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Recent Experiments/Results on Confinement Scaling in High Performance Lithiated Plasmas

S.P. Gerhardt, R. Maingi

Monday Physics Meeting
June 21, 2010

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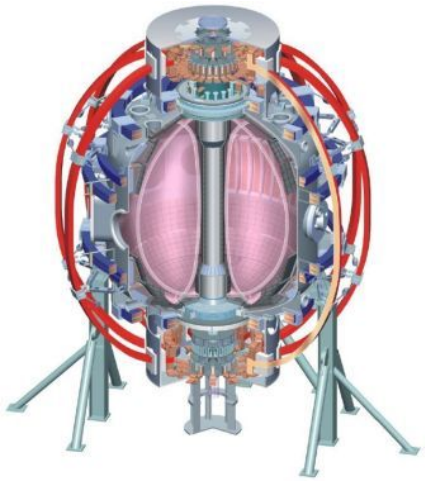
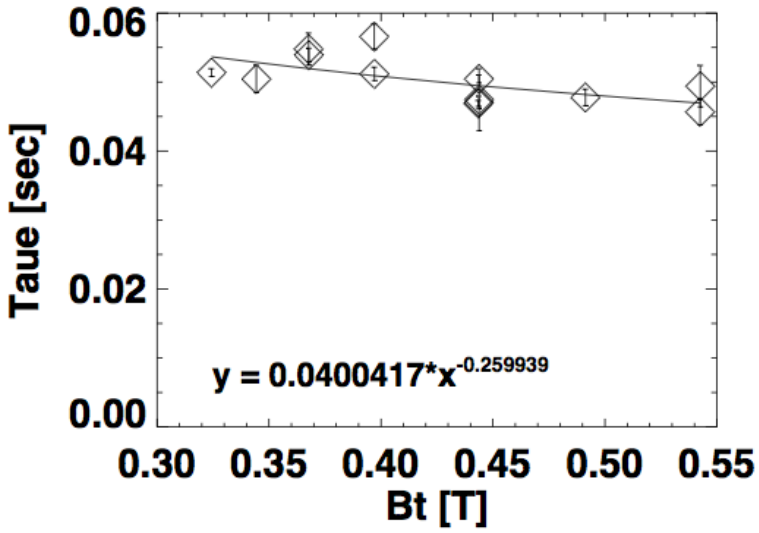
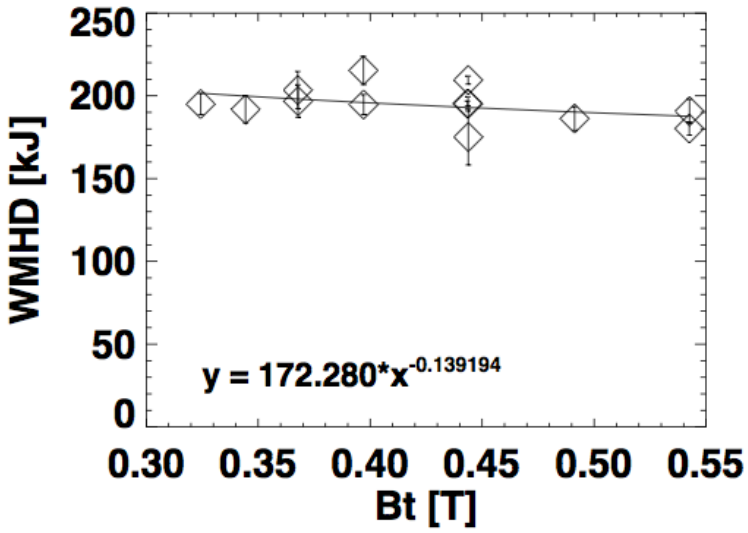


