NUBEAM Verification

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NSTX-U Physics Meeting

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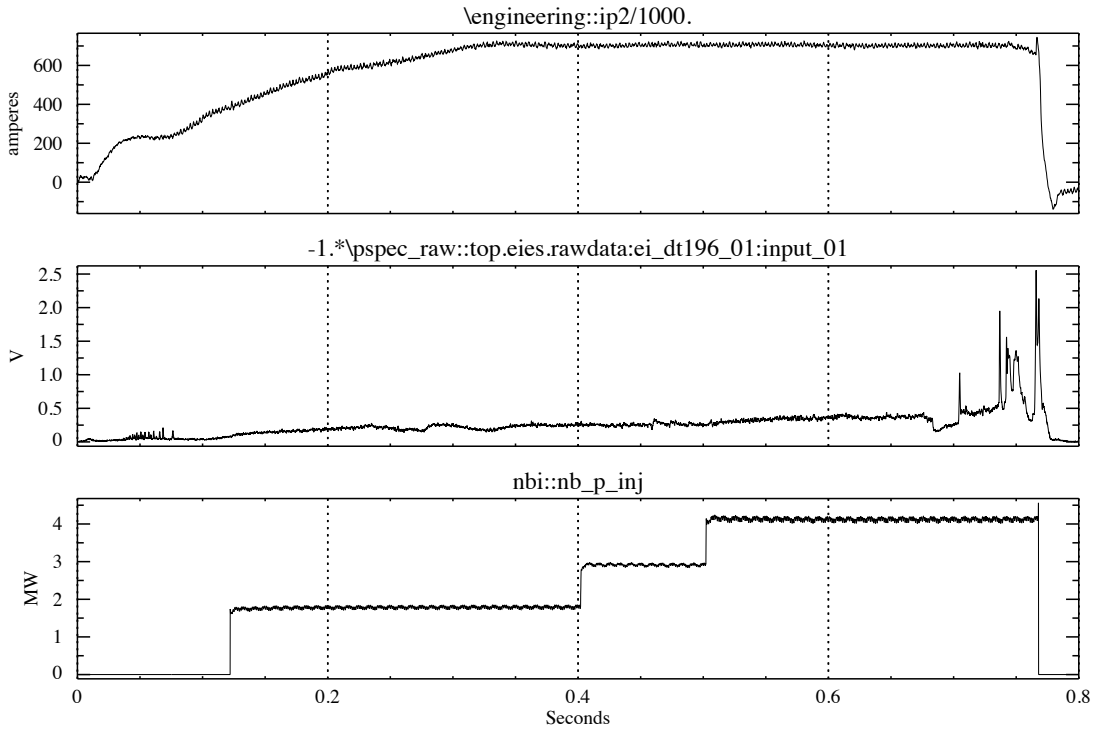
Feature in TRANSP automatically adjusts AFID to achieve agreement between measured and calculated neutrons

- Feedback algorithm written by Dan Boyer
- Implemented and running routinely in TRANSP and BEAST
- Assumes **flat** AFID (Anomalous Fast Ion Diffusivity)

- Here's the rub:
  - Fast ion losses have appeared to be higher in NSTX-U than in NSTX, sometimes reaching 50% of injected beam power to achieve agreement with neutrons
  - Gives high confinement times and enhancement factors, but……
  - Want to verify these calculations: is there something different about NSTX-U that gives rise to these **seemingly** higher losses
  - Can this comparison tell us anything about discharge characteristics?

