Estimate AC power for TeV Upgrade

UPDATE
Work in Progress

N. Walker

AD&I meeting 4.07.12

Assumptions

- **Simplistic scaling from current TDR AC power load 'matrix'**
- **Baseline linac remains the same**
  - upgrade beam energy: 265 – 500 GeV
- **New linac**
  - 15 – 265 GeV
  - 45 MV/m (avg) with $Q_0 = 2\times10^{10}$
- **Assume high current**
  - 2450 bunches @ 0.7×10^{10} particle/bunch
  - 7.44 mA
- **4 Hz operation**

Starting Point for Scaling

Electrical Power (operating-peak) in MW *(conventional numbers distributed by area systems)* [a]

UPDATED JUN 13 2012

A **RDR** (w adjusted cryo Jan 27 2011)

Area System	RF Power	Conventional Power (operating power)			Emerg Power	Total
		Conv (incl racks)	NC Magnets	Cryo		
e-sources	1.05	2.46	0.73	0.59	0.06	4.89
e+sources	4.11	8.59	8.9	0.59	0.21	22.4
DR	14	2.38	7.92	2.52	0.23	27.05
RTML	7.14	5.12	4.74	0	0.15	17.15
Main Linac	75.72	23.40	0.78	42.9	0.404	143.2
BDS	0	4.62	2.57	0.41	0.2	7.8
Dumps	0	3.83	0	0	0.12	3.95
IR	0	0	0	0	0	0
TOTALS	*102*	*50.4*	*25.6*	***47.0***	*1.4*	**226**

B **TDR 5Hz Full Power** (KCS) 5Hz

RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional [e]		Total
				Normal Load	Emerg Load	
0.96 [b]	0.09	0.73 [b]	0.59	1.02	0.16	3.55
1.39	0.09	4.94	0.59	2.19	0.35	9.6
12.8		4.46	1.45 [m]	2.56	0.14	21.4
5.64	0.32	1.26	0 [f]	0.15	0.14	7.5
93.2 [h]	4.9	0.914	44.2 [g]	9.99	5.18 [n]	158.3
0		10.43	0.41	0.24	0.28	11.4
0		0	0	1 [d]	0	1
0		1.16 [q]	2.65 [r]	0.09	0.17	4.1
114	*5.4*	*23.9*	*49.9*	*17.2*	*6.4*	**217**

C **TDR baseline - Low Power** (KCS) 10Hz

RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional [e]		Total
				Normal Load	Emerg Load	
1.28 [j]	0.09	0.73 [b]	0.80 [k]	1.02	0.16	4.08
1.39	0.09	4.94	0.59 [l]	2.19	0.35	9.6
8.67		2.97	1.45 [m]	1.84	0.14	15.1
4.76 [p]	0.32	1.26	0 [f]	0.12	0.14	6.6
58.1 [h]	4.9	0.914	40.5 [g]	8.10	5.18 [n]	118
0		10.43	0.41	0.24	0.28	11.4
0		0	0	1 [d]	0	1
0		1.16 [q]	2.65 [r]	0.09	0.17	4.1
74.2	*5.4*	*22.4*	*46.4*	*14.6*	*6.4*	**169**

changes compared to APR 19 2012 version

a) Numbers shown are peak operating power gathered per area systems only.

b) e-source numbers are taken from RDR (no detailed load table)

c) Refer to CFS criteria tables for details

d) Main dumps electrical power for associated components are taken from "RDR BDS dump parameters" dated May 2 2006

e) Conventional numbers shown are peak operating power (Low power conventional numbers scaled by low-power technical load)

f) RTML cryo is included with ML Cryo

g) ML/RTML Cryo for full power-5Hz was taken from meeting with T.Peterson on 1/28/2011. The 10Hz cryo was from T.Peterson excel file "ILCcryoTDP25May2012"

h) ML RF full power was taken from Nantista email/slide 2-18-2012. The 10Hz-low power used 413 RF quantity, and included Marx modulator impact, from Nantista slide/M.Ross email 5-30-2012

j) 320 KW was added to 10 Hz e-source RF (per John Sheppard, DAEGU Meeting April 24 2012)

k) Cryo corrections from Tom Peterson May 17 2012 email (5Hz to 10Hz Cryo is multiplied by 1.36 factor). File "ILCcryoTDP25May2012.xls" shows this to be 0.65MW, waiting for confirmation

l) File "ILCcryoTDP25May2012.xls" shows this e+cryo to be 0.49MW, waiting for confirmation

m) DR Cryo corrections from Tom Peterson/Mark Palmer May 17 2012 email

n) MAY 17 2012 meeting (w Tom Peterson & Akira Yamamoto) Cryo-Liquid Storage system 100KW per plant=total 600KW

p) RTML 10 Hz RF update per AlessandroVivoli email May 22 2012

q) Approx 580KW non-cryo load from SiD load table. Email K.Buesser to V.Kuchler on 6/8/2012 confirmed that this number is fine for ILD, for both garage position and and normal operation.

