Effect of Magnetic Geometry on ELM Heat Flux Profiles*

C.J. Lasnier,[a] A.W. Leonard, T.W. Petrie, and J.G. Watkins[a]

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

[a]Lawrence Livermore National Laboratory, Livermore, California 94551

[b]Sandia National Laboratories, Albuquerque, New Mexico

presented at the
14th International Conference on
Plasma Surface Interactions
in Controlled Fusion Devices

Rosenheim, Germany

May 22 - 26, 2000

GENERAL ATOMICS

105-00/rs

ABSTRACT

We explore what degree of magnetic control is necessary to insure sharing of edge localized mode (ELM) heat flux between upper and lower divertors in a double-null tokamak. We show for DIII-D using infrared thermography that the spatial distribution of Type-I ELM energy is less strongly affected by variations in magnetic geometry than is the time-averaged peak heat flux in attached discharges. We found that the degree of control necessary to share ELM heat flux deposition equally between divertors was less stringent than the control needed to balance the time averaged heat flux. We find that ELM energy is transported more than four times further into the scrape-off layer than the time-averaged heat flux.

*Work supported by the U.S. Department of Energy under Contract Nos. DE-AC03-99ER54463, W-7405-ENG-48, and DE-AC04-94AL85000

105-00 /rs

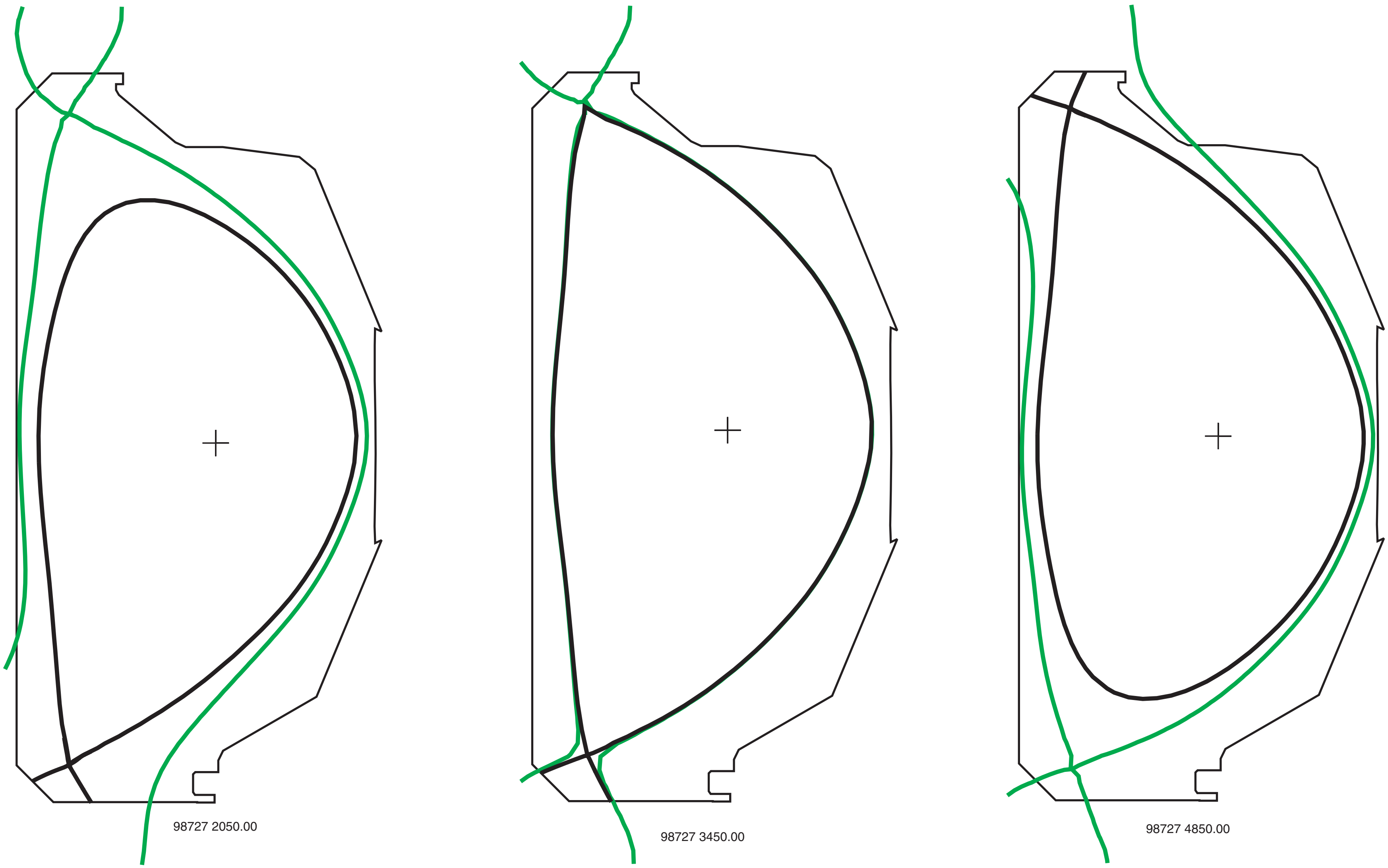
DEFINITION OF MAGNETIC BALANCE

- DRSEP = radial distance at the outer midplane between the flux surfaces connected to the upper and lower X–points

