Availsim runs and questions

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Questions from last meeting

- Did RDR availsim runs include scheduled downtimes?
  - 3 month annual downtime; no other scheduled downs.
  - Did not have penalty for downtime being unscheduled (say at 3 AM). Implicitly assumed that some would actually be planned.
  - Implemented scheduled downtimes at DESY for XFEL.
  - Increases total downtime while decreasing unscheduled downtime

Other questions?

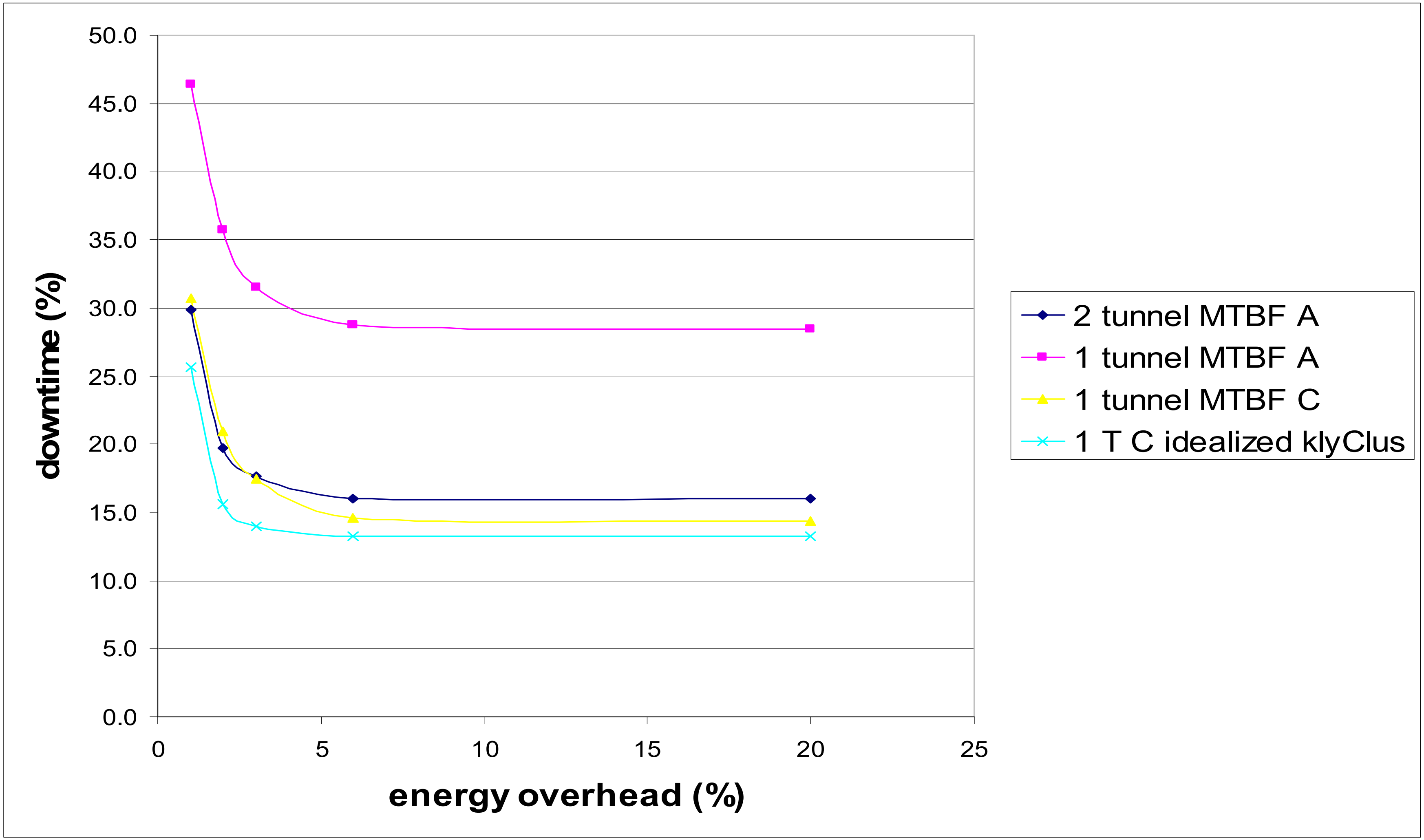
RDR simulation input deck

- Did not have central injector (DRs were at low energy ends of linac
- Had long e+ transport in linac tunnel, but not long e+ and e- low emittance RTML transport lines
- Had e+ source at 150 GeV
- Did not have low P option (had 24 cavities per RF unit)
- 2 vs 1 tunnel changed almost everything from being accessible with beam on to not in all regions (including DR and BDS)

New simulations

- Using RDR deck with tiny modifications
- Plot downtime vs energy overhead in ML.
- Idealized KlyClus simulation done by setting MTBF of all components that would be in cluster to 100*nominal (effectively infinite)

Downtime vs energy overhead



Observations

- Shapes don’t vary much. Idealized KlyClus may need slightly less energy overhead
- Offset of KlyClus is due to injector having less RF downtime. Artifact of how I adjusted the MTBFs.
- One run had 133 people in accelerator tunnel making repairs. If we limit number of people for practical reasons, downtime would increase.
  - DRFS will have worse problem with this if MTBFs and MTTRs are not much better than for RDR.

