Reduction of fluctuations and edge current during PPCD in MST

B. E. Chapman
and the MST group

Outline

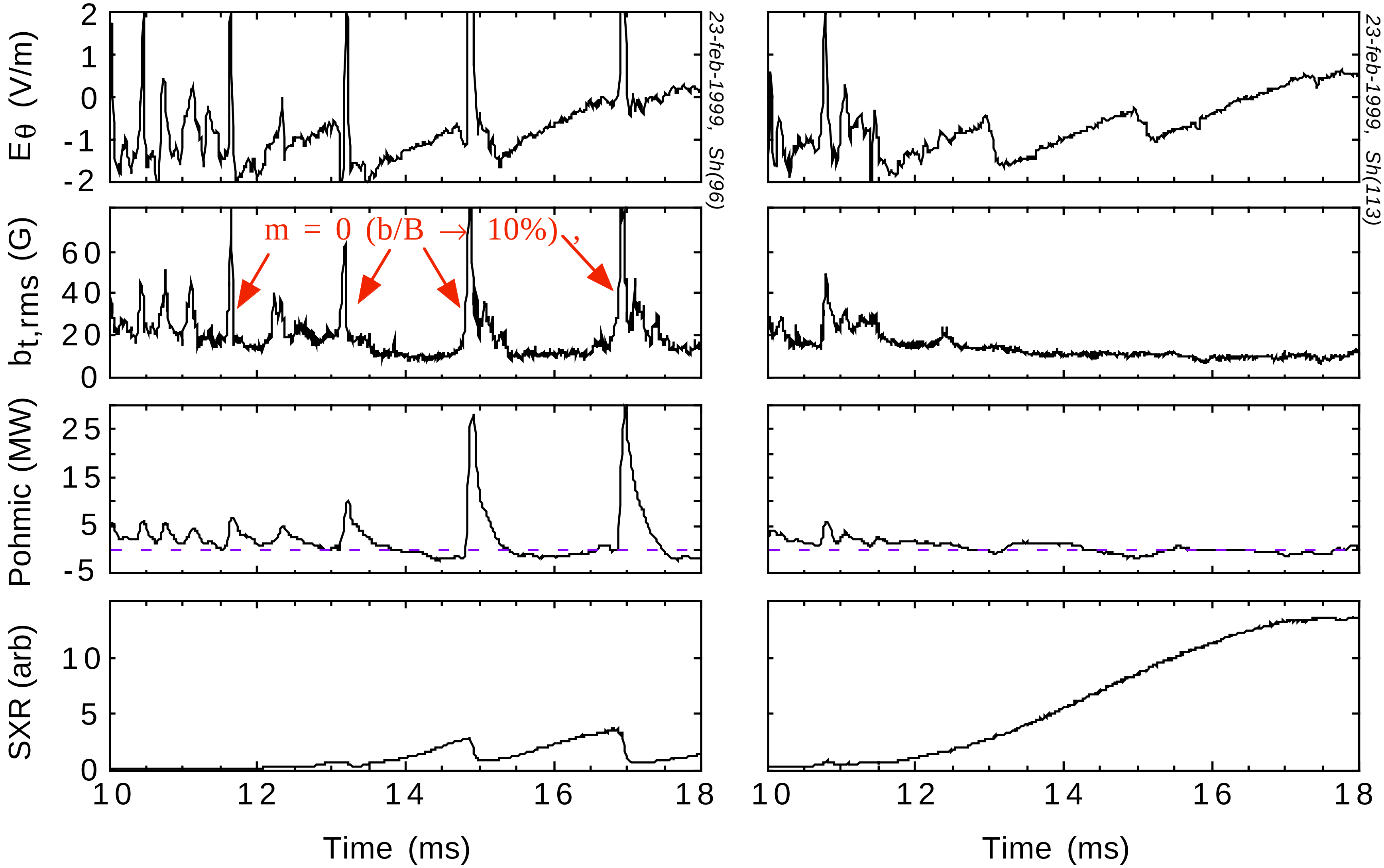
-- The key to sustained fluctuation reduction during PPCD

-- Magnetic fluctuations (including single helicity spectra)

-- Density and potential fluctuations

-- Edge current and heat flux

Key to sustained reduction of fluctuations (magnetic and electrostatic) during PPCD is suppression of edge-originating bursts



