NSTX

Supported by

U.S. DEPARTMENT OF ENERGY | Office of Science

Effect of 3-D magnetic perturbations on divertor heat and particle flux profiles

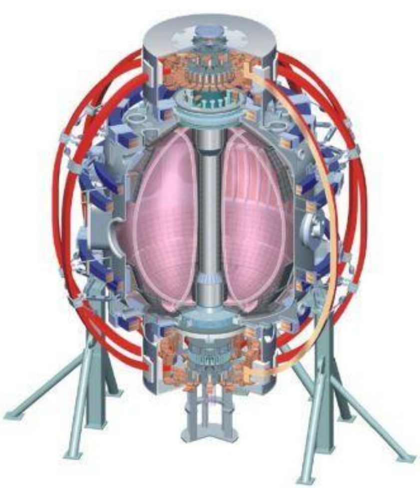
Joon-Wook Ahn, ORNL

Oak Ridge National Laboratory

J.M. Canik, R. Maingi, A.G. McLean, J.D. Lore, T.K. Gray, (ORNL), J.-K. Park (PPPL), V.A. Soukhanovskii (LLNL), A. Loarte (ITER)

and the NSTX Research Team

NSTX Result Review
Princeton, NJ
Nov 30-Dec 2, 2010



College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

This year's focus – parameter dependence

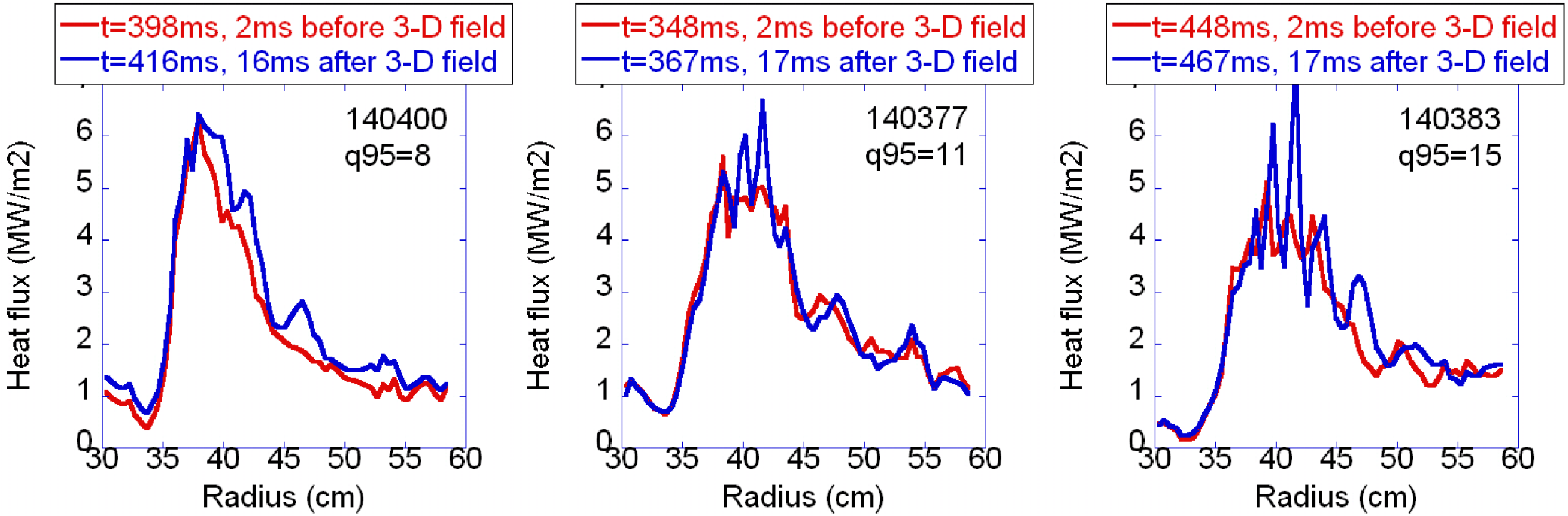
XP-1046

- Dependence on q95
- Dependence on pedestal collisionality
- Toroidally asymmetric heat and particle deposition (n=1)

