Magnetic diagnostic and MHD analysis for JT-60SA IC

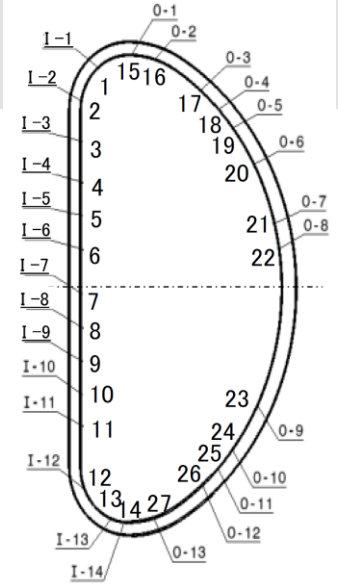
L. Pigatto, M. Bonotto, T. Bolzonella, D. Abate
M. Mattei, G. De Tommasi
M. Takechi, H. Tojo

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Overview

- Summary of 2020/21 activities
  - Data access and selected pulses
  - Models: CREATE-L & FIESTA
  - Analysis of energization shots: examples for CS2, CS3
- Outlook

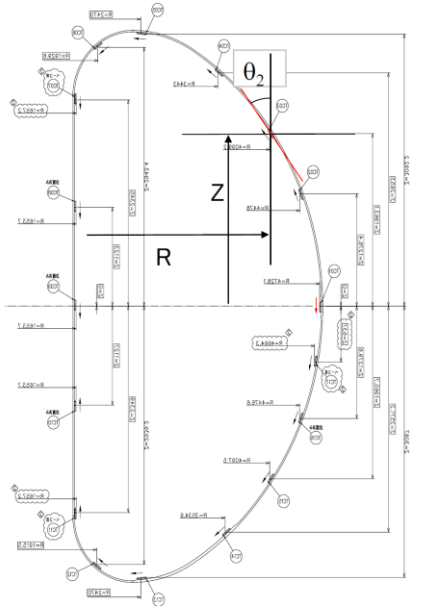
Magnetics for IC



- One-turn loops + 7 on SP
- TC probes + 6 on SP

Type	Number	Time resolution	Location	Purpose
Flux loop (One-turn loop)	27	4 kHz (MDAC)	Poloidally distributed	Poloidal magnetic field
TC probe	17	4 kHz (MDAC)	P02	Plasma current
Rogowski coil	2	4 kHz (MDAC)	P03, P06	Poloidal flux
Diamagnetic loop	1	4 kHz (MDAC)	P08	Plasma stored energy
AT probe	8	<1MHz	P01, P04, P07, P10, P13, P16	Magnetic fluctuation

Magnetics for IC



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Data access

Data from the EDDB database can be reached with python through the ‘eddb_pwrapper’ module, located in /analysis/src/eddb/eddb_pwrapper.py

! On Naka server accessible through VPN

This module contains the python **class** ‘eddbWrapper’ which builds a data type linking to the EDDB database through the ‘libeddb.so’ library.

Partial documentation (evolving) is available online
https://iterphysicswiki.euro-fusion.org/index.php/JT-60SA_EU_IC_team_2020-21:_Magnetics_validation_and_MHD/Disruption_analysis

A set of scripts exploiting ‘eddbWrapper’ is available (M.Iafrati):
https://iterphysicswiki.euro-fusion.org/index.php/D200025_public

