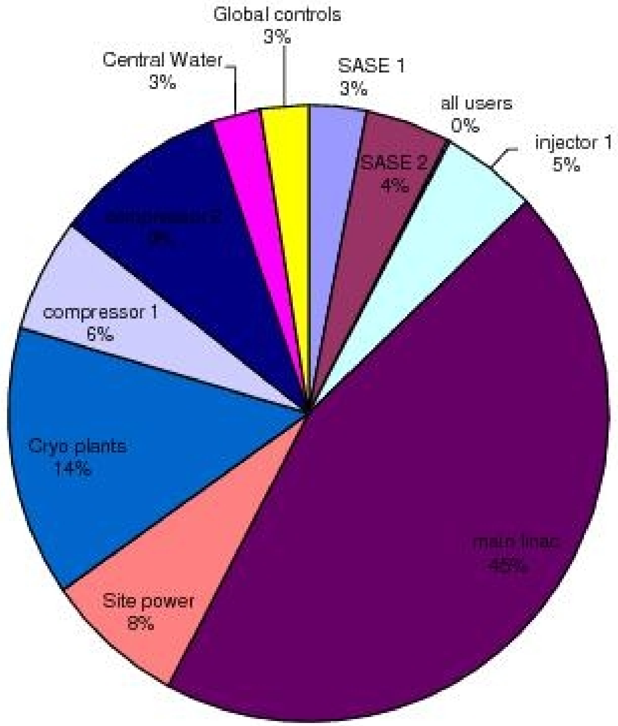
Availability Modeling Tool for the Cornell ERL

Example

DESY XFEL



Availability and Reliability Issues for ILC

T. Himel et al, PAC07

(NB: Shared domicile summer 1978)

Jim Crittenden

Cornell Laboratory for Accelerator-Based Sciences and Education

ERL@CESR Meeting
15 June 2011

Necessary Ingredients for Availability Estimation

I. Estimates of MTTF and MTTR (A = MTTF / (MTTR + MTTF))

✓

A. Component- and system-specific

B. Adjustable to identify bottlenecks ("improvement factors")

II. Region Definitions and Component Lists

A. Automated regeneration for easy comparison of scenarios

B. Downstream tuning time requires upstream availability

III. Modeling Code and Analysis

✓

A. MS Excel macros generate csv MATLAB input files

B. MATLAB modeling scripts (throw exponentials)

C. MS Excel post-processing (tables, graphics)

LC Availability Simulation Done for the LC Comparison Task Force
Tom Himel, SLAC
June, 2005

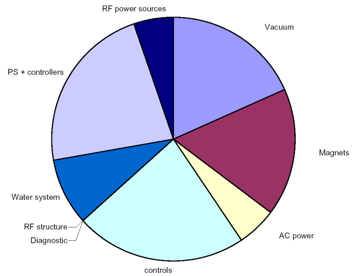
Overall plan of attack

- Write a simulation that given the MTBFs, MTTRs, numbers and redundancies of components, and access requirements for repair can calculate average availability and the integrated luminosity per year. Luminosity is mostly either design or zero in this simulation.
- Collect data on MTBFs and MTTRs of components in existing machines to guide our budgeting process
- Make up a reasonable set of MTBFs that give a reasonable overall availability. We allowed 25% downtime total. 10% was kept as contingency and MTBFs were tuned so the simulation gave 15% downtime.
- Iterate as many times as we had time for (one and a half iterations were done) to minimize the overall cost of the LC while maintaining the goal availability

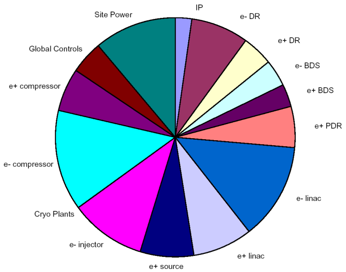
Example MTBFs: Superconducting LC, two tunnels

