Experimental Physics:
Capabilities and Facilities

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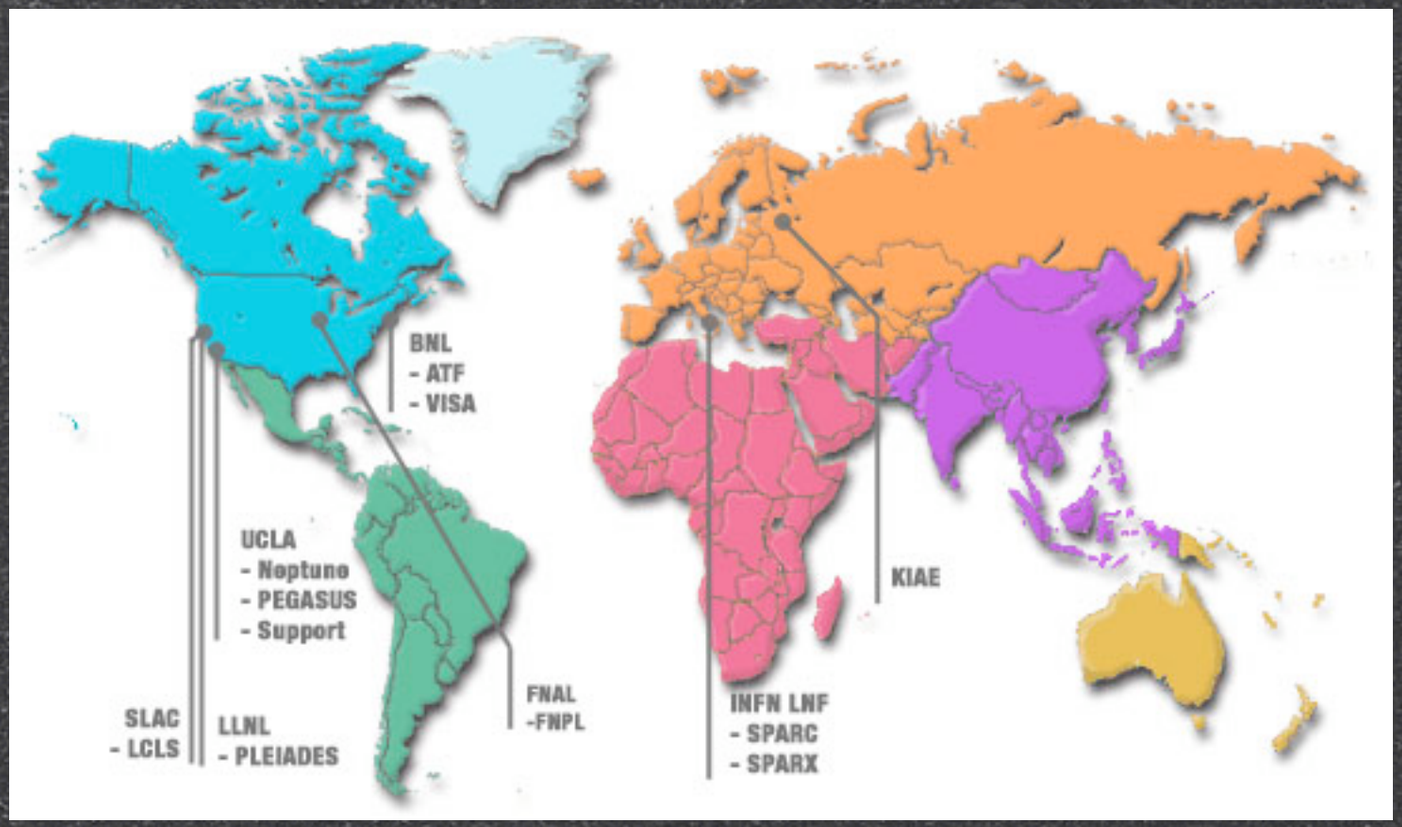
a presentation to the DOE: May 2004

