how to do the cabling of the tracking plane?

This is a compilation of the main required inputs. Please, if you are not competent about this topic, just search for your name and answer the question attached to it.

Diego Gonzalez-Diaz (18-7-2012)

I. general information on cables

maximum length of cables outside TPC ($cable_{out}$)

4m from lead-shield to electronics chassis **[Curro]**

1m from TPC to lead shield **?** **[Derek /Jose Luis]**

maximum length of cables inside TPC ($cable_{in}$)

1.2m **[Derek]** – **1.5m** **[Diego private estimate]**

NEXT-100	NEXT-DEMO++
$cable_{in}$: max_{length} == 1.5m $cable_{out}$: max_{length} == 5m	**?**

other information perhaps not obviously connected to the design:

is it possible to make all $cable_{out}$ with the same length?

It seems so (Diego) **?** **[All]**

is it necessary?

It seems so due to money arguments (Diego) **?** **[Javier]**

is it possible to make all $cable_{in}$ with the same length?

Present arrangement. No **[Derek]**

Modified arrangement by Diego. Seems so. Requires mockup test.

is it necessary?

It seems so due to money arguments (Diego) **?** **[Javier]**

II. Industrial and technical constraints

number of Dice boards in the final system	**103** [Alberto/Derek]. I also heard 108 and 111. **[Igor]** ?
minimum number of pins per DiceBoard	**71** **[Javier]**
minimum trace thickness due to practical limitations (fragility, ?)	**10µm** seems workable [from the D_o experiment]
minimum (trace thickness x width / length) due to resistive losses?	Requires some simul **[Diego]**. Ongoing. **100µm x 5µm / 90cm** looks still reasonable
minimum trace thickness for a bond-ply with Fraloc?	**5µm** **[Derek]**
minimum kapton thickness for a bond-ply with Fraloc?	**25µm** **[Derek]**
maximum kapton thickness	**127µm** **[Javier]**
pattern in the ground plane. What is possible?	**everything** **[Fran-Zaragoza]**
pattern in the ground plane. Any constraint for gas tightness /Fraloc bond-ply?	**[Derek]** ?

III. Physical requirements and related

maximum intra-cable and inter-cable cross-talk

<1pe/250pe, safe value **[Francesc, Curro, Javi, Azriel].**

Impedance matched?
(Note that this favors strip-line as a natural option to keep impedance correct in cable$_{in}$ and cable$_{out}$ [for micro-strip, small adjustments of the trace width will also work]

yes [Derek, Azriel]
no [Diego]

capacitance to ground?

less than C_{SiPM} [Diego, Azriel]
do a first principle estimate **[Azriel/Diego], ongoing.**

Maximum deterioration in rise-time?

Maximum deterioration in peak-time?

less than 1µm (for 1cm resolution) ? [Azriel]

Flexibility?

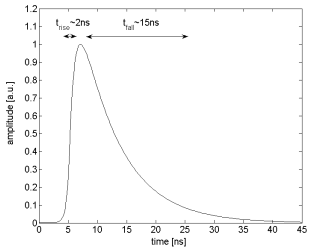
as thin as possible [Derek]

try 2 different cables in view of NEXT-100

Additional shielding for wrapping-up the cable?

Hard to say. It might be a good idea. **? [All]**

typical signal shape?



2ns rise-time / 15ns fall-time
[Nadja/Hamamatsu]

IV. Practical information

what is the total extension of the bond-ply region

I think only the cirlex region. ? [Derek]

SiPM capacitance at nominal HV

35pF [Azriel]

Cross-section view of Dice-board showing the ground and HV planes?. Would be nice.

? [Javier]

It seems we would like to keep the 10-15% rule for additional cables in the feed-through stack, correct?. I mean, what happens if we realize some cable has a problem or got damaged??. We make a new feedthrough?

? [Igor, Derek]

should not the Dice-Boards be accessible from the TPC-head once opened?. This seems to be a good idea for replacement. And it is hard to see any problem with it.

? [Igor, Derek]

V. Connectors

is there any problem with using the present Molex/Hirose at Zaragoza?, any reason for continuing research?

