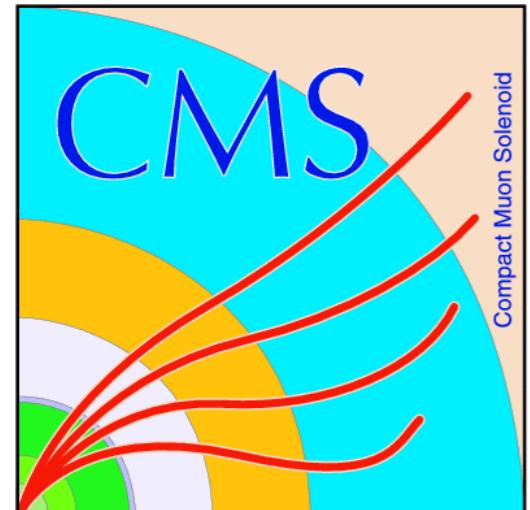


HD and LD integration update

Nadja Strobbe, with input from many
2020/12/9



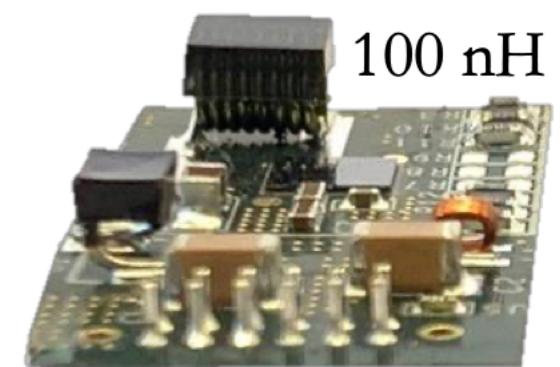
Outline

- Bpol2V5 integration
- Rules for motherboard mapping
- Other integration topics

Bpol2V5 integration

Bpol2V5 integration

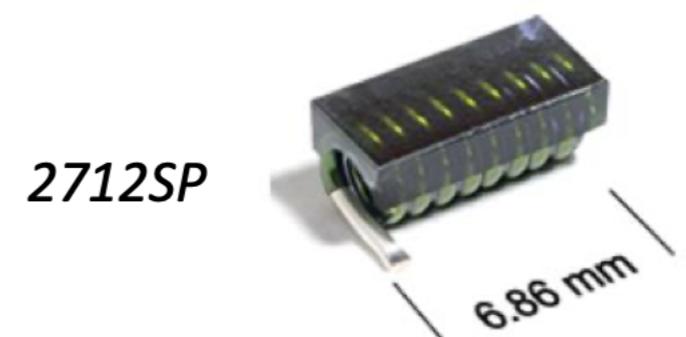
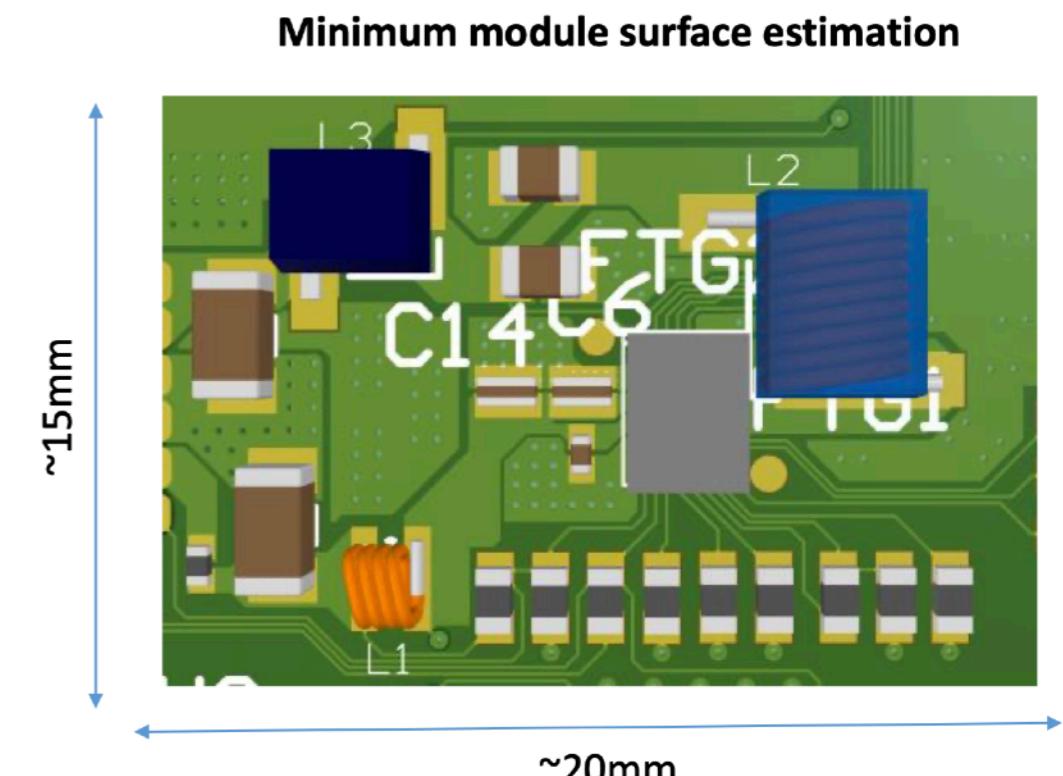
- Powering solution for the HD region and the engines relies on the bpol2V5 (ok up to 7×10^{15} n/cm² [1])
 - bpol12V cannot go into the HD region because of radiation tolerance (ok up to 2×10^{15} n/cm² [1])
 - bpol12V also too big to fit on the engine
- Powering in 2 steps:
 - bpol12V to convert down to 2.5 V
 - Then bpol2V5 to convert to needed lower voltages (1.2 & 1.5V)
 - Rating: up to 3A
- Place bpol2V5 where the power is needed, place bpol12V at larger radius (either on a LD module or on the periphery)