From Campus To The World

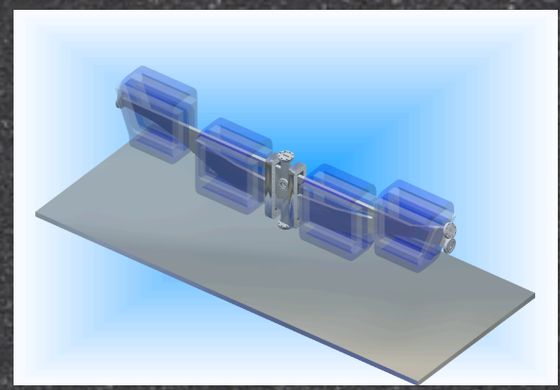


Neptune | PEGASUS | Support labs

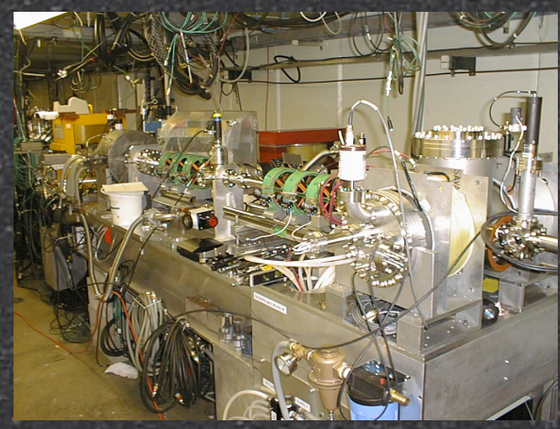
SLAC | LLNL | FNAL | BNL | INFN

Core Competencies

- Beam Dynamics and Manipulation
  - Beamline optics
  - Compression
  - Space Charge
  - Emittance Compensation



- Beam-Matter Interactions
  - Diagnostics
  - Transition Radiation: OTR, Near Field TR, CTR
- Beam-Radiation Interactions
  - Radiation production: FELs, Inverse Compton scattering
  - Acceleration: Plasma, IFEL, Dielectric, Wakefield



Key Technologies

PBPL Developed, Designed and Produced

- Magnets
  - Electromagnets: 2-6 poles; your pick – even #'s!
  - Permanent: High Gradient, Medium Gradient, Ring Tuned, Undulators
- Diagnostics
  - e-Beam: screens, slits, spectrometers, TR, CTR bunch length
  - γ-Beam: x-ray bent-xtal spectrometer; FEL FROG, GRENOULLE, & imaging spectrometer
  - Novel: Deflector, Tunneling, CER
- Structures
  - Photoinjectors
  - PWT linac
  - Deflecting cavity

Neptune

UCLA

Unique Capability

Photoinjector + Mars amplifier

e-Beam

15 MeV | 5 μm | 300 pC | 600 fs

γ-Beam

100J | 1 TW | 10μm

Beam-Radiation & AA Experiments | Mature Technologies | Diagnostics

PEGASUS

UCLA

Unique Capability

2m undulator | RF Testbed | Rapid development lab

e-Beam

16 MeV | “3 μm | 1 nC | 5 ps”

γ-Beam

Capable of supporting T^3 laser

Support and Development for Neptune | Student Training

FNPL (FNAL)