r) 1.3MW cryo load from SiD load table(dated 2010). This number was confirmed on CFS meeting May 22 2012(F.Asiri discussion with SiD) as approximate & best assumption at the moment, and further discussed by CFS with T.Peterson on May 24 2012, to help confirm the numbers. Email K.Buesser to V.Kuchler on Jun 8 2012 confirmed that ILD cryo for both garage position and normal operation are the same (or double the 1.3MW SiD cryo load)

DRAFT

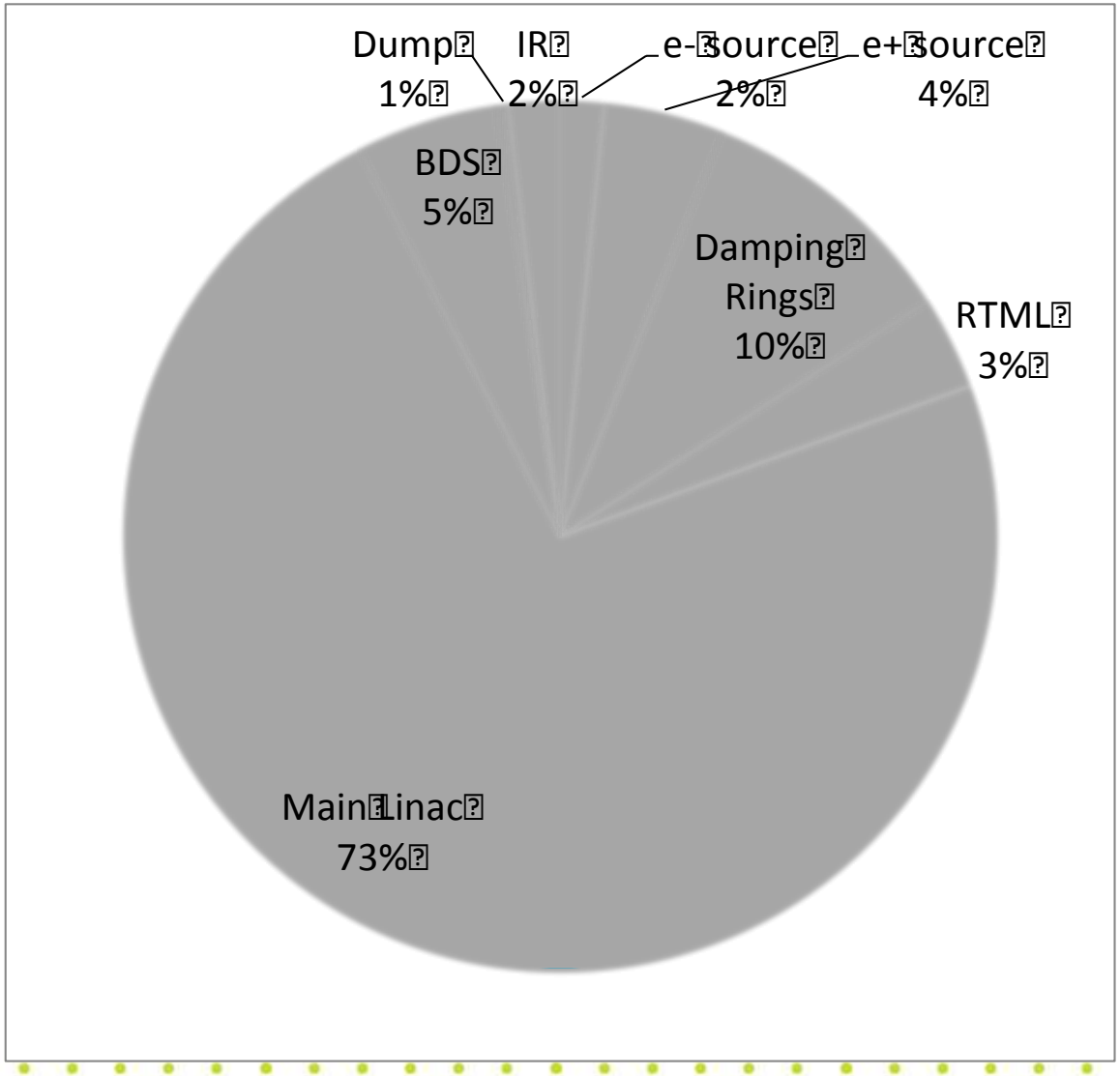
Starting Point for Scaling B

5Hz Full Power
n_b = 2625

conventional numbers distributed by area systems) [a]

