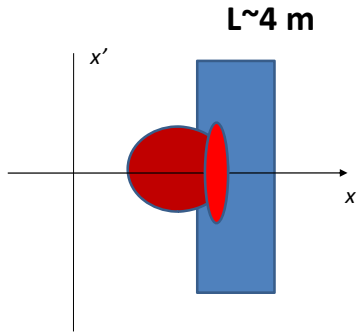


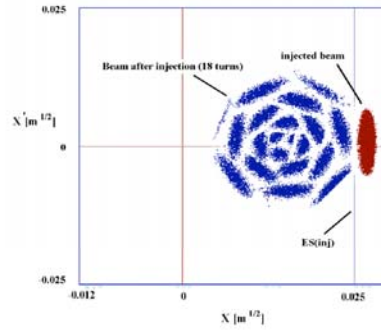
Injection

Strip-injection



Emittance $\sim 17 \pi$ -mm-mrad
 $N_B \sim 3 \times 10^{10}$ to 1×10^{11}

Multi-turn accumulation injection



Emittance $> 100 \pi$ -mm-mrad
 $N_B \sim 3 \times 10^{10}$ to 1×10^{11}

Multi-turn injection simulation

Strip injection for carbon ion synchrotrons

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$$\frac{dF_i}{dx} = \sum_{j \neq i} \sigma_{ji} F_j - \sum_{j \neq i} \sigma_{ij} F_i,$$

$$\frac{dF_4}{dx} = -\sigma_{45} F_4,$$

$$\frac{dF_5}{dx} = \sigma_{45} F_4 - \sigma_{56} F_5,$$

$$\frac{dF_6}{dx} = \sigma_{56} F_5,$$

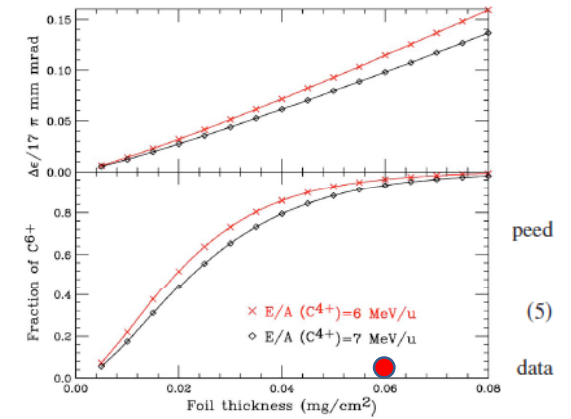
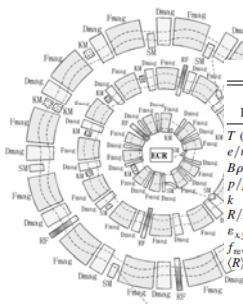


FIG. 1. (Color online) Bottom: fraction of C^{6+} vs the foil thickness (x) for injection energies of C^{4+} : 6 and 7 MeV/u, respectively. Top: fractional injection efficiency vs foil thickness; stripping foil vs

$$F_6(x) = 1 - e^{-\sigma_{45}x} - \frac{\sigma_{45}}{\sigma_{45} - \sigma_{56}} (-e^{-\sigma_{45}x} + e^{-\sigma_{56}x}).$$

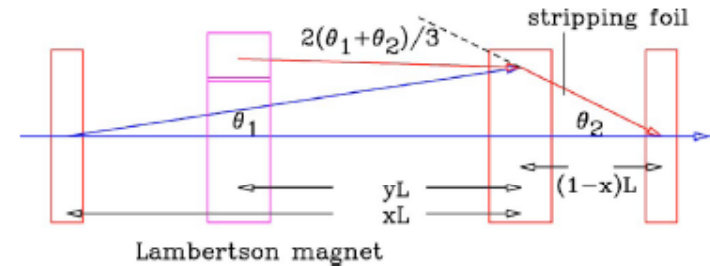


Possible Injectors

TABLE III. FFAG system parameter. $p/p_0 = (R/R_0)^{k+1}$, $B/B_0 = (R/R_0)^k$, $g/g_0 = (R/R_0)^{-k}$.

Parameter	Low-energy FFAG		Medium-energy FFAG		High-energy FFAG	
	Injection	Extraction	Injection	Extraction	Injection	Extraction
T (MeV/u)	0.04	6	6	100	200	400
e/m	1/3		1/2		1/2	
$B\rho$ (Tm)	0.086 34	1.0595	0.7064	2.9554	2.9554	6.3467
p/p_0	1	12.27	1	4.18	1	2.15
k		6.5		10.5		10.5
R/R_0	1	1.43	1	1.16	1	1.07
$\epsilon_{x,y}$ (π mm mrad)	108	8.8	8.8	2.1	2.1	0.98
f_{rev} (MHz)	0.215	1.878	0.909	3.050	2.025	3.151
$\langle R \rangle$ (m)	2.06	2.87	5.93	6.72	10.12	10.82

	LINAC	FFAG
E (MeV/u) C^{4+}	7	6
N/pulse (10^9)	60	5.9
Emittance ($\pi\mu$ m)	6.4	8.8
N_turn (10^9)	0.40	5.9
Pulse length (μ s)	300	
Tolerable foil hits	12	10
Accumulation turns	150	19
N_total (10^{11})	0.60	1.0
Emittance ($\pi\mu$ m) final	17	17



$$\frac{1}{3}(\theta_1 + \theta_2)yL \geq 3(\sigma_{inj} + \sigma_{cir}) + \Delta_{septum},$$

Septum separation

$$(x - y)L\theta_{septum} \geq H,$$

Injection beam clears from main dipoles

$$(1 - x)L \geq 1 \text{ m},$$

Enough space for stripping foil assembly

Using the 7 MeV/u linac or the 6 MeV/u FFAG C^{4+} sources, we can easily accumulate a beam of 10^{11} C^{6+} with an emittance of 17π -mm-mrad in the synchrotron.