Q & A for DRFS

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1. quantity of that part per 3 cryomodules Numbers of Components in DRFS

Item	Low P DRFS	Back-up	Full P DRFS	Back-up	BCD
Cavity	26		26		26
Directional Coupler	26		26		26
Magic Tee(Hybrid)	19.5		13		32
Load	39		13		24
700kW Klystron	6.5		13		
MBK					1
Focusing PM(EM)	6.5		13		1
Coil P/S	0	0	0		1
Heater P/S	1	1	1	1	1
Pre Amp	6.5		13		1
LLRF	6.5		13		1
Interlock module	6.5		13		1-26
Trigger Module/depend on fanout					1
MA Modulator	0.5	0.5	0.5	0.5	
DC P/S	0.5	0.5	0.5	0.5	
Modulator					1
Pulse Transformer					1

2. What happens when that part fails (e.g. lose energy from 4 cavities or lose energy from 3 cryomodules.

- Klystron: MTBF=110,000hr, ILC Op/year=5000hr, then 325 tubes are failured. Fraction=4.5%

  If overhead is more than 4.5%, klystron failures don't affect to the ILC operation. Repair is conducted in summer shutdown. If not, unscheduled maintenance would be necessary when failured fraction exceeds overhead.
- DC Power supply: MTBF of 70000hr is assumed. Fraction=7.1%

  This fraction exceeds the allowable overhead.

  It is possible to introduce backup DC power supply as the redundancy as MA modulator. Cost impact is discussed later.
- MA Modulator: Assume MTBF=from 50,000 to 70,000 hr.

  Back-up modulator covers the another modulator's failure. Since two modulators failures at the same time are very rare, we can expect no failure in a year operation. Failured MA modulator are repaired or exchanged in the scheduled shutdown.

If fraction of failed parts exceeds allowable value, they should be replaced in the short scheduled shut down. Especially fails for the DC power supply and MA modulator result in 13 klystrons (26 or 54 cavities) and fail influence is large.

Q(III)

- 3. The MTBF to assume for the part. Note that if something is redundant (say the klystron filament supply) the MTBF for a complete failure should be given, not the MTBF for one of the redundant pieces. In practice this will be the MTBF for **some common mode failure of the two redundant parts** (for example a ground fault). I sometimes just guess this to be **10 times the MTBF on the non redundant part** and this ends up large enough it doesn't cause much downtime.

- **4.** The MTTR for the part including transportation time

  Transportation time are estimated in page 20 of the previous slide in the high availability webex meeting, and it takes 30 minutes from one shaft for going and coming back.

- **5.** The number of people it takes to replace the part.

  The number of people it takes to replace the part are estimated in page 23 of the previous slide in the high availability webex meeting.

Q(IV)

3. **During long downs should I assume every last HLRF component is fixed or leave some fraction of them broken?**

In the case of DRFS, DC PS and MA modulator, which are back-uped, should be surely fixed to keep the enough redundancy. For the MA Klystrons, at the beginning of the ILC operation, we can expect the small numbers of failure since MTBF is large and we can leave some fraction of them broken. For other parts, it depends on whether it has an enough redundancy or not.

4. How long will the scheduled downs be (8 hours? 1 day?). **Will HLRF components be replaced during those scheduled downs?**

The components which has a risk of becoming poor redundancy should be replaced. For example, it is the case of DRFS, DC PS and MA modulator. 1 day is enough.

5. Presently I only repair do cryo repairs during the long down. I did not want to start with a perfect machine after each long down as I did not think that reflected reality. **Clearly I will now have to repair some HLRF components.** That is already a topic of question 3. Should I repair some of the other components also? What fraction?

Comments after the webex of 090722

- Overhead Issue

  Previous slide in high availability shows the average failures of klystron reach to 4.5%, while it would be small at the beginning, and if we make a preventative maintenance described in the webex meeting, we can expect much less than 4.5 % failures.

  So 2-3% overhead is acceptable.

- Example of Preventative maintenance

  Klystron cathode activity is monitored by dip method which doesn’t interrupt beam (by setting to standby mode) within 10min. Measurement, and it enables us to predict the klystron emission degradation and we can replace klystron before the failure. For some particular failures, we can conduct similar preventative maintenance, and hence we can prolong the MTBF.

- One day maintenance

  For one day maintenance, if we put a few supervisors in every shaft, they can control 2-3 clues (a pair of the person) to replace the failure components. From this system, we can count how many components to be replaced in a day.