The bursts

-- Same phenomenology in PPCD and EC discharges

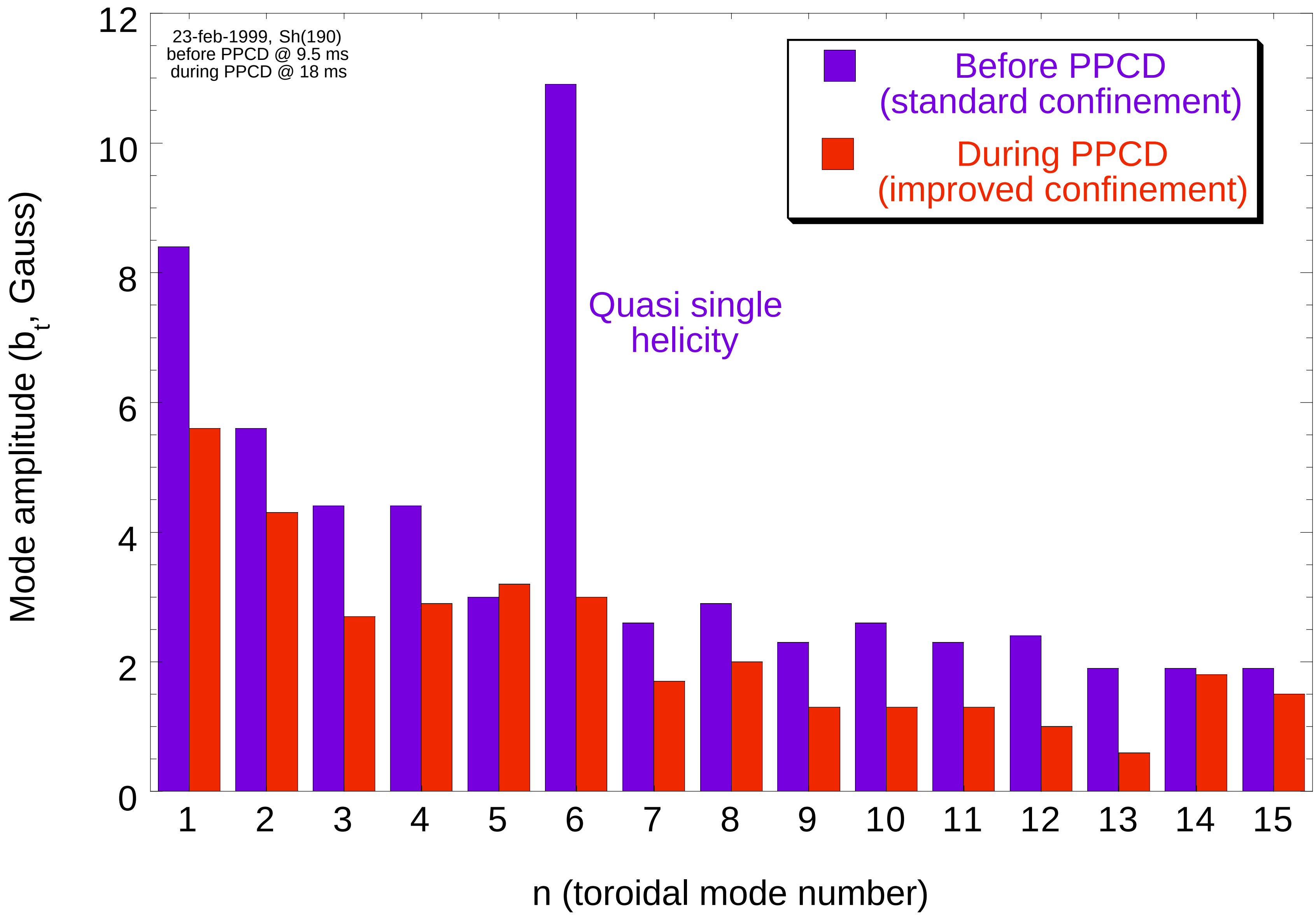
-- Also observed in IHTM (TPE-1RM20)?

-- Cause unknown, but observe increased ∇p and ∇J during PPCD

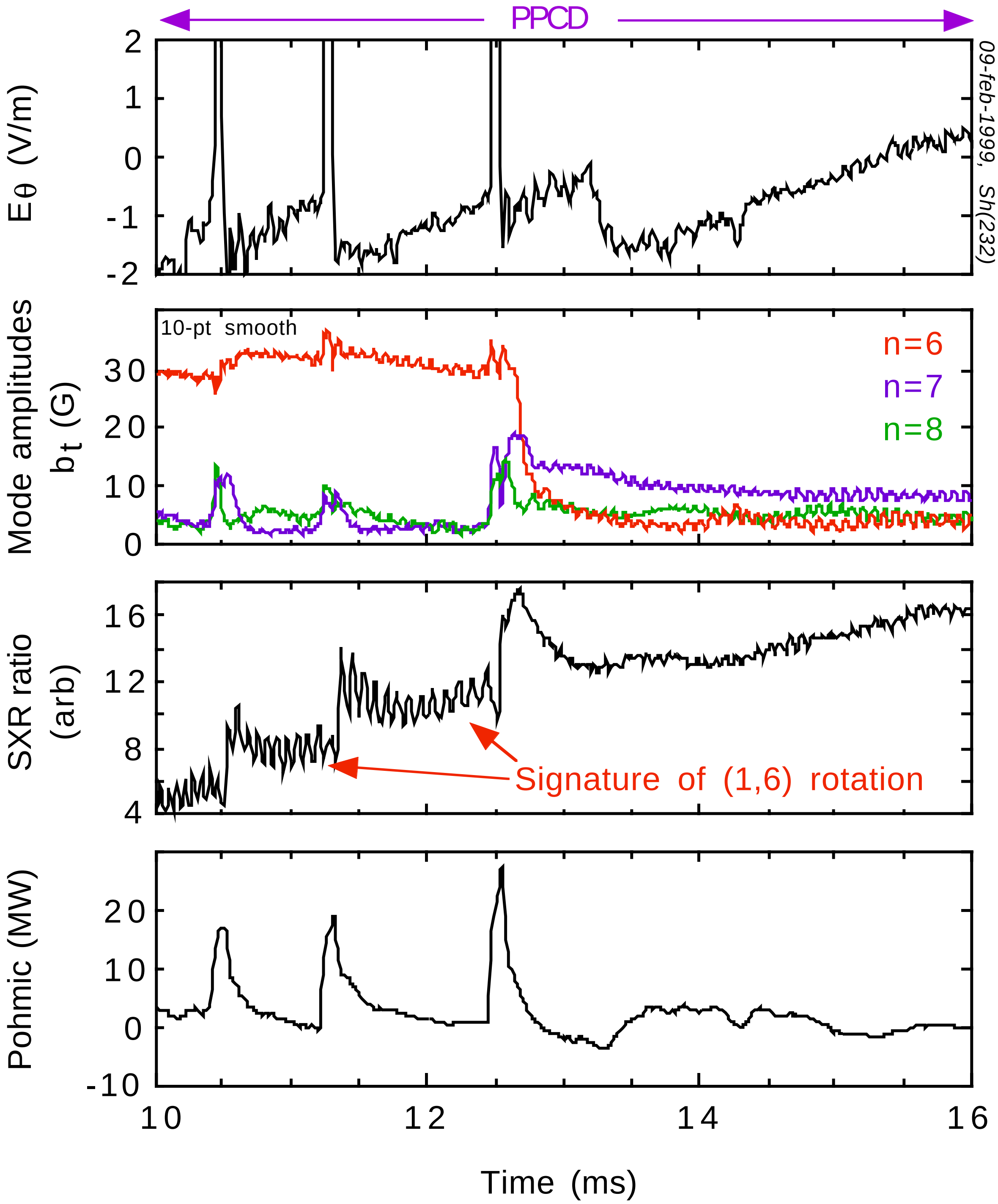
-- Bursts clearly associated with edge-resonant $m = 0$ fluctuations

