ML status and plans

Nikolay Solyak

For AD&I meeting, June 5, 2014

- Status of ML lattice design and LET studies
- Plans
- Resources

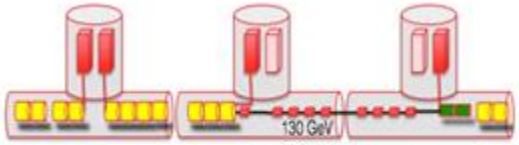
ML Lattice design status (incl. BC)

- Two stage BC migrated from RTML to ML. Lattice was re-optimized (w.r.t. RDR) for a new set of beam parameters, provided by DR
  - *Extra 3CM's in BC2 RF system to improve flexibility and support smaller bunch length option*
  - *Matching and optimization of wiggler*
  - *Better design of the extraction lines*
  - *Sensitivity studies are completed*

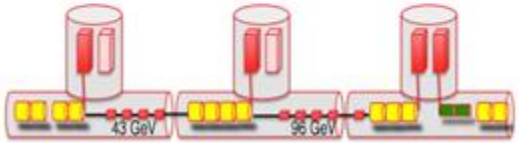
- Two ML lattices (KCS & DKS) were designed in TDR phase. DKS is the baseline for Japanese site:
  - *Earth curvature and realistic cryo-segmentation included*
  - *Collimation system after ML (migrated from BDS)*

