ECH/ECCD Launcher and LHCD Status and Plans

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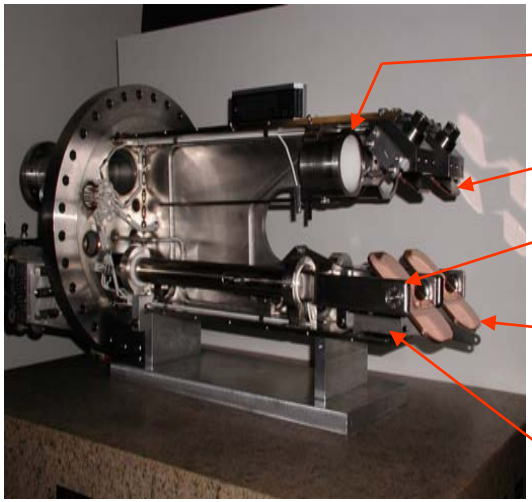
Presentation Overview

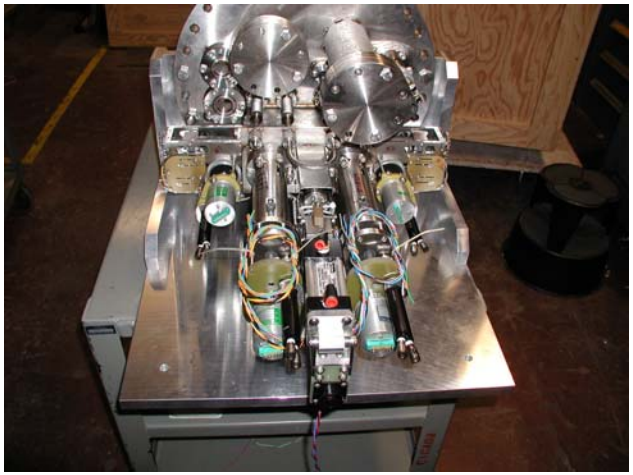
- ECH/ECCD Status
- Near-term ECH/ECCD Plans
  - Electric Motor Upgrade
  - Mirror Upgrade
- Long-term ECH/ECCD Plans
  - Steady-State 170 GHz Launcher
  - Long pulse 170 GHz Launcher
- LHCD Status and Plans
- Summary

ECH/ECCD Status

- Existing short pulse launcher shipped to KSTAR in April 2006.
  - 84GHz, 500kW, 2 sec, every 60 minutes.
  - Design based on DIII-D ECH/ECCD launcher.
- Launcher was used during first plasma operations.
  - Second Harmonic pre-ionization and heating.

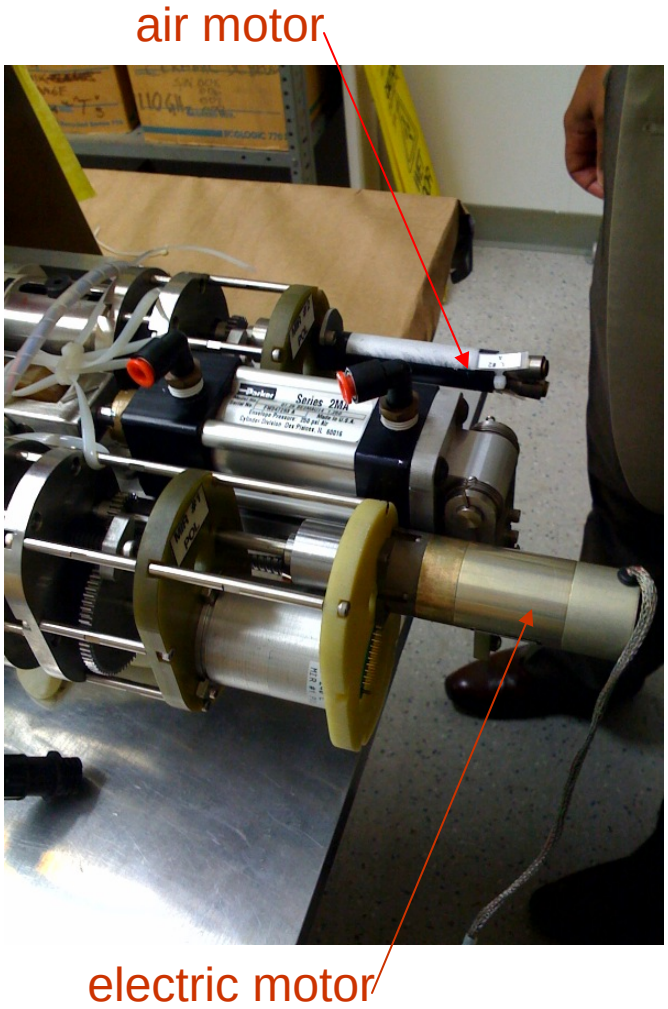
The KSTAR Launcher and DIII-D Launcher Share Design Features