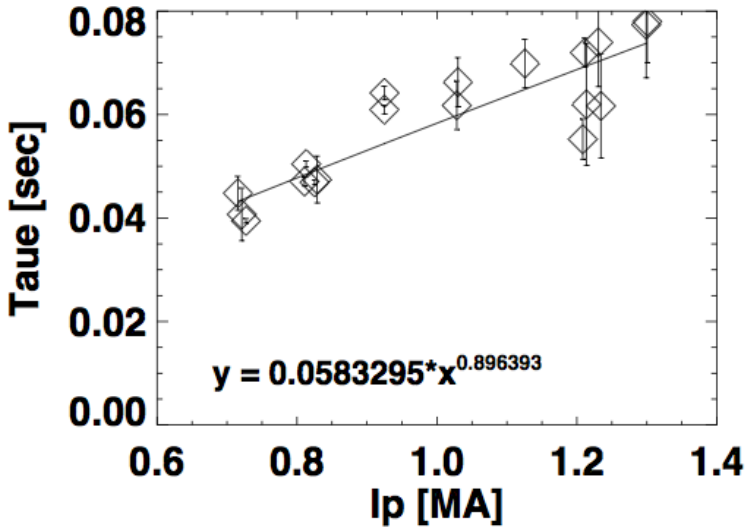
What we have

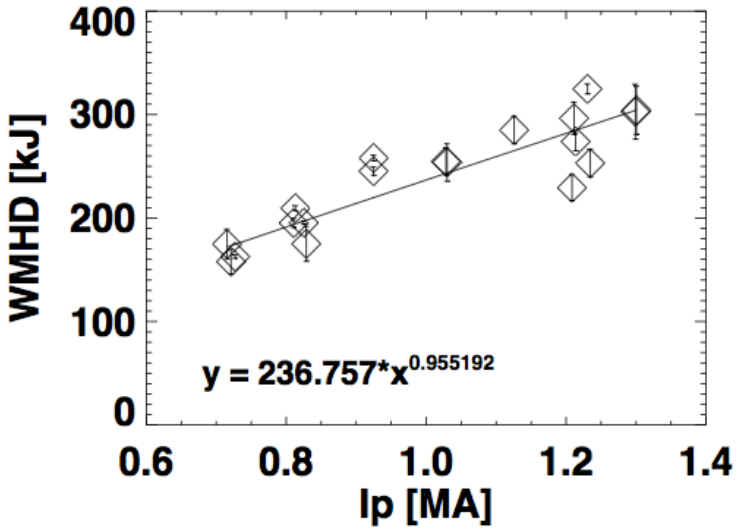
- XP-1043 had detailed scans of I_P, B_T, and P_{inj}.
  - In the morning fiducial shape, with 300 mg Lithium/shot.
  - Purpose of XP was to study scaling of SOL physics with these parameters.
    - Transport studies were an added bonus.
- Data analyzed in two different ways:
  - R. Maingi looked at global confinement using EFIT02.
  - S.P. Gerhardt went through TRANSP for thermal and global confinement.
  - Two analysis methods are pleasantly consistent.
- Large database of ~175 time slices over a range of high-performance Lithiated discharges
  - Compare trends in detailed scan to those in database.