Staging 125 GeV: Emittance after DMS correction

Scenario: Full size tunnel half occupied



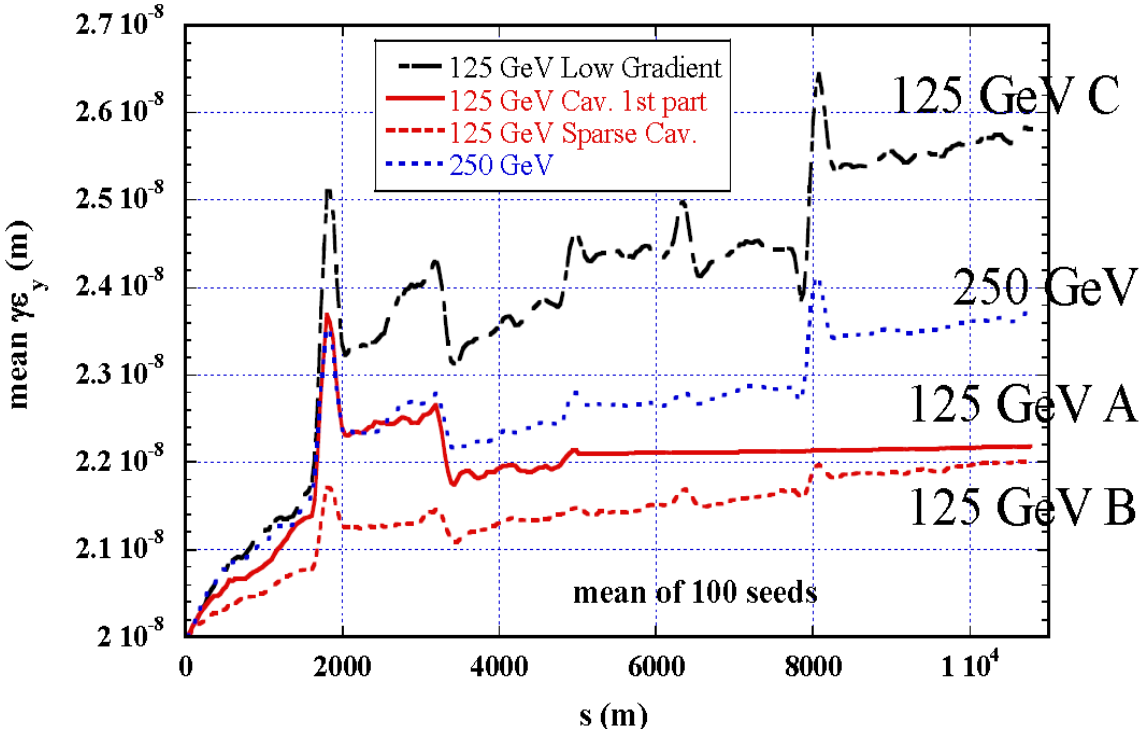
A: all cavities in 1st part



B: sparsely distributed cavities

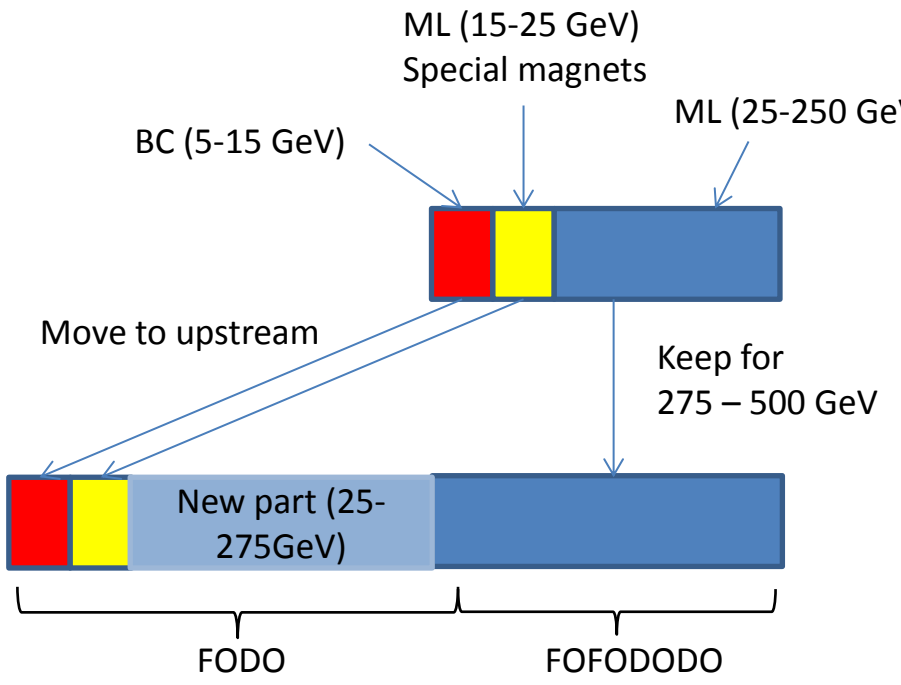
C: all cavities with half gradient (for comparison only)

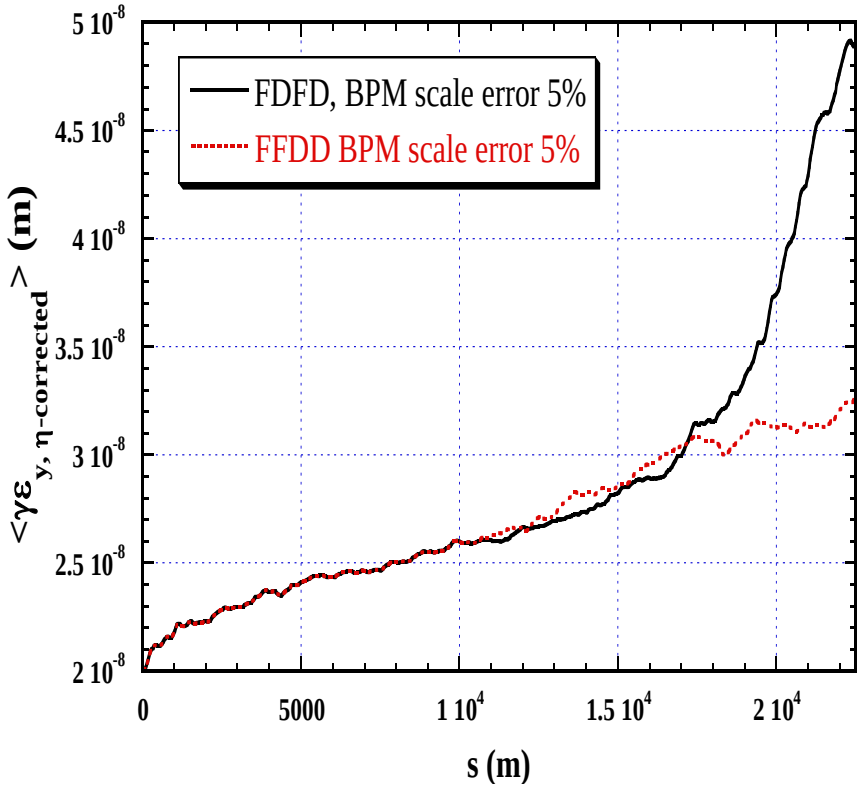
Vertical emittance along the linac, mean of 100 random seeds.
"Standard errors" (except Q roll) and Dispersion Matching Steering



