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NSTX

# NSTX contributions to new ITPA/ITER disruption database


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For the NSTX Team


**NSTX Physics Meeting**
**January 23, 2006**


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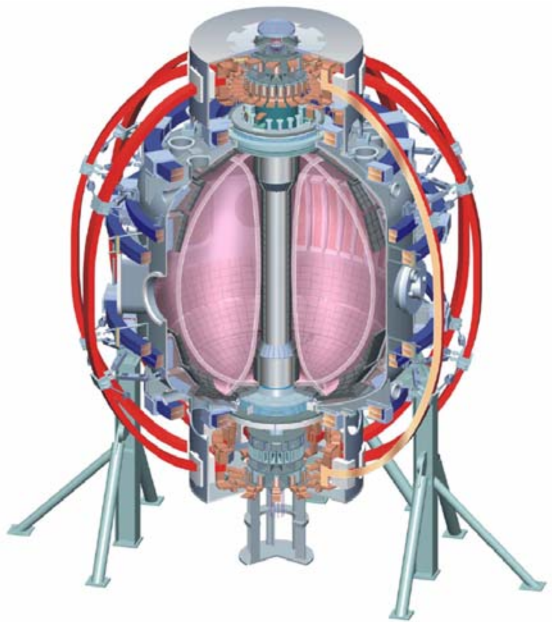


*Culham Sci Ctr*
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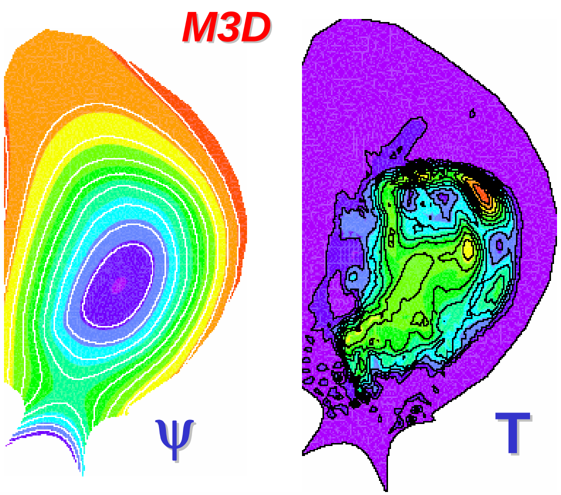
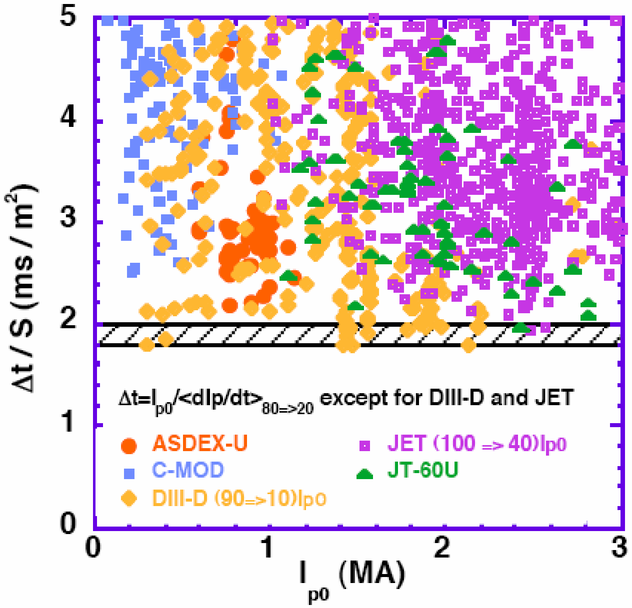
# Present knowledge indicates risk from electromagnetic impulse of current quench barely acceptable for ITER



- 3D simulations of ITER VDE performed
  - Consistent with ITER disruption database
    - Halo fraction $I_{halo\text{-}max} / I_{P0} \sim 0.3$
    - Toroidal peaking factor (TPF) ~ 1-2.5
  - Toroidal peaking of halo current result of current channel kinking during quench




- More simulations needed to explain present data and extrapolate to BP
  - Understand $I_P$ quench rate scaling
    - Disruption database indicates $\Delta t/S \approx 2 ms/m^2$ →
  - Understand scaling of TPF and $f_{halo}$
    - Experiments observe TPF x $f_{halo} \approx 0.7$
  - Accurately compute EM forces on blanket
    - Need 3D plasma ***and*** 3D structure models

