

AN EXPERIMENT ON THE CONCEPT OF ACTIVE RECYCLING CONTROL USING MOVING SURFACE PLASMA FACING COMPONENT

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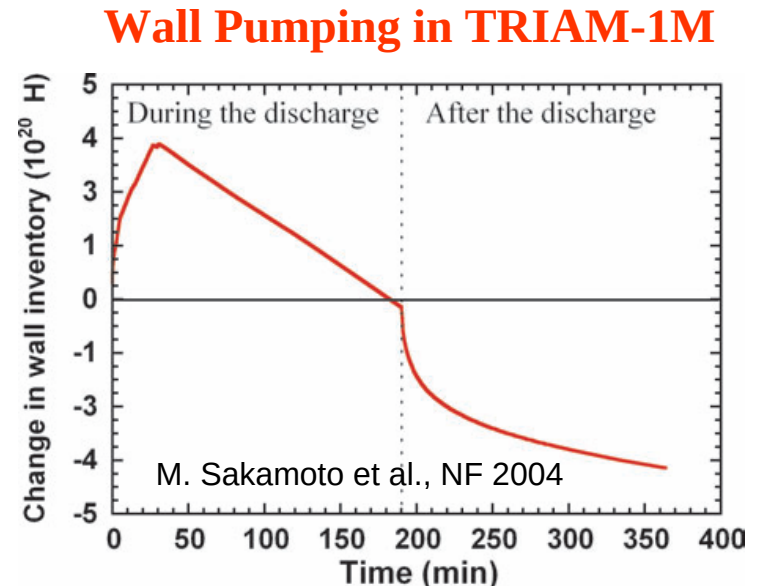
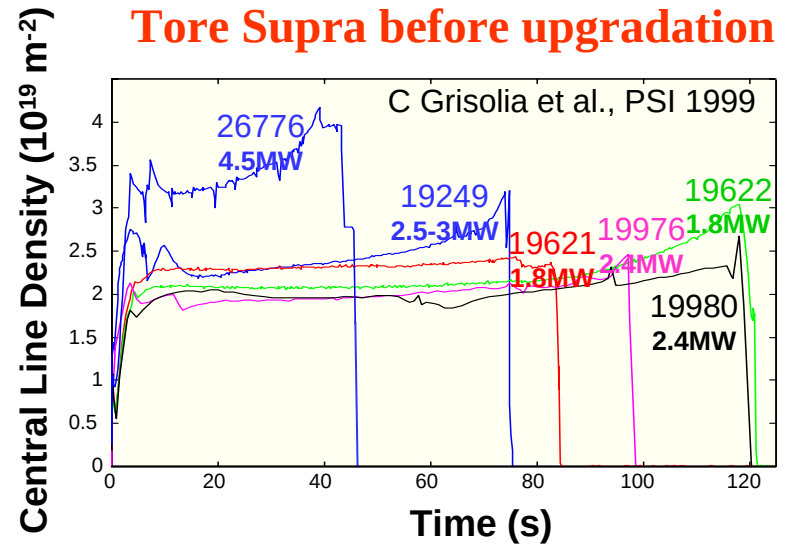
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in Steady State Magnetic Fusion Devices
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Introduction

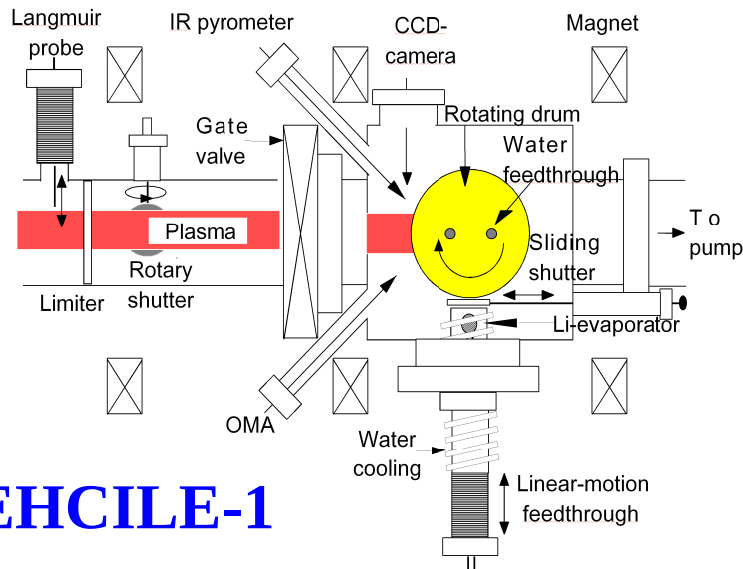
- One of the key issues for SSO of magnetic confinement devices is the plasma density control
- **reduced edge recycling is beneficial => controlled wall pumping.**
- Wall pumping efficiency depends on PFC surface property and is limited in time duration
- Wall conditioning will have finite lifetime
- **Enabling wall concept is required for SSO.**



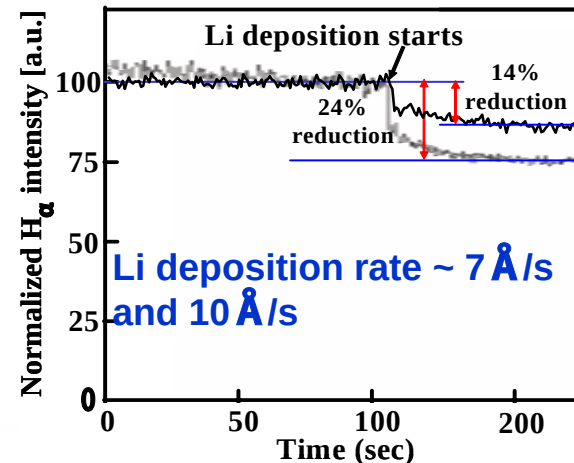
Introduction (contd..)