XP-1026

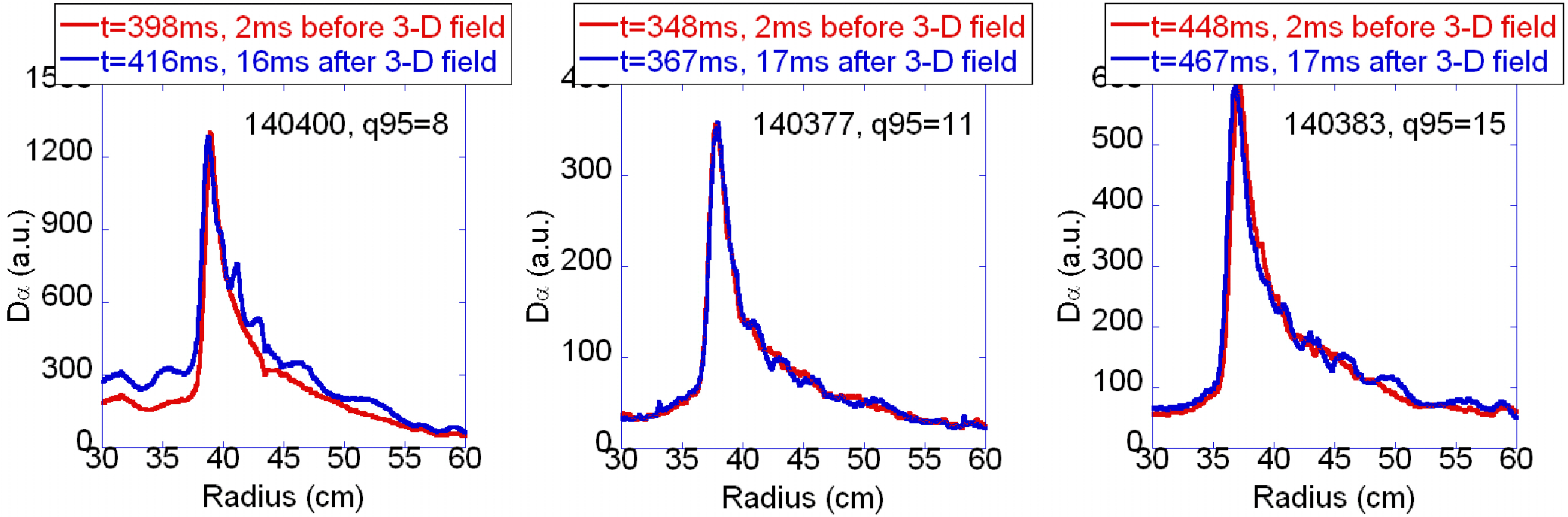
- Dependence on divertor collisionality
  → Effect of 3-D field on divertor detachment

Fraction of heat flux through split strike point channel is higher in higher q95 case



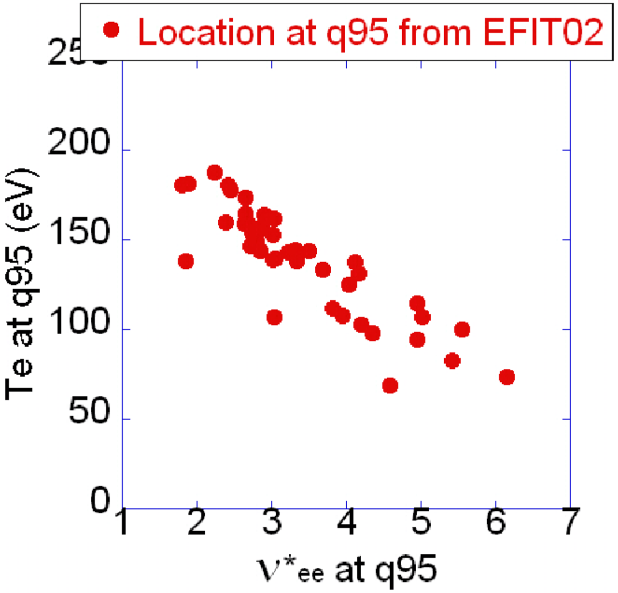
- Effect of 3-D field on the strike point splitting in heat flux profile becomes stronger with increasing q95
- Intrinsic strike point splitting in heat flux profile is also stronger in high q95