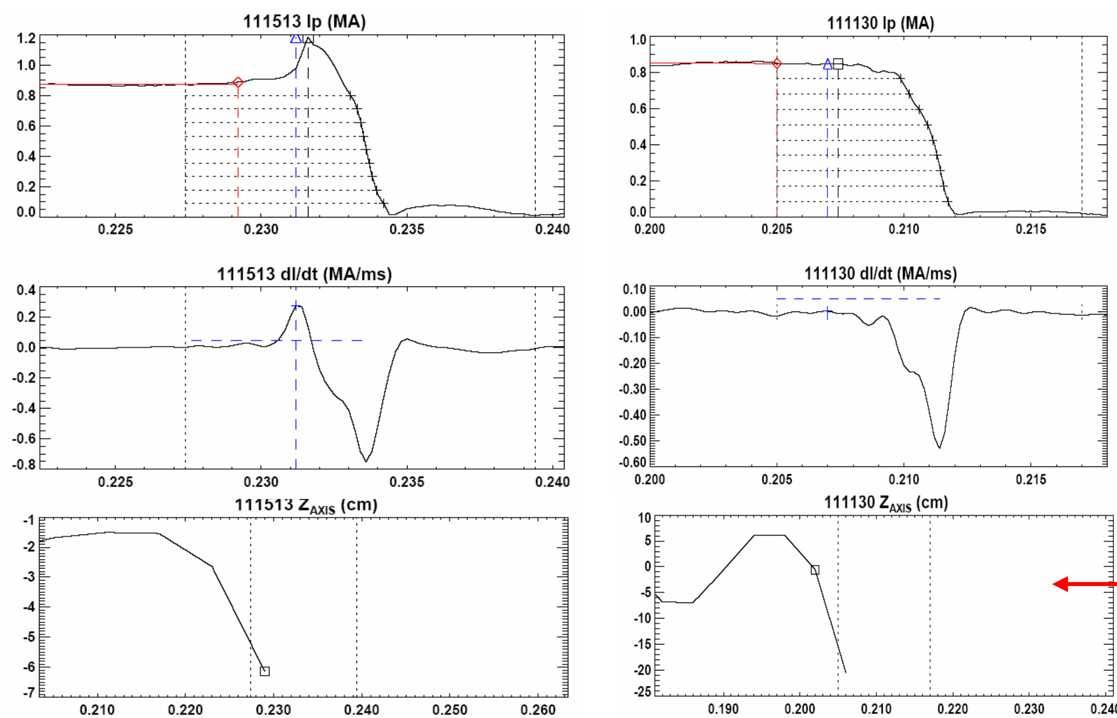


# Status of disruption analysis for NSTX

- **Scanned > 15000 NSTX shots (P. Roney)**
  - **Compute times at 90% and 10% of max $I_P$**
  - **Shot list for 500 fastest disrupting shots created**
- **200 fastest validated for subsequent analysis**
  - **Automated IDL routine → pre-disruption current, current spike parameters, decay evolution**
  - **Require good EFIT01 $\chi^2$ just prior to disruption**
    - **Compute 59 scalar parameters for DDB** →

