SYNCHROTRON RADIATION CONTRIBUTION IN THE INTERACTION REGION IN FCC-HH

FRANCESCO COLLAMATI

24-05-2016

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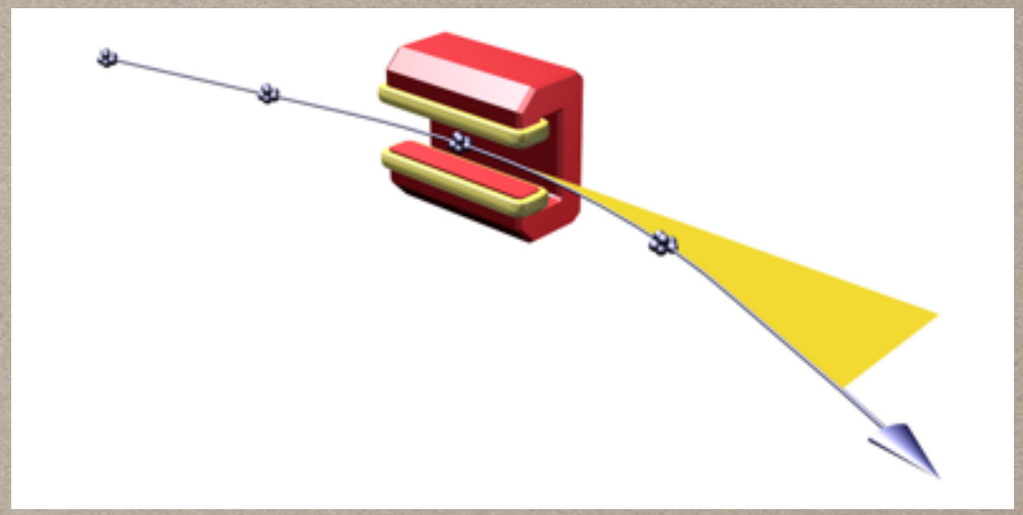

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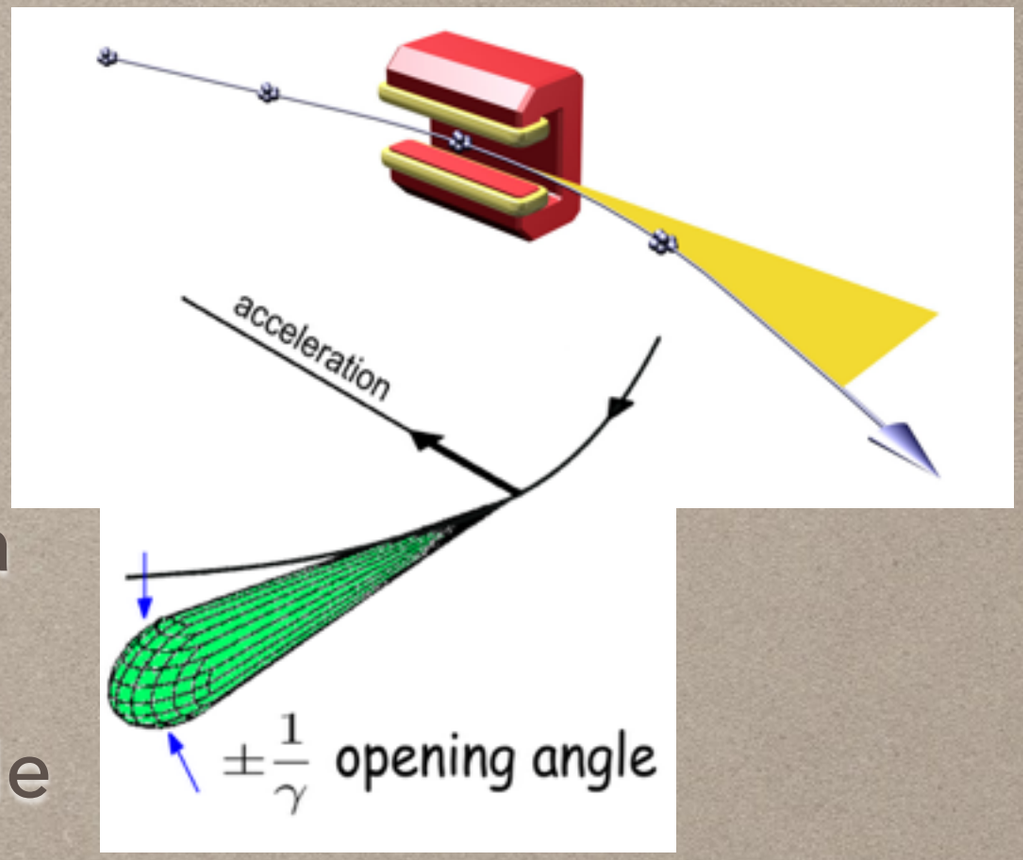

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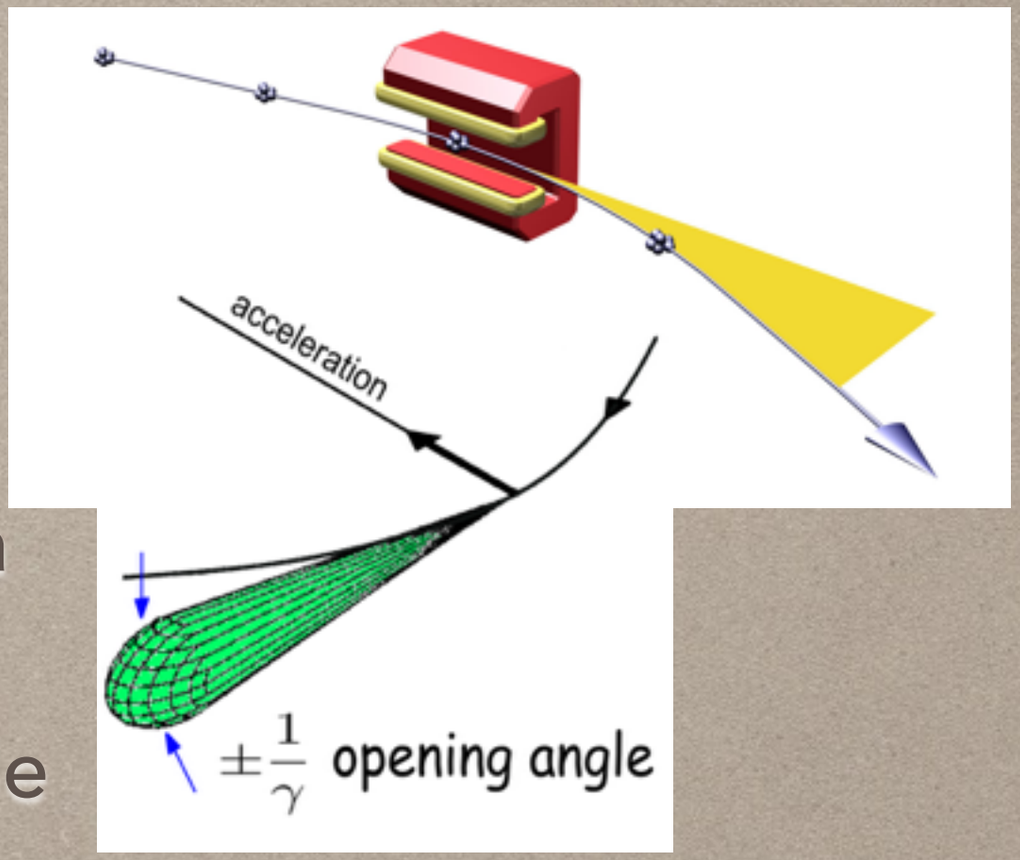
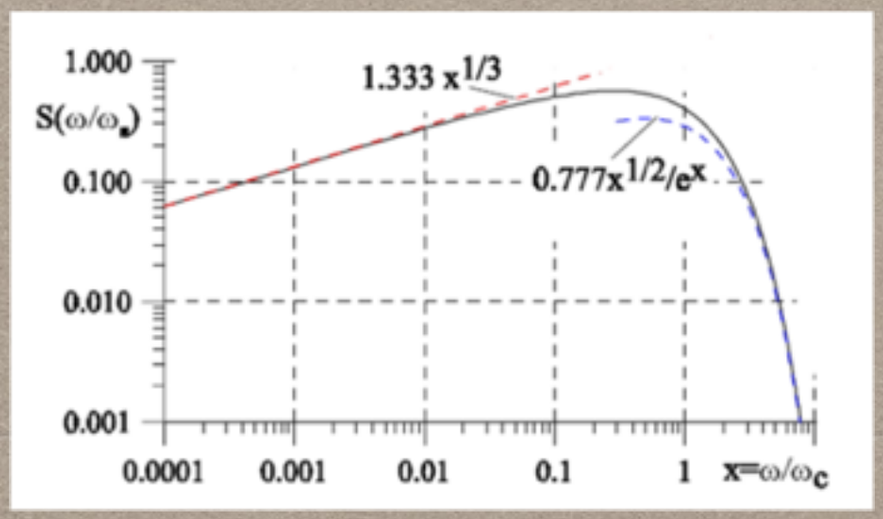