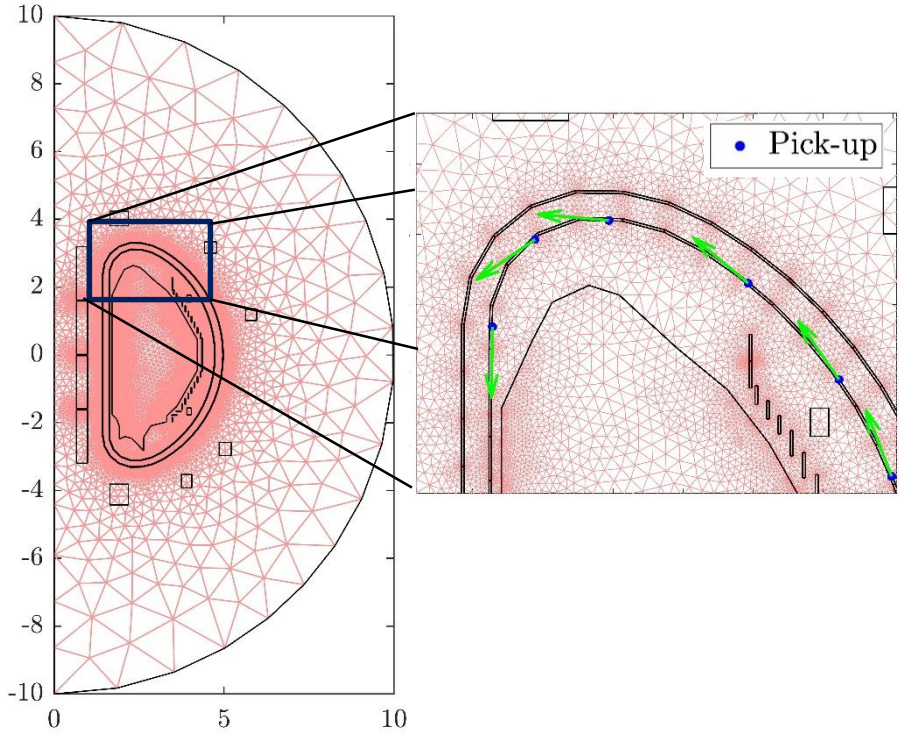
Fetching and plotting time-series data [edit]

Time series data can be gathered with the ***eddbreadTime*** method. A simple example is given below

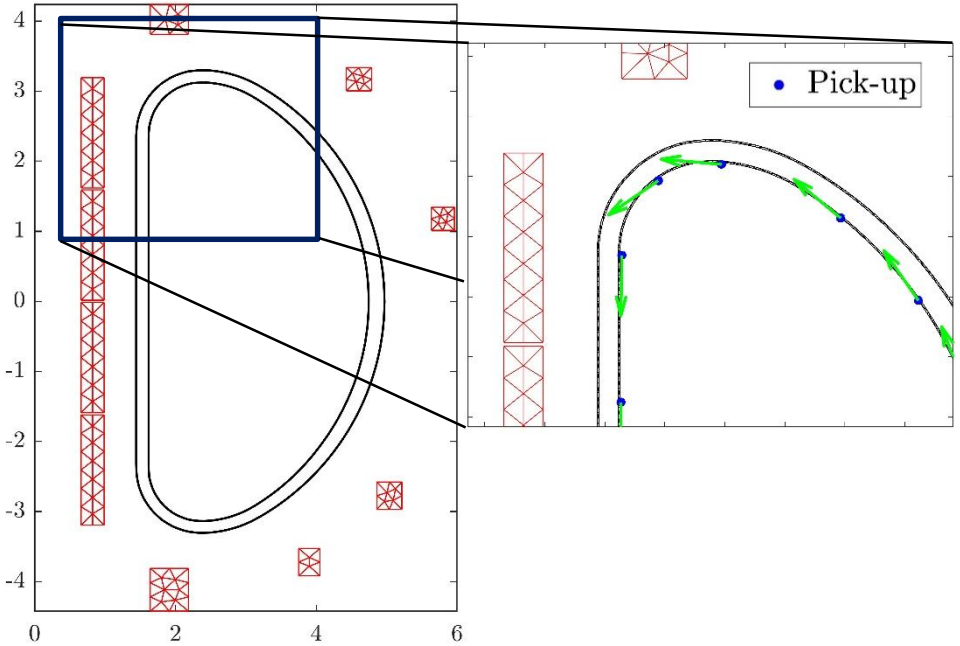
```
import sys
import numpy as np
import matplotlib.pyplot as plt
from ctypes import *

# Set path and import eddb_pwrapper
PATH_TO_LIB ='/analysis/lib/libeddb.so'
lib = cdll.LoadLibrary(PATH_TO_LIB)
sys.path.append("/analysis/src/eddb/")
from eddb_pwrapper import *

# Constructor & opening connection
eddb = eddbWrapper(PATH_TO_LIB)
# if .NUMPY = True data is stored as numpy arrays
# if .NUMPY = False data is stored as python lists
eddb.NUMPY = True
rtn_bool = eddb.eddbOpen()

# Example input to eddbreadTime
shot = 'E100127'
cat = 'MDAC'
dname = 'magPbTC1'
# Time window [s]
t1 = '-50.0'
t2 = '200.0'

# Fetching data
rtn_bool, shot_data = eddb.eddbreadTime(shot,cat,dname,t1,t2)

b_probe = shot_data['data']
t_probe = shot_data['time']

plt.figure()
plt.plot(t_probe, b_probe, label=dname)
plt.legend(loc=0)
plt.xlabel('t [s]')
plt.ylabel('B probe [T]')
plt.show()
```

