FTU experimental campaign 2014 – C1

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EUROfusion & Conferences

WP DTT-1	Liquid metal as Plasma Facing Component	2.5 ppy	(G. Mazzitelli)
WP MST2	Runaway generation and control in FTU	1.9 ppy	(B. Esposito)
ER	Parametric decay instability	1.9 ppy	(W. Bin)
ER	Density Limit Studies	1.3 ppy	(G. Pucella)
ER	Magnetic Reconnection	1.3 ppy	(P. Buratti)
WP PFC	Erosion and fuel retention experiments	0.7 ppy	(G. Maddaluno)

IAEA	Overview of the FTU results	(G. Pucella)
IAEA	On the measurement of the threshold electric field for runaway electron generation in FTU	(B. Esposito)
IAEA	Runaway Electron Control in FTU	(D. Carnevale)
IAEA	Cherenkov emission from non-thermal electrons in the presence of magnetic islands	(F. Causa)
IAEA	Peaked density profiles due to Neon injection on FTU	(C. Mazzotta)
IAEA	Driving m/n=2/1 Tearing Instability by Ne Injection in FTU Plasma	(A. Botrugno)
IAEA	Thermal loads on FTU actively cooled liquid lithium limiter	(G. Mazzitelli)
IAEA	EC Assisted Plasma Start-up Studies in ITER-like Configuration	(G. Granucci)
IAEA	(N)TM onset by central EC power deposition in FTU and TCV Tokamaks	(S. Nowak)
IAEA	Experiments on MHD instabilities with ECH/ECCD in FTU using a minimal RT Control System	(C. Sozzi)
EPS	First heated elongated plasmas with an actively water cooled liquid lithium limiter on FTU	(G. Calabrò)
EPS	Use of MHD markers as a tool for EC steering launcher calibration in FTU	(A. Moro)
PSI	Experiments on FTU with an actively water cooled liquid lithium limiter	(G. Mazzitelli)
PSI	Dust characterization in FTU tokamak	(M. De Angeli)
SOFT	First results on runaway electron studies using the FTU neutron camera	(D. Marocco)

Experimental programs (Ohmic + ECRH)

M01	FTU SOL scaling	(B. Viola)	
M02a	**Effect of Neon injection on density peaking**	**(C. Mazzotta)**	**0.5**
M02b	**Tearing mode activity induced by Neon gas injection**	**(A. Botrugno)**	**0.5**
M03	**MHD limit cycles near the density limit**	**(G. Pucella)**	**1**
M04a	**Density limit for low toroidal fields and plasma currents**	**(G. Pucella)**	**1**
M04b	Density limit with pellet injection	(G. Pucella)	
M05	Condition for plasma detachment	(O. Tudisco)	
M06	**FTU – Hmode**	**(G. Ramogida)**	**1**
M07	**Threshold electric field for runaway electron generation**	**(B. Esposito)**	**1**
M08	**Runaway electron control with new feedback strategies**	**(D. Carnevale)**	**2**
M09	Commissioning of new ECRH fast Launcher	(G. Granucci)	
M10	**EC Assisted Breakdown**	**(G. Granucci)**	**2**
M11	OXB double mode conversion of EC waves	(W. Bin)	
M12	**Collective Thomson Scattering**	**(W. Bin)**	**1**
M13	**MARFE stabilization by ECRH**	**(W. Bin)**	**1**
M14	**ECRH on current ramp up for High Temperature plasmas**	**(F. P. Orsitto)**	**1**
M15	**ECRH on the magnetic island near the density limit**	**(G. Pucella)**	**1**
M16	**Control of sawteeth periods by pulsed ECH/ECCD**	**(S. Nowak)**	**0.5**
M17	**Effect of central ECH/ECCD deposition on (N)TM onset**	**(S. Nowak)**	**1**
M18	**(N)TM control by ECH/ECCD**	**(C. Sozzi)**	**3**
M19	Wall cleaning with ECRH	(C. Sozzi)	
M20t	**Thermal loads on the LLL**	**(G. Mazzitelli)**	**2.5**

