The Latest Positron Source Parameter Table

01/19/2012

Background

- Tables were composed by Benno and Nick
- Most of the data has been cross checked by ANL and DESY
- EDMS (D*943695)

Requirements

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Primary positron source requirements**													
2														
3					*Centre-of-mass energy Ecm (GeV)*						*L upgrade*		*E_{cm} upgrade*	
4	*Variant*	*Parameter*			**200**	**230**	**250**	**350**	**500**		**500**		**1000**	
5		Pulse repetition rate		Hz	5	5	5	5	5		5		4	
6		Number of bunches	n_b		1312	1312	1312	1312	1312		2625		2450	
7		Positron bunch population	N_+	$\times 10^{10}$	2	2	2	2	2		2		1.74	
8		Positron Polarization	P_+	%										
9		Over-production margin (yield*)			50%	50%	50%	50%	50%		50%		50%	
10														
11		Energy to DR		GeV	5	5	5	5	5		5		5	
12		DR transverse acceptance	$\gamma (A_x + A_y)$	m	0.07	0.07	0.07	0.07	0.07		0.07		0.07	
13		DR relative energy acceptance	$\pm$		1.0%	1.0%	1.0%	1.0%	1.0%		1.0%		1.0%	
14														
15		Positron bunch seperation	Δt_b	ns	554	554	554	554	554		366		366	
16		Positron bunch seperation $\times f_R$	$\Delta t_b f_{RF}$		720	720	720	720	720		476		476	
17		Positron beam pulse length	t_b	μs	727	727	727	727	727		961		897	
18		Positron pulse current	I_{beam}	mA	5.8	5.8	5.8	5.8	5.8		8.8		7.6	

Drive beam parameters

					Centre-of-mass energy Ecm (GeV)					L upgrade	E_{cm} upgrade
	Variant	*Parameter*			**200**	**230**	**250**	**350**	**500**	**500**	**1000**
1	**Electron drive beam (primary electron beam)**										
5		e- linac pulse repitition rate		Hz	10	10	10	5	5	5	4
6		Number of bunches	n_b		1312	1312	1312	1312	1312	2625	2450
7		Electron bunch population	N_-	$\times 10^{10}$	2	2	2	2	2	2	1.74
9		*Nominal 5Hz mode:*									
11	FC	Beam energy		GeV				178	253	253	503
13		*10Hz alternate pulse mode:*									
14		Beam energy for e+ production		GeV	150	150	150				
15		Beam energy for physics (lumi prod.)		GeV	102	118	128				
20	FC	Beam energy for e+ production (dumped)		GeV	147	147	147				
21		Average beam power (e+ prod.) dumped		MW	3.1	3.1	3.1				
23		Electron bunch seperation	Δt_b	ns	554	554	554	554	554	366	366
24		Electron beam pulse length	t_b	µs	727	727	727	727	727	961	897
25		Electron pulse current	I_{beam}	mA	5.8	5.8	5.8	5.8	5.8	8.8	7.6
69		*Fixed undulator length scenario*									
70		Effective undulator length	L_{und}	m	147	147	147	147	147	147	132
71		Effective undulator field	B_{und}	T	0.86	0.86	0.86	0.68	0.48	0.48	0.249
72		undulator period length	λu	cm	1.15	1.15	1.15	1.15	1.15	1.15	4.3
73		Electron energy loss in undulator (e+ p	ΔE_{und}	GeV	3.0	3.0	3.0	2.6	2.6	2.6	2.4
74		Electron energy loss in undulator (lumi	ΔE_{und}	GeV	1.3	1.8	2.1				2.4
75		Rel. enery spread induced by und.(assumed initial 0.3%)			0.087	0.100	0.112	0.118	0.089	0.089	0.068
76		Total energy spread (assumed 0.3% initial)			0.312	0.316	0.320	0.322	0.313	0.313	0.308
77		Rel. enery spread induced by und.(assumed initial 0.2%)			0.092	0.112	0.117	0.116	0.097	0.097	0.066
78		Total energy spread (assumed 0.2% initial)			0.220	0.229	0.232	0.231	0.222	0.222	0.211
79		Rel. enery spread induced by und.(assumed initial 0.1%)			0.098	0.111	0.120	0.120	0.102	0.102	0.070
80		Total energy spread (assumed 0.1% initial)			0.140	0.149	0.156	0.156	0.143	0.143	0.122
81		Rel. enery spread induced by und.(assu	$\Delta(\delta E/E)_u$	%	0.098	0.113	0.123	0.122	0.103	0.103	0.071
82		Emittance growth	$\Delta\gamma\varepsilon$	nm	-0.4	-0.6	-0.7	-0.55	-0.4	-0.4	-0.19