DRSEP = -3.8 cm **lower single null**

DRSEP = +0.1 cm **double null**

DRSEP = +3.4 cm **upper single null**

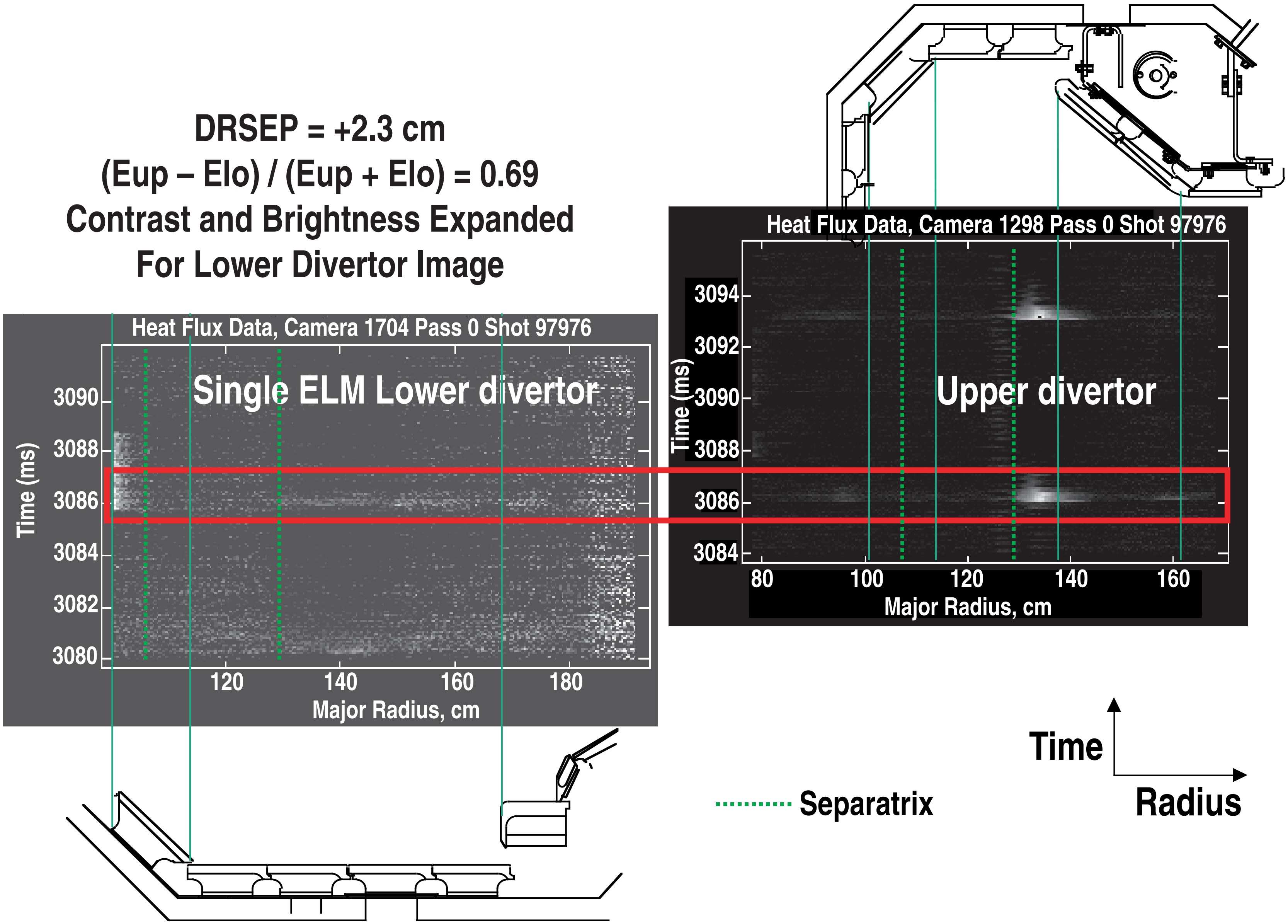


105-00 /rs

- **Plasma parameters:**
  - I_p = 1.4 MA
  - B_T = 2.0 T
  - Ion ∇B drift downward
  - $n_e \cong 5 \times 10^{13}\ m^{-3}$ (varying)
  - Attached Elming H–mode