- After DMS emittance growth mostly from WF
- No significant difference between A and B
- Lowering gradient increases emittance growth

Upgrade, ECM from 500 GeV to 1 TeV

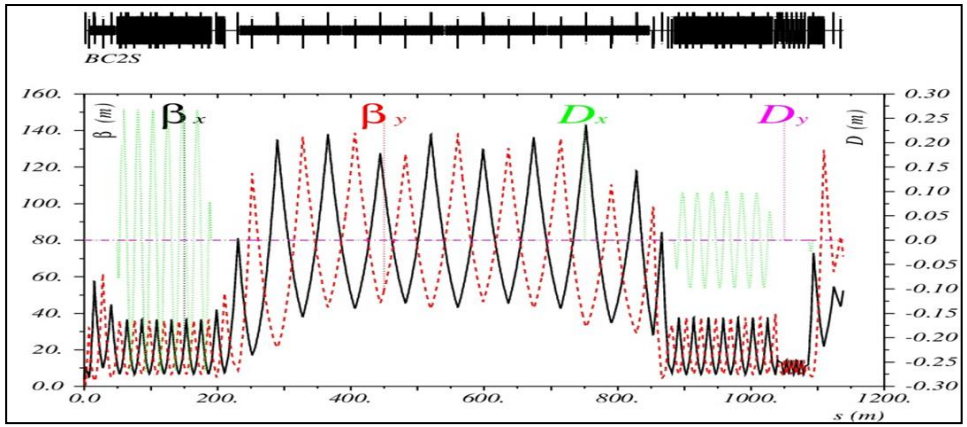


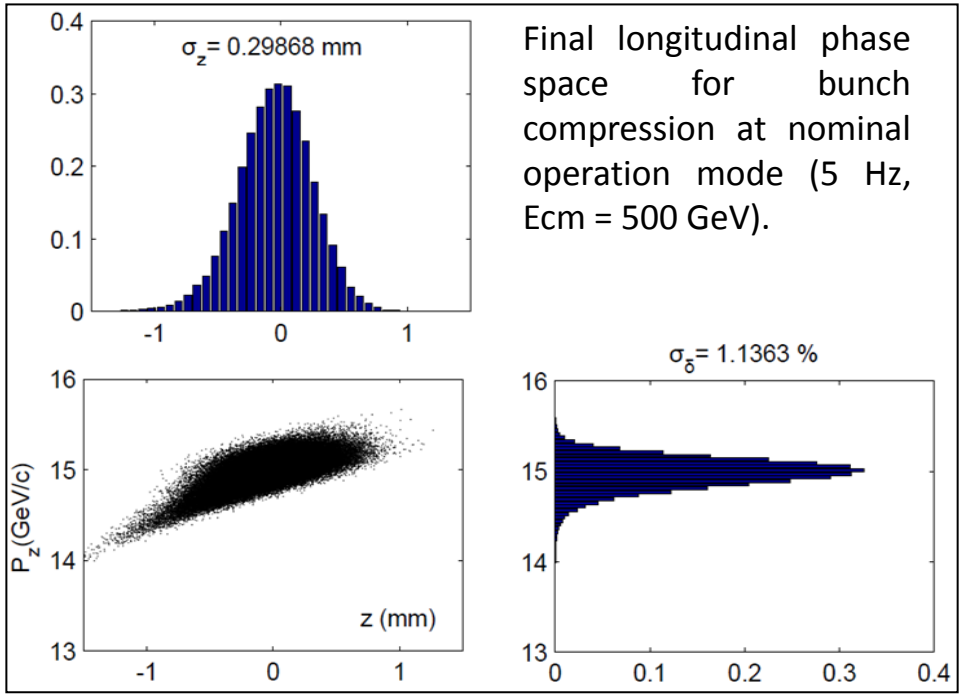


Magnets designed for 250 GeV FODO will be used up to 500 GeV beam.

