

Availsim DRFS and klyClus setup, assumptions, questions

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Introduction

- There are a lot of numbers that describe the RF system.
- Did best I could choosing them from talks and asking people questions.
- Need experts to check them before wasting time running simulations.

KlyClus assumptions

- 19 klystrons per cluster in low_P and 36 for high_P including the 2 spares.
- Quick switching in of spares, simulated by giving klystrons, modulators etc. very long MTBFs. Clusters are not modeled in detail.
- 1 water pump station per cluster with redundant pumps simulated with very long MTBF.
- Assume high power RF switches (1 per cryomodule) do not fail. (Because only causes a problem if there is another failure). So don't even list it as a part.

KlyClus assumptions

- Did not model high power waveguide failure. Can just add as lumped item if wanted or else just add 1% downtime. – put in Chris model
- Will water, water instrumentation, AC power, timing, controls or other problem have single point of failure to bring down a whole cluster? – MCR will get answer from CFS
- Assume 1 LLRF module per cavity and lose 1 cavities energy if it dies. Should I have a some LLRF modules per cluster that kill cluster when they die? How many? Make redundant? - yes

DRFS assumptions

- All bad klystrons, modulators etc. repaired during 16 hour repair +8 hour recovery each 2 weeks
- Assume klystron MTTR of 4 hours including transport. (Only effects number of people needed for making repairs as opportunistic repairs are not being done.)
- Mod anode supply is redundant so make MTBF 10 times larger than given in DRFS talk (70k hours). Lump DC supply in with it. Also redundant. Use combined MTBF of $70k/2*10 = 350k$ hours. (Note am already assuming magnet supplies have 1E6 hour MTBF. Should I increase the MTBF assumed here?)
- Klystron filament supply is redundant so make MTBF 10 times normal supply (but MTBF table A already has boosted all PS to 1E6 hours (SLAC/FNAL/DESY experience is 40k hours and APS is 0.5E6 hours), so just set to 2E6 hours.

DRFS assumptions

- No vacuum pump, gauge, or Vacuum pump PS as getter is used for klystron. – ewan is worried the getter won't work. More study is needed. Availsim can easily put back these components
- Assume certain number of timing and other controls per modulator, not per klystron
- Assume 1 water pump in tunnel per 13 klystrons. No redundancy.
- Assume 1 LLRF module per cavity and lose 1 cavities energy if it dies. **Should I have some LLRF modules per klystron that kill klystron's output when they die? How many? In tunnel or out?**
- 1 klystron pre-amp (sub-booster) per klystron (not shown in diagram in DRFS talk but included in a list there)

Input decks

- Next 3 slides show spreadsheets with numbers for low_P 12 cryomodule section of accelerator to make checking thorough yet simple.
- Differences from RDR are highlighted in yellow
- Would like people to double check the numbers.

