

# Preliminary tests with the IQM system, the University of Florence experience.



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

DIPARTIMENTO DI  
SCIENZE BIOMEDICHE  
SPERIMENTALI E CLINICHE



**Azienda  
Ospedaliero  
Universitaria  
Careggi**

# Careggi University - Hospital Florence

## Radiation Oncology Unit

Director: Prof. Lorenzo Livi

### Equipe

Benedetta Agresti	Icro Meattini
Pierluigi Bonomo	Fabiola Paiar
Vittorio Cintolesi	Maria Grazia Papi
Carla De Luca Cardillo	Maurizio Pertici
Beatrice Detti	Silvia Scoccianti
Alessandra Galardi	Vieri Scotti
Daniela Greto	Gabriele Simontacchi
Monica Mangoni	Susanna Sulprizio

## Medical Physics Unit

Director: Dr. Stefania Pallotta

### Equipe

Chiara Arilli  
Marta Casati  
Antonella  
Compagnucci  
Livia Marrazzo  
Cinzia Talamonti  
Silvia Calusi (fellow)

## Our radiotherapy facilities

- 3 linacs for 3DCRT, IMRT and VMAT
- 1 Tomotherapy
- 1 Gamma Knife
- Brachitherapy unit PDR
- 1 CT with 4D option



# Careggi University - Hospital Florence

## Treated patients per year

1800 external beam radiotherapy  
800 chemotherapy  
200 brachitherapy and radiometabolic

## Clinics and chemotherapy

Inpatient clinic  
Outpatient clinic  
Day hospital

## Research projects:

- Development and testing of new detectors for radiotherapy;
- Project and development of Proton Computed Tomography;
- Image registration techniques;
- Multipurposes Phantom for GammaKnife;
- Deormable and Breathing phantoms;
- Phase III Trials, translational research and preclinical studies.

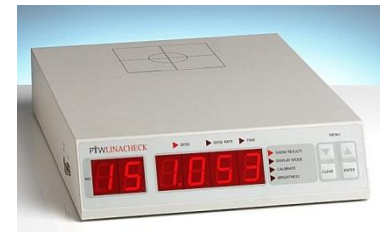
# IQM TESTS



29 September 2014 – 24 December 2015

Elekta Precise Linac

Every day after Linac QA acquisition  
(LinaCheck detector)

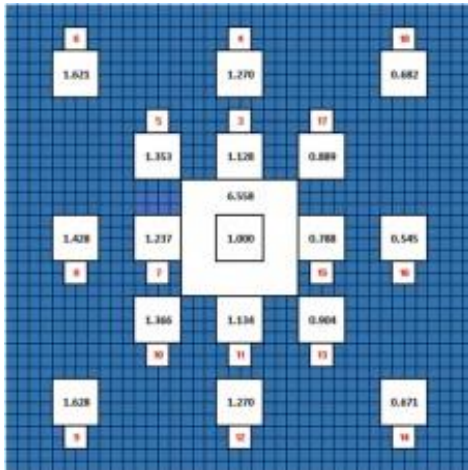


**Inter-Fraction Detector Repeatability**  
**Intra-Fraction Detector Repeatability**

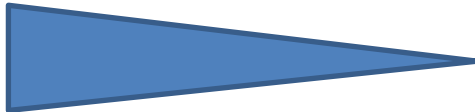
# IQM TESTS



## Intra- Fraction Detector Repeatability



10 repeated measurements  
39:59 total acquisition time

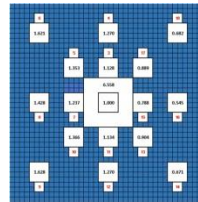


# IQM TESTS



## Inter- Fraction Detector Repeatability

3 treatments



Gantry angle =  $0^\circ$   
50 MU per field  
17 4x4 cm fields  
1 10x10 cm field



IMRT H&N treatment (modified)  
4 beams  
 $240^\circ$ ;  $320^\circ$ ;  $0^\circ$ ;  $80^\circ$   
10 segments per beam

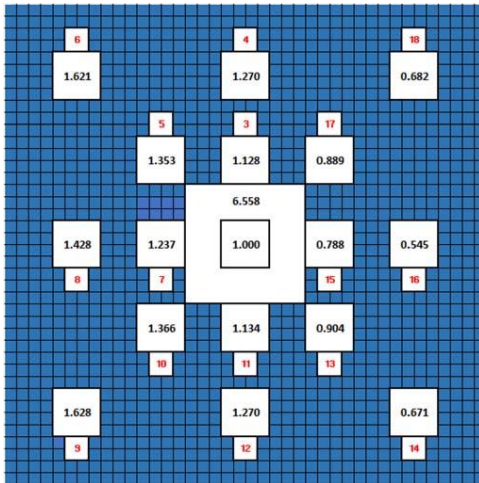


IMRT pelvic treatment (modified)  
5 beams  
 $255^\circ$ ;  $315^\circ$ ;  $45^\circ$ ;  $105^\circ$ ;  $180^\circ$   
10 segments per beam

# IQM TESTS



## Inter- Fraction Detector Repeatability



98 repeated measurements in 30 days  
(3: 5 measurements per day)

3:59  $\pm$ 0:01 mean acquisition time  
6:36:06 total acquisition time

# IQM TESTS



## Inter- Fraction Detector Repeatability



72 repeated measurements in 21 days  
(1: 4 measurements per day)

6:19<sub>±</sub>1:05 mean acquisition time  
7:29:28 total acquisition time



# IQM TESTS



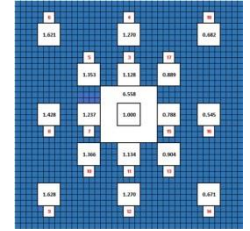
## Inter- Fraction Detector Repeatability



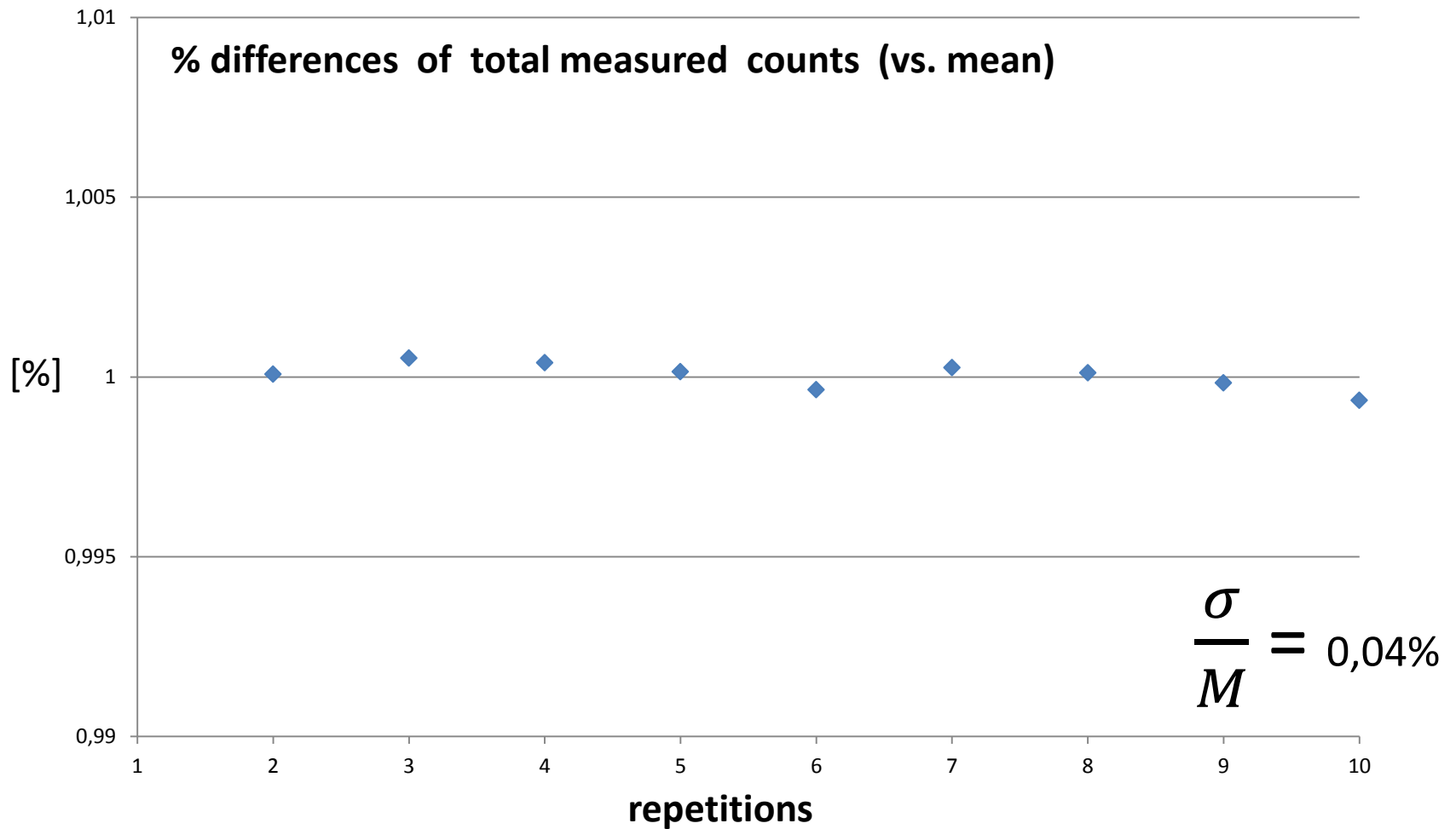
76 repeated measurements in 30 days  
(1: 4 measurements per day)

