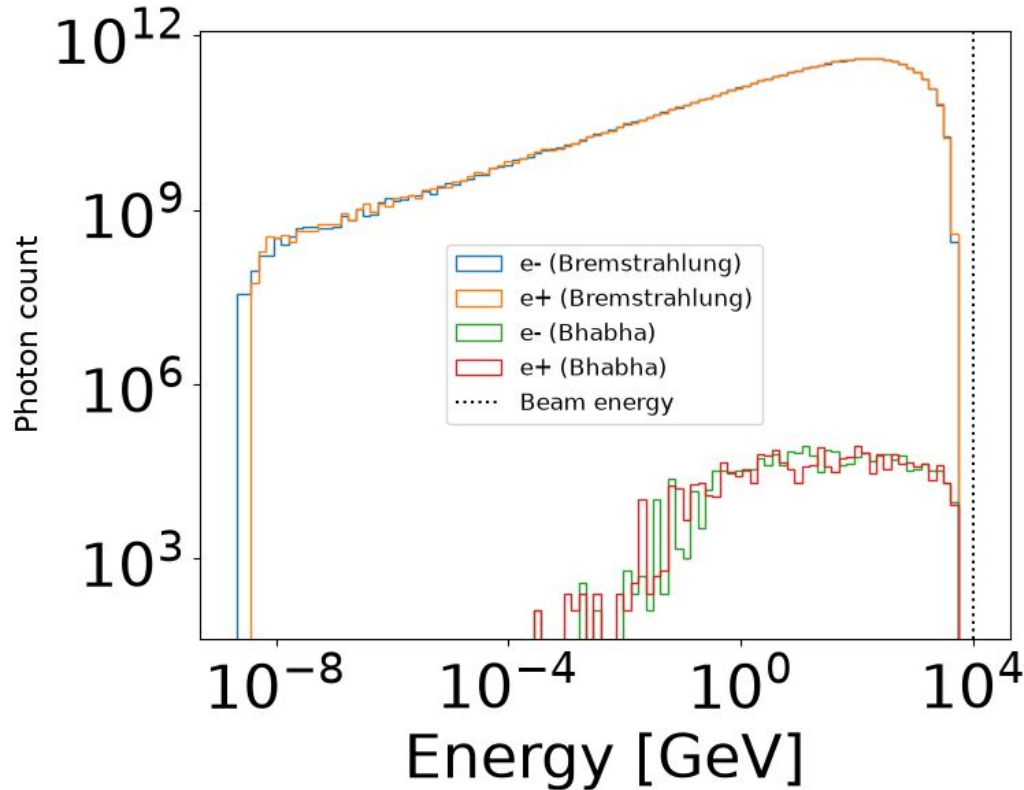


Simulating a Muon Collider in WarpX: Goals for Project

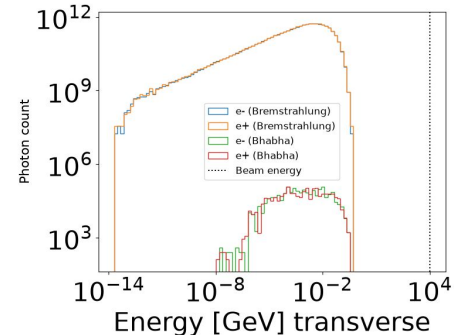
- Deploying WarpX for a muon collider, including beam-beam effects
- Testing modifications for the code that need to correctly model muon behavior, including QED effects
- Visualizations of collisions
- Understanding muon collider performance under different parameters.

