

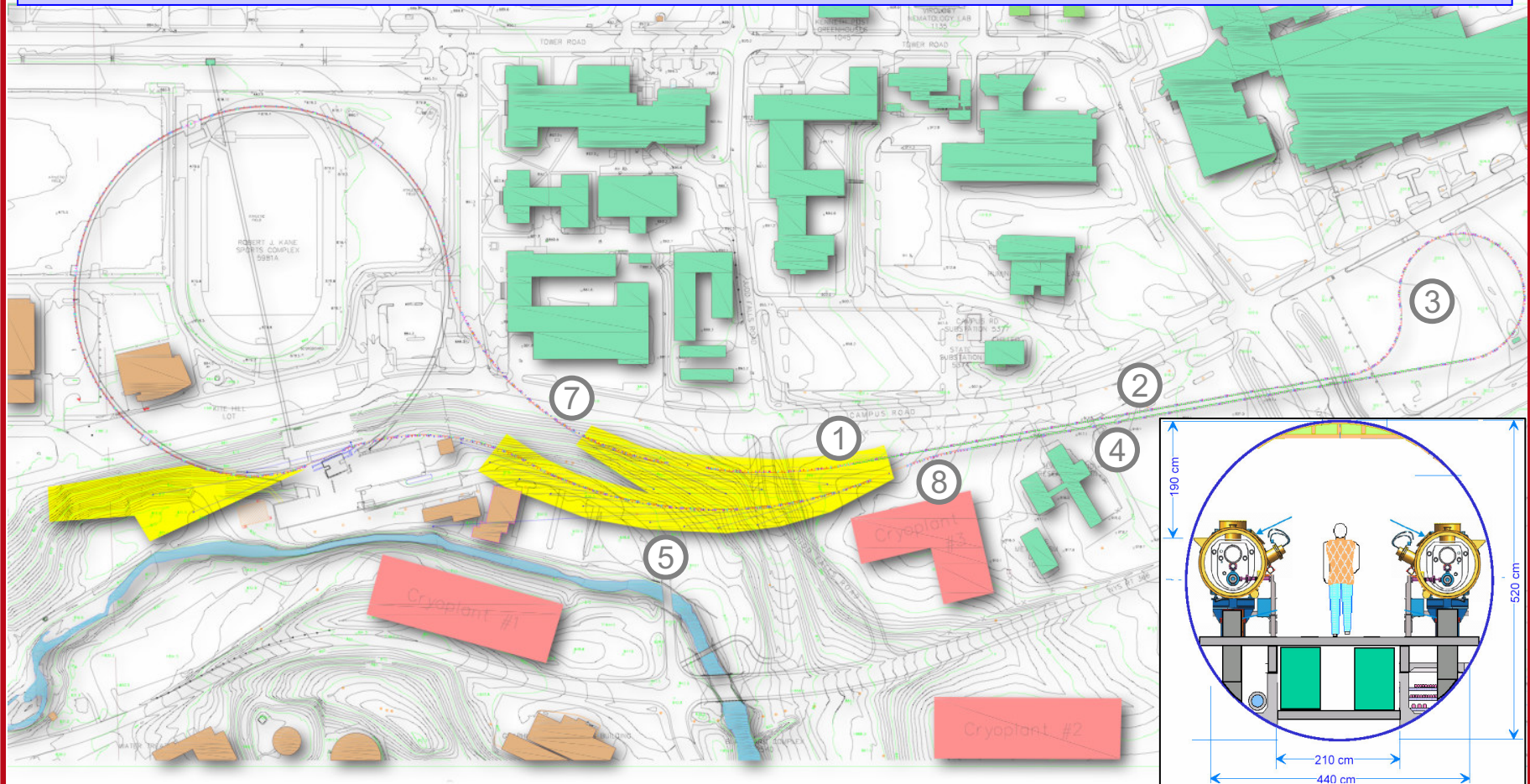
1



Progress Toward an ERL Extension to CESR

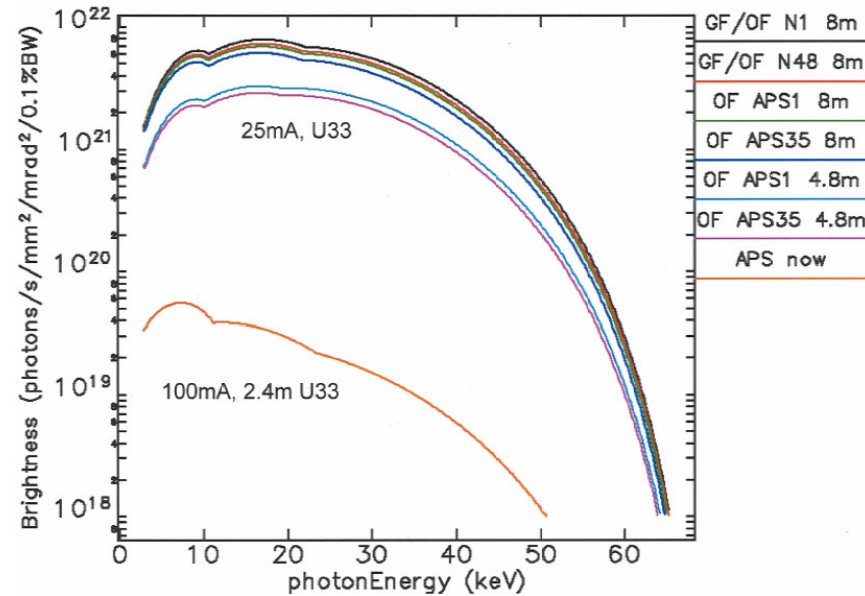
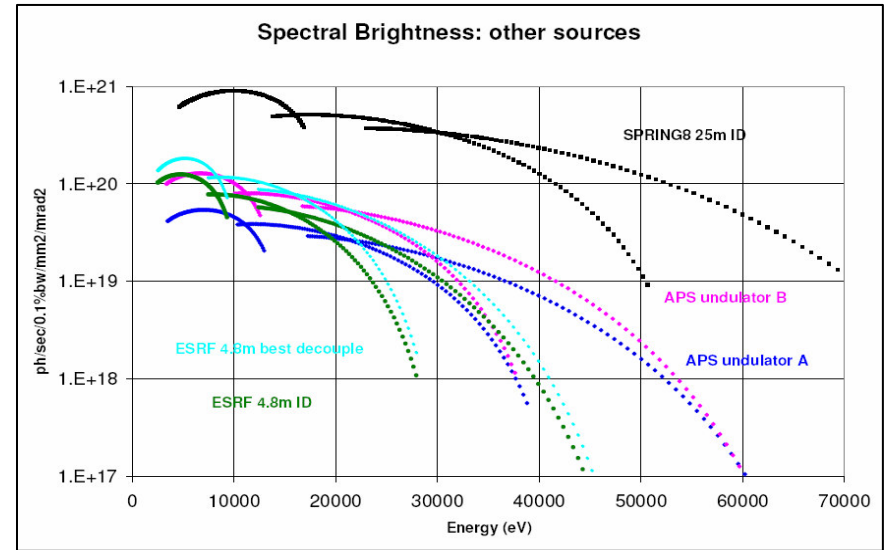
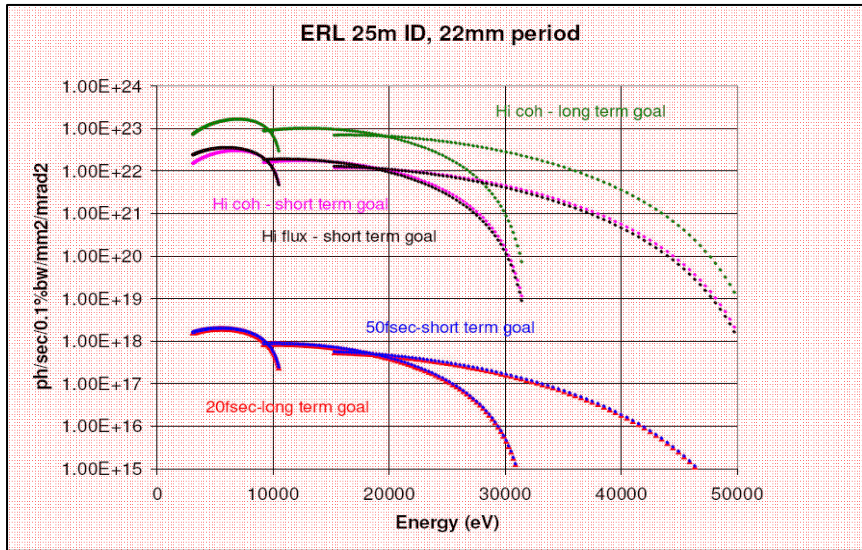


G.H. Hoffstaetter, I.V. Bazarov, D.H. Bilderback, J. Codner, D. Dale, B. Dunham, K. Finkelstein, M. Forster, S. Greenwald, S.M. Gruner, Y. Li, M. Liepe, C. Mayes, D. Sagan, C.K. Sinclair, C. Song, A. Temnykh, M. Tigner, Y. Xie



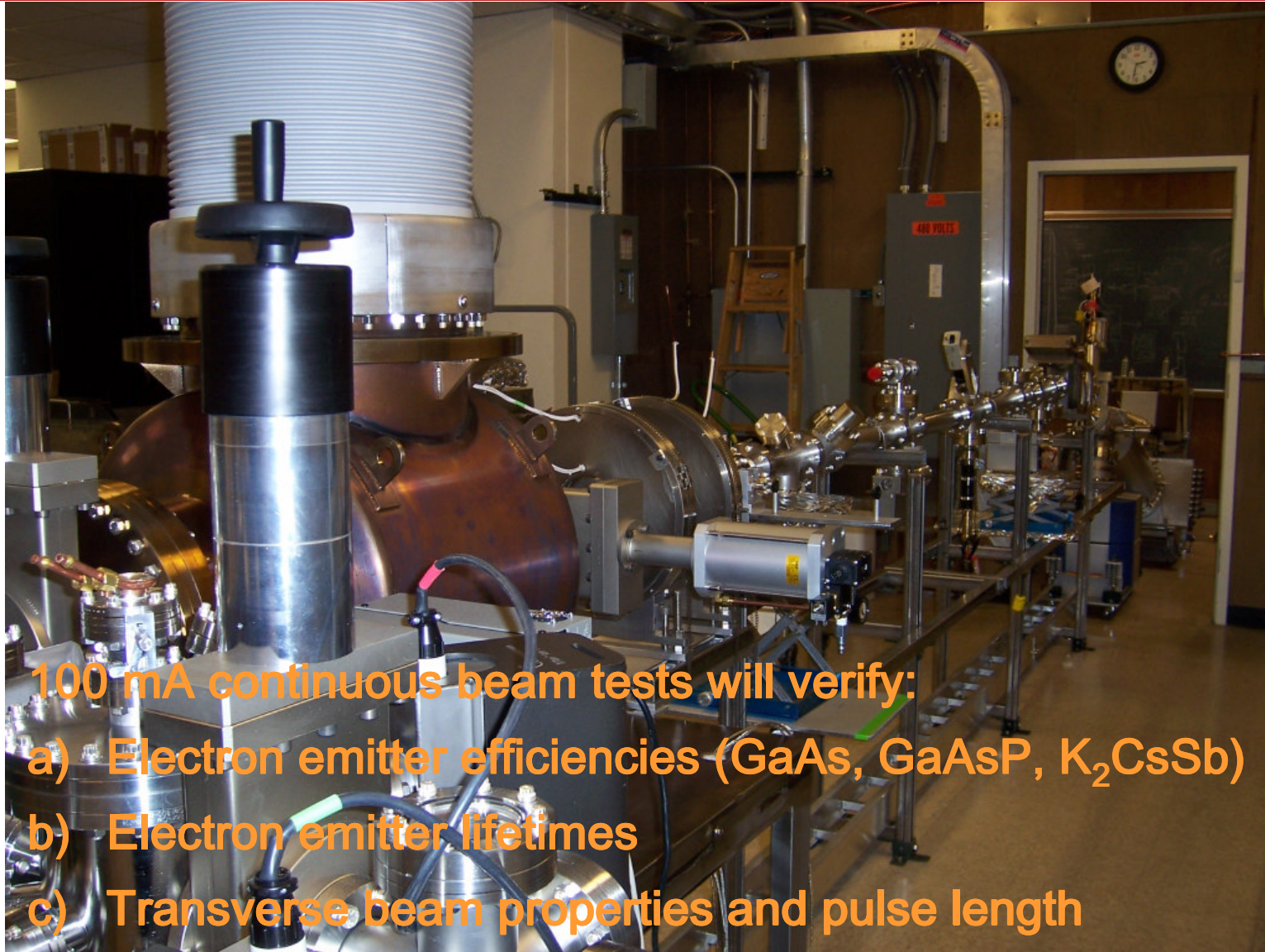


How large is the advantage of ERLs ?