-- But may or may not originate with the $m = 0$'s: in PPCD, $m = 0$ resonant surface may be well inside the large-gradient region

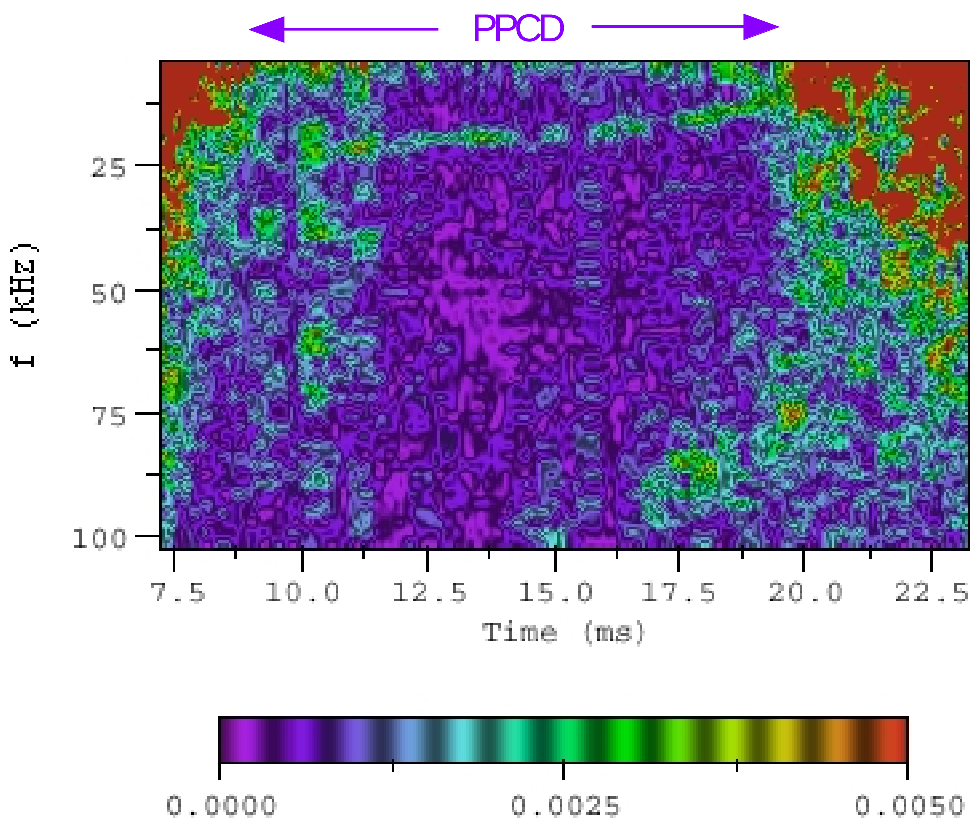
Burst-free PPCD at low current often exhibits a flat and reduced m = 1 (n = 6-15) spectrum



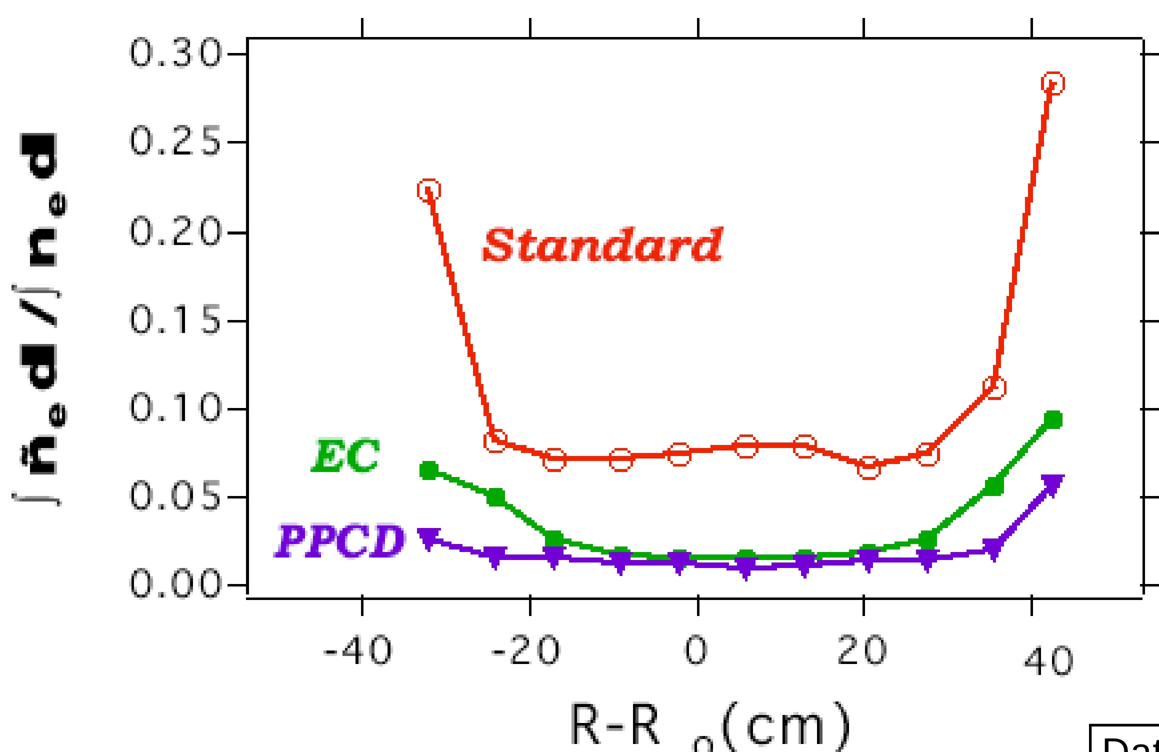
Quasi single helicity spectra can appear during PPCD, most often at higher Ip