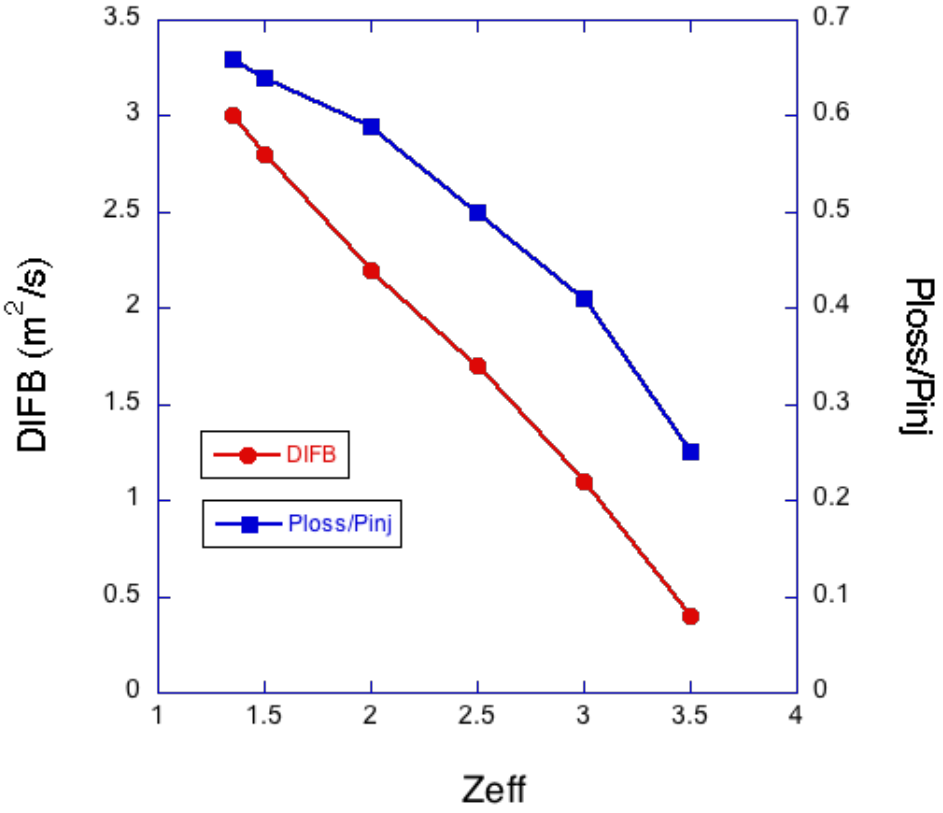
Ran L-mode fiducial with Beamline 1 only on 4/8 in order to obtain CHERS data

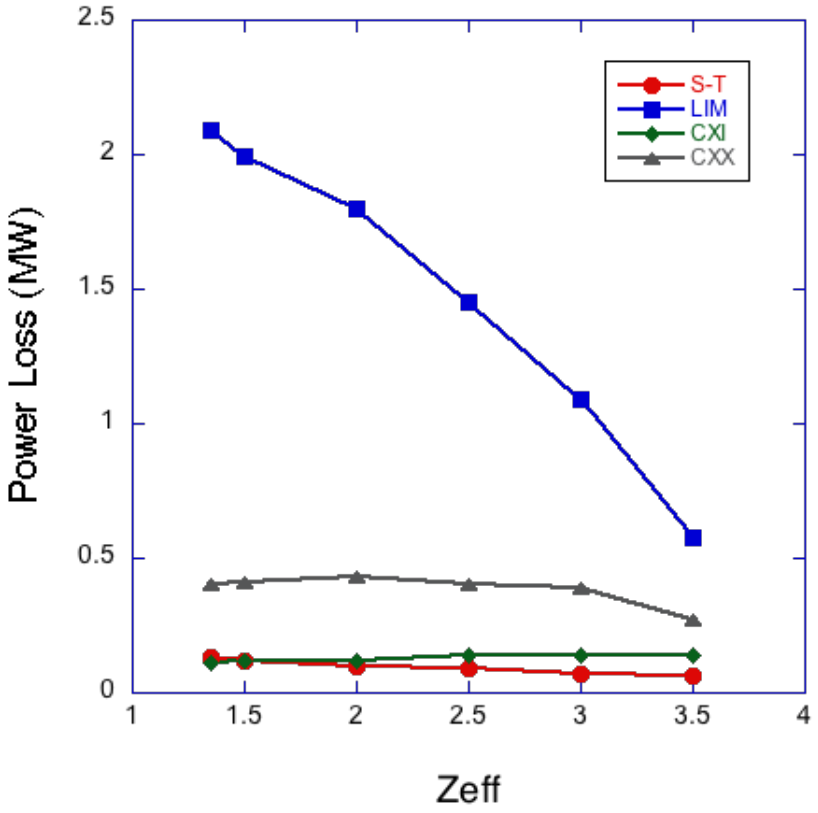
- 204202 – last shot of day on Fri., 4/8
- Chose two times of interest: 0.65 S (4.15 MW), 0.47 s (2.5 MW, 1B+1C)
- Examined loss dependence on Zeff, DN0OUT (neutral density at boundary)
- Used CHERS T_i and v_ϕ, but not impurity density (Zeff~1.3)