? [All]

should we use 100 ohm differential for the matched option (fine, it is probably 50ohm/trace, to be checked)?. Ok, but we need 80pin connector. Who is looking for it?

? [Derek]

activity per unit mass of present Molex/Hirose?

? [Susana, Javi]

maximum connector dimensions

? [Javi, Derek]

0.3mm (height) x
4.5mm (width) x
6mm(length).

VI. Electronics

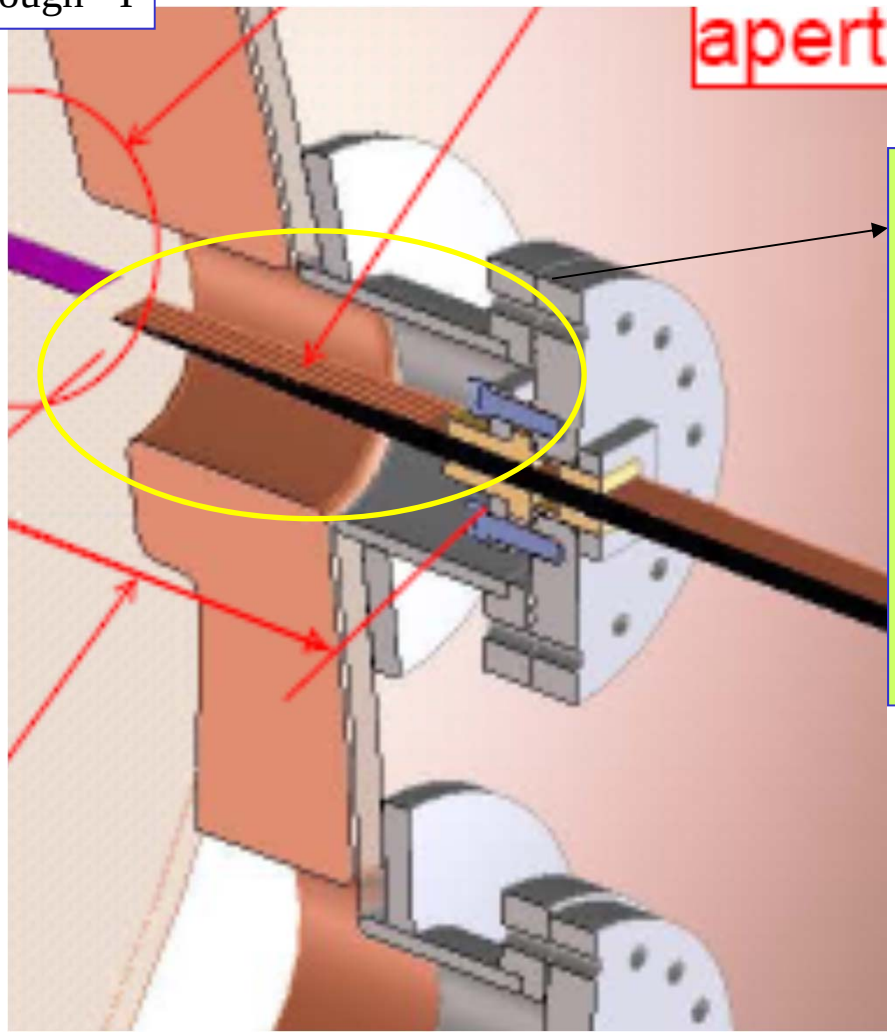
Option 1: I get an officially stamped schematics that I can use for reference. **? [Curro]**

Option 2: we accept that I can describe the signal as that on a simple transimpedance amplifier with R_{in} =50ohm and a feedback loop RC=0.5-2μs (ideal integrator). Gain R/R_{in} is immaterial. **? [Curro]**