Density fluctuation reduction with PPCD is broadband and global

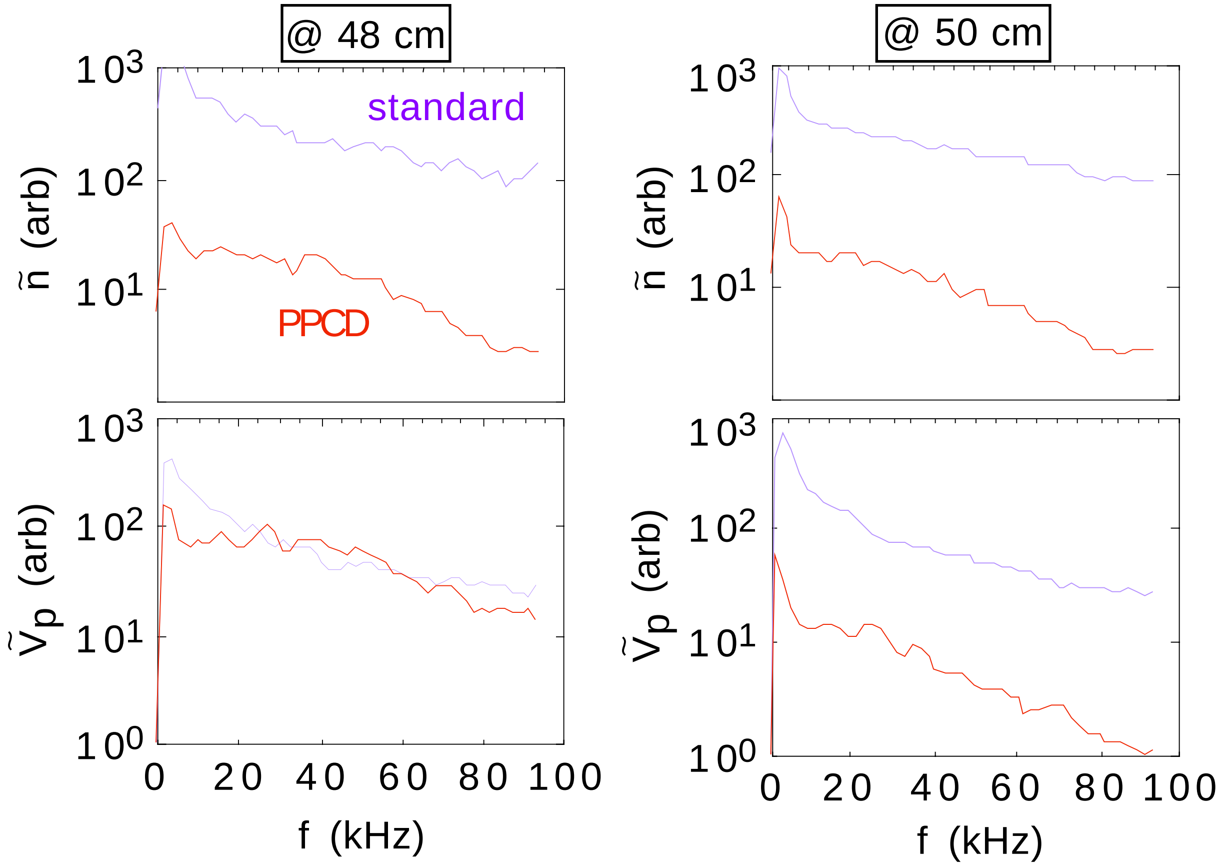


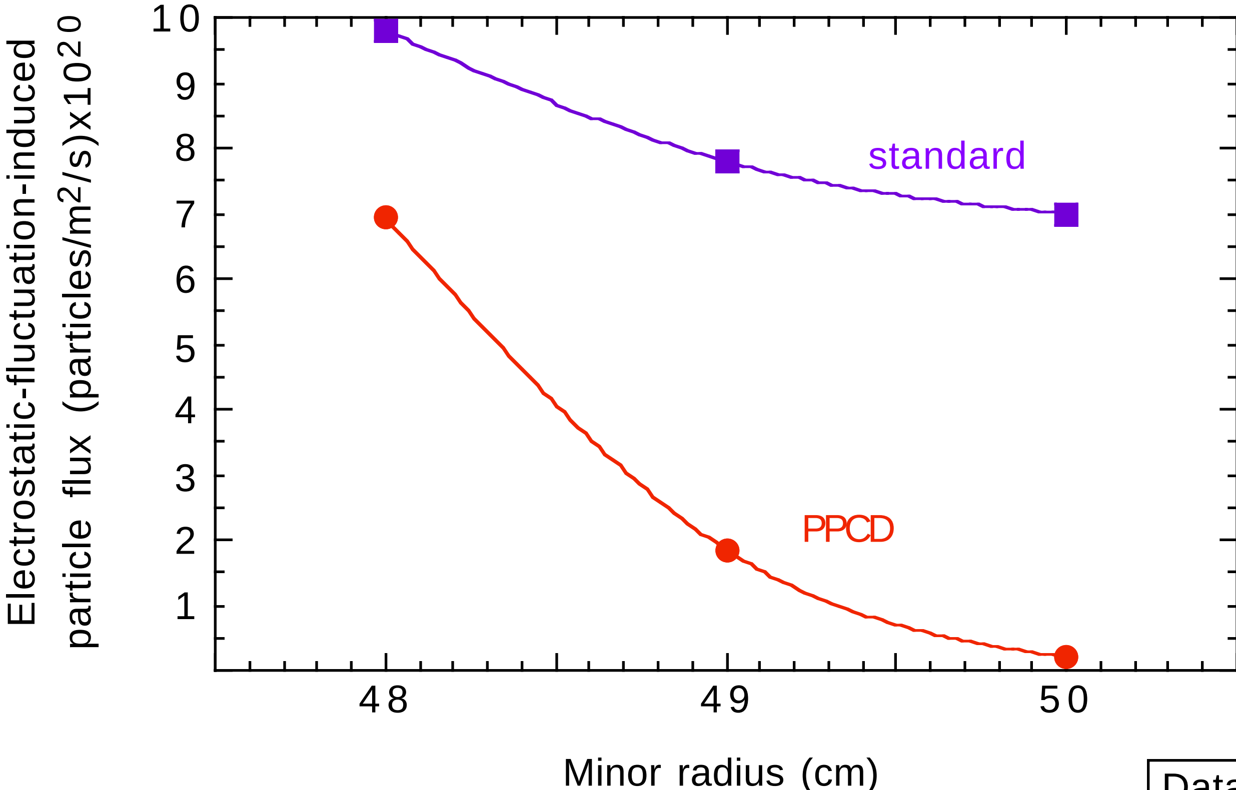
Density fluctuation power spectra vs. time in a ~ 400 kA PPCD discharge (with burst suppression)