MTTF/MTTR Improvement Factors

MTBF to improve	Table A	Table C
factor_mttf_PS_controller	10	50
factor_mttf_water_instr	10	30
factor_mttf_magnet	20	20
factor_mttf_electronic_modu	3	10
factor_mttf_fs	10	10
factor_mttf_elec_small	1	10
factor_mttf_PS	5	5
factor_mttf_kickpulser	5	5
factor_mttf_mb_klystron	1	5
factor_mttf_coupler_intlk	5	5
factor_mttf_coupler_intlk_el	1	5
factor_mttf_vac_valve_conti	1	5
factor_mttf_vac_mech_devi	5	5
factor_mttf_MPS_region	1	5
factor_mttf_PS_corrector	1	3
factor_mttf_modulator	1	3
factor_mttf_valve	1	3
factor_mttf_waterpump	1	3

More detailed RF info needed

system	component name	subsys/segment	problem name	quantity	parameter effected	add/mult	degradation	MTBF	MTTR	broken after repair	access needed?	n repair people	randseed	Starting MTBF
			RF for main e- linac without undulator (conventional e+ source)											
	e- linac		SC RF include=no region=e- linac subregion= egain_nominal_MeV=237500 engy_overhead_pct=0.06 n_spare_klys=0											
RF structure	Cavities	cavity	**degrade**	8088	energy overhead e- linac	add	**-11.00**	1.0E+08	672		1	2		1.0E+08
RF structure	Cavities	cavity	broken	8088	energy overhead e- linac	add	-31.14	1.0E+08	672		1	2		1.0E+08
RF structure	Cavity tuner	cavity	broken	8088	energy overhead e- linac	add	-31.14	1.0E+06	672		1	2		1.0E+06
RF structure	Cavity piezo tuner	cavity	broken	8088	energy overhead e- linac	add	-5.00	5.0E+05	672		1	2		5.0E+05
RF structure	LLRF	cavity	broken	8088	energy overhead e- linac	add	-31.14	3.0E+05	1		-1	1		3.0E+05
RF structure	power coupler	coupler	**degrade**	8088	energy overhead e- linac	add	**-264.00**	1.0E+07	**2**	**power co**	1	2		1.0E+07
RF structure	power coupler	coupler	broken	8088	energy overhead e- linac	add	-747.36	1.0E+07	**2**	**power co**	1	2		1.0E+07
RF structure	power coupler disc	coupler	disc	8088	energy overhead e- linac	add	-31.14	1.0E+50	672		1	2		1.0E+50
RF structure	coupler interlock sensors	coupler	broken	8088	energy overhead e- linac	add	-747.36	5.0E+06	1		1	1		5.0E+06
RF structure	coupler interlock electronics	coupler	broken	8088	energy overhead e- linac	add	-747.36	1.0E+06	1		-1	1		1.0E+06
RF structure	VacP	coupler	broken	1011	energy overhead e- linac	add	-747.36	1.0E+08	4		1	2		**1.0E+08**
RF structure	VacP power supply	coupler	broken	1011	energy overhead e- linac	add	-747.36	1.0E+06	1		-1	1		**1.0E+06**
Vacuum	VacP	beamline	broken	1011	luminosity	mult	1.00	1.0E+07	4		1	2		1.0E+07
Vacuum	VacP power supply	beamline	broken	1011	luminosity	mult	1.00	1.0E+05	1		-1	1		1.0E+05
Cryo	insulating vacuumP	cryo string	leak	102	energy overhead e- linac	add	-2491.20	1.0E+05	8		1	2		1.0E+05
Cryo	cryo JT valve	cryo string	broken	102	energy overhead e- linac	add	-2491.20	3.0E+05	2		1	2		3.0E+05
RF power sources	Modulators	klystron	broken	337	energy overhead e- linac	add	-747.36	5.0E+04	4		-1	2		5.0E+04
RF power sources	pulse cables	klystron	broken	0	energy overhead e- linac	add	-747.36	2.0E+05	8		-1	2		2.0E+05
RF power sources	Pulse transformers	klystron	broken	337	energy overhead e- linac	add	-747.36	2.0E+05	4		0	2		2.0E+05
RF power sources	Klystrons	klystron	broken	337	energy overhead e- linac	add	-747.36	4.0E+04	8		-1	2		4.0E+04
RF power sources	klys pre-amp	klystron	broken	337	energy overhead e- linac	add	-747.36	1.0E+05	1		-1	1		1.0E+05
RF power sources	VacG/Ctrl	klystron	broken	337	energy overhead e- linac	add	-747.36	1.0E+05	1		-1	1		1.0E+05
RF power sources	VacP	klystron	broken	337	energy overhead e- linac	add	-747.36	1.0E+07	8		-1	2		1.0E+07
RF power sources	spare klystron	klystron	broken	0	luminosity	add	-1.00	1.0E+50	8		-1	2		4.0E+04
RF power sources	VacP power supply	klystron	broken	337	energy overhead e- linac	add	-747.36	1.0E+05	1		-1	1		1.0E+05
controls	timing	klystron	broken	337	energy overhead e- linac	add	-747.36	3.0E+05	1		-1	1		3.0E+05
controls	other controls	klystron	broken	1011	energy overhead e- linac	add	-747.36	3.0E+05	1		-1	1		3.0E+05
Water system	Water pumps	klystron	broken	337	energy overhead e- linac	add	-747.36	1.2E+05	4		-1	2		1.2E+05
Water system	Water instr	klystron	broken	1011	energy overhead e- linac	add	-747.36	3.0E+05	2		-1	2		3.0E+05
Water system	Flow Switch	klystron	broken	1011	energy overhead e- linac	add	-747.36	2.5E+06	1		-1	1		2.5E+06
AC power	Electrical - >0.5	klystron	broken	337	energy overhead e- linac	add	-747.36	3.6E+05	4		0	2		3.6E+05
AC power	Electrical - .05<<0.5	klystron	broken	337	energy overhead e- linac	add	-747.36	3.6E+05	2		0	2		3.6E+05

