Linac Physics

Andrew Jason
June 10, 1998

Physics Charter

- **Physics Design**
  - **Beam dynamics**
  - **Structure specification**
  - **Other physics aspects (e.g., beam loss, tuning, magnets)**
- **Beam Diagnostics**
- **Chopper**
- **Bunch Rotator**
- **Integration with commissioning**

LANSCE-1 R&D for 99

R&D

1.1.2.1	RF Structure Physics	0.5
1.1.2.2	Accelerator Engineering	
1.1.2.4	Physics Design	2.2
1.1.2.5	Beam Diagnostics	2.8
1.1.2.6	RF Systems & Control	
1.1.2.7	RF Amplifier	
1.1.2.8	MEBT Chopper	2.8
1.1.2.9	Project Mgmt/Sys. Eng.	2.0
	Total R&D	10.3

LANSCE-1 Construction

Construction

1.4.1	RF Power	
1.4.2	DTL	1.0
1.4.3	CCDTL	1.0
1.4.4	CCL	1.0
1.4.5	Chopper, Bunch rotator	
1.4.6	Technical Support	7.0
	Total Construction	10.0
	Total SNS	**20.3**
	Total Physics	**9.3**

Physics Resources - LANSCE-1

- Experience in many linac projects (PSR, FEL, GTA, APT, several small projects)
- Los Alamos spallation source studies (PSR upgrade, LANSCE II, LPSS)
- Beam dynamics and codes (DOE code center)
- Diagnostics, pulsed power, and magnet sections
- Mechanical Engineering section and model shop
- Structures design and Tuning Lab
- Large hydrogen brazing facility
- Superconducting Rf Lab

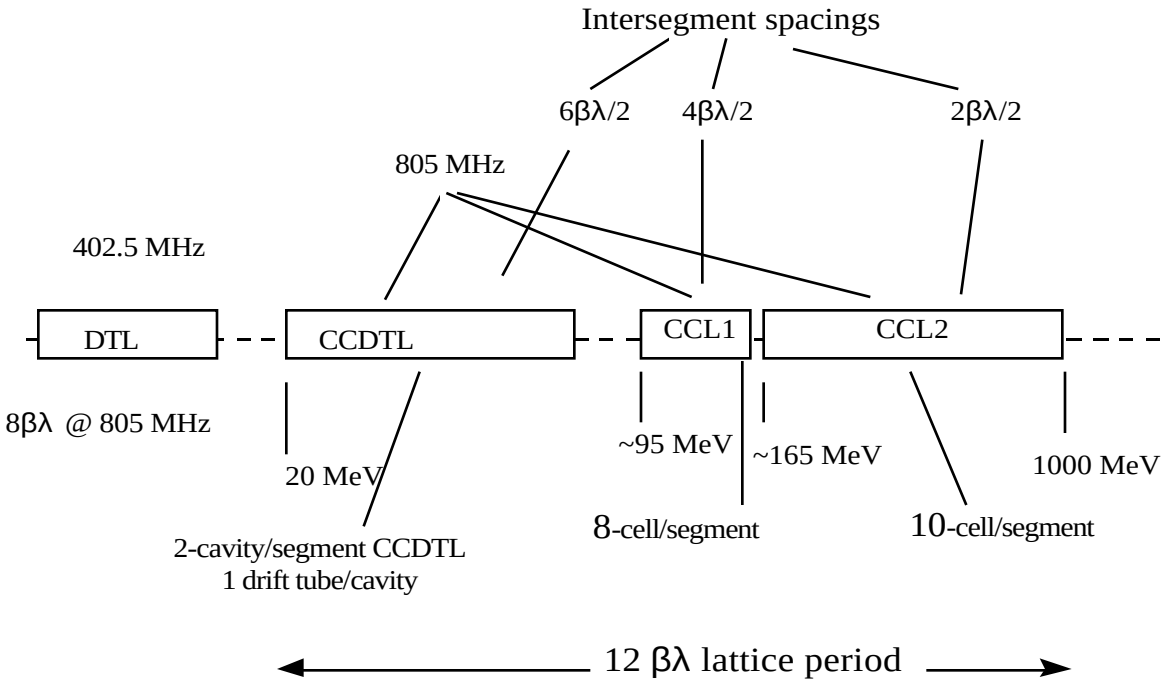
Technical Progress Since CDR

- Lattice modification for engineering feasibility and simplicity
- Optimize rf partitioning scheme for simpler upgrade
- Error studies (code development)
- Gas stripping (major loss source)
- Time dependent E&M calculations for chopper
- Analysis of superconducting alternative
- Match DTL to RFQ - end to end simulation*
- Establish beam-energy spread for ring longitudinal matching*