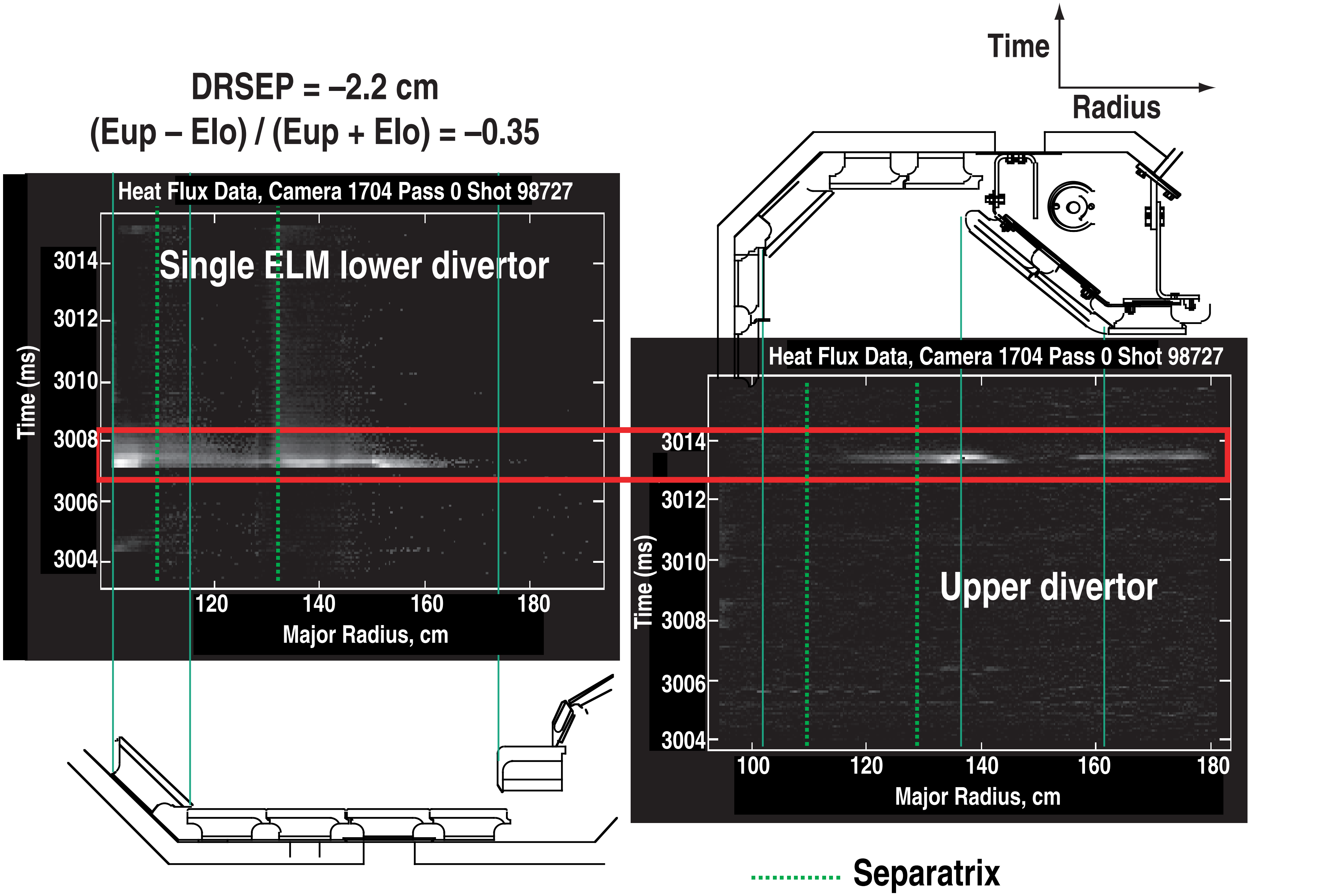
UPWARD BIAS GAVE LOCAL HOT SPOT

DRSEP = +2.3 cm
(Eup – Elo) / (Eup + Elo) = 0.69
Contrast and Brightness Expanded
For Lower Divertor Image