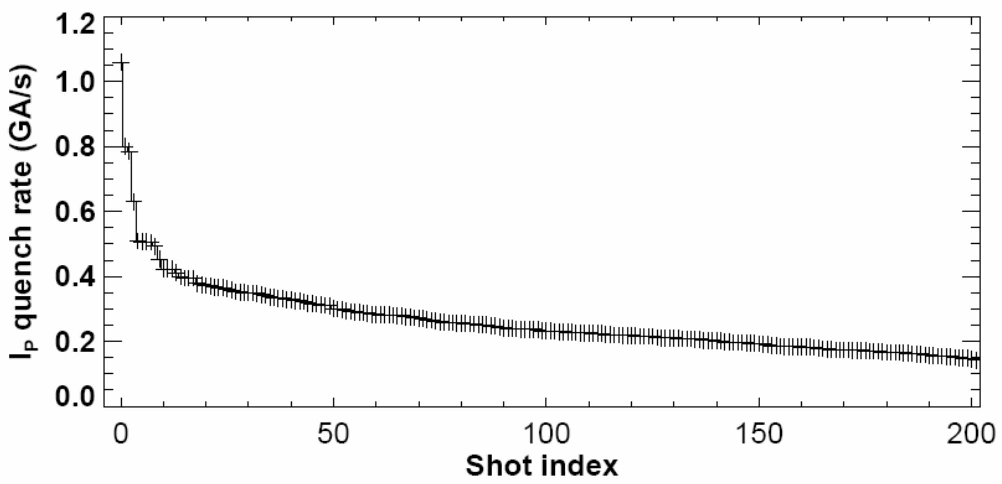
AMIND = 0.615350
AREAD = 2.12568
BEPMHD_D = 0.249387
BETAND = 2.05320
BETANMAX = 2.73693
BETMHD_D = 9.40708
BPOLD = 0.178586
BTD = -0.290775
CAUSED =
CHISQD = 128.806
COMMENT =
CONFIGD = DND
DATE = 20040204
DELTALD = 0.389872
DELTAUD = 0.357423
DIDTMAX = 2.93594e+06
DIVNAME = Open
DRSEPD = -0.00319415
ELM_E =
EVIDRAE_E =
INDENTD = 0.00000
INTLID = 1.06075
IPD = 850862.
IPEQD = 855434.
IPPHASED = flattop
IPSPK = 846804.
IPSPK_E = N
KAPPAD = 2.00466
NINDXD = 0.00000
PHASED =
Q95D = 3.71889

QMIND = 0.750468
RGEOD = 0.863886
RMAGD = 0.966210
SHOT = 111130
TIME = 0.194000
TIME1 = 0.211735
TIME2 = 0.211559
TIME3 = 0.211435
TIME4 = 0.211301
TIME5 = 0.211143
TIME6 = 0.210917
TIME7 = 0.210598
TIME8 = 0.210207
TIME9 = 0.209859
TIME95MAX = 0.192629
TIMED = 0.205000
TIMEDIDTMAX = 0.2070
TIMEQD = 0.202000
TIMERMAX = 0.00000
TIMESPK = 0.207400
TOK = NSTX
TQ_E =
VDE_E =
VDEDRIFT = DN
VOLD = 10.8582
WDIAD = 215027.
WTOTD = 51543.8
ZMAGD = -0.00581699