Unique Capability

High Charge Multibunch SC Photoinjector

e-Beam

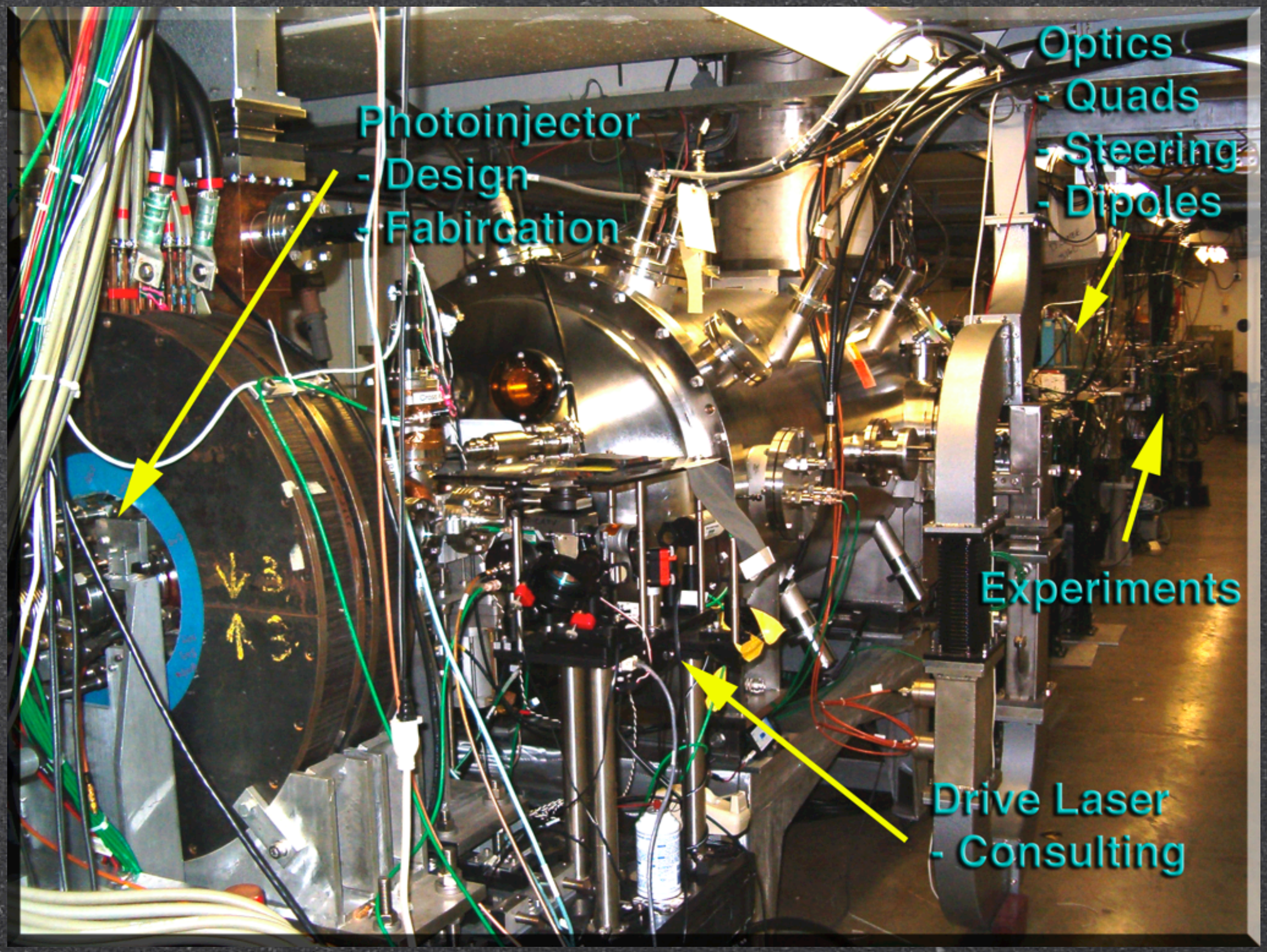
17 MeV | 20+ μm | 15 nC | 5 ps

Other

Chicane compressor | Undersubscribed beamline | Streakable time scales

Plasma (AA) Experiments | Support Technologies

Example: FNPL



PLEIADES (LLNL)