- The emitted radiation is composed by several harmonics of the revolution frequency:



critical frequency (& energy): the frequency above which half of the power is emitted

$$\omega_c = \frac{3}{2} c \frac{\gamma^3}{\rho}$$

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- However, in **Very High Energy** p-p colliders the effect starts to be visible, and should be carefully evaluated
  - I.e. LHC, FCC-hh…

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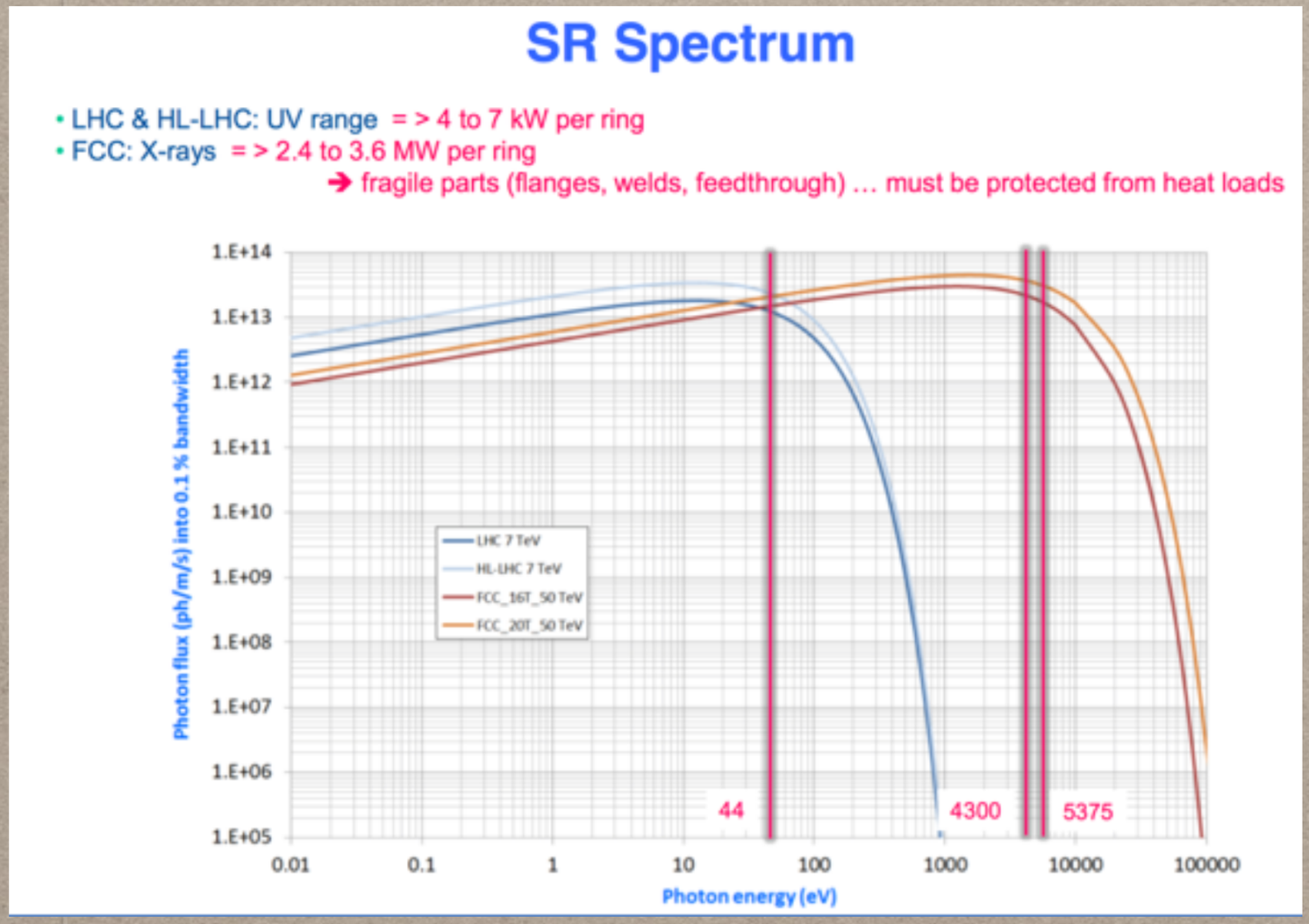
- Energy distribution of synchrotron radiation photons for LHC and FCC-hh:



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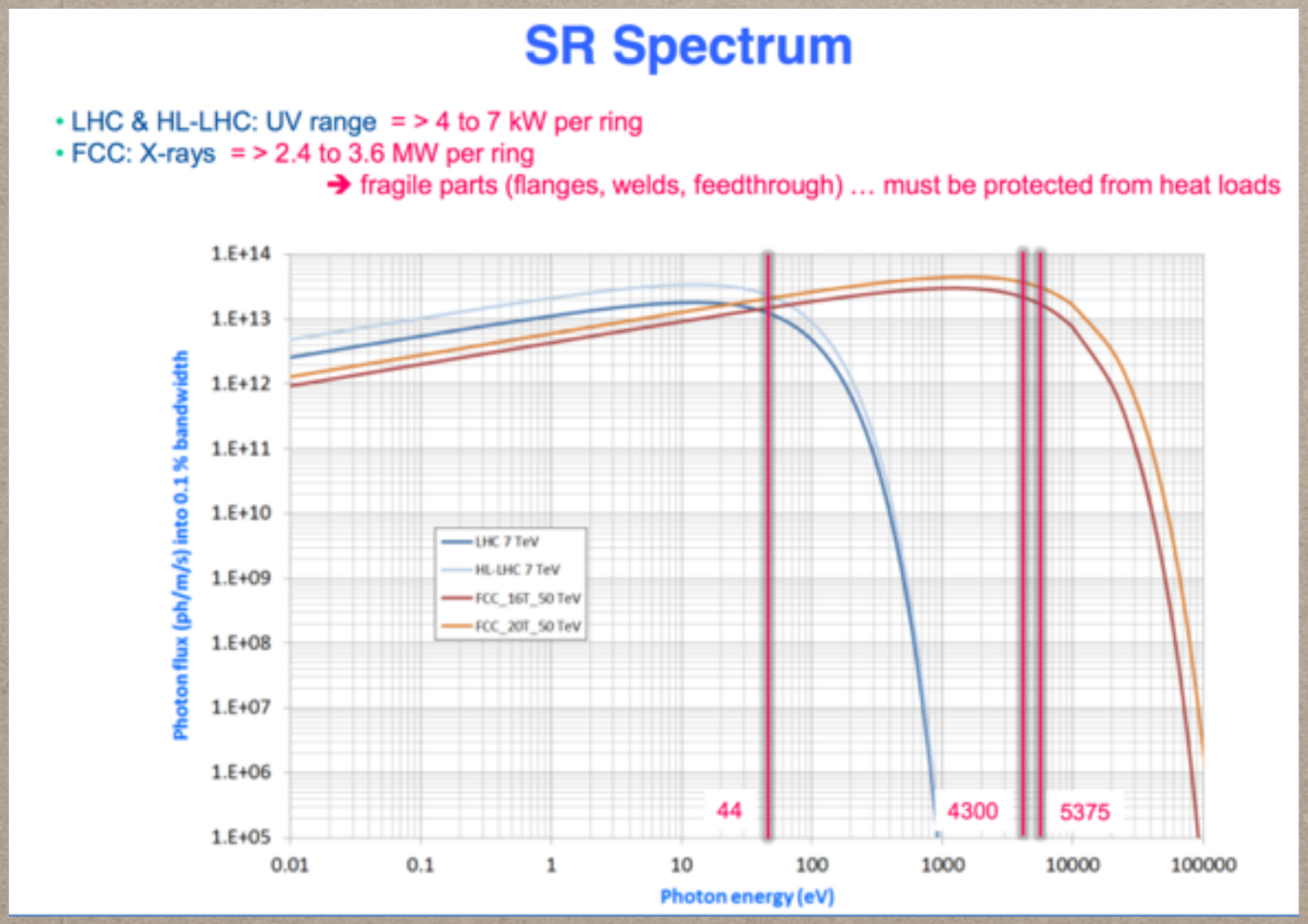