bPOL2V5 module

Bpol2V5 integration

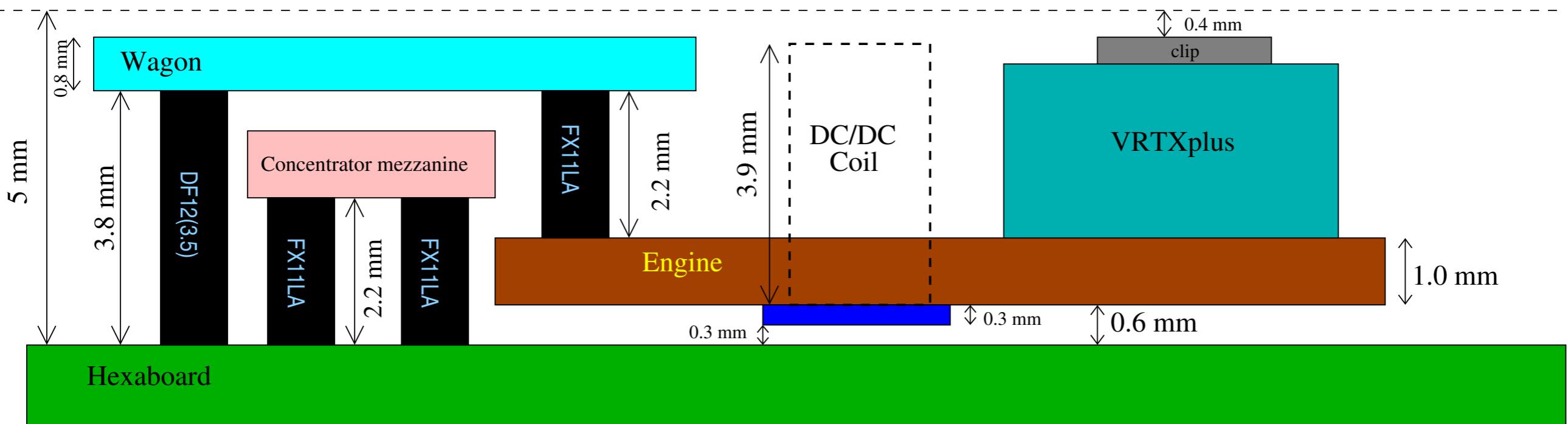
- Bpol2V5 should be integrated on very thin mezzanine, rather than incorporated directly onto engine/wagons
- Needs low-profile coil
 - Candidates identified
 - Heights 2mm – 3.15mm
 - Only need 1 of the 3.15mm coils (has $L=100\text{nH}$), so this option minimizes series resistance
- Note: see Karol's talk for detailed height budget with tolerances



LD region

- bpol2V5 only needed for the engine
 - Exploring concept of placing bpol2V5 mezzanine PCB below the engine, and the coil (and other components) sticking up through a hole in the engine.
- Would need 1 bpol2V5 per LD engine to supply 1.2V (~1A)
 - If we need to also power GBT-SCA with 1.5V from the engine, we would need another bpol2V5...

