LHC Luminosity

N_b	protons/bunch	1.10E+11	
k_b	# of bunches	1000	
f_{rev}	Rev. frequency	11245	Hz
$\varepsilon^*_{x,y}$	Norm. emittance	3.50E-06	m
β^*	Beta at IP	1.5	m
E	Energy	3500	GeV

m_{p0}	Mass of proton	0.938	GeV
σ_{tot}		0.1	barn

γ	E/m_{p0}	3.73E+03	
β_{rel}	$\sqrt{1-1/\gamma^2}$	1.00E+00	
$\varepsilon_{x,y}$	$(\varepsilon^*_{x,y})/(\gamma\ \beta_{rel})$	9.38E-10	m
$\sigma_{x,y}^2$	$\varepsilon_{x,y}\ \beta^*$	1.41E-09	m

L	$N_b^2\ k_b\ f_{rev} / (4\ \pi\ \sigma_{x,y}^2)$	7.69E+36	Hz/m^2
		7.69E+32	Hz/cm^2

$Rate_{tot}$	$L\ \sigma_{tot}$	7.69E+07	Hz
Pileup	$Rate_{tot}/(f_{rev}\ k_b)$	6.83E+00	

Beam size			
$\varepsilon^*_{x,y}$	Norm. emittance	3.50E-06	m
β_x	Beta horizontal	176	m
β_y	Beta vertical	204	m
E	Energy	3500	GeV
M	Magnification	0.3	
m_{p0}	Mass of proton	0.938	GeV

γ	E/m_{p0}	3.73E+03	
β_{rel}	$\sqrt{(1-1/\gamma^2)}$	1.00E+00	
$\varepsilon_{x,y}$	$(\varepsilon^*_{x,y})/(\gamma\ \beta_{rel})$	9.38E-10	m
σ_x	$\sqrt{(\varepsilon_{x,y}\ \beta_x)}$	4.06E+02	µm
σ_y	$\sqrt{(\varepsilon_{x,y}\ \beta_y)}$	4.37E+02	µm
$\sigma_{x\ image}$	$\sigma_x\ M$	1.22E+02	µm
$\sigma_{y\ image}$	$\sigma_x\ M$	1.31E+02	µm

$6 \times \sigma_{x\ image}$	7.31E+02	µm
$6 \times \sigma_{y\ image}$	7.87E+02	µm

CCD size ~ 6mm OK
CCD pixel size ~ 10µm OK

Synchrotron light LHC 3.5 TeV

N_b	protons/bunch	1.10E+11	
k_b	# of bunches	1000	
f_{rev}	Rev. frequency	11245	Hz
E	Energy	3500	GeV
ρ	Bending radius	6000	m
$\phi_{telescope}$	Aperture	5.00E-03	m
$d_{telescope}$	Distance	24	m

m_{p0}	Mass of proton	0.938	GeV
q_{e-}	Charge electron	1.60E-19	C
ε_0	Dielectric constant	8.85E-12	F/m
c	Speed of light	3.00E+08	m/s

γ	E/m_{p0}	3.73E+03	
β_{rel}	$\sqrt{1-1/\gamma^2}$	1.00E+00	
P	$2\ c\ e^2\ \Upsilon^4 / (12\ \pi\ \varepsilon_0\ \rho^2)$	2.48E-13	W
φ_{geom}	$\phi_{telescope}/d_{telescope}$	2.08E-04	rad
φ_{rad}	$2/\Upsilon$	5.36E-04	rad
ΔL	$\rho\ (\varphi_{geom} + 2\ \varphi_{rad})$	7.68E+00	m
Δt	$\Delta L/c$	2.56E-08	s
p	$P\ \Delta t$	6.35E-21	J/p^+ turn
w	$p\ N_b\ k_b\ f_{rev}$	7.86E+00	mW
ω_{cr}	$3\ c\ \Upsilon^3 / (2\ \rho)$	3.90E+15	rad/s
λ_{cr}	$2\ \pi\ c\ /\ \omega_{cr}$	4.84E+02	nm

At 3.5 TeV the critical wavelength is right in the visible

Synchrotron light LHC 450 GeV

N_b	protons/bunch	1.10E+11	
k_b	# of bunches	1000	
f_{rev}	Rev. frequency	11245	Hz
E	Energy	450	GeV
ρ	Bending radius	6000	m
$\phi_{telescope}$	Aperture	5.00E-03	m
$d_{telescope}$	Distance	24	m

m_{p0}	Mass of proton	0.938	GeV
q_{e-}	Charge electron	1.60E-19	C
ε_0	Dielectric constant	8.85E-12	F/m
c	Speed of light	3.00E+08	m/s

γ	E/m_{p0}	4.80E+02	
β_{rel}	$\sqrt{1-1/\gamma^2}$	1.00E+00	
P	$2\ c\ e^2\ \Upsilon^4 / (12\ \pi\ \varepsilon_0\ \rho^2)$	6.78E-17	W
φ_{geom}	$\phi_{telescope}/d_{telescope}$	2.08E-04	rad
φ_{rad}	$2/\Upsilon$	4.17E-03	rad
ΔL	$\rho\ (\varphi_{geom} + 2\ \varphi_{rad})$	5.13E+01	m
Δt	$\Delta L/c$	1.71E-07	s
p	$P\ \Delta t$	1.16E-23	J/p$^+$ turn
w	$p\ N_b\ k_b\ f_{rev}$	1.43E-02	mW
ω_{cr}	$3\ c\ \Upsilon^3 / (2\ \rho)$	8.28E+12	rad/s
λ_{cr}	$2\ \pi\ c\ /\ \omega_{cr}$	2.28E+05	nm

Note that the ΔL is longer then the magnet itself so the total power will be lower than that.

At 450 GeV the light is emitted in the far infrared and can not be used for imaging (in fact there is an undulator to solve the problem)