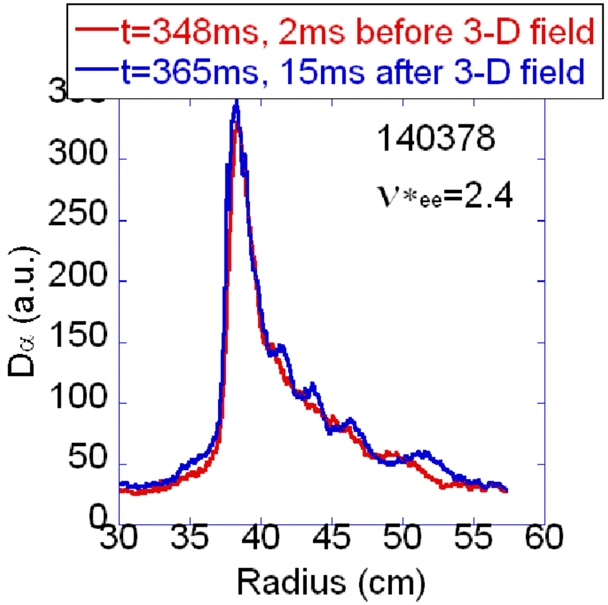
Splitting in Dα profile does not show as strong dependence on q95 as in heat flux

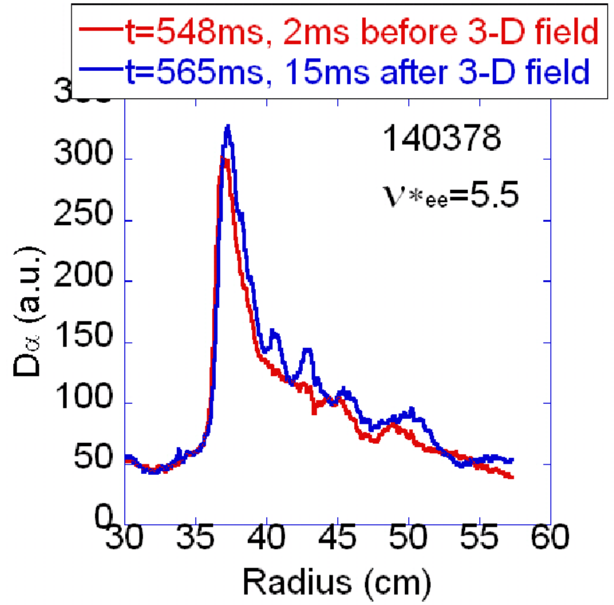


- Splitting in Dα profile by applied 3-D field shows less dependence on q95 than in heat flux profile
- Low q95 produces more pronounced strike point splitting, ie opposite trend to the heat flux profile???