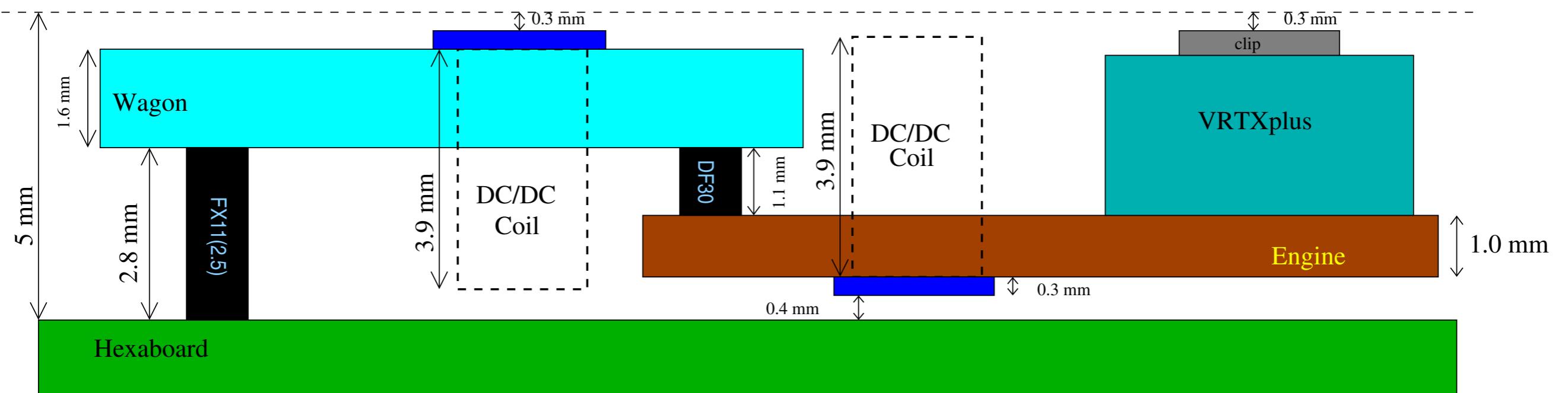
Engine Power estimate



HD region

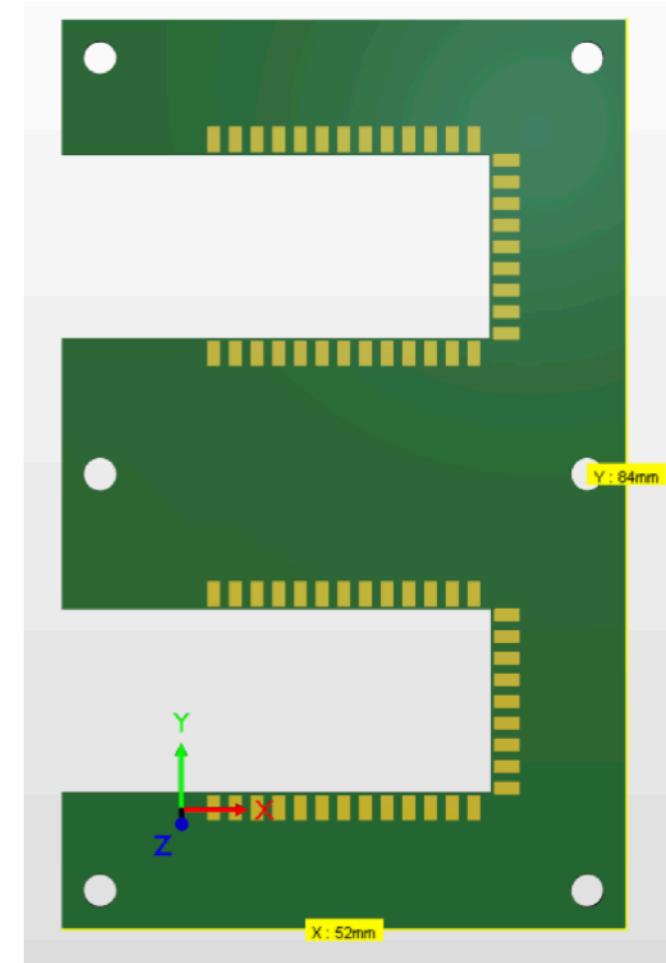
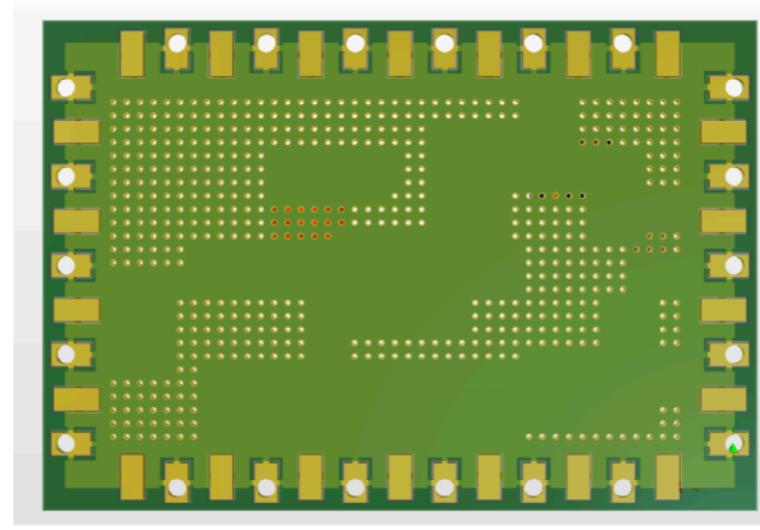
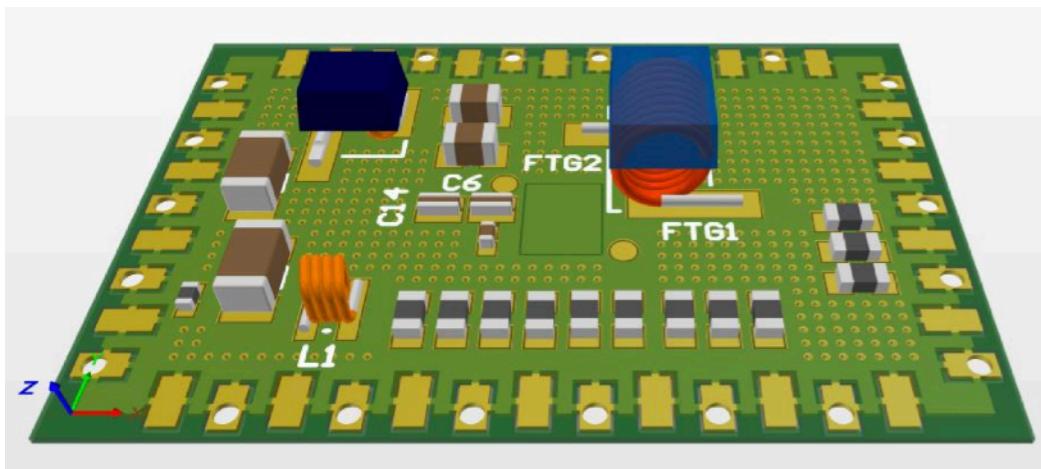
- bpol2V5 needed both for the engine and for the module
 - Exploring similar concept for engine
 - No room on the HD hexaboard, so intend to mount the bpol2V5 mezzanines onto the HD wagon: mezzanine pcb above the wagon, with coil sticking through a hole in the wagon towards the module
- Need 1 bpol2V5 per HD engine to supply 1.2V (~2A)
- Need 2 bpol2V5 per HD module to supply 1.2V (~2.9A, max rating is 3A)
- Need 1 bpol2V5 per HD module to supply 1.5V (~2.5A)
 - If we keep SCA, could perhaps supply its 1.5V from the “module” bpol2V5 (250mW/SCA) instead of adding extra bpol2V5 on the engine

HD module power estimate



Planned tests

- To decide on connection scheme, P. Rubinov has designed a set of small test boards
- Will allow for testing of different soldering strategies
 - solder through hole
 - solder pad to pad
- Boards arrived yesterday!