Overview of applied models

CREATE-L



FIESTA



Probe polarity history

Early vs late shot comparison shows corrections on polarity and conversion coefficients of pick-ups & flux loops

R (mm)	Z (mm)	θ_2 (deg)	NS [m2]	PID	connection inversion
4735,5	-28,346	0,28	0,3406	magPbTC1	o
4487,26	1280,48	21,2	0,3367	magPbTC2	o
4111,42	1969,39	34,89	0,3373	magPbTC3	
3464,51	2653,87	50,39	0,3384	magPbTC4	
2471,23	3100,36	85,14	0,3402	magPbTC5	o
1945,48	2965,08	124,41	0,3393	magPbTC6	o
1641,4	2344,88	179,06	0,3405	magPbTC7	o
1634,2	1123,1	180,01	0,3386	magPbTC8	
1635,6	-0,2403	180,21	0,3387	magPbTC9	
1635	-1127,7	180,17	0,3400	magPbTC10	o
1640,3	-2348,1	180,27	0,3387	magPbTC11	o
1931,77	-2964,5	234,21	0,3416	magPbTC12	
2470,92	-3097,7	274,28	0,3398	magPbTC13	o
3549,92	-2573	311,04	0,3420	magPbTC14	o
4104,26	-1973	324,55	0,3404	magPbTC15	o
4485,63	-1283,4	338,37	0,3462	magPbTC16	
4674,74	-620,06	350,24	0,3420	magPbTC17	