8:32<sub>-</sub>1:17 mean acquisition time  
10:49:16 total acquisition time

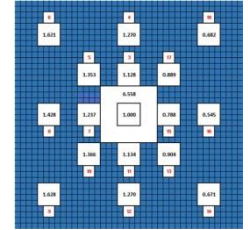
# IQM TESTS- RESULTS



## Intra- Fraction Detector Repeatability



# IQM TESTS- RESULTS



## Intra- Fraction Detector Repeatability

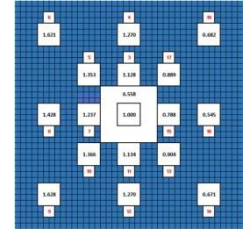
3

5

10

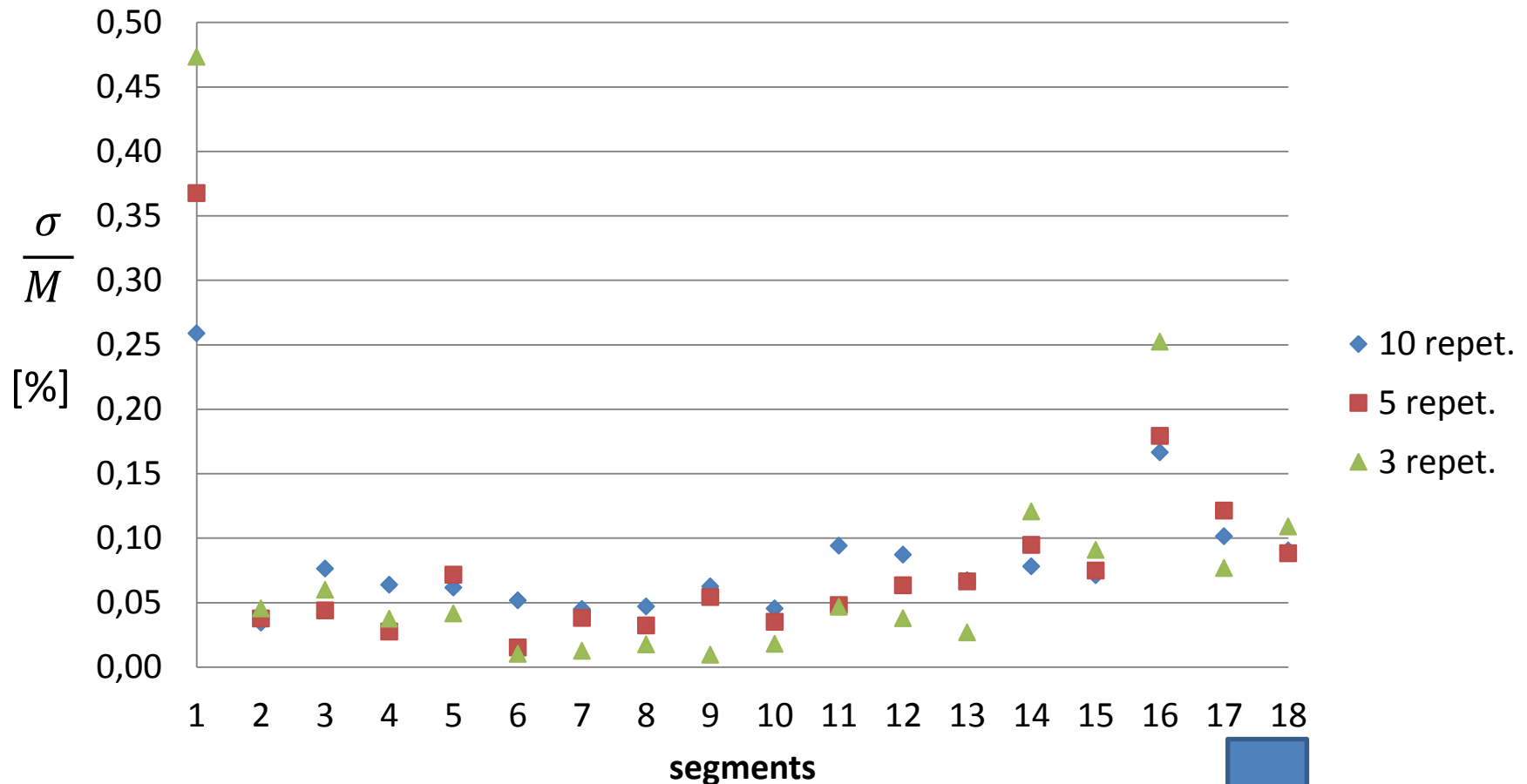
	M	$\sigma$	$\sigma / M$ [%]	M	$\sigma$	$\sigma / M$ [%]	M	$\sigma$	$\sigma / M$ [%]
1	19601,86	92,78	0,47	19623,20	72,13	0,37	19630,23	50,83	0,26
2	130292,07	59,19	0,05	130309,07	49,06	0,04	130297,53	44,84	0,03
3	30675,93	18,43	0,06	30677,54	13,52	0,04	30677,34	23,44	0,08
4	42407,40	15,88	0,04	42406,33	11,67	0,03	42398,10	27,11	0,06
5	35025,13	14,55	0,04	35041,86	25,11	0,07	35036,44	21,62	0,06
6	54192,40	5,53	0,01	54193,34	8,20	0,02	54176,18	28,07	0,05
7	24323,08	3,06	0,01	24327,97	9,27	0,04	24324,36	10,98	0,05
8	29124,60	5,15	0,02	29130,69	9,43	0,03	29125,37	13,67	0,05
9	55092,02	5,31	0,01	55076,16	29,91	0,05	55062,01	34,41	0,06
10	35599,23	6,45	0,02	35597,49	12,47	0,04	35593,67	16,17	0,05
11	30007,49	14,05	0,05	30014,72	14,47	0,05	30000,27	28,26	0,09
12	46232,36	17,57	0,04	46218,44	29,29	0,06	46201,28	40,33	0,09
13	24238,11	6,53	0,03	24244,06	16,13	0,07	24241,45	16,31	0,07
14	26691,72	32,20	0,12	26686,97	25,29	0,09	26678,64	20,85	0,08
15	16106,10	14,62	0,09	16110,58	12,07	0,07	16108,17	11,48	0,07
16	11821,47	29,85	0,25	11820,73	21,20	0,18	11819,33	19,69	0,17
17	23389,68	17,99	0,08	23380,91	28,38	0,12	23388,14	23,75	0,10
18	23211,70	25,33	0,11	23218,72	20,48	0,09	23213,80	21,00	0,09