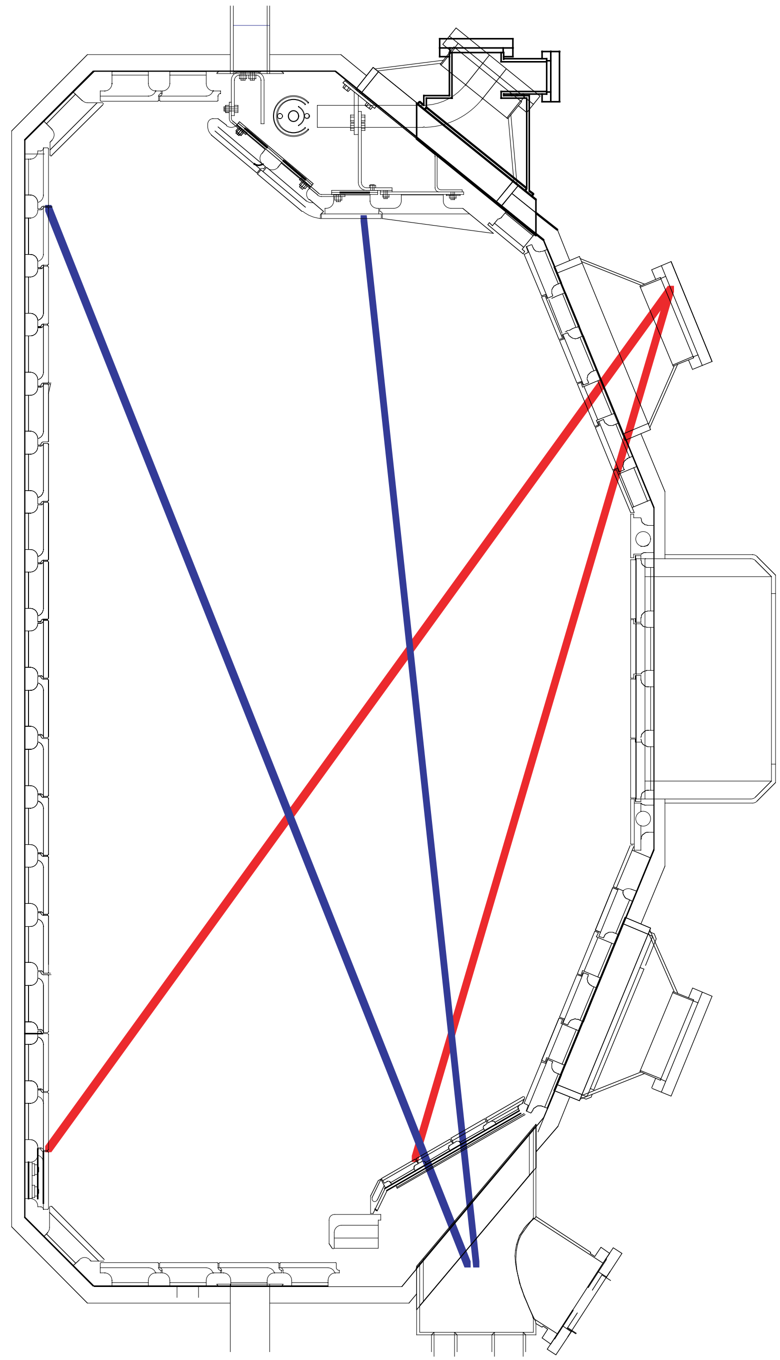
105-00 /RS

DOWNWARD BIAS GAVE BROAD ELM PROFILE IN LOWER DIVERTOR



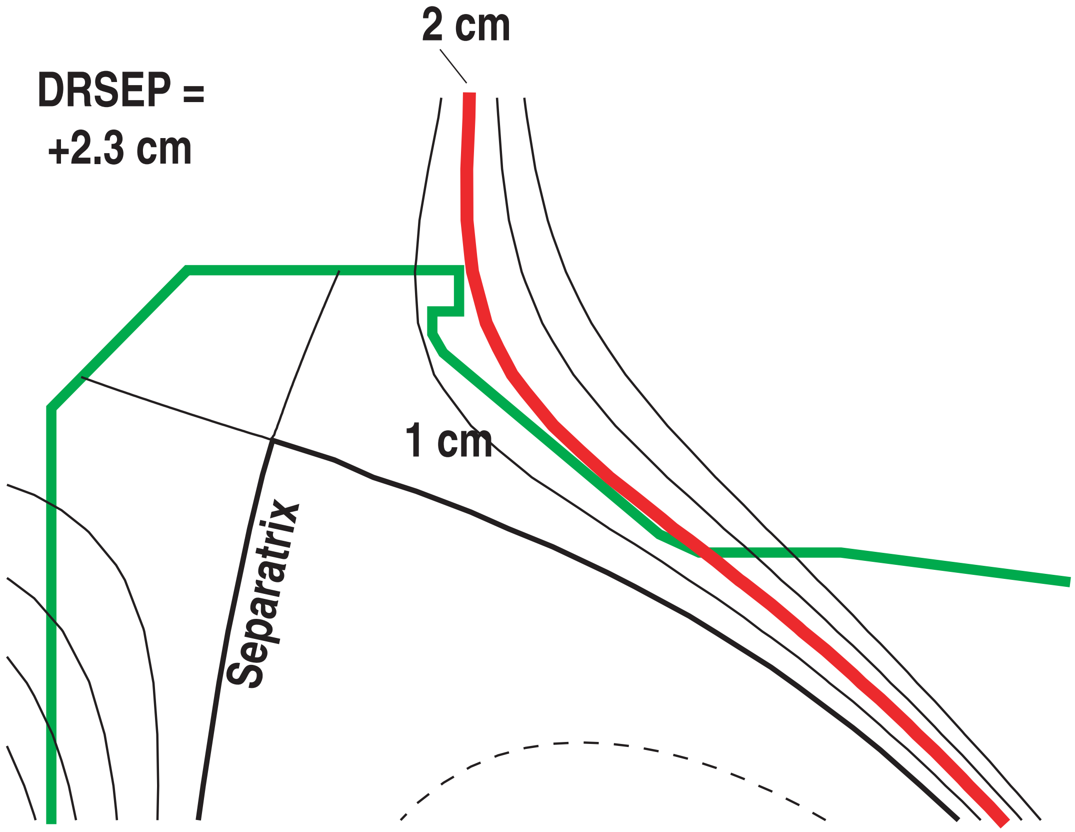
105-00 /RS

IRTV SIGHTLINES



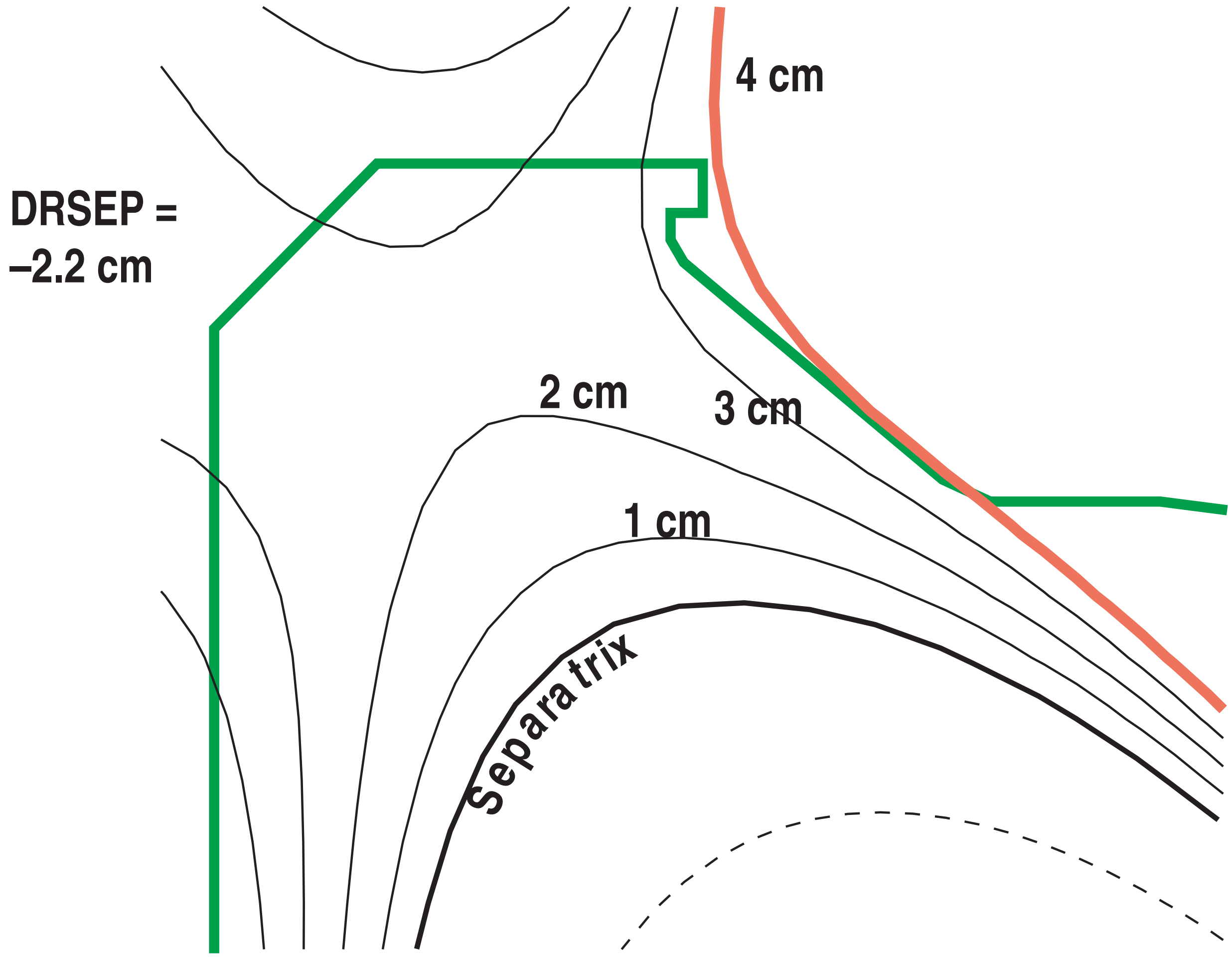
105-00 /rs

THE 2 CM FLUX LINE DID NOT CLEAR THE BAFFLE FOR DRSEP = +2.3 CM



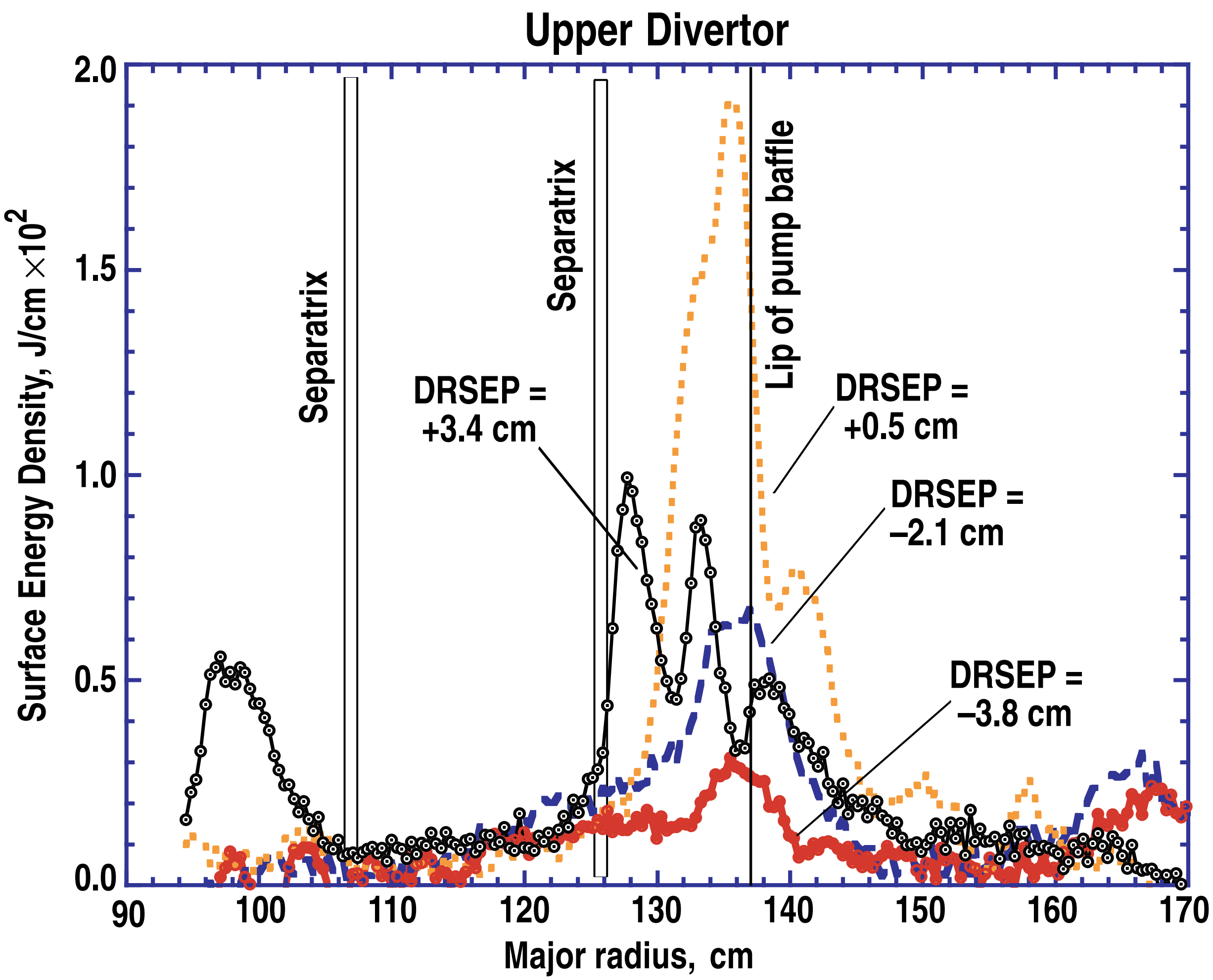
105-00 /rs

THE 4 CM FLUX LINE INTERSECTS THE UPPER BAFFLE FOR DRSEP = –2.2 CM



