Reverse-Shear Discharge Current-Profile Development

FP&T *TFTR*

Steven H. Batha[†]

F. M. Levinton,[†] **M. G. Bell,**[§]
G. L. Schmidt,[§] **S. D. Scott,**[§]
and the TFTR Group

[†]***Fusion Physics & Technology, Inc.***

[§]***Princeton Plasma Physics Laboratory***

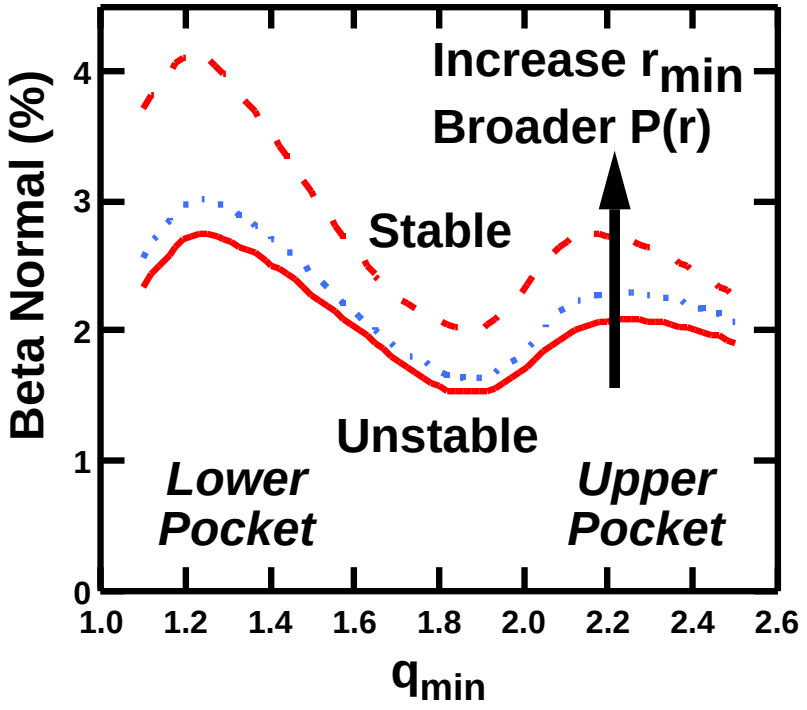
Presented November 12, 1996 at the
38th Annual Meeting of the
Division of Plasma Physics

This work supported by the U. S. Department of Energy contract No. DE-AC02-76-CH03073.

RS plasma stability depends upon q_{min} and r_{min}

FP&T *TFTR*

- **More stable: larger r_{min}, lower q_{min}**
  - **need broader pressure profile**
- ***Goal:* explore upper stability pocket**



q(a)=6.3
Larger r_{min}
Broader pressure and larger r_{min}

–M. W. Phillips *et al.*, *Physics of Plasmas* 3, 1673 (1996).