Experimental campaign 2014 – C1

EUROfusion

M03	MHD limit cycles	1
M04a	DL low BT	1
M07	RE generation	1
M08	RE control	2
M12	CTS	1
M15	DL with ECRH	1
M20t	CLLL	2.5

Conferences (extra EF)

M02a	Ne – peaking	0.5
M02b	Ne – MHD	0.5
M06	FTU-H	1
M10	EC assisted BD	2
M17	NTM destabilization	1
M18	NTM RT control	3

Extra

M13	MARFE stabilization	1
M14	ECRH ramp-up	1
M16	ST control	0.5

20-23/05		Restart
27/05	M04a	DL low BT
28/05	M10	EC assisted BD
29/05	M03	MHD limit cycles
30/05	M07	RE generation
03/06	M13	MARFE stabilization
04/06	M06-M16	FTU-H / ST control
05/06	M12	CTS
06/06	M02a-M02b	Neon injection
10/06	M10	EC assisted BD
11/06	M14	ECRH ramp-up
12/06	M15	DL with ECRH
13/06	M08	RE control
17/06	M18	NTM RT control
18/06	M17	NTM destabilization
19/06	M18	NTM RT control
20/06	M08	RE control
24/06	M18	NTM RT control
25/06	M20-M06	CLLL / FTU-H
26/06	M20	CLLL
27/06	M20	CLLL

M02a Neon injection - Peaking

9	Program
2	Zero
0	Recovery
3	Repeat

Pulse Plan

Zero shot for 5.2 T

Determinazione del punto di lavoro della valvola, scan in densita'e isteresi:
Bt=5.2 I 360 kA ne=4 10^19 PValve a 1.3 Come la 37342 riprendere il punto di lavoro provando e il range della calibrazione della valvola (4 scariche)
Bt=5.2 I 360 kA ne=5 10^19 + densita'
Bt=5.2 I 360 kA ne=7 10^19 + densita'
Bt=5.2 I 360 kA ne=2 10^19 densita' minima (4 scariche e soglia della disuzione anticipando il t di ingresso del Neon)

Variazione corrente
Bt=5.2 I 500 kA ne=4 10^19
Bt=5.2 I 700 kA ne=4 10^19

Variazione q (campo piu' basso)
Zero shot for 2.5 T
Bt=2.5 I 360 kA ne=4 10**19 Neon in t e quanitita' da stabilirsi
Bt=2.5 I 360 kA ne=6 10**19 Neon in t e quanitita' da stabilirsi
Bt=5.2 I 500 kA ne=4 10^19

C. Mazzotta

M02b Neon injection - MHD

8	Program
1	Zero
0	Recovery
0	Repeat

Pulse Plan

Early Ne puff to get a long second phase of mode dynamics without disruption

1) Zero at 3.6 T – 6.0 T - 7.2T depending on operations
2) I_p=360 kA; n_e= 0.6-0.8 10^{20} m^{-3} ; B_T=3.6 T
3) I_p=360 kA; n_e= 0.6-0.8 10^{20} m^{-3} ; B_T=6.0 T
4) I_p=360 kA; n_e= 0.6-0.8 10^{20} m^{-3} ; B_T=7.2 T

Early Ne puff to get a long second phase of mode dynamics without disruption. Pellet injection 300 ms after Ne injection.

5) I_p=360 kA; n_e= 0.6-0.8 10^{20} m^{-3} ; B_T=6.0 T
6) I_p=360 kA; n_e= 0.6-0.8 10^{20} m^{-3} ; B_T=6.0 T

If possible

3 discharges (Ne injection for MHD formation without disruptions)

- I_p=360 kA B_T=3.6 T n_e= 0.6 10^{20} m^{-3}
- I_p=600 kA B_T=6.0 T n_e= 0.8 10^{20} m^{-3}
- I_p=700 kA B_T=7.2 T n_e= 1.0 10^{20} m^{-3}

A. Botrugno

M03 MHD limit cycles

11	Program
2	Zero
4	Recovery
3	Repeat

Pulse Plan

Compare standard q > 3 cases with q < 3 ones (no 3/1 resonance).