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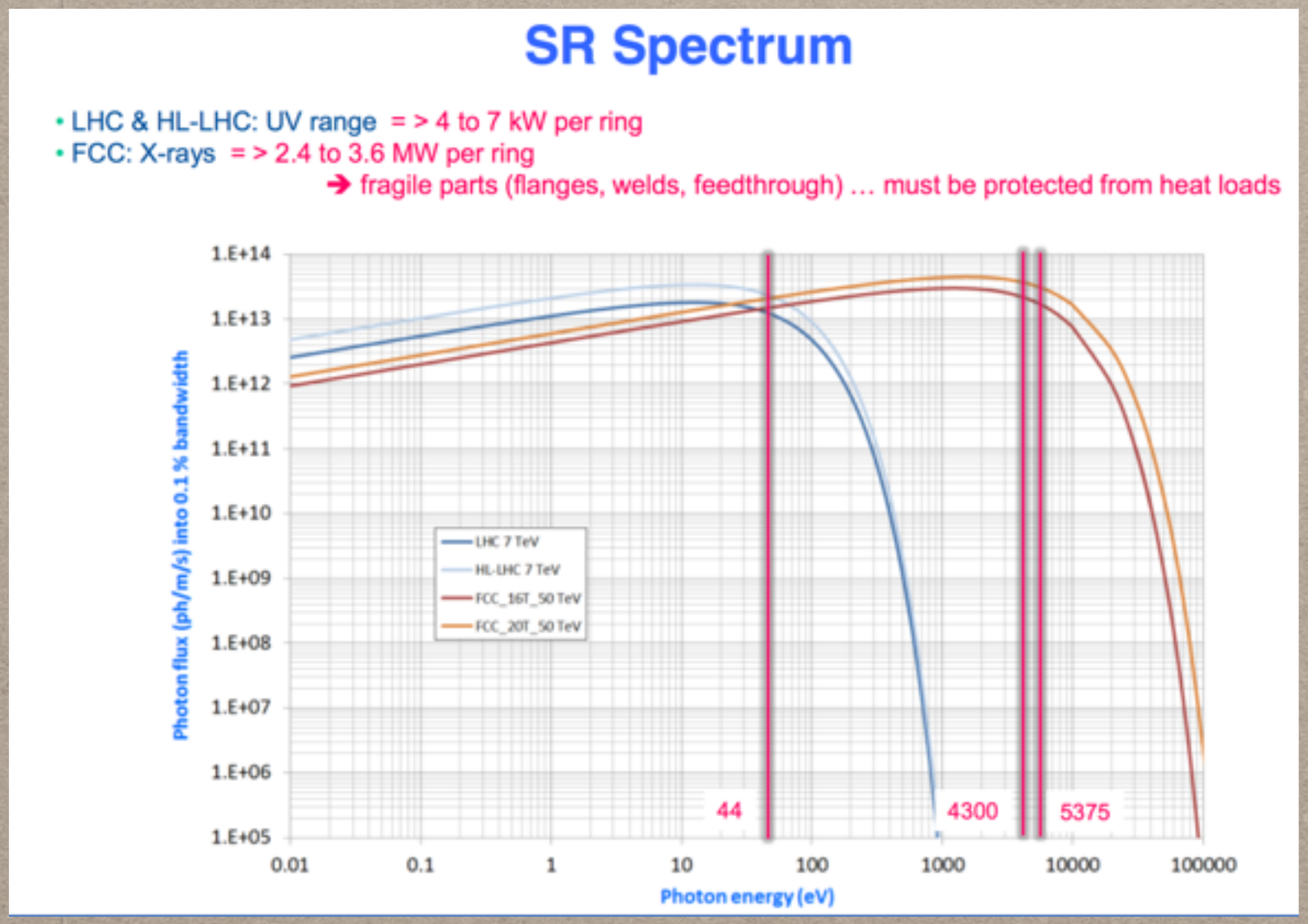

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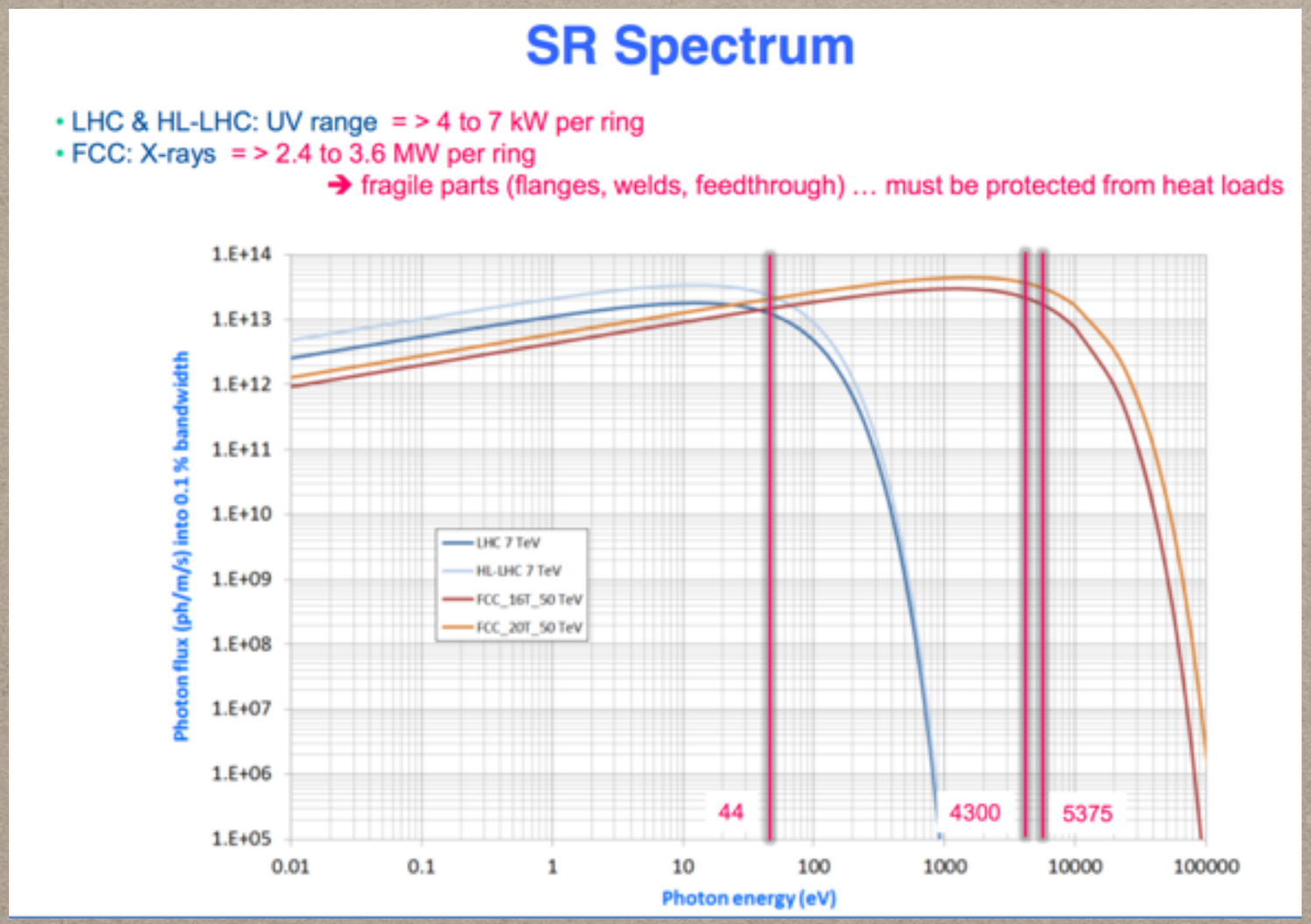

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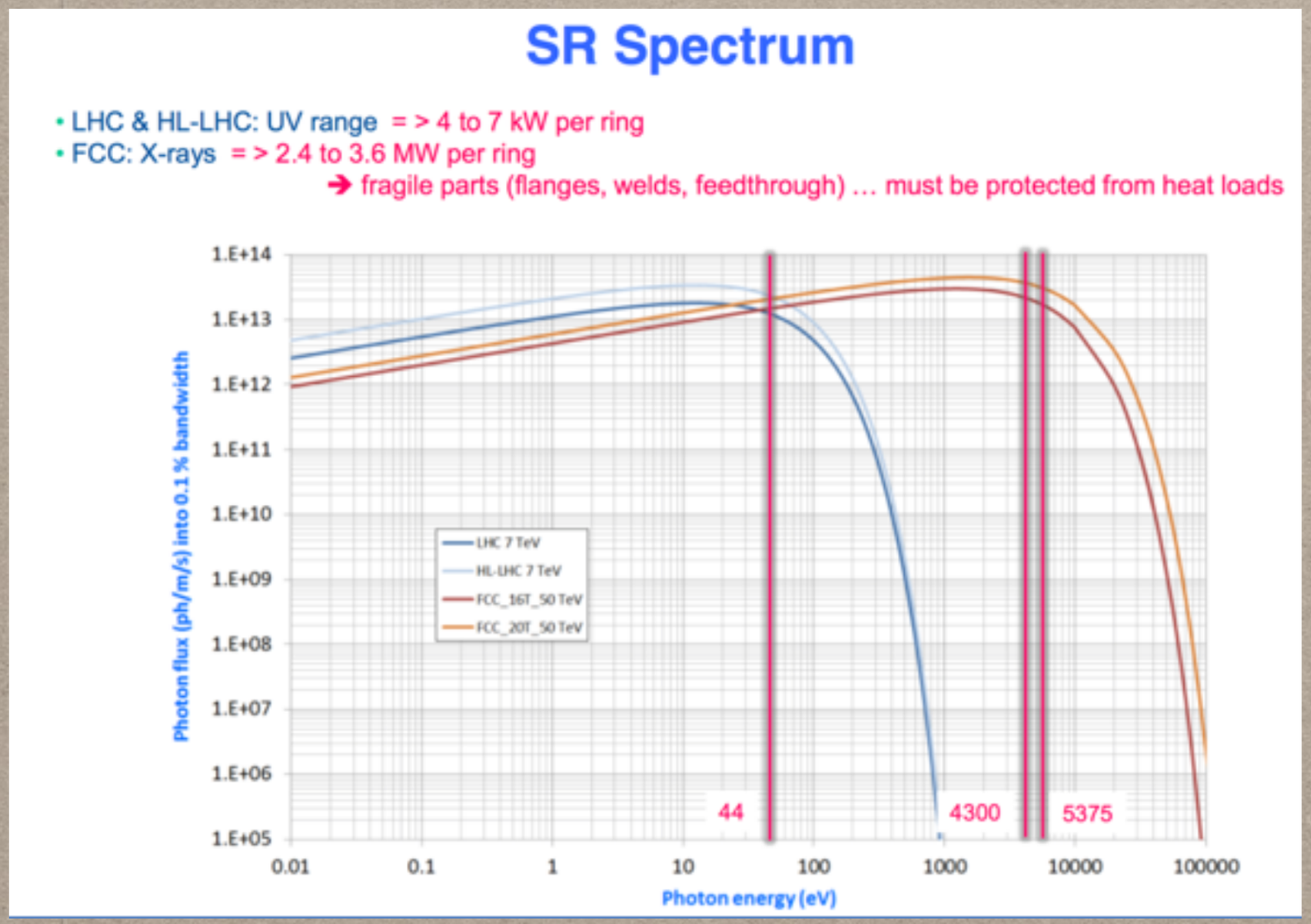

