FCC-ee injector linacs layout and specs

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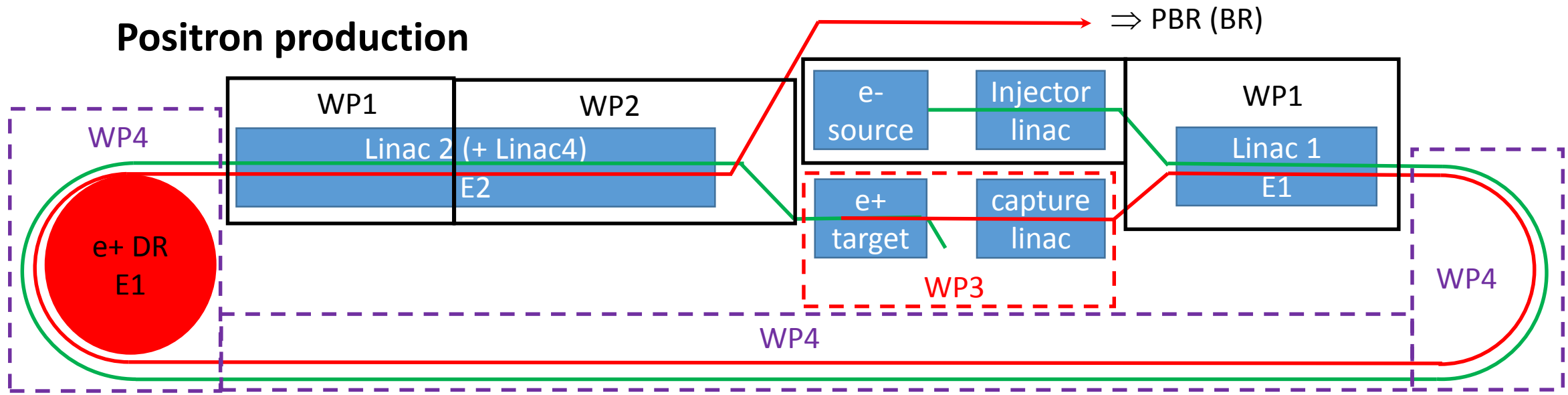
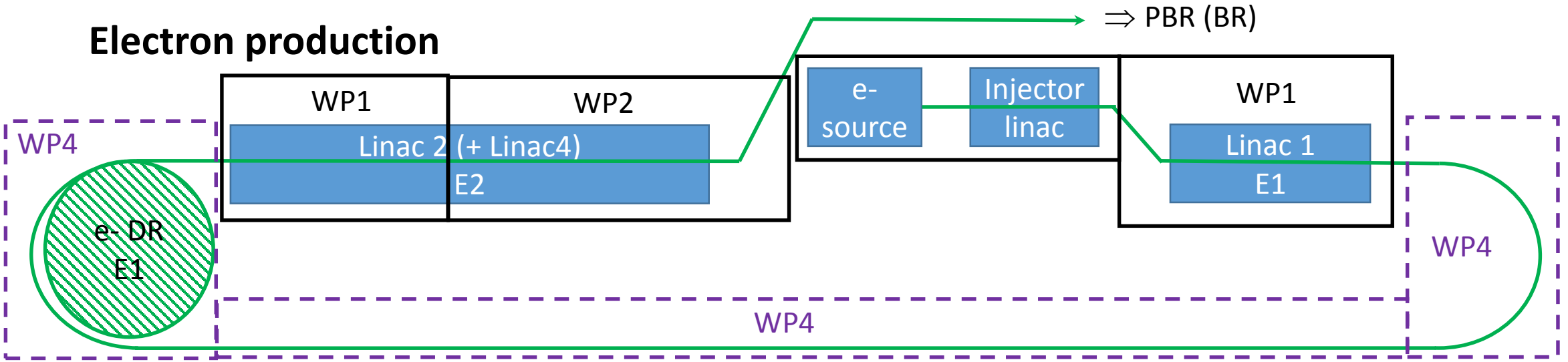
Layout of the injector 6 GeV (20 GeV)





Repetition Rate

- Positron production mode:
  - Positron production and damping: 100 Hz
  - Linacs have to make 2 RF pulses at 100 Hz:
    - One pulse for driver beam
    - One pulse for positron beam
  - **Effective repetition rate for linac RF pulses: 200 Hz**
- Electron production mode:
  - If no DR is used, repetition rate: 200 Hz
  - If DR is used for electrons: repetition rate is limited by DR: 100 Hz

Bunch parameters at injection into PBR and BR

parameter	Baseline	Alternative	Comments
Ring for injection	PBR	BR	
Injection energy [GeV]	6	20	Fixed
Bunch population	2.1e10	2.1e10	
Minimum bunch spacing [ns]	15, (17.5, 20)	15, (17.5, 20)	Tbc with the wake limit
Transverse emittances (RMS): ε_x,y [nm]	**4, 4 < 12**	**1.2**, 0.2	**Update since last report**
Normalized transverse emittances (RMS): γε_x,y [um]	**48, 48**	**48**, 8	**Update since last report** Vertical acceptance of BR
Bunch length (RMS) [mm]	10	10	
Energy spread (RMS) [%]	0.1	0.1	
Injection scheme	Off axis injection:	On axis injection ?	Confirmation is needed
Transverse acceptable emittances (RMS): ε_x,y [nm]	**15, 60** **(12, 41)**		**Update since last report (Alt. Ring)**

Question to Frank(?): Do we really need Norm.Vert.Emit. of 8 um at BR injection? Can it be larger?