Unique Capability

100 MeV High Rep Rate & Falcon Laser

e-Beam

100 MeV | 10 μm | 500 pC | 5 ps

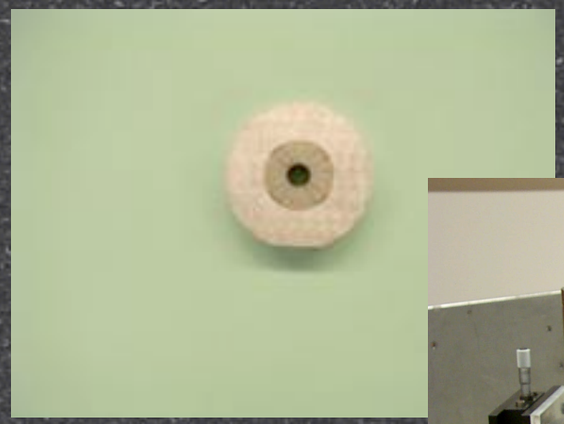
γ-Beam

“10J | 100 TW” | 1μm

Thomson Scattering | Beam Manipulation | Beam & X-ray Diagnostics

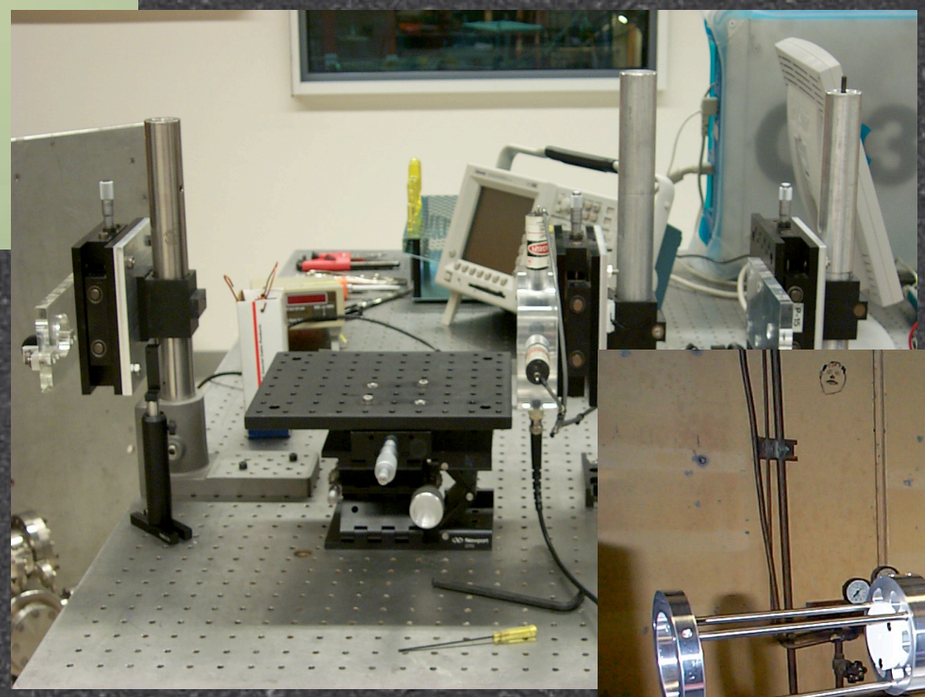
Technology Example: PMQs

Concept; Design; Simulation; Assembly & Testing by PBPL
Installed at LLNL and working well