Gun prototype: well advanced

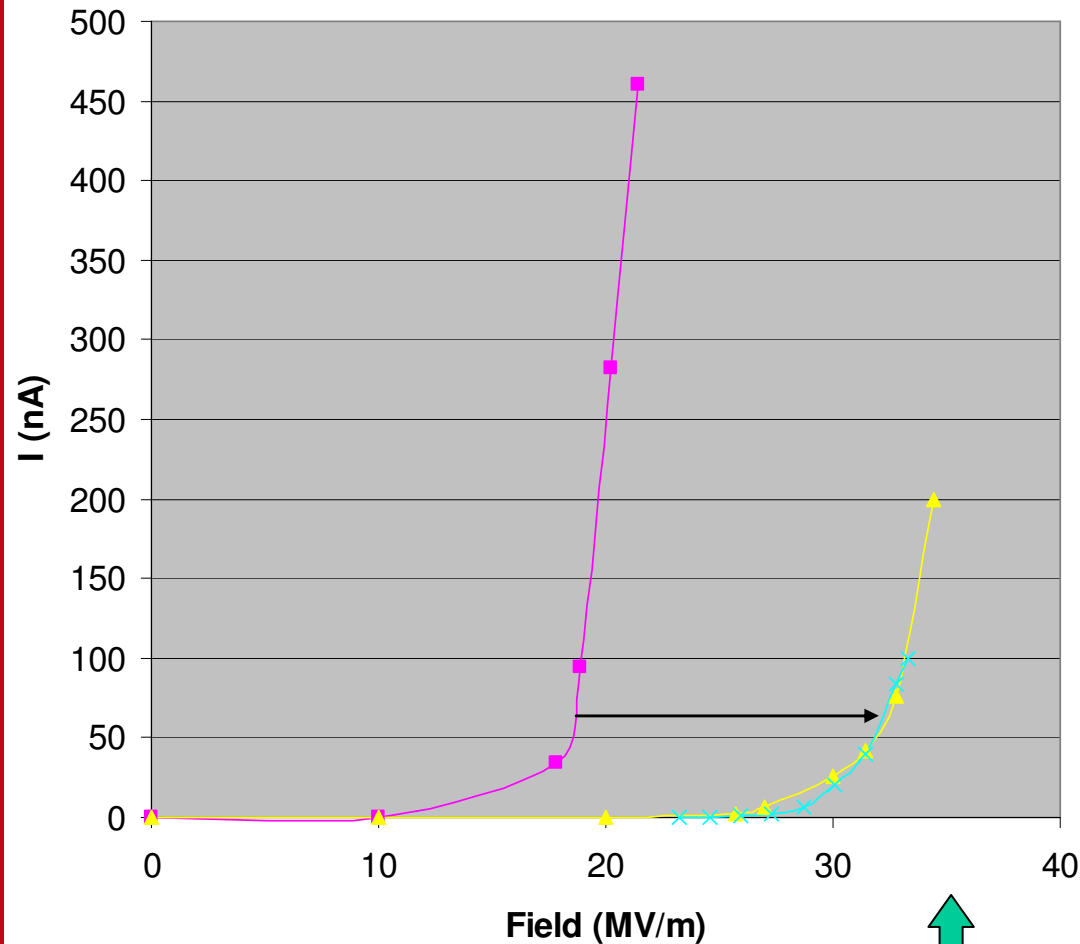


100 mA continuous beam tests will verify:

- Electron emitter efficiencies (GaAs, GaAsP, K₂CsSb)
- Electron emitter lifetimes
- Transverse beam properties and pulse length



High Voltage with surface treatment



Following the new procedures, the 'good' Ti electrode improved from 20 MV/m to nearly 35 MV/m (pink to yellow curve)

The blue curve shows the results for a SS disk that was electro-polished, then 'SRF-cleaned'

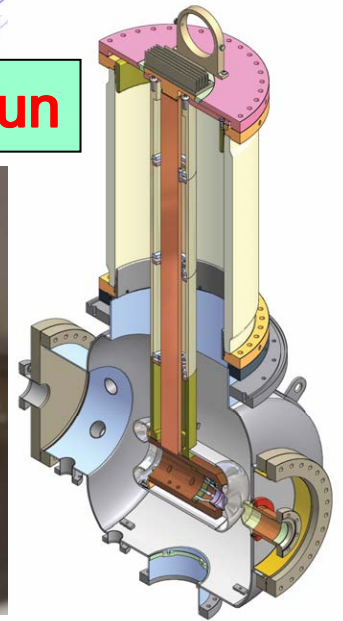
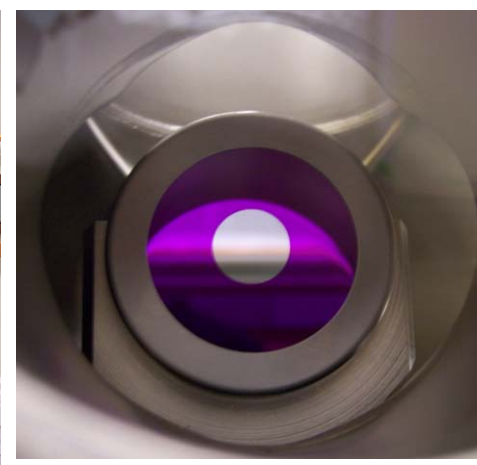
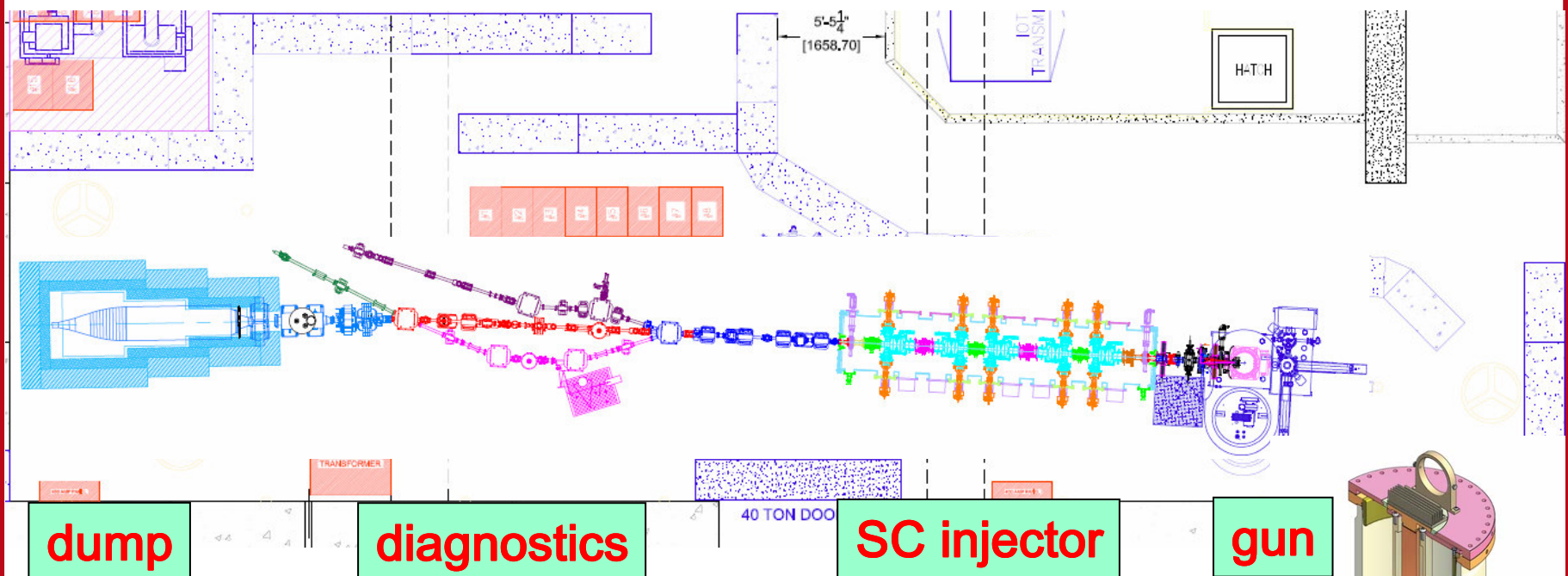
Hand diamond polishing of electrodes may be a thing of the past!