Higher pedestal collisionality helps produce stronger profile splitting

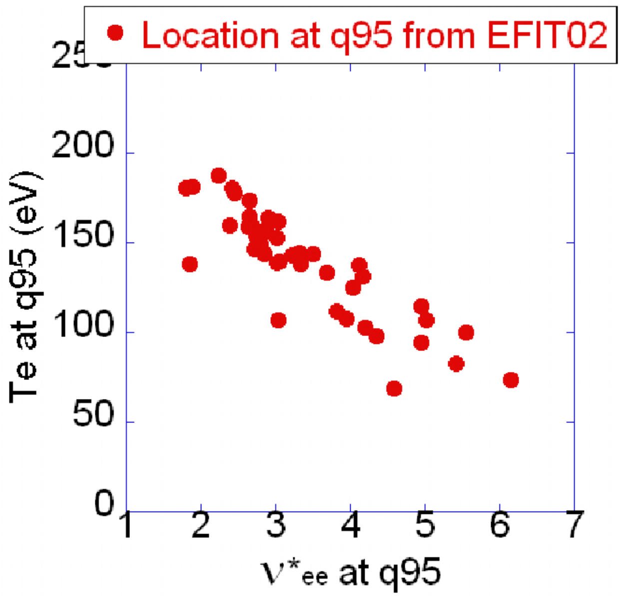


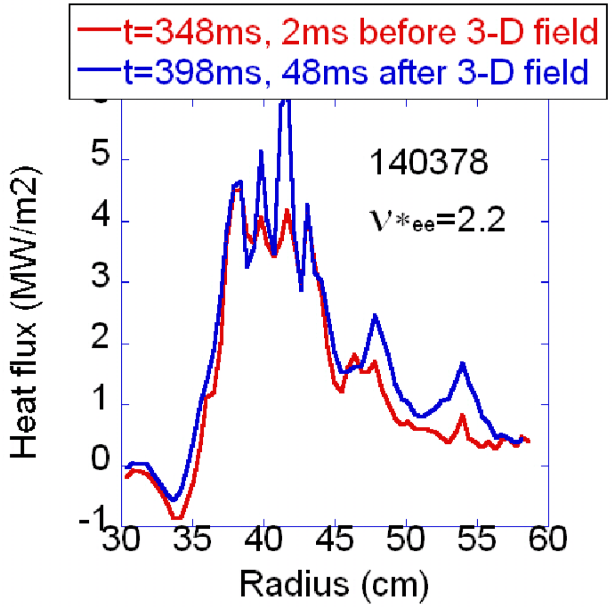


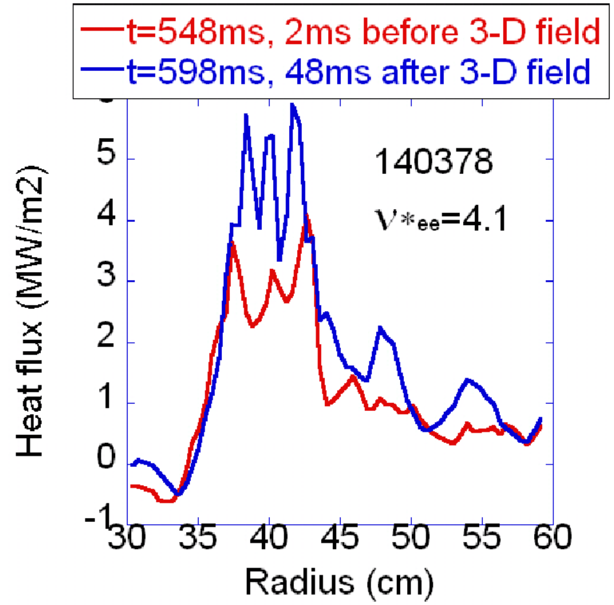


- Pedestal electron collisionality is high ($v^*_{ee, q95}$=2-6) and shows clear correlation with pedestal T_e
- Splitting in D_α profile becomes stronger with higher collisionality