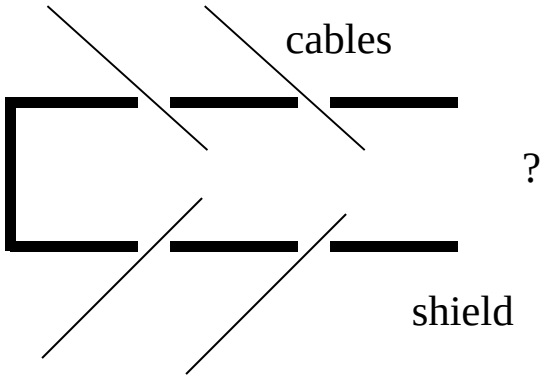
which RC to take? **? [Curro]**

specific questions

Feedthrough - I

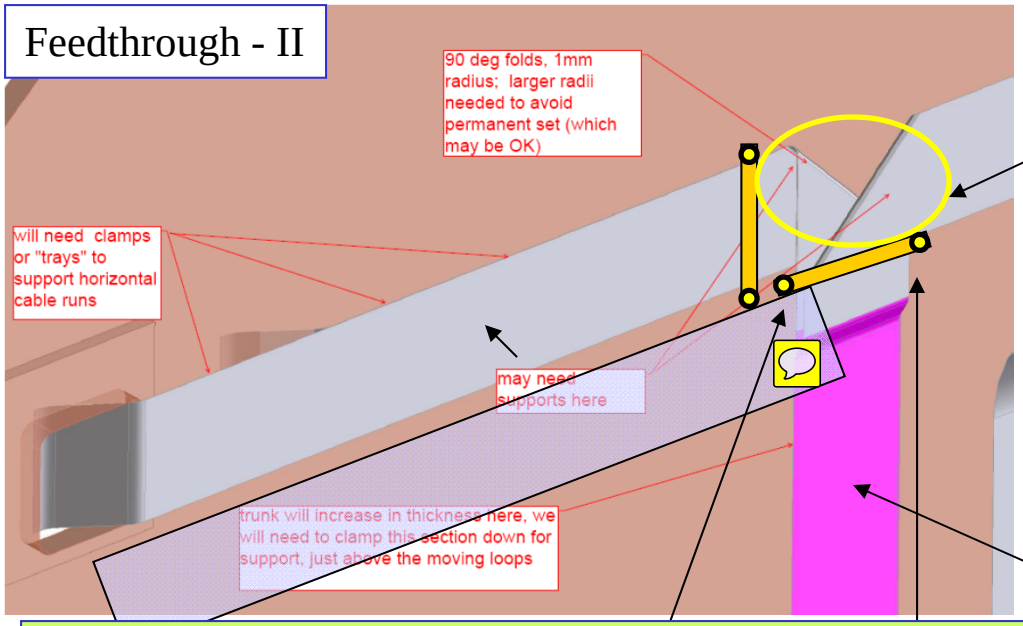


I understand that the end with the connectors falls down under gravity, **correct?. Or how far from the feed-through do we plan to do the bond-ply?**. In order to shield connectors, all cables have to fit through a copper shield with some slit on it. I do not see how to easily retract 56 cables through a slit by the 20cm required for outside connection (unless some mechanism pulls from inside). **How is this done?**. Perhaps one can make 4 slits. This should be even more comfortable over 4 feed-throughs (see later). Means ~ 7 cables/slit. However not sure it is doable even then...



In any case, in case of emergency it seems one might want to access the inside (opening the head) while pushing the feed-throughs inwards, in order to ensure that cables are retracting properly?. **Do we require some additional ~15cm length for this contingency?**

Feedthrough - II



Is this bend here realistic enough to justify this arrangement?. Since bends in reality will not take place in one plane but go out of the carrier plate plane, we need to know if they can be brought back to the carrier plate plane soon enough to be clamped before the bend of next row takes place. This seems to be the only way to keep this tidy.

Remember there are Dice-Boards immediately underneath the trunk. Such boards have to be rotated 90deg allowing for the cable to go direct down. This seems to be possible according to next figure. **Correct?. Indeed cables from such boards are the first ones to be routed.**

It seems it will be useful to clamp here before the cables in the next row are routed. One has to start cabling from above to below and for each row from the trunk-inwards to trunk outwards. I am not sure that cables can be bent over such small space and brought be back to the surface of the carrier plate soon enough so that it does not interfere with next row. In any case, having these clamps will help a lot. **Is there any space for them?. Similar question to any clamp used along the cable.** From the drawings of slide 11 it looks really tight.