System max is 35 MV/m



Cornell Injector prototype: Verification of beam production





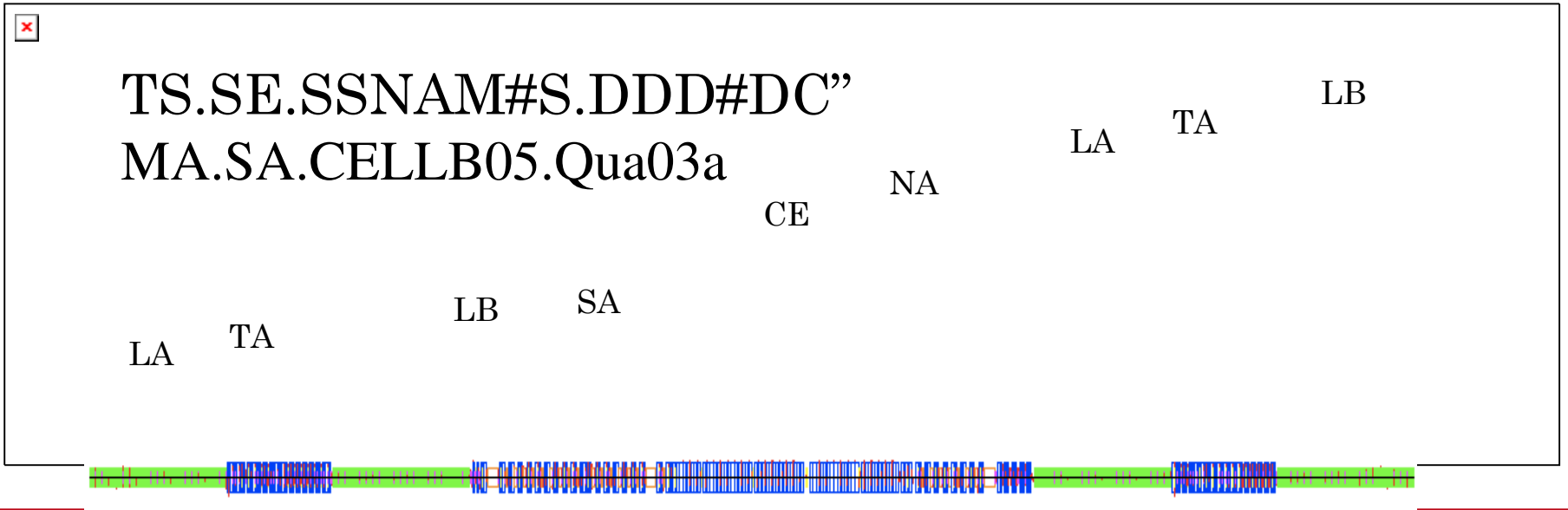
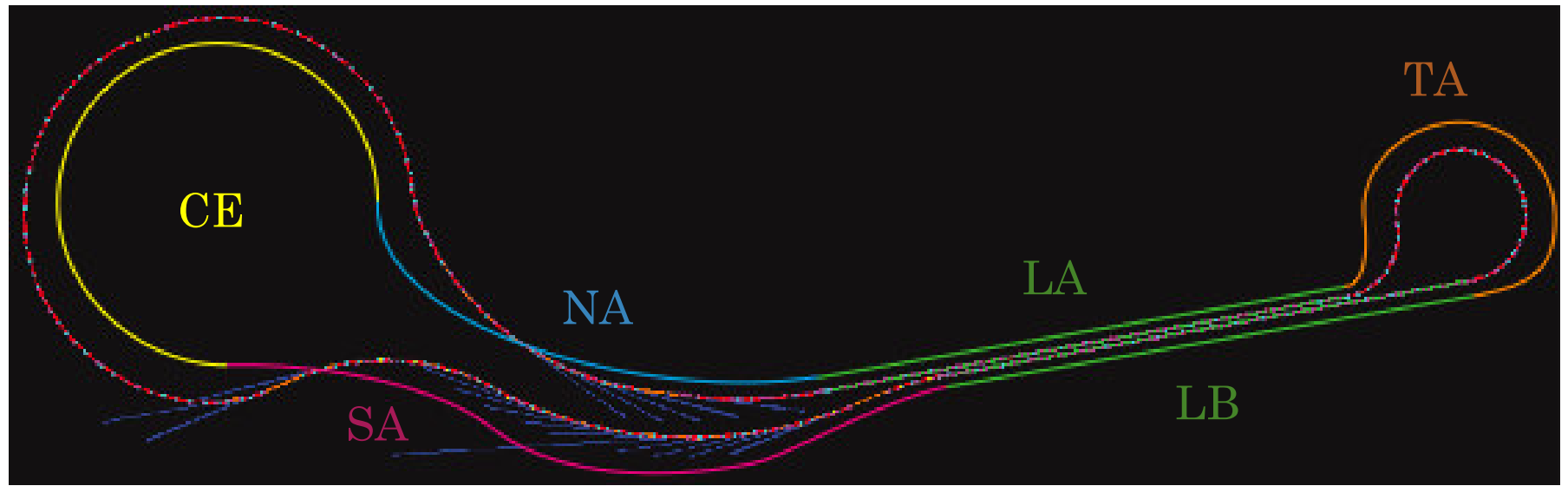
(1) Challenges for x-ray ERLs



- **Production of low emittances + limiting emittance growth**
 - **Optics in the linac for very different energies (0.01 - 5GeV)**
 - **Limit coupler kicks / cavity misalignments**
 - **Limit optics errors and adjust fields to radiated energy**
 - **Low emittance growth optics similar to light sources**



Incoherent Synchrotron Radiation (ISR)

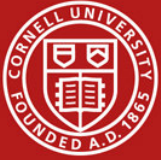




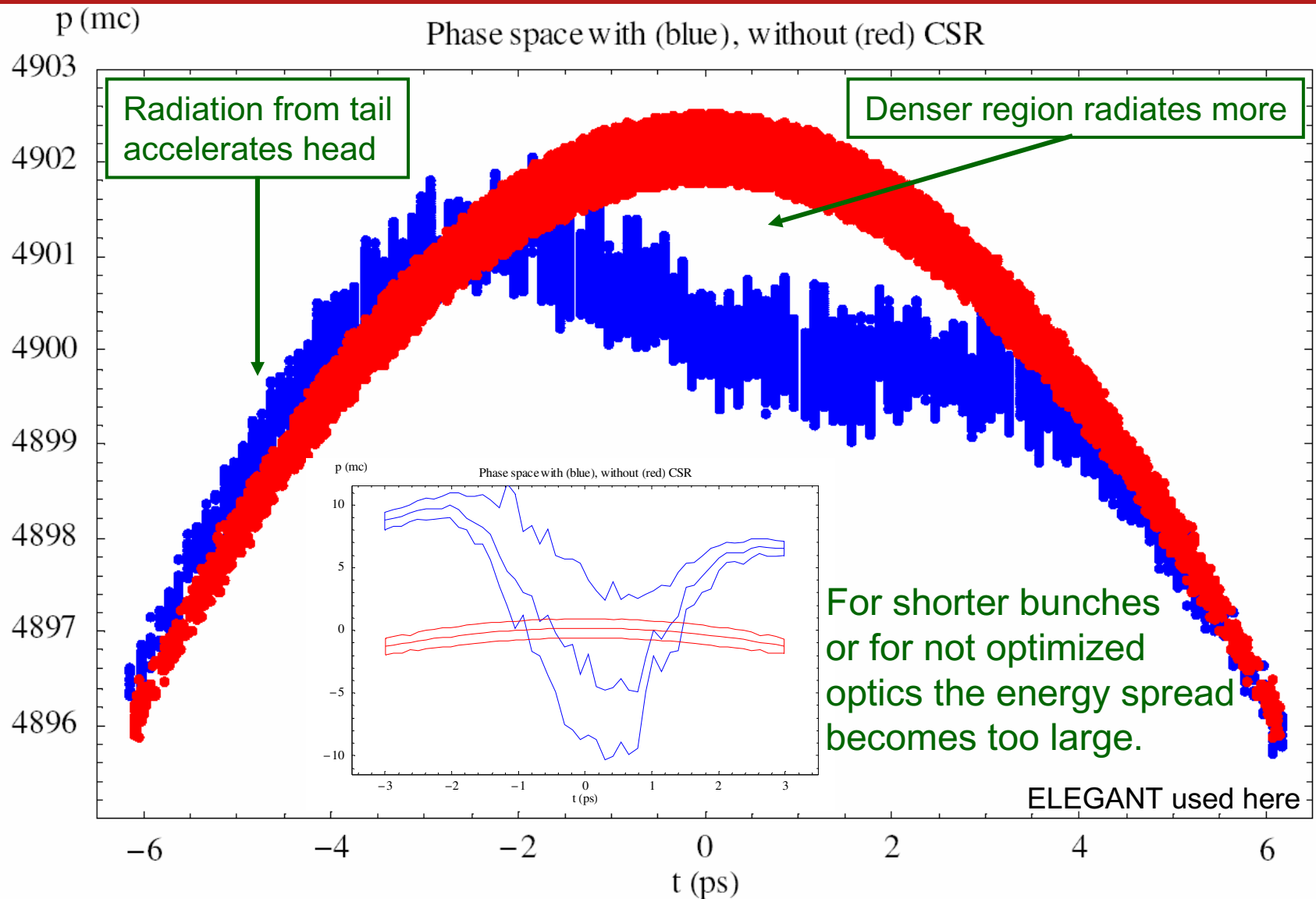
(2) Challenges for x-ray ERLs



- **Limit energy spread after deceleration, e.g. 5GeV to 10MeV**
 - **Accurate time of flight correction, including sextupoles**
 - **Limit energy spread from wake fields**
 - **Limit energy spread from intra beam scattering (IBS) and rest gas scattering**
 - **Limit energy spread from incoherent / coherent synchrotron radiation (ISR / CSR)**



CSR in ERL bends

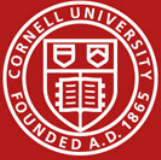




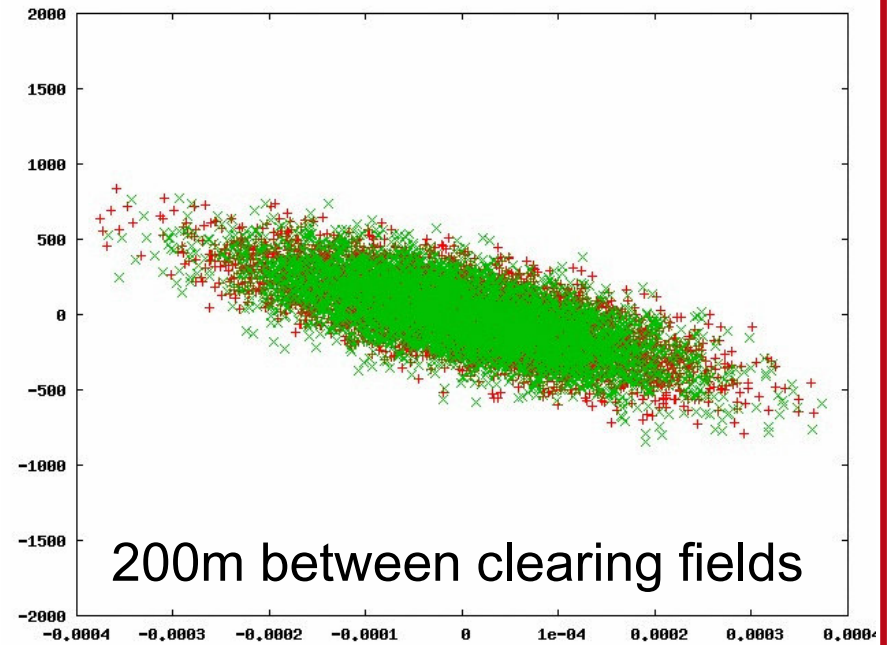
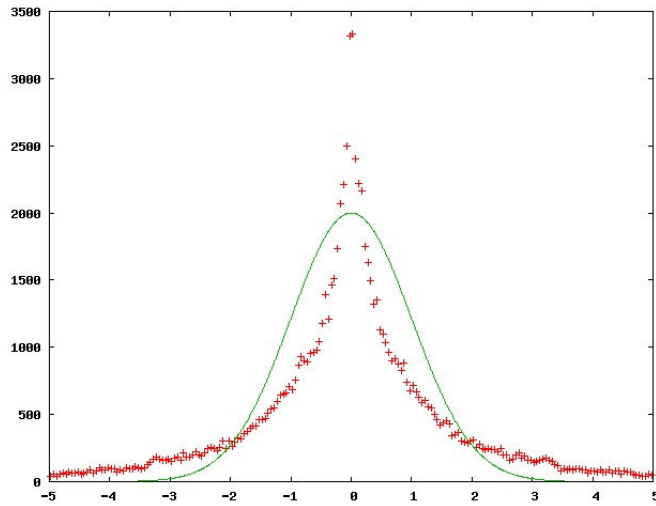
(3) Challenges for x-ray ERLs



- **Beam loss concerns**
 - **Beam loss from IBS / Touschek**
 - **Rest gas scattering**
 - **Disturbance from ions / ion removal**
 - **Halo development**

