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Characterizing the SOL Losses of HHFW Power in H-Mode Plasmas

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Wave Heating and Current Drive TSG
XP 1510 TSG Review
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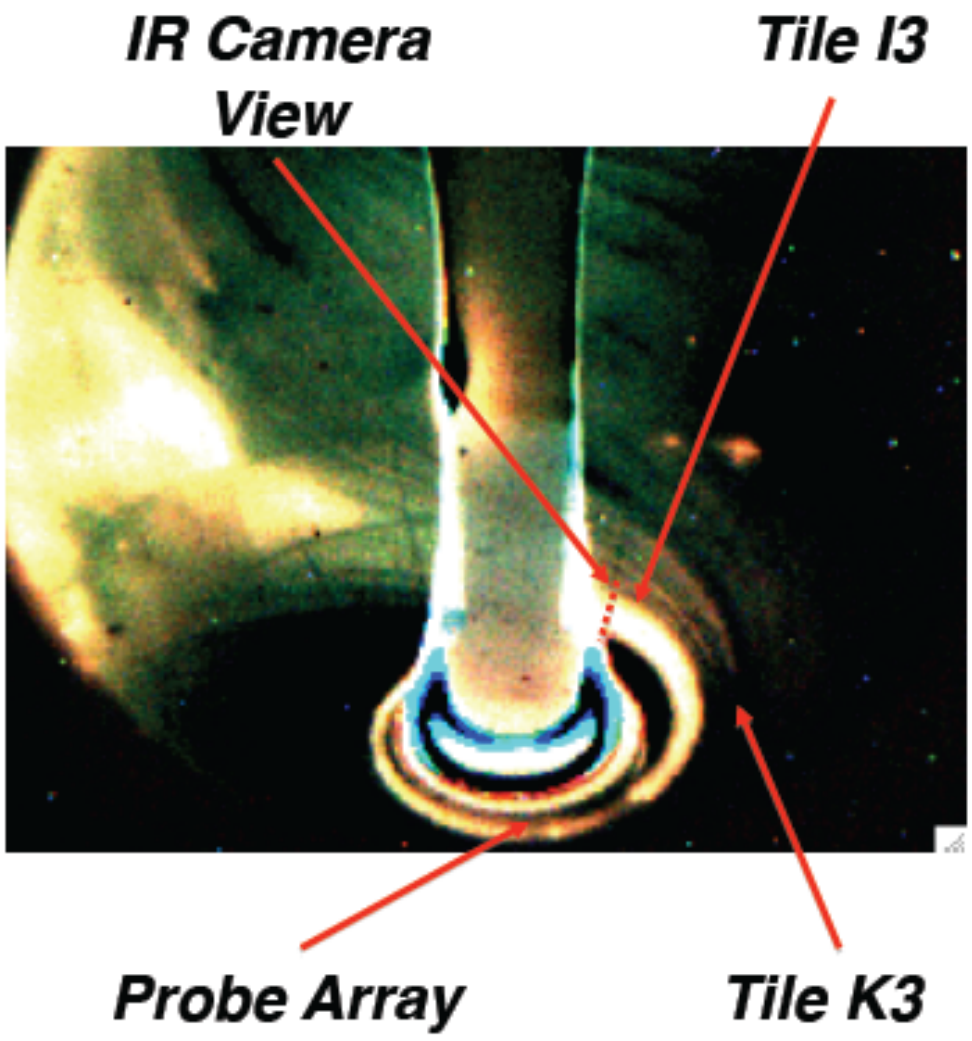
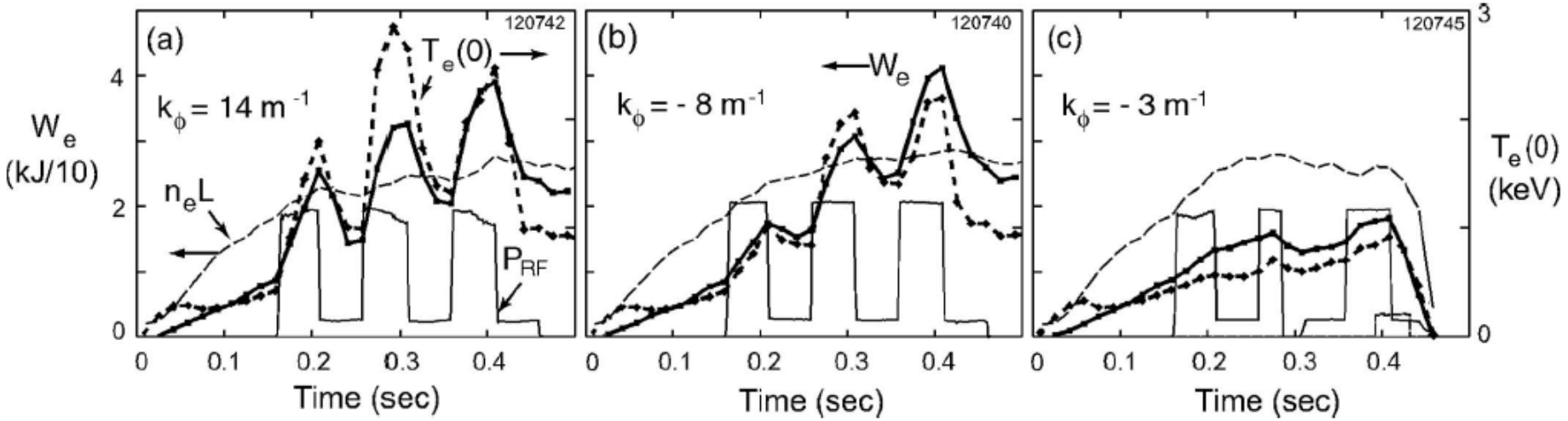
Main Goal: Characterize (and minimize) RF Spirals and other SOL losses