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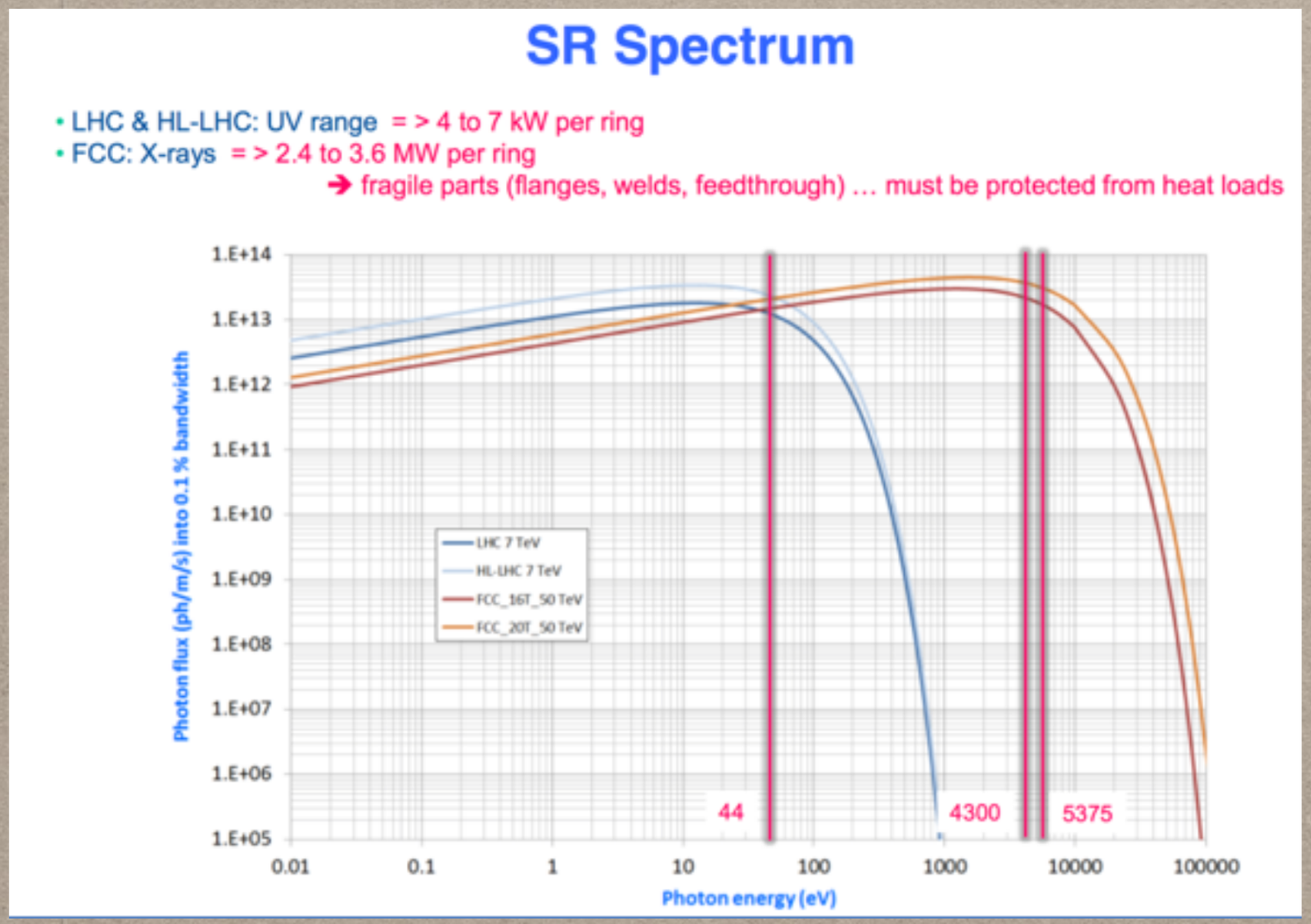

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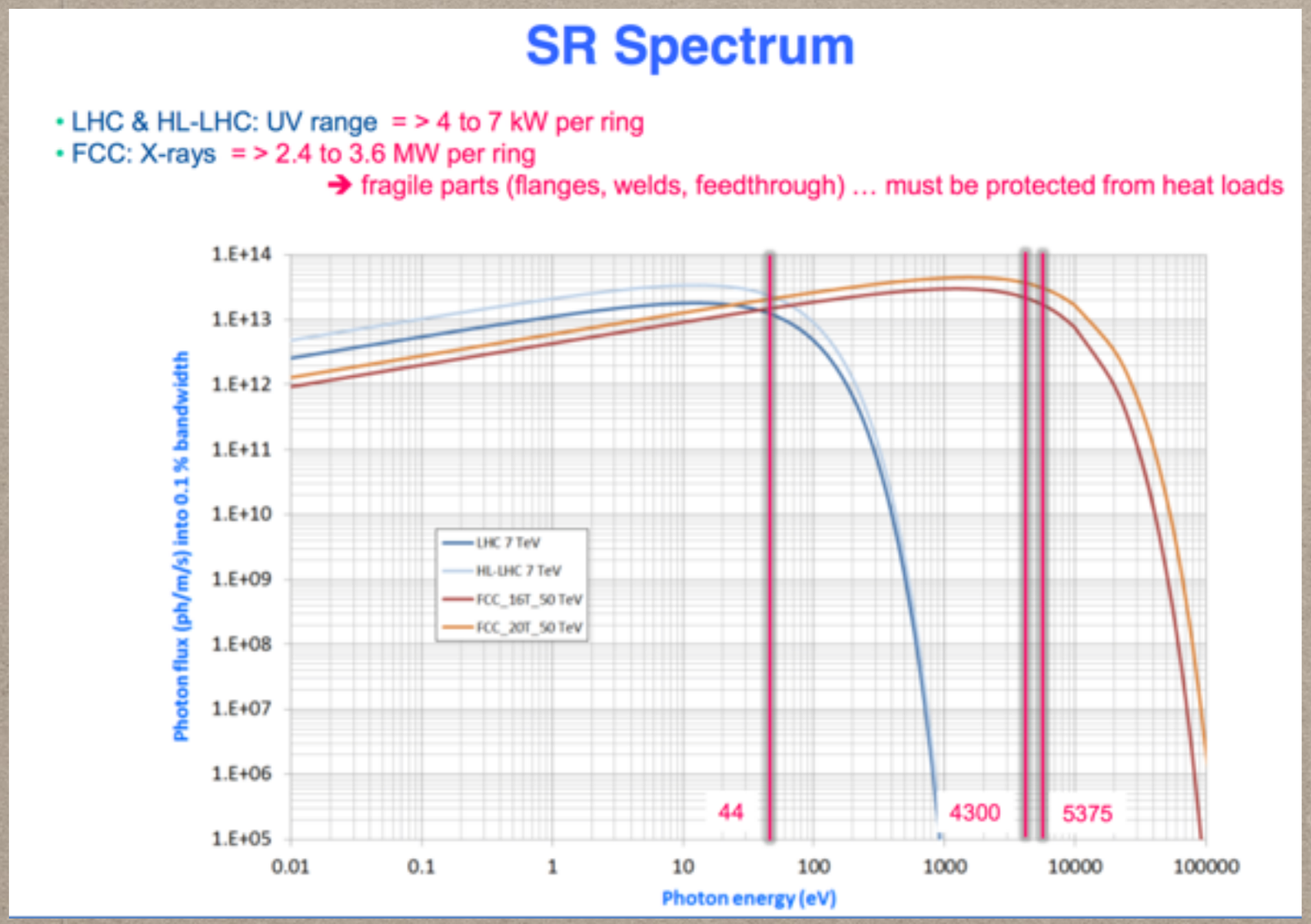