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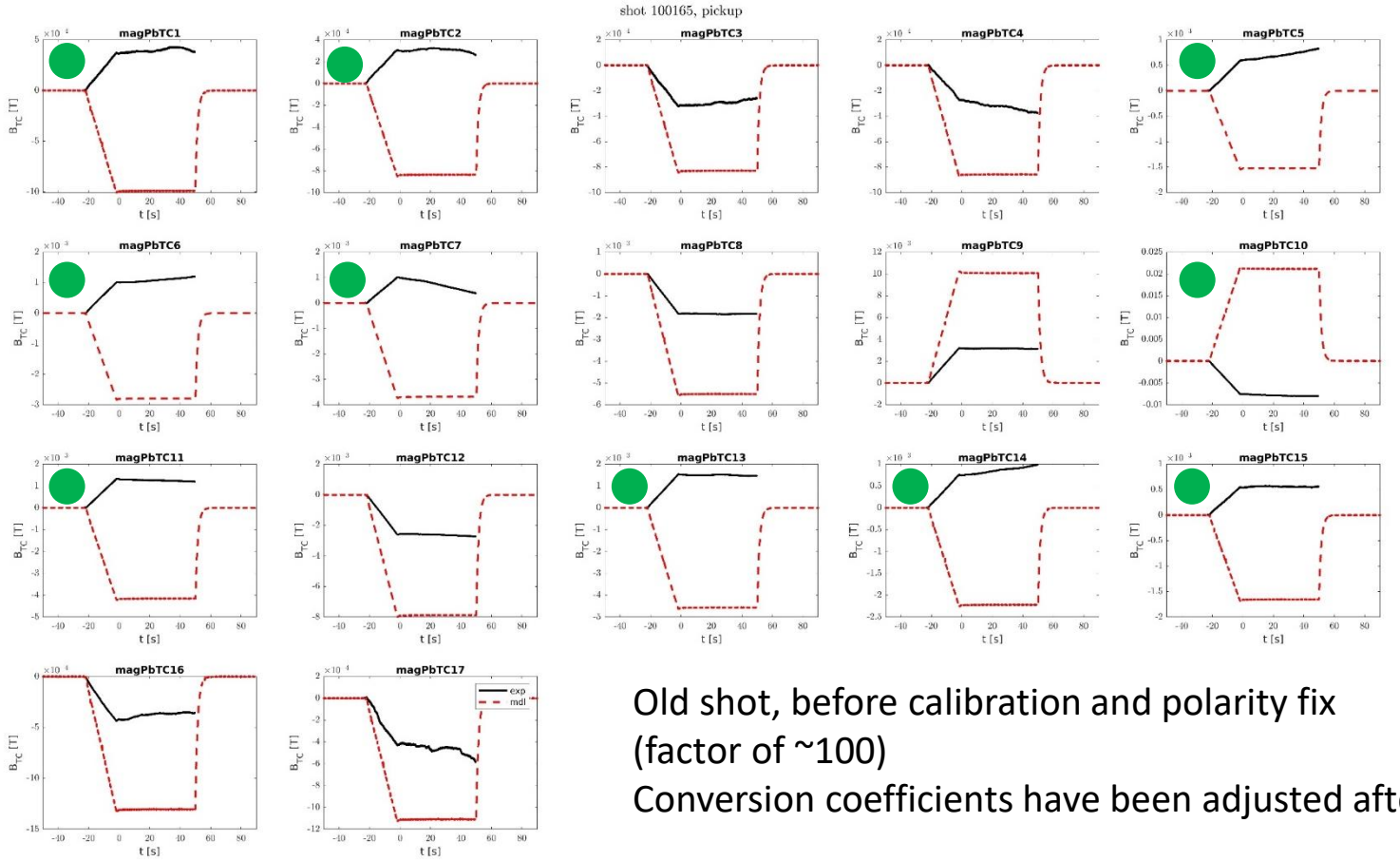
Number		R [mm]	Z [mm]	S[m2]	PID	connection inversion
1	I-1	1879,8	2933,1	11,1	magFlxLp1	o
2	I-2	1641,4	2520,2	8,46	magFlxLp2	o
3	I-3	1626,2	1976,9	8,31	magFlxLp3	o
4	I-4	1624,6	1427	8,29	magFlxLp4	o
5	I-5	1624,1	976,9	8,29	magFlxLp5	o
6	I-6	1623,7	377	8,28	magFlxLp6	o
7	I-7	1622,9	-73	8,27	magFlxLp7	o
8	I-8	1623,8	-373	8,28	magFlxLp8	o
9	I-9	1623,8	-973	8,28	magFlxLp9	
10	I-10	1624,3	-1423	8,29	magFlxLp10	
11	I-11	1624,8	-1745,4	8,29	magFlxLp11	
12	I-12	1691,8	-2688,3	8,99	magFlxLp12	
13	I-13	2021,2	-3038,4	12,83	magFlxLp13	o
14	I-14	2302,3	-3120,9	16,65	magFlxLp14	
15	O-1	2392,2	3117,5	17,98	magFlxLp15	o
16	O-2	2775,6	3058,4	24,2	magFlxLp16	o
17	O-3	3416,7	2699,6	36,67	magFlxLp17	o
18	O-4	3758,1	2397,6	44,37	magFlxLp18	o
19	O-5	3966	2166,3	49,42	magFlxLp19	o
20	O-6	4296,5	1680,1	57,99	magFlxLp20	o
21	O-7	4619,3	882,7	67,04	magFlxLp21	o
22	O-8	4693,4	532,2	69,2	magFlxLp22	o
23	O-9	4297,4	-1676	58,02	magFlxLp23	
24	O-10	3969,3	-2161,8	49,5	magFlxLp24	
25	O-11	3760,4	-2399,2	44,42	magFlxLp25	
26	O-12	3497,1	-2624,3	38,42	magFlxLp26	
27	O-13	2753	-3059,9	23,81	magFlxLp27	