1) Zero at 3.6 T
2) 3.6 T / 500 kA (target q > 3), ne up to tearing mode onset
3) 3.6 T / 500 kA, density limit (ref. 34159, 34162, 34164)
4) Recovery
5) 3.6 T / 700 kA (target q < 3), ne up to tearing mode onset
6) 3.6 T / 700 kA, density limit (the end if cycles are present)
7) Recovery
8) Repeat with different gas (the end if cycles are present)
9) Recovery
10) 3.6 T / 700 --> 500 kA, current ramp-down near density limit
11) Repeat

Local variations of the current density profile induced by means of the 140 GHz electron cyclotron heating system.

12) Zero at 5.3 T
13) 5.3 T / 500 kA (target), ne up to tearing mode onset
14) 5.3 T / 500 kA, density limit (ref. 34259)
15) Recovery
16) Target just below density limit
17) Repeat (adjust gas)
18) ECRH deposition scan: q = 1.5 --> 2.5
19) ECRH at q = 2.5
20) ECRH deposition scan: q = 2.5 --> 3.5

G. Pucella

M04a Density limit at low BT

8	Program
4	Zero
8	Recovery
0	Repeat

Pulse Plan

1) Zero at 5.2 T
2) 5.2 T / 250 kA density limit
3) Recovery
4) 5.2 T / 360 kA density limit
5) Recovery
6) Zero at 4.0 T
7) 4.0 T / 250 kA density limit
8) Recovery
9) 4.0 T / 360 kA density limit
10) Recovery
11) Zero at 3.0 T
12) 3.0 T / 250 kA density limit
13) Recovery
14) 3.0 T / 360 kA density limit
15) Recovery
16) Zero at 4.0 T
17) 4.0 T / 250 kA density limit
18) Recovery
19) 4.0 T / 360 kA density limit
20) Recovery

G. Pucella

M06 FTU – H mode

10	Program
2	Zero
0	Recovery
0	Repeat

Pulse Plan

- *RESTART*: test the 2.7T/200kA with high elongation in ohmic

1) **Zero** at 2.7T
2) **2.7T/200kA** "elongated" (combination of pulse #38049 (2.7T/250kA)
3) "circular with I_p ramp-up optimized" and
#37869 (5.5T/200kA) "D-shaped during the I_p flat-top")

- *EXPERIMENTAL DAY 04/06/2014: Compare circular and D-shaped plasma at 2.7T, heated pulses with no CLLL*

3) **Zero** at 2.7T
4) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 1gyr for 50m
5) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 1gyr for 200ms
6) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 2gyrs for 200ms
7) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 3gyrs for 200ms
8) **2.7 T/200 kA** (circular target), n_e =0.3x10^{20}m^{-3}, ECRH = max for 200ms

- *EXPERIMENTAL DAY 25/06/2014: Compare circular and D-shaped plasma at 2.7T, heated pulses with CLLL=1cm*

9) **Zero** at 2.7T
10) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 1gyr for 200ms
11) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 2gyrs for 200ms
12) **2.7 T/200 kA** (elongated), n_e =0.3x10^{20}m^{-3}, ECRH = 3gyrs for 200ms
13) **2.7 T/200 kA** (circular target), n_e =0.3x10^{20}m^{-3}, ECRH = max for 200ms

G. Ramogida

M07 Runaway generation

6	Program
5	Zero
2	Recovery
6	Repeat

Pulse Plan

Perform a series of low density (manual gas programming) discharges at different magnetic fields and plasma current in order to widen the range of variability of plasma parameters in which the critical electric field for runaway generation is measured