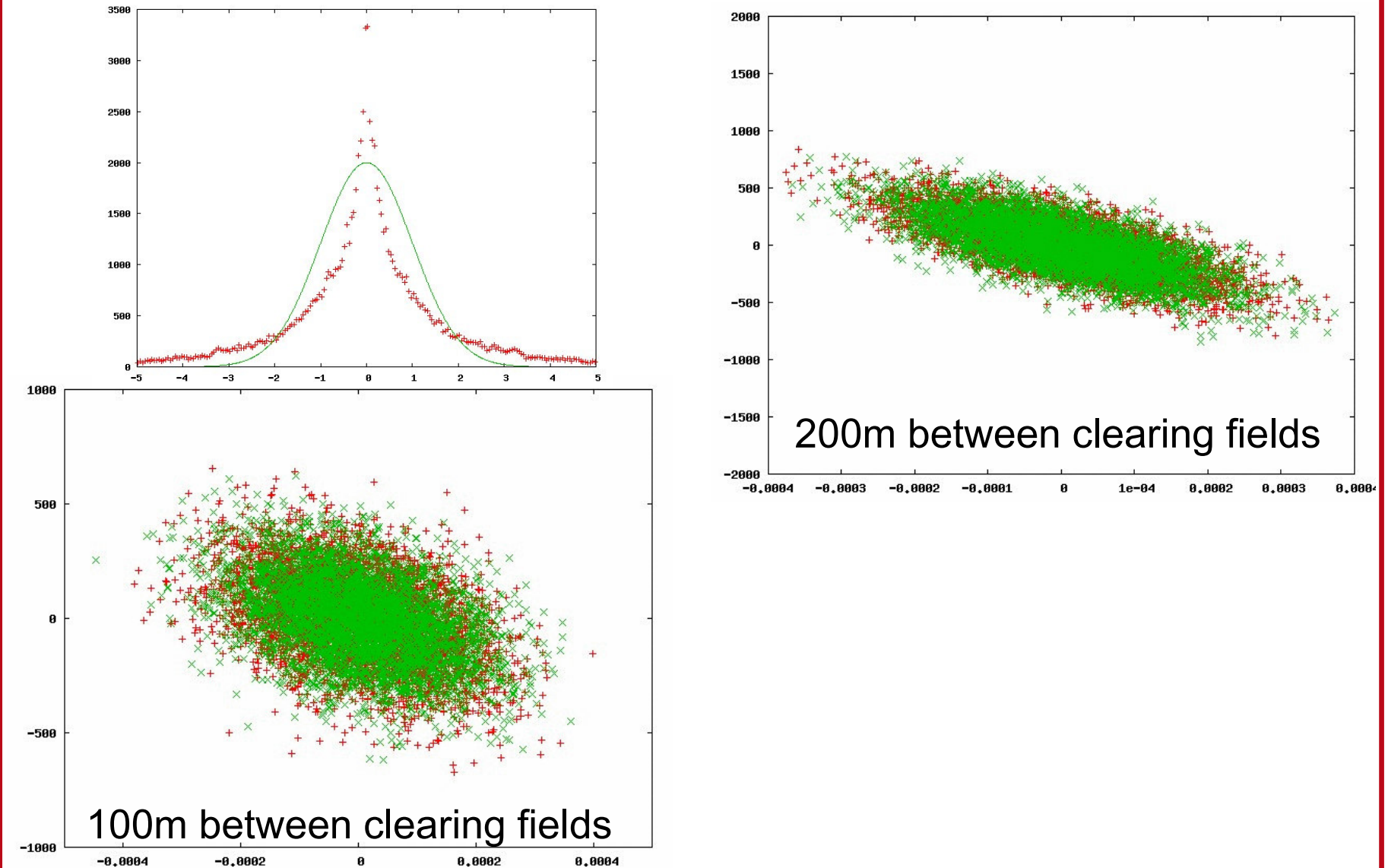


Ions in an ERL beam



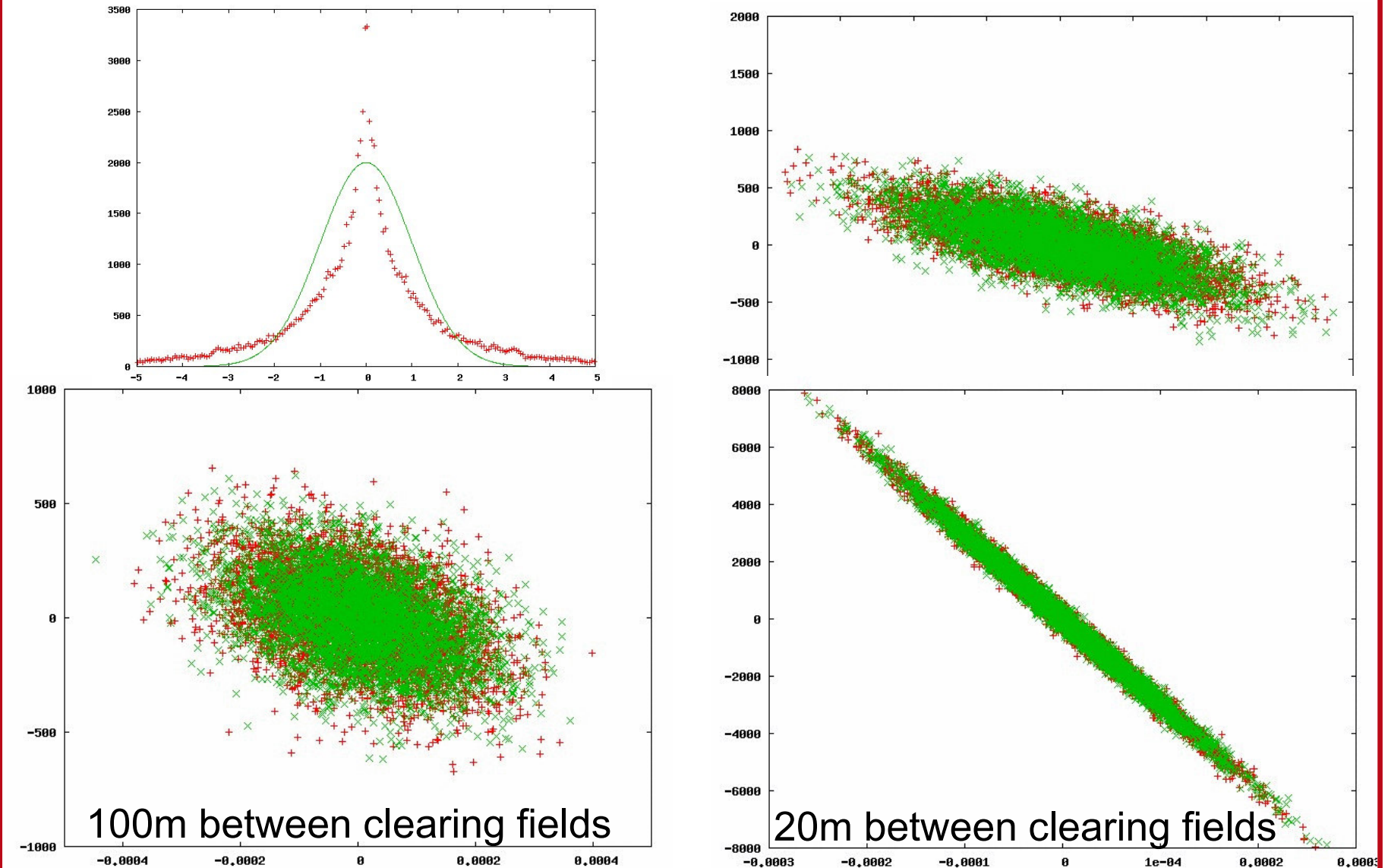


Ions in an ERL beam





Ions in an ERL beam





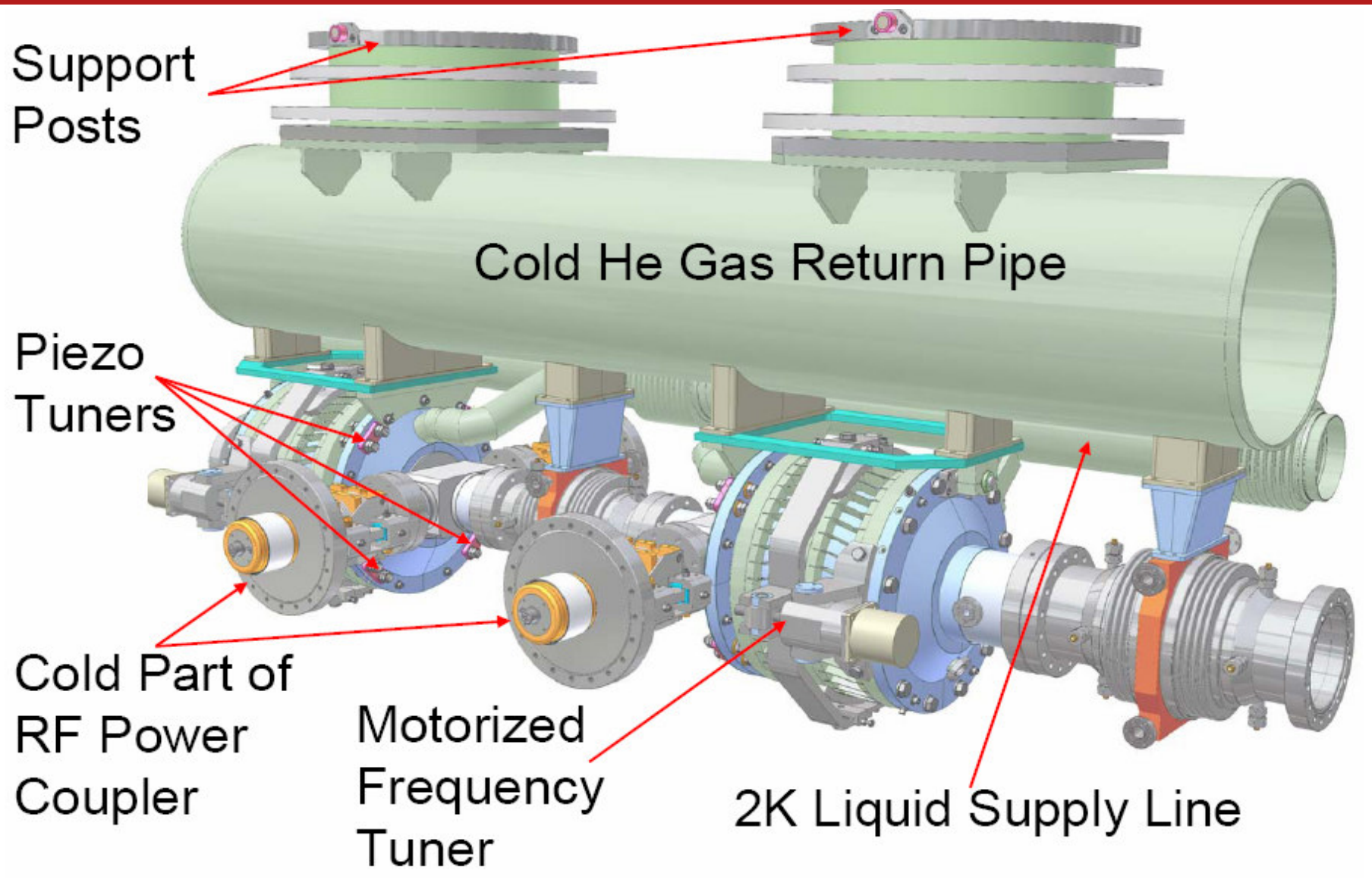
(4) Challenges for x-ray ERLs



- **Superconducting RF challenges**
 - **Phase and amplitude control for very narrow frequency window (10^{-8})**
 - **Avoid heating / Higher order mode absorption**
 - **Limit cooling power**