EFIT02 Analysis Shows Weak Negative B_T Scaling and Strong Positive I_P Scaling



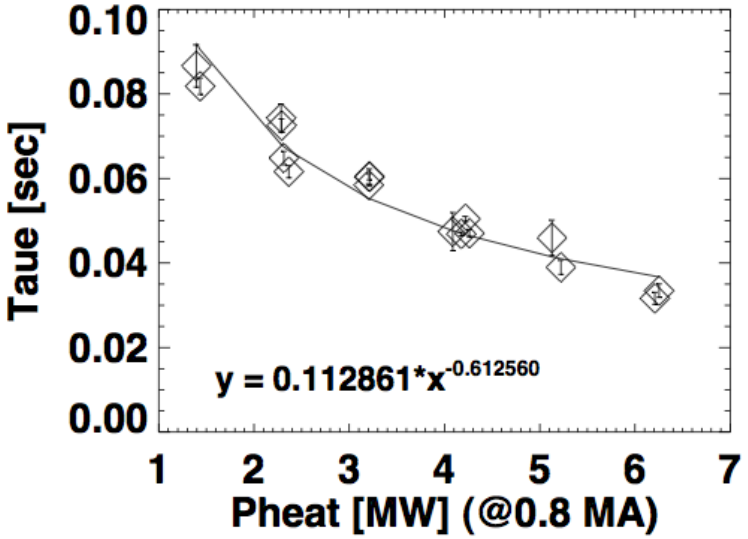


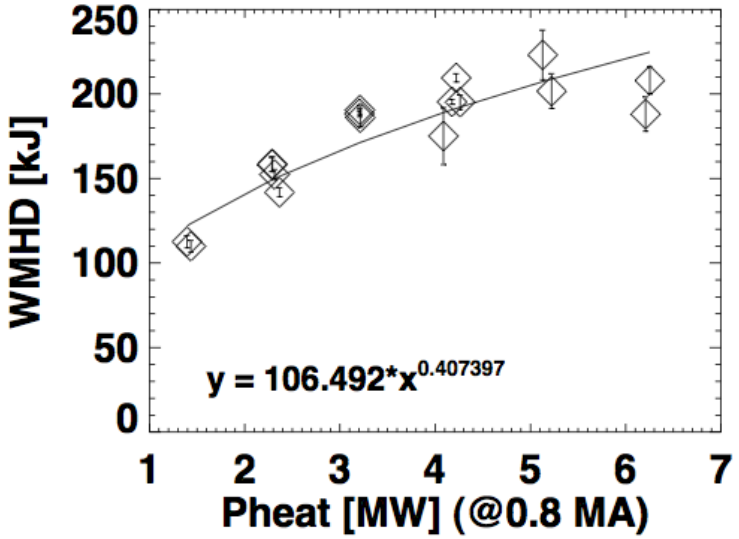


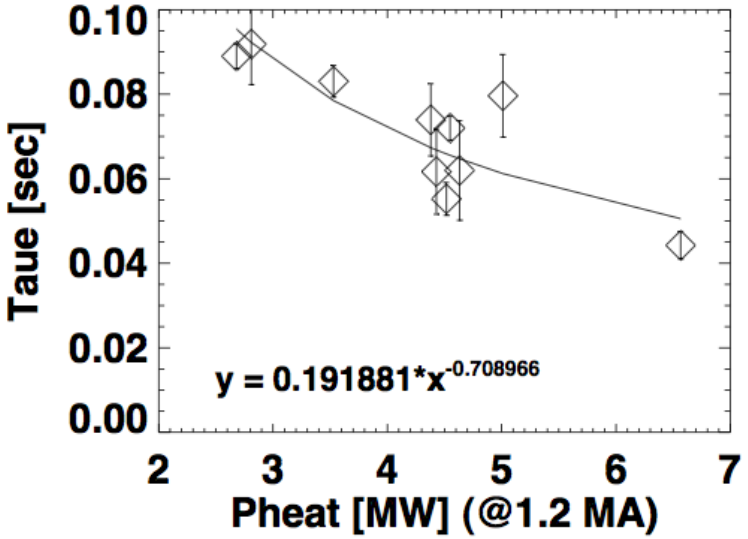


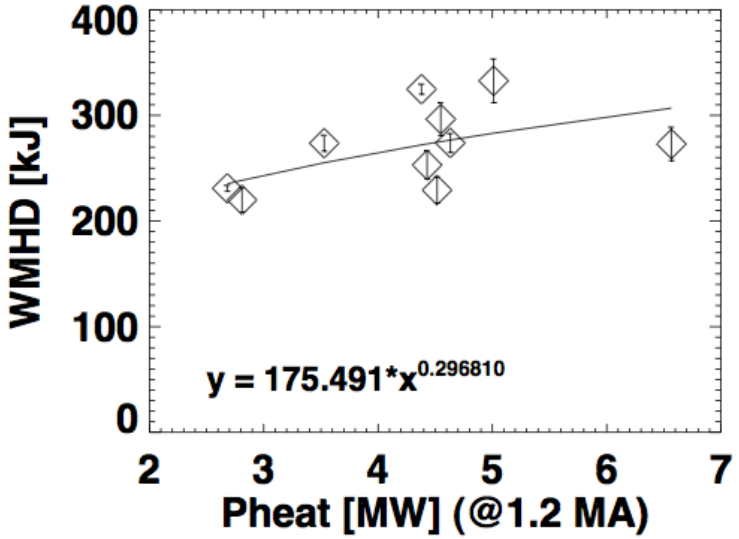
R. Maingi