•A variety of innovative concepts have been proposed using moving surface plasma facing components (MS-PFC), for online regeneration of particle trapping capabilities.

POP Experiments in laboratory scale linear plasma facility



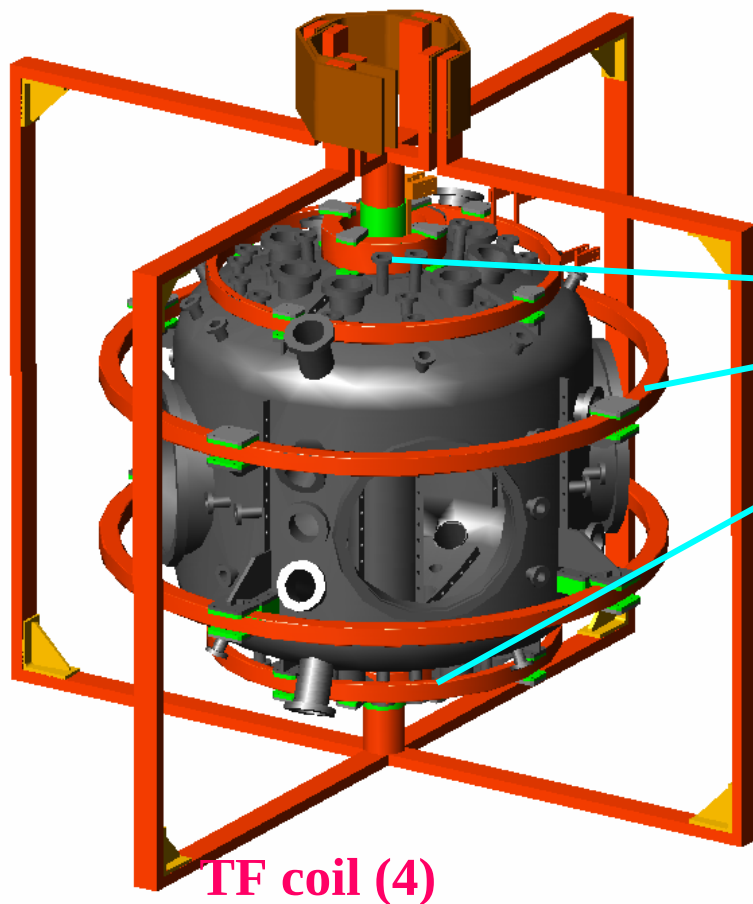
VEHICLE-1



Y. Hirooka et al. Fusion Sci. Technol. 47 2005

A similar rotating drum but coated with plasma-sprayed tungsten has been employed as the limiter in the Compact Plasma-wall interaction Device (CPD) to evaluate the particle control capability of MS-PFC and its effect on the core plasma performance.

CPD EXPERIMENTAL DEVICE



TF coil (4)

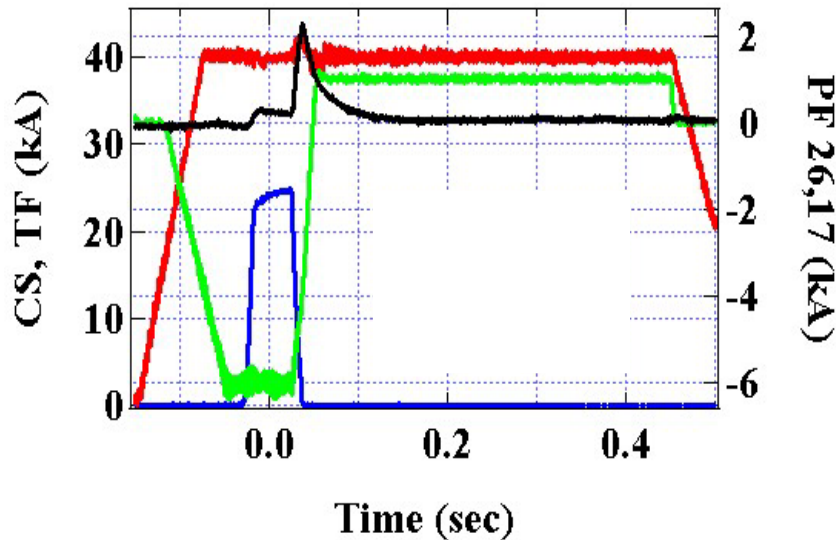
PF coil (3 Pair)