Note that since, with this arrangement, **there is basically an unique way of doing the cabling** (except left-right symmetry) there is an unique way of mounting the DBOs. **Correct?** Accordingly, replacing a single DBO will require un-mounting everything and mounting the full carrier plate again (except if by chance they were the last to be mounted –violates Murphy's law) or soldering in an impossible position. This seems very unreasonable. **Is not it??**

a way to avoid that is to foresee some pins that go from the Dice-Board to the back of the carrier plate. It is possible to solder there (might help a bit). No idea how to do this without connectors except for soldering the pins. One can also omit the problem: there are surely sneaky ways of placing in a new Dice-Board + cable and still respecting the old scheme, but entropy will then increase rather fast. **Would this be acceptable?**

Feedthrough - III

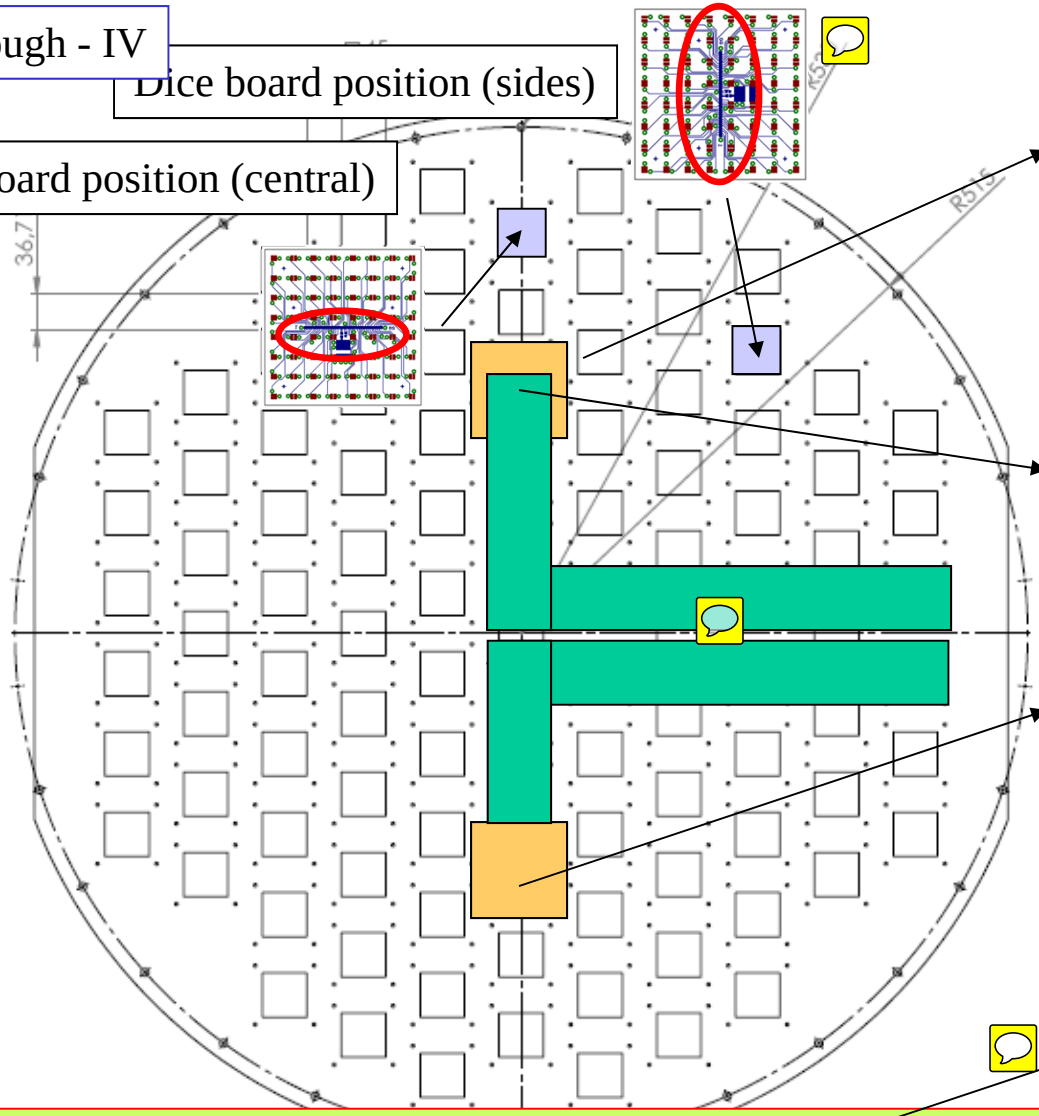
?