# IQM TESTS- RESULTS

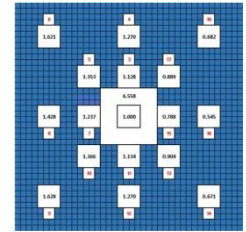


## Intra- Fraction Detector Repeatability

all segments - 1 day , 10 repetitions

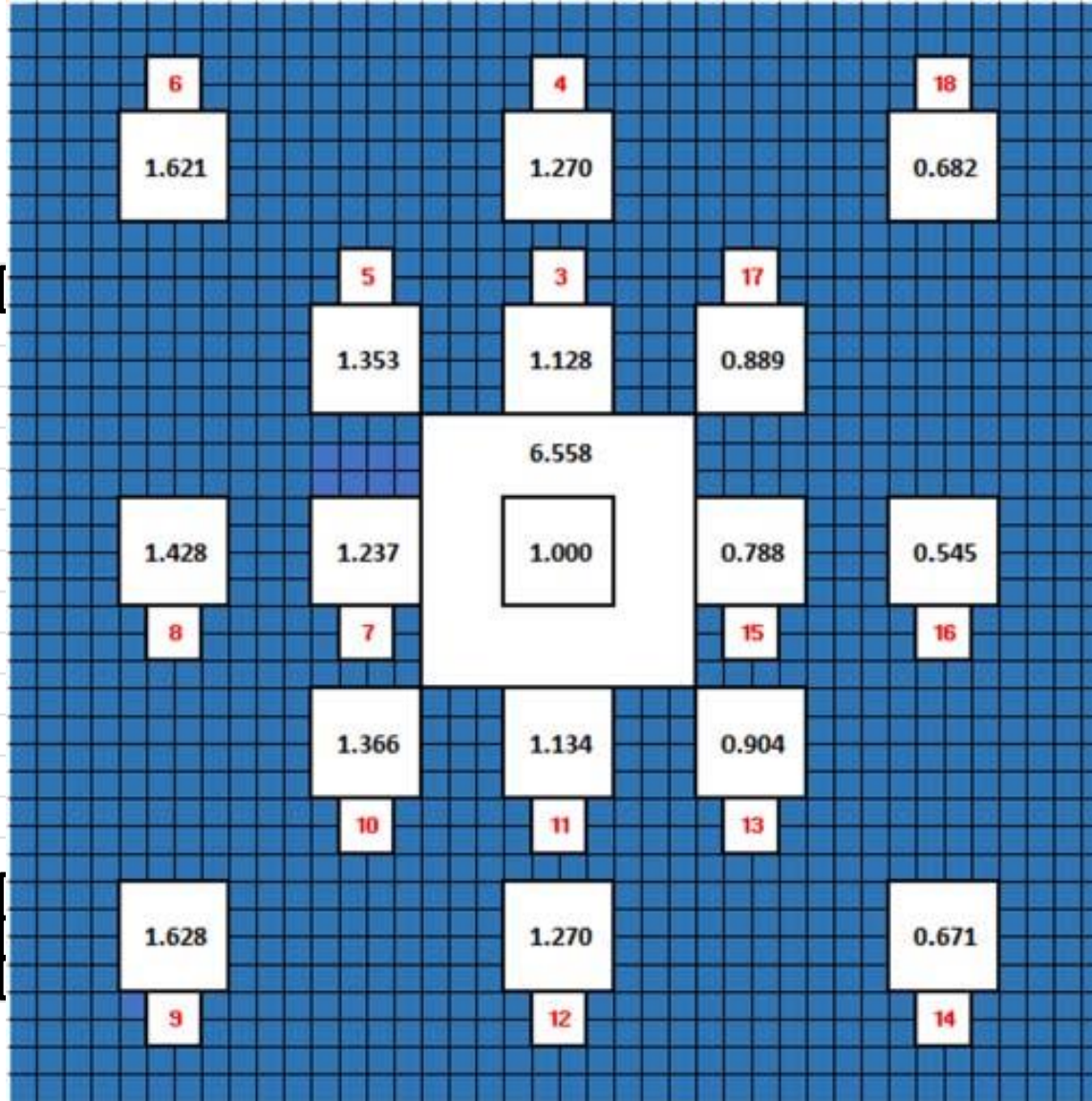


# IQM TESTS- RESULTS



Intra-

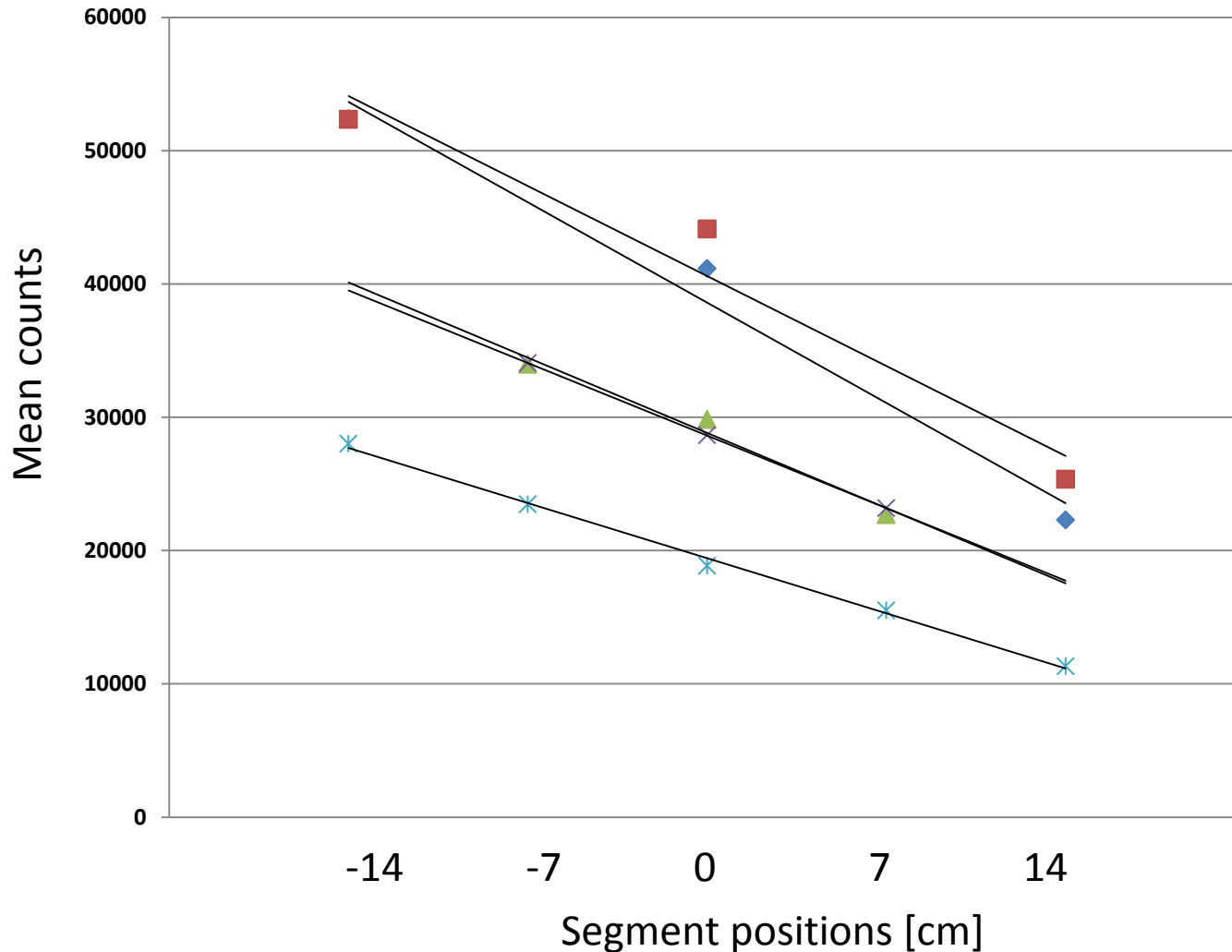
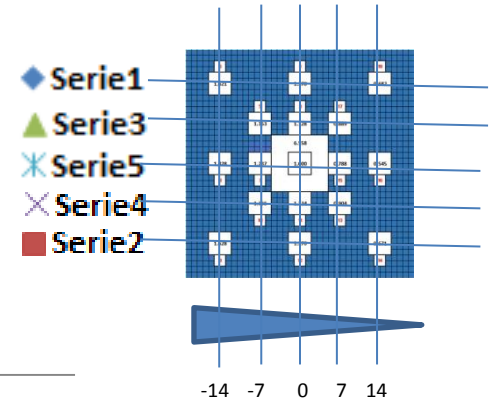
	M
1	19601,86
2	130292,07
3	30675,93
4	42407,40
5	35025,13
6	54192,40
7	24323,08
8	29124,60
9	55092,02
10	35599,23
11	30007,49
12	46232,36
13	24238,11
14	26691,72
15	16106,10
16	11821,47
17	23389,68
18	23211,70



