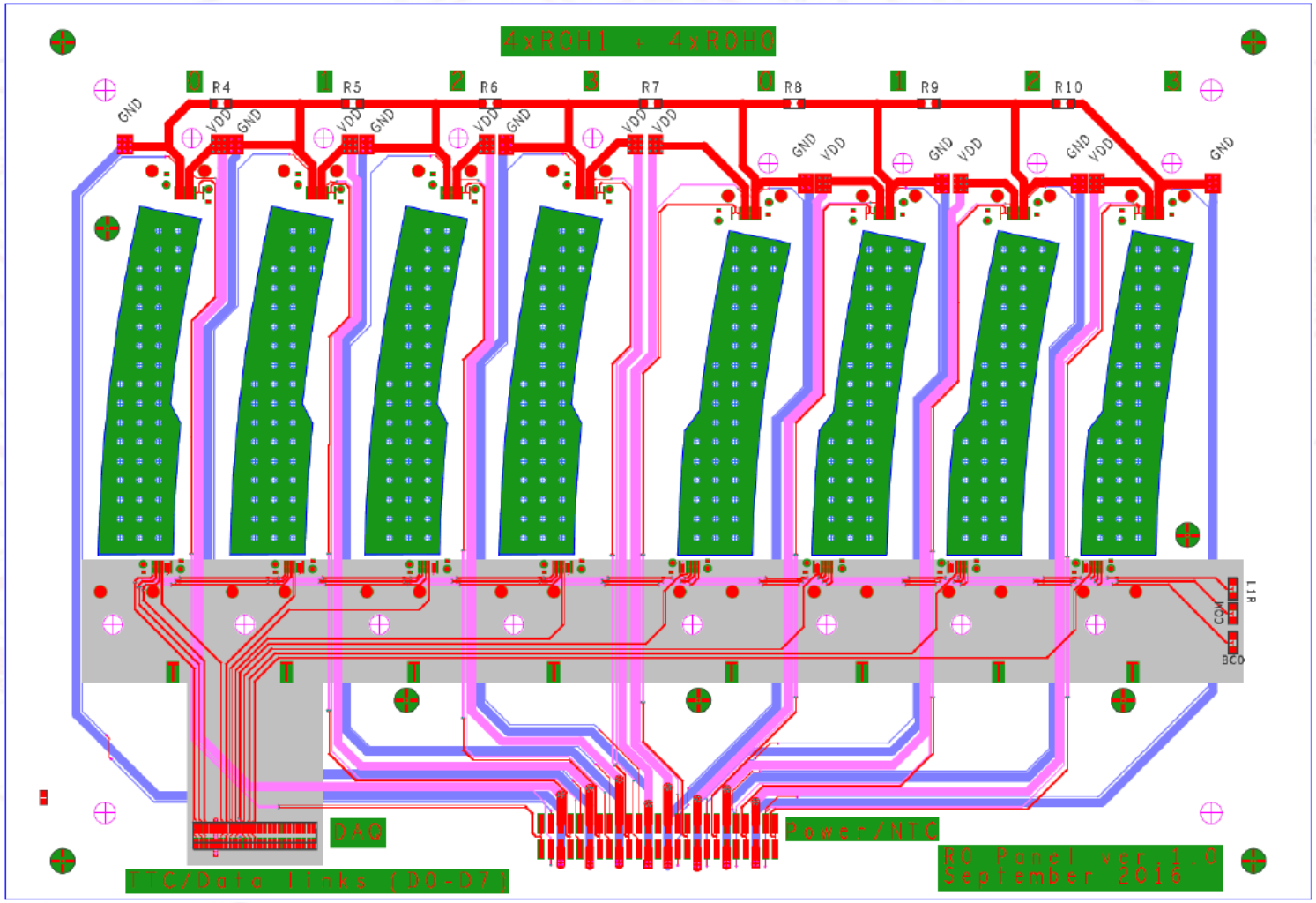


Summary & Outlook

- So far a full set of petal hybrids (except the R2) was populated with silver epoxy glue (only changing one thing at a time) → going for UV glue with the next one now
- All hybrids are working and produce reasonable results (with direct powering as well as with feast DCDC)
- Removed and replaced the capacitor arrays with discrete ones (even after having them fully populated and bonded)
- One hybrid (R0H1 with BCO fix & two mini sensors attached) is still travelling around the world and collecting data (to get some comparison between the sites and setups, maybe)
- Next Steps (in FR):
  - check if BCO fix for R3 improves the problem with timeouts
  - test the R4 frame (not really an issue)
  - Replace capacitor arryays on all R0 hybrids (and other rings)
  - investigate the idea of building and testing of hybrids in panels, starting with R0 (in principle a larger testframe holding 4xR0H0 and 4xR0H1 hybrids)
  - Build a R0 module to check the full performance as well (with power board ?)
  - Glue another R5 using (checking) the toolset