EFIT02 Analysis Shows Strong Power Degradation



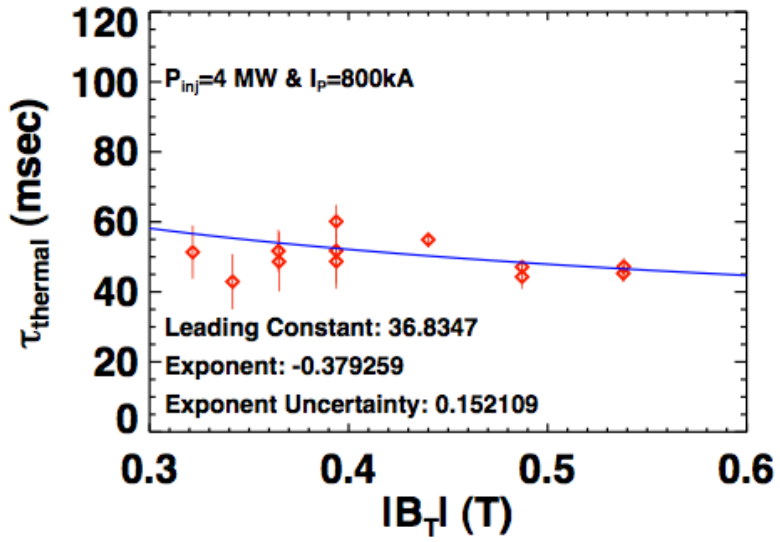


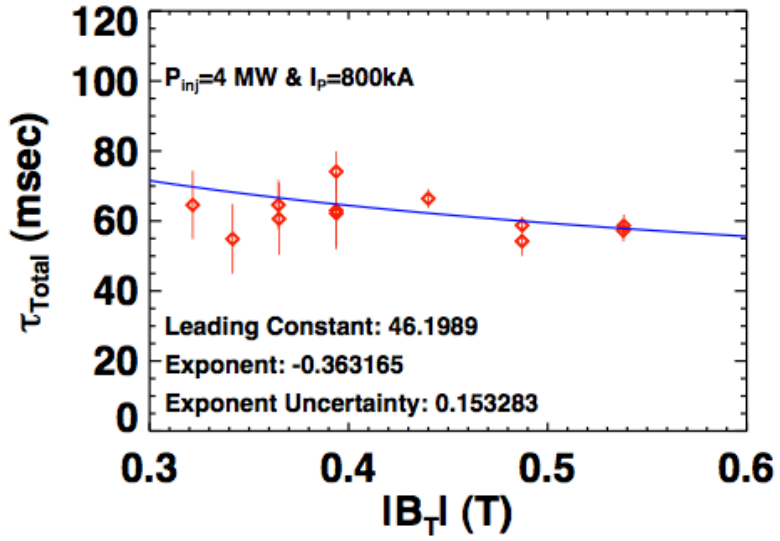


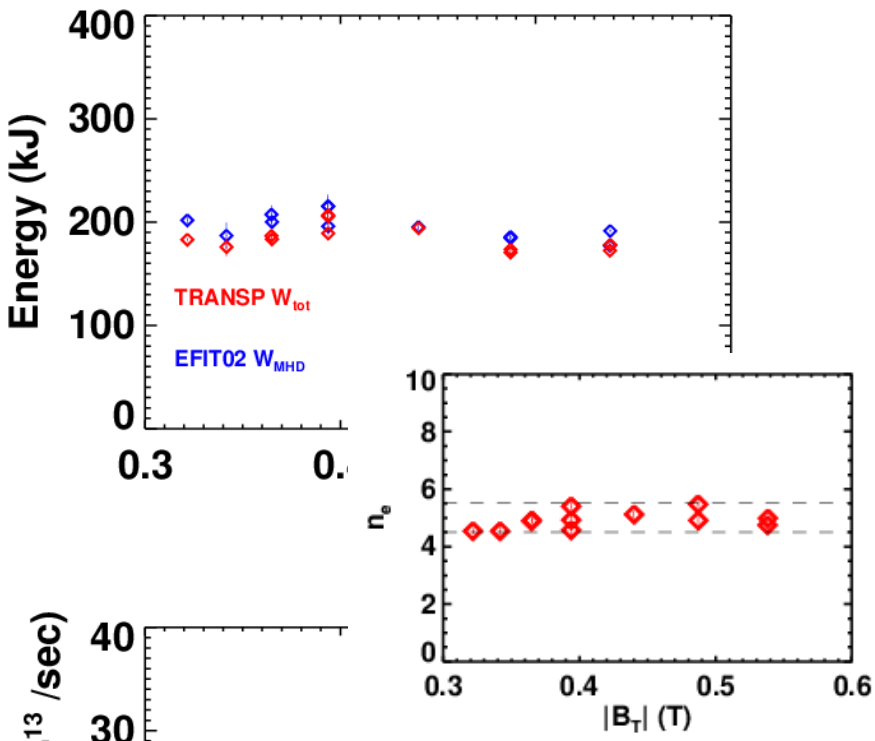


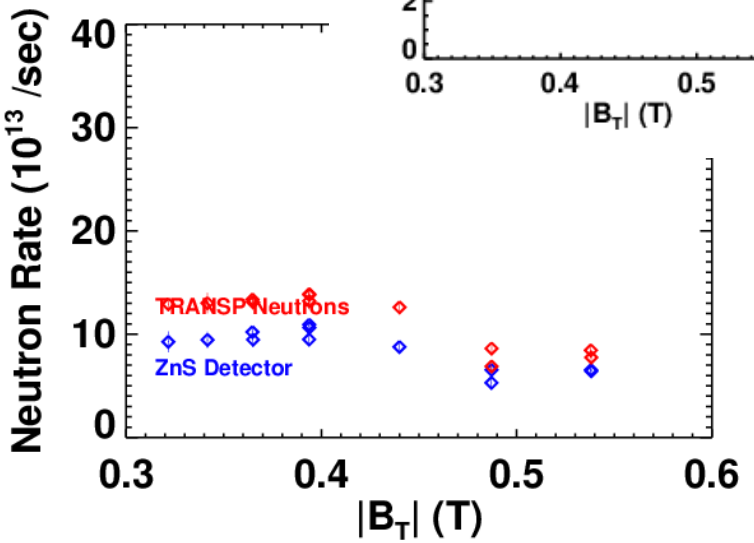
R. Maingi

TRANSP Analysis of Same Data Confirms Weak (negative) B_T Dependence