1) Zero at 6 T
2) Standard shot at 6T, 500 KA
3) Zero at 7.2 T
4) 7.2 T / 350 kA
5) Repeat (adjust density to find exavt value for RE generation)
6) 6 T / 700 kA
7) Repeat (adjust density)
8) 7.2 T / 700 kA
9) Repeat (adjust density)
10) Standard shot at 6T, 500 KA (re-establish good low density conditions after 700 kA shot)
11) Zero at 4.5 T
12) 4.5 T / 350 kA
13) Repeat (adjust density)
14) Zero at 5.3 T
15) 5.3 T / 350 kA
16) Repeat (adjust density)
17) Zero at 8 T
18) 8T / 500 kA
19) Repeat (adjust density)

B. Esposito

M08 Runaway control

Pulse Plan

[D01-D02] Perform a series of low density with low prefill and neon injection induced disruptions to obtain RE plateaus and validate the new signals (even before if possible by other pulses). In the meanwhile the new controller that make use of new signals is tested (RE plateaus are necessary). The old RE position controller policy is turned on for safety reasons.

4	Program
1	Zero
4	Recovery
12	Repeat

1) Zero at 6 T
2) Standard shot at 6T, 500 KA
3) S60M36RC01: low-prefill, V and F optimized for large F excursion, Ne injection (3 Atm, 40ms, 98V) @ 1.0s, density reference 1.5E-19 u to 1.0s [see 36569]
4) Repeat (adjust density profile)
5) Repeat (adjust prefill)
6) Repeat (adjust time and pressure of Ne puff)
7) Standard shot at 6T, 500 KA (re-establish good low density conditions and to clean the camera from Ne)
8) Repeat 3) (adjust density profile)
9) Repeat (adjust prefill)
10) Repeat (adjust time and pressure of Ne puff)
11) Standard shot at 6T, 500 KA

SATISFACTORY TARGET SCENARIO (RE plateau), NEW CONTROL CODE & SIGNALS

12) Scenario Pulse [(Ip ramp down 100ms, REdes 1.16), (FC gain, Vloop gain, controller speed tuning]
13) Repeat (adjust FC gain, Vloop gain, controller speed adjust)
14) Repeat (adjust FC gain, Vloop gain, controller speed adjust)
15) Repeat (adjust FC gain, Vloop gain, controller speed adjust)
16) Standard shot at 6T, 500 KA
17) Scenario Pulse [(Ip ramp down 200ms, REdes 1.1), (FC gain, Vloop gain, controller speed tuning]
18) Repeat (adjust FC gain, Vloop gain, controller speed adjust)
19) Repeat (adjust FC gain, Vloop gain, controller speed adjust)
20) Repeat (adjust FC gain, Vloop gain, controller speed adjust)

NO SCENARIO

12) 6 T / 360 kA (M07 RE generation) with V and F optimized for large F excursion, Ne injection (3 Atm, 40ms, 98V) @ 1.1s
13) Repeat (adjust density)
14) Repeat (adjust prefill)
15) Repeat (adjust time and pressure of Ne puff)
16) Standard shot at 6T, 500 KA
17) 6 T / 360 kA (M07 RE generation) with V and F optimized for large F excursion, Ne injection (3 Atm, 40ms, 98V) @ 1.2s
18) Repeat (adjust density)
19) Repeat (adjust prefill)
20) Repeat (adjust time and pressure of Ne puff)

D. Carnevale

M10 EC assisted breakdown

Pulse Plan

14	Program
2	Zero
0	Recovery
3	Repeat

Polarization conversion at inner wall>>>Oblique injection angle
Zero at 5.3 T
5.3 T / ECRH 400kW P8 Upper 20º t=0 / Vloop=8V (no commutation)
5.3 T / ECRH 400kW P8 Upper 24º t=0 / Vloop=8V (no commutation)
5.3 T / ECRH 400kW P12 L1 20º t=0 / Vloop=8V (no commutation)
5.3 T / ECRH 400kW P12 L1 10º t=0 / Vloop=8V (no commutation)