Klystron Cluster

system	component name	subsys/segment	problem name	quantity	degradation	MTBF	MTTR	broken after repair	access needed?	n repair people	Starting MTBF	improvement factor
RF structure	Cavities	cavity	degrade	104.00	-11.00	1.00E+08	672		1.00	2.00	1.00E+08	1.00
RF structure	Cavities	cavity	broken	104.00	-31.14	1.00E+08	672		1.00	2.00	1.00E+08	1.00
RF structure	Cavity tuner	cavity	broken	104.00	-31.14	1.00E+06	672		1.00	2.00	1.00E+06	1.00
RF structure	Cavity piezo tuner	cavity	broken	104.00	-5.00	5.00E+05	672		1.00	2.00	5.00E+05	1.00
RF structure	LLRF	cavity	broken	104.00	-31.14	3.00E+05	1		1.00	1.00	3.00E+05	1.00
RF structure	power coupler	coupler	degrade	104.00	-269.88	1.00E+07	2	power cou	1.00	2.00	1.00E+07	1.00
RF structure	power coupler	coupler	broken	104.00	-269.88	1.00E+07	2	power cou	1.00	2.00	1.00E+07	1.00
RF structure	power coupler disc	coupler	disc	104.00	-31.14	1.00E+50	672		1.00	2.00	1.00E+50	1.00
RF structure	coupler interlock sensors	coupler	broken	104.00	-269.88	5.00E+06	1		1.00	1.00	5.00E+06	1.00
RF structure	coupler interlock electronics	coupler	broken	104.00	-269.88	1.00E+06	1		1.00	1.00	1.00E+06	1.00
RF structure	VacP	coupler	broken	12.00	-269.88	1.00E+08	4		1.00	2.00	1.00E+08	1.00
RF structure	VacP power supply	coupler	broken	12.00	-269.88	1.00E+06	1		1.00	1.00	1.00E+06	1.00
Vacuum	VacP	beamline	broken	12.00	1.00	1.00E+07	4		1.00	2.00	1.00E+07	1.00
Vacuum	VacP power supply	beamline	broken	12.00	1.00	1.00E+05	1		1.00	1.00	1.00E+05	1.00
Cryo	insulating vacuumP	cryo string	leak	2.00	-2698.80	1.00E+05	8		1.00	2.00	1.00E+05	1.00
Cryo	cryo JT valve	cryo string	broken	2.00	-2698.80	3.00E+05	2		1.00	2.00	3.00E+05	1.00
RF power sources	Modulators	klystron	broken	2.00	-1619.28	5.00E+06	4		-1.00	2.00	5.00E+04	100.00
RF power sources	pulse cables	klystron	broken	0.00	-1619.28	2.00E+07	8		-1.00	2.00	2.00E+05	100.00
RF power sources	Pulse transformers	klystron	broken	2.00	-1619.28	2.00E+07	4		-1.00	2.00	2.00E+05	100.00
RF power sources	Klystron 10MW	klystron	broken	2.00	-1619.28	4.00E+06	8		-1.00	2.00	4.00E+04	100.00
RF power sources	klys pre-amp	klystron	broken	2.00	-1619.28	1.00E+07	1		-1.00	1.00	1.00E+05	100.00
RF power sources	klys filament supply	klystron	broken	2.00	-1619.28	1.00E+08	2		-1.00	1.00	1.00E+06	100.00
RF power sources	klys solenoid supply	klystron	broken	2.00	-1619.28	1.00E+08	2		-1.00	1.00	1.00E+06	100.00
RF power sources	VacG/Ctrl	klystron	broken	2.00	-1619.28	1.00E+07	1		-1.00	1.00	1.00E+05	100.00
RF power sources	VacP	klystron	broken	2.00	-1619.28	1.00E+09	8		-1.00	2.00	1.00E+07	100.00
RF power sources	spare klystron	klystron	broken	0.00	-1.00	1.00E+50	8		-1.00	2.00	4.00E+04	100.00
RF power sources	VacP power supply	klystron	broken	2.00	-1619.28	1.00E+07	1		-1.00	1.00	1.00E+05	100.00
controls	timing	klystron	broken	2.00	-1619.28	3.00E+05	1		1.00	1.00	3.00E+05	1.00
controls	other controls	klystron	broken	6.00	-1619.28	3.00E+05	1		1.00	1.00	3.00E+05	1.00
Water system	Water pumps	klystron	broken	1.00	-1619.28	1.20E+07	4		-1.00	2.00	1.20E+05	100.00
Water system	Water instr	klystron	broken	3.00	-1619.28	3.00E+05	2		0.00	2.00	3.00E+05	1.00
Water system	Flow Switch	klystron	broken	3.00	-1619.28	2.50E+06	1		0.00	1.00	2.50E+06	1.00
AC power	Electrical - >0.5	klystron	broken	1.00	-1619.28	3.60E+05	4		0.00	2.00	3.60E+05	1.00
AC power	Electrical - .05<<0.5	klystron	broken	1.00	-1619.28	3.60E+05	2		0.00	2.00	3.60E+05	1.00

