The Advanced Superconducting Test Accelerator

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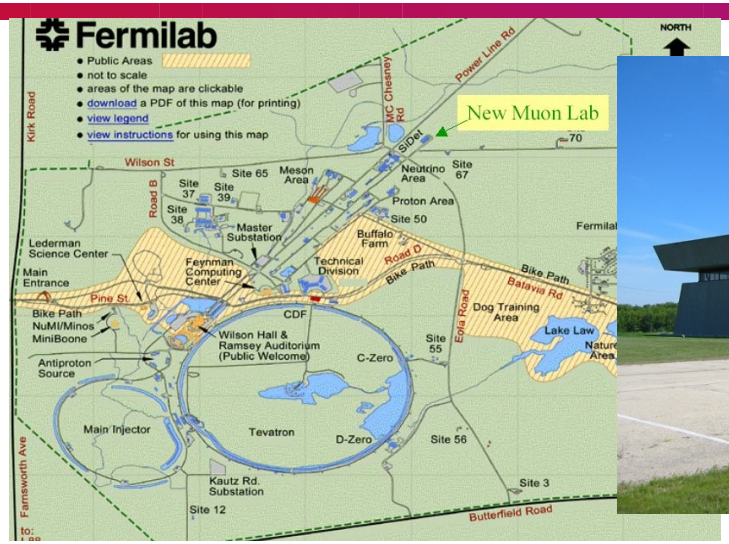
Many Names, Many Purposes

- A linear electron accelerator with many purposes...
  - ILC Test Facility
  - Cryomodule Test Line
  - User Facility
  - AAR&D



- Within the last few years, just some of its many names...
  - ILC Test Facility
  - NML
  - SRF@NML
  - SRFTA
  - ASTA

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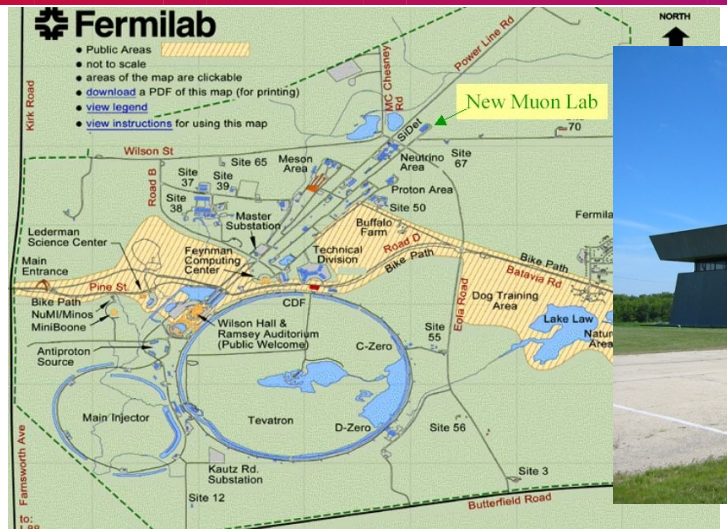

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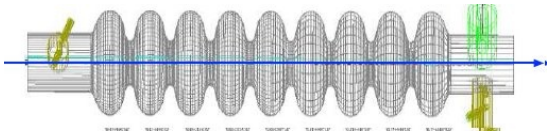
Superconducting RF Acceleration

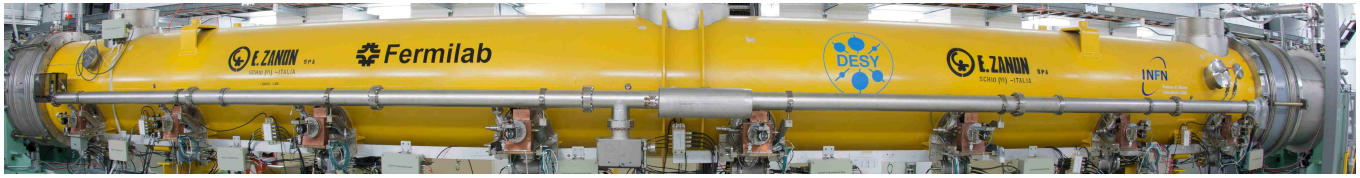
- Problem: Structures with static EM fields don't easily accelerate
- Solution: Use structures with time oscillating fields (TM mode, with an E field pointing along the trajectory of the particles)



- Problem: Gradient (acceleration per meter) is proportional to current, which leads to huge heating (losses).
- Solution: Use superconductivity to get large currents with minimal losses.

