The NSFC Project for Ultrafast Tunable EUV FEL

A Seeded Extreme-UV FEL at Dalian

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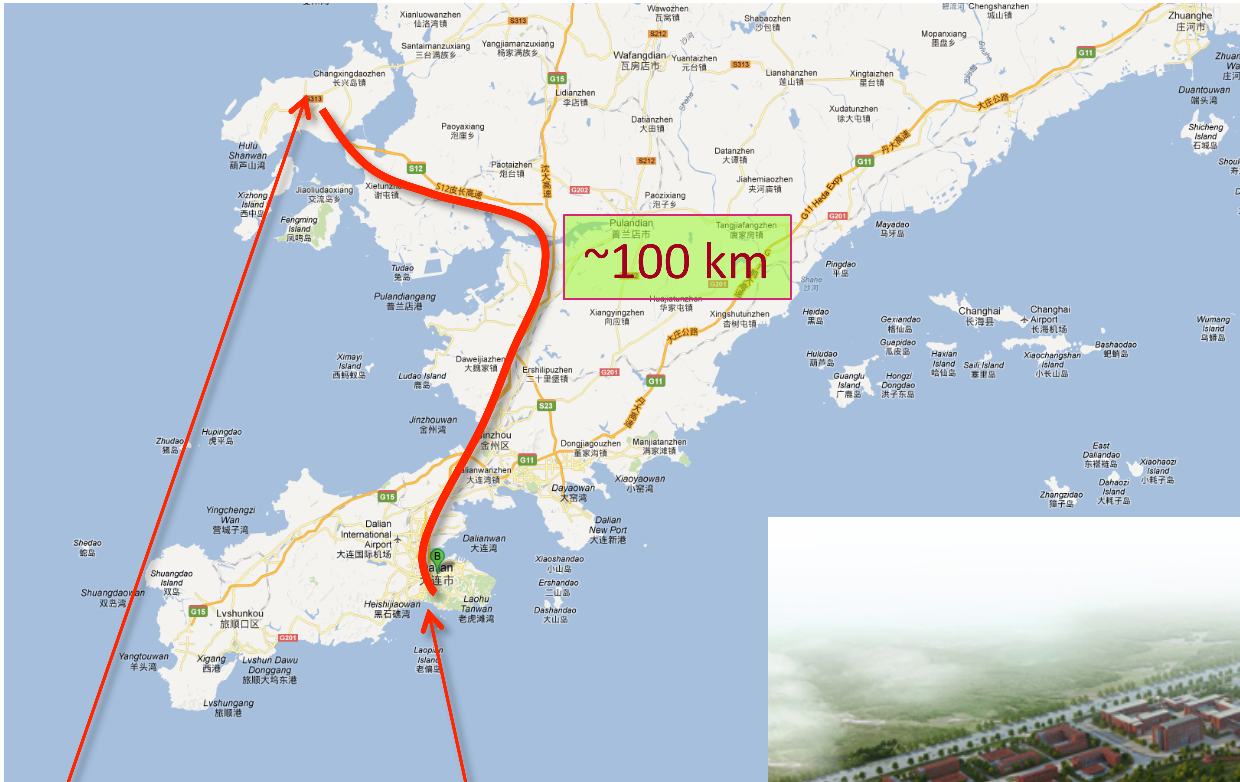
Workshop of SSSFEL, 2012

Dalian

Shanghai

Site for Dalian Coherent Light Source



New DICP Campus

Main DICP Campus

EUV FEL

New DICP Campus

DCLS Building

Basic
Energy Science
Building

Outline

Proposed FEL Machine

Scientific case

Schedule

Major Technical Specifications of the Proposed Dalian EUV FEL Facility

- Targeted Wavelength Range:

  50-150nm, completely tunable
- Pulse Energy: ~100 μJ (100 MW)
- Repetition Rate: up to 50 Hz
- Pulse Width: 100 fs/1ps
- Two FEL Lines