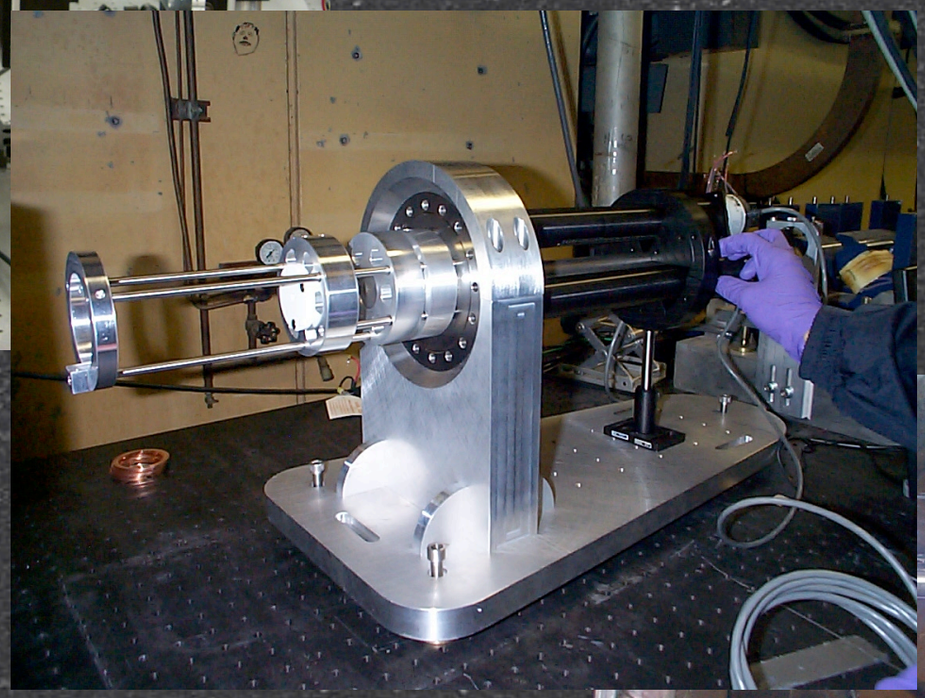


PMQ

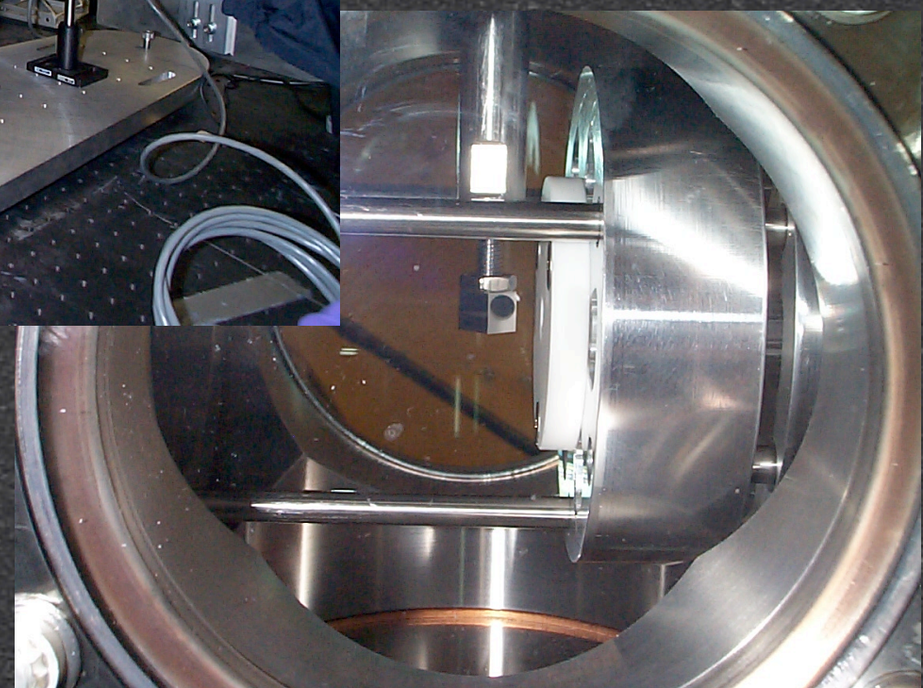
> 500T/m
5mm ID
z position Focus
FFDDF lattice



