A Mechanical Installation Prototype for the DCLS Radiator Section

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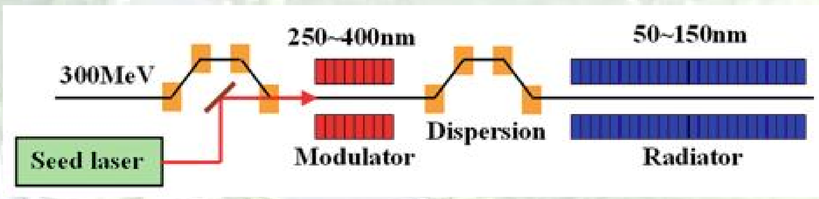
Abstract

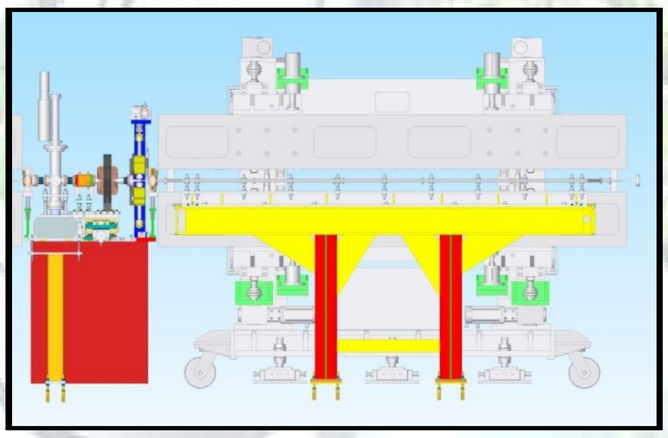
The design of the mechanical system for DCLS radiator section was completed. The key components in each system, including the undulator, phase shift, magnets, vacuum chambers, CBPM, profile, and their supports, were fabricated and tested, respectively. In order to check the overall design and confirm some components design, a radiator section prototype was installed by using these components. The dynamic properties of the mechanical assembly were tested in this prototype. Most of the design was confirmed during the installation, but still some problems were found. The modification for the overall design and some components design, as well as the selection from several design for some components, have been made before their mass production.

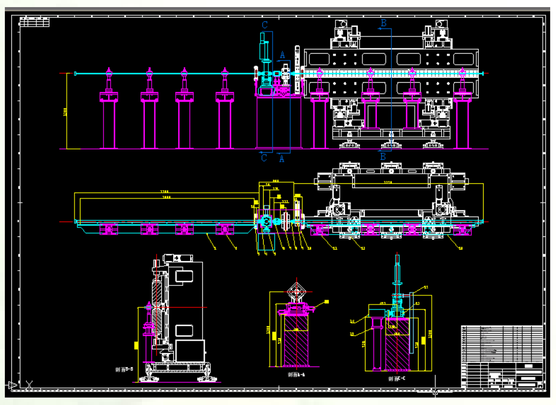
dcls

Dalian Coherent Light Source (DCLS) is designed to be working on the HGHG FEL principle. DCLS could be lasing at extreme ultra-violet wavelength with full tunable regime of 50 to 150nm. The construction started at 2014.



Beam energy	300 MeV
Relative energy spread	1×10^{-4}
Normalized emittance	1-2 mm.mrad
Peak current	300 A
Seed laser wavelength	240-360 nm
Seed laser width (FWHM)	1 ps
Radiator period length	30 mm
Radiator parameter	0.3-1.6
FEL wavelength	50-150 nm
FEL pulse energy	>100 μ J

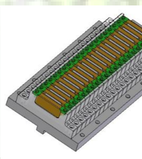


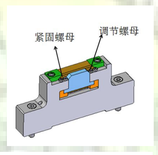


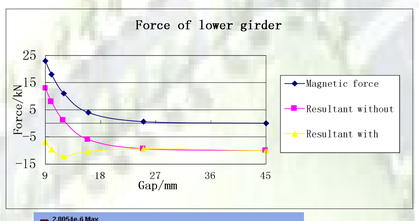
Installation prototype design

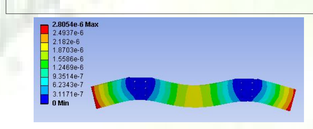
Undulator

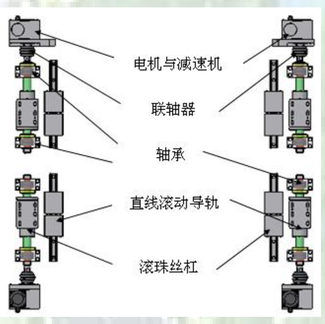
Gap range	9~25 mm
Resolution of Gap	<5 μm
Peak field	0.2~0.8 T
First field integral	<50 Gs-cm
Second field integral	<3000 Gs-cm2
Peak-to-peak trajectory deviation	<20 μ m
R.M.S phase error	<5 °
Length of each undulator	<3 m