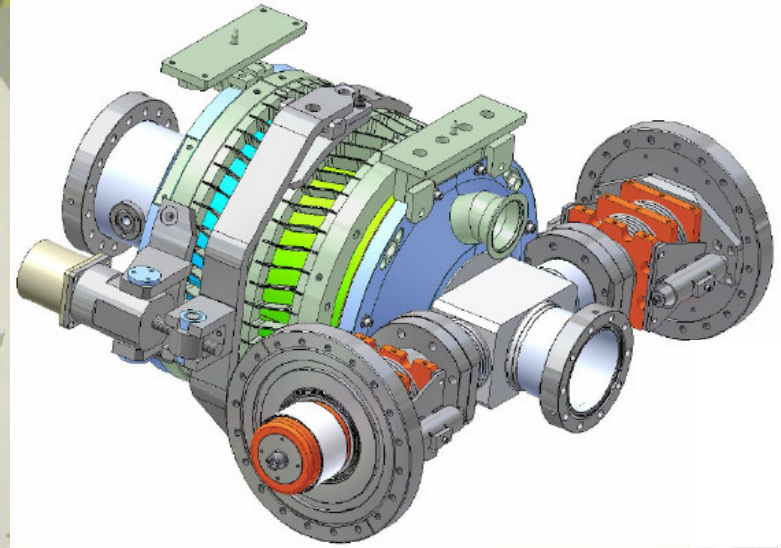


Assembly of the injector accelerator





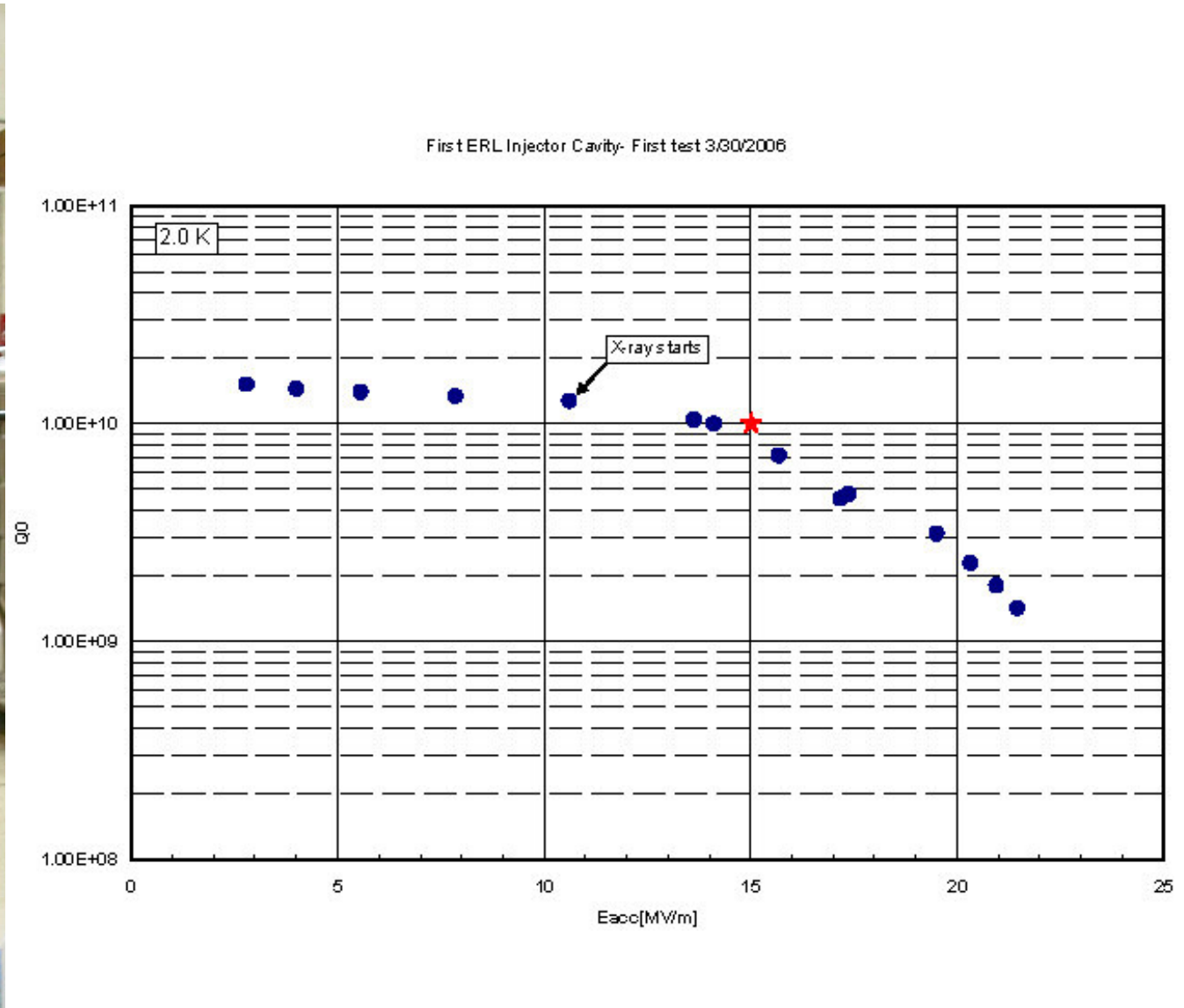
ERL accelerator R&D and construction

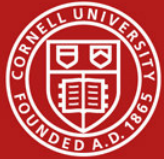


Superconducting Cavities, high power input coupler, and high precision frequency tuners are all developed and build at Cornell (with outside collaborators)

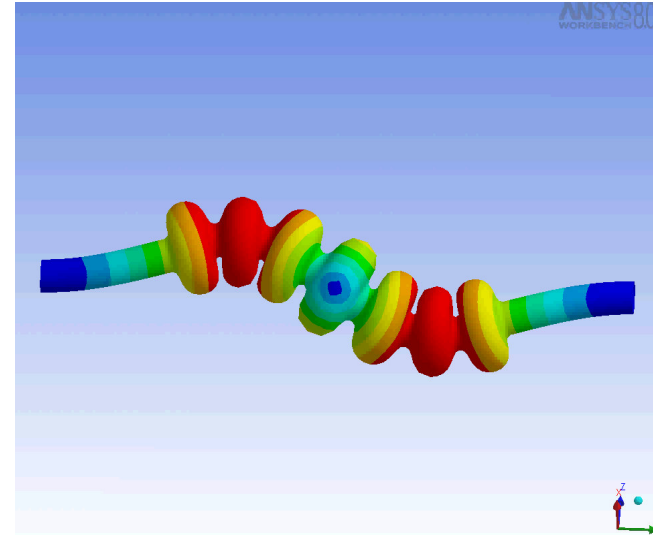
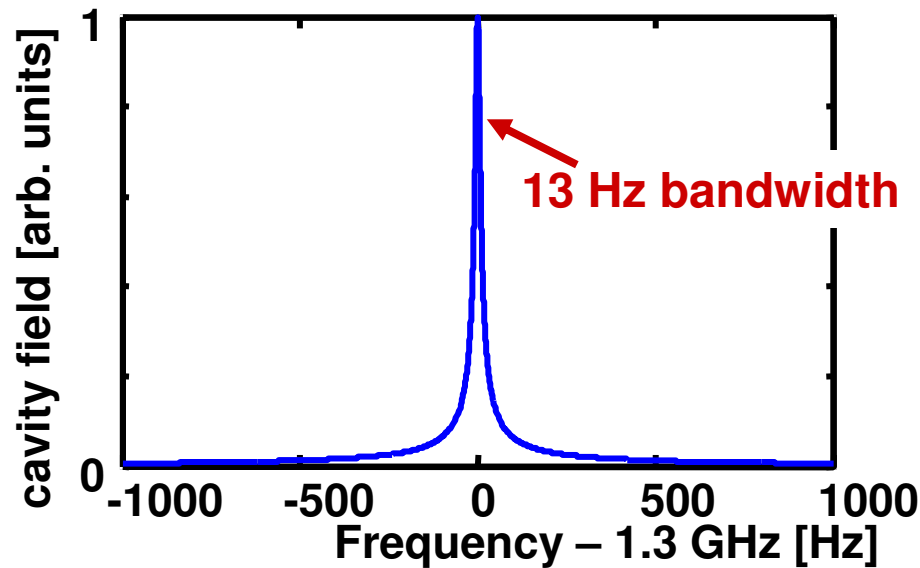


First vertical test

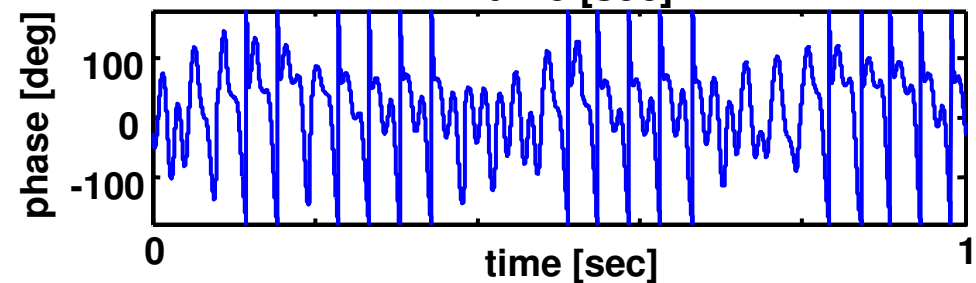
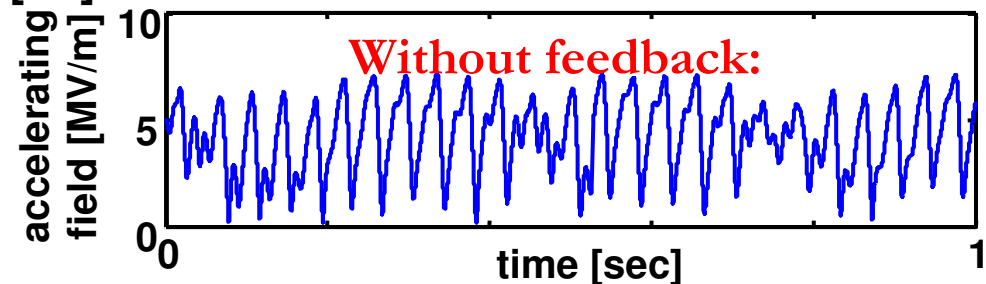




Cavity control for SC linacs (ERL & ILC)

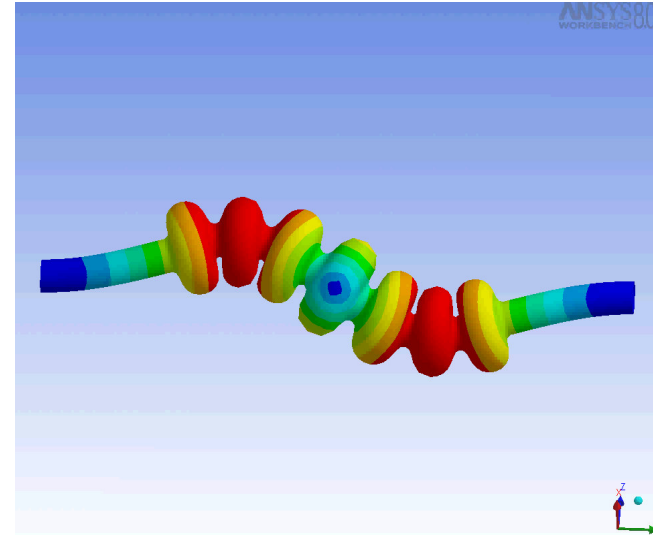
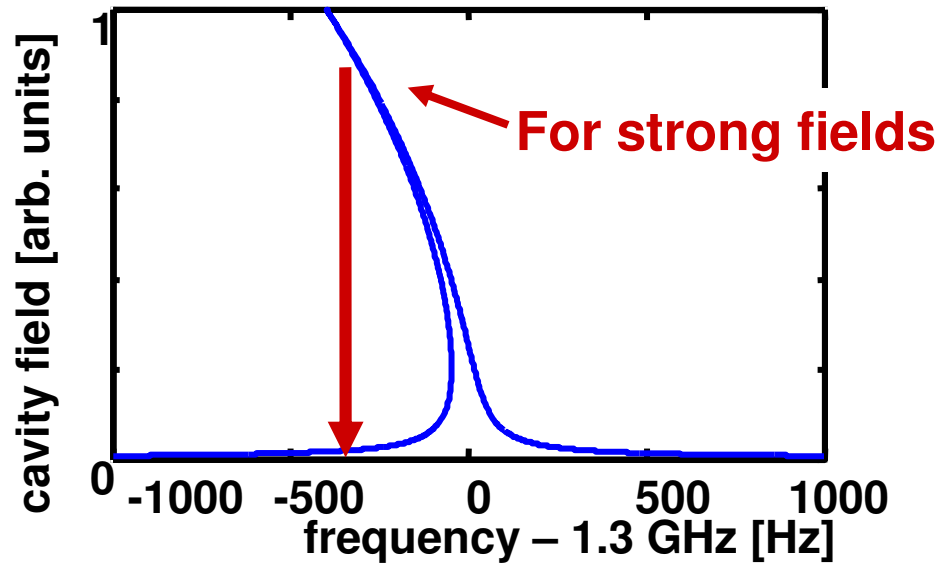


- Run cavity with lowest possible bandwidth for ERL.
- But frequency stabilization becomes very critical.