Available space to place bpol12s

- We need to find a place for the bpol12Vs that supply the bpol2V5s
- Two possible locations:
 - On the periphery – Not enough space for all
 - Inside the cassette, on the LD module (only mech. connection)
- Can also consider a mixed approach



Available space for bpol12Vs inside the cassette

Using numbers from the baseline doc
for #LD modules and #needed bpol12s

- 1 bpol12 per HD module
- 1 bpol12 per HD engine
- 1 bpol12 per LD engine

Table assumes no deported bpol12 on
the module with the HD engine, could
be relaxed where needed

**Conclusion: there are just enough
LD modules to place all needed
bpol12s**

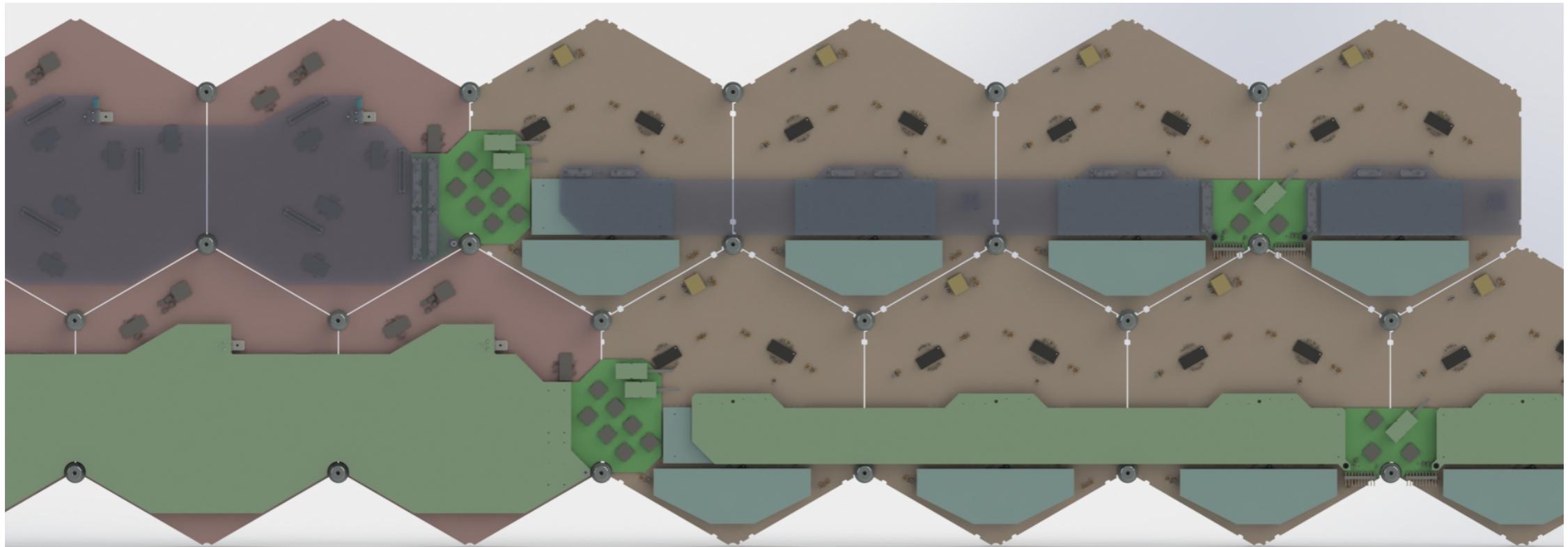
If more engines are needed, might
need to use space on periphery

Layer	LD modules available	HD bpol12s	Diff	HD+LD bpol12s	Diff
1	26	16	10	24	2
2	23	16	7	24	-1
3	26	16	10	24	2
4	25	16	9	24	1
5	26	16	10	24	2
6	25	16	9	24	1
7	26	16	10	24	2
8	25	16	9	24	1
9	29	16	13	24	5
10	24	16	8	24	0
11	28	17	11	25	3
12	24	17	7	25	-1
13	28	17	11	25	3
14	26	17	9	25	1
15	30	17	13	26	4
16	26	17	9	25	1
17	30	17	13	26	4
18	26	17	9	26	0
19	30	17	13	26	4
20	28	17	11	26	2
21	30	17	13	26	4
22	28	17	11	26	2
23	30	17	13	26	4
24	30	17	13	26	4
25	33	17	16	26	7
26	31	17	14	26	5
27	34	17	17	26	8
28	32	17	15	26	6

Mapping rules

Mapping – nomenclature

- **Engine**: Contains VTRX+ and IpGBT
- **Wagon**: Connection between modules and engine, currently contains GBT-SCA, contains ECOns for HD region
- **Concentrator mezzanine**: Only for LD region, contains ECOns
- **Train**
 - LD region: LD wagon + LD Engine + LD wagon
 - HD region: HD Engine + HD wagon



Note: HD region only conceptual idea

Rules for the mapping LD region

- LD and HD modules cannot belong to the same train
- **Link counts:**
 - **Engine: max 6 DAQ elinks and max 14 TRIG elinks**
 - Nominally, max 3 DAQ elinks and max 7 TRIG elinks arrive on each side of the engine
 - But, engine has 2 crossing elinks, accommodating imbalance between links from either side, e.g. 5 trig elinks from one side and 9 from the other.
This comes at a cost of extra wagon varieties
 - Full modules must have at least 2 TRIG elinks and 1 DAQ elink
 - **Full modules can have max 4 TRIG and 2 DAQ elinks**
 - Assumed for the wagon-module connector pinouts
 - Assumed for Concentrator mezzanine connector pinout
 - This rule is violated for some modules in CE-E

Rules for the mapping LD region

- **Link counts:**
 - Partial modules:
 - Fives count the same as full modules
 - Half and Semi must have 1 or 2 TRIG elinks and must have 1 DAQ elink
 - Threes do not contribute any elinks to the overall count
 - Don't contribute TRIG data at all
 - DAQ data goes into ECON of adjacent Full module
- **Radiation considerations**
 - Should place components where they are within their radiation tolerance (e.g. neutron equivalent fluence)
 - VTRX+: fine in LD region
 - bpol12V: can actually be rather tight margin, depends on exact tolerance — to be double-checked