8.2 GHz Klystrons (8×25 kW, CW) are used to inject RF power for the production of RF plasma as well as for ECH

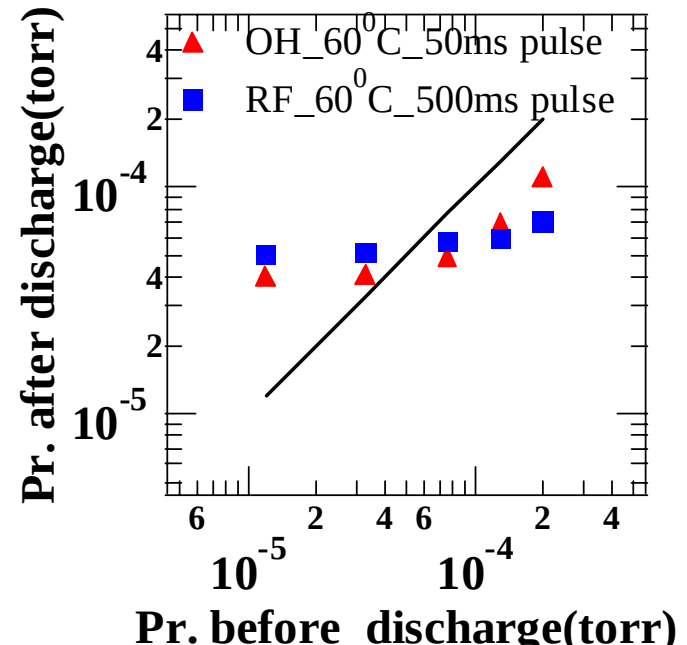
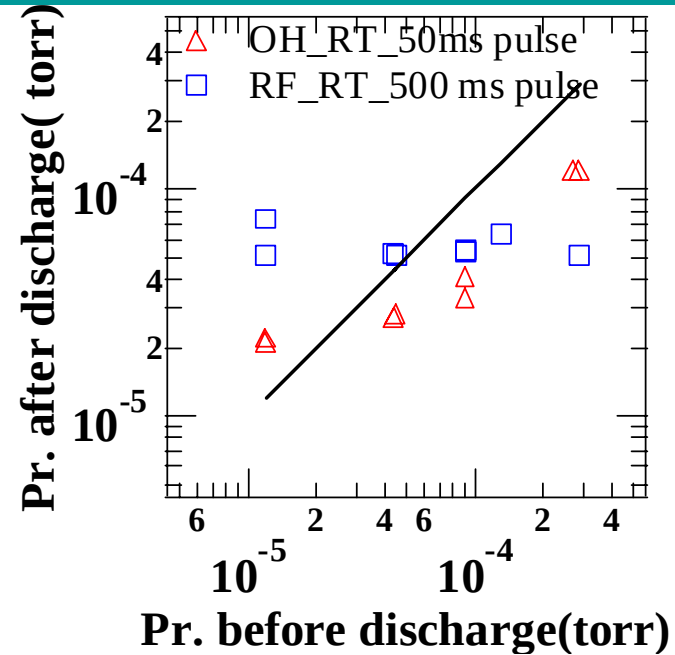
Vacuum vessel radius	0.6m
Center stack radius	0.135m
Plasma major radius (R_0)	0.3m
Plasma minor radius (a)	0.2m
Toroidal magnetic field (B_T) at R_0 for $I_{TF} = 4 \times 90$ kA	0.25 T
Aspect ratio ($A = R_0/a$)	1.5

Wall pumping experiment in CPD

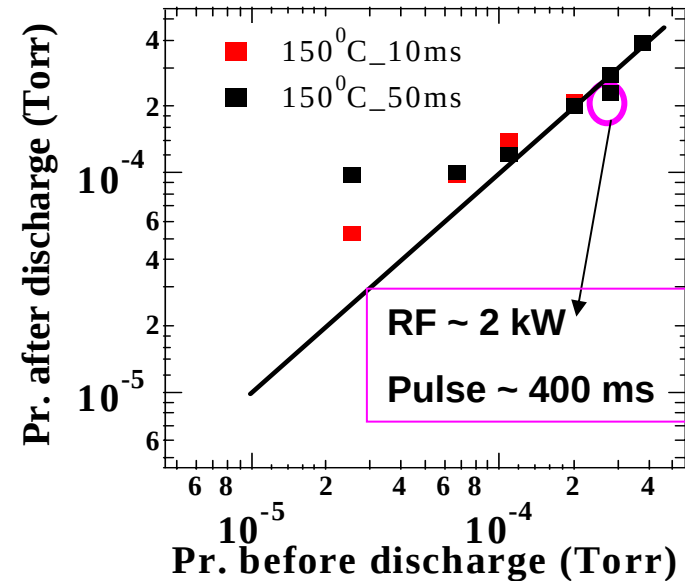
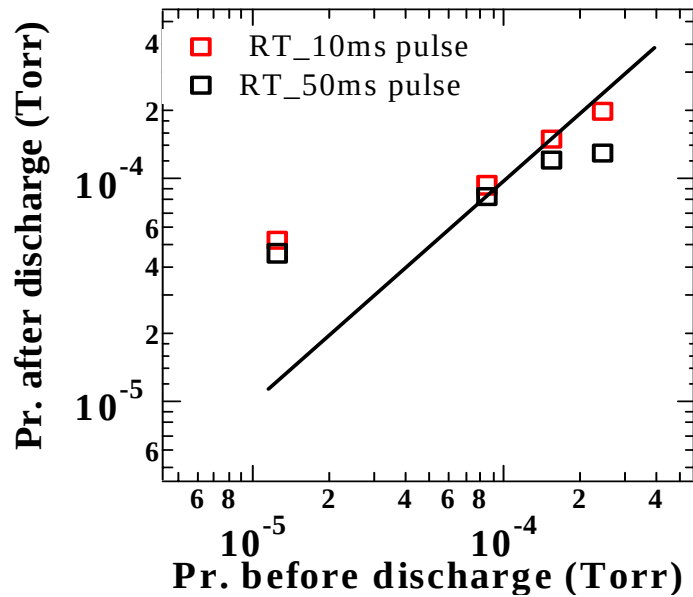
Typical coil current waveforms in CPD