I can not find a way how the cable carriers can be used. In the hanging loops?. But what about clearance between cables then?. And why is this needed?. In the proposed arrangement everything follows nicely straight tracks.

Feedthrough - IV

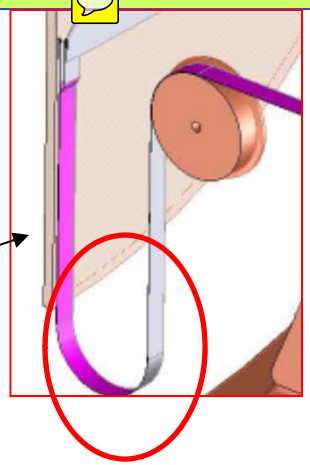
Dice board position (sides)

Dice board position (central)



Will the wheels be placed in front of the flange?. This seems to be a good idea. **Will they be placed around here, perhaps?. How will they be fixed by the way?**

maximum cable length ~53cm+25 cm+20cm (for connector access without head removal) + 25cm wheel-connector **~150cm. [Derek estimate for maximum length (120cm)].**
minimum cable length ~ 20cm+25cm **~45cm Correct?.**

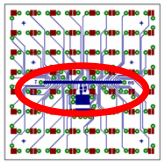


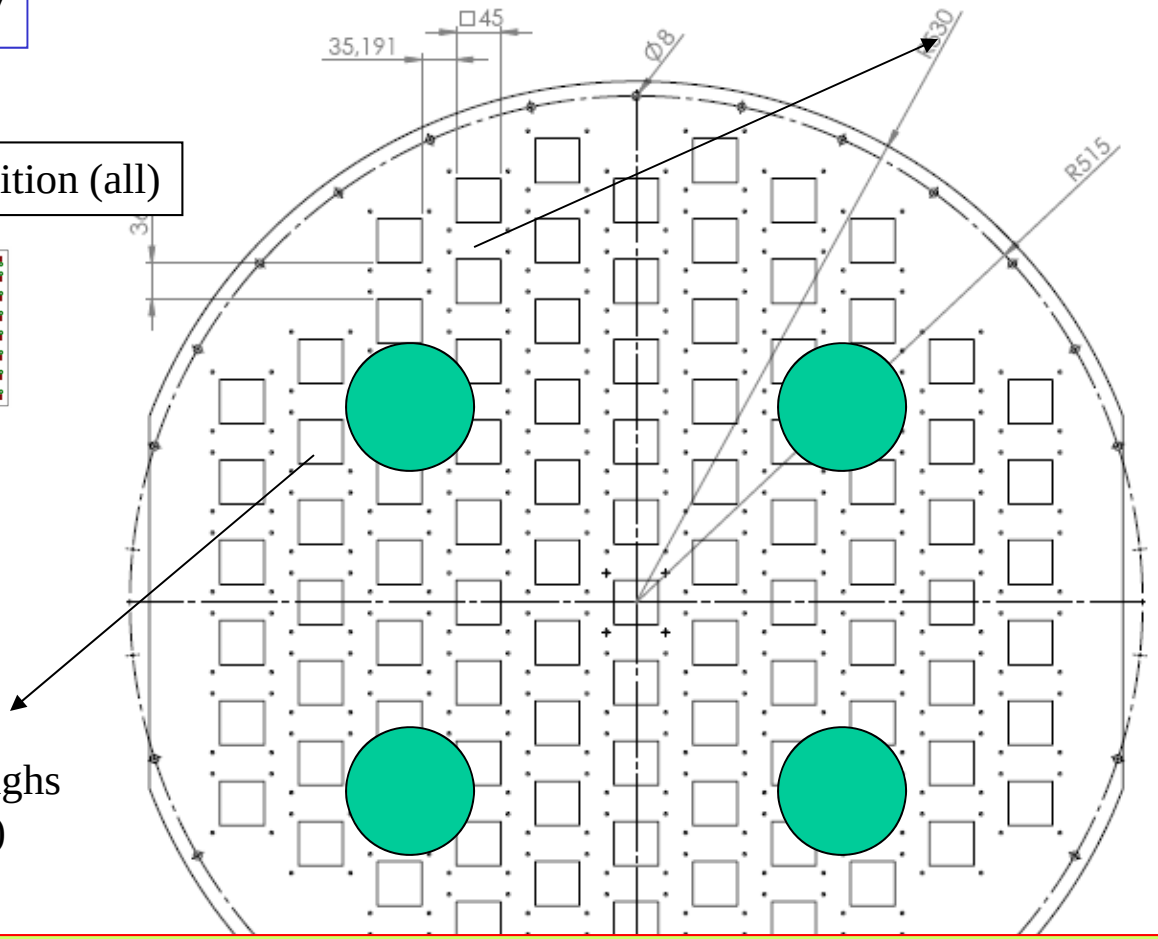
might not fit unless individual cables are designed