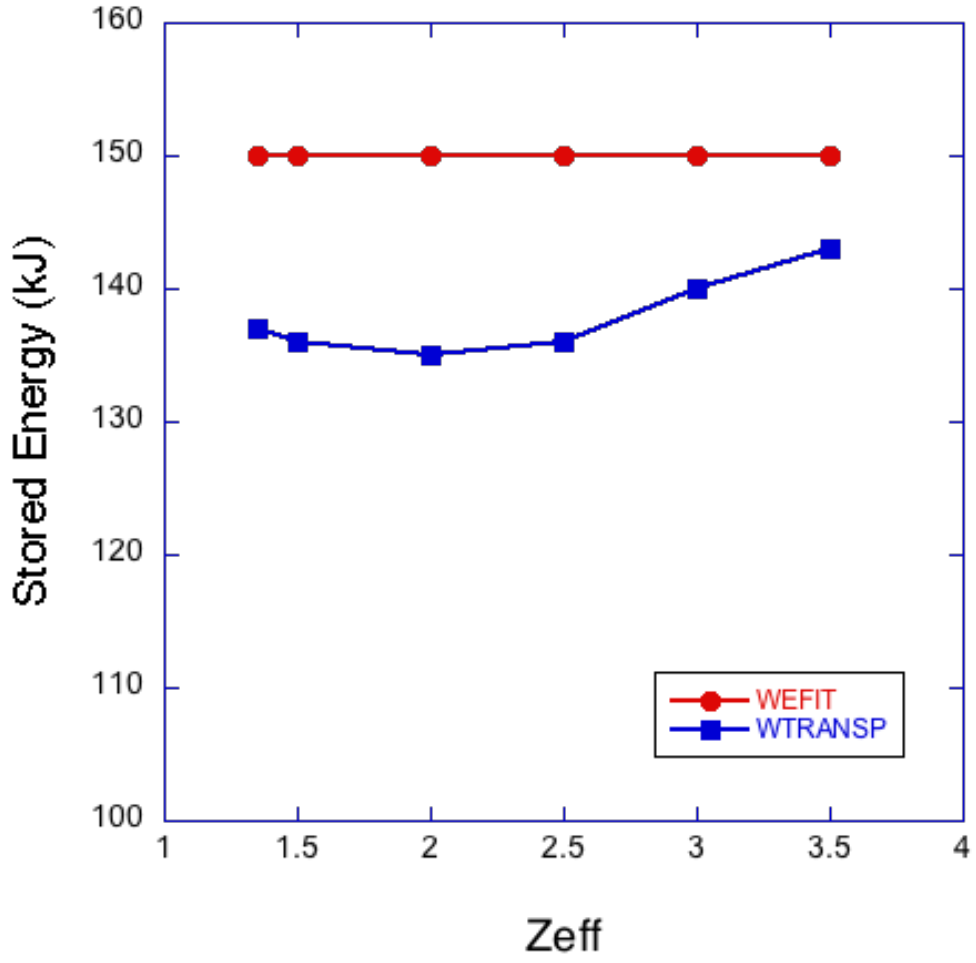
Strong dependence of losses on Zeff (t=0.65 s)