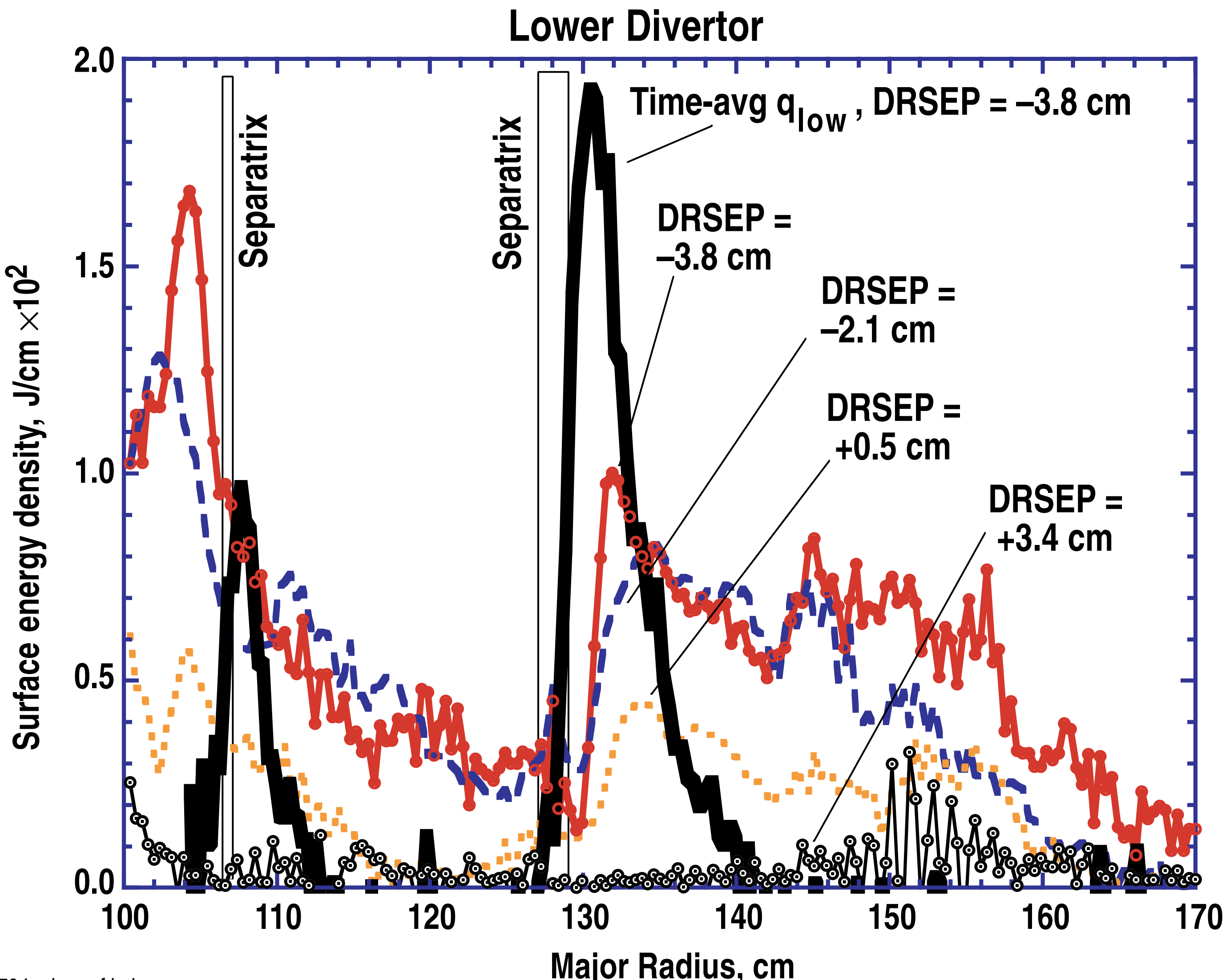
105-00 /rs

UPPER DIVERTOR PROFILES SHOW EFFECT OF DRSEP VARIATION



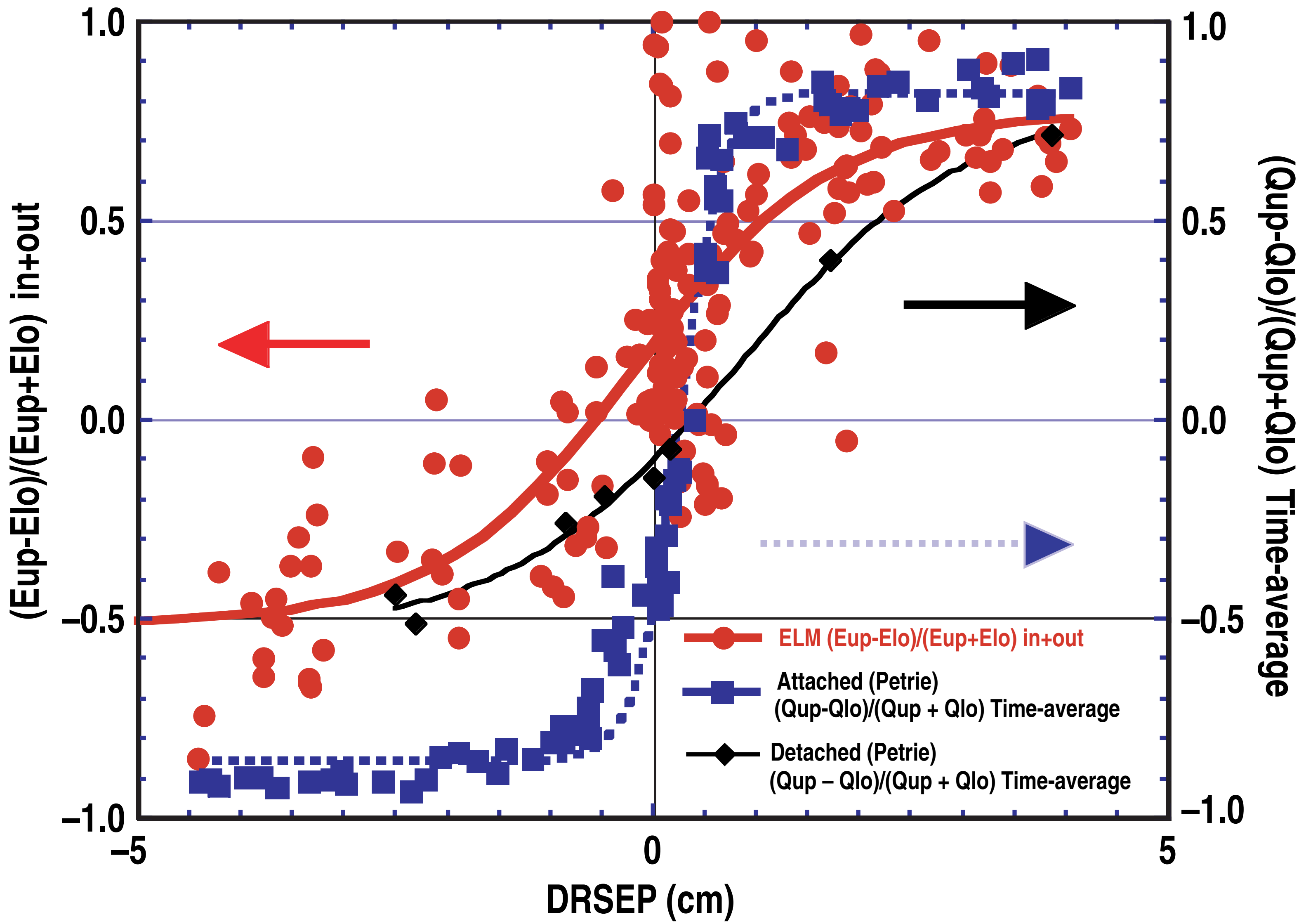
98727_1298_elmprof.kal

ELM HEAT NEAR THE SEPARATRIX IS MOST STRONGLY AFFECTED BY DRSEP



98727_1704_elmprof.kal

A LARGE CHANGE IN DRSEP IS NECESSARY TO SHIFT THE ELM HEAT TO THE OPPOSITE DIVERTOR



105-00 /rs

ELMs HAVE WIDER EFFECTIVE SCRAPE-OFF LENGTH

- ELM energy deposition DRSEP scale length: 1.9 cm