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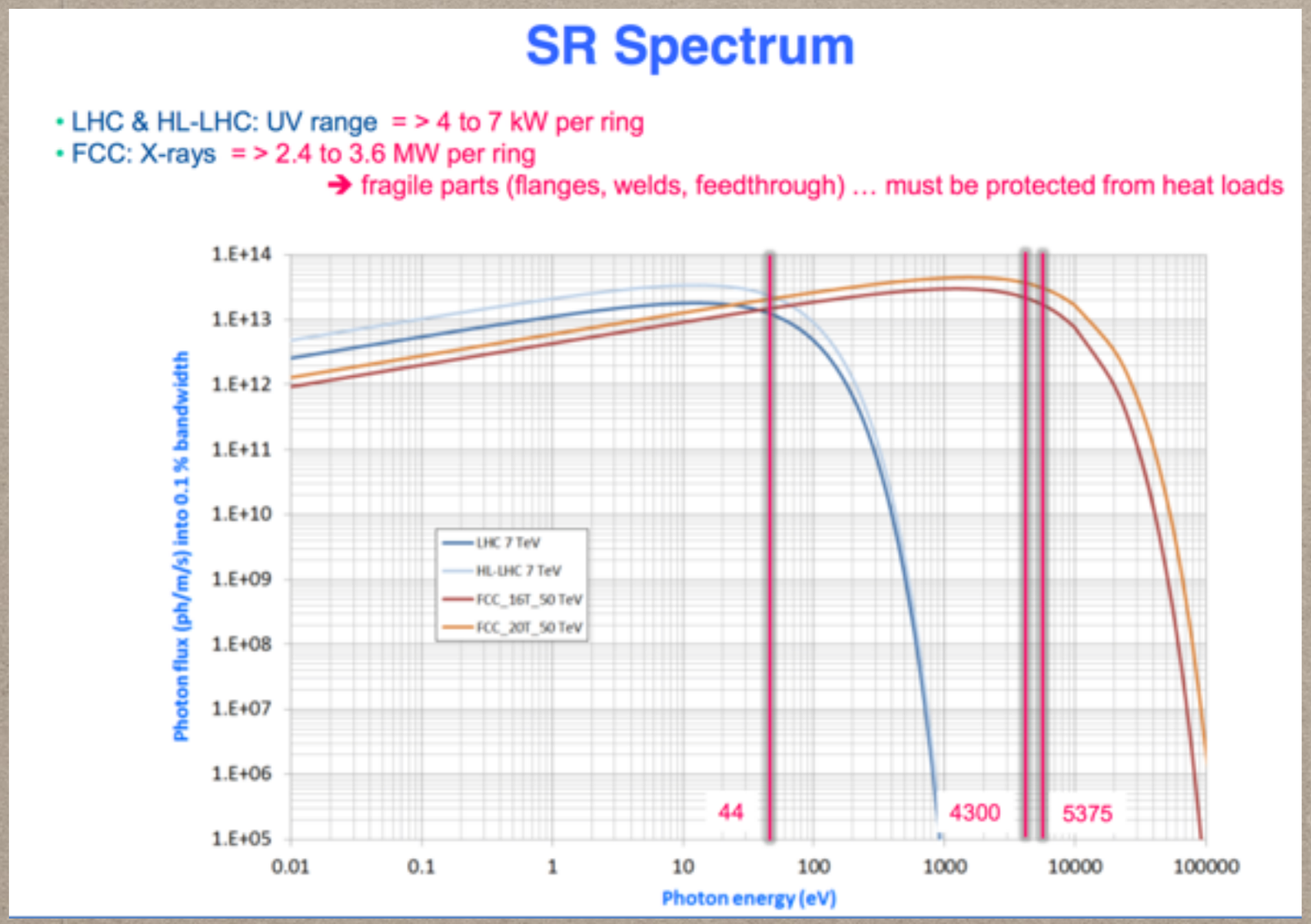

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More, and more energetic photons!

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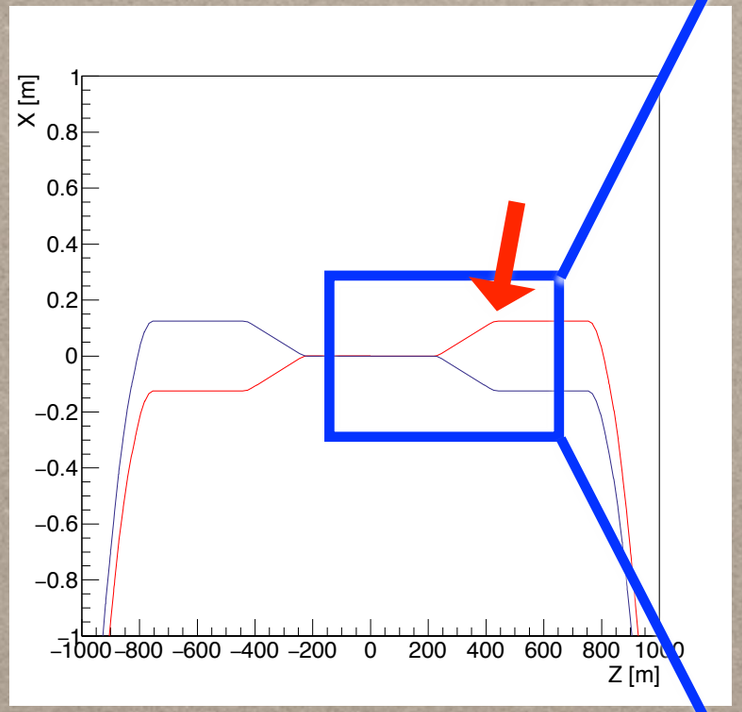
➡ The radiation cone is very narrow:

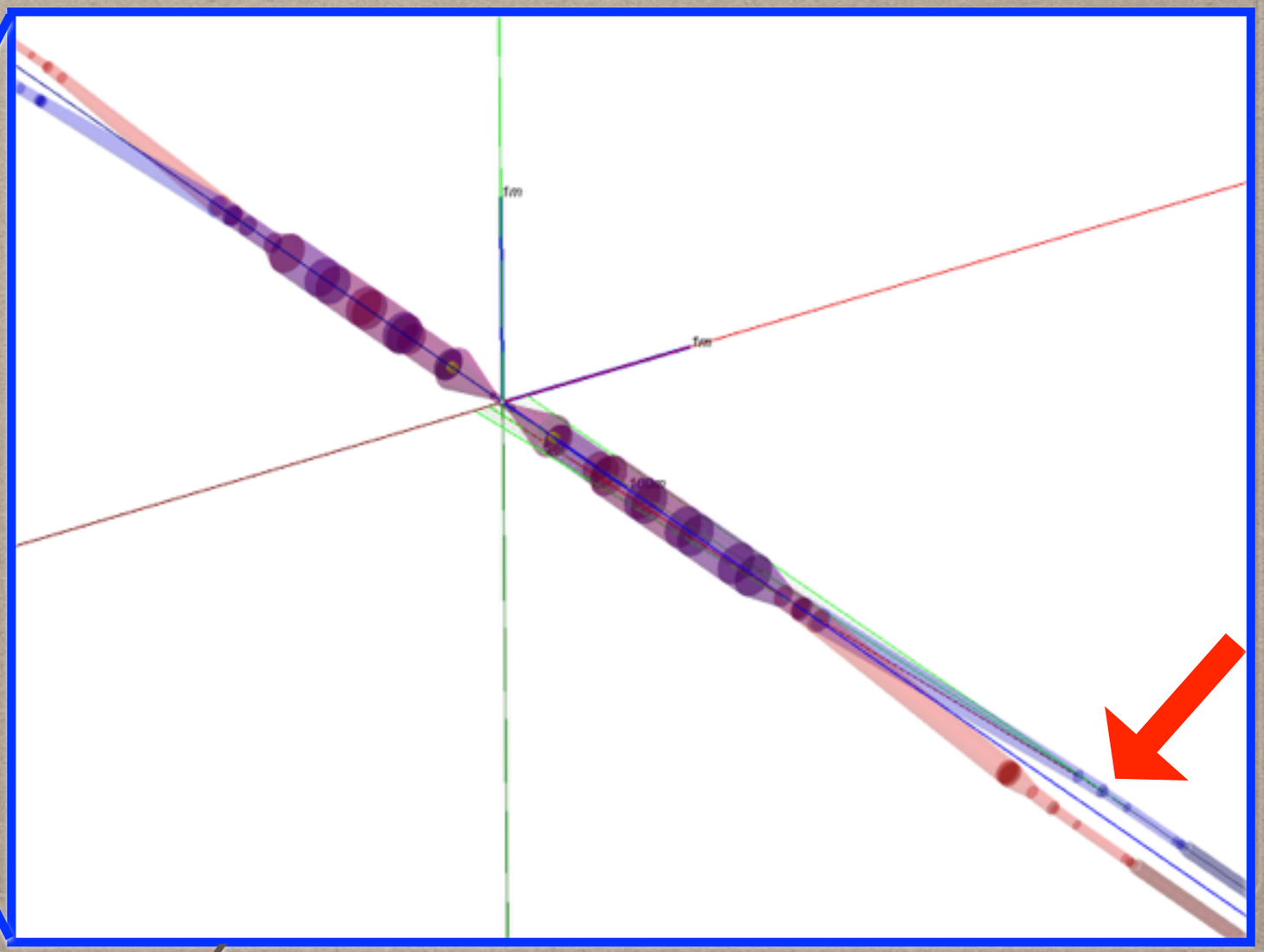
$$\gamma_p = \frac{E_p}{m_p} = \frac{50TeV}{938MeV} \sim 5 \times 10^4$$

$$\frac{1}{\gamma_p} \sim 1.9 \times 10^{-5} rad \sim 10^{-3} grd$$

MY TASK

- My (current) task is to **evaluate the contribution of synchrotron radiation** photons emitted in the last bending magnets **into the interaction region**
- Tool used: **MDISim**