$\sigma$	$\sigma / M$ [%]
50,83	0,26
44,84	0,03
23,44	0,08
27,11	0,06
21,62	0,06
28,07	0,05
10,98	0,05
13,67	0,05
34,41	0,06
16,17	0,05
28,26	0,09
40,33	0,09
16,31	0,07
20,85	0,08
11,48	0,07
19,69	0,17
23,75	0,10
21,00	0,09

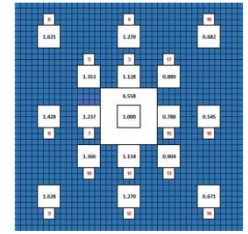
# IQM TESTS- RESULTS

## Spatial response

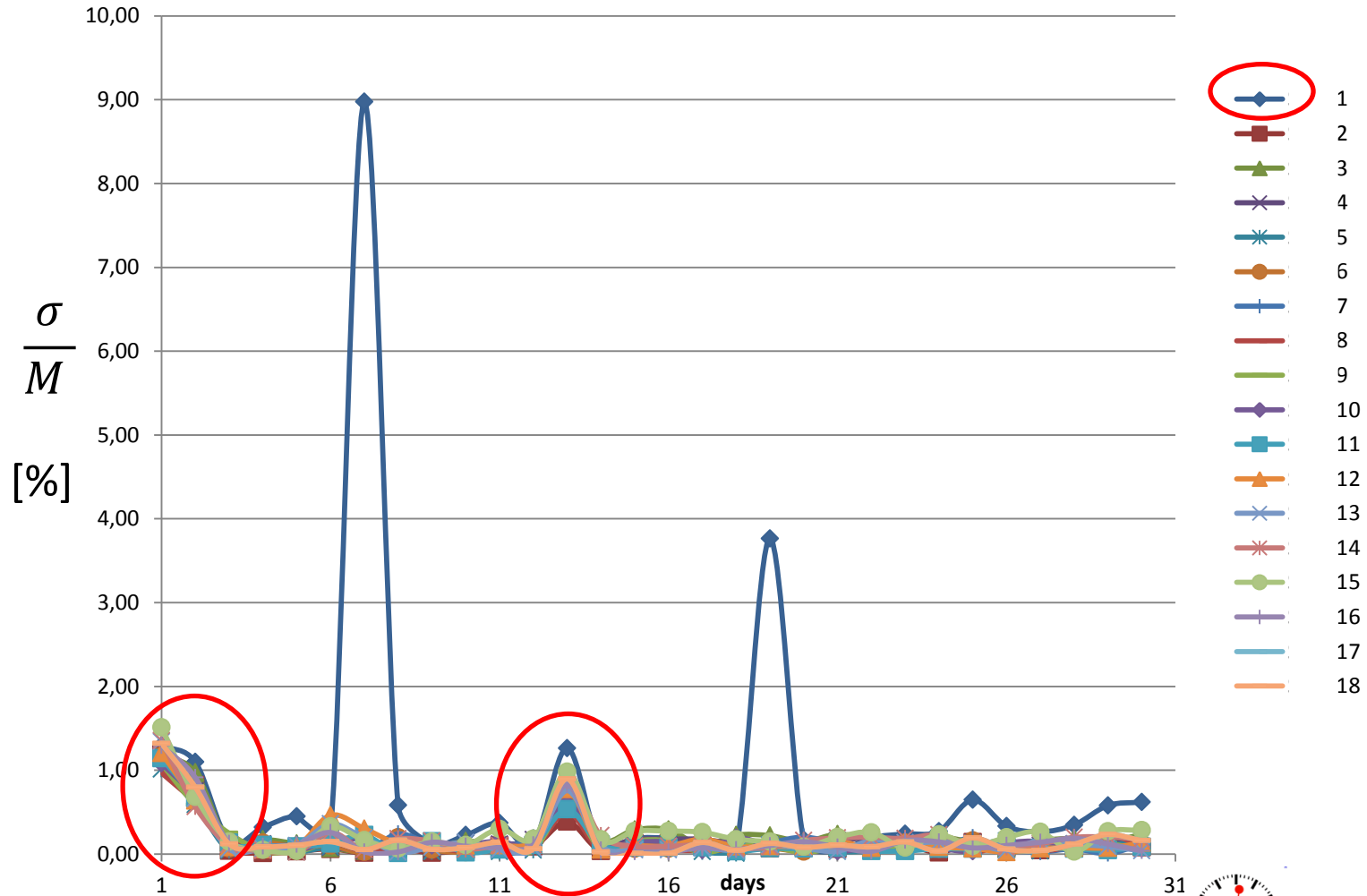


- ◆ Serie1
- Serie2
- ▲ Serie3
- × Serie4
- ✱ Serie5

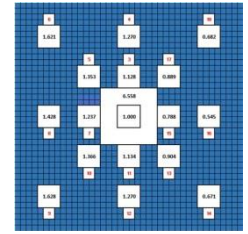
# IQM TESTS- RESULTS



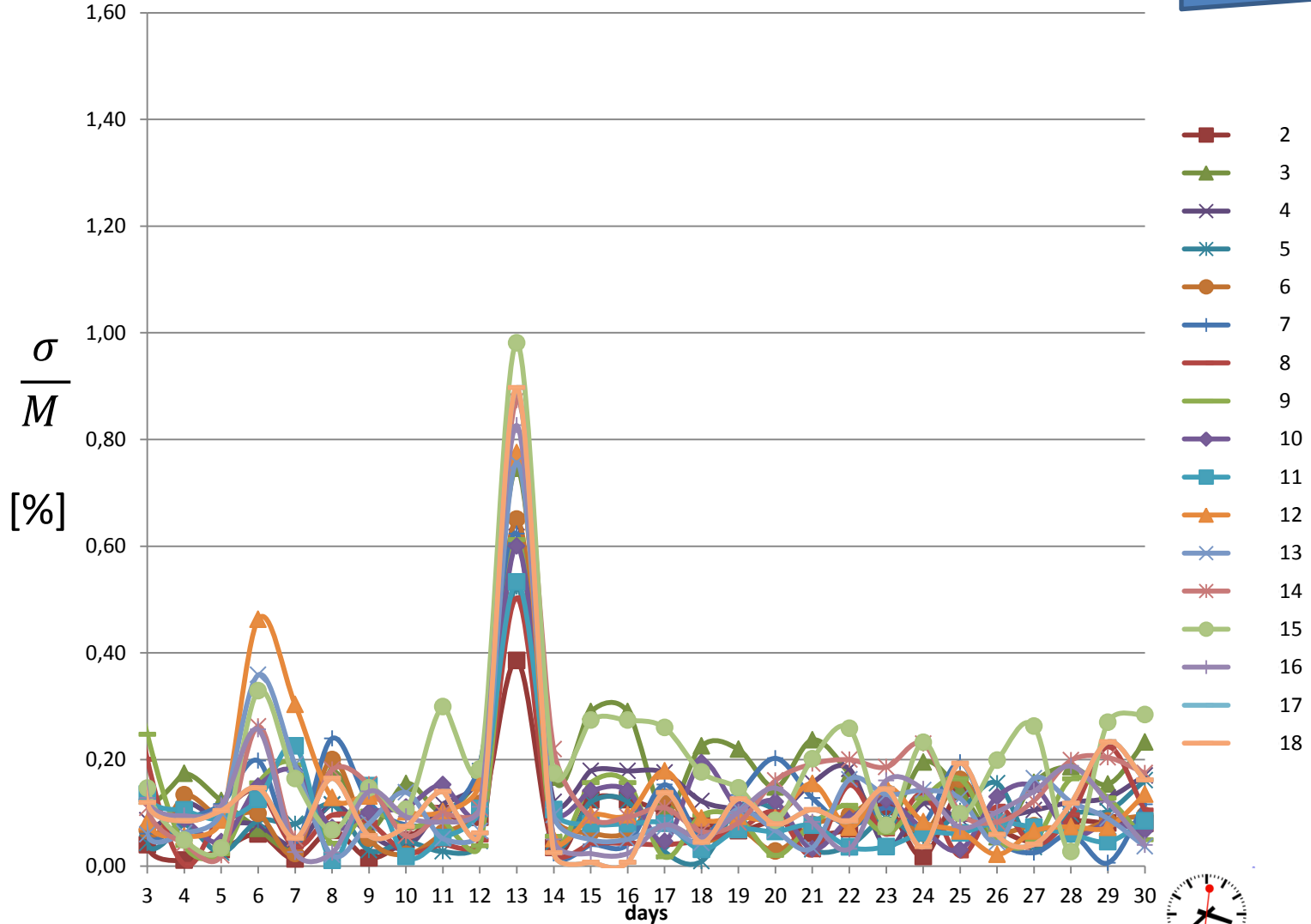
## Inter-Fraction Detector Repeatability



# IQM TESTS- RESULTS



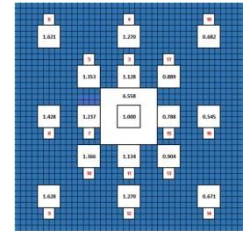
## Inter-Fraction Detector Repeatability