Rules for the mapping LD region

- **Geometric considerations**
 - **Service routing path should not be impeded**
 - Affects orientation of full module (bpol12 blocks full height)
 - Affects wagon shapes, e.g. no wagon spanning multiple modules that are all on the edge, except near the 30 degree line
 - Engines must be placed between two full modules
 - Full module and a “five” could be allowed if no other option, but at the cost of a special CB version
 - Straight wagons are preferred, but can be any shape
 - Layout of board should be possible, so can't become too narrow
 - Should allow for Conc mezz to be connected to wagon near partial modules
 - Three partial must be attached to Full module, not another Partial
 - Aim to balance both sides of the train

Rules for the mapping HD region

- A HD Train can only have HD Modules connected to it
- **Link counts:**
 - **The HD Engine has 2 DAQ IpGBTs and 5 TRIG IpGBTs**
 - Would be better for engine layout if we only needed 4 TRIG IpGBTs
 - At most 2 “coupled” TRIG IpGBTs
 - **pair of IpGBTs must contain whole number of ECONs**
 - Constraint from the backend
 - “coupled” = must be interpreted together,
i.e. receives packets from same ECON-T
 - Example:
ECON-T-1 → IpGBTs 1 & 2, and ECON-T-2 → IpGBTs 2 & 3: NOT ok
ECON-T-1 → IpGBTs 1 & 2, and ECON-T-2 → IpGBTs 3: ok
 - **Radiation considerations**
 - VTRX+ on HD engine must be at radius satisfying the radiation tolerance

Rules for the mapping HD region

- **Geometric considerations**
 - No more than 4 HD Modules in a HD train, the inner-most module in a train of 4 must be a partial module
 - constrained by size of PCB that can be easily manufactured
 - perhaps also constrained by available connector pins for control
 - Connections to the HD Engine can be made from one side only
 - The HD Engine must sit on the HD-LD boundary, and overlap with a LD module (needed because of its size)

Possible rule modifications?

- **#daq elinks per LD engine 6 → 7**
 - Currently: max 6, 1 elink needed to control 2nd SCA
 - If GBT-SCA is removed, and EC port is used in multidrop mode to control trig IpGBTs, then 7 daq elinks are possible
- **#crossover elinks for LD engine 2 → 3**
 - Currently: 2 crossing elinks implemented in EngineV2
 - EngineV2 also includes some functionality for scintillator section, which will be removed for final version. Should free up enough pins to add an extra crossing elink if desired

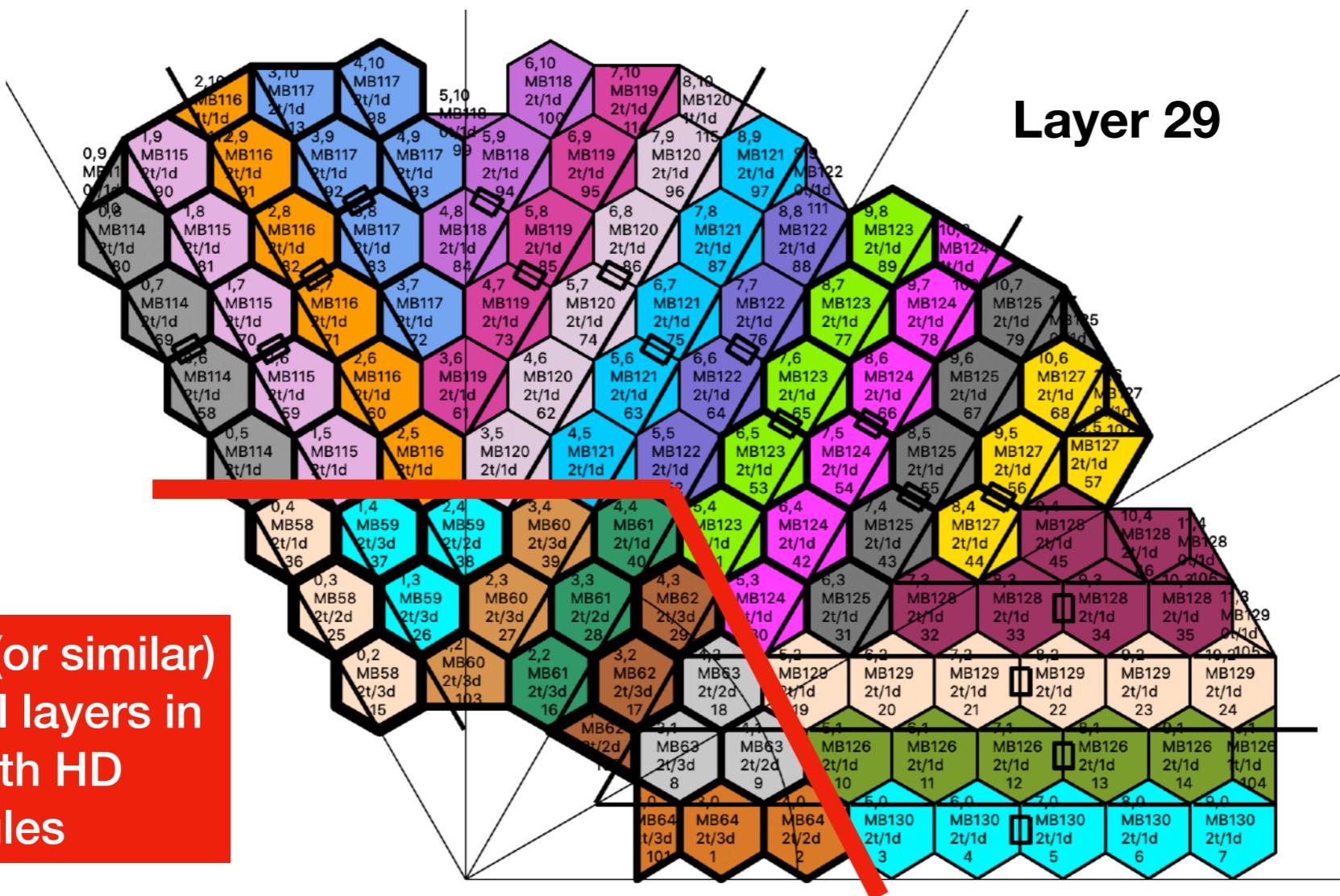
Possible rule modifications?