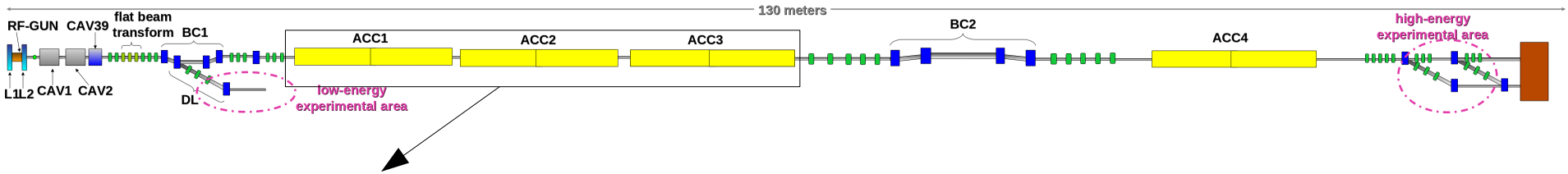
Standard design:

- "9-cell cavity"
- Beta (v/c) = 1
- f=1.3 GHz
- Phase is timed such that the electron bunch always hits the maximum field
- 8 cavities put into a single cooling structure = 1 cryomodule.



ASTA as an ILC Test Facility

- No longer stated often as a purpose for ASTA
- Still has played a role in the fundamental design and funding of the facility.



- One “ILC unit” = 3 Cryomodules, powered off of a shared klystron (power supply connected with waveguides)
- At one point, TWO “ILC Units” were planned, and there is room, but there no longer appears to be much interest in this.

ASTA as a Cryomodule Test Line

SRF is the current standard for large-scale particle accelerators.

For linear accelerators, energy is proportional to number of cryomodule used.

- IOTA=  (1/2)
- ASTA=  -> 
- Project-X= 
- ILC...