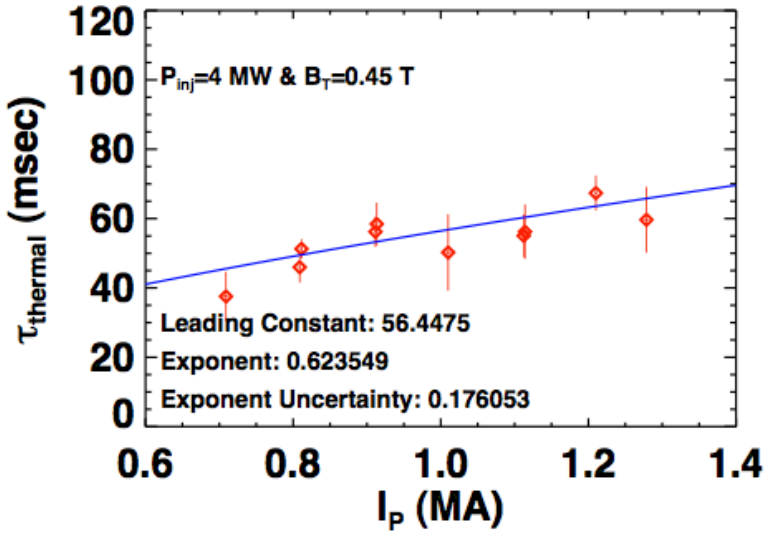


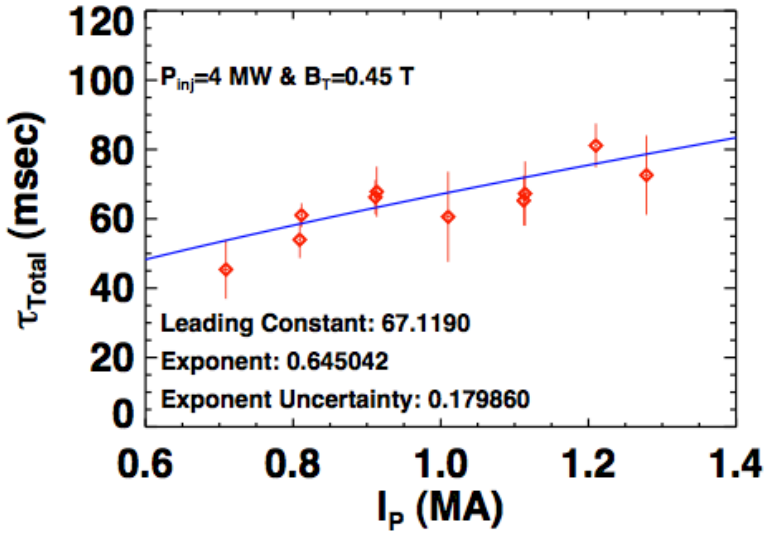


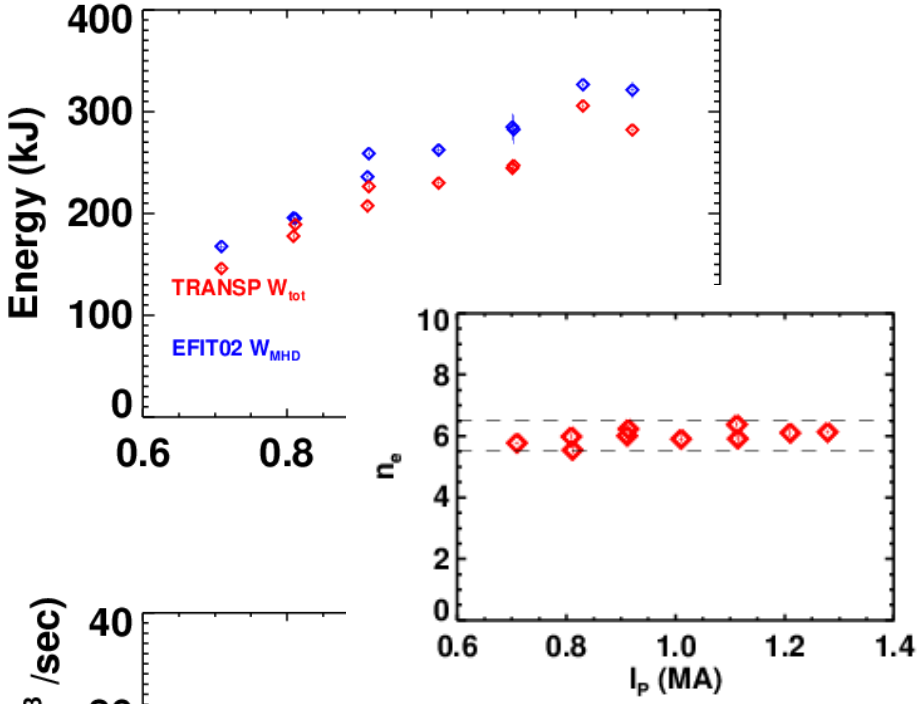


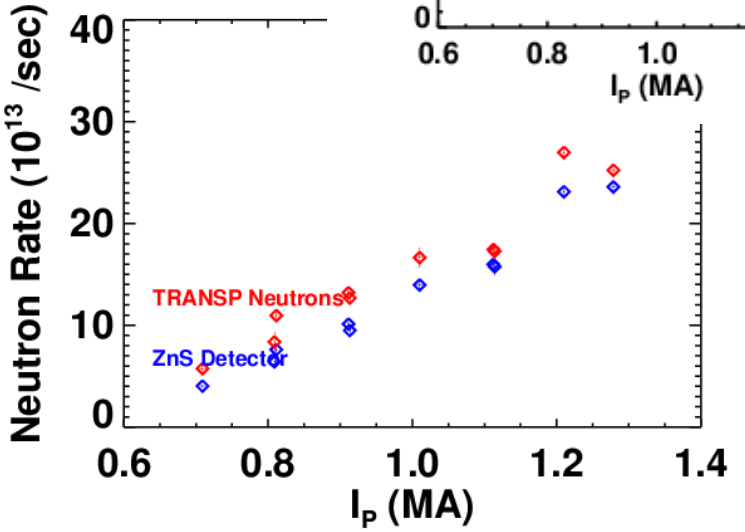


TRANSP Analysis of Same Data Confirms Strong I_P Dependence (Bit Weaker that EFIT Analysis)