- No external pumping
- Experiment is carried out during last two days of last year three month experimental campaign
- A critical gas pressure is observed beyond which wall pumping is observed in both short pulse(50 ms) and long pulse(500 ms) discharges

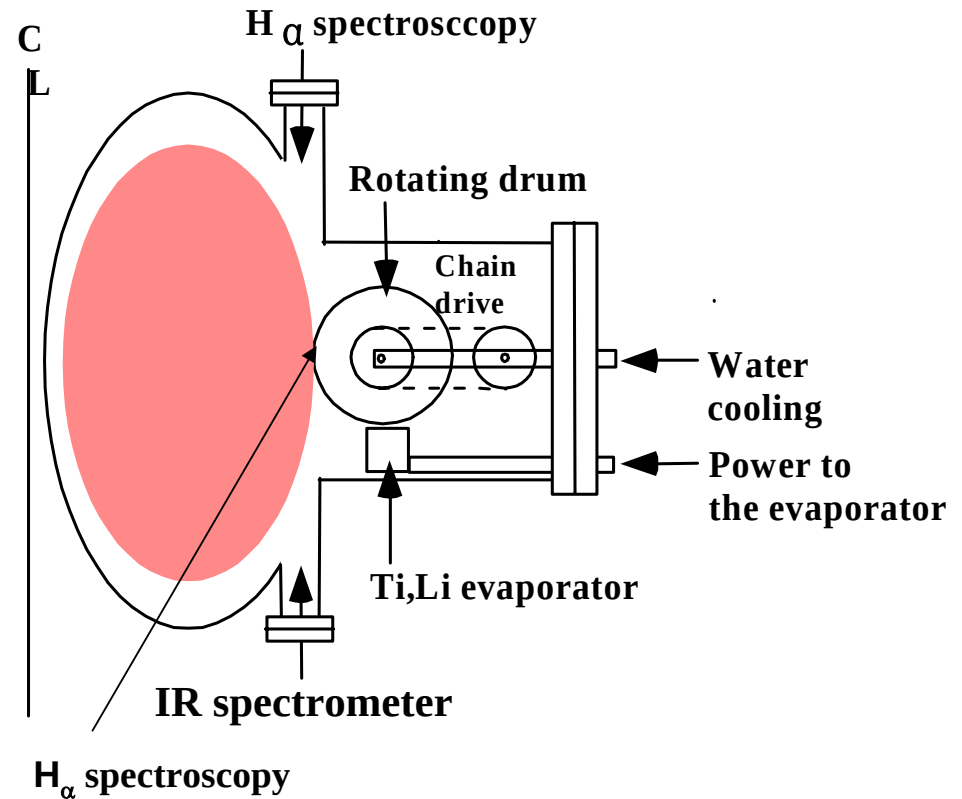
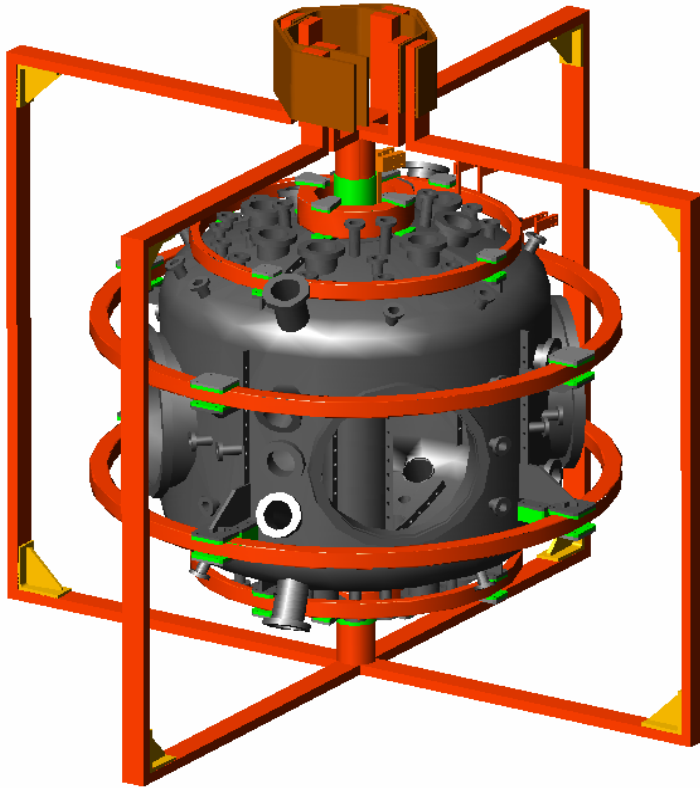


