Proposed NSTX HHFW Antenna Conditioning in 2011

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Power Limiting Mechanisms on the HHFW Antenna

- **The new current straps reduce interior voltages while keeping strap/frame currents approximately the same as before – good opportunity to test mechanisms on which future antenna designs are based (ITER, DIII-D)**
    - Does reducing internal voltages and E-fields increase antenna power limit?
    - Does internal arcing depend on strap currents (frame currents and sheath voltages)?
    - Does lithium coating on antenna decrease power limit? If so, can antennas be cleaned/conditioned?
    - Is it coating on the interior or the exterior of the antennas that limits power?
    - Can sufficient power density be demonstrated that the number of straps can be reduced in NSTX-U?

- **Approach for Antenna Conditioning:**
    - Condition antenna to high power/power limit before operating LITER.
    - Periodically check operation of conditioned antenna.
    - Condition and operate antenna after lithium is introduced; note differences.
    - Periodically check operation in lithium environment.

- **Diagnostics:**
    - Fast camera view of antenna
    - IR view of antenna to distinguish temperature/power deposition from light
    - Spectroscopic information (filters on camera, filterscopes)
    - Neutral pressure monitor with fast ion gauge

Theory Support:
- TOPICA to model charging potential of magnetic field lines.
- Microwave Studio calculations of frame currents.

Does reducing internal V (electrostatic E) increase power limit for clean antennas?

- **IF YES**
  - **Should be able to achieve >5 MW in Li-free environment. This should be a goal to test antenna design theory.**
  - **Voltage limits should be independent of array phasing (power will depend on phase through loading variation).**
  - **Find out if vacuum limits can be reached in plasma.**
- **IF NO**
  - **Frame/FS currents and rectified sheaths generated by inductive E may be limiting operation to previous strap currents.**
  - **voltage limits may depend on array phasing through changed antenna environment.**
  - **need to determine maximum power/strap current as a function of array phase and density.**

Does Li deposition on antenna affect voltage/power limit? Is the Li on the interior or exterior of the antenna the more important factor?

- After antenna is conditioned to high power operation in the absence of Li, periodically test vacuum voltage holding to establish baseline for conditioning degradation.
- After observing that voltage holding has not degraded OR after vacuum conditioning back to best values, test power coupling to some fiducial RF plasma (~2-3 pulses).
- Continue this periodic checking after Li is introduced into system
  - if vacuum voltage holding is degraded, Li coating and/or Li dust on the antenna interior may be responsible for arcing.
  - if vacuum voltage limit is unchanged, but power limit in plasma has decreased, Li coating on external antenna surfaces may be responsible for arcing.

While antenna conditioning should not follow a prescribed recipe at this stage of development, a general procedure can help answer operational questions.

- **Vacuum condition antennas early in campaign.**
- **Plasma condition antennas before introduction of lithium. Goal should be > 5 MW.**
- **Periodically check on both the vacuum voltage holding and the plasma power limits.**
- **Vacuum and plasma condition after introduction of lithium; compare to lithium-free operation.**
- **Determine whether conditions internal or external to antenna limit high power operation.**