*E*nhanced *R*everse *S*hear (ERS) transitions achieved in new regimes

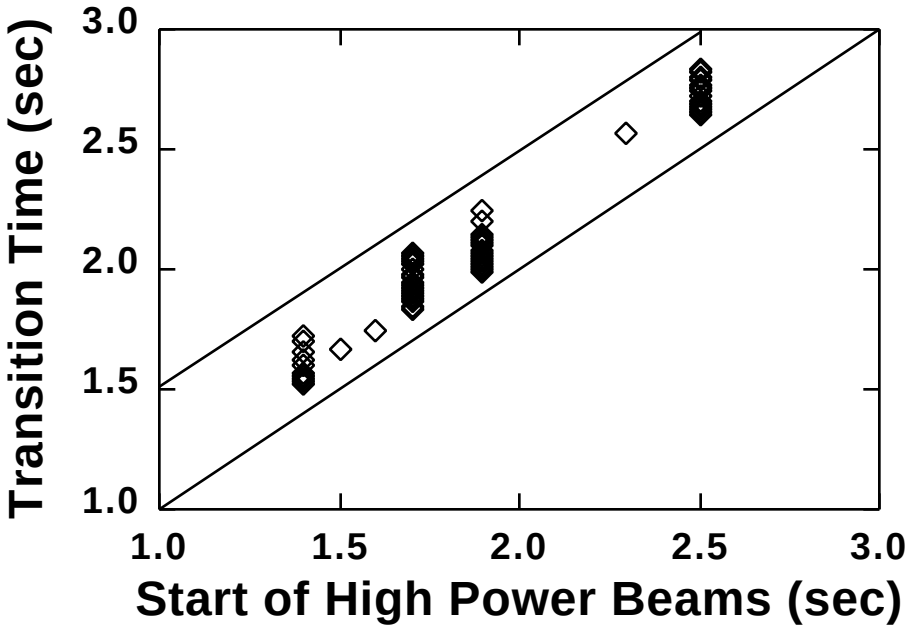
FP&T ***TFTR***

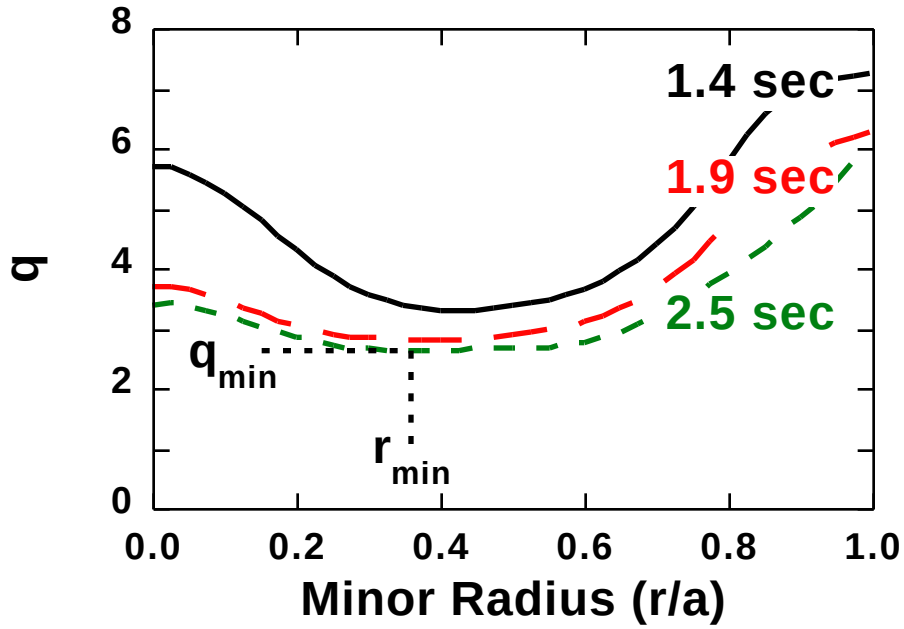
- **1.6 MA standard discharge**
  - **beam timing, Li pellet trigger**
- **2.2 MA discharges increase RS region**
  - ***inductive methods:*** **plasma growth, plasma current ramp rate, beam directionality**
- **Lower toroidal field**
  - **scaled discharge to test theories**
  - **previous talk by Zarnstorff**

Transitions occur for a wide range of q profiles

FP&T *TFTR*

- Transitions obtained for early injection
- q(R) evolution same for all discharges
- q(R) at transition time varies