Data courtesy of D. Brower

Electrostatic fluctuations and particle transport reduced in extreme edge

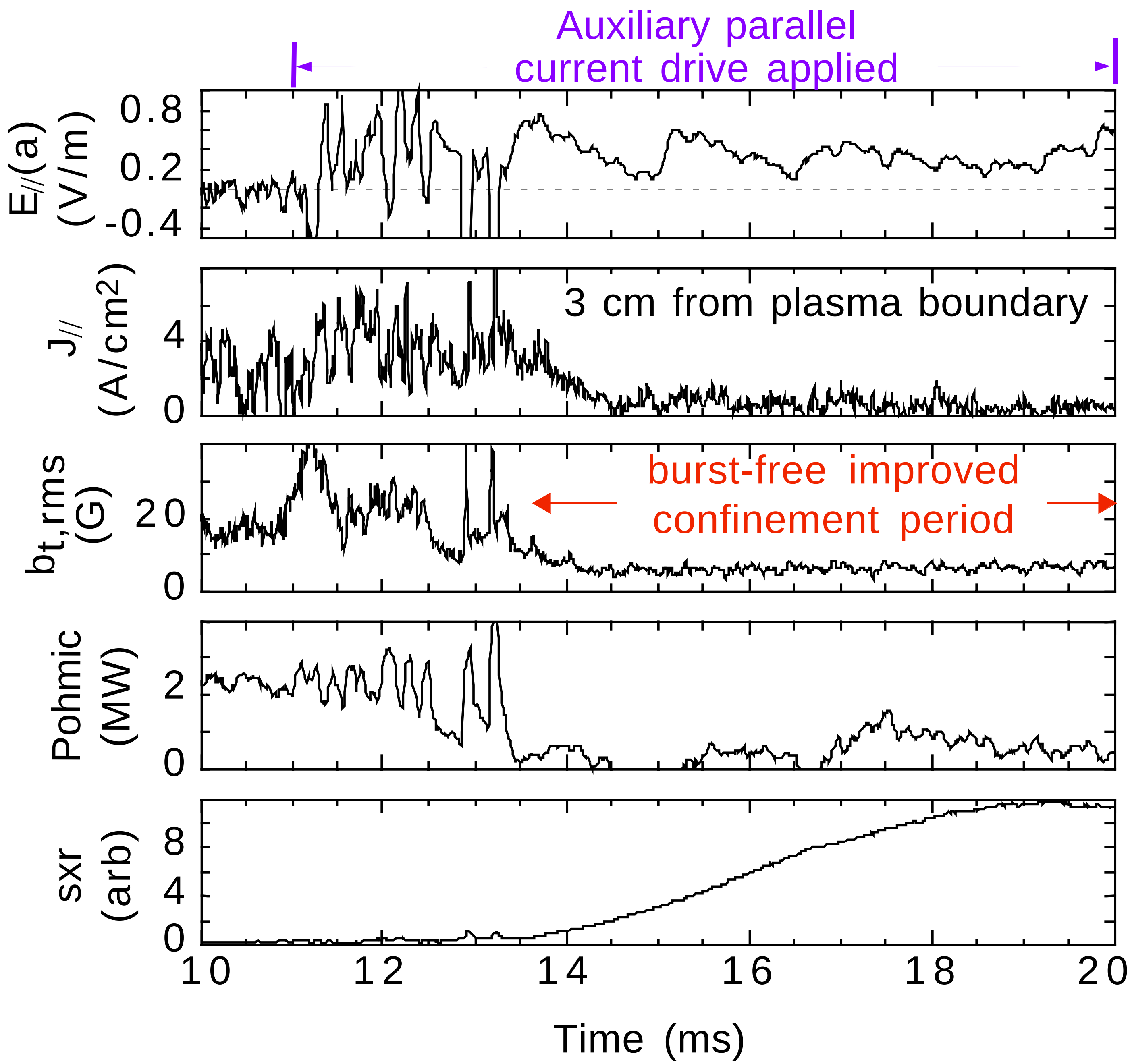




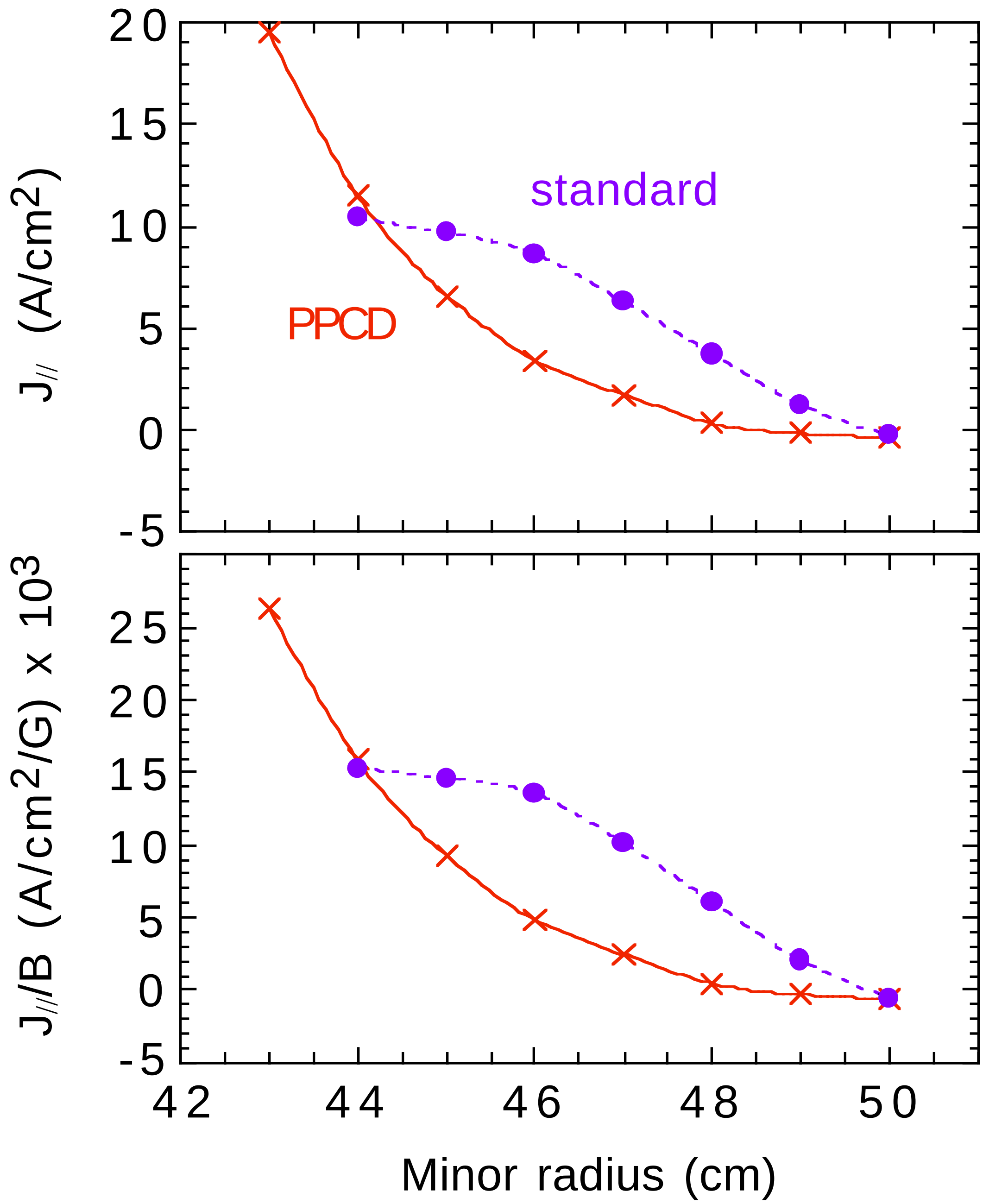
Data courtesy of C.-S. Chiang

Reduction of edge parallel current and heat flux during PPCD

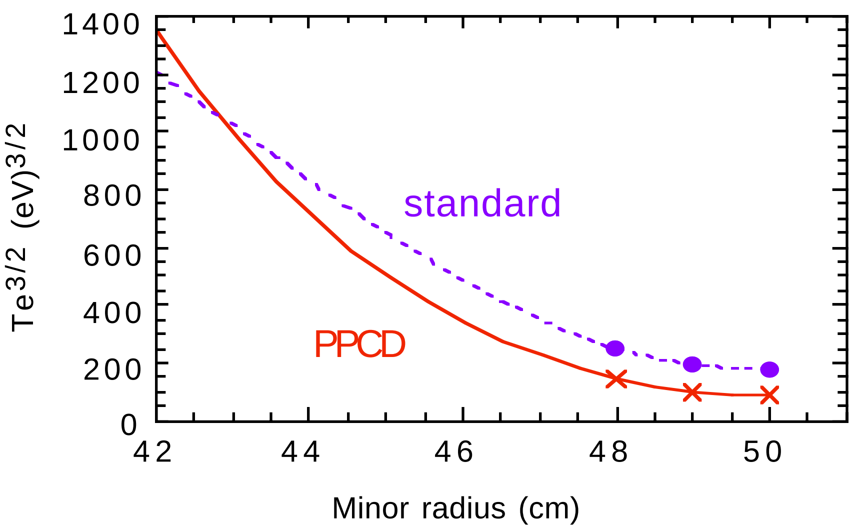
Edge parallel current is reduced during improved confinement, burst-free PPCD