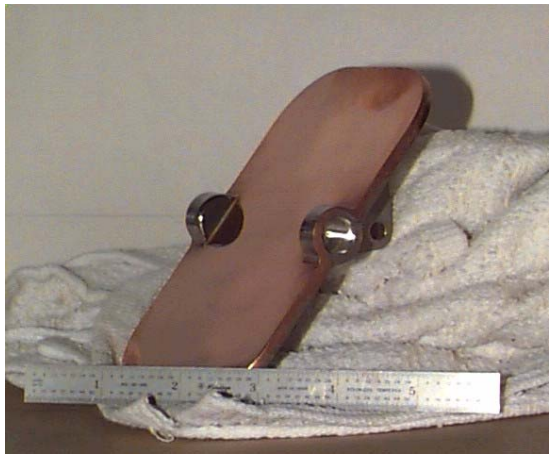
Near-Term ECH/ECCD Plans – Electric Motor Upgrade

- An electric motor drive for the DIII-D ECH/ECCD launchers has been developed.
  - Replaces the existing air motors.
  - More precise real-time control of mirror steering.
  - Enhanced capability as a function of control system development.
- Because the KSTAR mirror actuators are identical to the DIII-D launcher poloidal actuators, the identical components can be used on the KSTAR launcher.
- Electric drive is presently being tested at DIII-D, along with control development.
- This task can be completed in CY09.



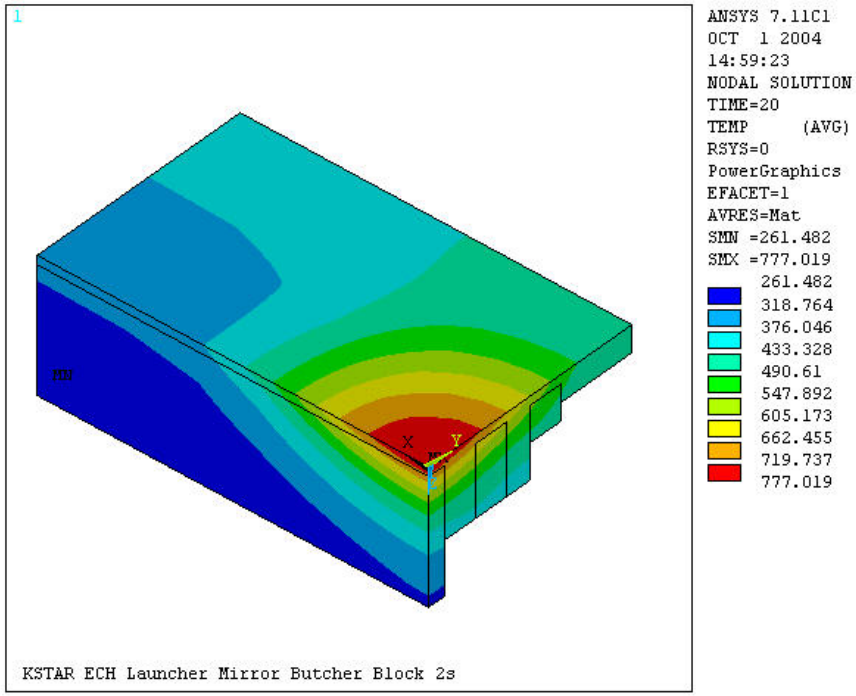
Near Term ECH/ECCD Plans – Mirror Upgrade

- Existing mirror geometry is identical to DIII-D mirrors.
  - Fixed mirror is flat, not focusing.
- Completely stainless steel construction.
  - Thermal requirements are less severe than DIII-D.
- Electromagnetic forces are higher.
  - More detailed electromagnetic analysis may show that the currents and forces induced during a disruption are below the present estimate.
  - Use copper & stainless steel construction of DIII-D mirrors to provide more thermal margin.
    - ~1MW, 5 second pulse

