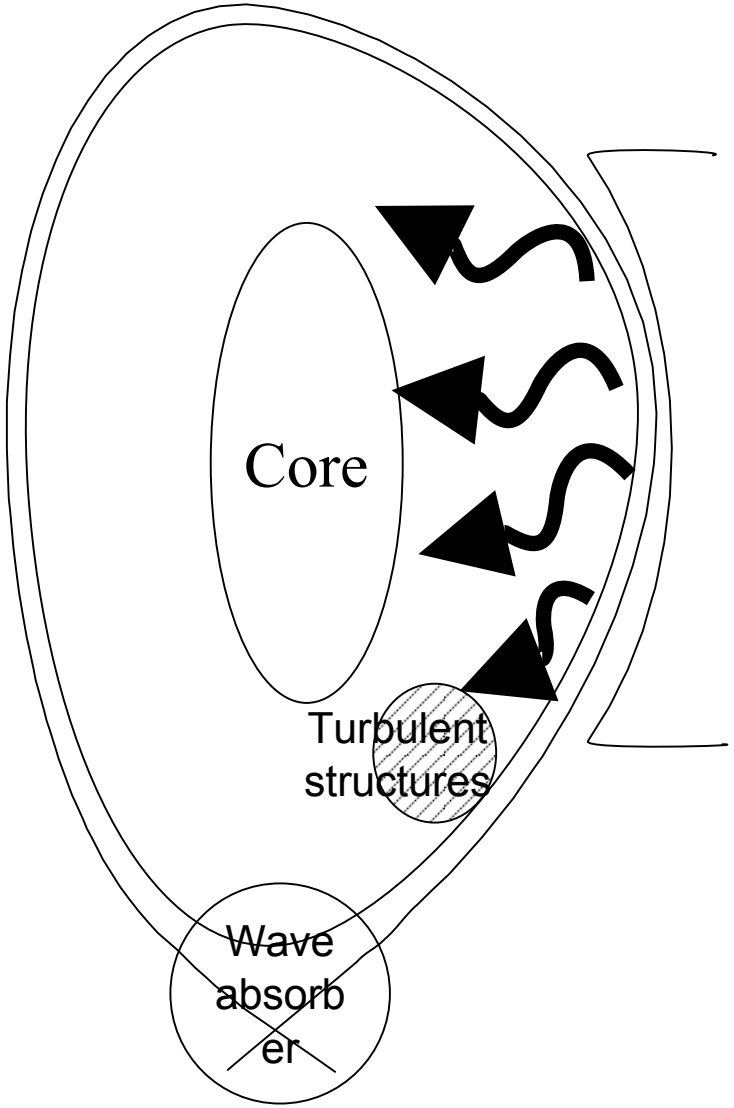
Experiment to study HHFW asymmetries

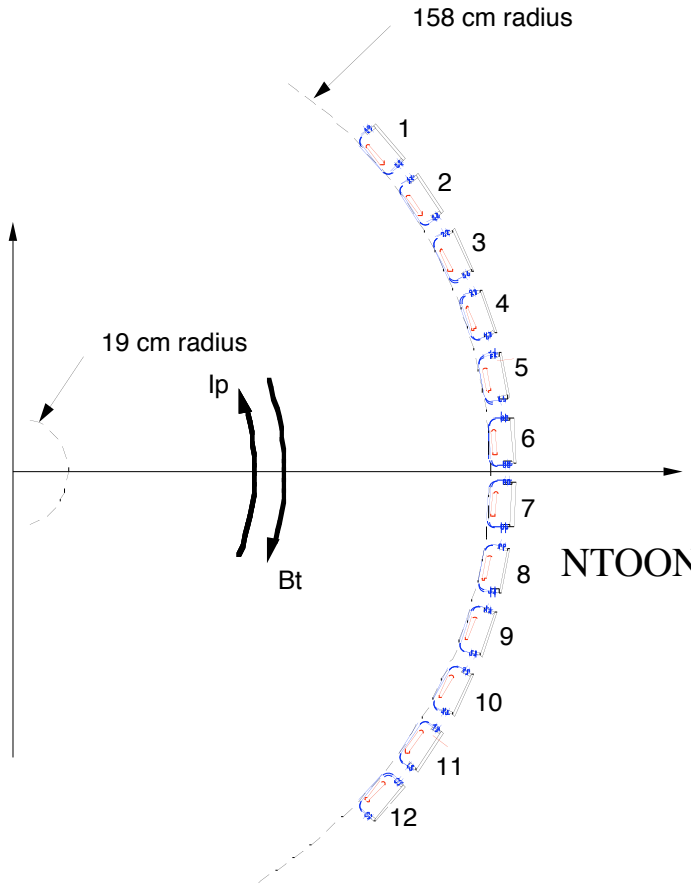
- The Hall terms in the dielectric cause the antenna launch to have a preferred direction relative to B x Grad n
  - Leads to known “co-counter” asymmetry with poloidal B
- Can launch asymmetry couple to geometrical poloidal asymmetries to affect heating efficiency?
  - Parasitic absorption in diverter?
  - Wave scattering from turbulent fluctuations?
  - Does launching geometry (up-down, +/- Bz, Ip) change power deposition/efficiency?
- Modeling studies with AORSA2D using simple antenna sources and poloidal asymmetries
- Can we exploit the asymmetry in the antenna design to discover other heating efficiency issues?