Device	Nominal MTBF (hours)	Factor improvement over nominal needed	Source of nominal MTBF	# of devices	Increase in down time (%) if MTBF is 10 x worse
all water cooled magnets	1E6	10	SLAC SLC had 5E5 Fermilab main injector had 2E6	2800	5.0
Large power supply controllers	1E5	40	SLAC SLC had 8E4	600	1.2
Large power supplies	2E5	10	Fermilab main injector had 6E4. TESLA design with redundant regulators estimated at 2E5	600	1.9
All electronics modules	1E5	3	Commonly used number for electronics modules	25000	3.8
Linac controls local backbone	1E5	9	Commonly used number for electronics modules	600	0.8
Vacuum valve controllers	1.9E5	5	SLAC SLC had 1.9E5 for valves + controllers. Most failures were the controllers	300	1.3
Flow switches	2.5E5	10	SLAC SLC had 2.2E5	1700	1.8
Water instrumentation	3E4	3	SLAC SLC had 3.5E4 Fermilab main injector had 5.6E4	330	1.2
AC power distribution small	3.6E5	10	SLAC SLC had 3.6E5	700	1.1
first 5 klystrons and related hardware (should be done with redundancy)	varied	20		10	0.4
Cavity tuner see caption for details	1E6	50	SLAC SLC magnet movers had 5E5. Assume tuner is similar as it is a mechanical stepping motor	18000	0.1
Vacuum pumps on the insulating vacuum	1E5	6	guess	150	1.6
Linac energy overhead	2%	1%	Energy overhead increased from 2% to 3%		5.0

Downtime by System



Downtime by Region



Zeroth-Order Report for the Next Linear Collider

SLAC Report 474 May, 1996

Laboratory	Availability	Reference
ANL (APS) 95	68.30%	Argonne National Lab., Private Communication, Site Visit – R. Gerig, D. Ciarlette
CERN (SPS) 94	69.30%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
CERN (SPS) 93	72.00%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
CERN (SPS) 92	74.00%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
CERN (SPS) 91	72.00%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
CERN (SPS) 90	74.00%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
CERN (SPS) 89	71.20%	1994 SPS & LEP Machine Statistics CERN SL / Note 95-15 (OP) M. Colin, G. Cultrut and B. Desforges
Fermi 91	72.64%	Fermi Accelerator System Tally Sheets, Site Visit – R. Mau
Fermi 92	65.86%	Fermi Acclerator System Tally Sheets, Site Visit – R. Mau
Fermi 93–94	63.71%	Fermi Acclerator System Tally Sheets, Site Visit – R. Mau
Fermi 93–94	63.71%	Fermi Acclerator System Tally Sheets, Site Visit – R. Mau
SLAC (SLC) 92	81.00%	1992 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC (SLC) 93	84.53%	1993 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC (SLC) 95	80.87%	1994/95 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC (ESA) 92	87.01%	1992 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC (ESA) 93	93.25%	1993 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC (ESA) 94	93.33%	1994 SLC Revealed Failure Tables, Internal SLAC Memo – W. Linebarger
SLAC SSRL 94	97.04%	SSRL, Private Communication, Site Visit – E. Guerra
SLAC SSRL 95	96.60%	SSRL, Private Communication, Site Visit – E. Guerra
AGS, FY95Q3	86.30%	Brookhaven National Lab, FY 95 3rd Qtr. Report – F. Weng
AGS, FY94Q4	86.70%	Brookhaven National Lab, FY 94 4th Qtr. Report – F. Weng
Cornell 91–92	74.10%	CESR Reliability Summary FY 1992–FY 1994 – D. Rice
Cornell 92–93	77.90%	CESR Reliability Summary FY 1993–FY 1994 – D. Rice
Cornell 93–94	84.00%	CESR Reliability Summary FY 1994–FY 1994 – D. Rice
KEK Photon Factory Linac 10/92–9/93	98.70%	KEK Operations Report FY 1992–FY 1993
KEK Photon Factory Linac 10/91–9/92	98.40%	KEK Operations Report FY 1991–FY 1992
KEK Photon Factory Linac 10/90–9/91	97.70%	KEK Operations Report FY 1990–FY 1991

Table 17-3. *Availabilities of several accelerator laboratories.*

Availability Survey 1996