BACKUP

R0 Test & Assembly Panel



Hybrid Inventory

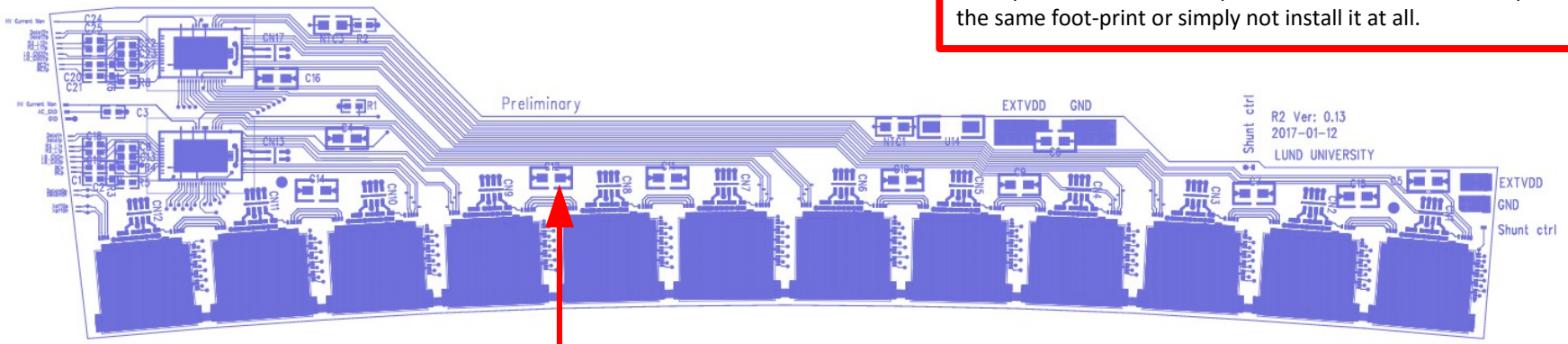
Ring	R0		R1		R3				R4		R5	
Hybrid	H0	H1	H0	H1	H0	H1	H2	H3	H0	H1	H0	H1
Passive Assembled	20	38	22	14	24	23	20	24	20	24	22	19
not assembled	10	10									1	1
Dummy	8	37	26	24	9			8				
Contag	16											

R2 HYBRID

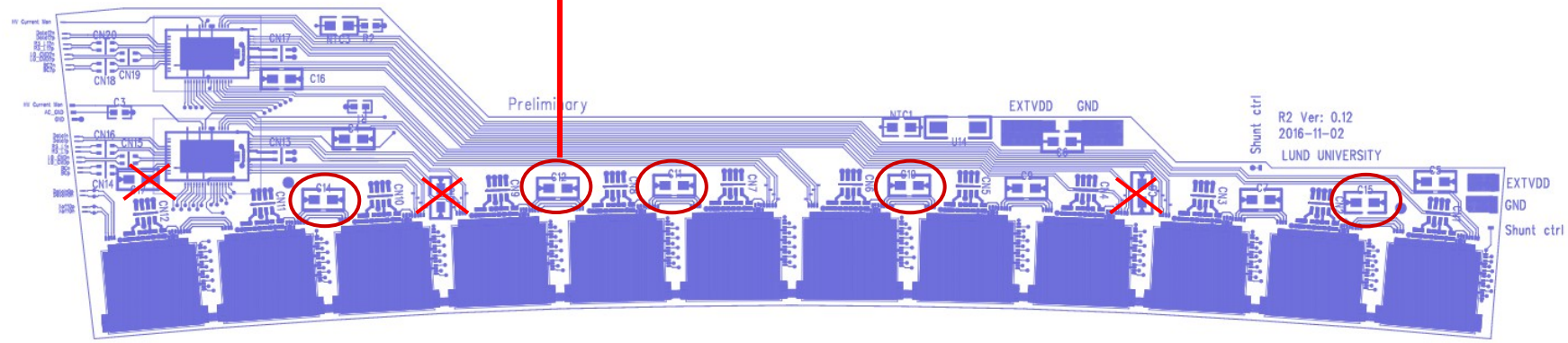
Carlos- All those big decoupling capacitors next to the ABCs are probably not needed and they are placed too close to bond pads. This may make things hard to bond. At least make them smaller (0402?) and move them further away from the bond-pads.