DRFS

system	component name	subsys/segment	problem name	quantity	degradation	MTBF	MTTR	broken after repair	access needed?	n repair people	Starting MTBF	improvement factor
RF structure	Cavities	cavity	degrade	104.00	-11.00	1.00E+08	672		1.00	2.00	1.00E+08	1.00
RF structure	Cavities	cavity	broken	104.00	-31.14	1.00E+08	672		1.00	2.00	1.00E+08	1.00
RF structure	Cavity tuner	cavity	broken	104.00	-31.14	1.00E+06	672		1.00	2.00	1.00E+06	1.00
RF structure	Cavity piezo tuner	cavity	broken	104.00	-5.00	5.00E+05	672		1.00	2.00	5.00E+05	1.00
RF structure	LLRF	cavity	broken	104.00	-31.14	3.00E+05	1		1.00	1.00	3.00E+05	1.00
RF structure	power coupler	coupler	degrade	104.00	-44.00	1.00E+07	2	power cou	1.00	2.00	1.00E+07	1.00
RF structure	power coupler	coupler	broken	104.00	-124.56	1.00E+07	2	power cou	1.00	2.00	1.00E+07	1.00
RF structure	power coupler disc	coupler	disc	104.00	-31.14	1.00E+50	672		1.00	2.00	1.00E+50	1.00
RF structure	coupler interlock sensors	coupler	broken	104.00	-124.56	5.00E+06	1		1.00	1.00	5.00E+06	1.00
RF structure	coupler interlock electronics	coupler	broken	104.00	-124.56	1.00E+06	1		1.00	1.00	1.00E+06	1.00
RF structure	VacP	coupler	broken	12.00	-124.56	1.00E+08	4		1.00	2.00	1.00E+08	1.00
RF structure	VacP power supply	coupler	broken	12.00	-124.56	1.00E+06	1		1.00	1.00	1.00E+06	1.00
Vacuum	VacP	beamline	broken	12.00	1.00	1.00E+07	4		1.00	2.00	1.00E+07	1.00
Vacuum	VacP power supply	beamline	broken	12.00	1.00	1.00E+05	1		1.00	1.00	1.00E+05	1.00
Cryo	insulating vacuumP	cryo string	leak	2.00	-2698.80	1.00E+05	8		1.00	2.00	1.00E+05	1.00
Cryo	cryo JT valve	cryo string	broken	2.00	-2698.80	3.00E+05	2		1.00	2.00	3.00E+05	1.00
RF power sources	Modulators	klystron	broken	2.00	-1619.28	3.50E+05	4		1.00	2.00	3.50E+05	1.00
RF power sources	pulse cables	klystron	broken	0.00	-1619.28	2.00E+05	8		1.00	2.00	2.00E+05	1.00
RF power sources	Pulse transformers	klystron	broken	0.00	-1619.28	2.00E+05	4		1.00	2.00	2.00E+05	1.00
RF power sources	Klystron DRFS	klystron	broken	26.00	-124.56	1.20E+05	4		1.00	2.00	1.20E+05	1.00
RF power sources	klys pre-amp	klystron	broken	26.00	-124.56	1.00E+05	1		1.00	1.00	1.00E+05	1.00
RF power sources	klys filament supply	klystron	broken	2.00	-124.56	2.00E+06	2		1.00	1.00	2.00E+06	1.00
RF power sources	klys solenoid supply	klystron	broken	0.00	-124.56	1.00E+06	2		1.00	1.00	1.00E+06	1.00
RF power sources	VacG/Ctrl	klystron	broken	0.00	-124.56	1.00E+05	1		1.00	1.00	1.00E+05	1.00
RF power sources	VacP	klystron	broken	0.00	-124.56	1.00E+07	8		1.00	2.00	1.00E+07	1.00
RF power sources	spare klystron	klystron	broken	0.00	-1.00	1.00E+50	8		1.00	2.00	4.00E+04	1.00
RF power sources	VacP power supply	klystron	broken	0.00	-124.56	1.00E+05	1		1.00	1.00	1.00E+05	1.00
controls	timing	klystron	broken	2.00	-1619.28	3.00E+05	1		1.00	1.00	3.00E+05	1.00
controls	other controls	klystron	broken	6.00	-1619.28	3.00E+05	1		1.00	1.00	3.00E+05	1.00
Water system	Water pumps	klystron	broken	2.00	-1619.28	1.20E+05	4		1.00	2.00	1.20E+05	1.00
Water system	Water instr	klystron	broken	6.00	-1619.28	3.00E+05	2		1.00	2.00	3.00E+05	1.00
Water system	Flow Switch	klystron	broken	6.00	-1619.28	2.50E+06	1		1.00	1.00	2.50E+06	1.00
AC power	Electrical - >0.5	klystron	broken	2.00	-1619.28	3.60E+05	4		1.00	2.00	3.60E+05	1.00
AC power	Electrical - .05<<0.5	klystron	broken	2.00	-1619.28	3.60E+05	2		1.00	2.00	3.60E+05	1.00