Wall pumping experiment in CPD (*contd..*)



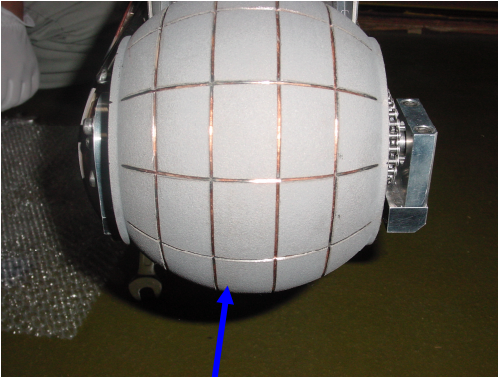
- Similar experiment is carried out just after two month vessel venting.
- Wall pumping effect is still observed at room temperature condition but at baking temperature of $\sim 150^{\circ}\text{C}$, no sign of wall pumping is found.

CPD and Rotating Limiter arrangement

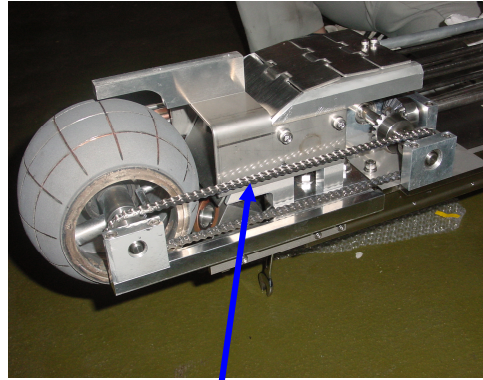


Various Components of Rotating Limiter Arrangement

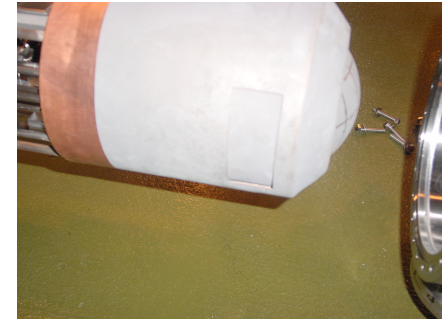
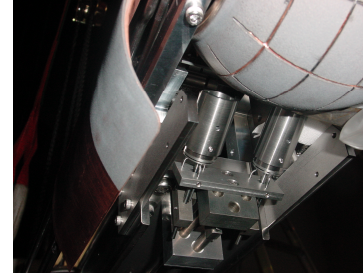
Plasma-sprayed W on the Cu rotating limiter with an active cooling system.



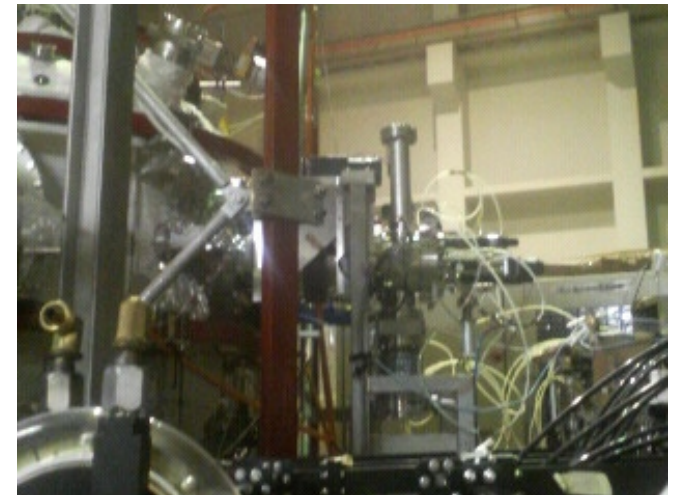
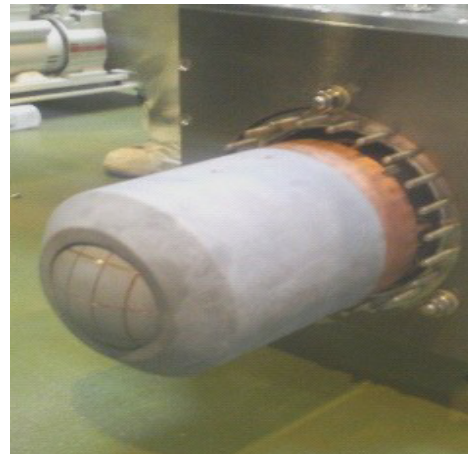
Rotating Drum