Minimum low field target
5.3 T / ECRH 400kW P12 L1 20º t=0 / Vloop=2V
Repeat 6) [optimization]
Zero at 2.5 T
2.5 T / ECRH 400kW P12 L1 20º t=0 / Vloop=2V
Repeat 9) [optimization]
Repeat 9) [optimization]

Vertical error field scan at minimum low field target
5.3T /400kW/Vloop_min for Bvscan (100G)
5.3T /400kW/Vloop_min for Bvscan (step ± 50G)
5.3T /400kW/Vloop_min for Bvscan (step ± 50G)
5.3T /Vloop_min/BV max at 800kW
2.5T /400kW/Vloop_min for Bvscan (100G)
2.5T /400kW/Vloop_min for Bvscan (step ± 50G)
2.5T /400kW/Vloop_min for Bvscan (step ± 50G)
2.5T /Vloop_min/BV max at 800kW

G. Granucci

M12 Collective Thomson Scattering

4	Program
1	Zero
0	Recovery
9	Repeat

Pulse Plan

(All the discharges will be shortened in length, down to 1s)

Study of thermal scattering, find scattering on- and off-axis, setting of the attenuations on ECE + stray radiation:

1) Zero at 7.2 T

Low density:

3) 7.2 T / 500 kA ne=6.5·1019, linear scan with line of sight **on-axis**, **tor. ang. 5°**

4) Repeat 2) for setting of attenuations

5) 7.2 T / 500 kA, ne=6.5·1019, linear scan with line of sight **on-axis**, tor. ang. **35°**

6) Repeat 4) for setting of attenuations

7) 7.2 T / 500 kA, ne=6.5·1019, linear scan **off-axis** (on m:n=2:1 position), tor. ang. **5°**

High density:

7) Repeat 2) with ne=9.5·1019

14) Repeat 4) with ne=9.5·1019

15) Repeat 6) with ne=9.5·1019

Density scan:

18) Repeat 2) with density scan 5·1019 –› 8·1019 during ECRH shot

19) Repeat 2) with density scan 8·1019 –› 1.1·1020 during ECRH shot

22) Repeat 6) with density scan 5·1019 –› 8·1019 during ECRH shot

23) Repeat 6) with density scan 8·1019 –› 1.1·1020 during ECRH shot

W. Bin

Scan along the probe beam path:

14) 7.2 T / 500 kA, ne=6.5·1019, scan with the line of sight **along the probe beam**, **tor. ang. 5°**

M13 MARFE stabilization

Pulse Plan

1) Zero at 4.8 T
2) 4.8 T / 500 kA ne=8.0·1019 flat top, reference Ohmic shot
3) 4.8 T / 500 kA, density ramp-up to find the density limit for disruption (ndisr) and the line average density of MARFE onset (nmarfe) - Ohmic shot
4) 4.8T / 500kA, flat top: nmarfe < ne < ndisr, ECRH from new launcher line-4 (L4_NL) for 500 ms from t=900 ms, poloidally toward the equatorial plane with constant toroidal injection angle (β*=5°, with ϑ=-11.6°, ϕ=-7.1°)

*If in shot 4) ECRH **stabilizes** MARFE:*

5) Density ramp-up to find the density limit for disruption when ECRH is injected to keep MARFE stabilized - ECRH (L4_NL) for 500 ms with the same launching angles as in 4)
6) 4.8T / 500kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane up, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=-18.4°, ϕ=-6°)
7) 4.8T / 500kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane down, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=6.4°, ϕ=-8.1°)

*If in shot 4) ECRH **do not stabilize** MARFE:*

5-bis) the same as shot 6): 4.8T / 500kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane up, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=-18.4°, ϕ=-6°)
6-bis) the same as shot 7): 4.8T / 500kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane down, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=6.4°, ϕ=-8.1°)
7-bis) the same as shot 5) but with injection angles to be defined after shots 5-bis) and 6-bis): density ramp-up to find the density limit for disruption when ECRH is injected to keep MARFE stabilized - ECRH (L4_NL) for 500 ms