Lennart-I have removed 3 of them C8, C13 and C17. Others has been moved so that there are at least 1.5mm from any bond-pad. If there is still a problem it should be possible to mount a smaller capacitor on the the same foot-print or simply not install it at all.

NEW layout



OLD layout



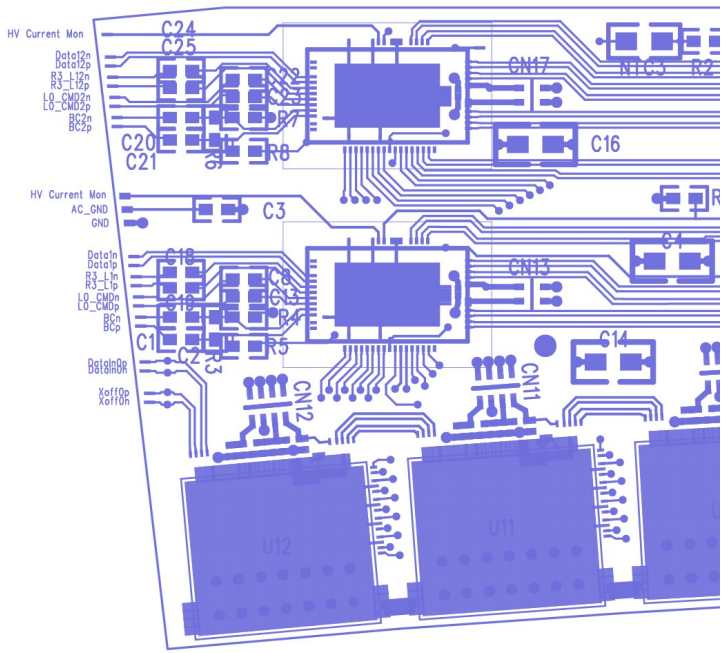
Carlos- The ABC130s seem to be given fixed IDs when all wires are bonded. At the moment we run the programme to bond all pads and remove the specific bonds by hand but that will change in the future to only bond the desired pads. Therefore, it's too inflexible to do this on the PCB even if it can be corrected by removing bonds and adding missing bonds.

Lennart - The fixed id-pattern for the ABC130 on the PCB has been replaced. The Id-is now set by the bond-wires.

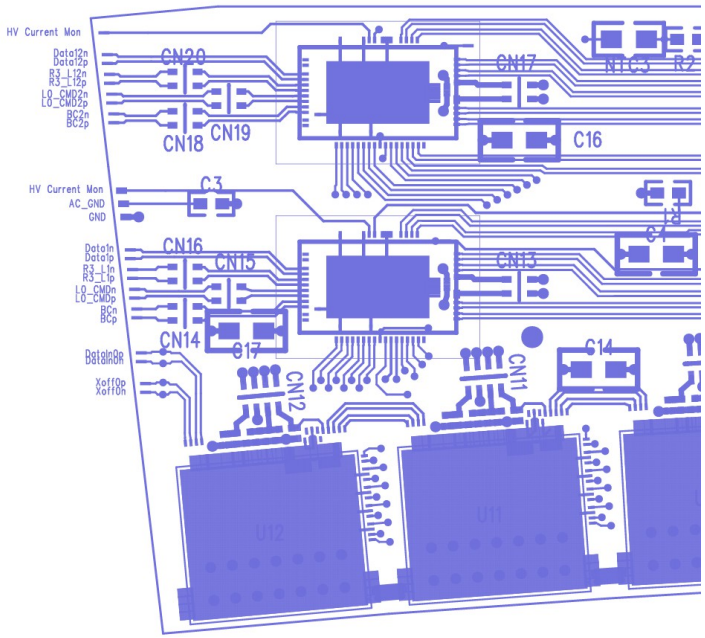
Carlos - A bonus to the previous one, the first ABC130 seems to have chip ID 0, which has be avoided from the firmware point of view. So at least that chip must be bonded differently if this design goes through. Both barrel and endcap hybrids produced so far have the ABC130 IDs starting in 16, so it would be desirable to stick to this. There are 2 HCCs on the hybrid so the IDs should be 16 to 21 (or 16-18 and 22-24) for both HCCs.