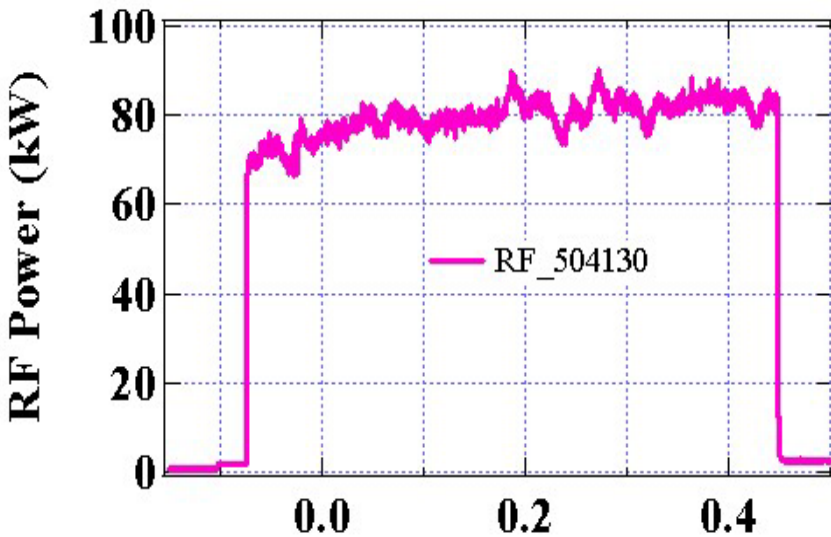
Chain Drive Arrangement



Rotating Limiter attachment with CPD



Experimental Condition



2nd harmonic plasma breakdown using ~80 kW RF power ($R_{\text{res}} = 21.33 \text{ cm}$)

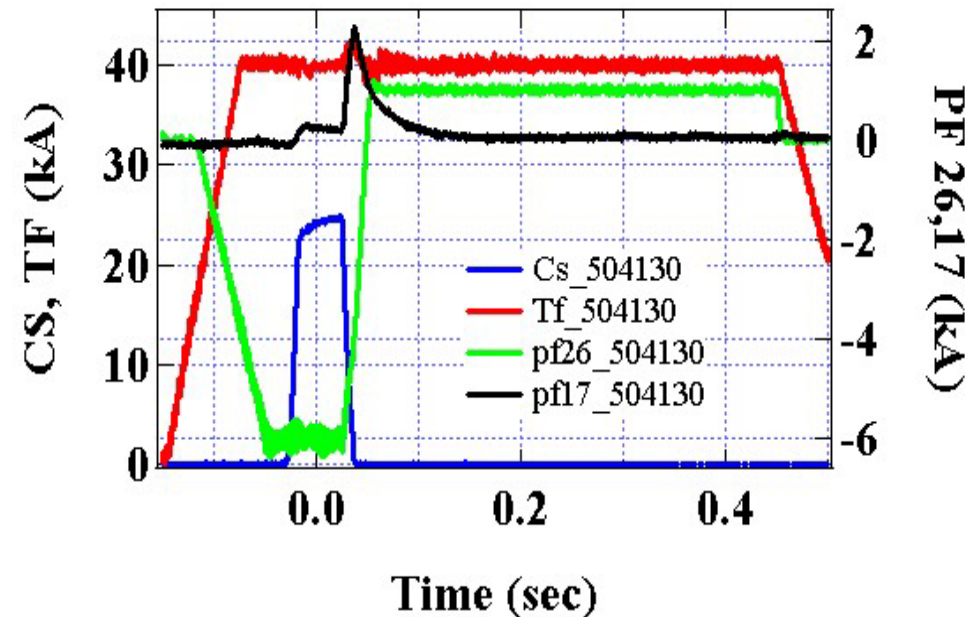
Ohmic phase is only for ~10 ms;

Pure RF plasma after ~35 ms;

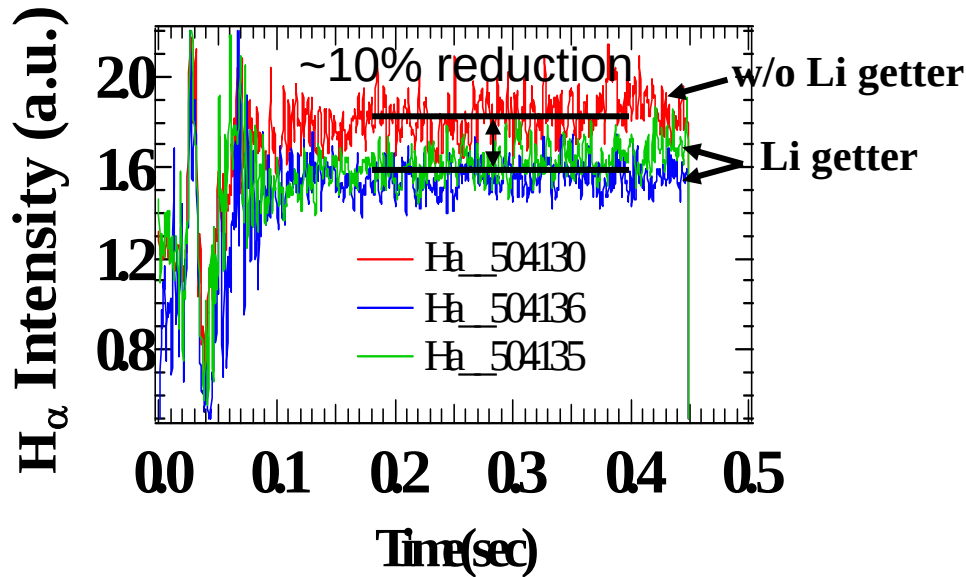
RL head position is ~ 44.0 cm;