Higher pedestal collisionality helps produce stronger profile splitting

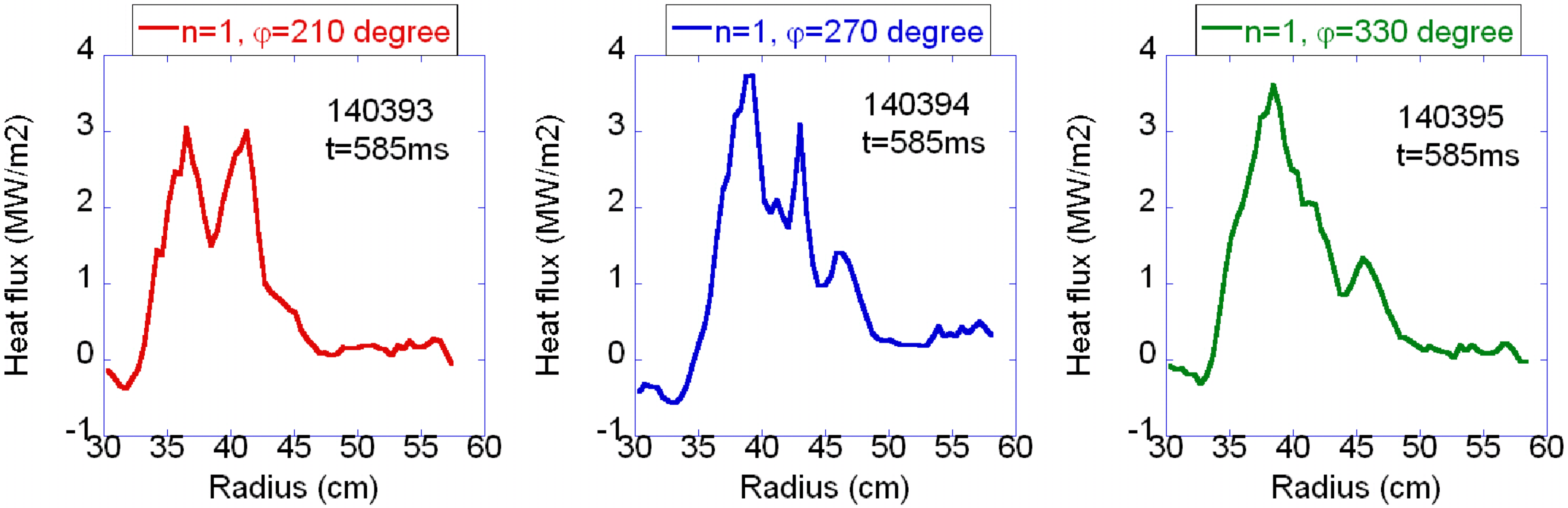






- Pedestal electron collisionality is high ($v^*_{ee,\, q95}$=2-6) and shows clear correlation with pedestal T_e
- Splitting in D_α profile becomes stronger with higher collisionality
- Heat flux profile splitting shows less consistent trend with collisionality

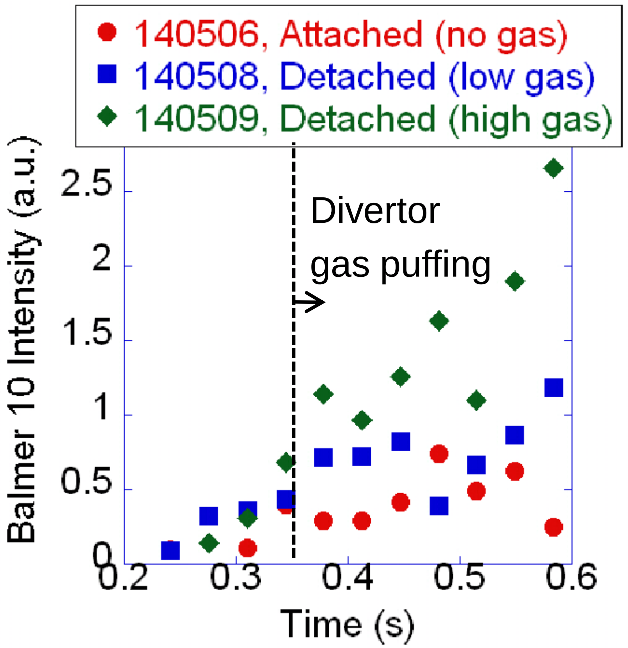
n=1 field application produces clear non-axisymmetric divertor profiles



- Application of n=1 field is expected to produce less splittings in the divertor profiles and different splitting patterns at different toroidal angles → Static rotation of applied n=1 field

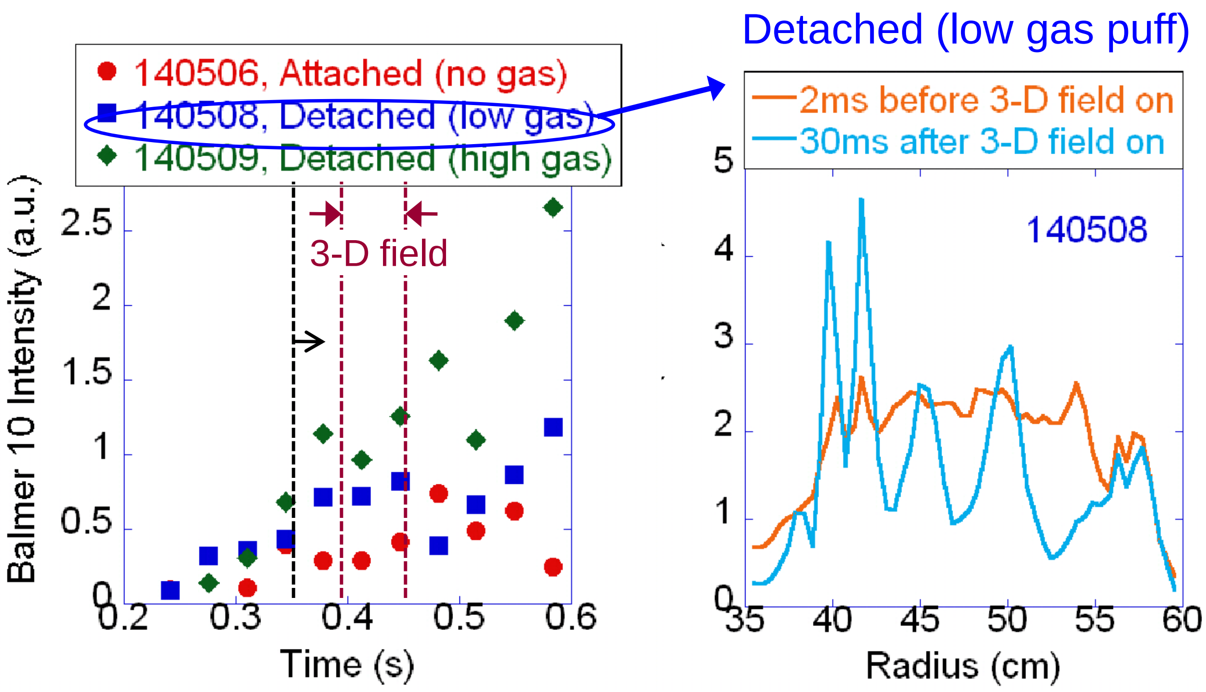
- Comparison with field line tracing shows good agreement