RF Info needed

- Just need number of units per 3 cryomodules. Total numbers are calculated.
- Yellow highlighted items change for low P, should be same for KlyClus and DRFS.
- Pink highlighted items different for KlyClus and DRFS
- Add any new items, particularly any that cause large energy losses (e.g. high power waveguide).

RF specific questions

- What will MTBF of DRFS klystron, modulator, focus supply etc be?
- How long will it take to replace a DRFS klystron and how many people?
- How will interlocks be done in DRFS? Just trip 4 cavities? **YES** How about vacuum interlocks? LLRF? **Entire Cluster goes down for KlyClus (REALLY!)** Still trip multiple cryomodules? What happens with a cavity quench or power coupler problem? Just 4 cavities? **YES** Are all LLRF and interlock electronics in accelerator tunnel? **YES**
- Same questions for klystron cluster. In particular, if quench or coupler problem how many cavities must have their power turned down together? Can it be only lowered or are on/off the only choices?

RF specific questions

- For RDR assumed RF interlocks (vacuum, arc etc) were redundant such that more than one interlock had to be bad to trip off the klystron. XFEL is NOT doing this? Should I change the assumption? **NO**. Know that this means the MTBF of the interlock electronics will have to be >>100k hours.
- What is MTBF/MTTR of things which effect full RF unit of klyston cluster e.g. arc or vacuum leak in main waveguide? Can LLRF kill a whole cluster? If so, MTBF and MTTR of that (or number of electronic modules involved)
- For klystron cluster, can klystron be replaced while we are running? **YES** How many spares per cluster? Enough that we can ignore multiple failures? **YES** (Difficult to simulate each klystron cluster in detail, tracking number of dead klystrons and their effect on beam energy).

Administrative/management questions

- Do we want to do only low power option?
- How will we handle energy overhead? RDR had none and I modeled 3% to avoid having zero availability.
- Presumably we will tune MTBFs to get the desired availability. How will we evaluate the cost of achieving those MTBFs? If don't choose to do this, how will we compare the cost saving of the proposed rebaseline to the tougher MTBFs we have to achieve.
- Do we want to assume that similar devices (e.g. power supplies) in different regions have same MTBFs? **YES**
- Would like someone else to learn to run availsim. Mainly so they can help tune, check work, fully understand all assumptions. Who?

Peripheral questions (effect share of downtime taken by other systems)

- Does anyone want to look into assumed MTBFs and MTTRs (note we start with crude assumptions and then in the worst cases, force them to be better. Tend to look at the improvement factor as a measure of how difficult it is to achieve the MTBF.
- Are we willing to keep model of recovery time proportional to downtime?
- How many people can be in tunnel on an access day? (this will effect e.g. how rapidly DRFS can be repaired. In early studies I limited this to 50. Removed that restriction for final studies. Argument for a limit is that operations can't keep track of too many people and the search is likely to be lost.
- In DR how will PS be done? Accessible? I think availsim has them as accessible right now but plans changed because of heating from cables and they no longer are.
- Need new parts counts for RTML and DR?
- Is 15% budgeted downtime + 10% contingency = 75% uptime the right goal?

Peripheral questions (effect share of downtime taken by other systems)

- Do we want to have scheduled maintenance days?
- How long from killing beam to being able to enter accelerator tunnel to make repairs? (radiation cool down and locking off power supplies)
- How long from last person out of tunnel to ready to try to put beam through (standardize magnets). Correct to assume repairs are done in controlled access so that no search is needed? If not, how long does search take?
- What should we assume for keep-alive-source? Will there be a powerful enough one that one can use it for MD including things like beam based alignment? How long will it take to get it turned on?