The Layout of the Dalian EUV Light Source

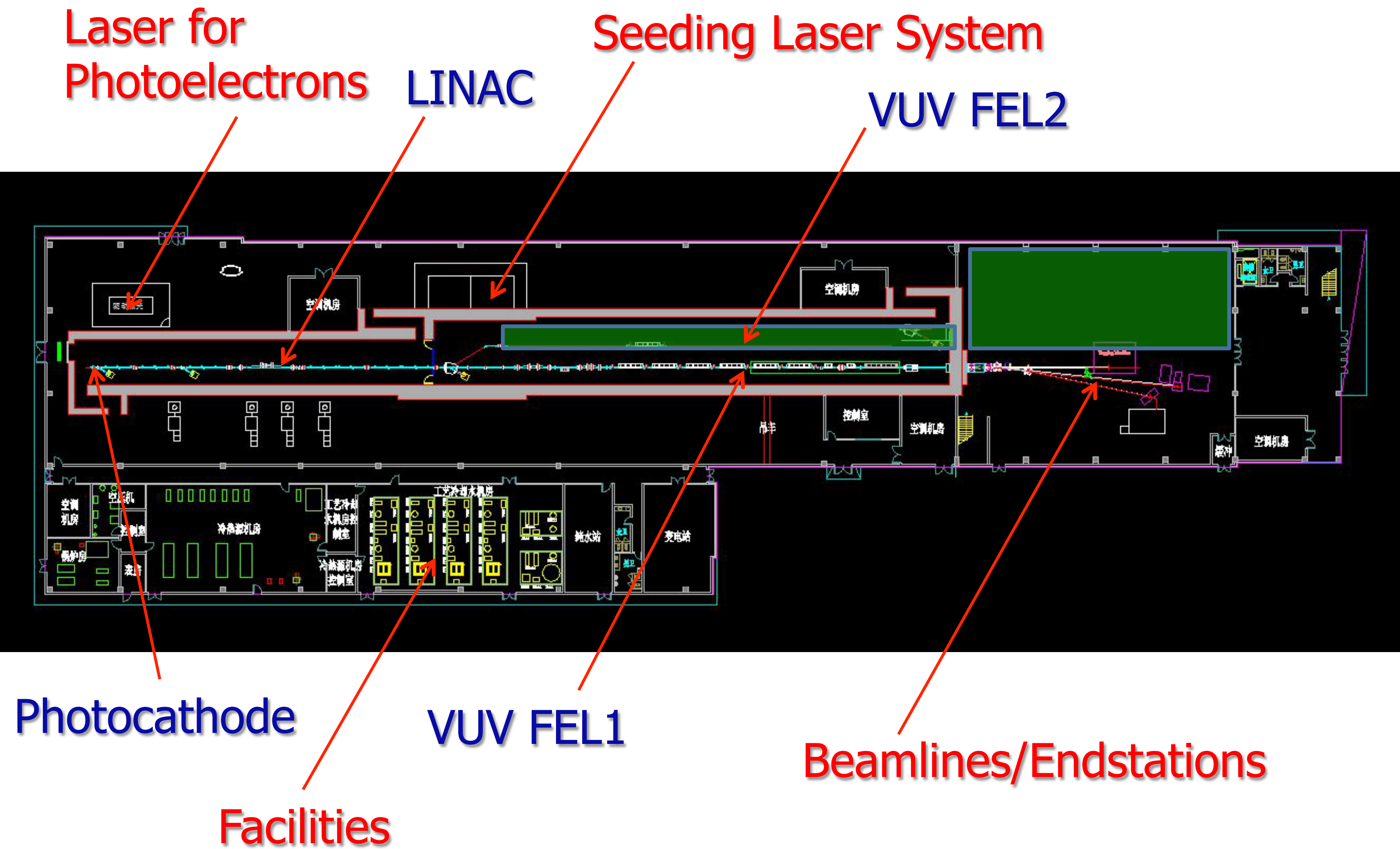
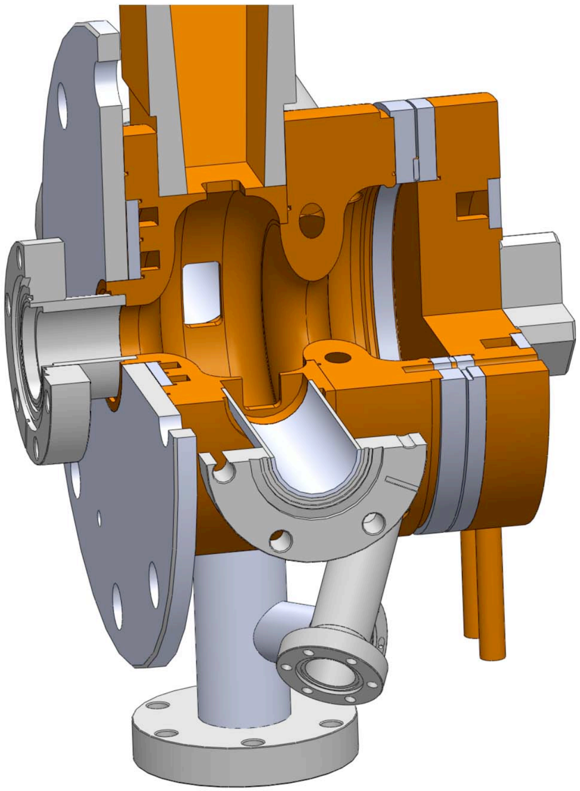
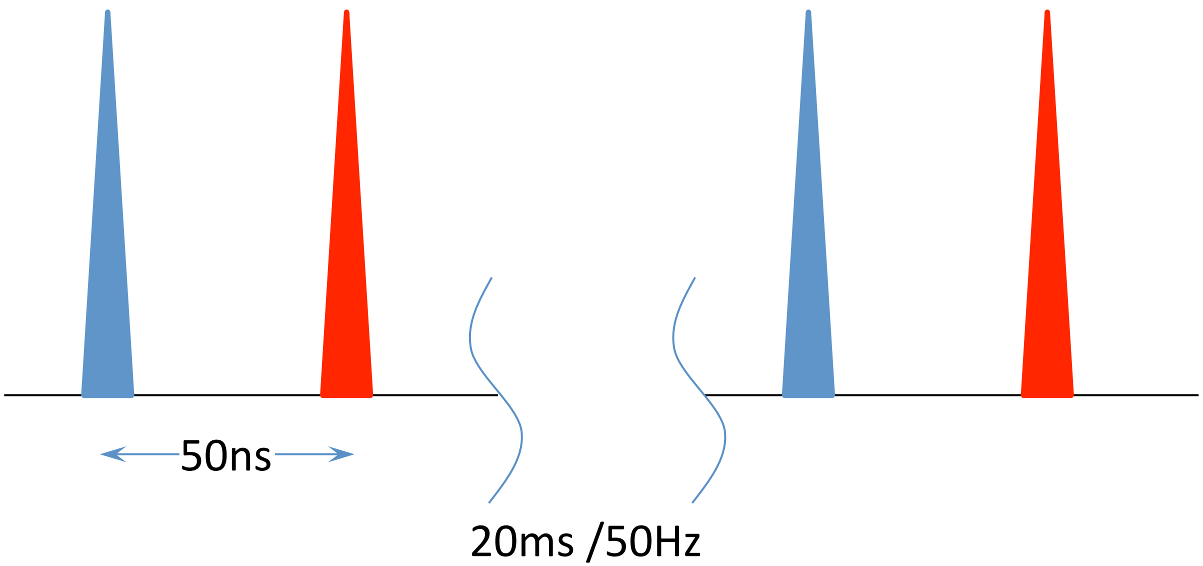


Photo cathode (BNL type)



Key parameter	
Cathode material	Cu
Gun gradient (MV/m)	100
Laser power(uJ)	250
Laser longitudinal length (ps)	10
Emmittance (mm-mrad, rms）	2
Quantum efficiency	$3*10^{-5}$