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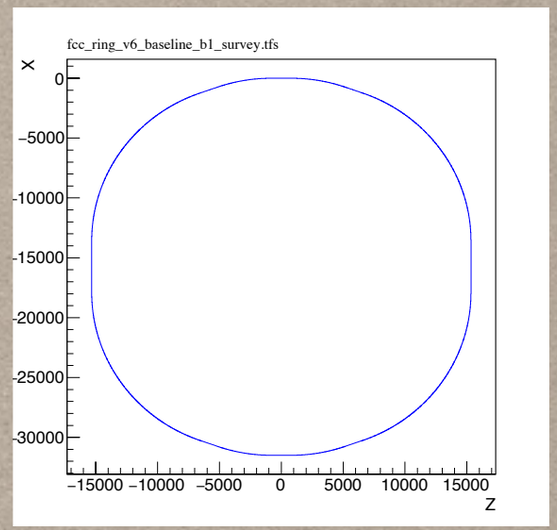

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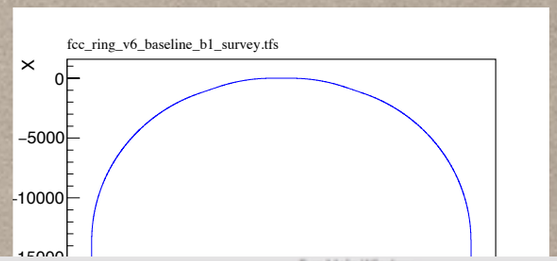

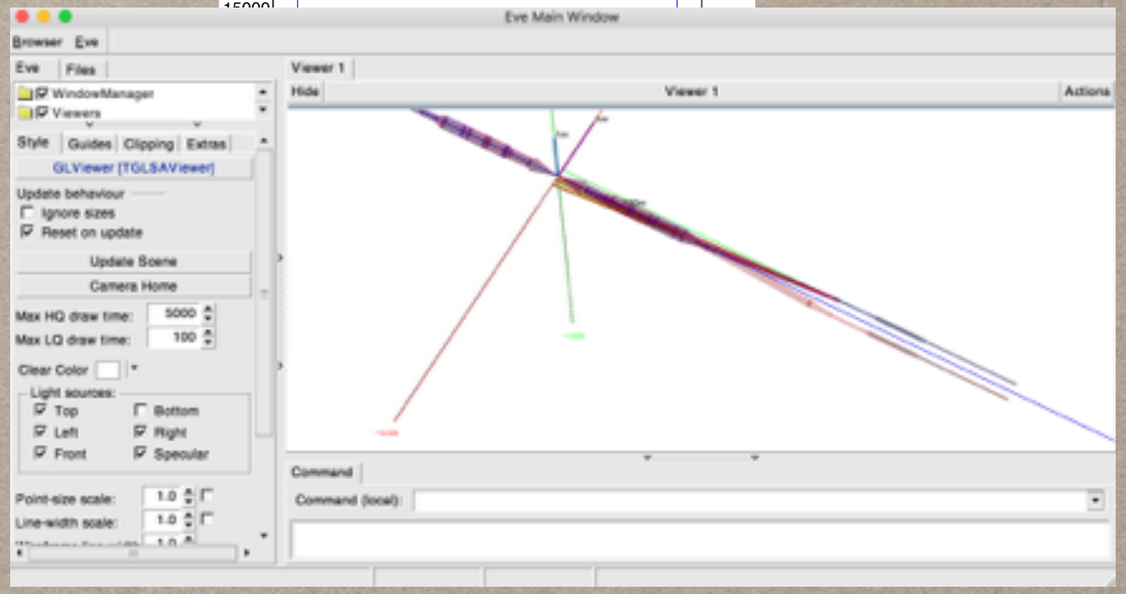

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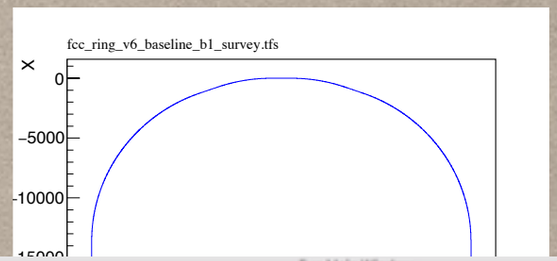

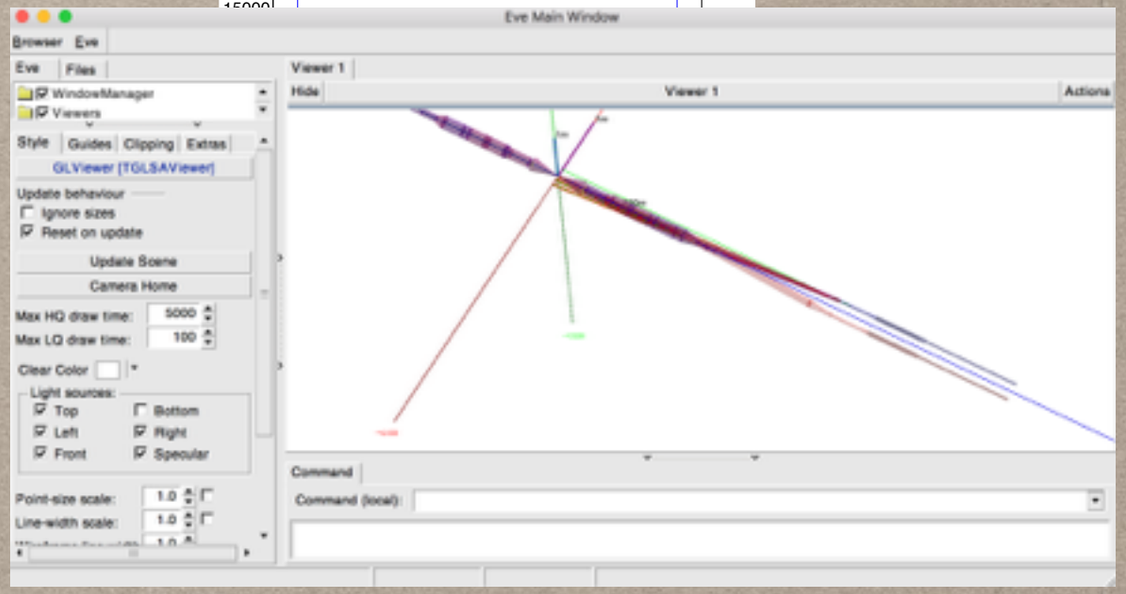

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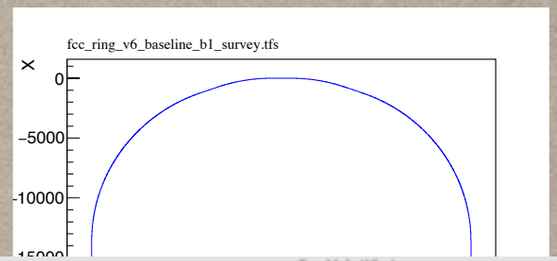

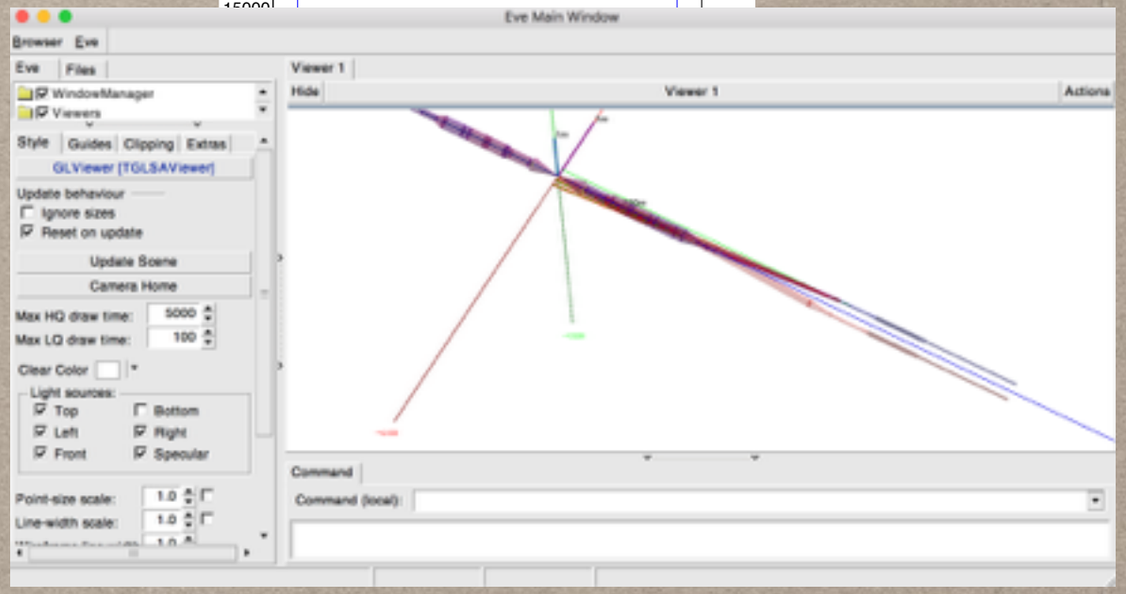

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  - ➡ Import geometry and SR in **Geant** to perform full simulation