2021-02-15

CS3 – 100165 TC probes*1/100



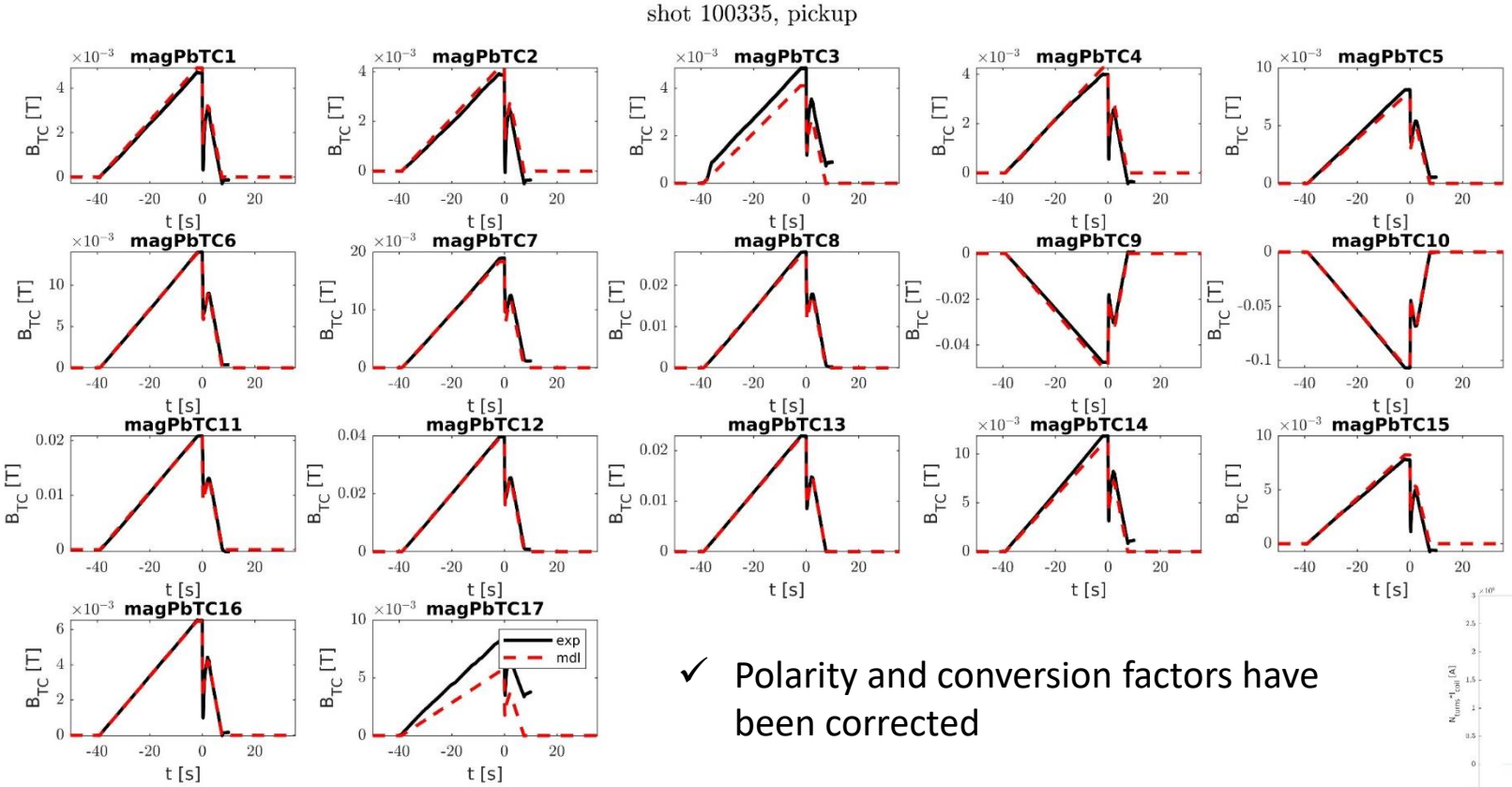
TC probes showing switched polarity: 01, 02, 05, 06, 07, 10, 11, 13, 14, 15

These have been switched after E100203

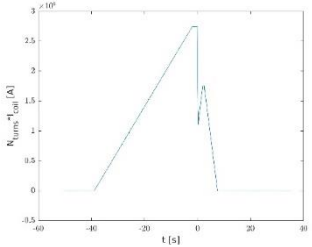
Old shot, before calibration and polarity fix (factor of ~100)