Double pulse technique



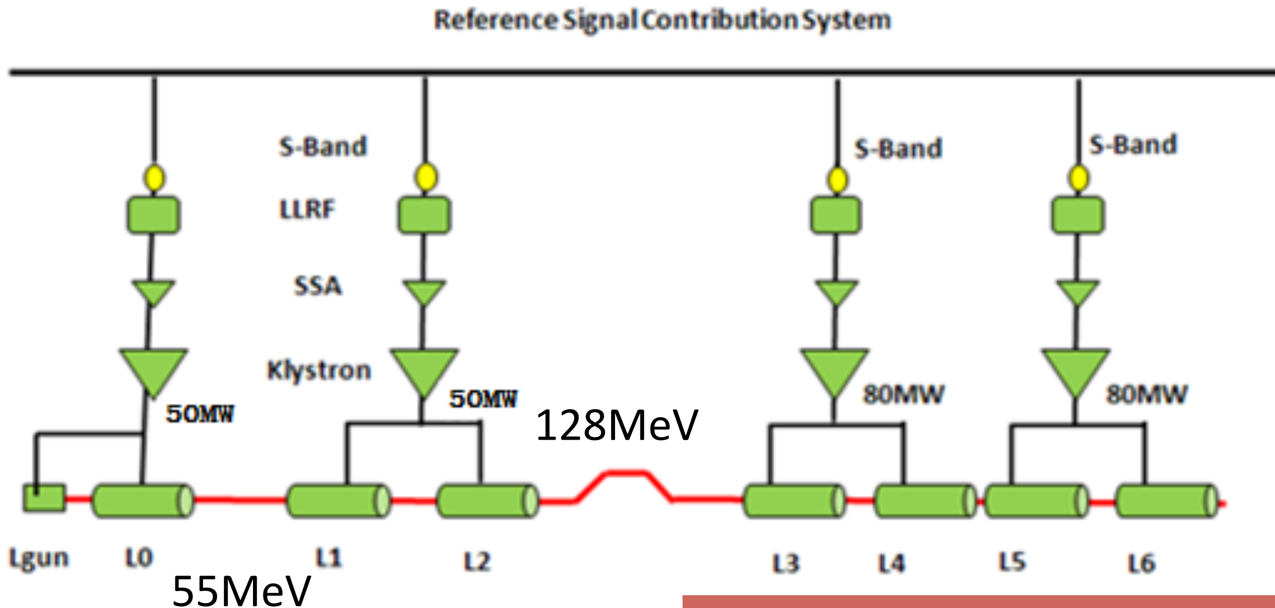
From PSI SwissFEL CDR

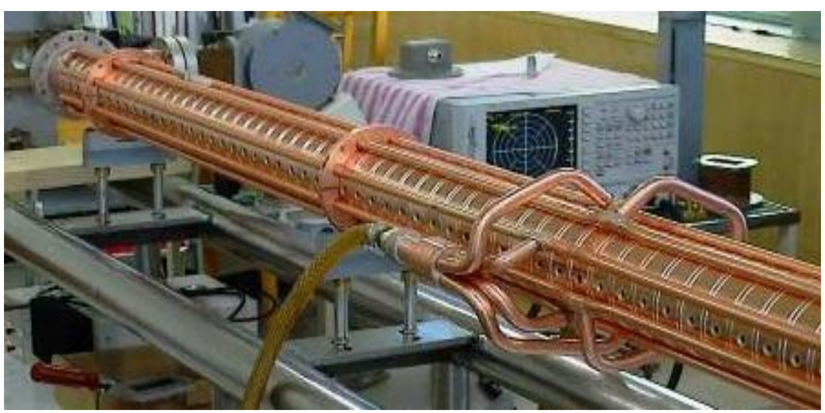
Double the flux of optical beam

Alternative of the second arm of undulator

Kicker of electron beam

SLAC type S-band linac structure

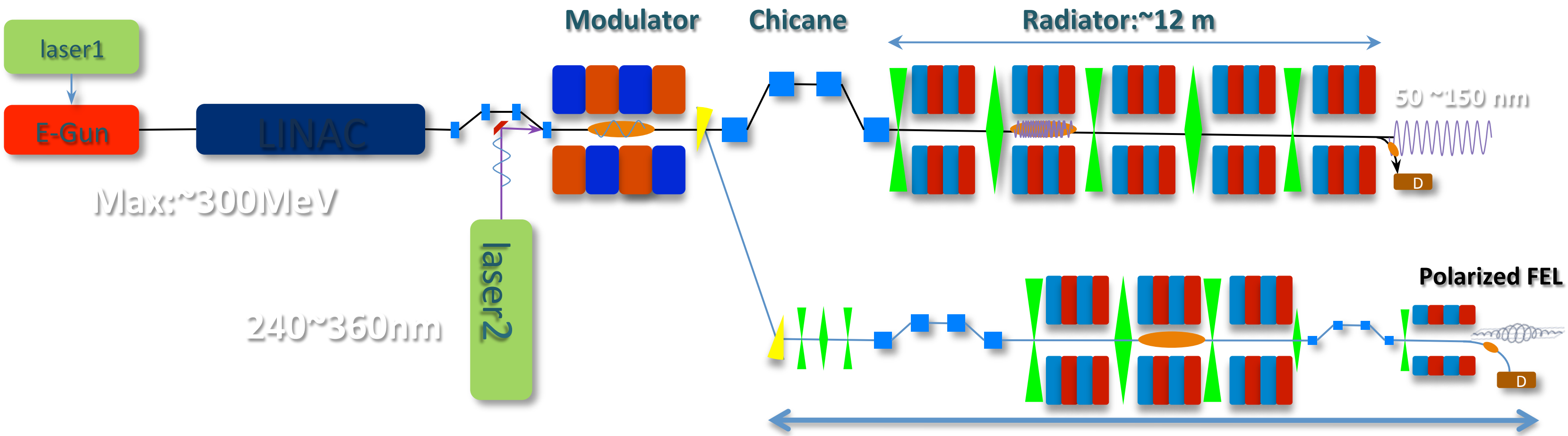




Key parameter	
Maxium e beam energy (MeV)	300
Energy spread (rms)	<0.20%
Emmittance (mm-mrad, rms）	≤4.0
Bunch length (ps, FWHM)	≤1.0
Charge per bunch (nC)	0.5
Repetition rate (Hz)	50