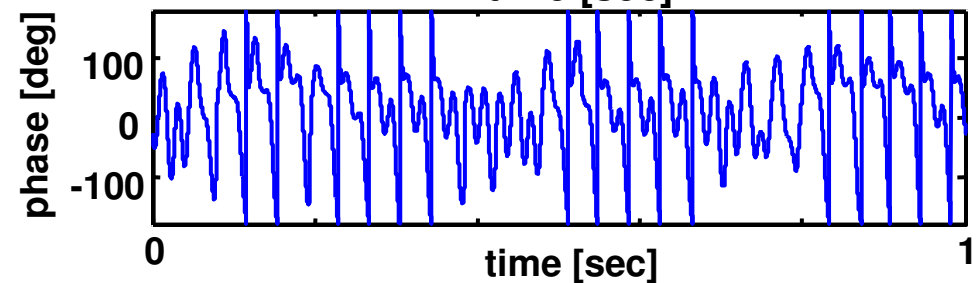
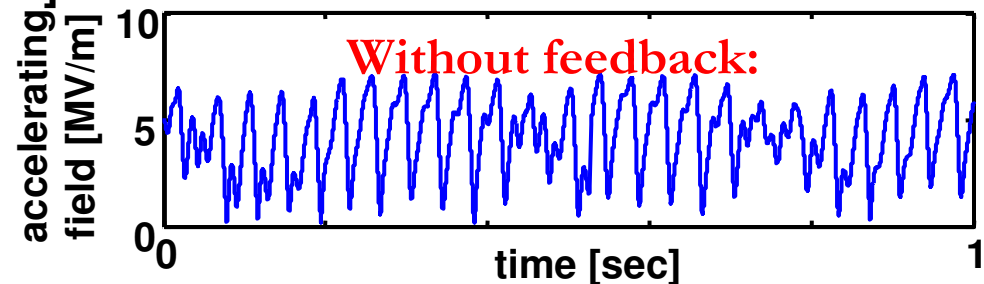




Cavity control for SC linacs (ERL & ILC)

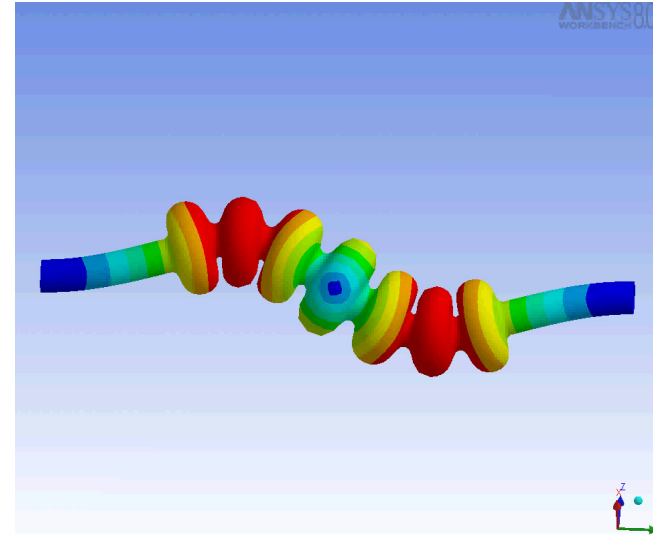
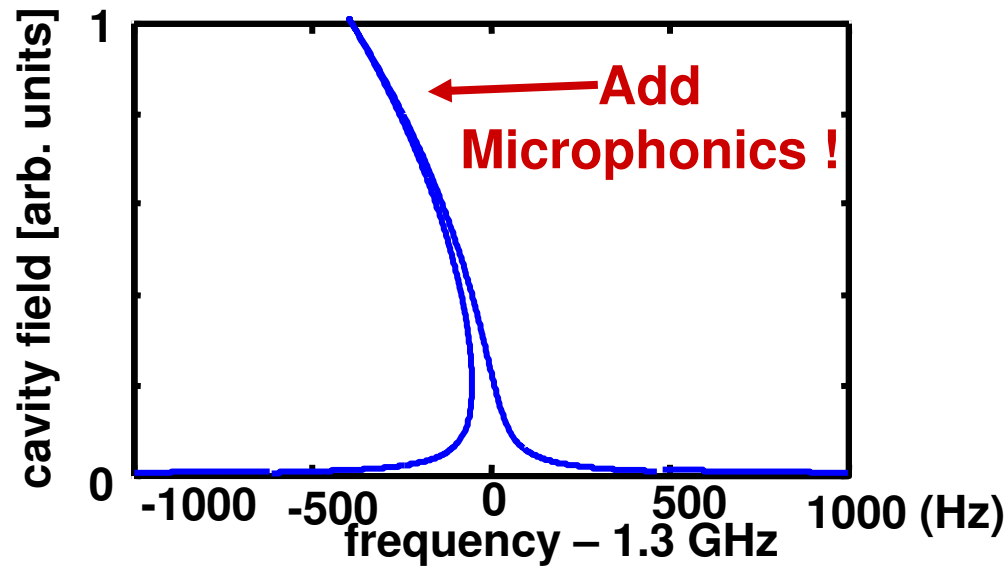


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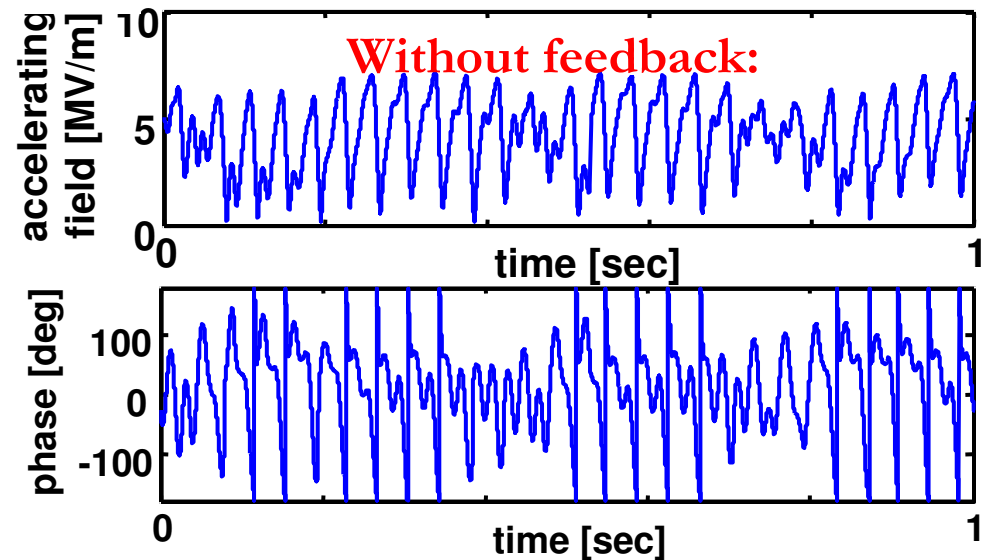




Cavity control for SC linacs (ERL & ILC)

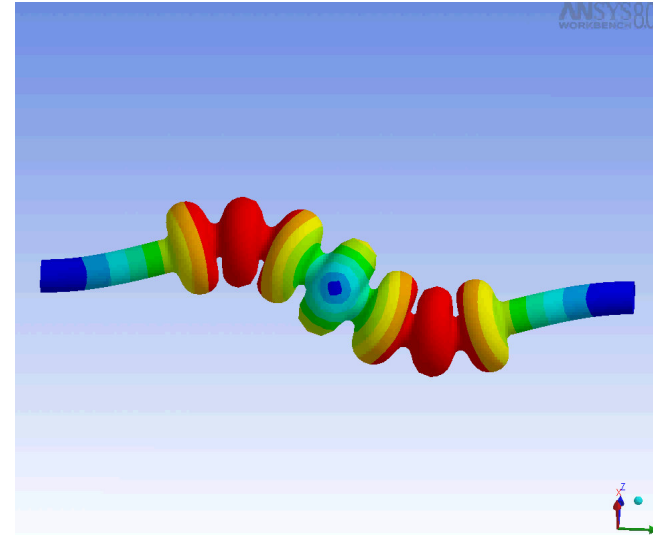
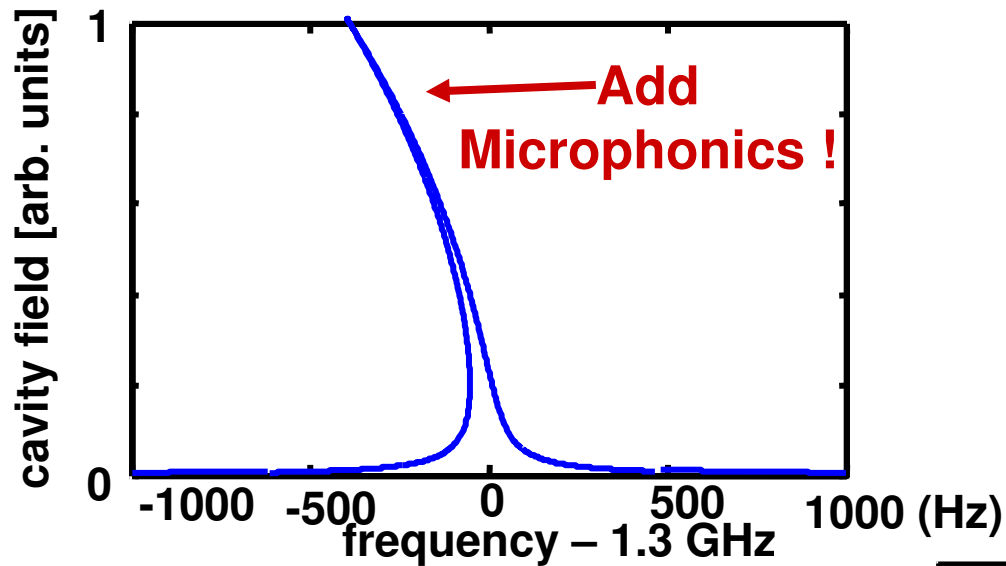