- **More trig elinks per LD engine?**
 - Currently: 2 trig IpGBTs on the engine, so 14 trig elinks
 - Baseline doc assumed 3 trig IpGBTs, so 21 trig elinks; could be of use in some CE-E layers
 - However, going back to 3 trig IpGBTs would be extremely difficult, if not impossible!
 - Board layout is challenging already (+ will need to make a hole to fit the quite large bpol2V5)
 - Connector is very tight, for sure cannot add 7 elinks
 - Is it really worth it?
 - What would be effect of raising thresholds a bit?
 - Can always add another engine for the cases where it seems to matter

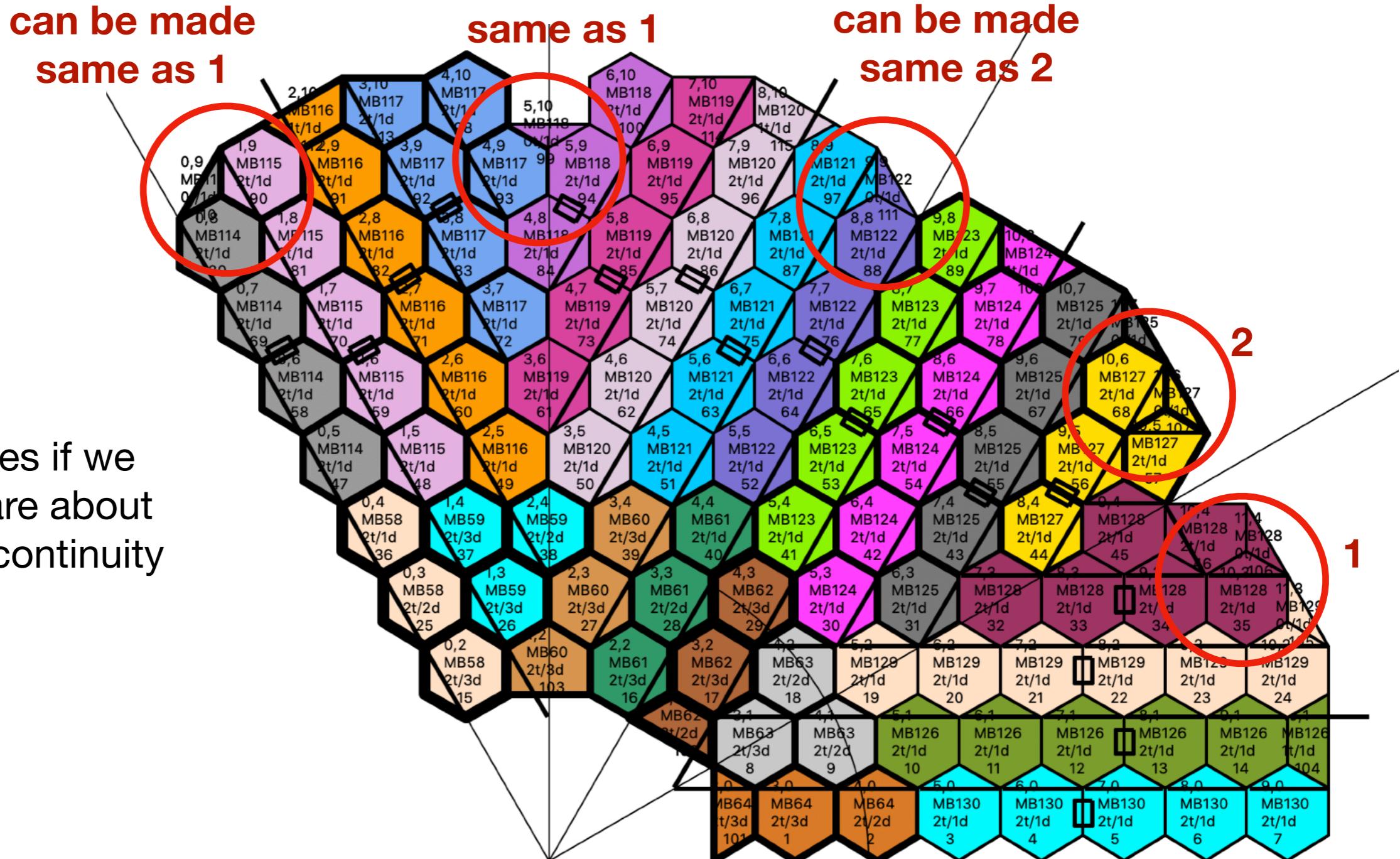
Other topics

CE-H HD region

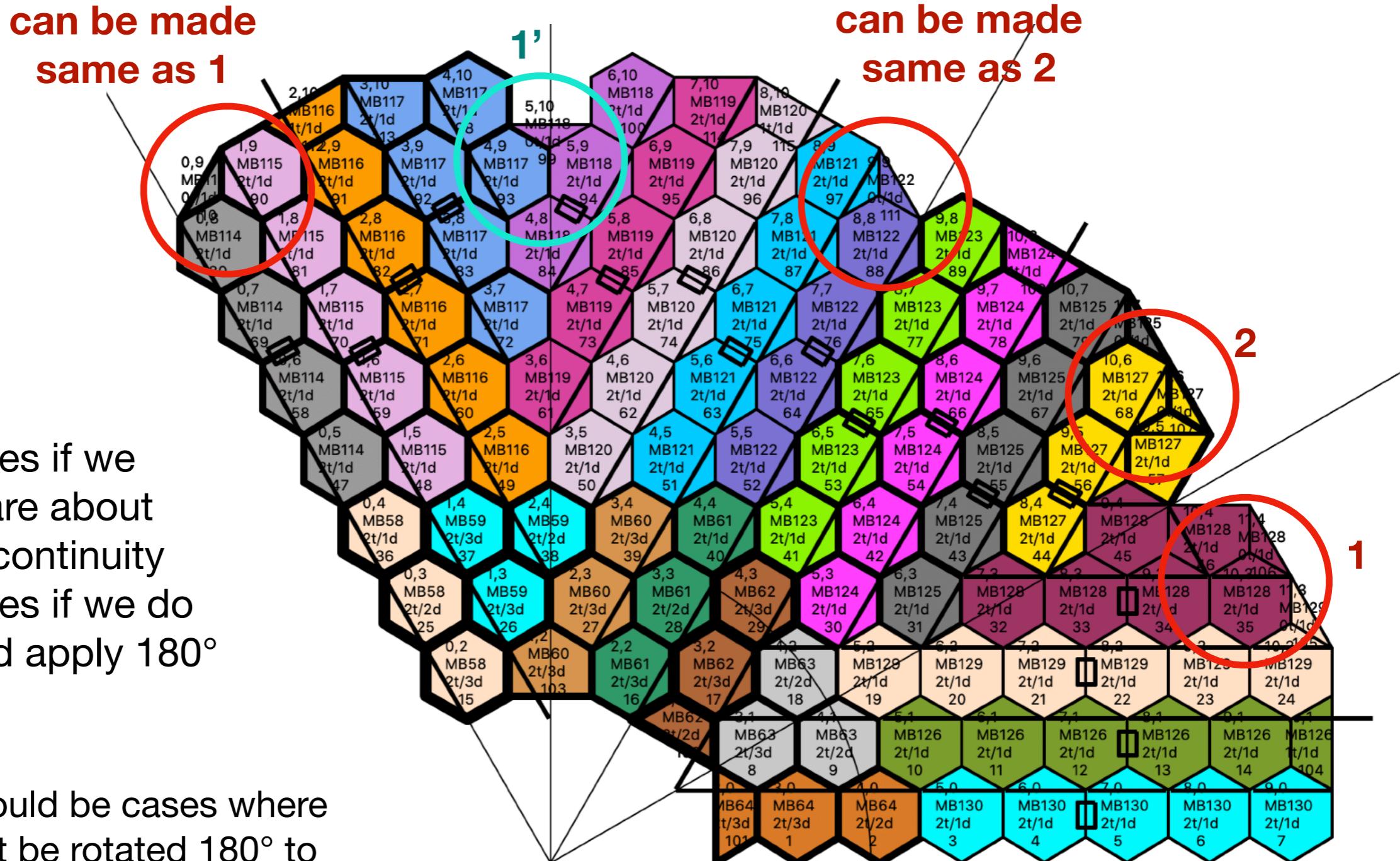
- Propose to streamline the HD region in the CE-H to reduce number of HD wagon varieties that are needed
- Small tweaks of LD \leftrightarrow HD module wrt baseline document



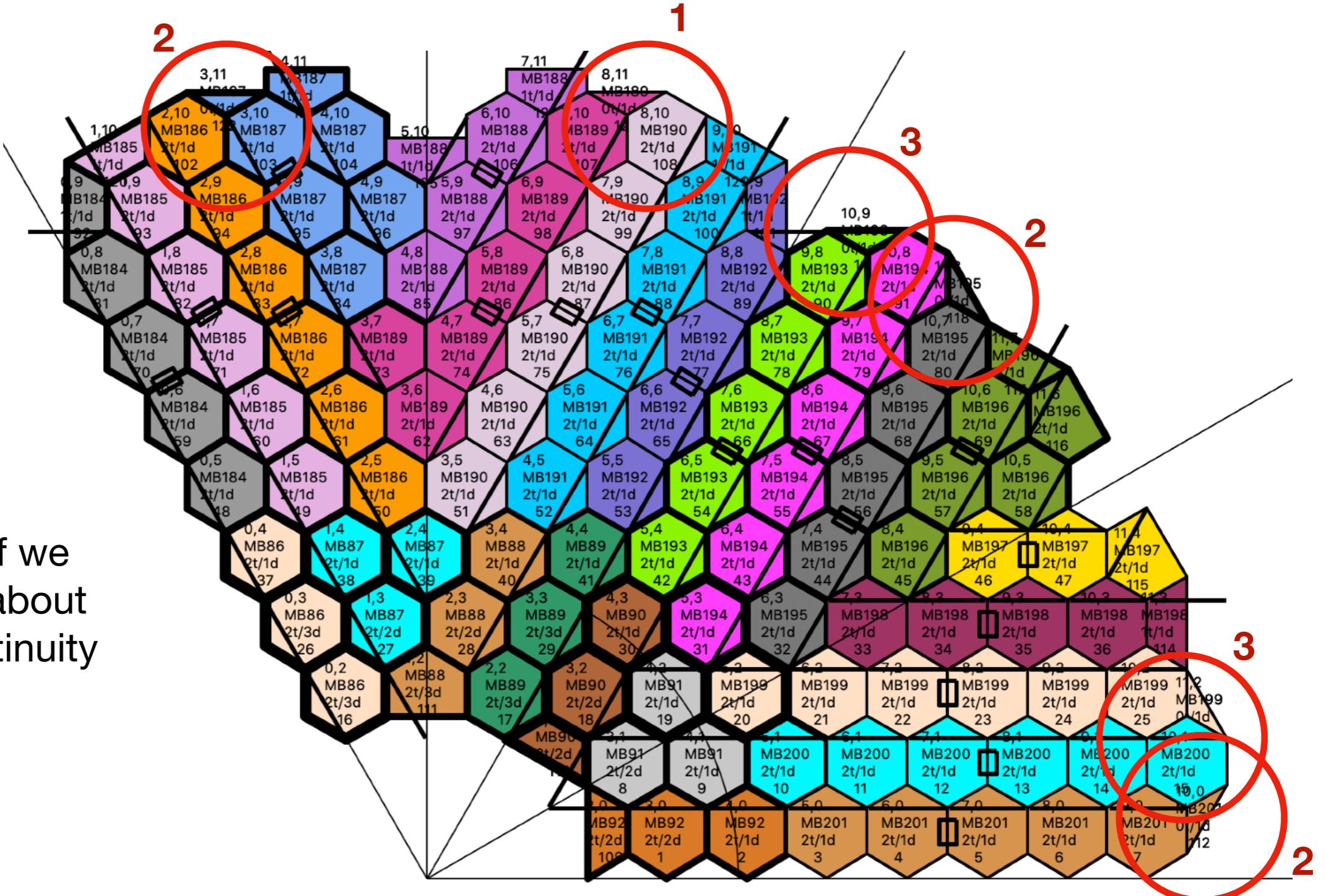
How many Three+Full HB varieties might we need?