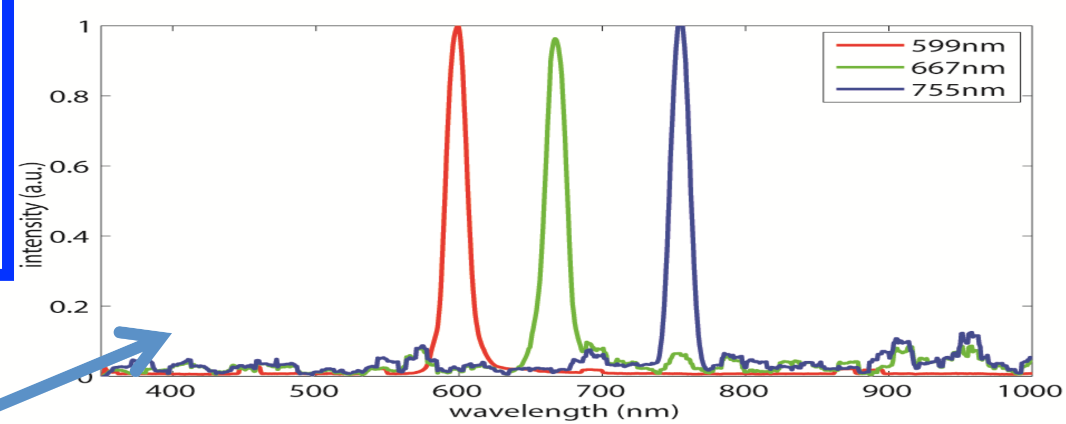
DCLS： 50-150nm tunable

HGHG



Second arm of FEL undulator

Adjustment:
Wavelength of seed laser
Gap of modulator
Gap of radiator



SDUV

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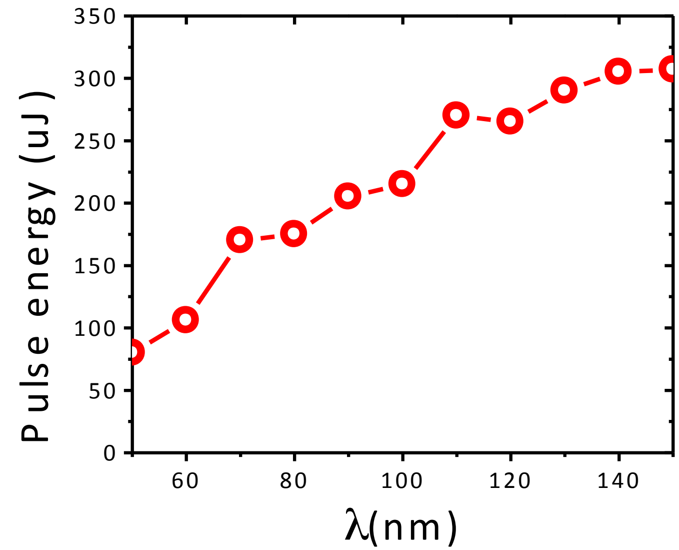
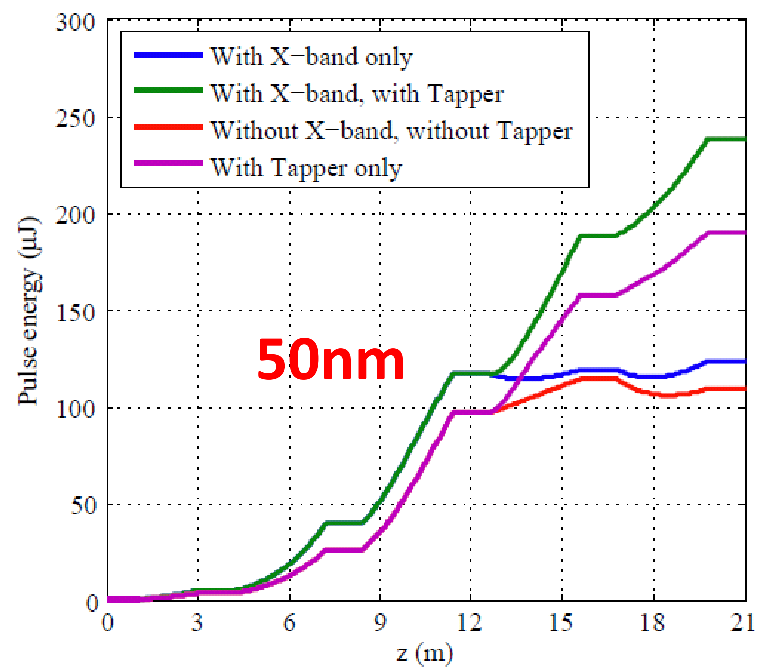
Hybrid undulator

Modulator parameter	
Period (mm)	50
Gap (mm)	10-60
Total length(m)	0.5
Radiator parameter	
Period (mm)	30
Gap (mm)	9-40
Total length(m)	12+6
Seed laser parameter	
Wavelength (nm)	240-360
Pulse length (fs/ps)	100/1
Power (uJ)	10/100