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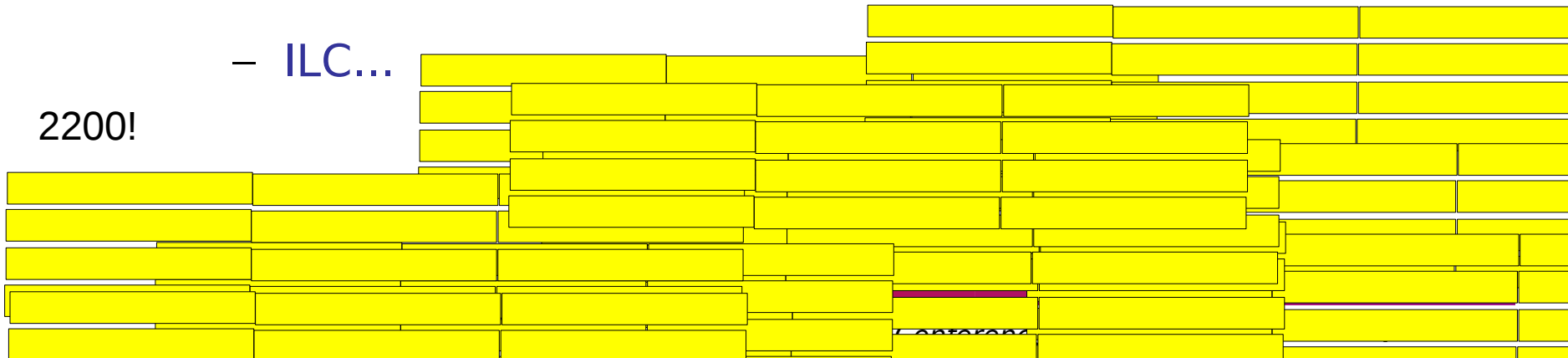
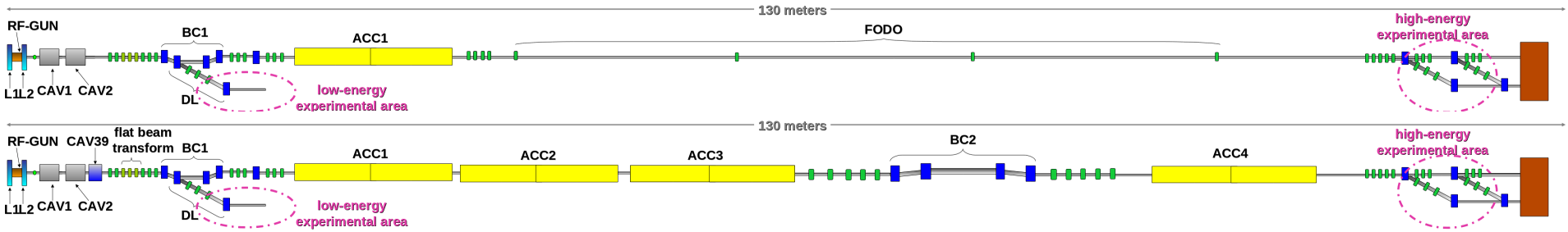
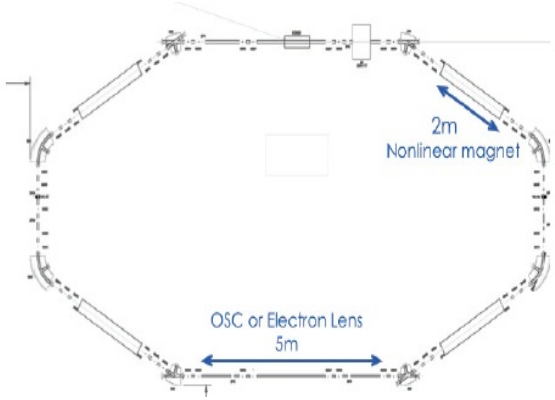
2200!



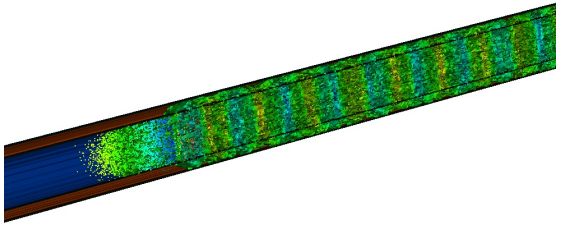
ASTA as a User's Facility/AAR&D



- Two experimental areas, each with multiple lines (maybe)
  - LE (20-50 MeV)
  - HE (20-900 MeV)
- Also possible for direct insertion in to the main linac.
- Some candidates:
  - IOTA (Integrable Optics Test Accelerator)
  - DWA
  - High Brightness beam studies



(image courtesy of S. Nagaitsev)