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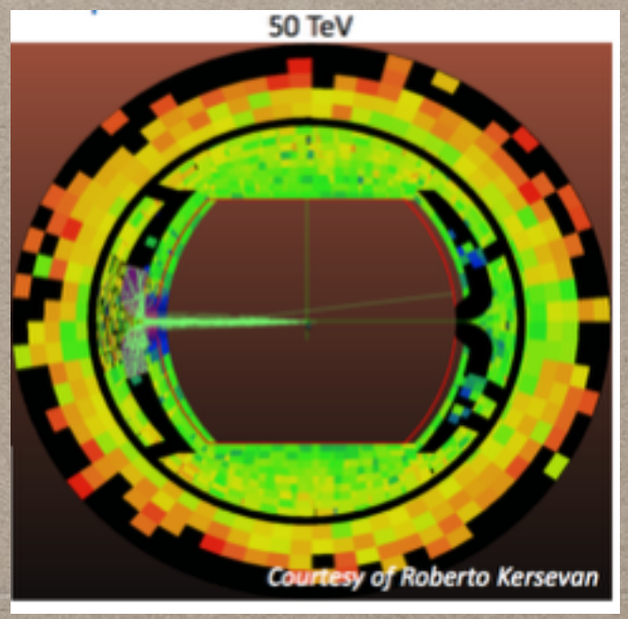

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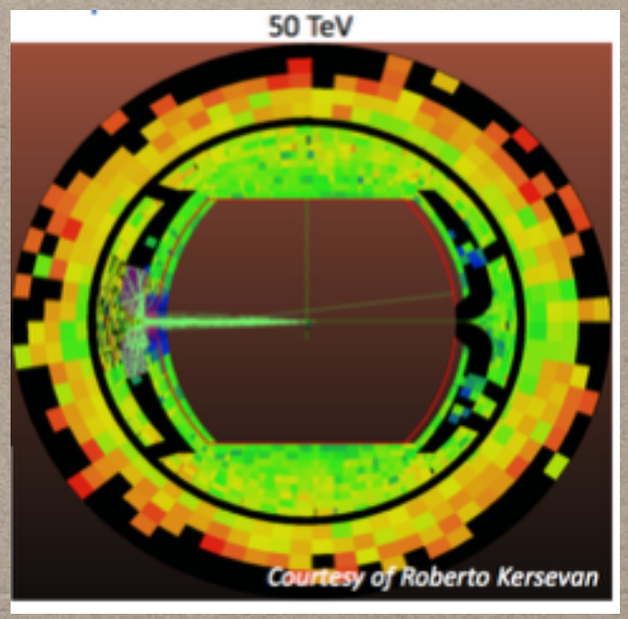

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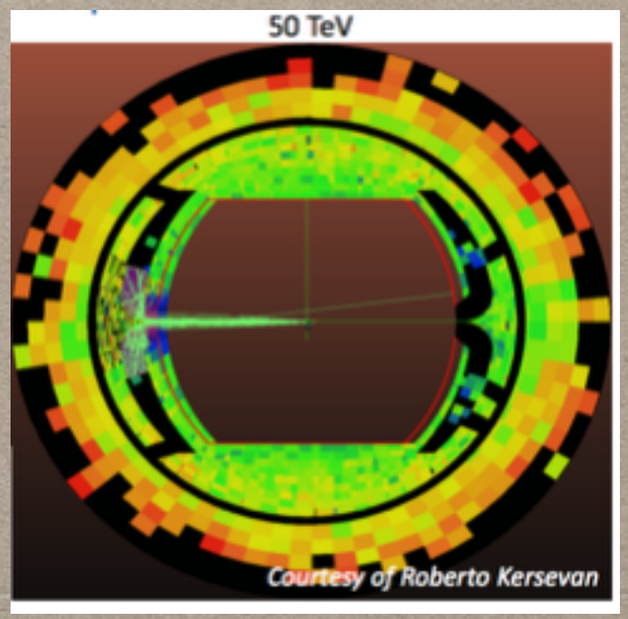

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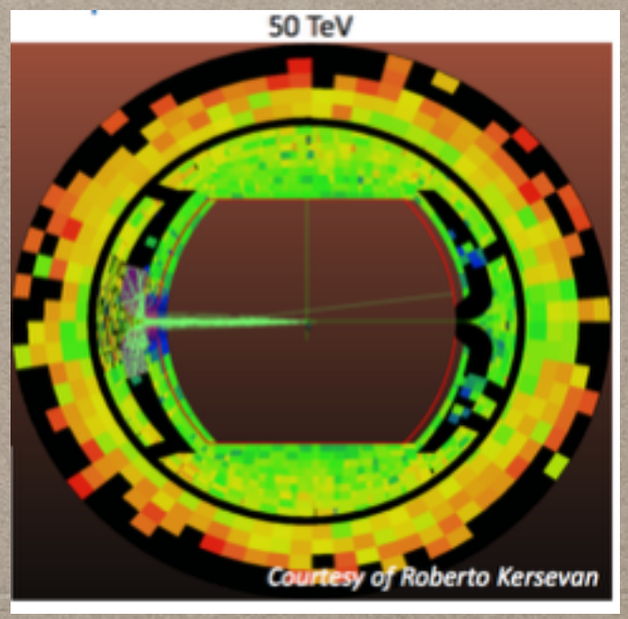

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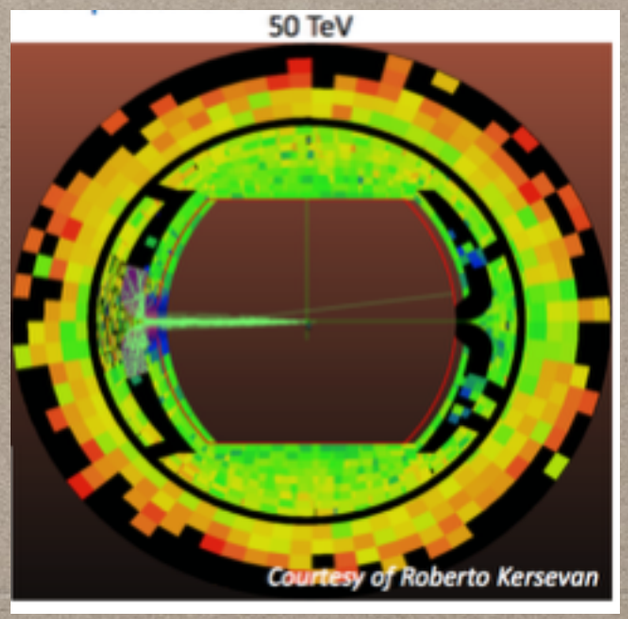