<u>During burst-free PPCD, edge current is reduced and edge current profile steepens</u>



During burst-free PPCD, edge conductivity and the dynamo emf appear to drop



-- Edge datapoints from Langmuir probe spline fit to Thomson scattering data further inside

-- $\Delta(Z_{eff})$ unknown

-- MHD dynamo electric field measured at 48 cm with B-dot and spectroscopic probes:

E_{dynamo} (standard) = 0.77 V/m

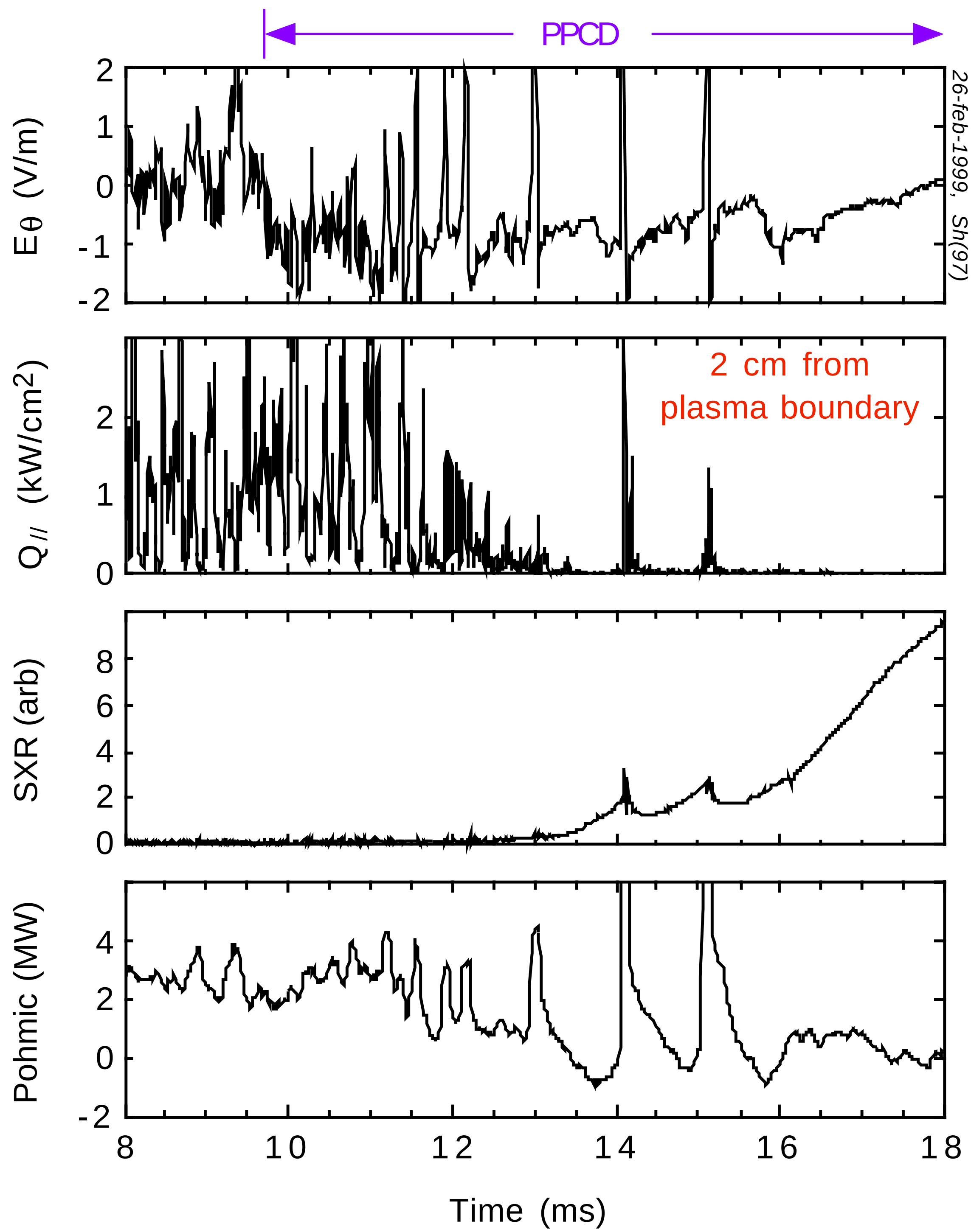
E_{dynamo} (PPCD) = 0.17 V/m

-- Parallel Ohm's law: $J = \sigma(E_{applied} + E_{dynamo})$

-- E_{dynamo} and/or σ decrease more than $E_{applied}$ increases

-- So changes in fluctuations and transport induced by PPCD play larger role in determining edge current than does PPCD itself

Consistent with the drop in edge current, the edge parallel heat flux drops as well



How are the fluctuations reduced?