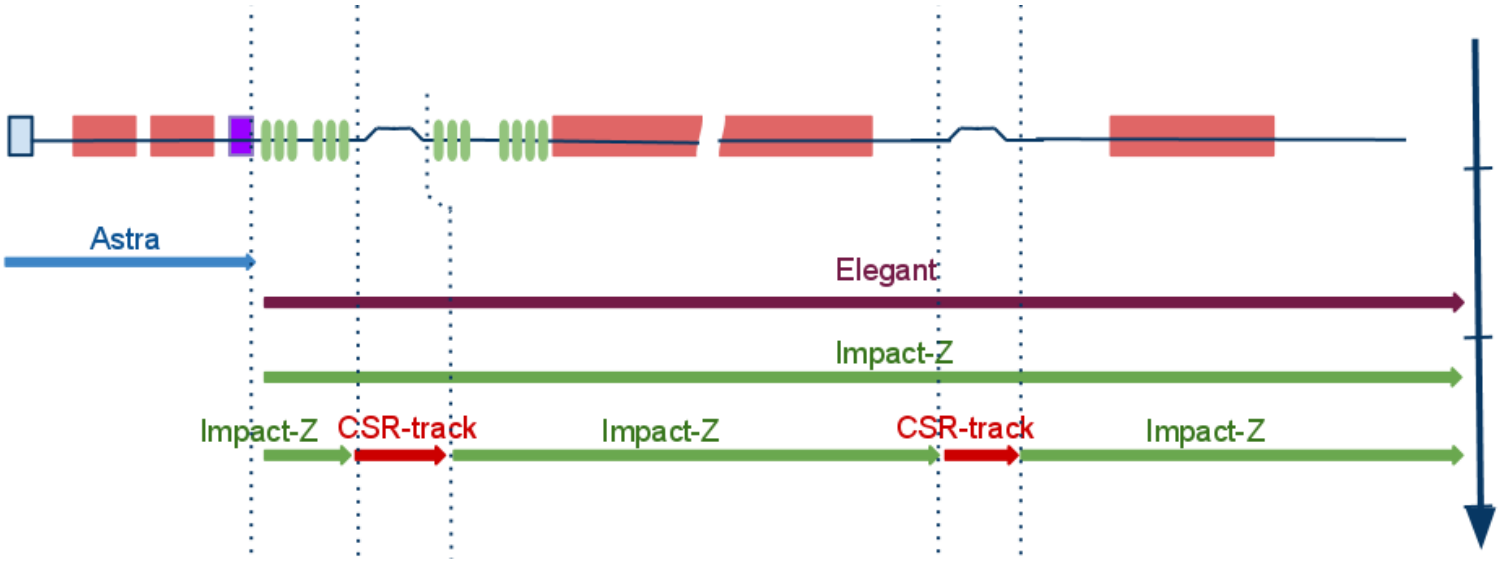


(image courtesy of F. Lemery)