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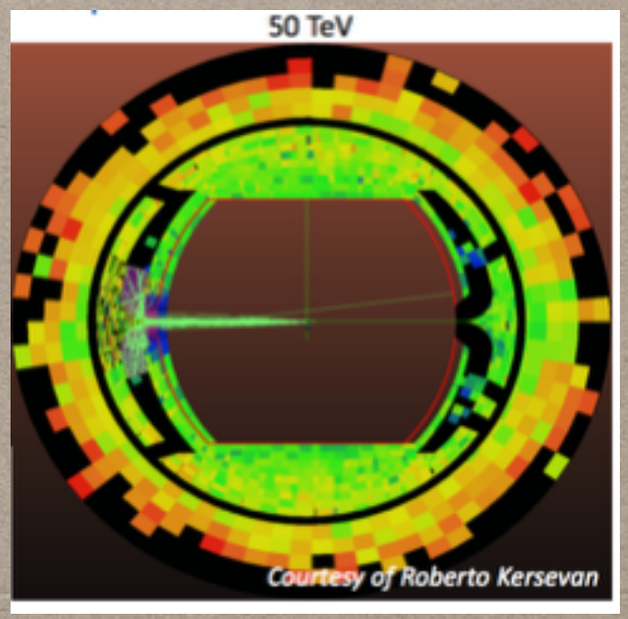
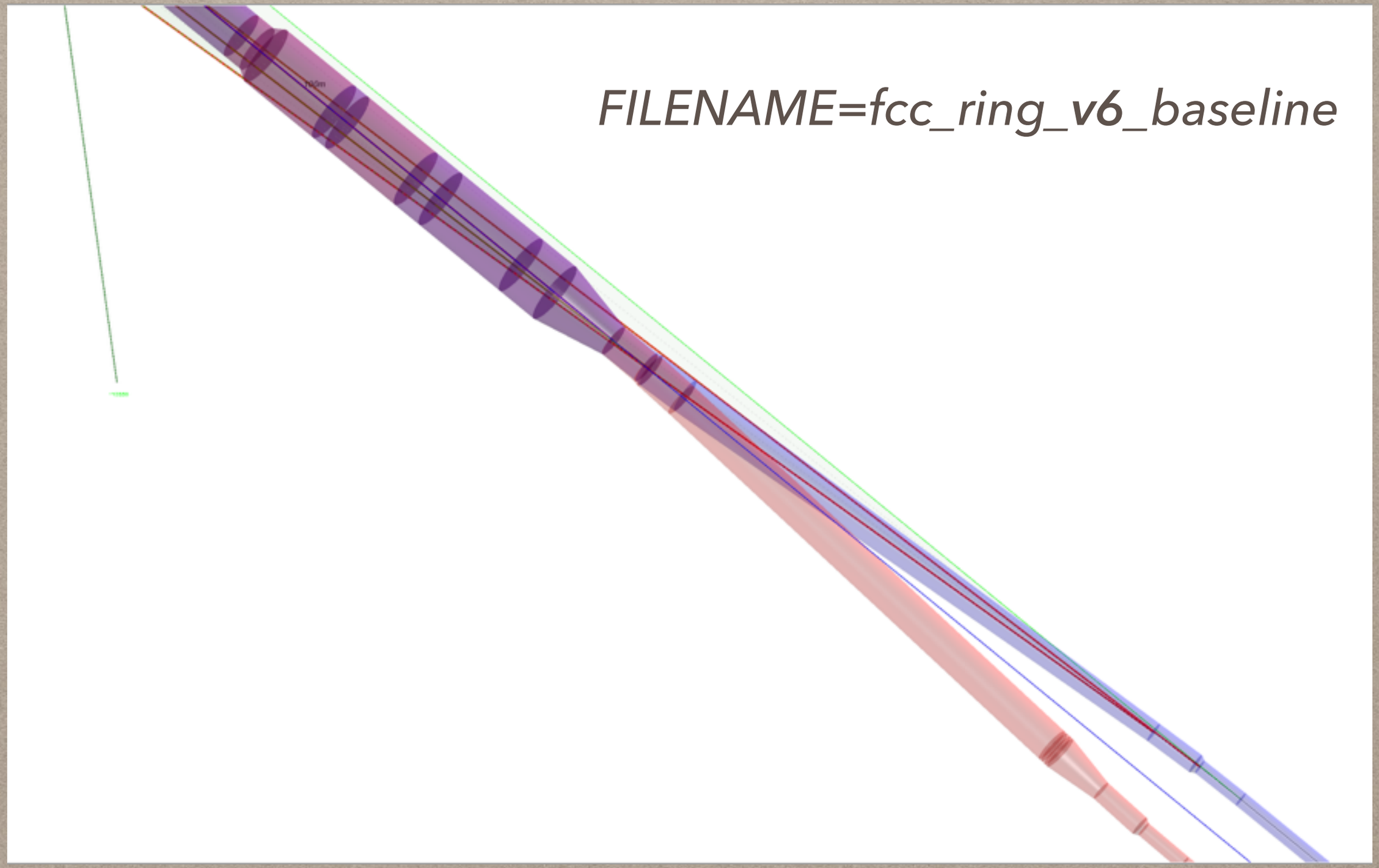
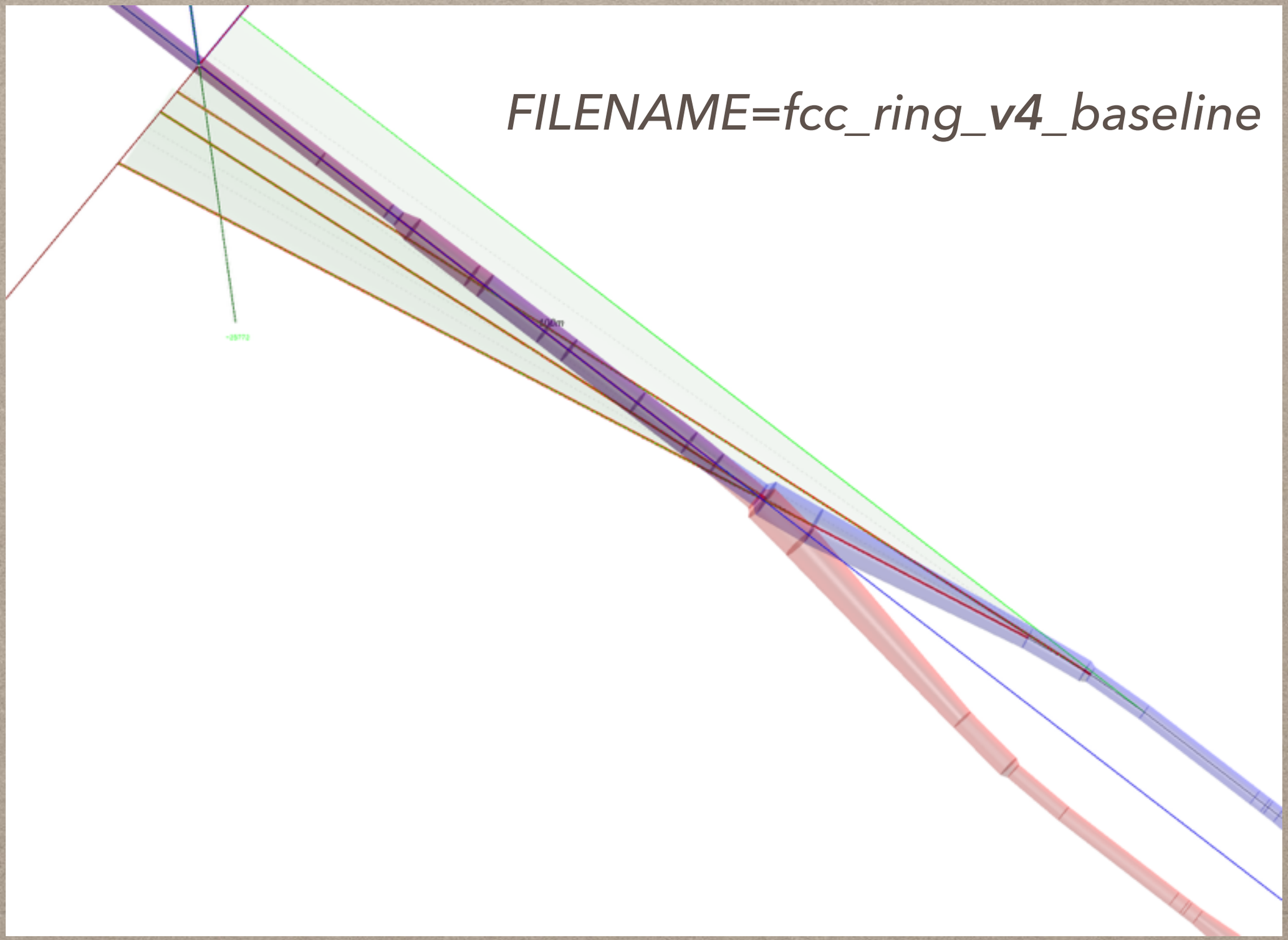
  - Is "total absorption of the pipe" a "too good scenario"!?
- Evaluate (by means of MC) the fraction of SR photons exiting the beam pipe
- **If** still a **non negligible** contribution, evaluate the impact of:
  - Edge effect
  - Angular distribution of photons
  - Polarization of photons



"CONE" DIRECTION



"CONE" DIRECTION



spare

LHC, HL-LHC and FCC-hh Parameters

	LHC Design		HL-LHC	FCC	
	Nominal	Ultimate	Nominal	16 T	20 T
Energy [TeV]	7			50	
Luminosity [x10^{34} $cm^{-2}.s^{-1}$]	1.0	2.3	5*	5 to 30	
Current [mA]	584	860	1090	509	609
Proton per bunch [x10^{11}]	1.15	1.7	2.2	1.0	
Number of bunches	2808		2736	10600	8900
Bunch spacing [ns]	25			25 (then 5 ?)	
Critical energy [eV]	44.1			4300	5375
Photon flux [ph/m/s]	1 10^{17}	1.5 10^{17}	1.9 10^{17}	1.7 10^{17}	2.6 10^{17}
SR power [W/m]**	0.22	0.33	0.42	36.3	68.0
Photon dose [ph/m/year]	1 10^{24}	1.5 10^{24}	1.9 10^{24}	1.7 10^{24}	2.6 10^{24}

* Levelled luminosity

** to be multiplied by 0.8 to get the average power in the arc taking into account the quadrupoles and interconnects lenghts

SYNCHROTRON RADIATION