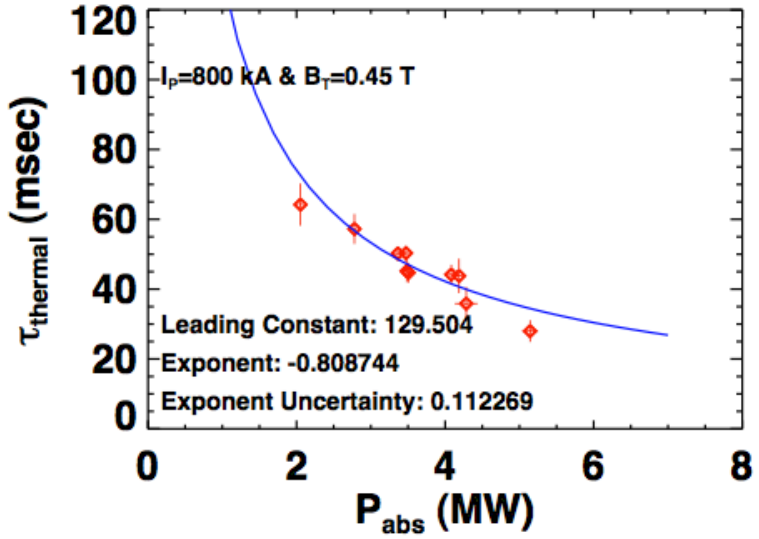


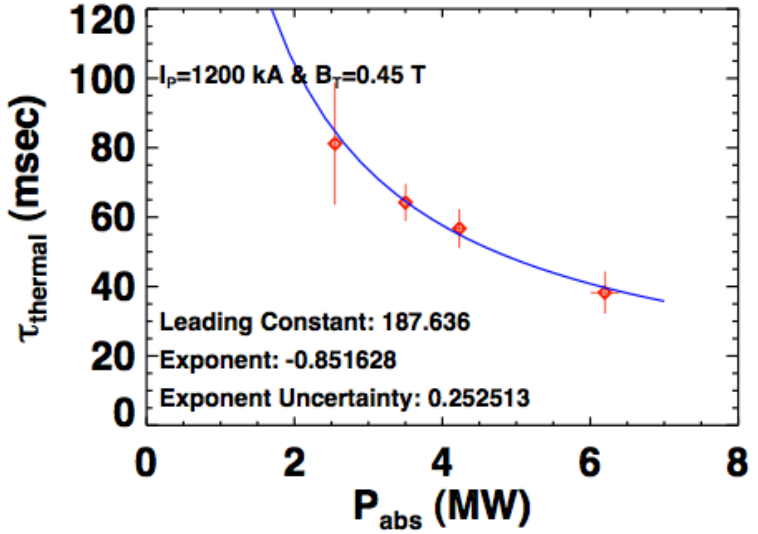


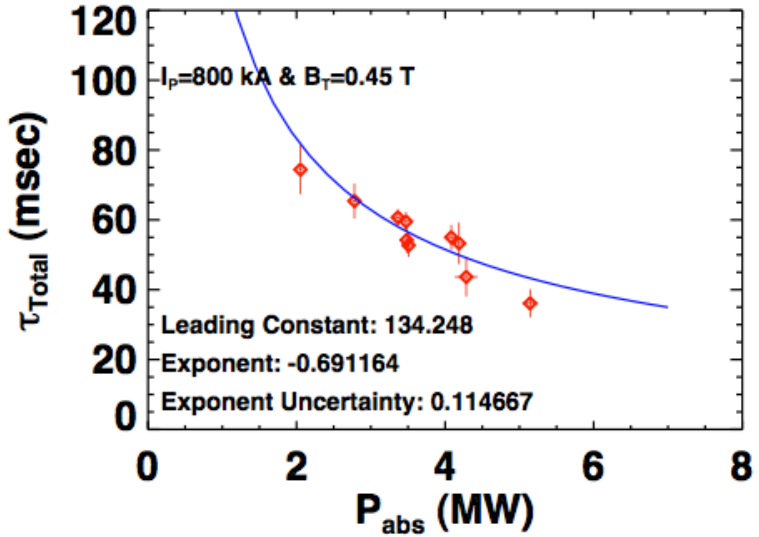


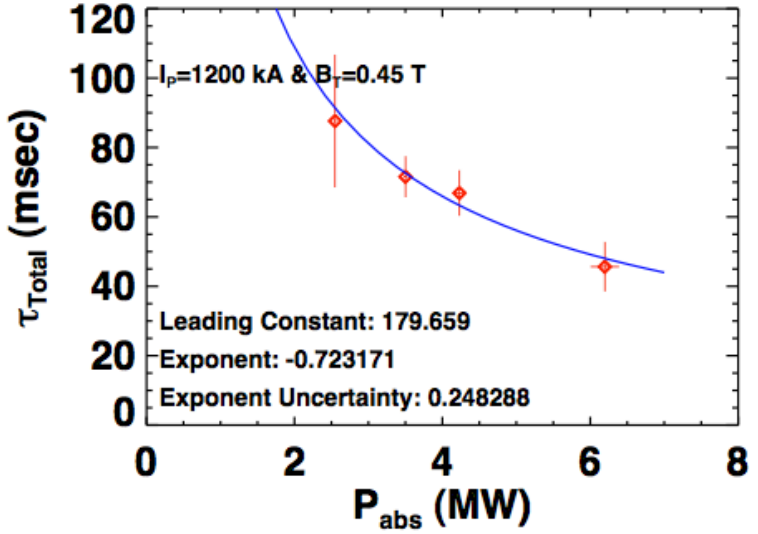


TRANSP Analysis Confirms Strong Power Degradation, Agrees with EFIT02 Analysis Within Error