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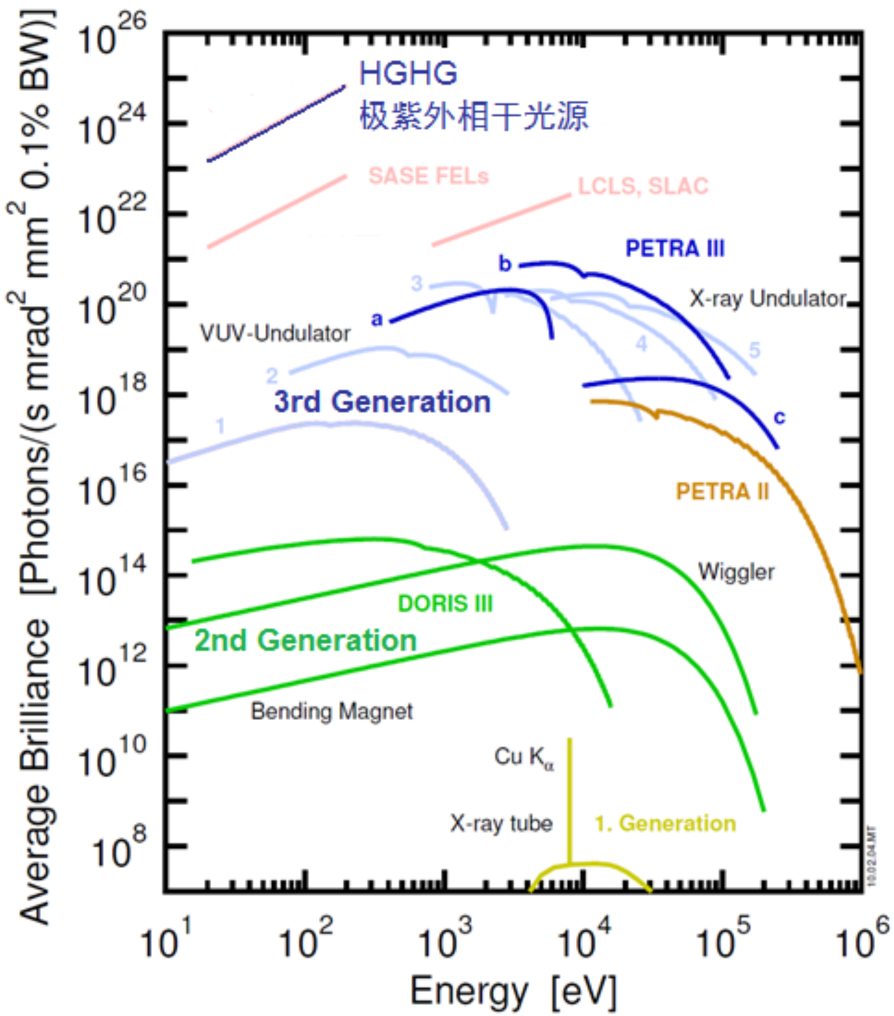
Major Opportunities in Research

- High Brightness
  - Sensitive Detections of Atomic and Molecular Species

- Ultrafast Character (ps,fs)
  - Probing ultrafast processes of molecules in gas phase and at surfaces



Workshop of SSSFEL, 2012

Scientific case

Needs in Basic Energy Research

Energy and Environment are the two most important limiting factors for the development of modern society. Facing the crises in both energy and environment, we must

1) Find more efficient ways in usage of fossil energy sources;

2) Develop new clean energy sources.

A majority of the energy sources of current and future are chemical and molecular systems.

Background of DICP

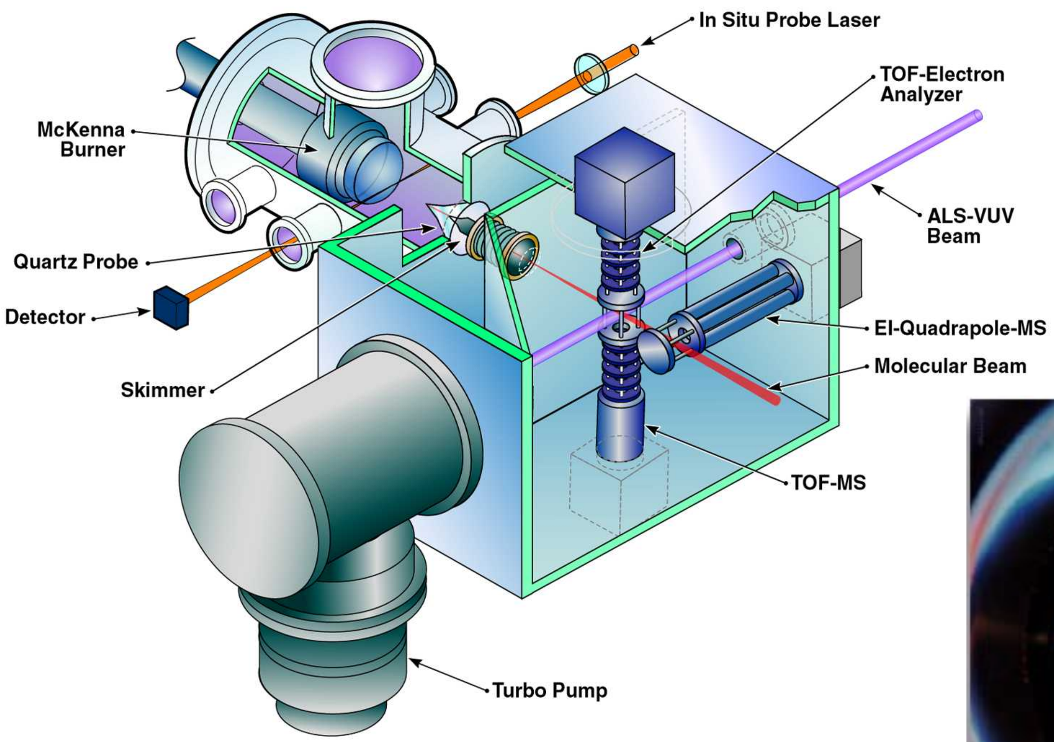
- DICP has started the energy research since its foundatio
- Dalian national laboratory for clean energy

Fossil energy conversion
Low carbon catalysis and engineering
Energy environmental engineering
Fuel cells and batteries
Energy storage
Hydrogen energy and advanced materials
Biomass conversion and bio- energy
Solar energy
Ocean energy
Basic &strategic studies on energy