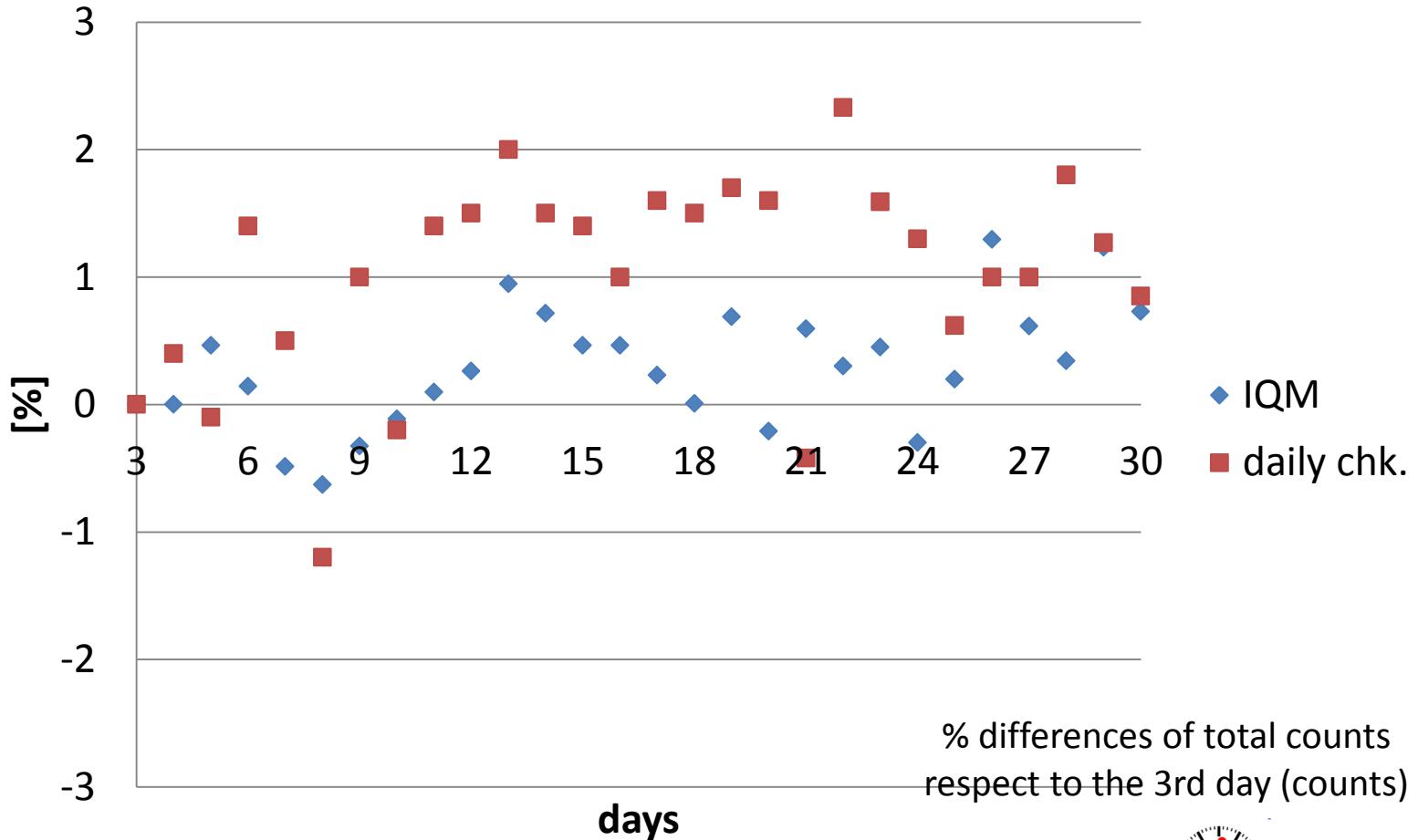


# IQM TESTS- RESULTS



## Inter-Fraction Detector Repeatability

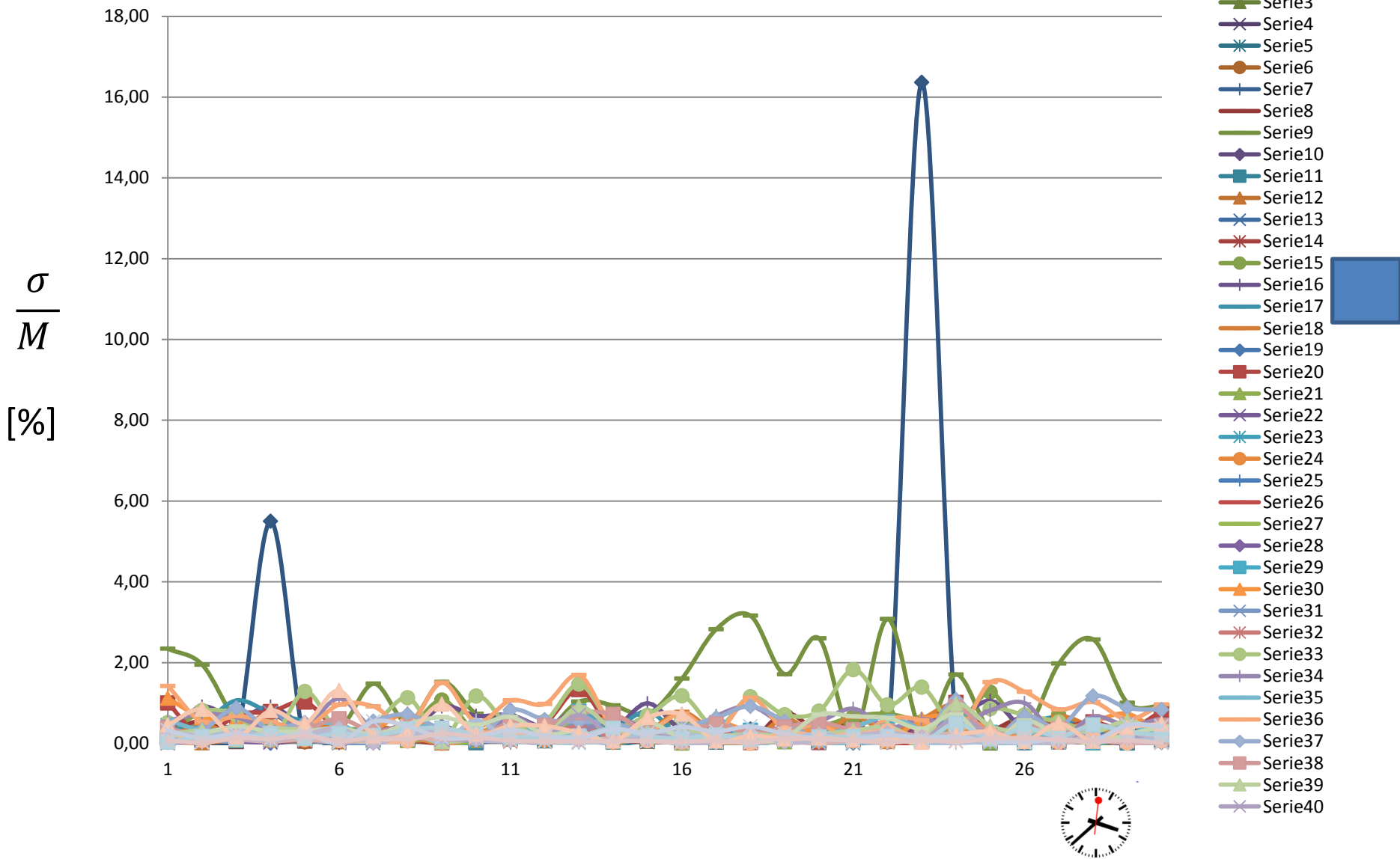
IQM and LINAC output changes vs. time



# IQM TESTS- RESULTS

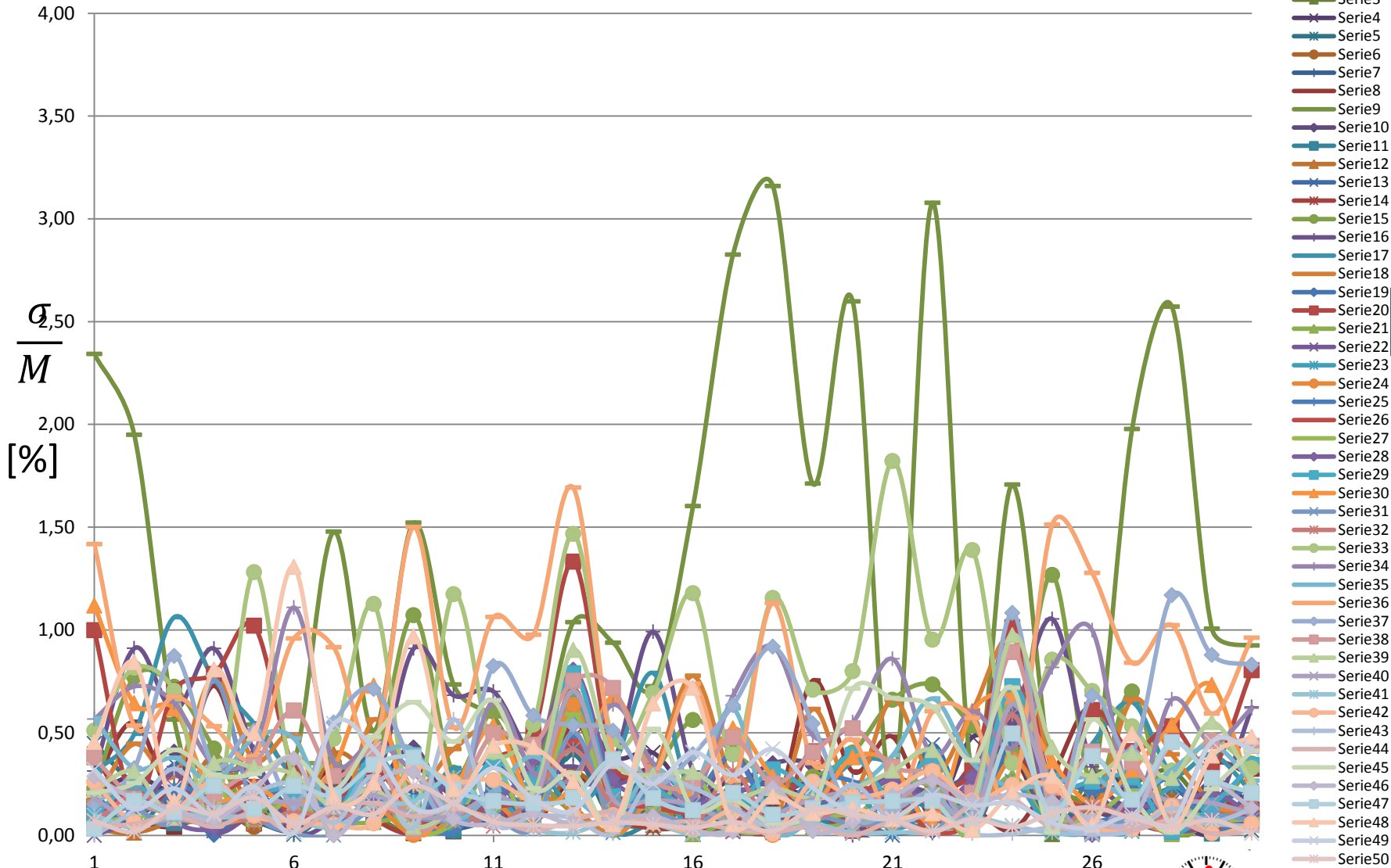


## Inter-Fraction Detector Repeatability



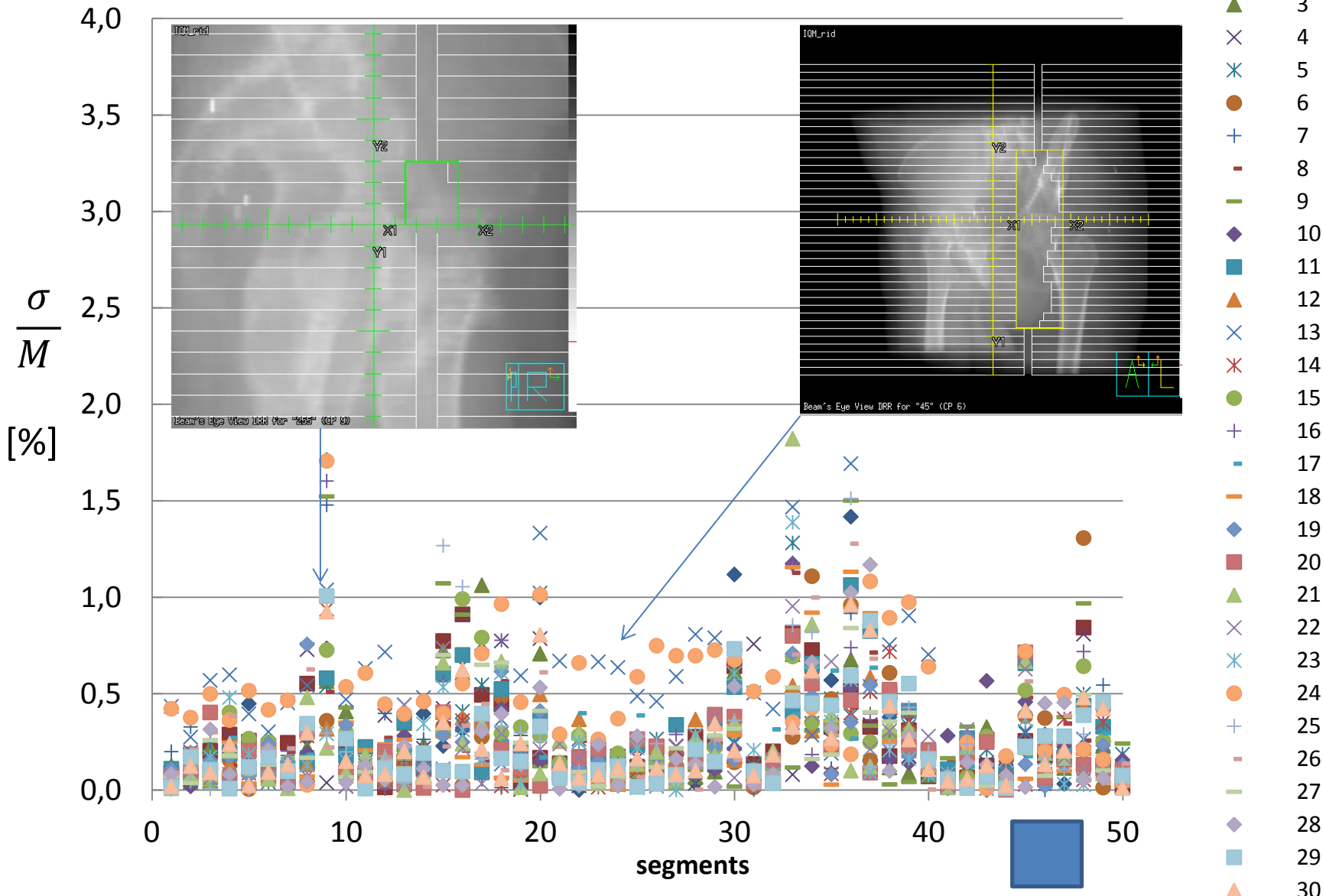