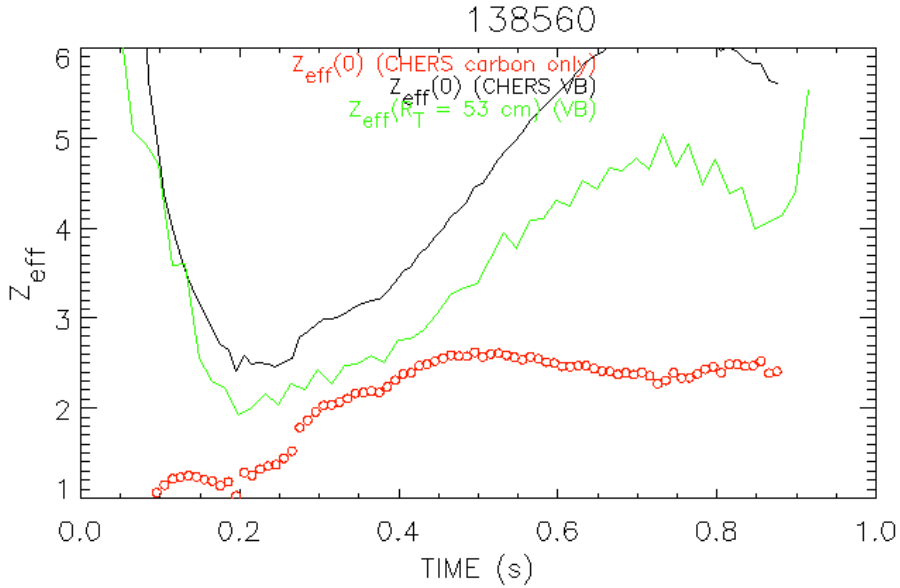




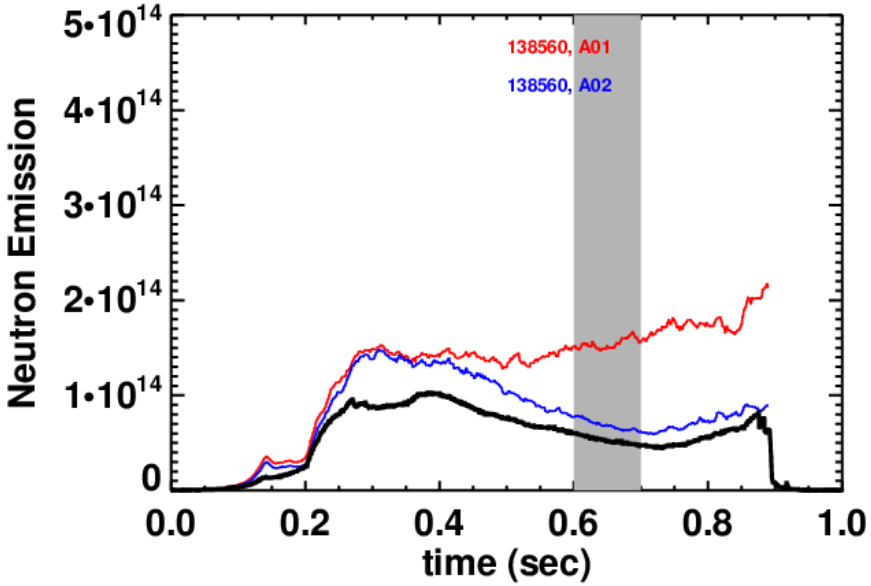


Impurity Dynamics are Not Well Constrained in these TRANSP Runs

- ***Large influx of impurities after 0.5 seconds causes large increase in Z_{eff}.***
- ***What is this stuff?…too much Z_{eff} to be metal?***



TRANSP analysis of this data set used either CHERS carbon or chordal VB to constrain Z_{eff}, depending on which matched the neutron time evolution better.



Red: Neutron emission from TRANSP using measured carbon profile.

Blue: Neutron emission from TRANSP run using a spatially flat value of Z_{eff}, with time evolution from chordal measurement, and assumed charge of carbon.