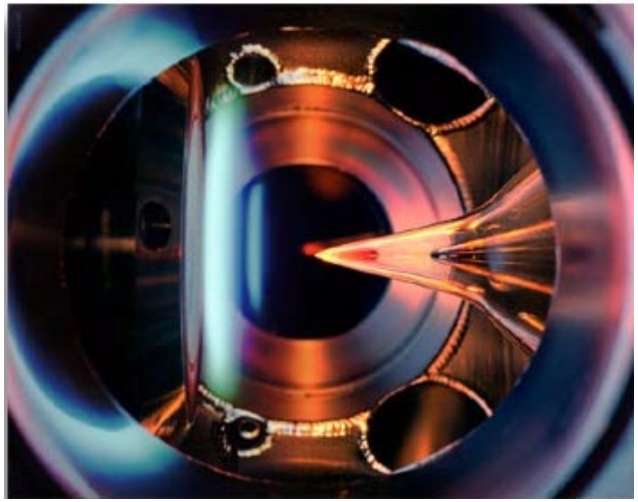
Usage of fossil energy

New clean energy

Case I: Combustion



cience 308, 1887-1889 (2005)



(Direct VUV Ionization)

Molecular Ionization Energies

Molecular ionization is very important for detection of atomic and molecular systems, while EUV is the most efficient tool for this.

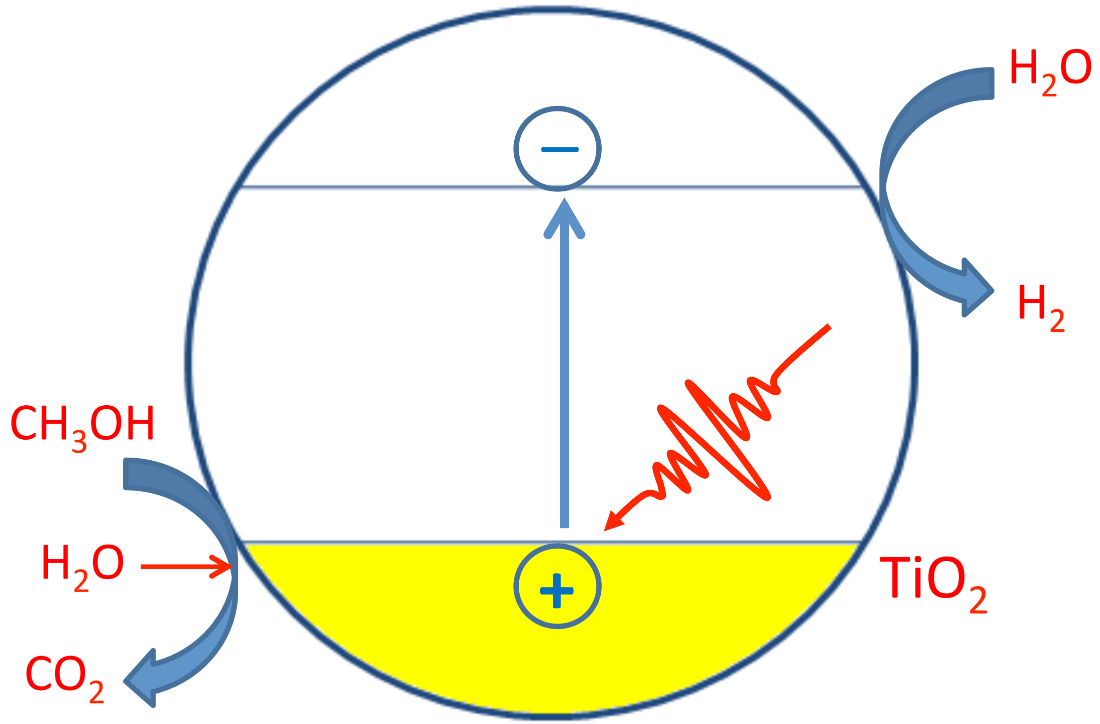
Electron impact ionization can produce fragmentation, and has no species selectivity

Molecule	IE (ev)
CH_4	12.61
CH_3	9.84
CO	14.01
NO	9.26
H_2	15.43
OH	13.0
H	13.6
CH	10.64
CH_3F	12.5
CH_3O	10.88
CH_3Cl	11.26

10 eV ~ 120 nm

Case II: Ultrafast Dynamics at Surfaces

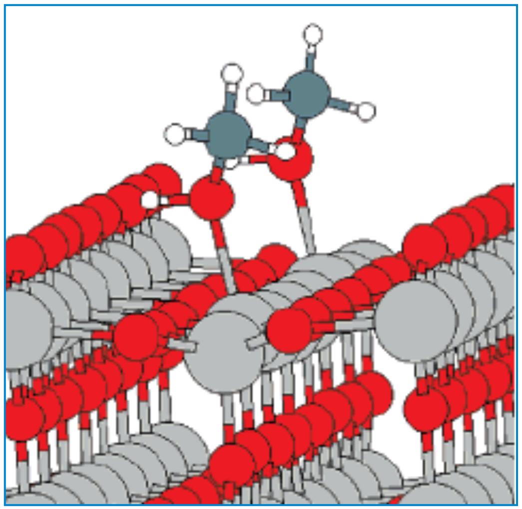
Time Resolved UPS Probe (Pump-Probe)



Chem. Rev. **95**, 735 (1995)