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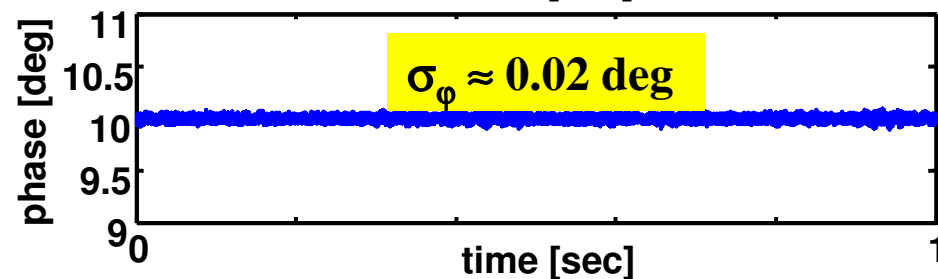
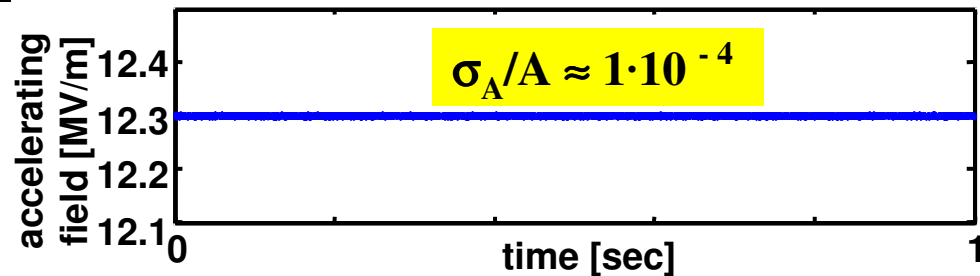




Cavity control for SC linacs (ERL & ILC)

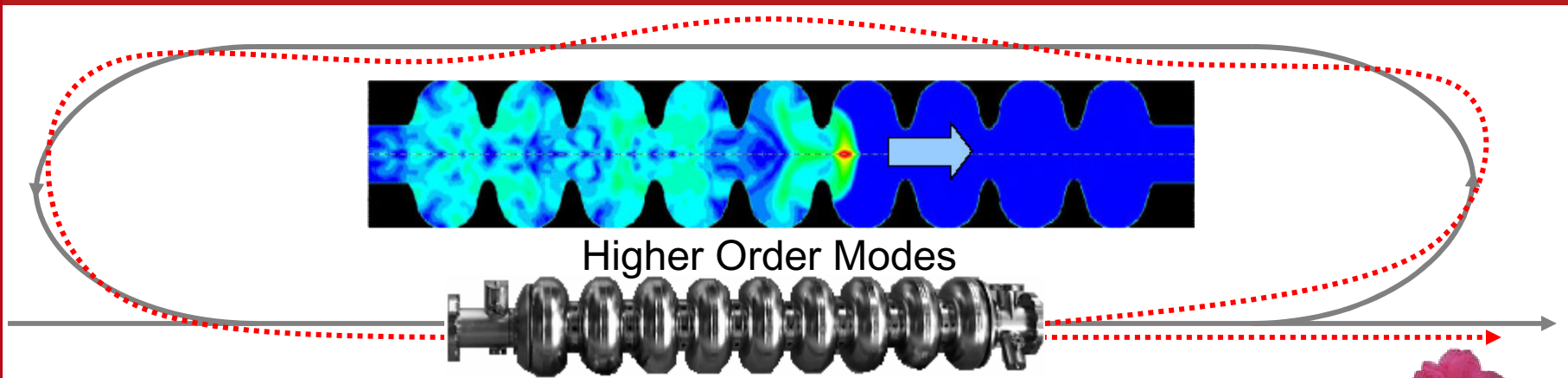


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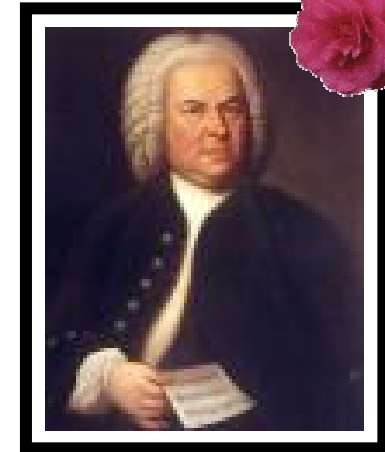




BBU: Collective Instabilities



$$V_x(t) = T_{12} \frac{e}{c} \int_{-\infty}^t W_x(t-t') V_x(t'-t_r) I(t') dt'$$



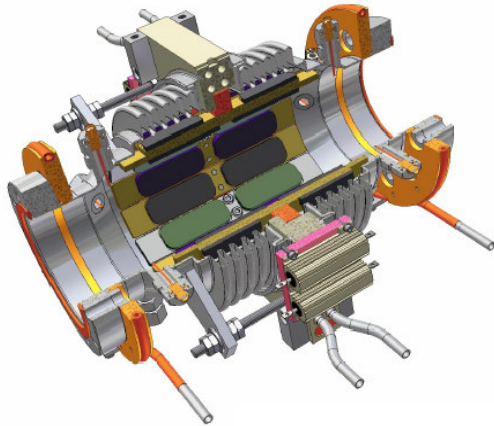
HOM absorbers have been designed to allow more than 400 mA.



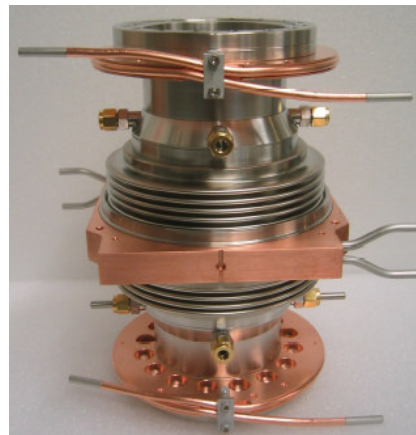
HOM absorbers a la Cornell



From design



to production and

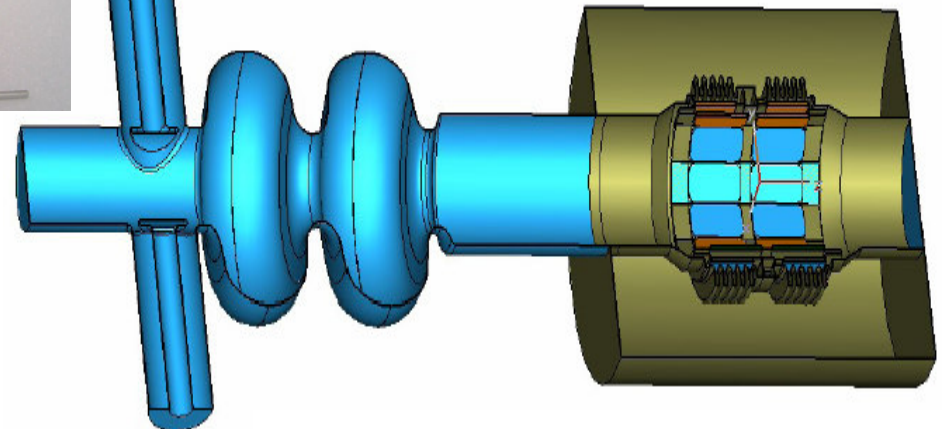


The Cornell-type HOM absorbers:

- first developed for CESR
- adopted internationally
- Refined for the ERL

HOM absorbers quickly reduce unwanted field components.