4.8T / 350kA:

8) 4.8 T / 350 kA the same as shot 3): density ramp-up to find the density limit for disruption (ndisr) and the line average density of MARFE onset (nmarfe) - Ohmic shot
9) 4.8 T / 350 kA the same as shot 5): density ramp-up to find the density limit for disruption when ECRH is injected to keep MARFE stabilized - ECRH (L4_NL) for 500 ms with the same launching angles as in 4)
10) 4.8 T / 350 kA the same as shot 4): 4.8T / 350kA, flat top: nmarfe < ne < ndisr, ECRH from new launcher line-4 (L4_NL) for 500 ms from t=900 ms, poloidally toward the equatorial plane with constant toroidal injection angle (β*=5°, with ϑ=-11.6°, ϕ=-7.1°)
11) 4.8 T / 350 kA the same as shot 6): 4.8T / 350kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane up, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=-18.4°, ϕ=-6°)
12) 4.8 T / 350 kA the same as shot 7): 4.8T / 350kA, flat top: nmarfe < ne < ndisr, ECRH (L4_NL) for 500 ms, the same toroidal angle as in shot 4) β*=5° and poloidal scan from equatorial plane down, from (ϑ=-11.6°, ϕ=-7.1°) to (ϑ=6.4°, ϕ=-8.1°)

11	Program
1	Zero
0	Recovery
0	Repeat

W. Bin

M14 ECRH ramp-up

11	Program
1	Zero
0	Recovery
2	Repeat

Pulse Plan

1. **Reproduce** the shot 32607 and check the stability of the plasma position (2shots)
2. **Increase Temperature1/Check stability and reconnection** .Increase the power to the centre progressively to get a 4 **gyrotrons central heating** (2shots)
3. **Delay Reconnection to get High bulk Te**.Move one gyrotron to the position of the q=2 (leaving progressively only two and three gyrotrons heating the centre) and check the effect on the possible delay of the time of the reconnection (2 shots)
4. **Increase Temperature2/Time scan ECRH** . .Make a time scan of bulk ECRH heating : tECRH=20ms, 30ms: see the effect on Temax(3shots)
5. **Increase Temperature3/Time scan of Ip slope**.Make a scan on the time of the change of the time derivative of the current from t=50ms , to t=60ms, and t=40ms, and see if there is an effect on Temax, and on the delay of the reconnection (2 shots)
6. **Shape q-profile by overshoot**.**test in a technical session** the technique of the overshoot (if it's available) on the shot 32607(2shots)

Total 11 shots . + 2 shots in a technical session

F. P. Orsitto

M15 Density limit with ECRH

8	Program
1	Zero
4	Recovery
4	Repeat

Pulse Plan

1) Zero at 5.3 T
2) 5.3 T / 250 kA, density ramp-up, ECRH 400 kW
3) Repeat
4) 5.3 T / 250 kA, density ramp-up, ECRH 800 kW
5) Repeat
6) 5.3 T / 360 kA, density ramp-up, ECRH 400 kW
7) Repeat
8) 5.3 T / 360 kA, density ramp-up, ECRH 800 kW
9) Repeat
10) 5.3 T / 500 kA, density ramp-up, ECRH 400 kW
11) Recovery
12) 5.3 T / 500 kA, density ramp-up, ECRH 800 kW
13) Recovery
14) 5.3 T / 700 kA, density ramp-up, ECRH 400 kW
15) Recovery
16) 5.3 T / 700 kA, density ramp-up, ECRH 800 kW
17) Recovery

G. Pucella

M16 Sawtooth period control

1	Program
2	Zero
0	Recovery
7	Repeat

Pulse Plan

Effect of fast EC modulation inside q=1 on sawtooth locking using Bt power ramp

1) Zero : ref. #37502
2) Bt ramp up / 500 kA / ne~0.6, with maximum available EC power (3 or 4 gyrs.) in co-ECCD, central deposition, 125 Hz, 500 ms
3) Repeat 2) with 250 Hz, 500 ms
4) Repeat 3) with 166 Hz, 500 ms
5) Repeat 3) with 100 Hz, 500 ms
6) Repeat 3) with 200 Hz, 500 ms

