Los Alamos
NATIONAL LABORATORY
EST. 1943

USPAS Course
RF Linac Design Project

LA-UR-14-24393

Beam Starting Parameters

- x/y normalized emittance: 0.5 um each plane
- x/y beta functions: β_x = 100 m β_y = 200 m
- RMS bunch length 10 ps (3 mm)
- RMS energy spread 10^{-3}
- no initial chirp
- starting momentum $\beta\gamma$ = 200
- Set bunched_beam to clip at 3 sigma, not 2

- Use at least 25k particles when calculating final results (you can use many fewer to “tune up” but be careful – statistics get worse)

Physical Specifications & Constraints

- Linac overall length not to exceed 350 meters
- accelerator based on 1-GHz, 9-cell SRF standing-wave cavities (so, use cavity focusing)
  - use the 9-cell cavity model you've been using for the past several days
  - maximum average gradient (on-crest voltage / cell length): 35 MV/m
  - use no more than 150 9-cell cavities total
- 3rd harmonic cavities based on 3-GHz, 9-cell SRF standing-wave cavities (ibid)
  - use the 9-cell 3rd-harmonic cavity model we looked at earlier today
  - maximum peak voltage gain per cavity: 30 MV/m
  - use no more than 10 3rd-harmonic cavities total
- Dipole magnetic fields not to exceed 1 T
- Placement of quads, compressors, etc. up to you; however…
  - Maintain non-RF component-to-component clearance (drift space) of at least 10 cm between quads, dipoles, etc.
  - Maintain at least 1m clearance between RF cavities and anything other than another RF cavity
  - At this time, do not worry about putting in space for diagnostics, pumpout ports, etc.

Final Beam Requirements

- The last element in your model shall be a 5-meter drift space; beam properties calculated at the end of that drift.

- Beam energy requirement: 5.00 GeV (kinetic) ± 10 MeV

- RMS beam property requirements
  - x/y emittance not to exceed 1 μm normalized
  - bunch length not to exceed 0.1 ps
  - energy spread not to exceed 0.25%
  - spot size not to exceed 1 mm
  - beam to be at an approximate waist
    - $|\alpha_{x,y}| < 1$
    - $\sigma_x = \sigma_y \pm 10\%$

Linac Design Report Template

Insert a plot of your design's horizontal and vertical spot size vs. distance along your linac. Use the .mag file to include a beamline graphic along the bottom of the screen.

You might want to use a log scale for the vertical axis, to better show the spot size evolution.

Linac Design Report Template

Show a plot of the longitudinal phase space at the end of your design

Show a histogram of the beam current at the end of your design

Linac Design Report Template

Linac Parameter	Design Goal	Achieved / Used
Total length	< 350 m	
Fundamental (1-GHz) cavities		
maximum number	< 150	
maximum on-crest voltage per cavity	< 35 MV	
Harmonic (3-GHz) cavities		
maximum number	< 10	
maximum on-crest voltage per cavity	< 30 MV	
Max. dipole magnetic field	< 1 T	

Linac Design Report Template

Beam Parameter	Symbol	Design Goal	Achieved
Final energy	E_k	5 GeV ± 10 MeV	
Largest spot size along linac	$\sigma_{x,max}$ $\sigma_{y,max}$	< 5 mm	
Normalized emittance	ε_{nx}	< 1.0 μm	
	ε_{ny}	< 1.0 μm	
Bunch length	σ_t	< 0.1 ps	
Energy spread	σ_d	< 0.25%	
Spot size	σ_x	< 1 mm	
	σ_y	< 1 mm	
	σ_x / σ_y	0.9 – 1.1	
Beam Divergence	$\lvert\alpha_x\rvert$	< 1	
	$\lvert\alpha_y\rvert$	< 1	