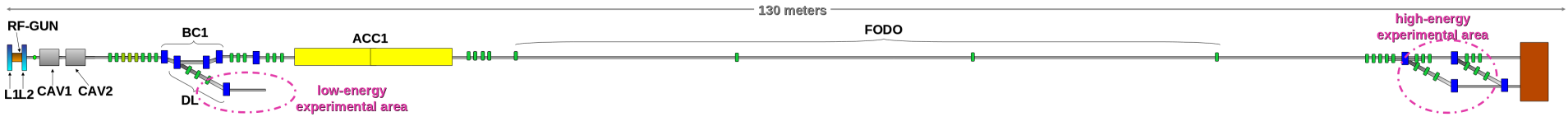
Simulation Design

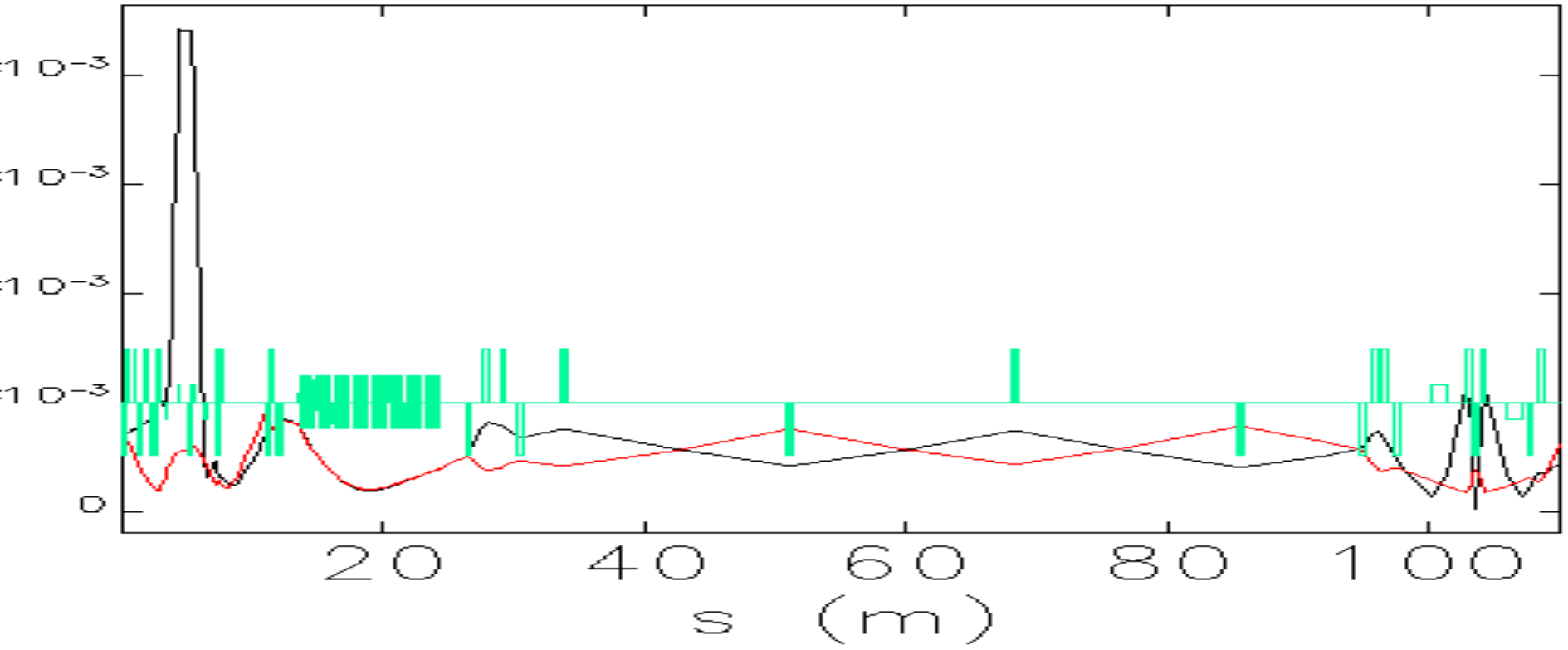
My job on the experiment is modeling the full beamline and using them to aid in the design and (eventual) operation.

Due to the size of the experiment, and range of energies and possible bunch charges, a variety of codes are necessary to accurately model it.



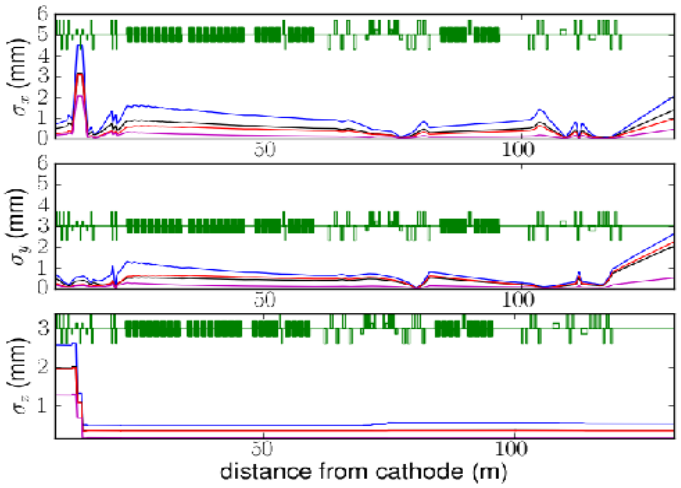
Some Simulations...