Electron production: nominal beam

	L1 out	TL + DR + BC	L2 in	L2 out	L4 in	L4 out	Comments
Bunch population [1e10]	> 2.1			**2.1**		**2.1**	Loss budget ?
Energy [GeV]	E1		E1	**6**	6	**20**	E1: DR energy
Bunch train length [ns]	~ 1000						
Bunch separation [ns]	15 - 20						Wake limited
Bunch length [mm]	1 - 2		~ 1	~ 1	~ 1	**~ 1**	< 10mm
No DR after L1							Injection into PBR
Norm emittances: γε_x,y [um]	< 48		< 48	< 48			
Norm energy spread [%]	~ 0.1		~0.1	**0.1**			
Repetition rate [Hz]	200						
DR after L1							Injection into BR
Norm emittances: γε_x,y [um]	< 48		< 48, 8	< 48, 8	< 48, 8	**< 48, 8**	If BR needs γε_y = **8 um**
Norm energy spread [%]	~ 0.1		~0.1	~0.1	~0.1	**0.1**	
Repetition rate [Hz]	100						Limitted by DR

Positron production: driver beam

	L1 out	TL + BC?	L2 in	L2 out	L4 in	L4 out	Comments
Bunch population [1e10]	1 - 3			1 - **3**		**1**	Electrons for 4.2e10 positrons
Energy [GeV]	E1		E1	**6**	6	**20**	
Bunch train length [ns]	~ 1000						e+production limited
Bunch separation [ns]	15 - 20						Wake limited
Bunch length [mm]	1 - 2		~ 1	~ 1	~ 1	~ 1	
Number of bunches	25-30						
Norm emittances: γε_x,y [um]	<1000		<1000	<1000	<1000	<1000	
Norm energy spread [%]				<1		<1	
Repetition rate [Hz]	100						e+production limited

Positron production: nominal beam

	L1 in	L1 out	TL + DR + BC	L2 in	L2 out	L4 in	L4 out	Comments
Bunch population [1e10]	~2.5	~2.5			**2.1**		**2.1**	2 x 2.1; Loss budget?
Energy [GeV]	0.2	E1		E1	**6**	6	**20**	
Bunch train length [ns]	~ 1000							e+production limited
Bunch separation [ns]	15 - 20							Wake limited
Number of bunches	25-30							
Bunch length [mm]	-	~3		~ 1	~ 1	~ 1	~ 1	< 10mm
Norm emittances: γε_x,y [um]	**~8000**	**~8000**		< 48	**48**			Injection into PBR
Norm emittances: γε_x,y [um]	**~8000**	**~8000**		< 48, 8	< 48, 8	< 48, 8	**48, 8**	Injection into BR
Norm energy spread [%]	-	~8		~0.1	**0.1**		**0.1**	
Repetition rate [Hz]	100							e+production limited

Positron beam parameters at 200 MeV							
Drive beam energy	**6 GeV**			**20 GeV**			
	FULL	**±3.8% @2MV, 32 deg.RF**	**±7.8% @4MV, 43 deg.RF**	**FULL**	**±3.8% @2MV, 32 deg.RF**	**±7.8% @4MV, 43 deg.RF**	
Total e+ yield	2.64	–	–	8.1	–	–	Ne+/Ne-
Accepted e+ yield	–	1.46 ($\sigma_{x/y}$ = 1.5mm)	1.94 ($\sigma_{x/y}$ = 1.2mm)	–	4.46 ($\sigma_{x/y}$ =1.5mm)	5.93 ($\sigma_{x/y}$ =1.2mm)	Ne+/Ne-
Bunch length (rms)	–	2.2	2.7	–	2.2	2.7	mm
Emittance geometrical (rms)	23.7	17.2	18	23.7	17.2	18	μm
Energy spread (rms)	–	6.0	8.3	–	6.0	8.3	%

Injector requirements for Top-up operation and for Z, W, H, and tt modes

- Requirement for bunch-to-bunch intensity variation for initial filling
  - (~10 cycles from BR): **3% per cycle** => 3/sqrt(10) ~ 1%
  - This includes the whole injector chain from the source to the CR injection
- Requirements for Top-up operation:
  - few (~3) % level of intensity control is necessary in the CR during top-up filling.
  - This is **~30% of nominal** (2.1e10) bunch population in the injectors
  - Production of **trains of bunches** with this population and **arbitrary bunch structure** will be necessary to fill the BR for topping-up the CR in the selected buckets