- Attached time-averaged heat flux 0.4 cm (Petrie, this meeting paper P-3.45)
- Detached time-averaged heat flux 2.2 cm (Petrie P-3.45)
- Median ELM energy on the divertor plates 10 KJ

UP/DOWN BALANCE DOES NOT AFFECT ELM ENERGY DISTRIBUTION AS STRONGLY AS TIME-AVERAGED HEAT FLUX

- The plot shows the difference between ELM energy deposited in the upper and lower divertor plates, divided by the total ELM energy reaching the divertor plates
- Upper divertor is similar to time-average
- Lower divertor is less dominant
- Upper divertor still shows a hot spot during ELMs on the nose of the upper baffle
- Some lower divertor energy outside view of camera
- ELM heat flux is easier to balance than the time-averaged heat flux

DISCUSSION

- The ELM energy behaves similarly to the peak heat flux when DRSEP is changed
- ELM deposited energy in the divertors is strongly affected by magnetic balance, but the effective scale length is longer than for time-averaged attached peak heat flux
- During downward bias, there is still a hot spot on the upper baffle during ELMs
- The energy deposited near the separatrix in the lower divertor is most strongly affected
- It is easier to balance ELM energy between upper and lower divertor than to balance the time-averaged heat flux. DRSEP does not have to be controlled as precisely