Rotating speed : 10 rpm;

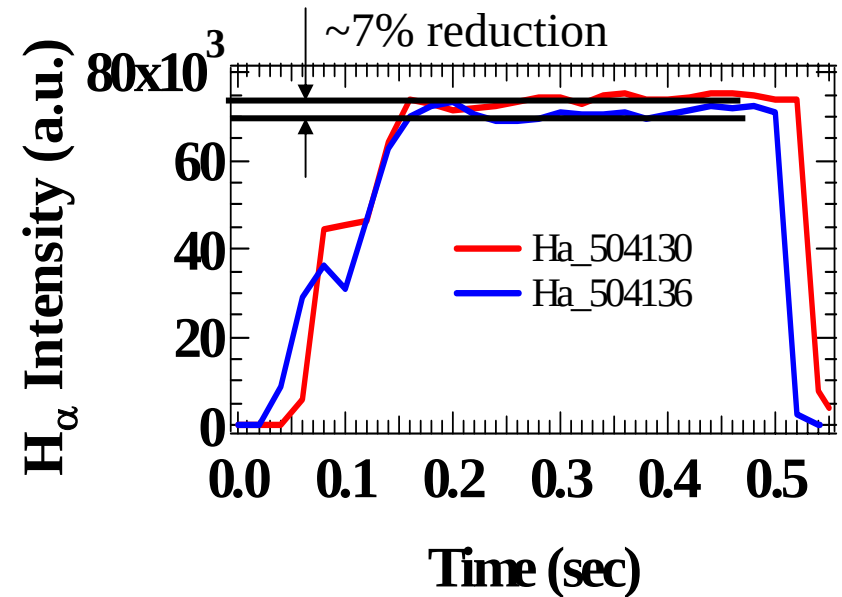
Li evaporator current : 85 A



First Experimental Result



Tangential view at limiter surface
from radial port



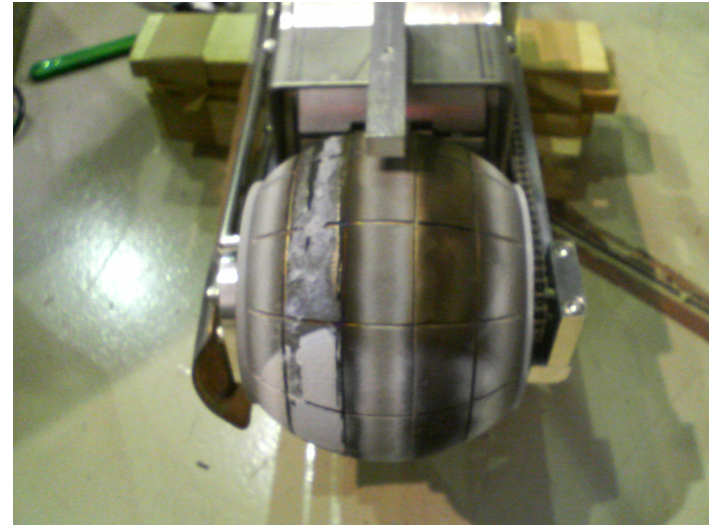
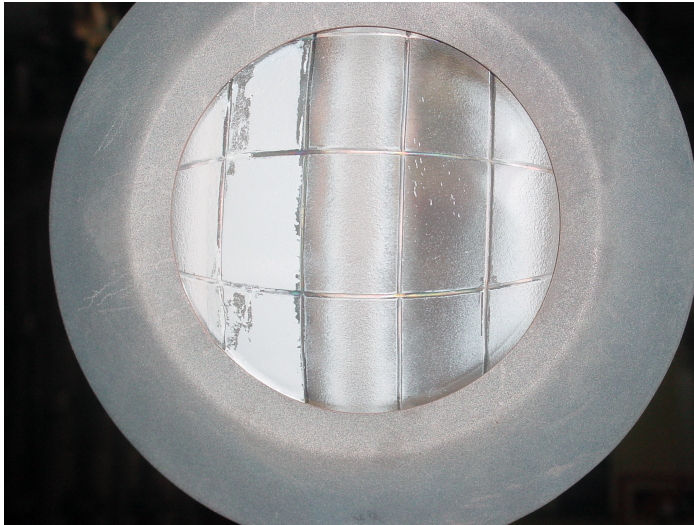
Tangential view at limiter surface from
top port

Approximately 10% reduction in H_α intensity is observed near Rotating limiter surface

Unfortunately, no measurement of H_α intensity at other toroidal position!