- Constant DN0OUT = 1e11 cm^{-3}, assuming flat Zeff



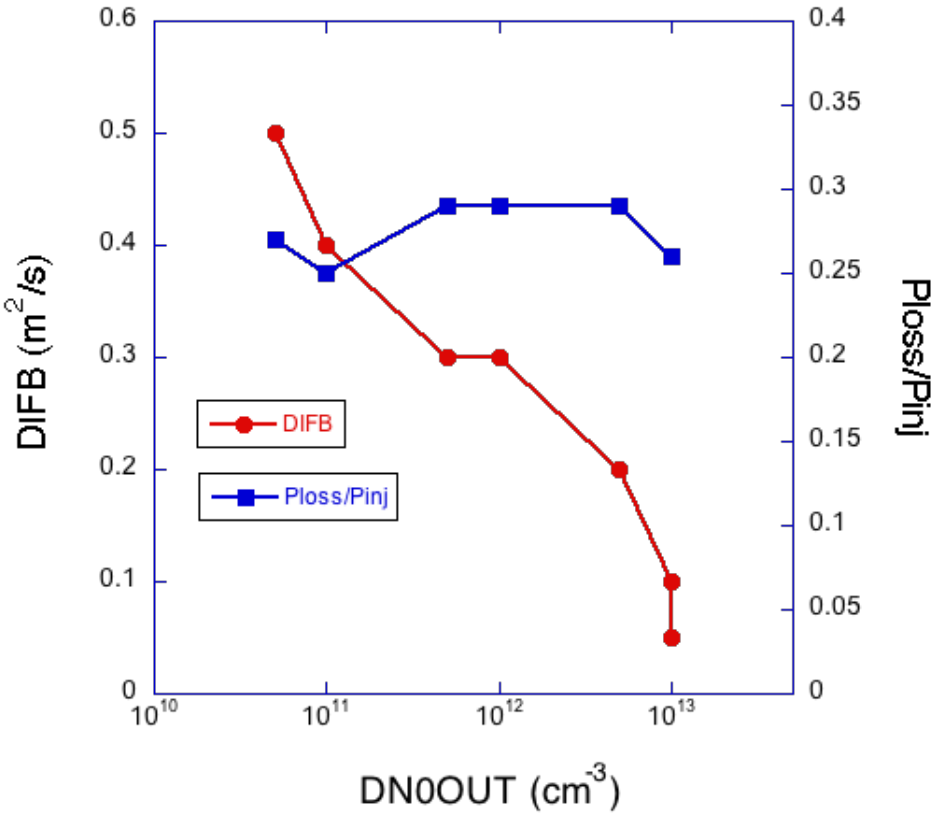


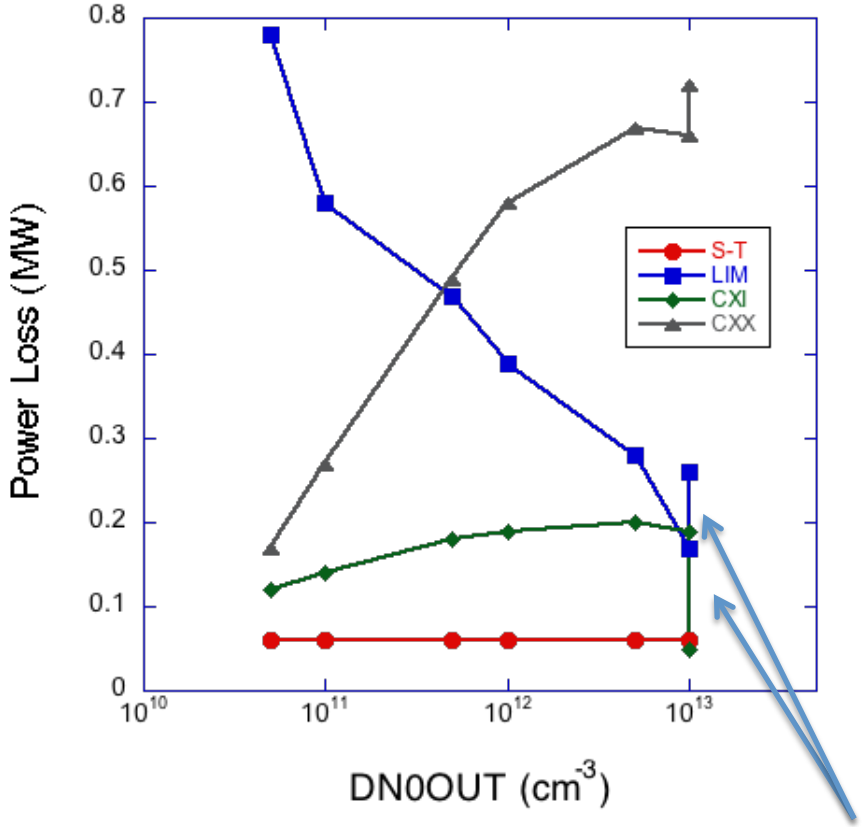
Stored energy closer to that of EFIT02 with higher Zeff



Dependence of total loss on DN0OUT not strong, but interplay between c-x and bad orbit loss

- Zeff = 3.5 (flat); $W_{stored,TR}$~144 kJ, $W_{stored,EFIT02}$~150 kJ





magnitude of error bar

Fast ion losses are "modest" (25%) at higher Zeff

- Does not seem to be a problem, if Zeff is ~3.5
  - Need a good Zeff measurement
- Begs the question as to whether there is a difference between NSTX and NSTX-U
  - Want to compare L-mode discharges that are as similar as possible

	113130 (t=0.4 s)	204202 (t=0.47 s)
Pinj (MW)	2.5 (1B+1C)	2.9 (1B+1C)
B_T (T)	0.45	0.65
I_p (MA)	0.7	0.7
T_{e0} (keV)	1.3	1.6
T_{i0} (keV)	1.4	1.9
$n_{e,bar}$ (10^{19} m^{-3})	1.8	2.6