Installation, made in Cornell

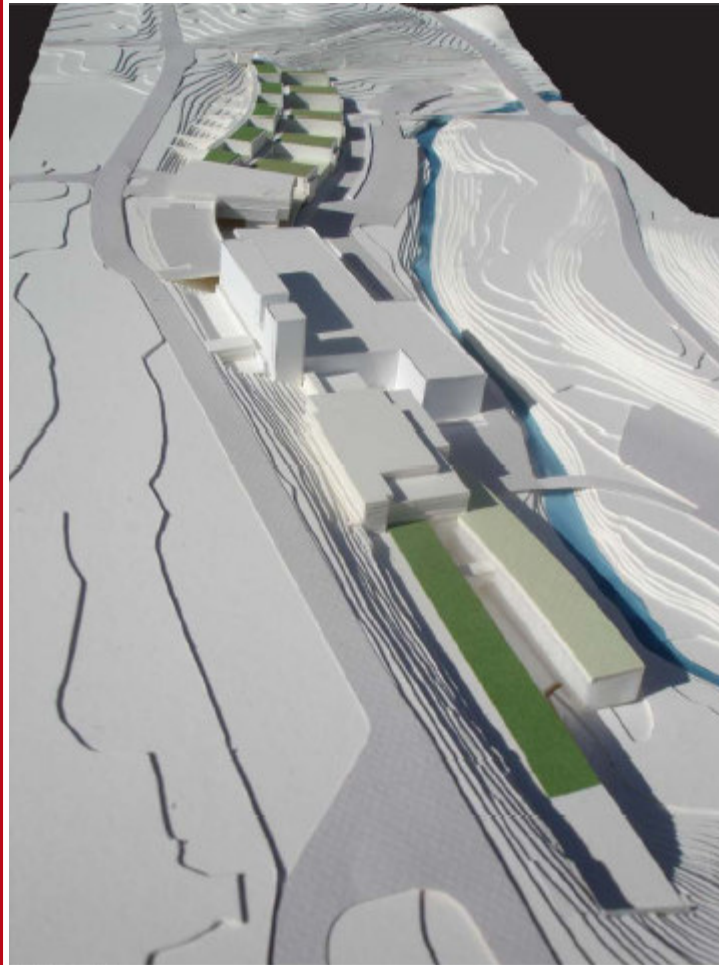




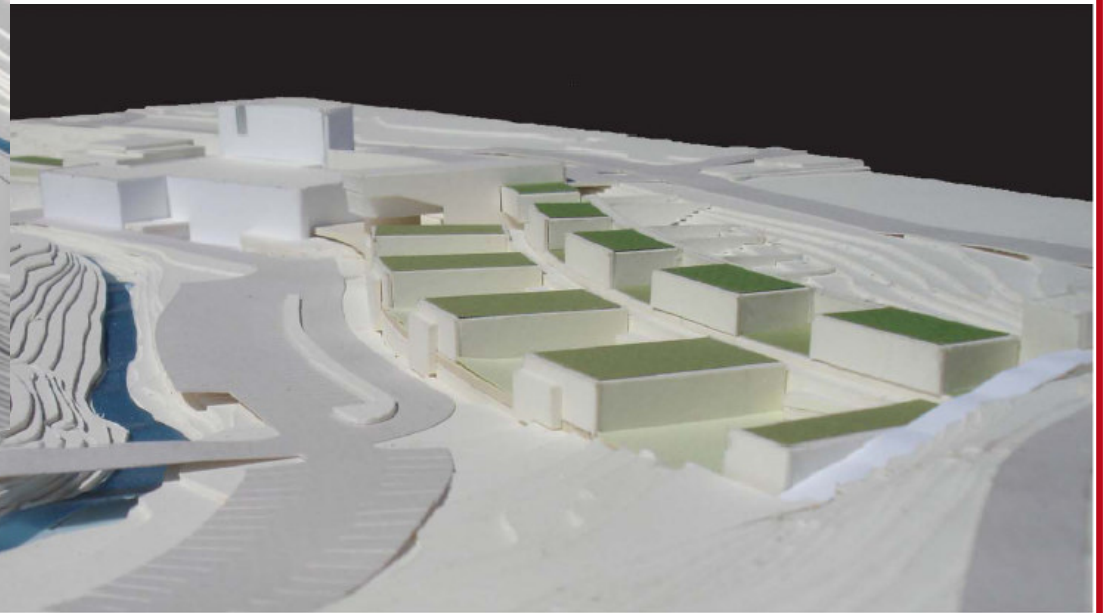
Space requirements



CLASSE



Present assignable space: 87,048 sq ft
New required space: 195,000 sq ft

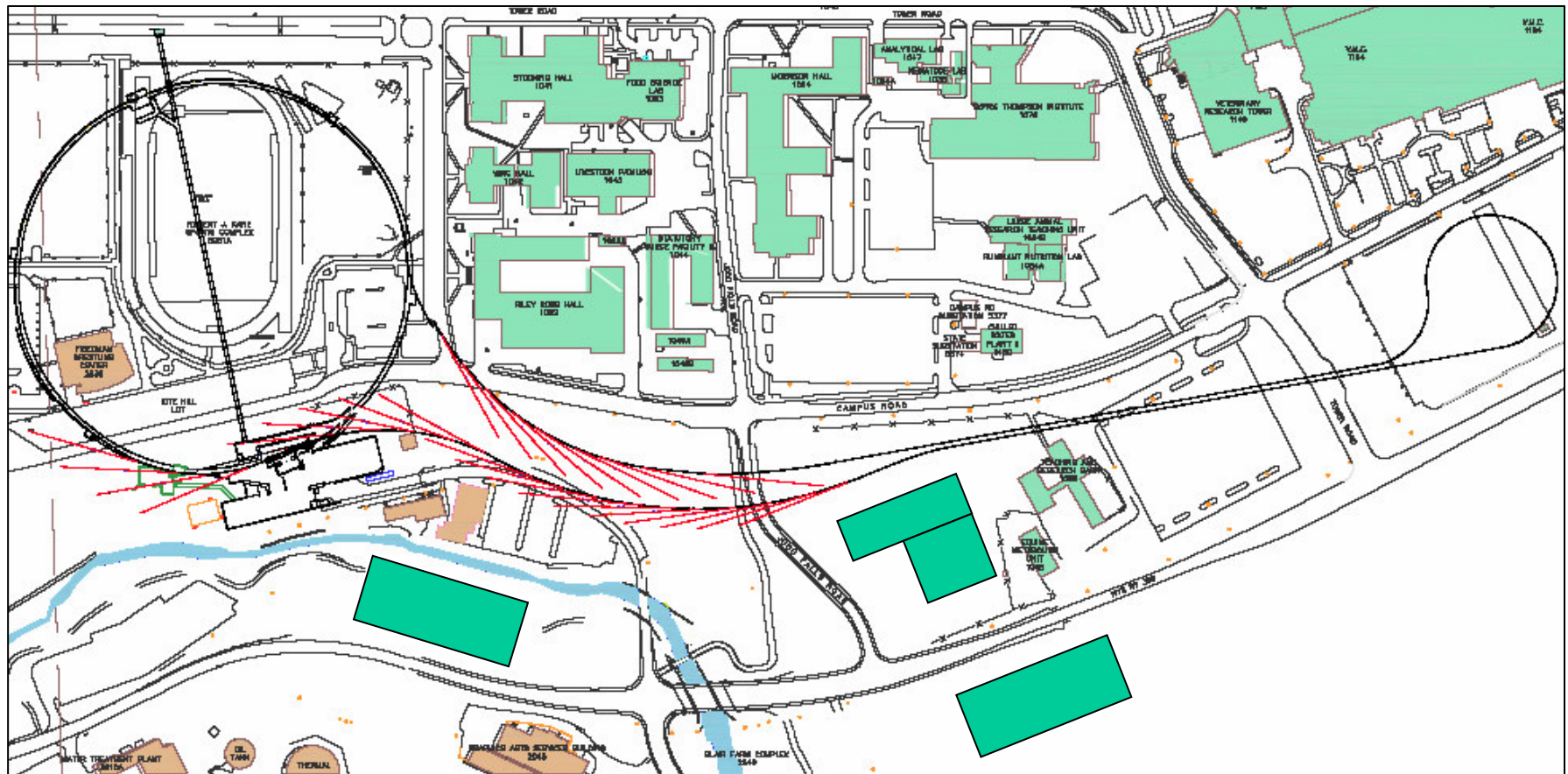


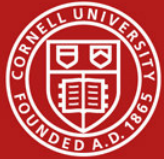


Cryogenic building

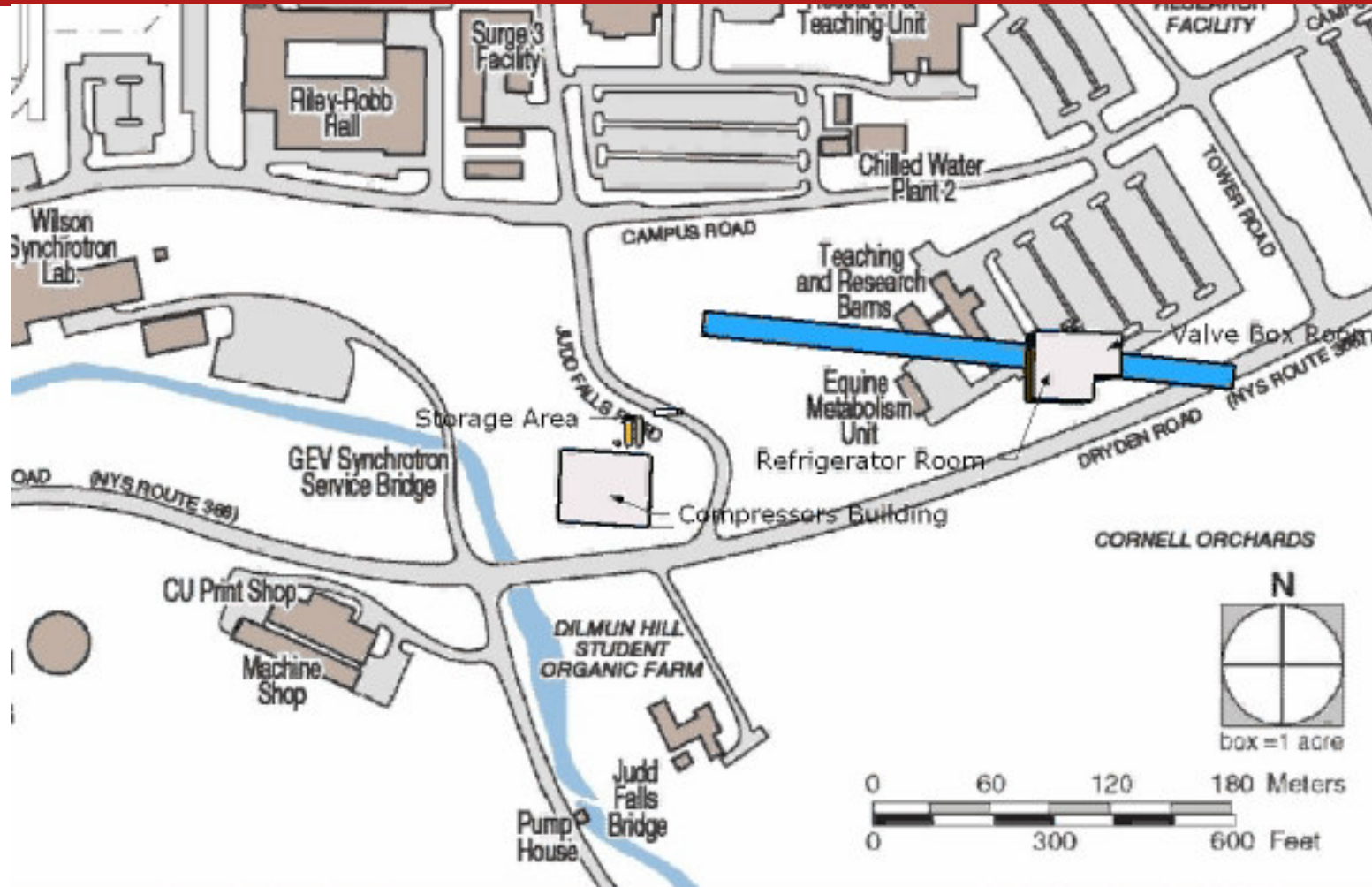


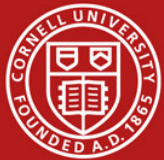
Two designs: 25 X 55 X 7m and 35 X 65 X 12m



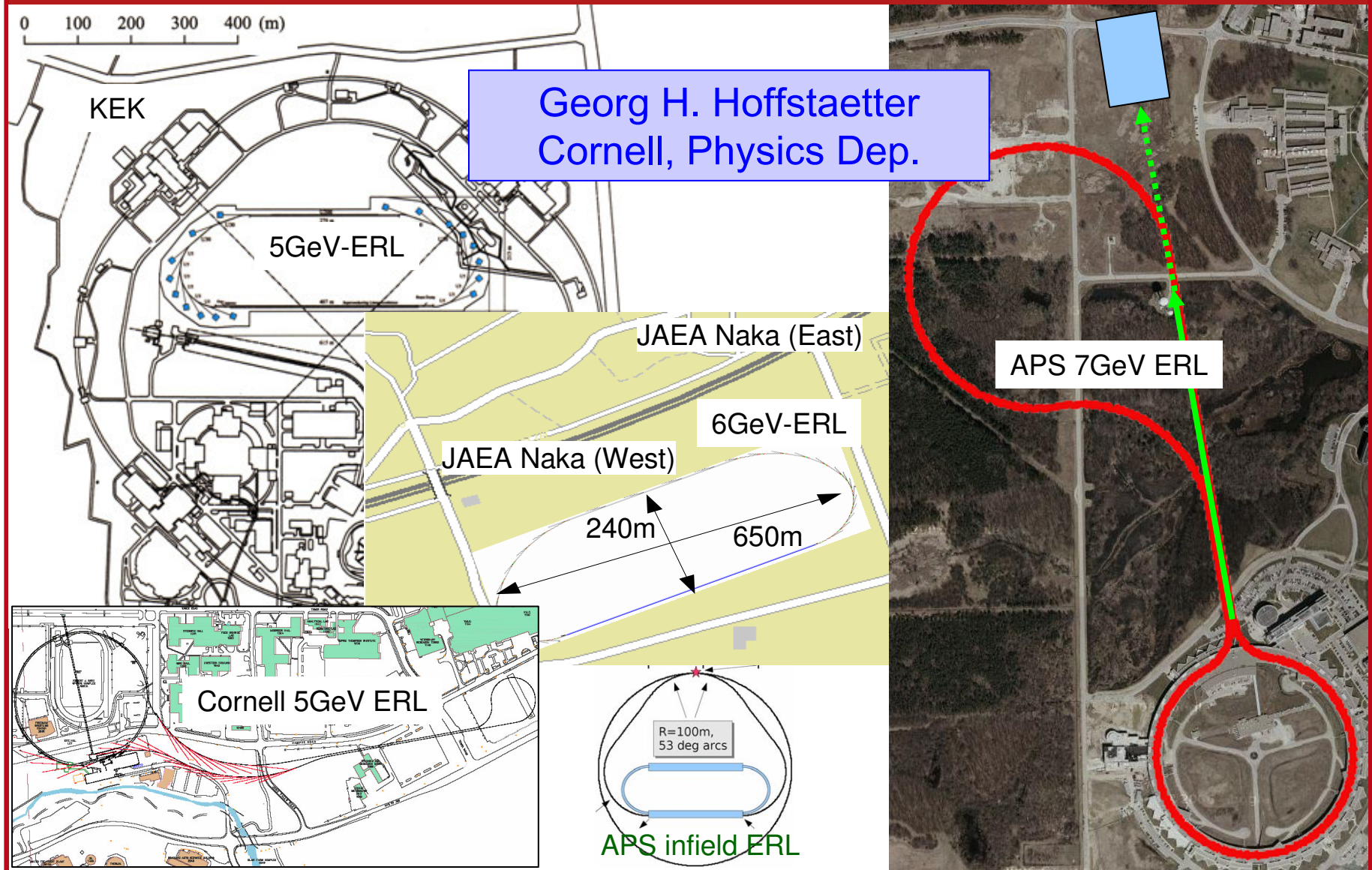


Cryogenic building





Energy Recovery Linacs as X-ray Sources





Next ERL workshop



See you at Cornell for ERL2009