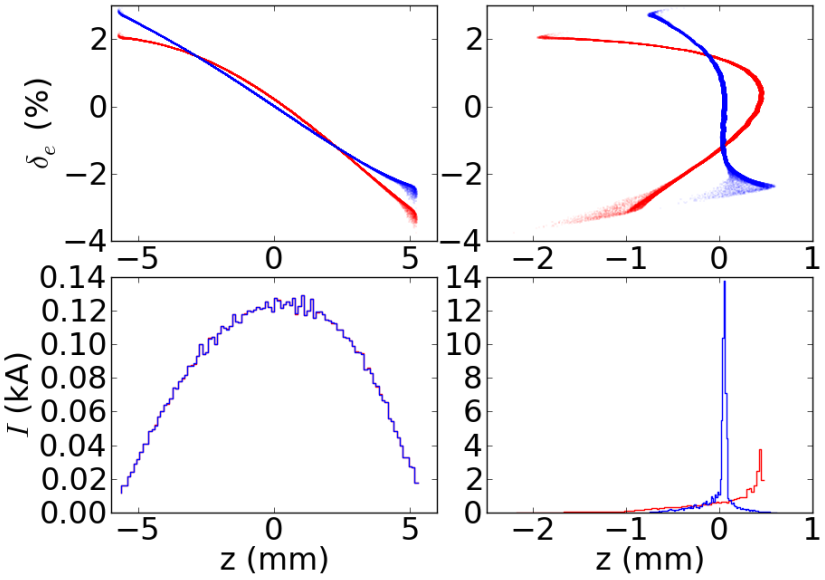


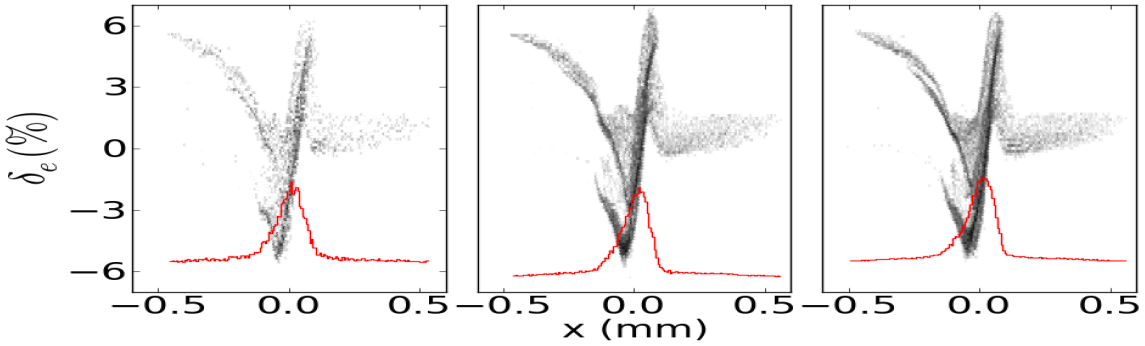
More...

SC calculations for various bunch charges:



Bunch compression with collective effects (SC & CSR):





Model	N	Par.	ε_x(μm)	δ(%)	$\hat{I}$ (A)
IMPZ-1D	$2 \cdot 10^5$	256[a]	71.1	3.06	8.25
CSRT-1DP	$2 \cdot 10^5$	1 μm	55.4	1.85	6.16
CSRT-1DP	$2 \cdot 10^5$	10%	54.9	1.83	8.04
CSRT-1DP	$2 \cdot 10^5$	5%	54.5	1.87	8.78
CSRT-1DP	$2 \cdot 10^5$	1%	55.3	1.87	7.73
CSRT-P2P	$5 \cdot 10^3$	10%	101	2.81	6.37
CSRT-P2P [b]	$5 \cdot 10^3$	10%	103	3.03	6.65
CSRT-P2P	$1 \cdot 10^4$	10%	102	2.89	6.57
CSRT-P2P	$2 \cdot 10^4$	10%	94.6	2.91	6.44
CSRT-P2P	$3 \cdot 10^4$	10%	98.4	2.86	6.44
CSRT-P2P	$2 \cdot 10^4$	5%	97.8	2.80	5.95

[a] number of longitudinal bins; [b] a different statistical sample of the 2×10^5 particles was used compared to previous line.