Cables have to be finely tailored one by one, otherwise even if the Dice-Boards are placed in the right order, the corresponding hanging loops will not fit. **Might not be a problem if the cables can be cut by hand to the right length?.** Buying all cables with different lengths I fear it will be unacceptable money-wise **(am I wrong?).** Cutting by hand might not work since it seems one typically needs one end with, e.g., sculptured traces (for the Dice-Board) and the other end with ZIF-compatible traces.

Feedthrough - IV

Dice board position (all)





4 feedthroughs
(no wheels)

I might propose... the super-duper random-accordion scheme

use just 4 feed-throughs and route the cables following reasonable pre-defined rules. Then all cables can be used with the ***same length***, ~approximately 50-75cm. With these dimensions I think it should usually work. If it does not, then try again. At most you have to undo some part of 1/4th of the carrier plate. Dice-boards can be assembled and disassembled anytime without touching the rest. Even better if it would be possible to access them from the back of the carrier plate. Material budget will be considerably less. Back to back ZIF on-board connectors can be used for connecting feed-through cables with Dice-Board cables (with 4 feed-throughs there is enough space). Clearance between cables will be naturally respected (at least to a larger extent than in previous scenario). **It is easy to build a mockup and test it**.

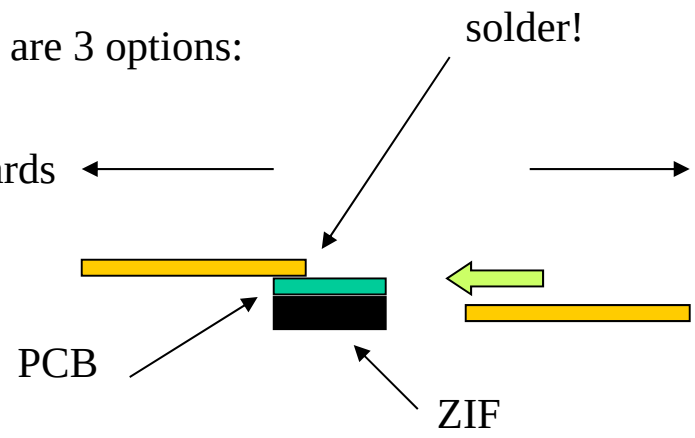
cable-to-cable connections

Derek, Javier, Diego did not manage to find direct ones. Possibly do not exist.

It seems there are 3 options:

main problem:

1) to the Dice-Boards ← → to the FEE

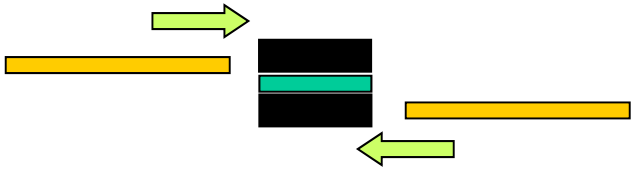


Javier does not like (but clearly it is a solution)

2) to the Dice-Boards ← → to the FEE

Derek does not like (takes a lot of space for feedthroughs— solvable if using 4)

3) to the Dice-Boards ← → to the FEE



height increases ~x3. [Derek]

Can it really work?.

Is there a through-hole version for our ZIF connectors [Javi/Derek]?

4) like 2 but with flex PC (Derek)