FOFODODO can make dispersion in downstream part small.
Loose tolerance of BPM scale error in DMS correction.

2-stage Bunch Compressor (current TDR design)





Final longitudinal phase space for bunch compression at nominal operation mode (5 Hz, Ecm = 500 GeV).

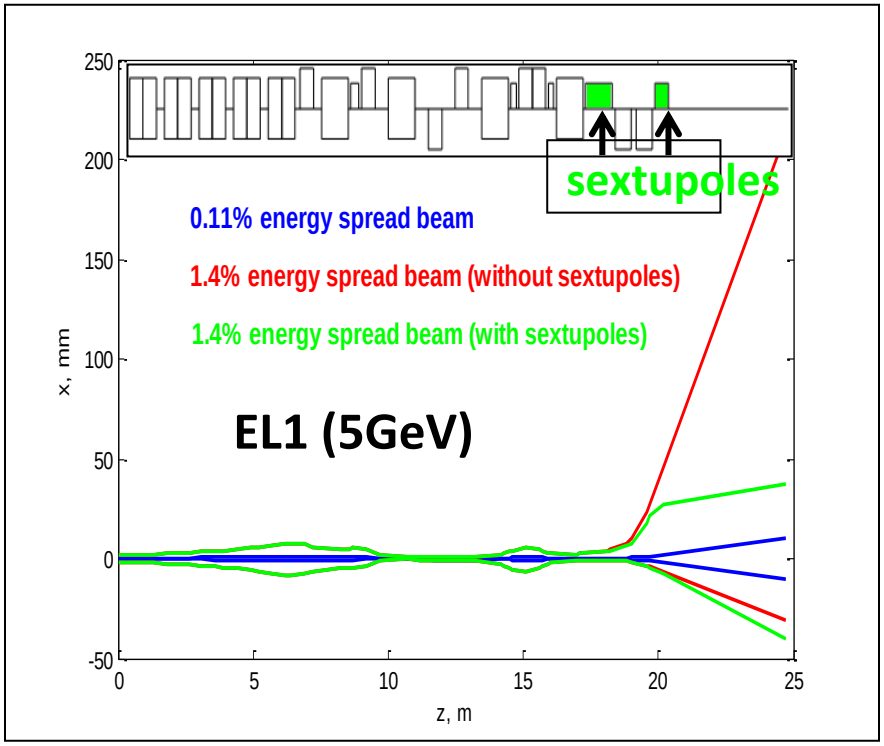
BC modifications (vs. RDR):

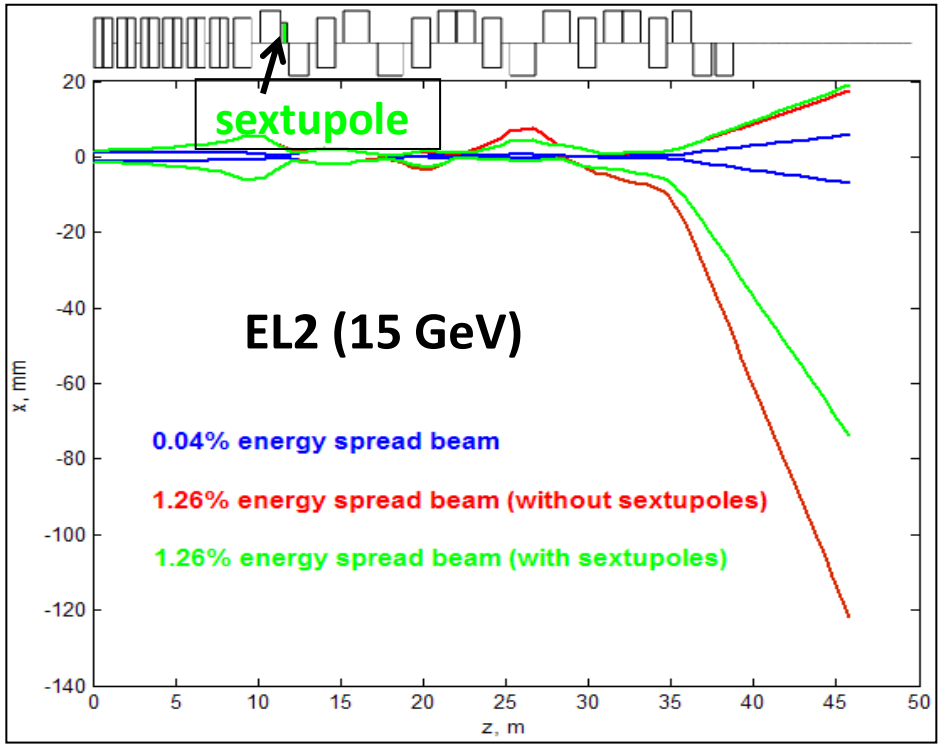
- 3 CM's with quads for BC1 (ILC design instead of XFEL).
- 16 RF units in BC2 RF (48 CMs; 416 cavities) to reduce gradient.
- New parameter optimization of BC wigglers (S. Seletskiy)
- New output parameters from DR
- New treaty point from RTML to ML