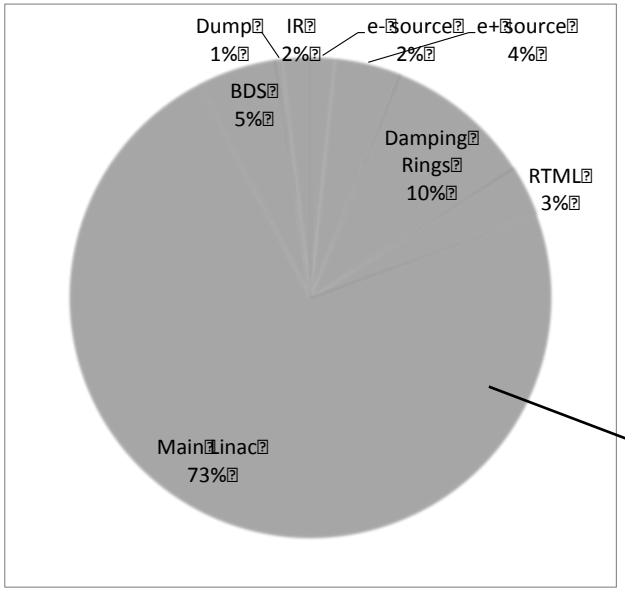
	TDR 5Hz Full Power (KCS) 5Hz						
	RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional [e]		Total
					Normal Load	Emerg Load	
e- source	0.96 [b]	0.09	0.73 [b]	0.59	1.02	0.16	3.55
e+ source	1.39	0.09	4.94	0.59	2.19	0.35	9.6
Damping Rings	12.8		4.46	1.45 [m]	2.56	0.14	21.4
RTML	5.64	0.32	1.26	0 [f]	0.15	0.14	7.5
Main Linac	93.2 [h]	4.9	0.914	44.2 [g]	9.99	5.18 [n]	158.3
BDS	0		10.43	0.41	0.24	0.28	11.4
Dump	0		0	0	1 [d]	0	1
IR	0		1.16 [q]	2.65 [r]	0.09	0.17	4.1
	114	*5.4*	*23.9*	*49.9*	*17.2*	*6.4*	**217**