No significant change is observed in the surface temperature of rotating drum as measured by IR spectrometer

Rotating Limiter after CPD Experiment

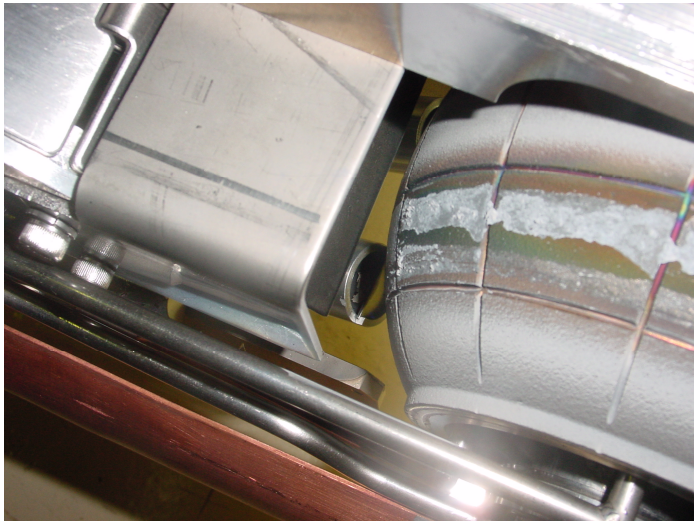


Non-uniform coating is observed on rotating drum surface (friction between rotating drum and cover might be one possible reason).

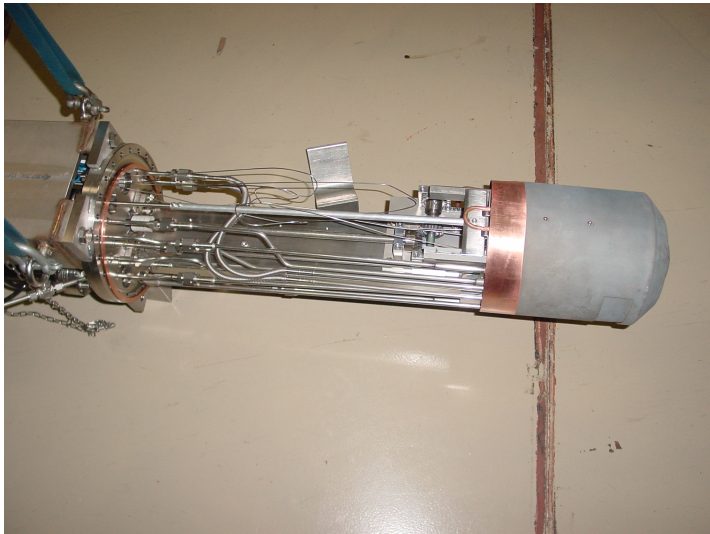
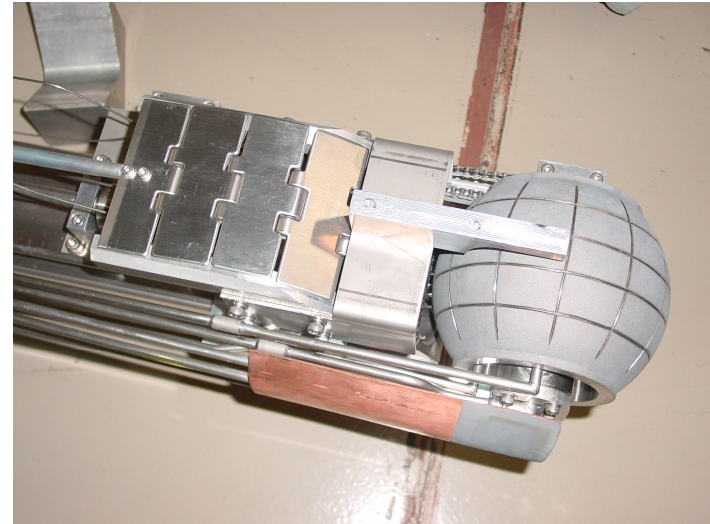
At some portion Li is completely depleted or there may be no Li deposition.

Both the Li ovens are found completely empty.

No sign of Li coating on near by vessel wall is observed.



Modification in Rotating Limiter arrangement



Plasma-sprayed W coating on the SUS rotating limiter is performed.

Three Li ovens are used in stead of two.

Thermocouples are attached on Li evaporator to monitor the evaporator temperature rise and hence to control Li deposition rate

SUMMARY

- **Wall pumping experiment has been carried out in CPD under various conditions of vessel wall.**
- **A critical gas fuelling pressure is found to exist beyond which wall pumping effect is observed (except one condition).**
- **First result of POP experiment with rotating limiter in CPD is encouraging.**
- **Detail characterisation of fuel recycling near rotating limiter surface and its effect on global plasma behaviour will be planned in the forthcoming experimental campaign with the improved rotating limiter arrangement.**

Background

- One of the key issues for steady state operation of magnetic confinement devices is the plasma density control => **reduced edge recycling is beneficial => controlled wall pumping.**
- Wall pumping effect depends on PFC surface property and is limited in time duration
- Effects of Wall conditioning will have finite lifetime because of surface saturation with trapped particles.
- Enabling wall concept and related R&D are thus necessary for the successful operation of steady state magnetic fusion devices beyond ITER.
- A variety of innovative concepts have been proposed using moving surface plasma facing components (MS-PFC), for online regeneration of particle trapping capabilities.