# IQM TESTS- RESULTS

## Inter-Fraction Detector Repeatability



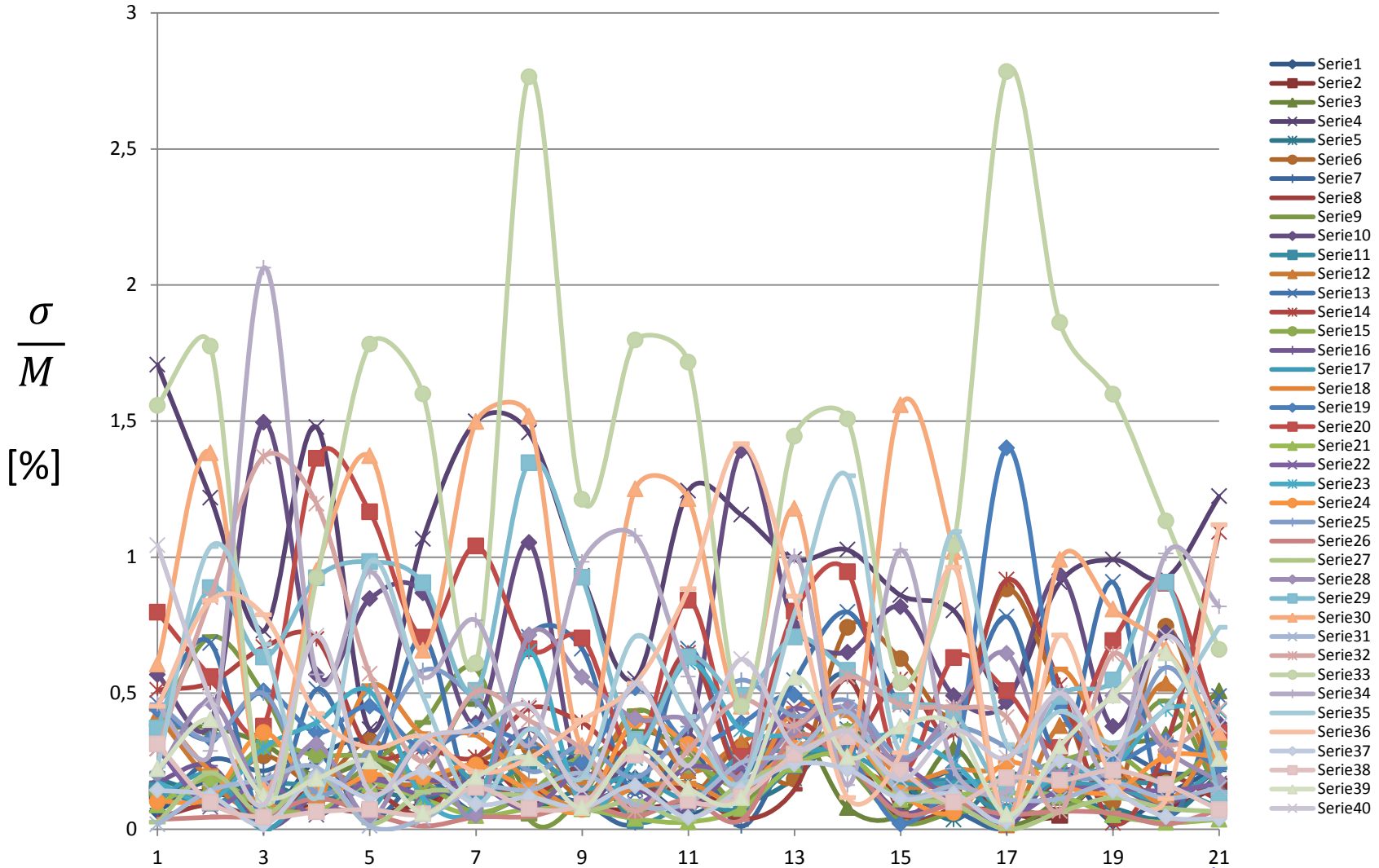
# IQM TESTS- RESULTS

## Inter-Fraction Detector Repeatability



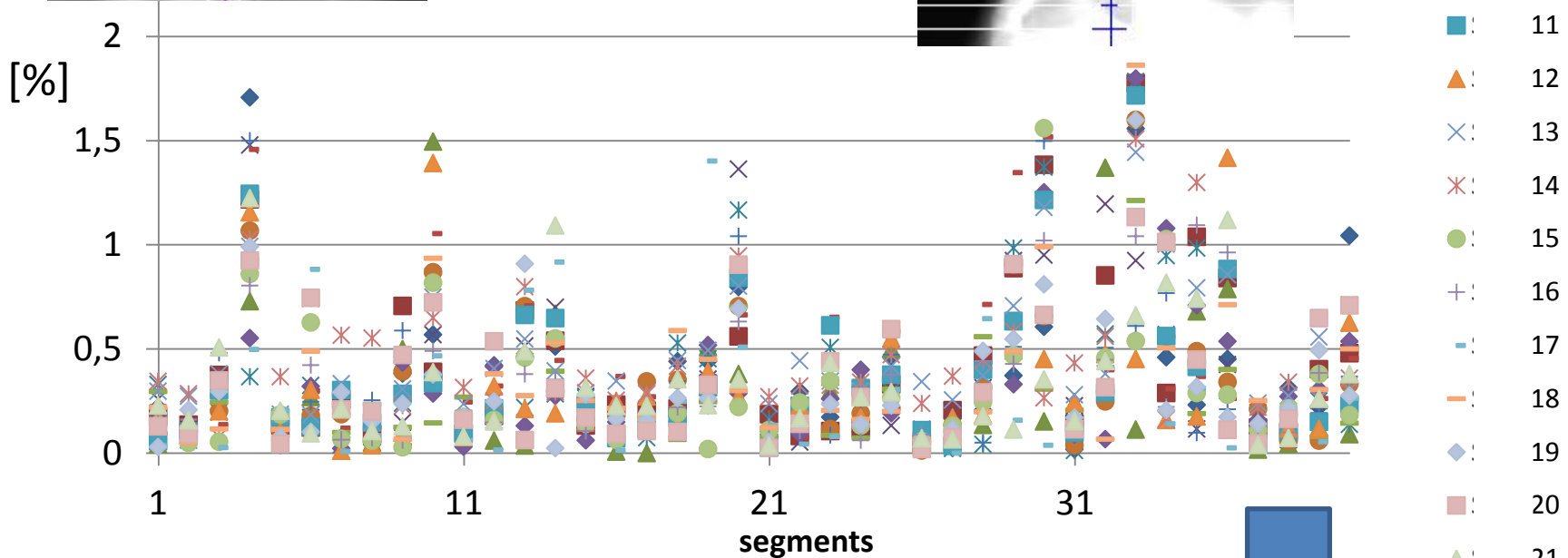
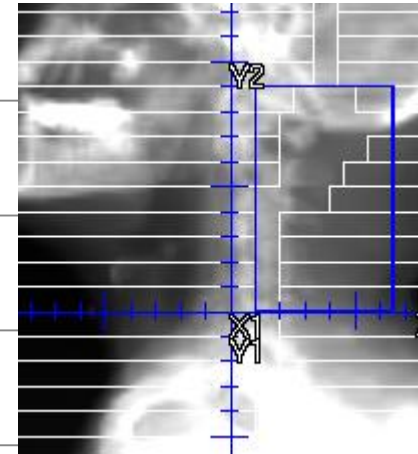
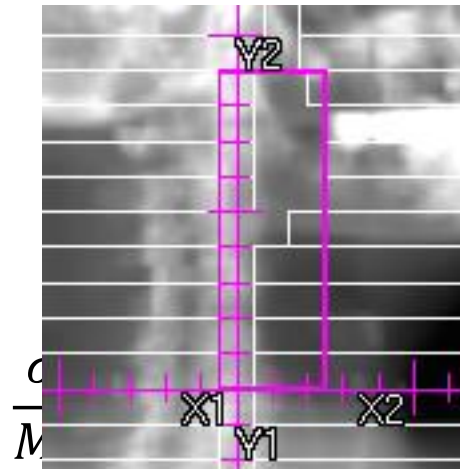