Pulsed wire testing



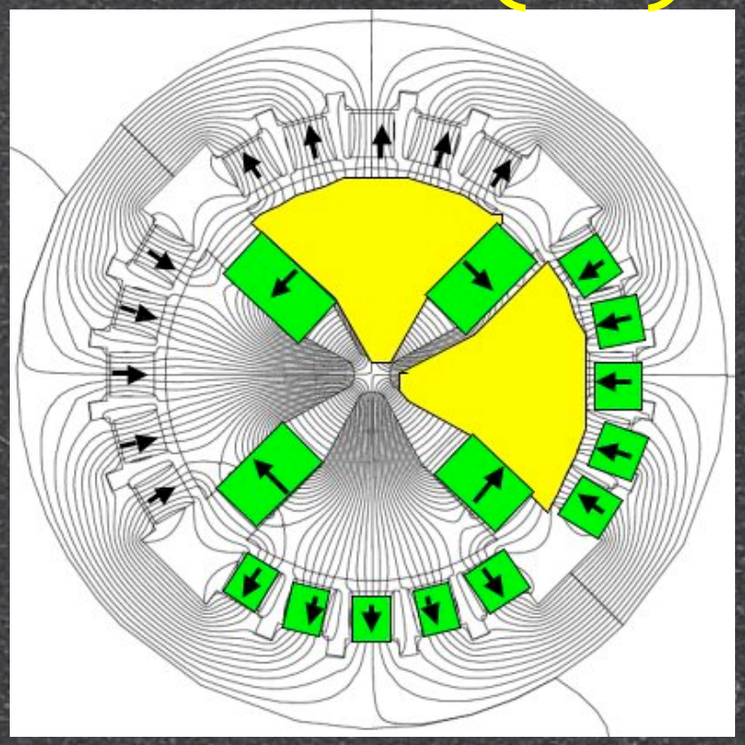
Assembly being installed



Ring Tuned PMQ for NLC

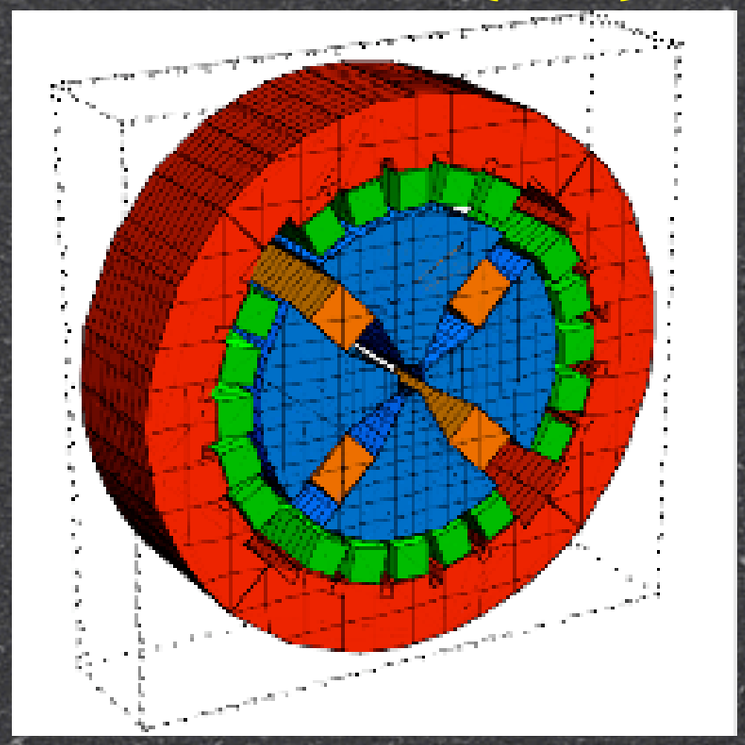
Maintain c-c alignment to 1μm

Pandira (2D)