- Bright and hot spirals form on upper & lower divertor during RF
  - Heat flux up to 2 MW/m^2 (for 1.8 MW coupled P_{RF})
- Previous studies complicated by spatial extent and intensity variation along length of spiral
- Other loss mechanisms (PDI) could be important too

HHFW heating improves with higher B_T, higher antenna phase, and lower n_{SOL}

- Increasing phasing improves both central T_e and stored electron energy
  - He discharges, B_T = 5.5 kG, I_p = 0.72 MA, P_{RF} = 2 MW



- Heating typically improves with increased B_T and decreased SOL n_e
- Suggests that poor heating efficiency results when fast-wave cutoff is too close to antenna

Three new/upgraded diagnostics will answer many of these questions

- **Wide-angle IR camera**: view most of lower divertor and most of RF spiral
  - Determine total power deposited underneath lower RF spiral and if spiral losses account for majority of lost HHFW (e.g. is PDI important?)
  - Determine variation of heat flux along length along the spiral
- **Radial arrays of RF Langmuir probes**: on both the upper and lower divertor at Bay I, near most intense part of spiral.
  - Direct measurement of RF rectification in spiral.
  - Estimate the peak heat flux in the spiral due to RF rectification for comparison to IR camera measurement from the same location
- **Upgraded SOL Reflectometer**: compatible with higher NSTC-U fields
  - Obtain SOL density profiles to determine location of RH cutoff.
  - SOL density profiles will be used in RF models

We want to study two H-mode scenarios during this first campaign

NBI + RF H-Modes

- Apply RF pulse to a ~ 2 MW NBI H-mode plasma
- Deuterium discharges
  - Larger SOL density
- Larger outer gap
  - Lighter loading
- Might be more suitable to Li wall conditioning

RF-Only H-modes

- Can be run at smaller gap
  - Better coupling
- Can use either He or D
  - He: Lower recycling -> lower SOL density
  - He: better control of plasma
  - D: higher n_{SOL} should give higher losses
- RF-only in He might be good choice for boronized conditions