Applied 3-D fields can reattach detached plasma



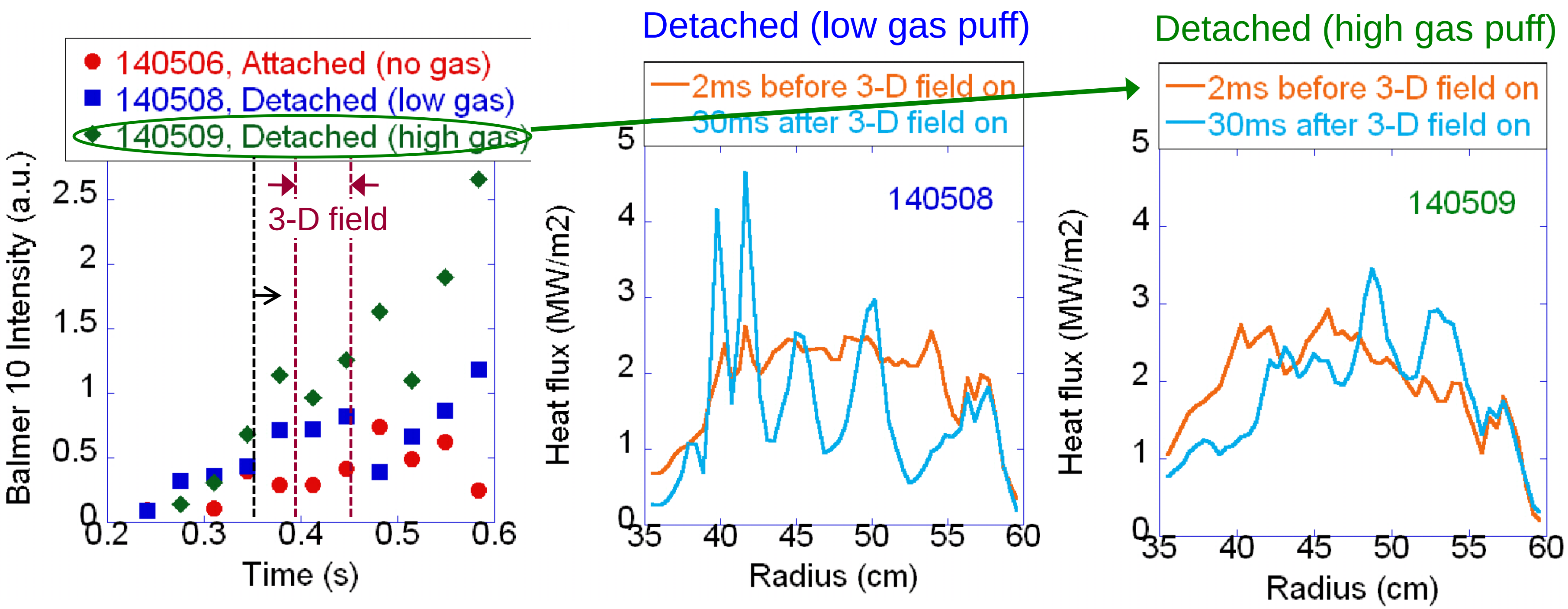
- Divertor plasma was made increasingly detached by raising divertor gas puffing
- Divertor plasma regime was monitored by multiple diagnostics (divertor spectroscopy, Langmuir probe, IR camera, etc)
- Balmer 10 line intensity: good indicative of volume recombination, characteristic of divertor detachment