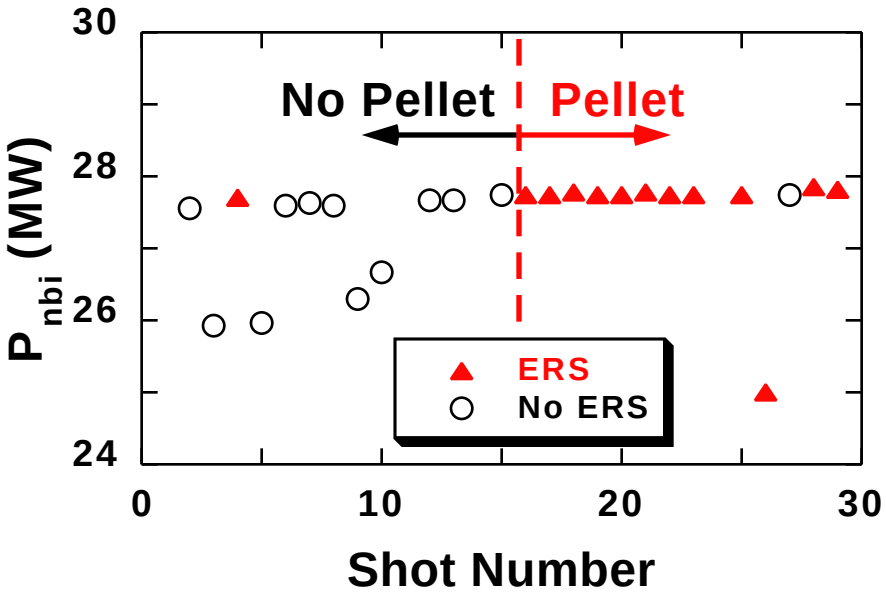


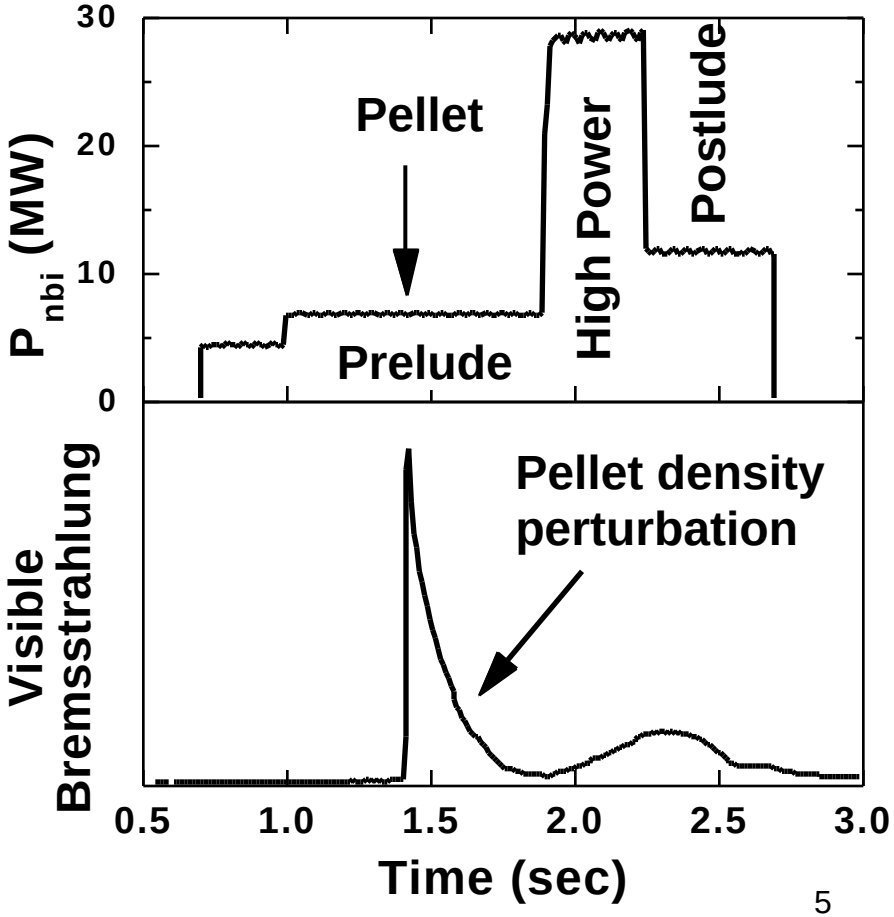
– Radial electric field corrections to q profile not important in prelude