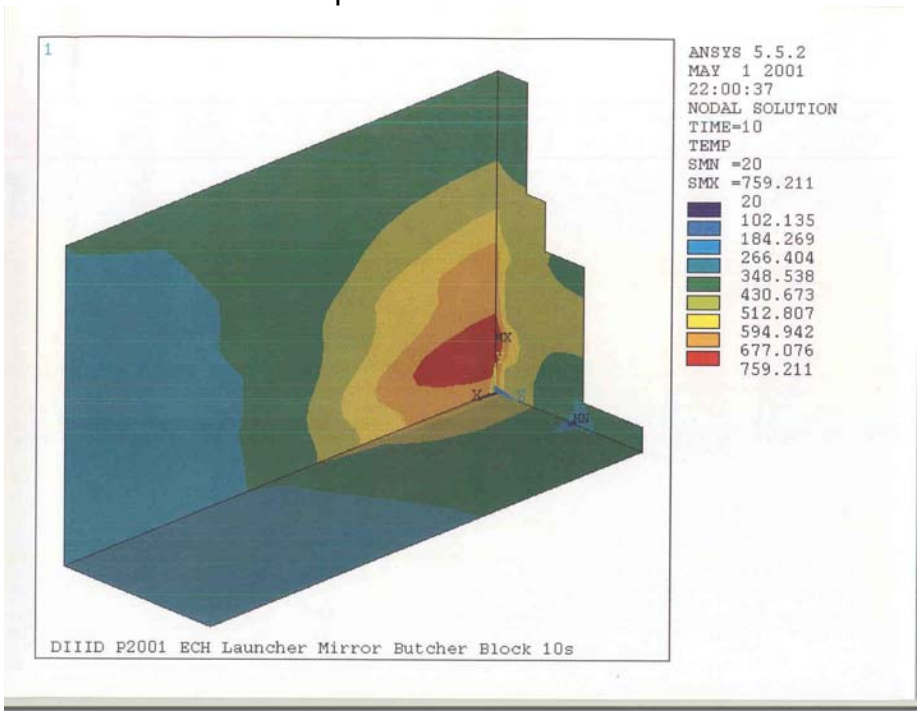


Heating of DIII-D mirror after 10 sec plasma pulse with 1MW of ECH for 10 sec is similar to KSTAR mirror after 20 sec plasma pulse with 0.5MW of ECH for 2 sec

Present KSTAR Mirror



Present DIII-D / Proposed KSTAR mirror



- Mirror fabrication can be completed by the end of CY09 for installation prior to the CY10 run.

Long Term ECH/ECCD Plans – Steady State 170 GHz Launcher

- A launcher that will support ECH/ECCD pulse lengths of tens of seconds is desired.
  - Thermal steady state.
- Development of new, actively cooled mirrors is required.
- Development of flexible coolant lines that can accommodate the motion of the steerable mirror is required.
- Mirror development and pre-conceptual design will require ~$120K in FY09 and $120K in FY10
- Design and fabrication of an antenna would be $600K in FY10, FY11, and FY12.

Long Term ECH/ECCD Plans – Long Pulse 170 GHz Launcher

- An advanced,10 second pulse launcher for the 170 GHz system could be designed and produced for less time and money than the steady state launcher.
- Actively cooled, steady state fixed mirror.
  - Low thermal stresses ➔ very long life.
    - Replacements and re-alignments not required.
- Passively cooled steerable mirror.
- Use electromagnetic analysis results from the existing launcher upgrade to optimize mirror for thermal performance.
  - Obtain a mirror design that will survive two to three run years.
  - Upgrade steerable mirror at a later date.
- This launcher could be completed in CY11.
  - Funds for CY12 not required.
    - $600K savings.

LHCD Status and Plans

- Initial uncooled launcher.
- Small scope of work.
- Design consultation for key components such as grill assembly and vacuum joint.
- Detailed design and fabrication to be done in Korea.
- ~$80k PPPL effort.
- Builds on past design studies for actively cooled launcher.

Summary

- PPPL is prepared to perform the near-term upgrade tasks for the existing ECH//ECCD launcher during this calendar year.
  - Motor upgrade
  - Mirror upgrade
- PPPL has a developed a plan for developing, designing and building a steady state ECH/ECCD launcher for the 170GHz system.
- Progress towards this goal is contingent on funding from USDOE and Korea and approval of CY09 SOW.

Activity Name	Duration (Work Days)	Start Date	Finish Date
ECH Launcher Electric Drive Upgrade	110.00	6/1/09	10/30/09
Final Design of Components	30.00	6/29/09	8/7/09
Fab/Procure Components	30.00	6/29/09	8/7/09
Procure Motors	65.00	6/1/09	8/28/09
Final Design Review	10.00	9/1/09	9/14/09
Assemble and Test on Mockup	20.00	9/25/09	10/22/09
Ship / Install	25.00	9/28/09	10/30/09
ECH Launcher Mirror Upgrade	200.00	6/1/09	3/5/10
Gather VV/Cassette/Launcher Info	40.00	6/1/09	7/24/09
EM Analysis	45.00	6/29/09	8/28/09
Thermal Analysis	45.00	6/29/09	8/28/09
Final Design Mirrors	20.00	8/17/09	9/11/09
Final Design Review	10.00	9/1/09	9/14/09
Fab Mirrors/Mounting Hardware	70.00	9/14/09	12/18/09
Ship/Install	55.00	12/21/09	3/5/10
Steady State Launcher	160.00	6/22/09	1/29/10
Pre-Conceptual Design	55.00	6/22/09	9/4/09
Conceptual Design	80.00	10/12/09	1/29/10
Conceptual Design Review	10.00	12/14/09	12/25/09