
Interleaving of modulator to klystron connections.

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1. INTRODUCTION

In order to maximize the availability of the ESS linac, the impact of a modulator failure should be minimized. The superconducting part of the linac reportedly can still work with one or two cavities not being powered, under the assumption that they are not next to each other. The assumption being used below is that the more unaffected cavities there are between the ones that is without power, the better the possibilities to retune the linac. Interleaving patterns are with one exception constrained to them that can be done on one side of a penetration, i.e. for eight klystrons at a time.

2. PATTERNS

Depending on the number of klystrons connected to each modulator, we get different possibilities which are outlined below.

2.1 One modulator per klystron

Best case, no interleaving necessary or possible.

- Pattern 1A: abcdefgh Only single cavity un-powered

2.2 One modulator per two klystrons

If the modulator is connected to two klystrons next to each other, the availability of the linac will be compromised in case of a klystron failure as two adjacent cavities will fail. The alternative is to interleave the connections in order not to have two cavities next to each other which are being fed from the same klystron. There are different possibilities of this interleaving pattern, varying in complexity and in robustness to modulator failures.

- Pattern 2A: aabbccdd 0 cavities in between un-powered ones.
- Pattern 2B: ababccdd 1 cavity in between un-powered ones.
- Pattern 2C: abcdabccdd 3 cavities in between un-powered ones.

2.3 One modulator per four klystrons

Here the alternatives are fewer, as more cavities share the same power supply. The best that is achievable is one unaffected cavity between each of the affected ones.

- Pattern 3A: aaaabbbb 0 Cavities in between un-powered ones.
- Pattern 3B: aabbaabb 0 cavities in between un-powered ones.
- Pattern 3C: abababab 1 cavity in between un-powered ones.
- Pattern 3D: abcdabccabccabcc 3 cavities between unpowered ones, involves 16 cavities.

2.4 Three modulators per eight klystrons

This is a special case, where is a mix of 2.2 and 2.3 above. The modulators are feeding 3, 3 and 2 klystrons respectively.

- Pattern 4A: aaabbbcc 0 cavities in between un-powered ones.
- Pattern 4B: abcabcab 2 cavities in between un-powered ones.

3. COSTS AND RISKS

The more complex interleaving patterns add some costs and risks. The more complex patterns have longer cables, which will add cost. It might also involve additional crossings of cables, which might influence ground loops and EMC levels in the gallery. It further makes the correct labelling and connection of the cables important.

4. CONCLUSION

Interleaving the connections between the modulators and the klystrons is an interesting prospect of minimizing the impact of a modulator failure at a very low cost for the installation.