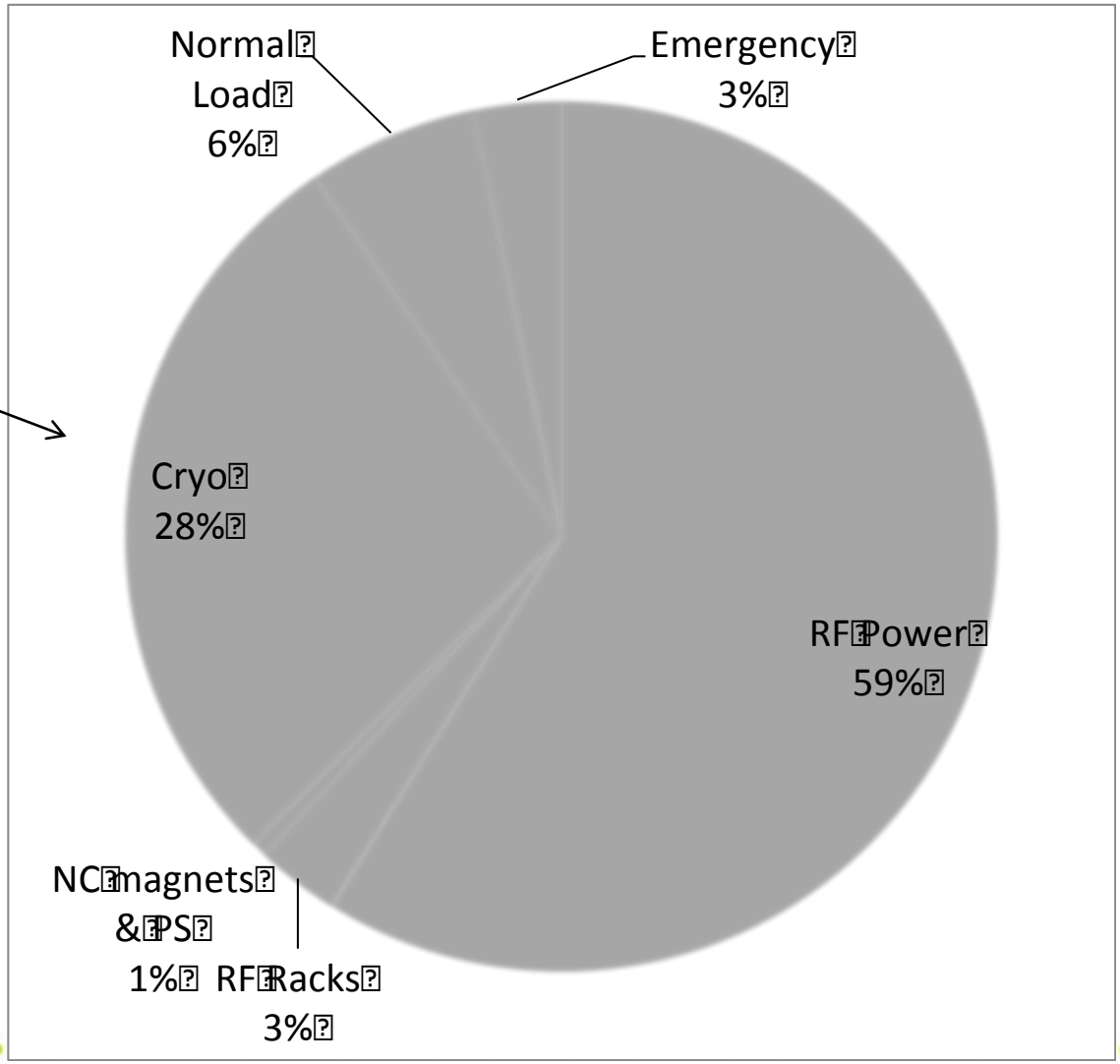
Fraction of 217 MW



Assume ~ constant

Fraction of 217 MW





Main Linac: 158 MW

Simplistic Scaling

- **RF AC power: $2.5 \cdot P_b \cdot \eta$ [$\eta = t_b/(t_b+t_f)$]**

KCS AC → RF efficiency (~40%) *Assumed constant*

- **Cryo**
  - RF dyn $L_{lin} \cdot F_{rep} \cdot T_b(1+1.1T_f) \cdot G^2/Q_0$
  - HOM dyn $L_{lin} \cdot F_{rep} \cdot T_b \cdot I_b^2$
  - Static L_{lin}
- **Damping Rings (3 assumed), and sources**
  - No change (over estimate)
- **BDS**
  - Magnets, normal CFS, dump x1.5 (WAG)
- **CFS (main linac)**
  - Normal load (for linac) $P_{AC(RF)}-P_b$
  - Emergency load L_{lin}

Adjustments (?)

5Hz Full Power
n_b = 2625

conventional numbers distributed by area systems) [a]

TDR 5Hz Full Power (KCS) 5Hz						
	RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional [e]	Total
					Normal Load / Emerg Load	
e- source	0.96 [b]	0.09	0.73 [b]	0.59	1.02 / 0.16	3.55
e+ source	1.39	0.09	4.94	0.59	2.19 / 0.35	9.6
Damping Rings	12.8		4.46	1.45 [m]	2.56 / 0.14	21.4
RTML	5	.32	1.26	[f]	.15 / 0.14	7.5
Main Linac	93.2 [n]	4.9	0.914	44.2 [o]	9.99 / 5.18 [n]	158.3
BDS	0		10.43	0.41	0.24 / 0.28	11.4
Dump	0		0	0	1 [d] / 0	1
IR	0		1.16 [q]	2.65 [r]	0.09 / 0.17	4.1
	104.5	*5.4*	*23.9*	**45.1**	*17.2* / *6.4*	**203**

Apply simple scaling to baseline numbers **C**

83.7

39.4

Installed vs operation (x1.3)
Scaled from baseline **C**

(Possible issue with RTML BC @ 10Hz)

-14 MW !!

Needs to be checked!

Upgrade Estimate

TeV Upgrade (estimate)							
	RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional		Total
					Normal Load	Emerg Load	
e- source	1.0	0.1	0.7	0.6	1.0	0.2	3.6
e+ source	1.4	0.1	4.9	0.6	2.2	0.4	9.6
Damping Rings	12.8		4.5	1.5	2.6	0.1	21.4
RTML	5.6	0.3	1.3		0.2	0.1	7.5
Main Linac (base)	58.5	4.9	0.9	28.5	8.1	5.2	106.1
Main Linac (upgrade)	73.5	4.9	0.9	20.6	10.1	3.9	113.9
BDS			15.6	0.8	0.4	0.3	17.1
Dumps					1.5		1.5
IR			1.2	2.7	0.1	0.2	4.1
	152.8	10.3	30.0	55.2	26.1	10.3	**284.7**

l_b = 7.44 mA
n_b = 2450
N = $5 \cdot 10^9$
f_{rep} = 4 Hz

G = 45 MV/m
Q_0 = $2 \cdot 10^{10}$
} upgrade linac

285 MW (±10 MW)

based on KCS numbers and simplistic scaling