Began with e⁺-e⁻ collider, with muon specifications

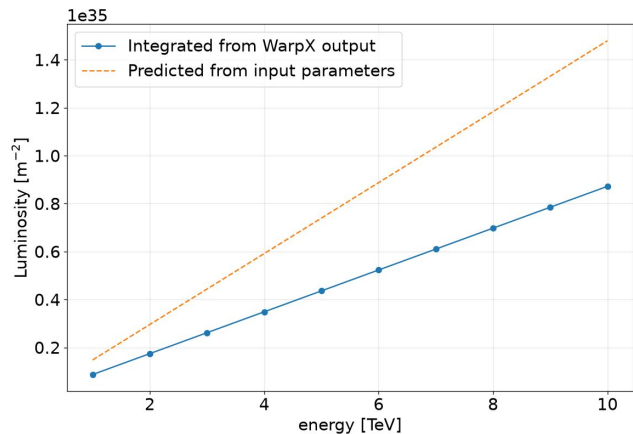


Parameter	Unit	version	
		relaxed	target
Center of mass energy	TeV	10	
Geometric Luminosity ¹	10 ³⁴ cm ⁻² s ⁻¹	5.77	19.2
Beam energy	TeV	5	
Relativistic Lorentz factor		47322	
Circumference ²	km	≈ 10	
Dist. of last magnet to IP	m	6	
Repetition rate	Hz	5	
Bunch intensity (one bunch per beam)	10 ¹²	1.80	
Injected beam power per beam	MW	7.2	
Normalized transverse rms emittance	μm	25	
Longitudinal norm. rms emittance	eVs	0.025	
Relative rms momentum spread	10 ⁻³	0.3	1
RMS bunch length in space	mm	5	1.5
RMS bunch length in time domain	ns	.017	0.005
Twiss betatron function at the IP	mm	5	1.5
Energy loss per turn ³	MeV	≈ 27.2	
Integrated RF gradient ⁴	MV	30	

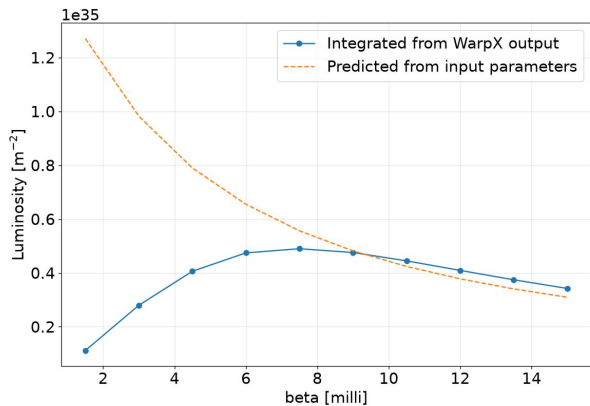
Table 6.1: Assumptions for the main parameters used in the design of a 10 TeV muon collider.



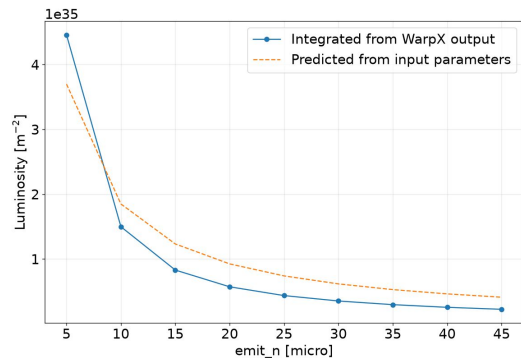
Varying parameters that affect luminosity



fixed $\beta = 5\text{mm}$, $\epsilon = 25\text{ }\mu\text{m}$



fixed $E = 5\text{ TeV}$, $\epsilon = 25\text{ }\mu\text{m}$



fixed $E = 5\text{ TeV}$, $\beta = 5\text{mm}$

Theoretically:

$$\mathcal{L}_{\text{cross}} = \frac{N_1 N_2}{4\pi \sigma_x \sigma_y} H_D = \frac{N_1 N_2 \gamma}{4\pi \epsilon_n \beta} H_D$$

Mysteries/next steps

- Shouldn't we expect $L \sim \gamma = E/(mc^2) \sim 1/m$, at fixed energy?
 - e-e collider with muon specifications: Luminosity $3.0 \cdot 10^{34} \text{ m}^{-2} \text{ s}^{-1}$
 - Naive muon collider [only changing mass]: Luminosity $4.6 \cdot 10^{34} \text{ m}^{-2}$
- Why is there a normalized emittance that peaks luminosity?
- Next steps: So far, I've just been varying the WarpX input files. Time to actually modify the code.