Undulator parameter

				Centre-of-mass energy Ecm (GeV)					*L upgrade*	*E_{cm} upgrade*
Varia	*Parameter*			**200**	**230**	**250**	**350**	**500**	**500**	**1000**
	Positron pulse production rate		Hz	5	5	5	5	5	5	4
	Electron beam energy (e+ prod.)		GeV	150	150	150	175	250	250	500
	Number of electron bunches	n_b		1312	1312	1312	1312	1312	2625	2450
	Electron bunch population	N_+	$\times 10^{10}$	2	2	2	2	2	2	1.74
	Photon energy (first harmonic)		MeV	10.1	10.1	10.1	13.7	28.0	28.0	27.605
	Photon openning angle (=1/γ)		μr	3.4	3.4	3.4	2.9	2.0	2.0	1.02
	Effective undulator length	L_{und}	m	147	147	147	147	147	147	132
	Effective undulator field	B_{und}	T	0.86	0.86	0.86	0.68	0.48	0.48	0.25
	undulator period length	λu	cm	1.15	1.15	1.15	1.15	1.15	1.15	4.3
	Electron energy loss in undulator	ΔE_{und}	GeV	3.0	3.0	3.0	2.6	2.6	2.6	2.4
	Average photon power		kW	63.1	63.1	63.1	54.7	54.7	109.3	65.5

Target parameters

Production Target

Basic target parameters			
Target material	6%Al-4%V		check!
Target mat. radiation length	35	mm	check!
Target thickness	14	mm	check!
Target thickness / X0	0.4		check!
Target wheel diameter	2	m	check!
Target wheel rotation speed	100	m/s	check!
Target angular rotation	955	RPM	check!
Photon drift distance	400	m	check!

Note that the photon target is specified for the most demanding spec.

Radiation damage	??
Activation	??
Est. lifetime	??

				Centre-of-mass energy Ecm (GeV)					*L upgrade*	*E_{cm} upgrade*
Variant	*Parameter*			**200**	**230**	**250**	**350**	**500**	**500**	**1000**
	Positron pulse production rate		Hz	5	5	5	5	5	5	4
	Electron beam energy (e+ prod.)		GeV	150	150	150	178	253	253	503
	Number of electron bunches	n_b		1312	1312	1312	1312	1312	2625	2450
	Electron bunch population	N_-	$\times 10^{10}$	2	2	2	2	2	2	1.74
	Photon energy (first harmonic)		MeV	10.1	10.1	10.1	14.1	28.5	28.5	27.6
	Photon openning angle (=1/γ)		μr	3.4	3.4	3.4	2.9	2.0	2.0	1.02
	Undulator length	L_{und}	m	147	147	147	147	147	147	132
	Required undulator field	B	T	0.86	0.86	0.86	0.698	0.42	0.42	0.25
	undulator period length	λu	cm	1.15	1.15	1.15	1.15	1.15	1.15	4.3
	undulator K	K					0.75	0.45	0.45	1.0
	Average photon power on target		kW	91	100	107	107	79	79	65.46
	Incident photon energy per bunch		J	9.6	9.6	9.6	8.1	6.0	6.0	6.67
	Energy deposition per bunch (e+ prod.)		J	0.72	0.72	0.72	0.59	0.31	0.31	0.29
	Relative energy deposition		%	7%	7%	7%	7.20%	5%	5%	4.40%
	Photon rms spot size on target		mm	1.4	1.4	1.4	1.2	0.8	0.8	0.7
	Peak energy density in target		J/cm^3	232.5	232.5	232.5	295.3	304.3	456.4	475
			J/g	51.7	51.7	51.7	65.6	45.0	101.3	105.4

Polarization

- 30% for all CM except TeV upgrade.