Effect of fast EC modulation inside q=1 on sawtooth locking using proper constant Bt

7) Zero at the chosen Bt
8) Repeat 2) at constant Bt
9) Repeat 8) with 166 Hz, 500ms
10) Repeat 8) with 100 Hz, 500ms

S. Nowak

M17 NTM destabilization

2	Program
2	Zero
0	Recovery
16	Repeat

Pulse Plan

Effect of on-axis co-/cnt-ECCD on (N)TM onset at Ip=500 kA.

1) Zero at 5.3 T
2) 5.3 T / 500 kA/ ne~0.65 (ref. #37581), 2 gyrs. , co-ECCD
3) Repeat 2) with 3 gyrs. , co-ECCD
4) Repeat 3) with 4 gyrs. (if possible), if not repeat 3) with ne~0.4
5) Repeat 3) with EC deposition around q=1
6) Repeat 3) in cnt-ECCD
7) Repeat 5) in cnt-ECCD
8) Repeat 4) in cnt-ECCD
9) Repeat 3) in pure heating
10) Repeat 4) in pure heating

Effect of on-axis co-/cnt-ECCD on (N)TM onset at Ip=360 kA and same pulse sequence as before.

11) Zero at 5.3 T
12) 5.3 T / 360 kA/ ne~0.65 (ref. #37599) , 2 gyrs. , co-ECCD
13) Repeat 12) with 3 gyrs. , co-ECCD
14) Repeat 13) with 4 gyrs. (if possible), if not repeat 13) with ne~0.4
15) Repeat 13) with EC deposition around q=1
16) Repeat 13) in cnt-ECCD
17) Repeat 15) in cnt-ECCD
18) Repeat 14) in cnt-ECCD
19) Repeat 13) in pure heating
20) Repeat 14) in pure heating

S. Nowak

M18 NTM real-time control

Pulse Plan

44	Program
3	Zero
12	Recovery
16	Repeat

Day ONE
reproduce Ne target (0.5 T / 500 kA, 0.6 1020 particles m -3)
1) Zero at 5.3 T
2-4) Target optimization (references 37448-37454)
to obtain the time response and offset value to be used as starting values for the active control
5-13) change beam scan starting radius (3 offset values) and scanning speed (3 values).
14-19) after selecting best scanning speed, Repeat using ECCD for the 3 offset values and 2 launching toroidal angles (if the time is enough)
Recovery pulses to be decided during the session

Day TWO
Test control with increasing power at different power level (?): use of multiple gyrotrons.
20) Zero at 5.3 T
21-23) Target optimization (references 37448-37454)
24-26) Tuning of fixed gyrotron (if available)
27-35) Test of Probe and suppress strategy: Tuning radial offset between gyrotrons (3values) and threshold of intervention (2 values)
36) Repeat best tuning using ECCD (if the time is enough)
37-45) Test Automatic incremental search strategy. Tune steps duration (3 values) and radial size (3 values)
46-48) Repeat using ECCD. Tuning of steps radial size (3 values) (if the time is enough)

Recovery pulses to be decided during the session

Day THREE
Continuation of Day TWO program if not completed
Comparison pulses in ECCD (if not performed before):
6+4 pulses

or: Control of MHD induced by density limit

49) Zero at 5.3 T
50-52) Target optimization (references 38027)
Test control strategy on
53-55) change priority logic to control of multiple launcher
56-58) Repeat using ECCD
Test control strategy with different Ip, both with ECRH and ECCD.
Recovery pulses to be decided during the session

C. Sozzi

M20t Thermal loads on the CLLL

Pulse Plan

a) Standard ohmic discharges: **16**
b) ECRH pulses (if available, non necessary): **4**

2	Program
0	Zero
0	Recovery
18	Repeat

G. Mazzitelli