Conversion coefficients have been adjusted after **E100210**

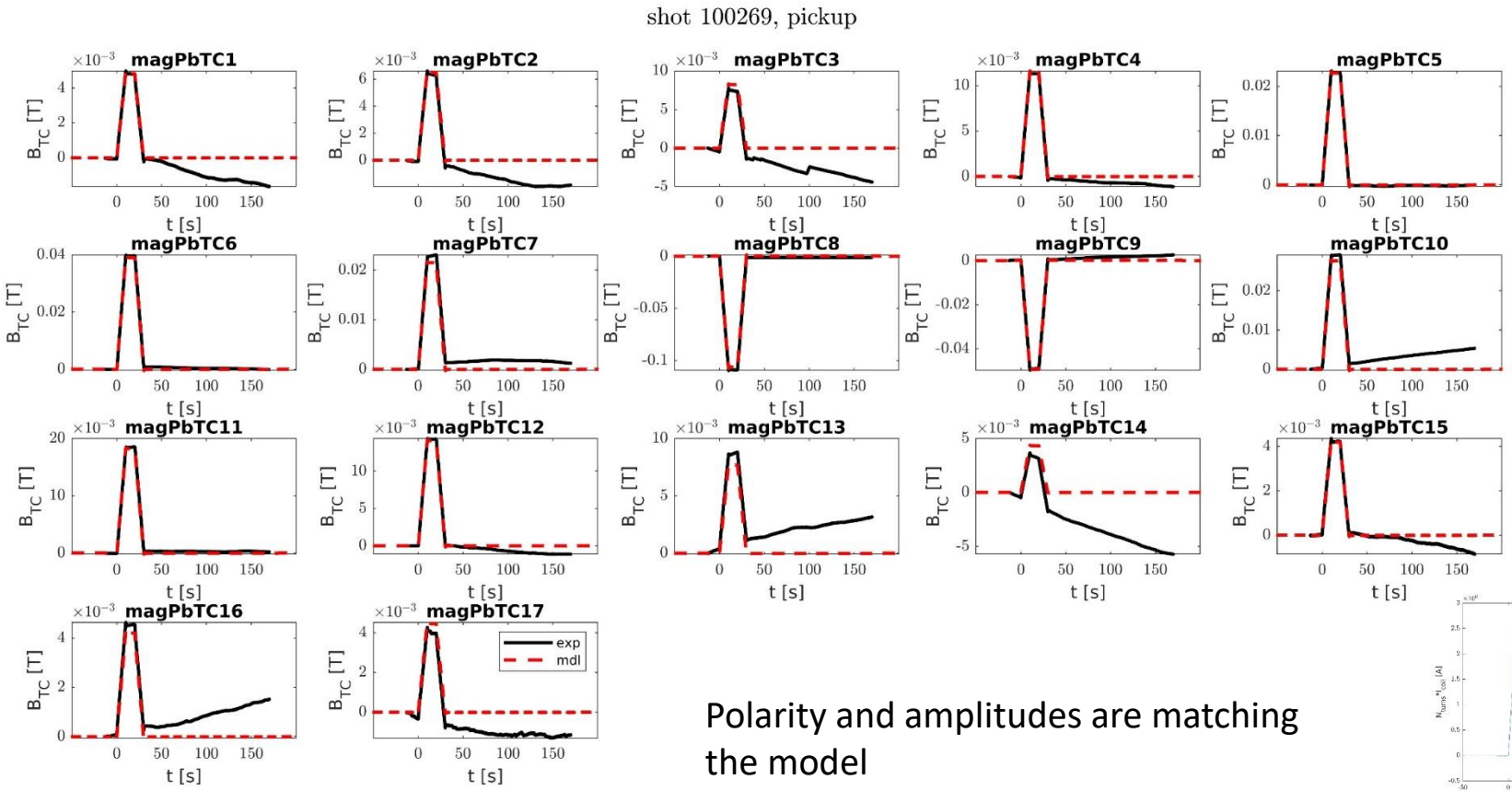
CS3 – 100335 TC probes



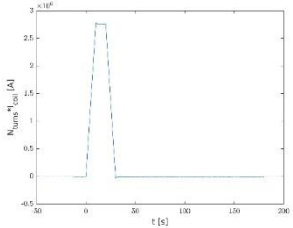
- ✓ Polarity and conversion factors have been corrected