Poloidal asymmetry may play a role in heating efficiency of “co” vs. “counter”

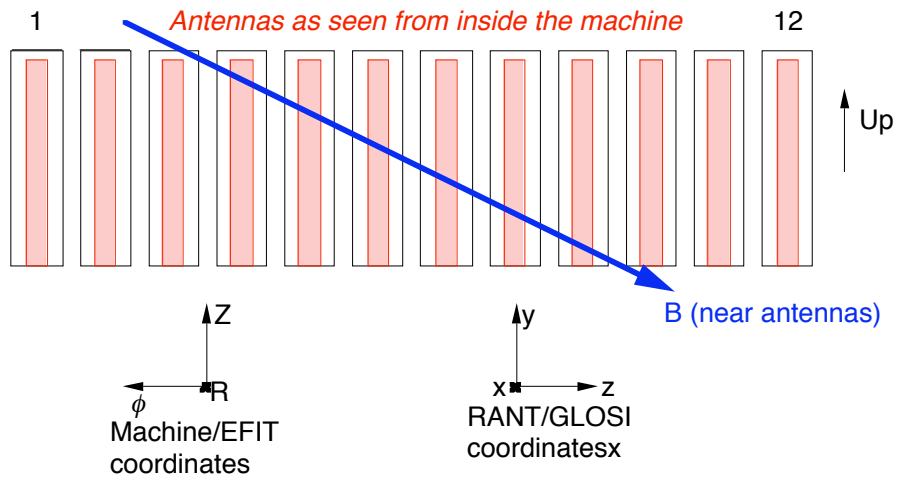


- Launch is not poloidally symmetric because of Hall terms in the RF dielectric tensor
- Field-line pitch causes “co-counter” asymmetry
- Turbulent structures near diverter could scatter waves
- Parasitic absorption in divertor may be important

Array numbering, phase and coordinate conventions



NSTX HHFW Antennas



NTOONS phase convention: $V_{i+1} = V_i exp(+j(\omega t-(\theta_{i+1}- \theta_i)) \sim exp(+j(\omega t-k_\phi \phi))$