Li pellets facilitate ERS transition

FP&T *TFTR*

- Pellet injection during prelude
- Variable injection time

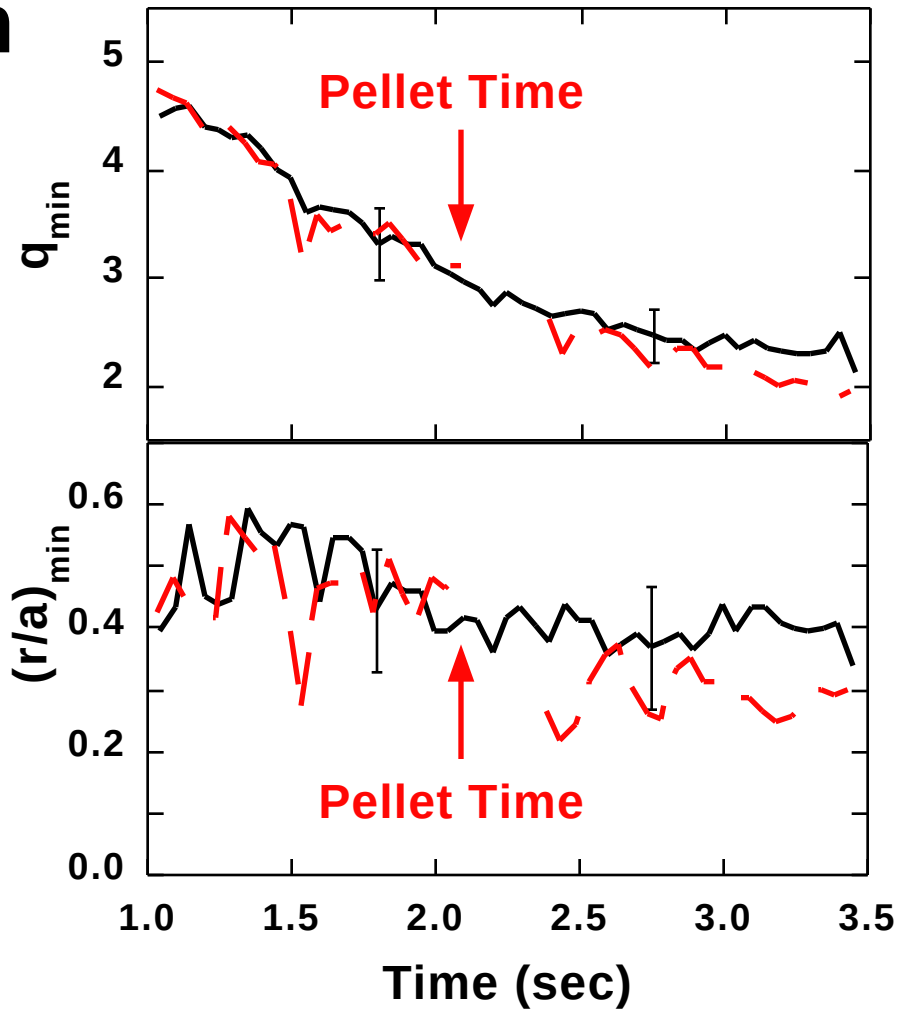




Li pellets have no significant effect on current profile evolution

FP&T *TFTR*

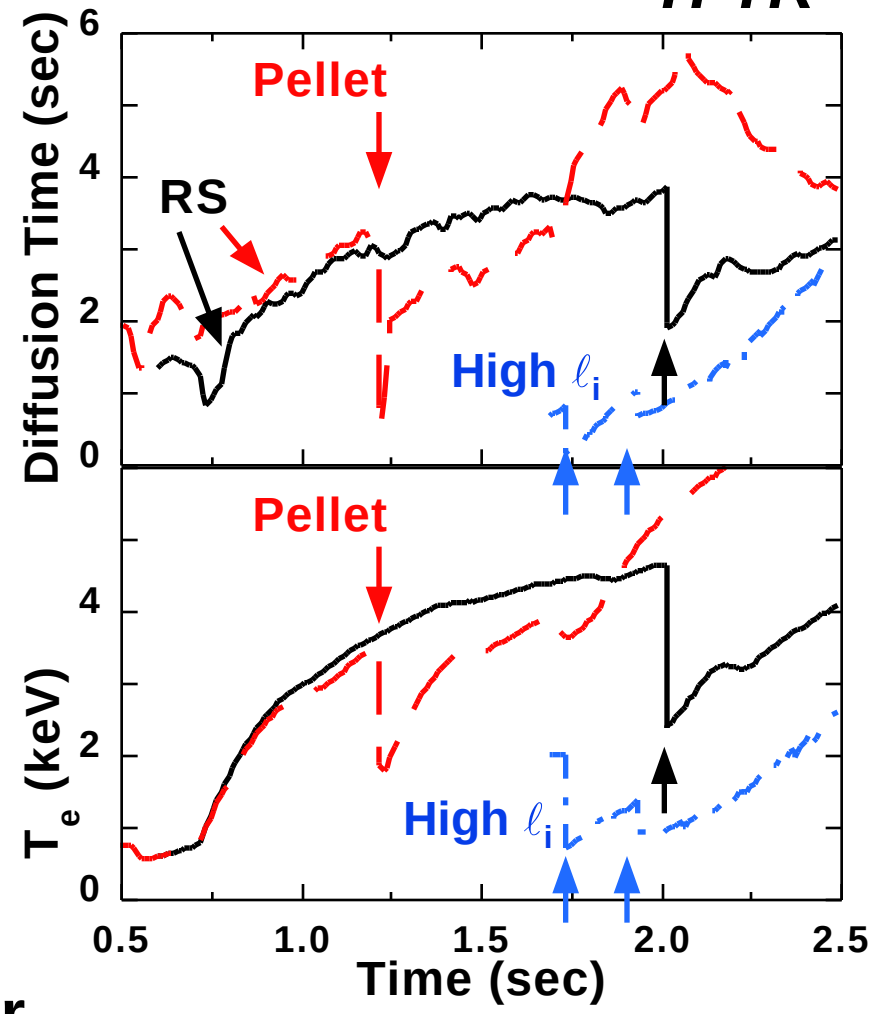
- q_{min}, r_{min} evolution unchanged
- No measurement through pellet injection
- Pellet times of 0.9 to 2.5 sec
- Different from ohmic pellets



Early heating impedes current penetration

FP&T

- **Beam injection during prelude**
  - **high T_e**
  - **high conductivity**
  - **slows current penetration**
- **Little penetration even after pellet injection**
- **Contrast: High-ℓ_i start**
  - **designed to speed up penetration**
  - **diffusion time much shorter**