RDR

system	component name	subsys/segment	problem name	quantity	degradation	MTBF	MTTR	broken after repair	access needed?	n repair people	Starting MTBF	improvement factor
RF structure	Cavities	cavity	degrade	104	-11.00	1.0E+08	672		1	2	1.0E+08	1
RF structure	Cavities	cavity	broken	104	-31.14	1.0E+08	672		1	2	1.0E+08	1
RF structure	Cavity tuner	cavity	broken	104	-31.14	1.0E+06	672		1	2	1.0E+06	1
RF structure	Cavity piezo tuner	cavity	broken	104	-5.00	5.0E+05	672		1	2	5.0E+05	1
RF structure	LLRF	cavity	broken	104	-31.14	3.0E+05	1		1	1	3.0E+05	1
RF structure	power coupler	coupler	degrade	104	-572.00	1.0E+07	2	power co	1	2	1.0E+07	1
RF structure	power coupler	coupler	broken	104	-1619.28	1.0E+07	2	power co	1	2	1.0E+07	1
RF structure	power coupler disc	coupler	disc	104	-31.14	1.0E+50	672		1	2	1.0E+50	1
RF structure	coupler interlock sensors	coupler	broken	104	-1619.28	5.0E+06	1		1	1	5.0E+06	1
RF structure	coupler interlock electronics	coupler	broken	104	-1619.28	1.0E+06	1		1	1	1.0E+06	1
RF structure	VacP	coupler	broken	12	-1619.28	1.0E+08	4		1	2	1.0E+08	1
RF structure	VacP power supply	coupler	broken	12	-1619.28	1.0E+06	1		1	1	1.0E+06	1
Vacuum	VacP	beamline	broken	12	1.00	1.0E+07	4		1	2	1.0E+07	1
Vacuum	VacP power supply	beamline	broken	12	1.00	1.0E+05	1		1	1	1.0E+05	1
Cryo	insulating vacuumP	cryo string	leak	2	-2698.80	1.0E+05	8		1	2	1.0E+05	1
Cryo	cryo JT valve	cryo string	broken	2	-2698.80	3.0E+05	2		1	2	3.0E+05	1
RF power sources	Modulators	klystron	broken	2	-1619.28	5.0E+04	4		1	2	5.0E+04	1
RF power sources	pulse cables	klystron	broken	0	-1619.28	2.0E+05	8		1	2	2.0E+05	1
RF power sources	Pulse transformers	klystron	broken	2	-1619.28	2.0E+05	4		1	2	2.0E+05	1
RF power sources	Klystron 10MW	klystron	broken	2	-1619.28	4.0E+04	8		1	2	4.0E+04	1
RF power sources	klys pre-amp	klystron	broken	2	-1619.28	1.0E+05	1		1	1	1.0E+05	1
RF power sources	klys filament supply	klystron	broken	2	-1619.28	1.0E+06	2		1	1	1.0E+06	1
RF power sources	klys solenoid supply	klystron	broken	2	-1619.28	1.0E+06	2		1	1	1.0E+06	1
RF power sources	VacG/Ctrl	klystron	broken	2	-1619.28	1.0E+05	1		1	1	1.0E+05	1
RF power sources	VacP	klystron	broken	2	-1619.28	1.0E+07	8		1	2	1.0E+07	1
RF power sources	spare klystron	klystron	broken	0	-1.00	1.0E+50	8		1	2	4.0E+04	1
RF power sources	VacP power supply	klystron	broken	2	-1619.28	1.0E+05	1		1	1	1.0E+05	1
controls	timing	klystron	broken	2	-1619.28	3.0E+05	1		1	1	3.0E+05	1
controls	other controls	klystron	broken	6	-1619.28	3.0E+05	1		1	1	3.0E+05	1
Water system	Water pumps	klystron	broken	2	-1619.28	1.2E+05	4		1	2	1.2E+05	1
Water system	Water instr	klystron	broken	6	-1619.28	3.0E+05	2		1	2	3.0E+05	1
Water system	Flow Switch	klystron	broken	6	-1619.28	2.5E+06	1		1	1	2.5E+06	1
AC power	Electrical - >0.5	klystron	broken	2	-1619.28	3.6E+05	4		1	2	3.6E+05	1
AC power	Electrical - .05<<0.5	klystron	broken	2	-1619.28	3.6E+05	2		1	2	3.6E+05	1