Lennart- The id:s on the schematics is changed to 16-21 for each of the two sets of ABC130-chips. But the id:s on the schematic is only a comment.

NEW layout



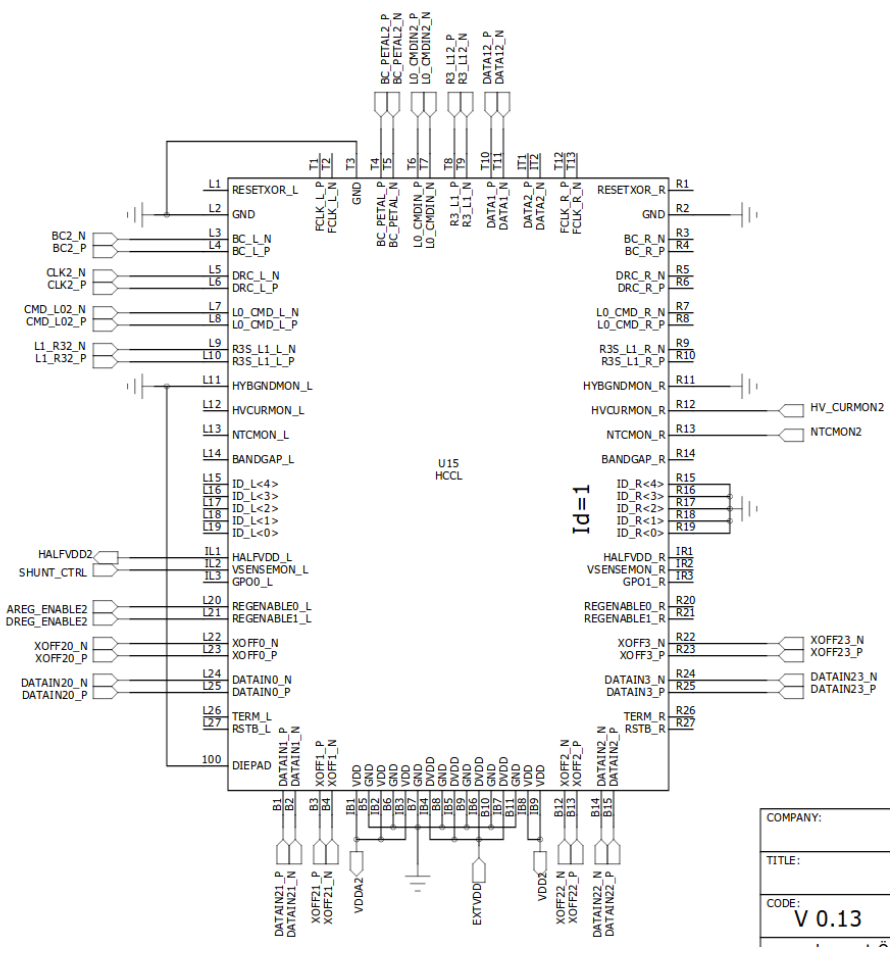
OLD layout



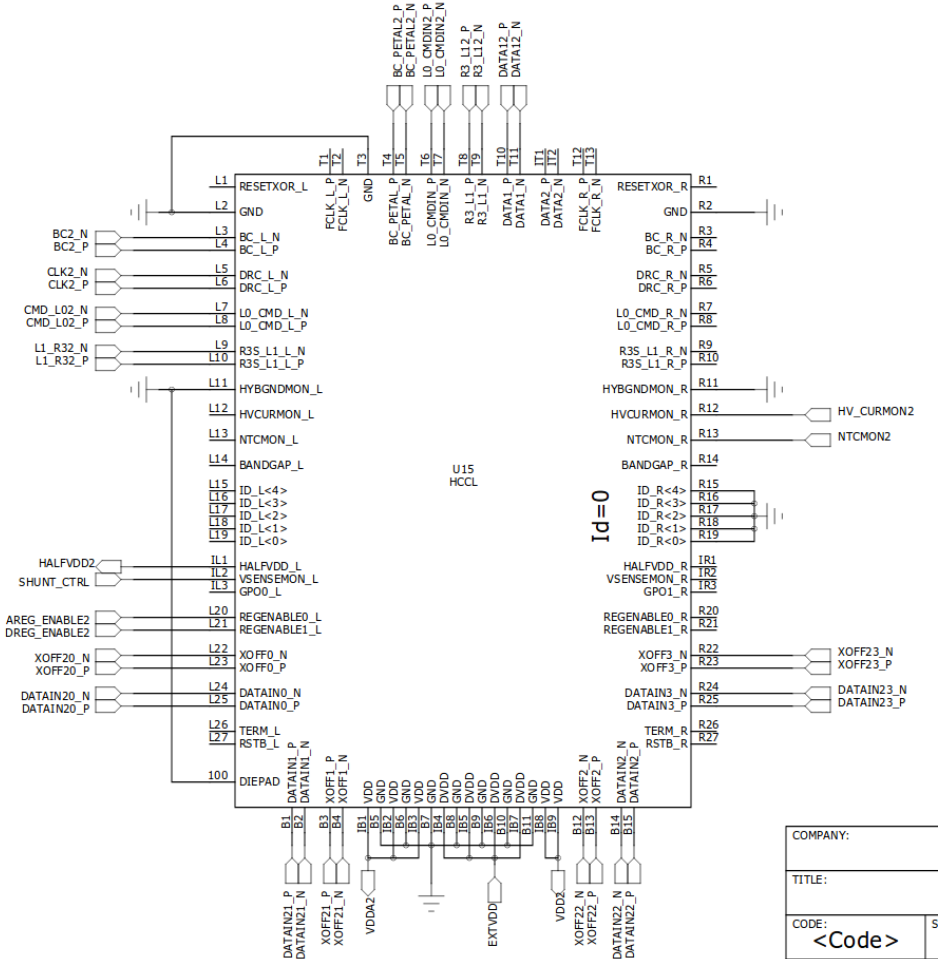
Carlos - I'm assuming that the schematic is wrong when it says "ID=0" for both HCCs, because that should not be the case.

Lennart - I have changed the Id:s for the two HCC to 0 and 1. But again it is only a comment on the schematics. The real id is given by the bond-wires. I guess that the id:s should be given in a systematic way on the whole petal.