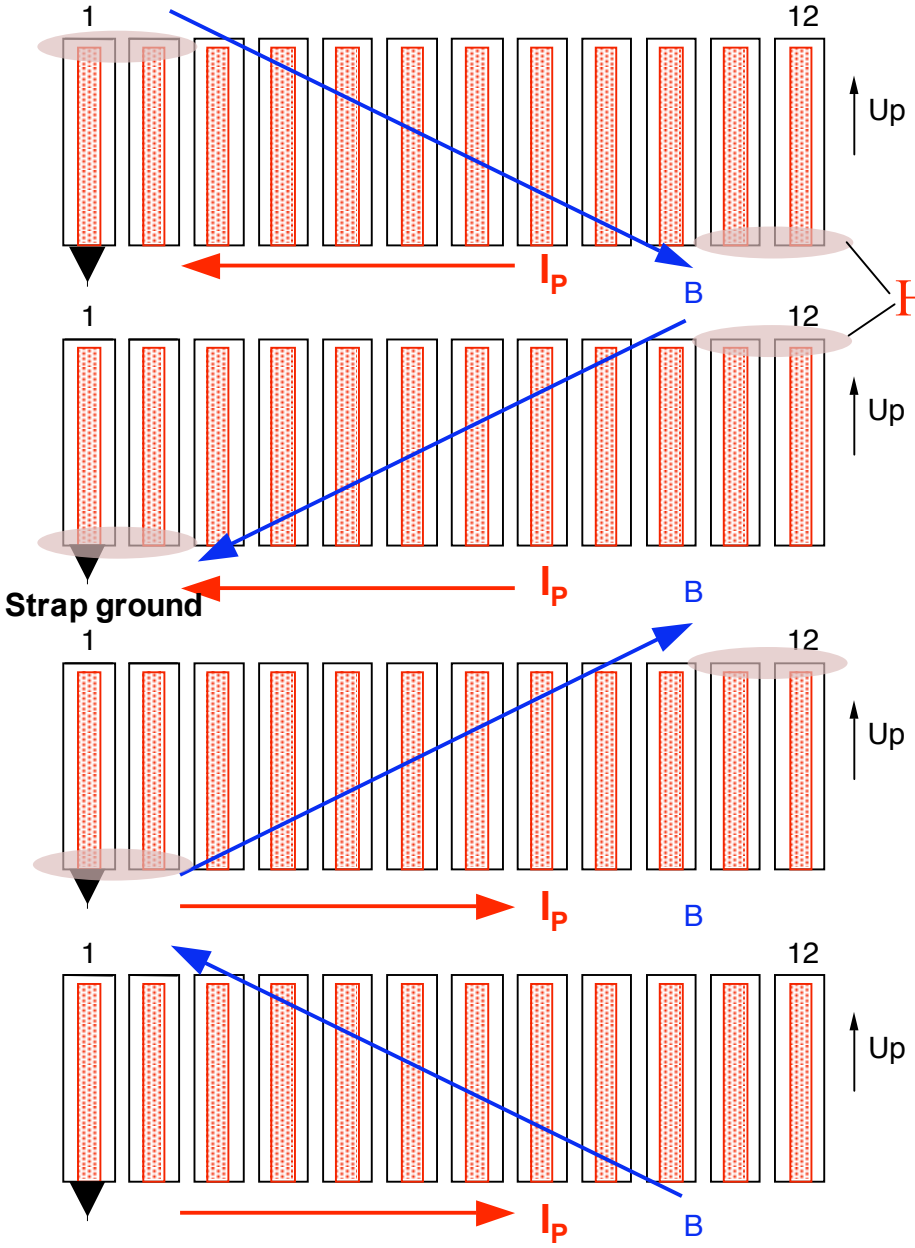
$\Delta\theta = \theta_{i+1}- \theta_i > 0$ → Wave travels in $+\phi$ direction, driving electrons in $+\phi$ direction, hence current in $-\phi$ direction.

$\Delta\theta > 0$ is counter-CD phasing
$\Delta\theta < 0$ is co-CD phasing

Note: RANT/GLOSI uses $exp(-i(\omega t-(\theta_{i+1}- \theta_i)) \sim exp(-i(\omega t-k_z z))$ phase convention, opposite of NTOONS.

XP to separate co/cntr-CD physics from poloidal, toroidal asymmetries

- Pitch angle change affects higher voltage sheath locations
- ±m change tests poloidal asymmetry (i.e., diverter location)
- ±n change tests toroidal asymmetry (i.e., NBI ports)



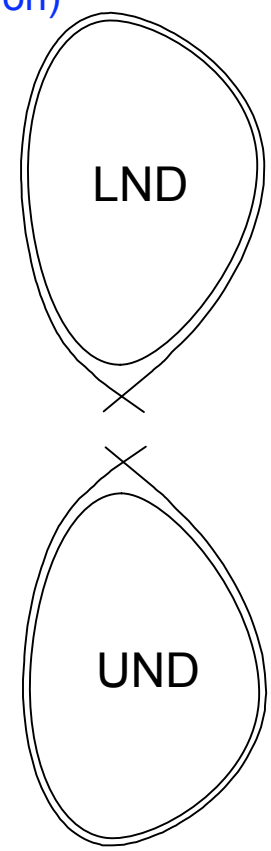
Present
co-CD is +m,+n,
away from diverter