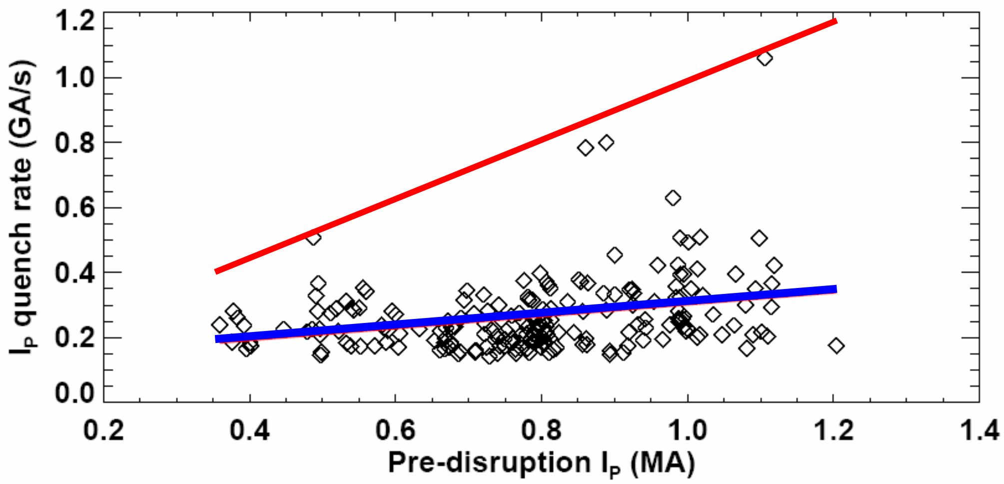



- **Many disruptions correlated with loss of vertical control**

# Absolute quench rates increase with plasma current




- Very few shots (<10) exceed quench rates of 0.4GA/s



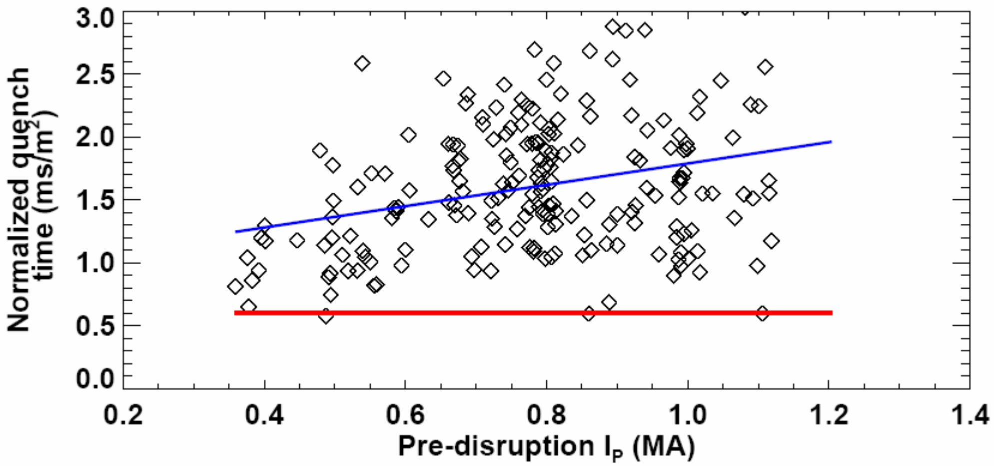

- The scaling with current is relatively weak on average
- However, the maximum quench rate does scale strongly with current…
  - Determined by very few shots

# Minimum normalized quench time is independent of $I_P$

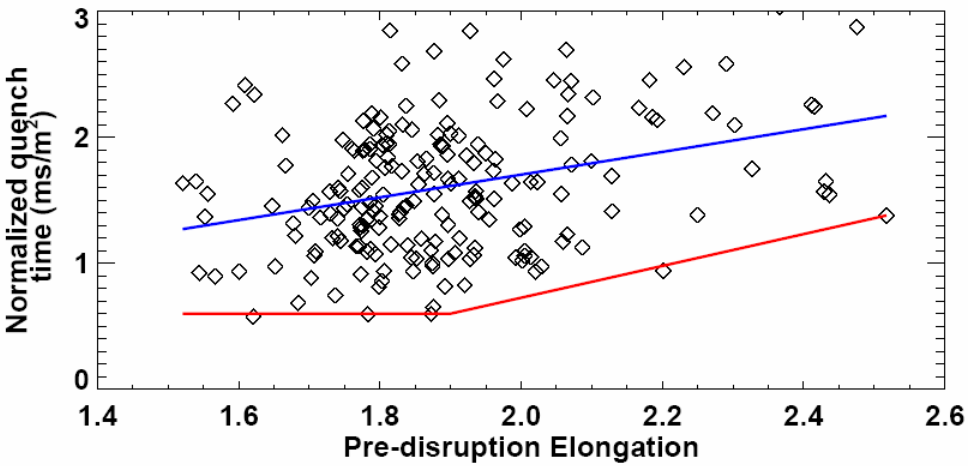
NSTX

**Expected normalized L/R decay time:**

$$\frac{\tau}{S} = \frac{L_p^{eff} / 2\pi R_0}{\eta_p}$$




- **The average normalized quench time increases with $I_P$**
  - **Hotter initial plasma?**
- **The minimum normalized quench time ≈ 0.6ms/m$^2$**
  - **Like tokamaks, no $I_P$ dependence**
  - **Absolute value is lower however**
    - **Colder plasma? Lower $l_i$?**




- **The average normalized quench time also increases with kappa**
- **The minimum normalized quench time also increases with kappa**
  - **Favorable scaling with kappa?**

# Status of ITPA DDB data submission

- **DDB software "new" as of July 2005**
  - In process of debugging DB submissions
- **200 shots loaded to ITPA DDB at GA for testing**
  - Data written to MDS+
  - Tree data read and transferred to SQL DB nightly
- **Web interface to data now available**
  - Can plot pre-disruption current and decay values
  - Available for any shot from any machine
    - DIII-D, JET, C-MOD, NSTX (JT-60U, MAST)

- **Shot** 106939
- **Tokamak** NSTX
- **IPD** 782253
- **TIMED** 0.389