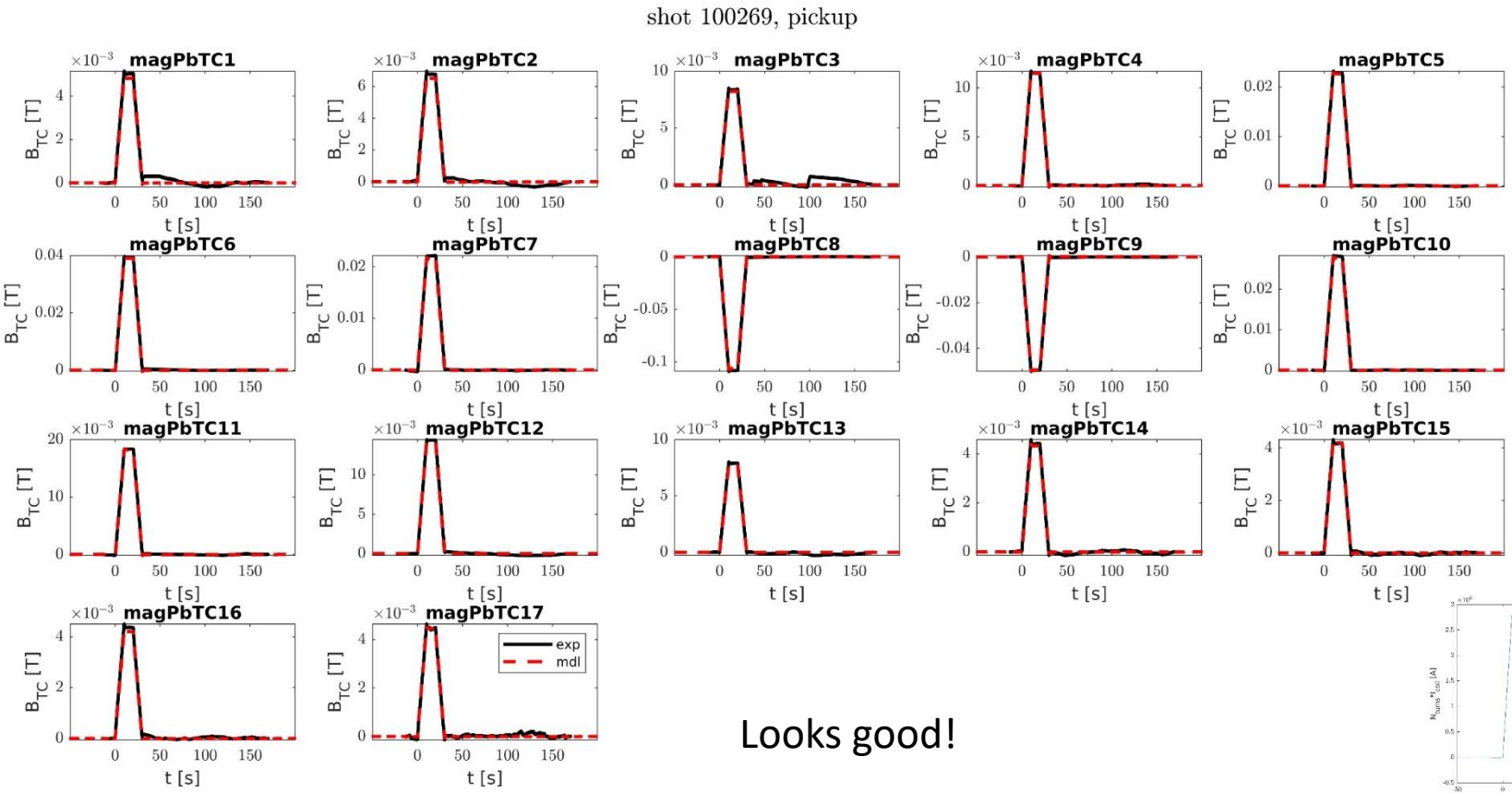
CS2 – 100269 TC probes



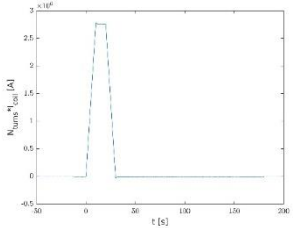
Polarity and amplitudes are matching the model



CS2 – 100269 w/ 2nd order correction



Looks good!



Summary & outlook

- ✓ Two models are available to simulate magnetic data: good match between signals and both models for all the analyzed cases. Some cases would need individual analysis.

- Links to Code Management area:
  - Support MHD and control modeling with magnetic sensor data

- Collaborate to the definition of calibration and sensor identification shots for machine restart
- Control room work and data analysis
- Documentation