Reverse B_T only
co-CD is -m,+n,
toward diverter,
changes sheath locations

Reverse I_p only
co-CD is +m,-n,
away from diverter,
changes sheath locations

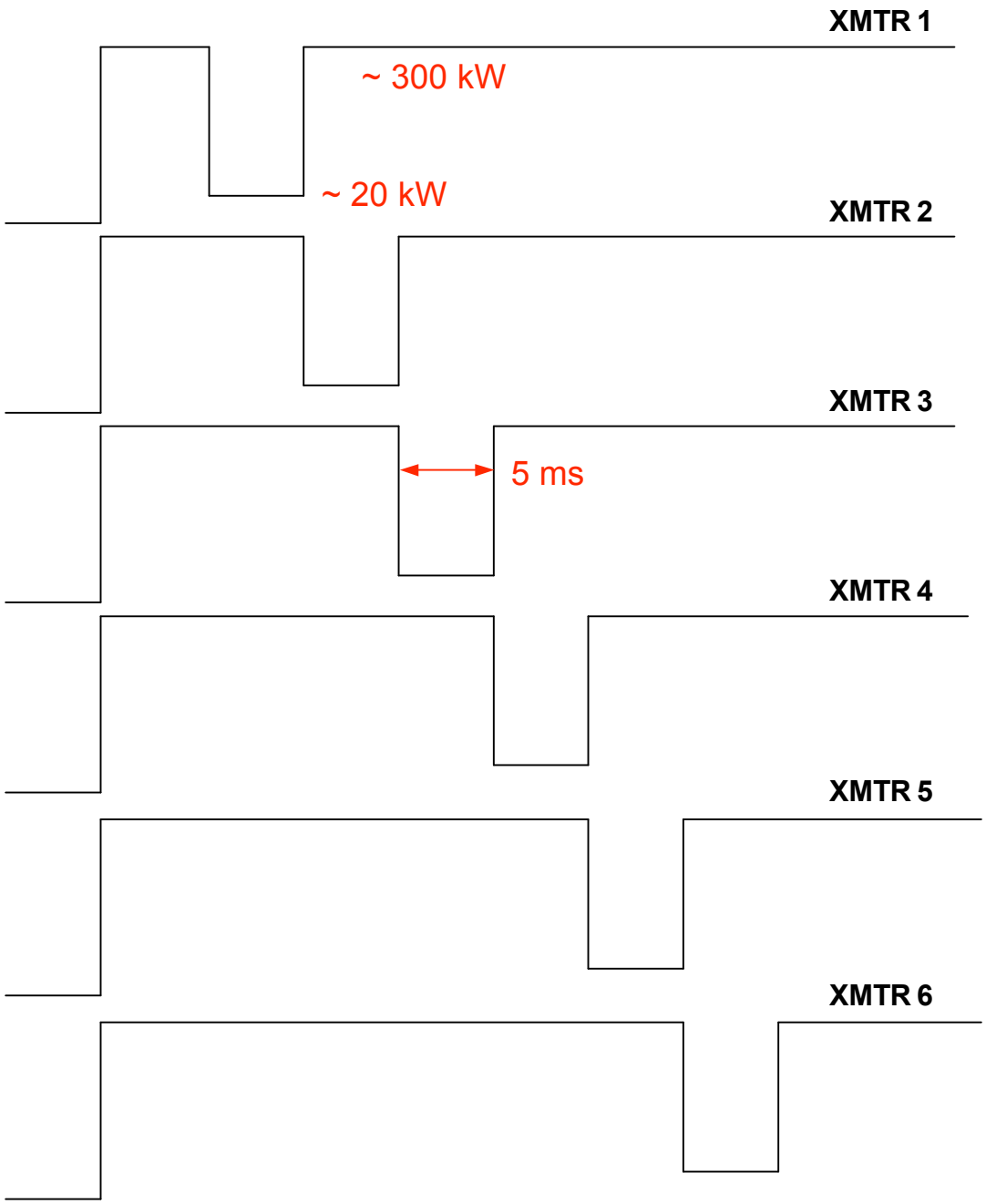
Reverse B_T and I_p
co-CD is -m,-n,
torward diverter

Changing diverter location may test plasma up/down asymmetry, but not antenna up/down asymmetry (ground location)



or DND?

6x6 Transmitter Scattering Matrix Can Be Measured In One Pulse



- Measure transmitter scattering matrix for each I_p, B_T configuration to get information on asymmetric plasma coupling.
- Plasma conditions need to be kept constant.
- Need six independent transmitter conditions.
- Notch transmitters to low power rather than turn off in order to keep phase reference.