NEW layout

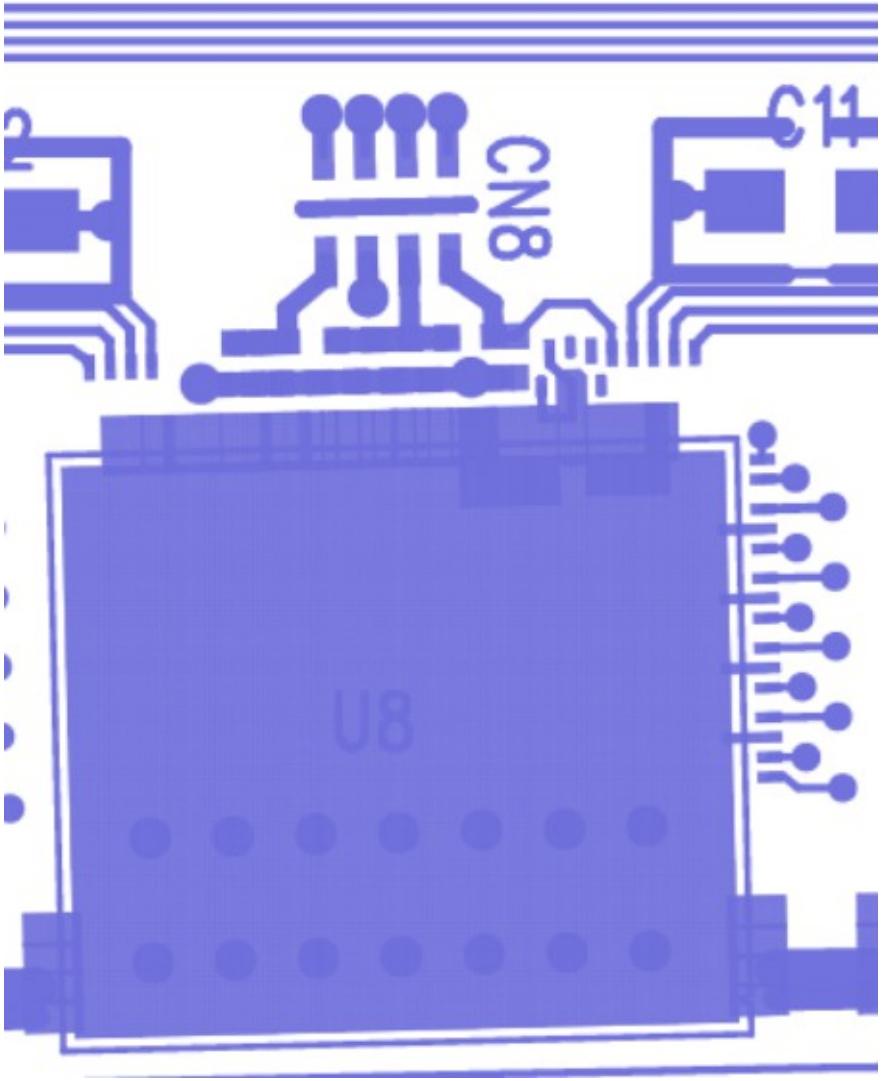


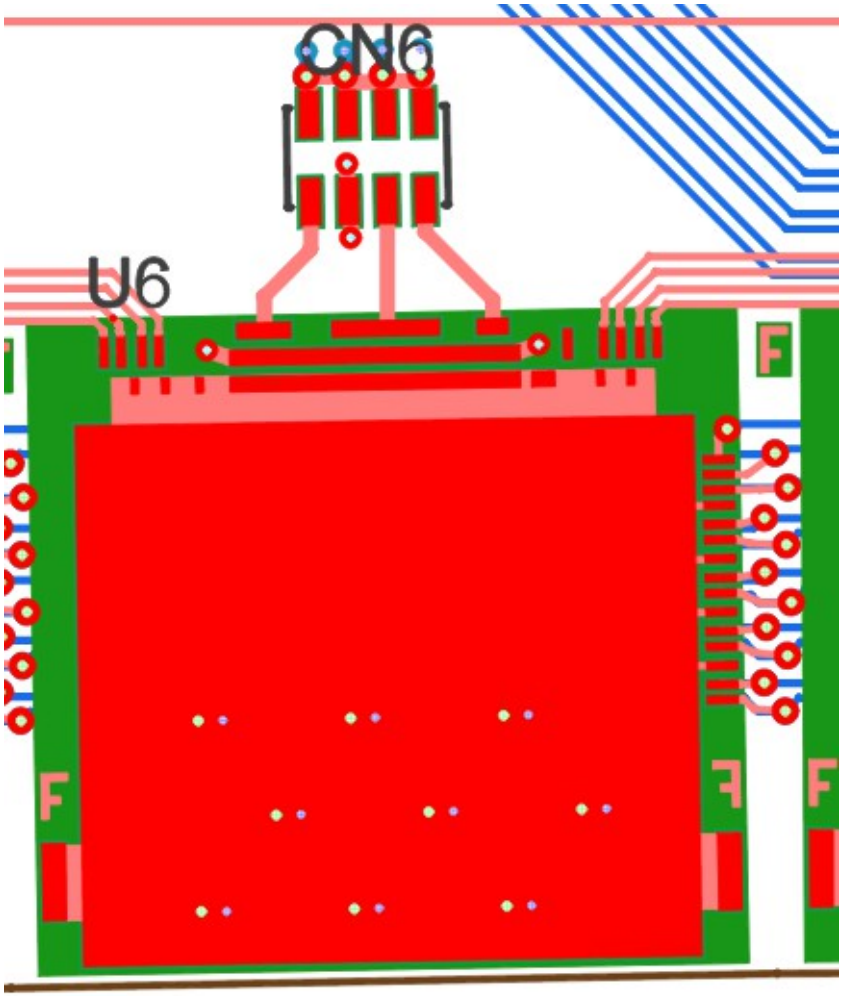
OLD layout



Carlos - Correct me if I'm wrong, but the ABC130 pads seem to have a different arrangement from all the other hybrids. Looking at the pads on the sides of the ABC130s, the distances are quite different. The endcap hybrids produced so far use the exact same arrangement as the barrel for the simple reason that this way, the bonding programmes don't have to be modified when bonding one or the other.

No action on present layout but will be changed for STAR layout to be identical with other hybrids





Next steps

- Commit changes to twiki page
- Report changes to ITK
- Send request for quote to Würth Elektronik GmbH & Co. KG
- Finnish the test frame PCB for the hybrid → Jan?