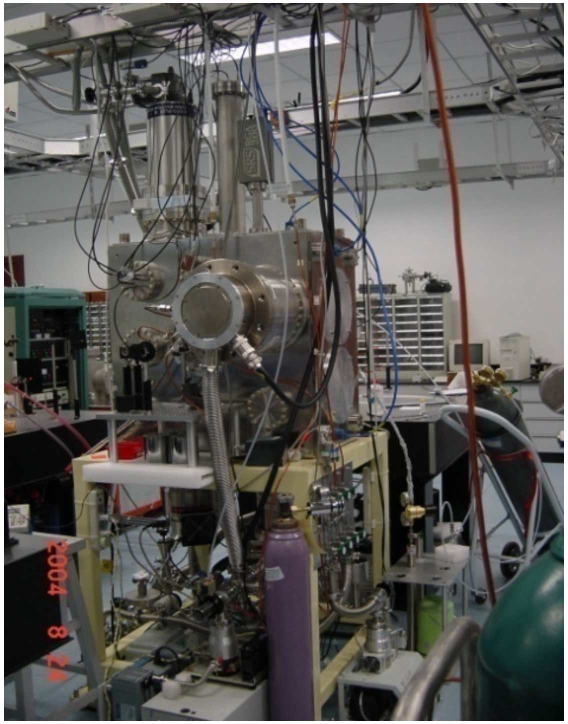
Dynamics of Photocatalysis on Surfaces

Photocatalysis
Electron dynamics in Solar Cells
Electron Transport Processes

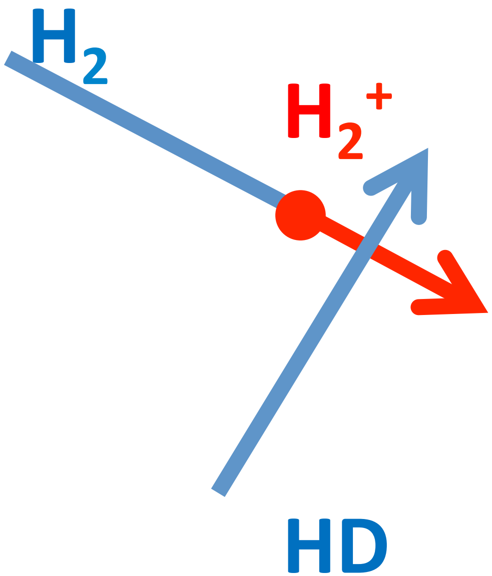


Case III: Ion molecule reaction

H/D atom Rydberg tagging technique



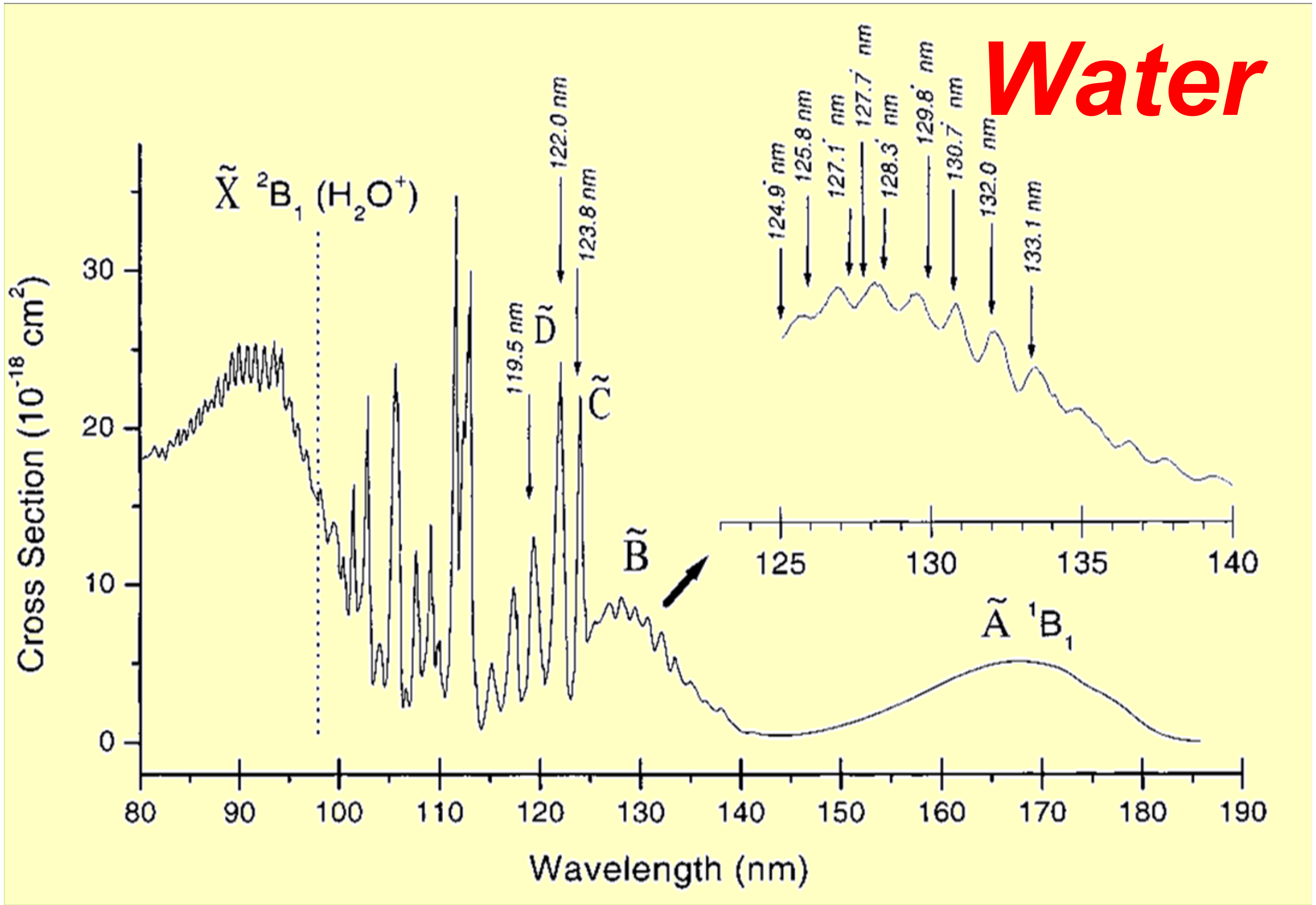
$H_2^+ + HD \rightarrow H_3^+ + D$



$H_2 \rightarrow H_2^+$ cross section: ~1.0×10^{-17} cm^2 @ 76nm

J. Chem. Phys. **126**, 094306 (2007)

Case IV: Photochemistry



Absorption Spectrum of the Water Molecule

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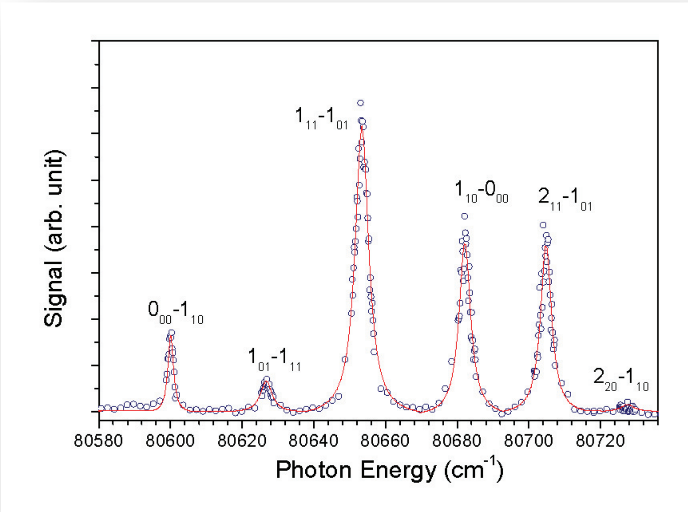
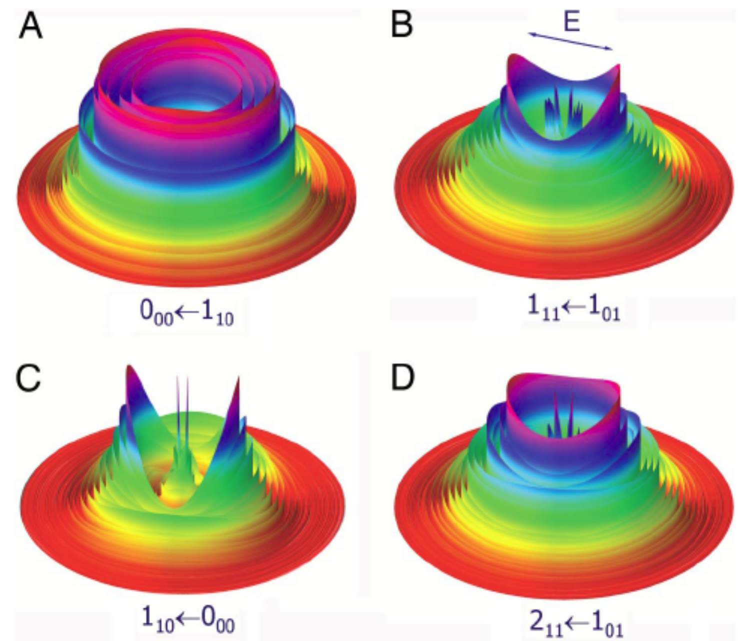
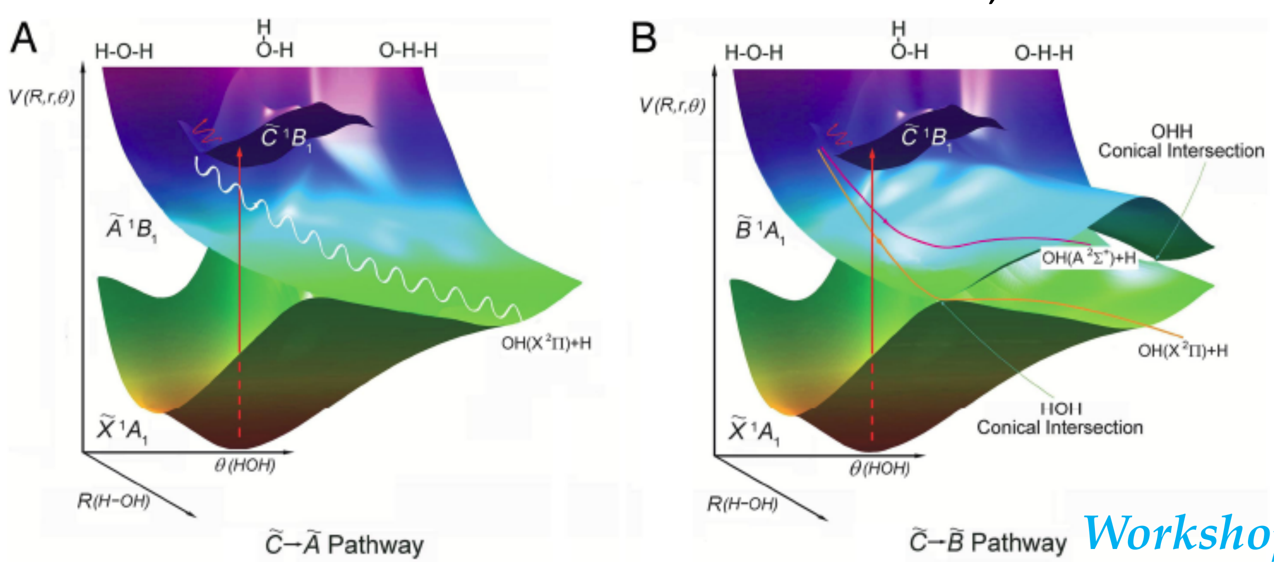
Case IV: Photochemistry





Yuan et al, PNAS v105 19148 (2008)



Welcome more innovational proposals

Schedule

2012.03 Starting of DCLS

Formal collaboration with SINAP

2012.04 First version of CDR and discussion

Beamline CDR by USTC

2012.11 Second version of CDR

Technical design of DCLS construction

2013.01 International discussion for DCLS & final version of CDR

2013.03 Start DCLS construction

2013.04 Detailed technical design for DCLS, user station

2014.03 Completion of construction

2014.05 Equipment to Dalian site

Installation and commissioning.

2015 First lasing

First User experiment on DCLS

Acknowledgement

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Prof. Qiang Gu
Prof. Bo Liu
Dr. Haixiao Deng
Dr. Jianhui Chen
……

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Thank you for attention

Welcome to Dalian