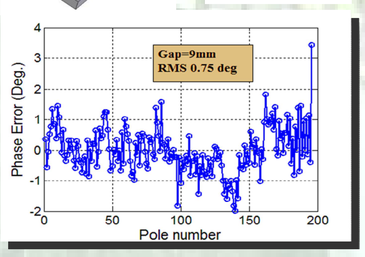










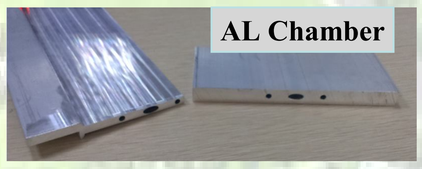


Vacuum chamber

- OFHC chamber
  15mm×6mm× δ 0.75mm×3.3m
- Al alloy chamber
  12mm×5mm× δ 0.5mm×3.3m
- AFP process: R_A <300 nm
- P_{max} < 1×10-7 Torr

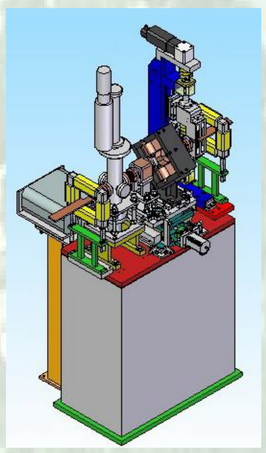
Three key techniques

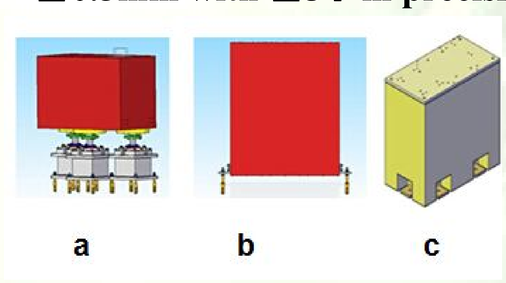
1. Elliptical pipe stretching
2. Long chamber brazing
3. Inner surface polishing



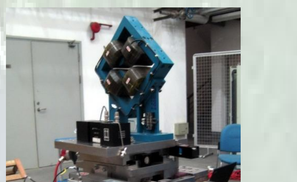
Support

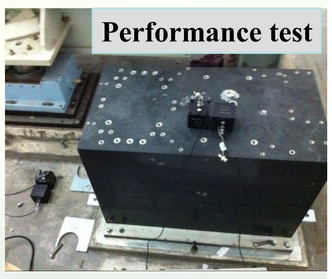
- Quadrupole, CBPM, profile, phase shifter, corrector are supported on the girder. Mechanical stability is the key issue in the design.
- Quadrupole requires a adjustment range of ±0.5mm with ±3 μ m precision for BBA.

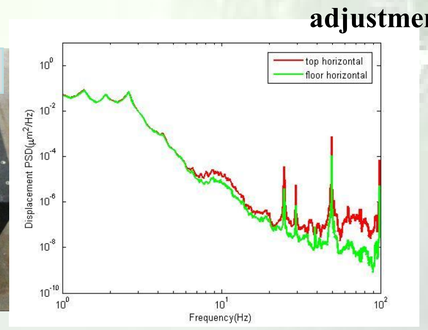


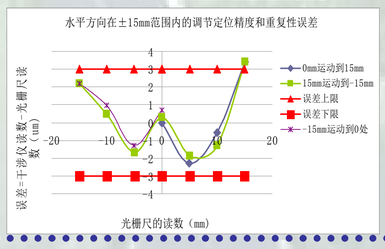


Granite+3D adjustment | Granite | Concrete | Granite+3D adjustment





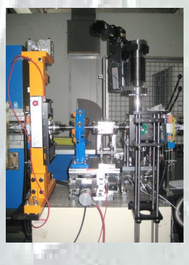


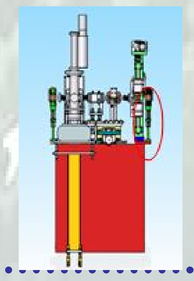


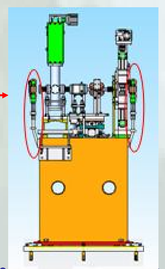
Installation

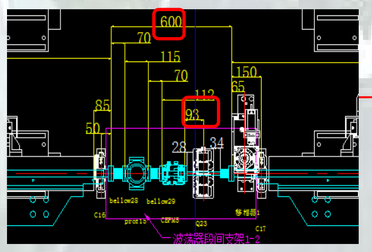
- Confirm the components mechanical design and fabrication.
- Confirm the overall design and interface of hardware.
- Confirm the installation procedure.
- Platform for some performance test.

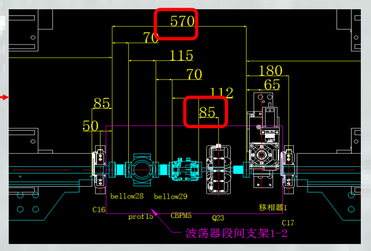
Radiator section prototype











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