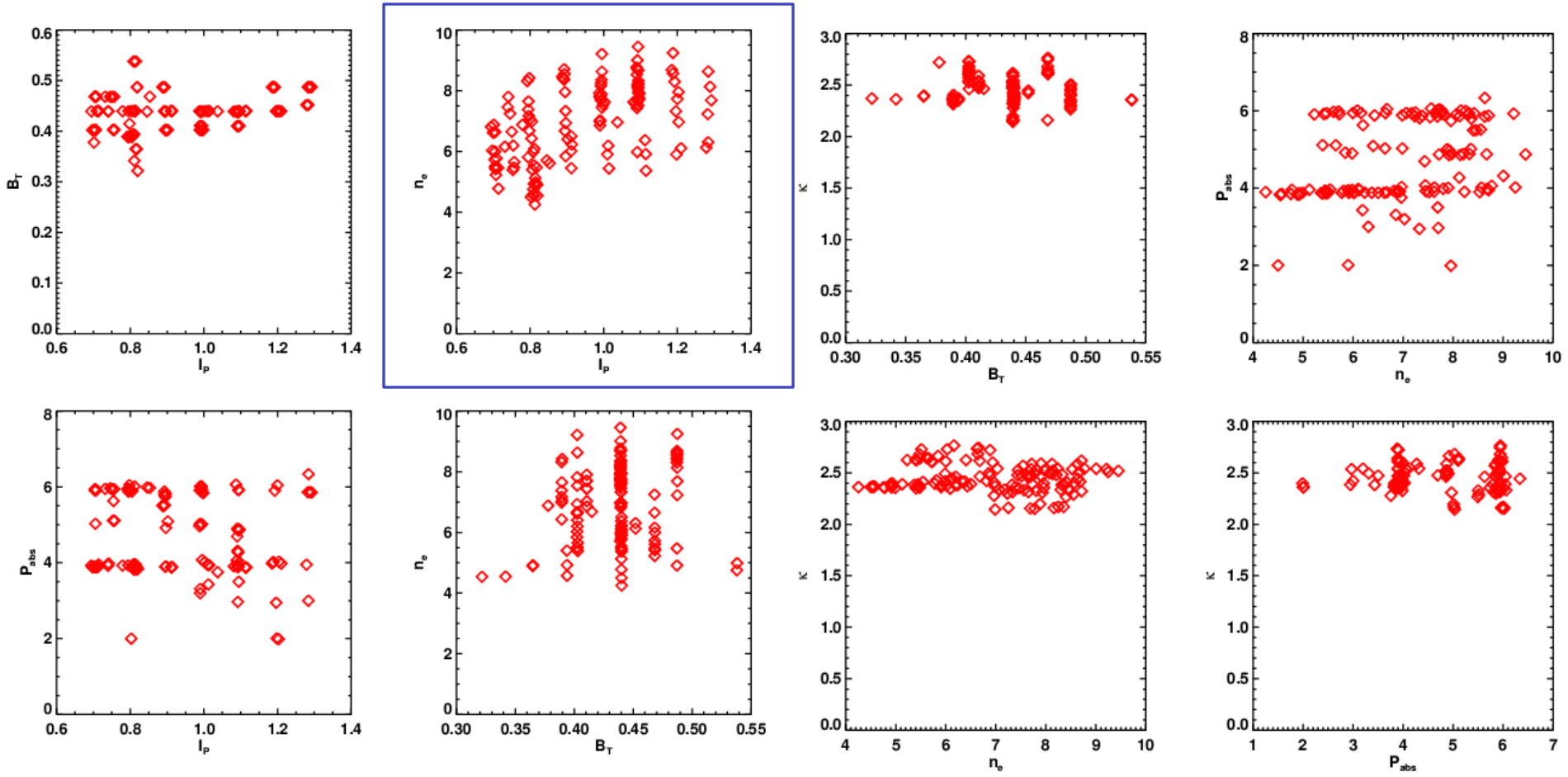
Black: measurement

Large Database Confirms Many of These Trends

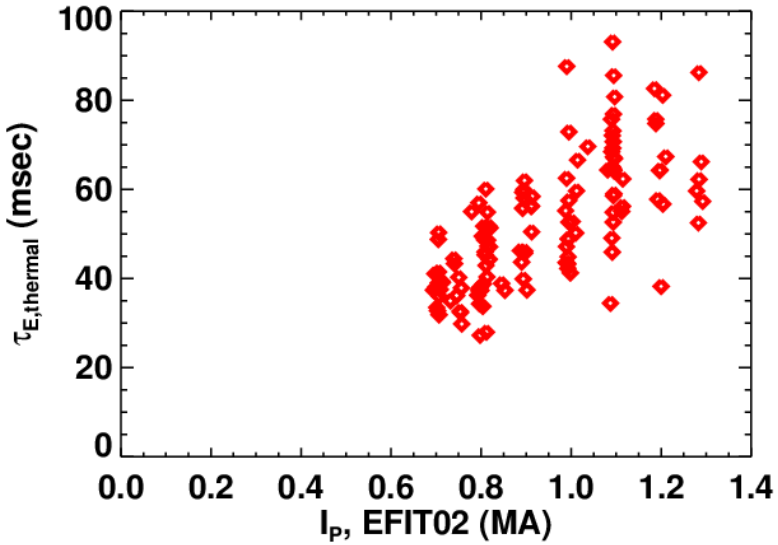
- Many from a variety of H-mode conditions:
  - High toroidal and poloidal beta experiments from ASC TSG in 2009.
  - MHD XPs pushing the normalized beta.
  - Good morning fiducials.
  - Rajesh's devoted scans.
  - Other randomly high performance shots.
- At least 75 msec averaging time, starting at least 1 current time after start of flat-top.
- Something like 175 discreet time windows.
- LRDFIT04s and "good" TRANSP runs for all cases.
- Previous data was actually a subset of this database.

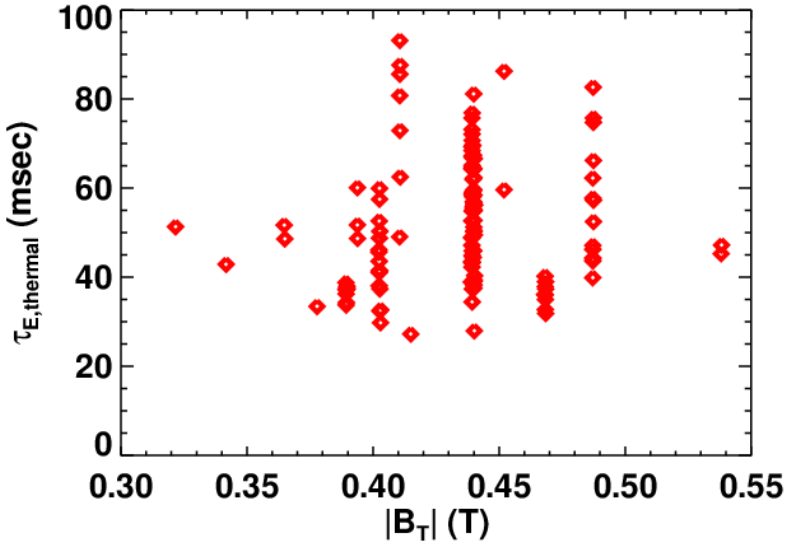
Database Covers Wide Range of Parameters

No strong co-linearity between n_e and I_P in this case.



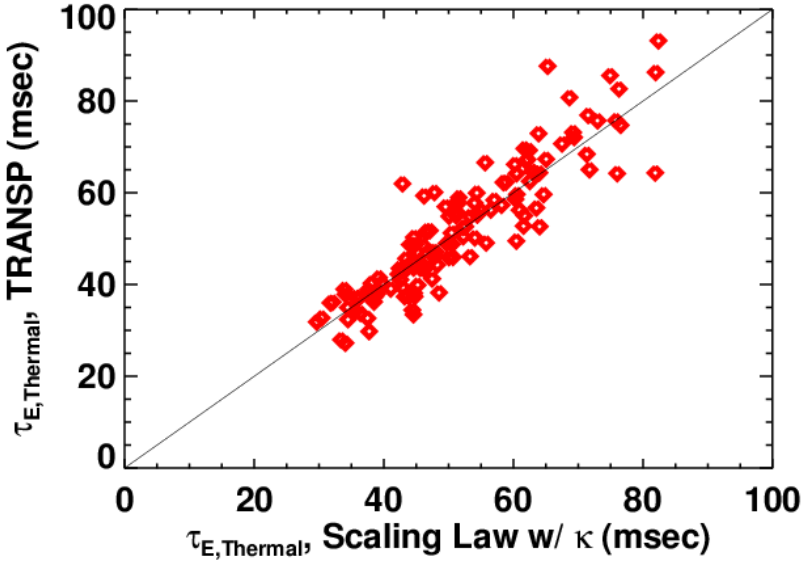
Confirm Strong I_P and Weak B_T Scaling In These Plasmas





B_T scaling was significantly weakened by the inclusion of the XP-1043 data.

$$\tau \propto I_P^{0.98} B_T^{0.002} n_e^{0.56} P_{abs}^{-0.84} \kappa^{0.36}$$



Conclusions

- Lots of recent analysis confirms that in long-pulse, high-β, Lithiated H-mode shots:
  - B_T dependence is weak.
  - I_P dependence is strong.
  - Power degradation is severe…but don't fall out of H-mode.
- Action items:
  - Connect this data to the older pre-lithium data set (transport TSG folks?)
    - What changed?! Lithium, shaping, …
  - Apply better regression analysis to large data set (SPG would gladly take help on this).
  - Fully develop how the devoted scaling studies project to the high-elongation advanced scenario plasmas (SPG IAEA presentation).
- Time scale: need to sort this out by IAEA meeting.