Applied 3-D fields can reattach detached plasma



- Applied 3-D fields make the detached divertor plasma re-attach in medium divertor gas level, leading to a peaked heat flux profile again

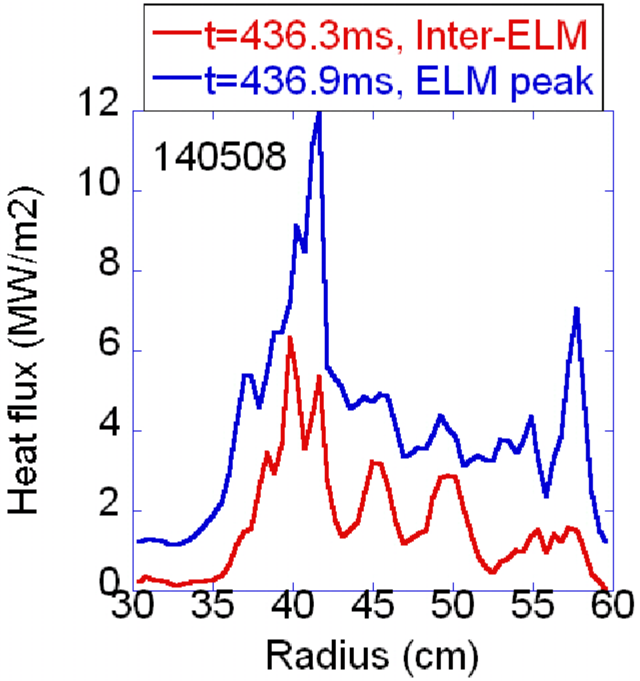
Applied 3-D fields can reattach detached plasma



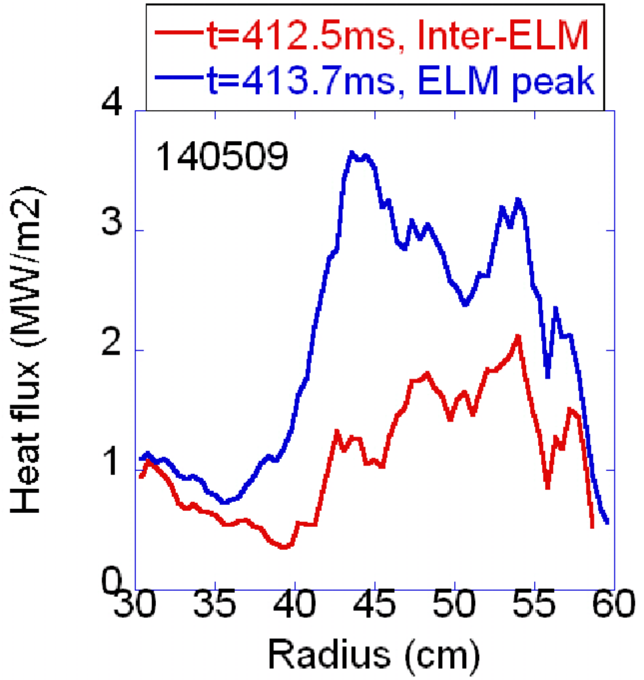
- Applied 3-D fields make the detached divertor plasma re-attach in medium divertor gas level, leading to a peaked heat flux profile again
- If the divertor gas puffing is high enough, plasma stays in the detached regime even with 3-D field applied

Divertor plasma can stay in the detached regime even during the ELM with strong gas puffing

3-D field to detached plasma (low gas)



3-D field to detached plasma (high gas)



- Both the inter-ELM and ELM heat flux profiles show peaked deposition at the separatrix with lower gas puffing rate

- Higher gas puffing produces significantly lower and flat heat flux profiles and makes the ELM size smaller, 3-D field produces striations only in the far SOL

Summary

- Higher q95 produces more splittings in the divertor profiles and higher fraction of heat flowing into the split strike point channels
- Higher pedestal collisionality makes the D_α profile splitting stronger but heat flux profile shows less clear trend in the range investigated, $2< \nu^*_{ee} <6$
- The toroidally asymmetric heat and particle deposition pattern by n=1 field application was confirmed experimentally
- 3-D fields can reattach detached divertor plasma but it can be overcome by additional gas puffing.