Could run either scenario in first HHFW run

Will probably be decided based on conditioning

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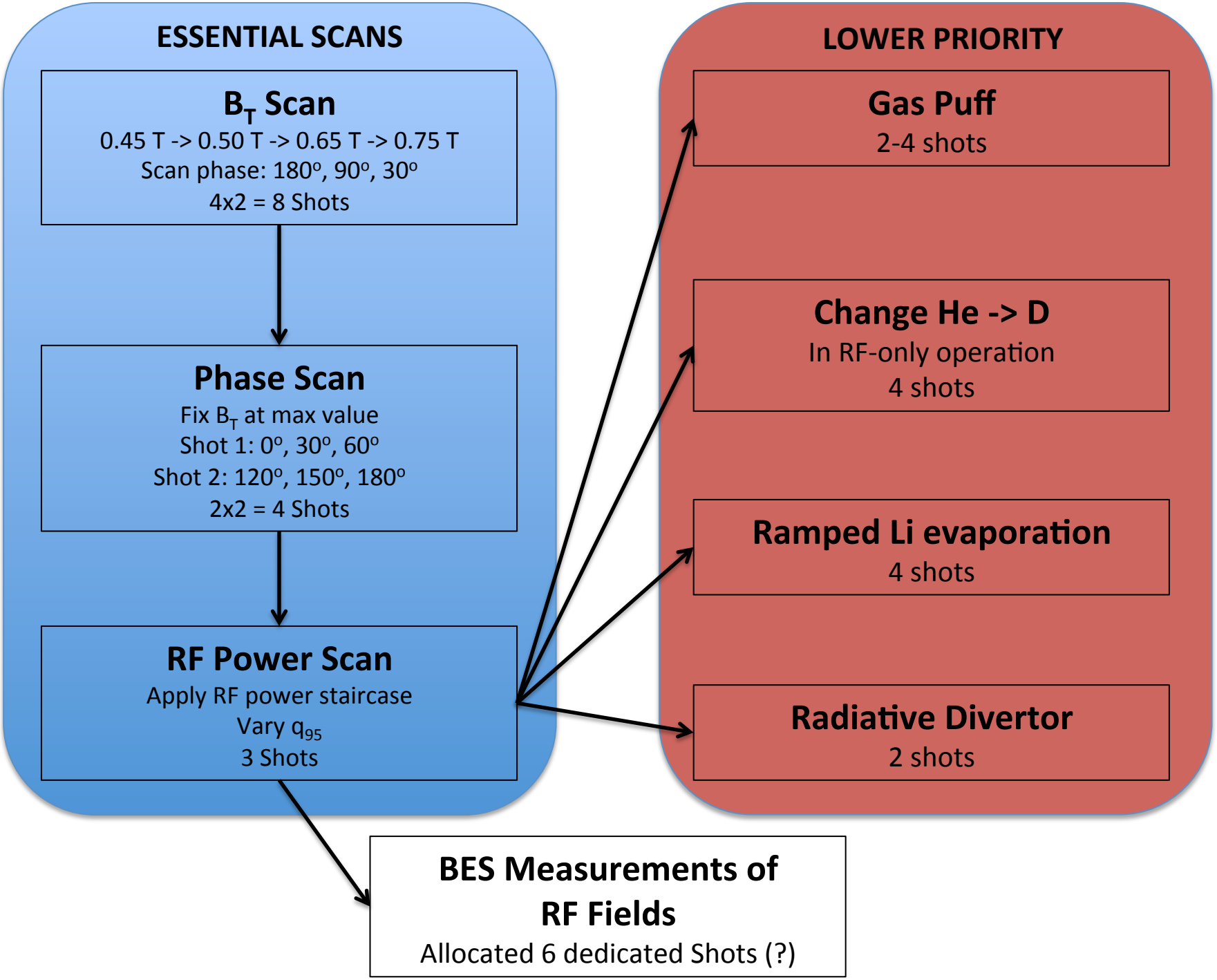
That being said, helium RF-only shots are more attractive for a pre-lithium run

Shot allocation for first run (Weeks 5-8)

- XP 1510 runtime allocation for weeks 5-8
  - 0.65 days of “Priority 1” time
  - plus 0.25 days of “Priority 2” time
- Assume 24 shots per day (20 minutes per shot)
  - 15 Priority 1 shots + 6 Priority 2 shots
- Furthemore, assume 50% shot failure in shot plan
  - Due to either machine hiccups or RF trips
- Dave Smith’s experiment “BES Measurements of RF Fields” was allocated 0.25 days ~ 6 shots of dedicated time
  - Will run BES in piggyback during NBI + RF shots anyway
  - Might even use diagnostic beam blips in RF-only


ESSENTIAL SCANS
B_T Scan
0.45 T -> 0.50 T -> 0.65 T -> 0.75 T
Scan phase: 180°, 90°, 30°
4x2 = 8 Shots
Phase Scan
Fix B_T at max value
Shot 1: 0°, 30°, 60°
Shot 2: 120°, 150°, 180°
2x2 = 4 Shots
RF Power Scan
Apply RF power staircase
Vary q_{95}
3 Shots
LOWER PRIORITY
Gas Puff
2-4 shots
Change He -> D
In RF-only operation
4 shots
Ramped Li evaporation
4 shots
Radiative Divertor
2 shots
BES Measurements of RF Fields
Allocated 6 dedicated Shots (?)