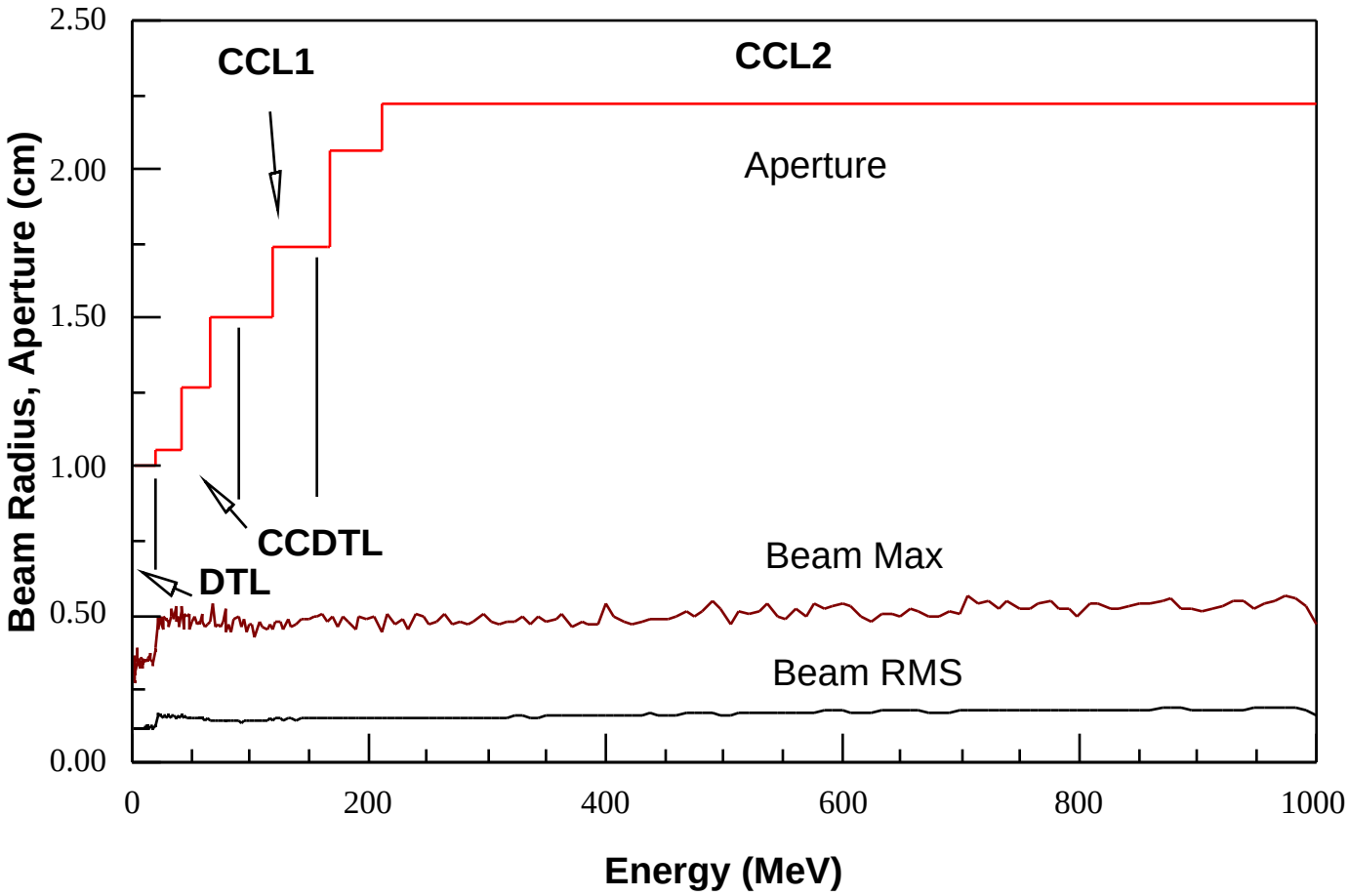
*interface activities

Structure Change for Higher Value

- Change from 11βλ period and vary cells/segment
- Allows space for diagnostics and lower-current-density quads
- Places coupling cavities for construction ease and higher pumping speed
- Maintain same gradient by decreasing accelerating phase

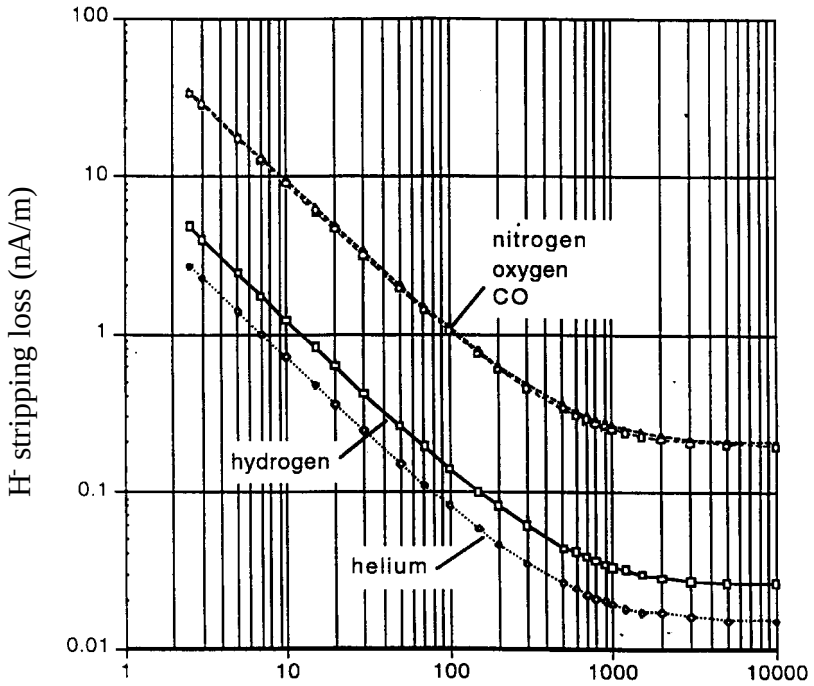


Large Aperture Maintained in New Configuration



Vacuum Requirements are Better Estimated

- From known cross sections, calculate beam neutralization at 10^{-8} torr for 4 mA
- Beam-loss power is better indicator of activation; 1 W/m gives estimated (still rough) 70 mRem/hr at 1 ft after 4 hr.
- For $5x10^{-8}$ torr hydrogen, peak activation is then about 10 mRem/hr



Energy (MeV)

Superconducting Linac Has Been Studied

- Assume a 10-MV/m cavity accelerating gradient (E_0T) from 200 MeV. Linac length will be about 300 m.
- With 10/98 start on 2-year R&D program (extra 13 M$), should finish on current schedule. TEC should be similar.
- Electrical operating costs would be about 4 M$ less/yr for SC (at $0.04/kW hr.
- H^- stripping loss would be low, no upgrade structure mods.
- Schedule and cost less certain. Technical risk in several areas:
  - Cavities have been developed by APT
  - Rf and mechanical control for turn-on transient and microphonics. May require one klystron/cavity
  - Power coupler; either develop a 0.75-MW device or control two couplers to cavity

Key Issues and Challenges

- Loss in linac and halo formation
- Chopper performance - beam in gap
- Tuneup-diagnostics specification
- Fast FET development for 2.5-ns chopper rise
- Participation of key people
  - Physics is well staffed for initial stages
  - Selective hiring for diagnostics & pulsed power
  - Tuning & structures-fab experts will be available appropriately as LEDA construction is completed