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## Inter-Fraction Detector Repeatability



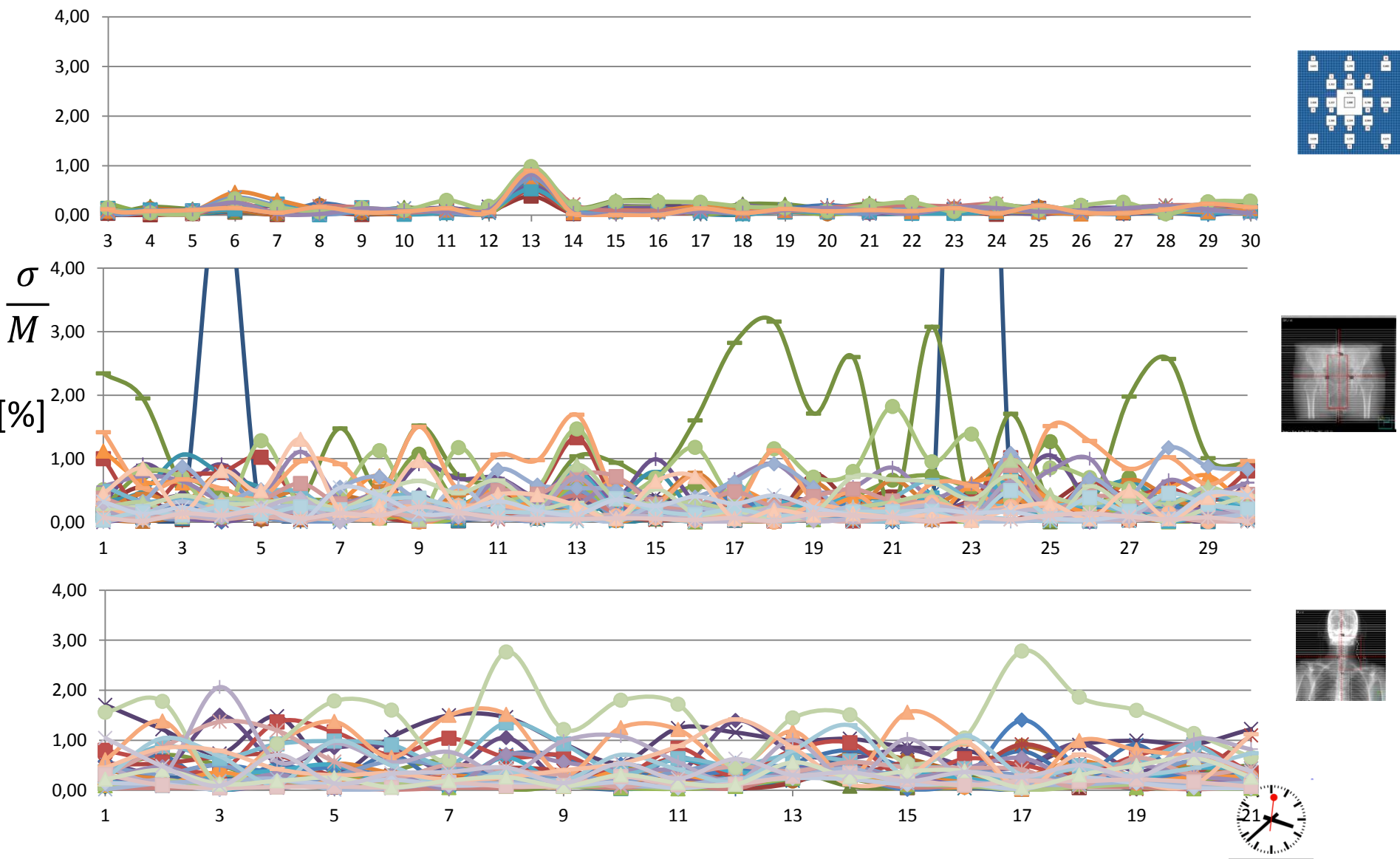
# IQM TESTS- RESULTS

## Inter-Fraction Detector Repeatability



# IQM TESTS- RESULTS

## Inter-Fraction Detector Repeatability

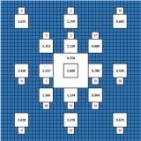






# IQM TESTS- CONCLUSIONS

Intra - fraction repeatability:  $\frac{\sigma}{M} = 0,04\%$

Inter - fraction repeatability:

	mean	dev.st
	0,15	0,17
	0,28	0,54
	0,36	0,36

**OPTIMAL PERFORMANCES**

# IQM TESTS- FUTURE PLAN

## Comparison between IQM and MapCheck

10 IMRT H&N plans

Inducing errors in: MU  
gantry angle  
collimator angle  
leaf positions (bank and single leaf)