-- Current profile modification one obvious explanation for PPCD

-- But magnetic and electrostatic fluctuations are reduced globally (got more than we hoped for)

-- EC, IHTM, and α-mode discharges have characteristics similar to PPCD (particularly in MST)

-- So explanations not based solely on current drive may be needed as well ($E \times B$ flow shear, etc.)

Which fluctuation reductions account for reduced energy transport?

-- Expect core reduction due to reduced m = 1 tearing fluctuations

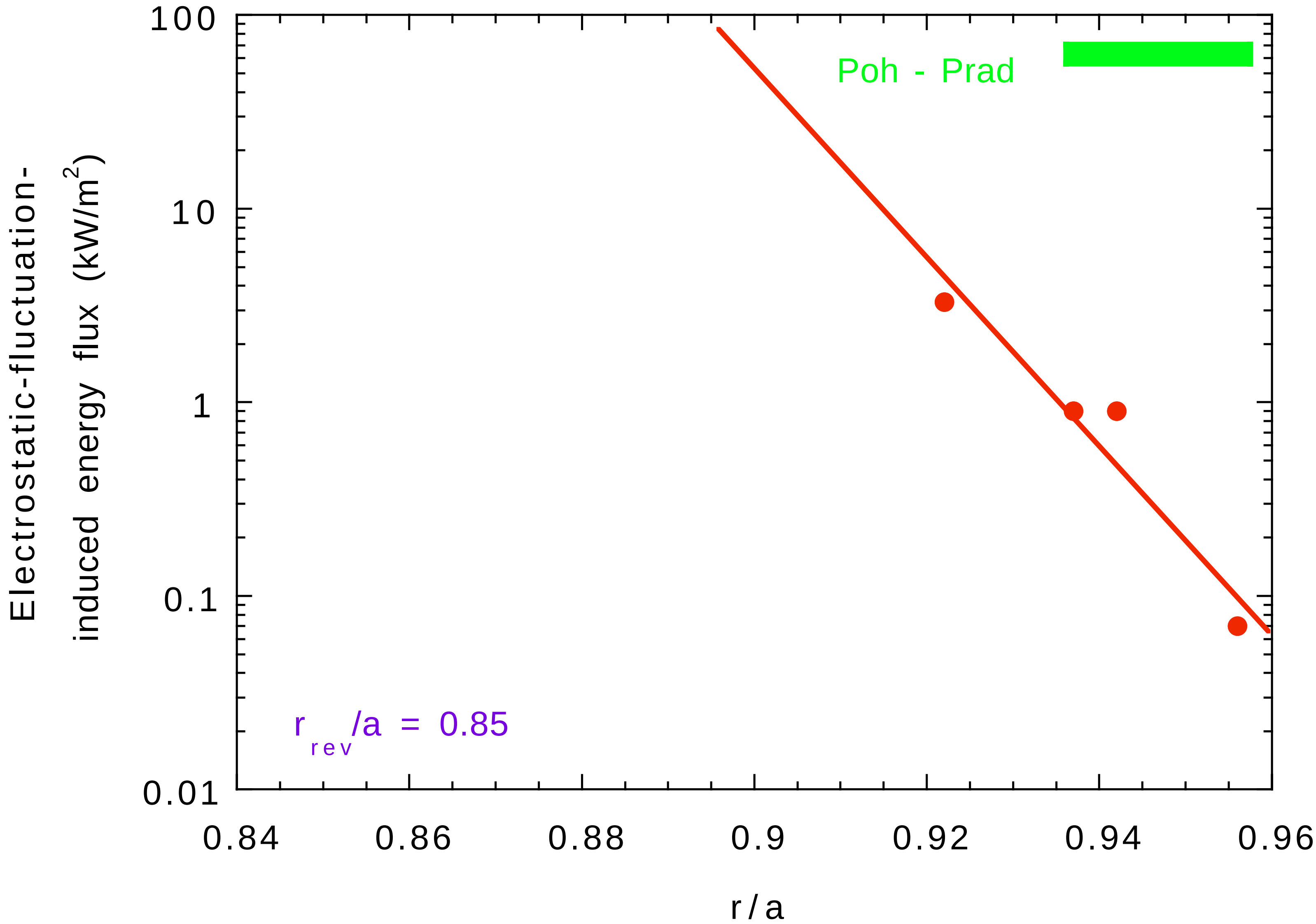
-- In the edge ($r/a > r_{rev}/a \sim 0.85$) of standard discharges:

(1) little contribution to energy transport from magnetic fluctuations

(2) electrostatic contribution also small, but have no data for $r/a < 0.92$

-- With $r_{rev}/a \sim 0.65$-0.75 (PPCD, EC), is "edge" region much broader?

Energy flux from electrostatic fluctuations small but increasing exponentially (Rempel et al., 1992)



Summary

-- Suppression of edge bursts key to sustained global fluctuation reduction

-- Magnetic fluctuations (m=1 and m=0) reduced in core and edge with single helicity spectra occurring in some PPCD and standard discharges

-- Density and potential fluctuations are reduced

-- Edge parallel current, parallel heat flux, conductivity, and dynamo electric field reduced

-- Role of edge fluctuation reduction in decreased energy transport not yet determined