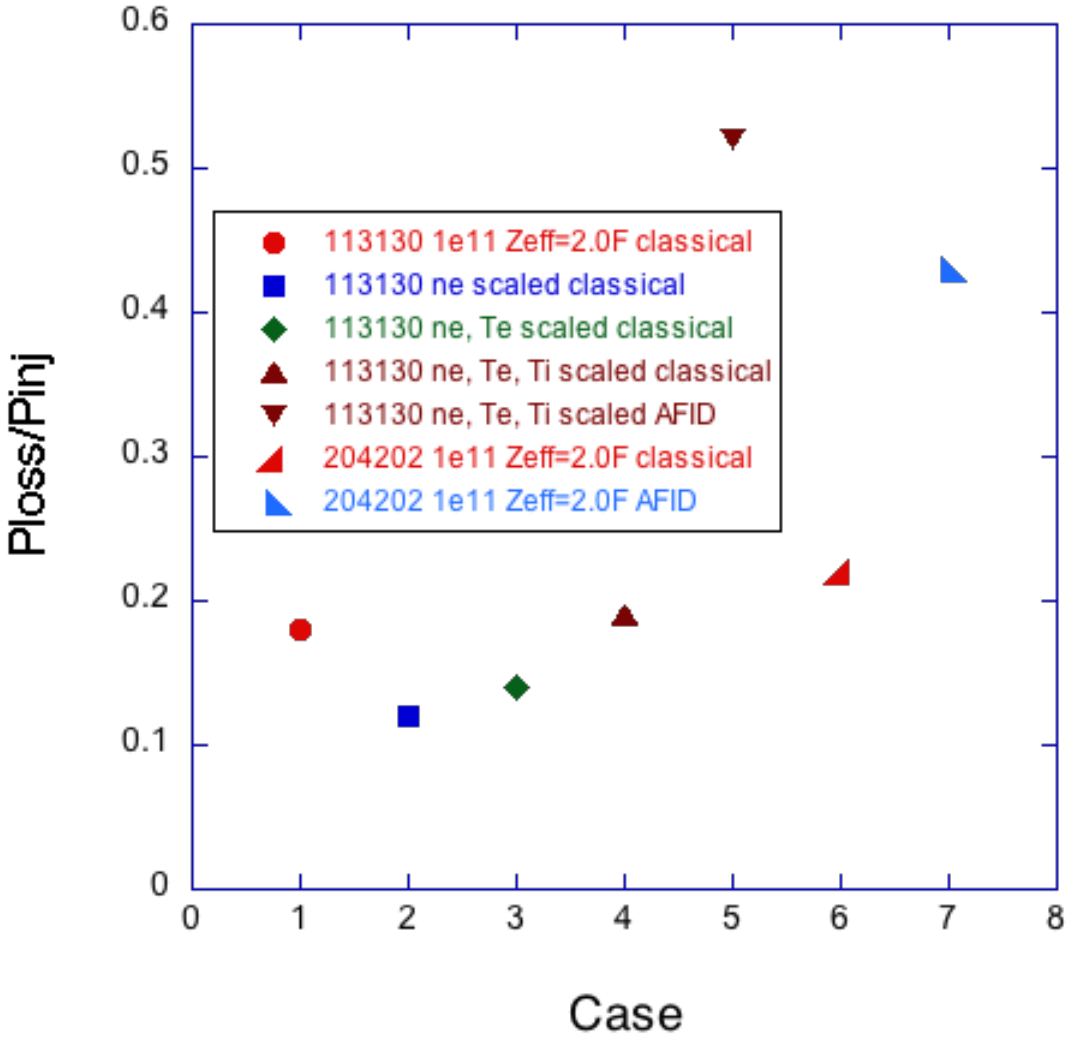
There are caveats

- Beam pulse in 113130 (0.37-0.41), so barely a slowing down time
  - You take what you can get!
- Beam voltages different
  - 113130 1B: 79kV, 1.6 MW 1C: 60 kV, 0.9 MW
  - 204202 1B: 73kV, 1.1 MW 1C: 89 kV, 1.8 MW
- I/O Gaps similar
- Similar losses for similar assumptions

Similar losses for similar assumptions

- Cases 4 & 6
- Cases 5 & 7

are the ones to inter-compare



Interim observations

- If you chose to believe the TRANSP/NUBEAM calculations for NSTX, there is no reason NOT to believe them for NSTX-U
- Right now, hampered by lack of good input data
- Need confidence in Zeff and neutral density (not to mention CHERS – Ron Bell is working on this)
- Uncorrected Error Fields can impact neutron production
  - Not taken into account in TRANSP
- Also, calculation assumes flat AFID for `neutron match
  - This can overestimate losses – all you really need to do is move fast ions out from very core. Flat AFID affects fast ions everywhere
  - Might consider using a profile for AFID (max in core, decreasing towards edge)
- Comparisons with FIDA profiles a next step as well