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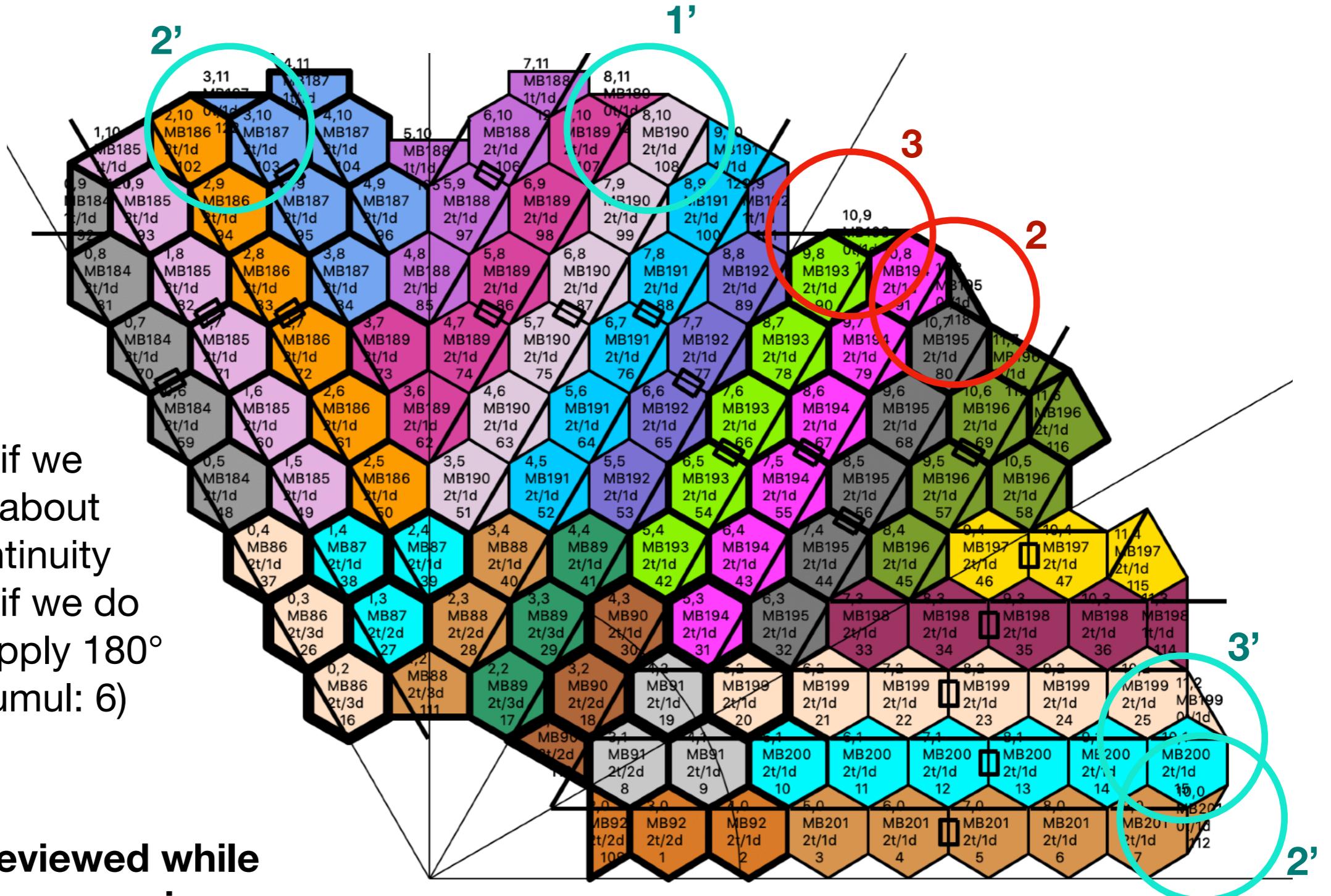
Layer 33:

- 3 varieties if we don't care about sensor continuity

How many Three+Full HB varieties might we need?

Layer 33:

- 3 varieties if we don't care about sensor continuity
- 5 varieties if we do care and apply 180° rotation (cumul: 6)



Other items

- Remove GBT-SCA? Talk in later session
- Include Rafael chip — affects pinouts etc
- Confirm #trig IpGBTs needed in HD region based on backend constraint
- Follow up on bpol12 radiation tolerance and compare with location of innermost LD modules
- Confirm power consumption so that # of needed bpol12s and bpol2V5s can be decided
- Choice of wire sizes inside the cassette
 - Must be coordinated with possible connectors
 - Should also consider deported DC/DCs