Several techniques explored to optimize q profile

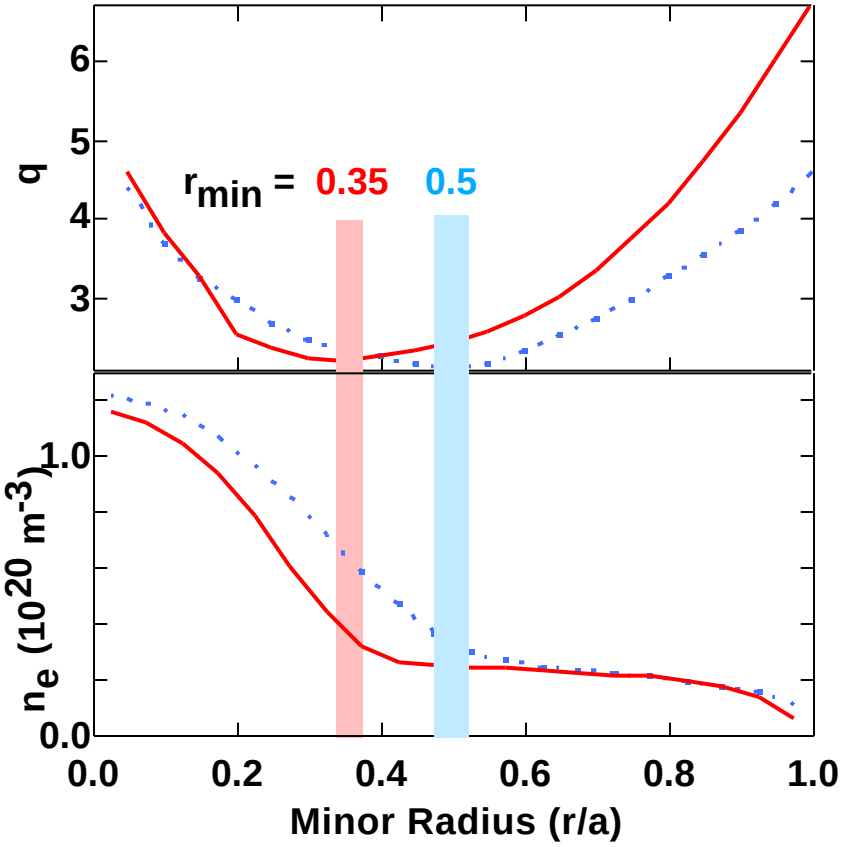
FP&T *TFTR*

- **Higher current**
- **Higher plasma current ramp rate**
- **During prelude:**
  - **optimized beam directionality**
  - **partial growth of plasma minor radius to lower q_{min}**

Higher current operation increased RS region

FP&T *TFTR*

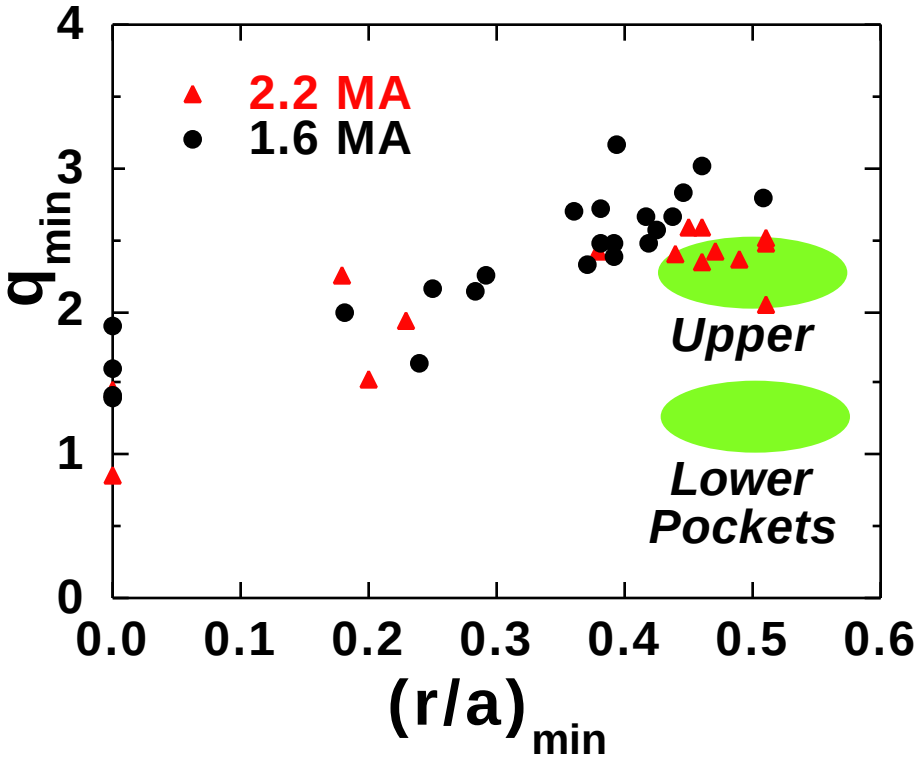
- Increased current from 1.6 to 2.2 MA
  - increased ramp rate
- Achieved larger r_{min} at same q_{min}
- Region of good confinement increased



Explored upper stability pocket at 2.2 MA

FP&T *TFTR*

- **Optimum startup**
  - **slightly co dominated**
  - **fast ramp rate**
  - **reached upper pocket**
- **Problem getting to lower q_{min} pocket**
  - **partial growth decreased q_{min} but r_{min} also decreased**



Conclusions

- **Li pellets**
  - **facilitate ERS transitions**
  - **no significant effect on q profile evolution**
- **2.2 MA discharges**
  - **increased r_{min}**
  - **good confinement region linked to RS region**
- **Explored upper stability pocket**
  - **could not reach lower pocket inductively**
  - **non-inductive current drive needed**

Inductive techniques altered q profile evolution

FP&T *TFTR*

- **New discharge**
  - **higher current**
  - **faster current ramp**
- **Improved:**
  - **lower q_{min}**
  - **larger r_{min}**