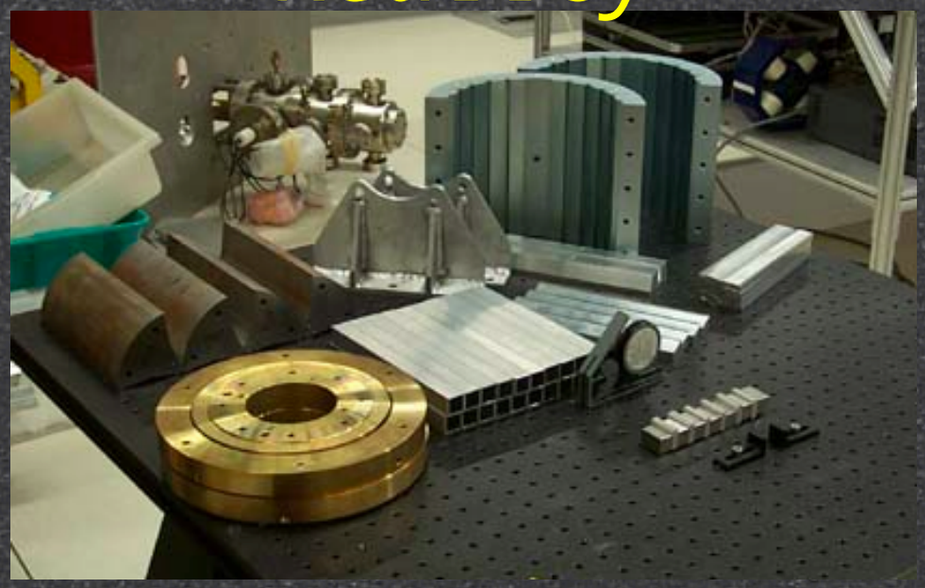


0.6 - 0.8 T
0.5% field error
±0.1mm c-c accuracy

Radia (3D)



Reality



Under assembly now.

Additional Facilities

VISA - ATF

Unique Capability

Highest brightness beam | 4m undulator | fully diagnosed | chicane compressor w CER diagnostics

SPARC

Unique Capability

Doesn’t exist! | Clean slate | Next level of Engineering for PBPL

Orion

Unique Capability

Exists even less! | Beam manipulation combines best of S-Bahn and compressor | Short bunches

Table of Activities

	Neptune	PEGASUS	PLEIADES	VISA - ATF	FNPL
Adv. Accel	IFEL PBWA Dielectrics				Trapping Plasma Lens PWFA
Beam Dynamics	Dogleg Chicane Velocity...		Velocity Bunching	Compressor Chicane	High Charge
Radiation Production	Nonlinear I-Compton THz	FEL Waveguide	Inverse Compton	FEL	
Diagnostics	CTR	Tested many past ideas	CTR X-ray 10μm beam	CTR CER Tomography	Wide range Spectrometer

+ SPARC (INFN) | Orion (SLAC)

Key Beam Parameters

	Neptune	PEGASUS	PLEIADES	VISA - ATF	FNPL
Charge	low	med	med	med	high
Energy	low	low	high	high	low
Emittance	medium	low	medium	low	high
Bunch Length	short	medium	short	short	long

So, what can we really do?

- Produce, accelerate, manipulate, diagnose and use high brightness beams.
- Gather shot-by-shot and statistical data for comparison with start-to-end simulations.
- Invent, design, and create key components for beam based experiments worldwide.

The Future

- Increased cross use of capabilities:
  "What's good for the IFEL is good for the plasma"
- Tighter integration of simulations and design.
- Digital manufacturing
- Femtosecond lasers & optical diagnostics
- Optical scale structures (nanotech!)

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Deficiencies

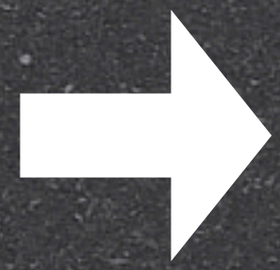
- Medieval laser technology
- Machiavellian data acquisition and electronics
- Limited on campus space:

Neptune: 4000sq-ft
STRB: 1000sq-ft

PEGASUS: 4000sq-ft
Prep Room: 900sq-ft

Core Capabilities

- Theory
- Simulation
- Design
- Fabrication
- Experiment
- Analysis



PBPL