- 2-stage BC (TDR) provides bunch length 150 - 300 μm
- Emittace growth ~6nm above budget, need more studies
- CM pitch control is required for emittance minimization

Extraction Lines nonlinear lattice

- For a beam with a high energy spread there is a substantial blow-up of beam size at the end of the EIs because of chromatic aberrations and nonlinear dispersion.
- Relatively weak sextupoles can contain the nonlinear halo and such solution doesn't require any additional beam collimation.





Beam Dynamics studies and issues

- From results of large amount of past studies in ML beam dynamics, our conclusion was (and is): No serious problem is expected.

- <u>However</u>
  - More simulations for emittance preservation in BC is necessary
  - BC + ML combined simulation is necessary for completeness
  - Experimental test of steering correction is desirable
  - How to proceed commissioning has not been studied
  - Our requirements may not be really understood or agreed by groups/people who should be responsible for the hardware e.g., alignment, magnet control, cavity control, …
    - Need to modify some of the requirements, for making them more realistic.
    - Coupler kicks in BC

S2E simulations: TDR Work

- Study of integrated luminosity performance
  - Static and dynamic errors: ground motion, jitter, feedbacks, …
- A lot work was done in past (RDR)
- Simulations tools exist and are mature
- Parameter sets and lattices have been changed, need to refresh work
- Need to fully document
- Need to prioritize the tasks to make efficient use of the (limited) available resources
  - Can image 0.5 – 2+ FTE / year in this effort.

Experimental studies of the BBA techniques at FACET and other facilities. Results and plans

- FACET: promising results demonstrated; need more work to understand the limitations.

- New proposals for experimental studies:
  - Fermi @ Electra
    - (S-band linac, 150m-long , two BC; 0.15-3GeV; ~20 correctors/BPMs)
  - ATF2/KEK:
    - ~11 X/Y correctors; 55 BPM's
    - WFS might address charge-dependent effects (WF?)

Plans for ML studies (FY15-16):

- **Priority #1: Develop AD&I plan compatible with CFS. Support pre-construction site dependent CFS work *(0.5-1 FTE for lattice design)***
  - ***Length of tunnel***
  - ***10 Hz operation for e- linac***
  - ***Staging scenario***
  - ***Choice of accelerating gradient***
  - ***CM length and cryo-segmentation***
- **Priority #2: Review TDR and develop work plan for LET studies and S2E simulations**
  - ***LET studies for ML, incl. BC (1 FTE)***
    - *Emittance simulations incl. coupler kick in BC, sensitivity studies,*
    - *static+dynamics errors, GM, feedback*
  - ***Dark current and radiation issues (revisit , LCLS-II) -?***
  - ***Beam dynamics + Engineering (0.5 FTE)***
    - *BC cryo-module pitch control engineering*
    - *Alignment studies and modeling, probably for whole machine (?)*
  - ***S2E simulations (with RTML and BDS) - 1-2 FTE***
  - ***Experimental studies (0.5 FTE)***
    - *Beam-Based Steering Correction, at FACET, Fermi, ATF2*
- **Priority #3: Other issues**
  - ***Risk analysis***
  - ***Machine protection***
  - ***Personnel protection (Radiation, shielding)***
  - ***Commissioning***

Resources:

Limited resources

- Currently available < 0.4 FTE:

  ~0.1 FTE in 2014 from America

  ~0.1 FTE from Europe

  ~0.2 from Asia

- Required ~ *3-4 FTE's in FY15-16 (ramping?)*