REPORT: Flat Stents cutting by Laser-MicroJet®

for Anonymous

by Florent Bruckert, Synova SA

TASK

The Laser-MicroJet® technology has been used for cutting stents on different materials and thicknesses. The aim was to prove that the machine M180 was able to cut during long cycles with the same quality as obtained with the 3 previous machines #61, #73 and #74.

1. SAMPLE DESCRIPTION AND PROCESS DESCRIPTION (FAP)

SUPPLIED MATERIAL 1	Material	CoCr
	Description	320 X 254 X 0.1 mm^3
	Full thickness	100 μm
SUPPLIED MATERIAL 2	Material	Nitinol NiTi
	Description	80 X 120 X 0.215 mm^3
	Full thickness	215 μm
SUPPLIED MATERIAL 3	Material	Nitinol NiTi
	Description	110 X 80 X 0.4 mm^3
	Full thickness	400 μm

Release of application report			
Project Leader		Industry BU Responsible	
Name:	Mr Florent Bruckert	Name:	Dr Carron Benjamin
Date:	08.07.2013	Date:	08.07.2013
Visum:	FBR	Visum:	MM

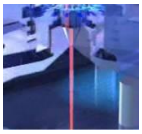
Program name	**Double panel MD 178-0808-00 RevC.nc**	**Double panel MD 178-0817-00 RevD.nc**	**S&R MD 130-0054-00 RevA**	**R51006**
Material	CoCr	CoCr	Nitinol	Nitinol
Thickness [µm]	100	100	215	400
Number of stent	252	180	3	1
Cutting time @ MEDINOL	6h46 (252 stents)	5h20min (90 stents)	0h53min53s	App2h50
Cutting time @ SYNOVA HQ	3h18min33s (126 stents)	10h24min09s (180 stents)	0h53min53s	2h13min36s
Required for buy off	1	1	2	2
Done WK26	1	1	2	2
Laser parameters: peak holes	Average power in the laser = 56.7 W Average power after the objective = 50.9 W Frequency = 2 kHZ Pulse width = 100 us Current percentage = 71 %			n/a
Laser parameters: cutting	Average power in the laser = 23.6 W Av. power after objective = 22.5 W Frequency = 2 kHZ Pulse width = 30 us Current percentage = 87 %		Average power in the laser = 24.7 W Av. power after objective = 24.0 W Frequency = 2 kHZ Pulse width = 35 us Current percentage = 82.5 %	
Panel size	320*254mm	320*254mm	80*120 mm	110*80mm
Comments	X=320mm Y=254mm	X=320mm Y=254mm	X=80 Y=120	X=110 Y=80

Note:
All the cutting speeds, specific accelerations and number of passes were defined in the nc-program. The cutting parameters have been set in your factory to use the same nc-files (Set and Repeat) in all of your machines.

2. PROCESS: INSTRUMENT & TEST PARAMETERS

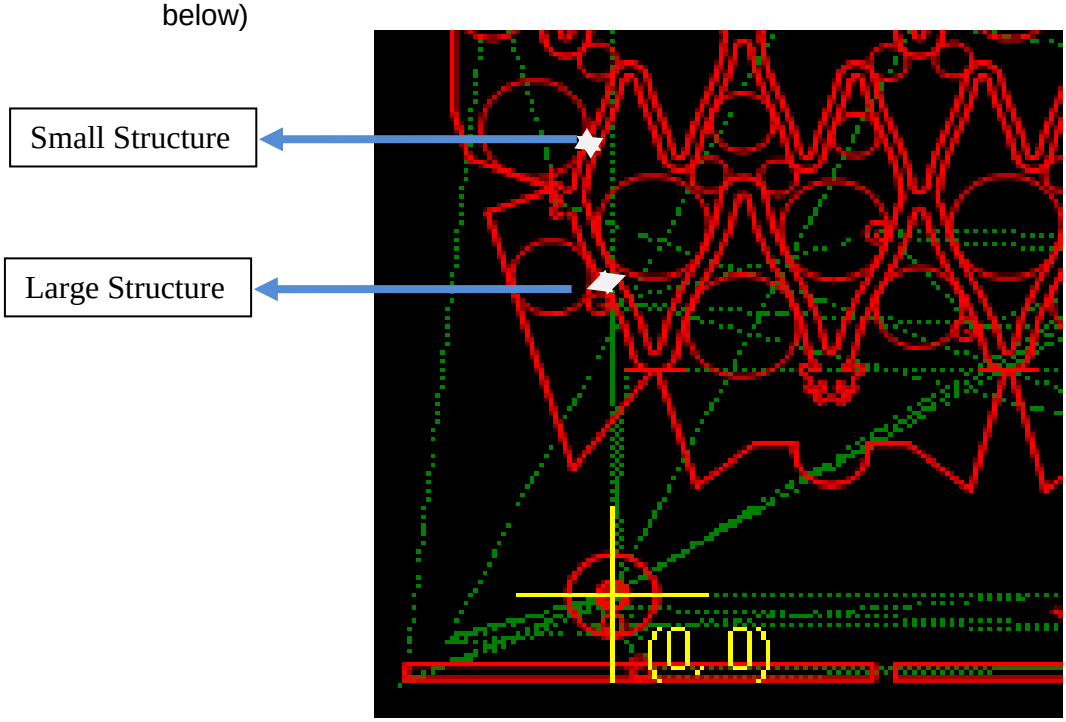
Your machine is equipped of a Q-switched, Nd:YAG laser 70W.

In the table below, the optimised processing parameters used in the experiments are summarised:

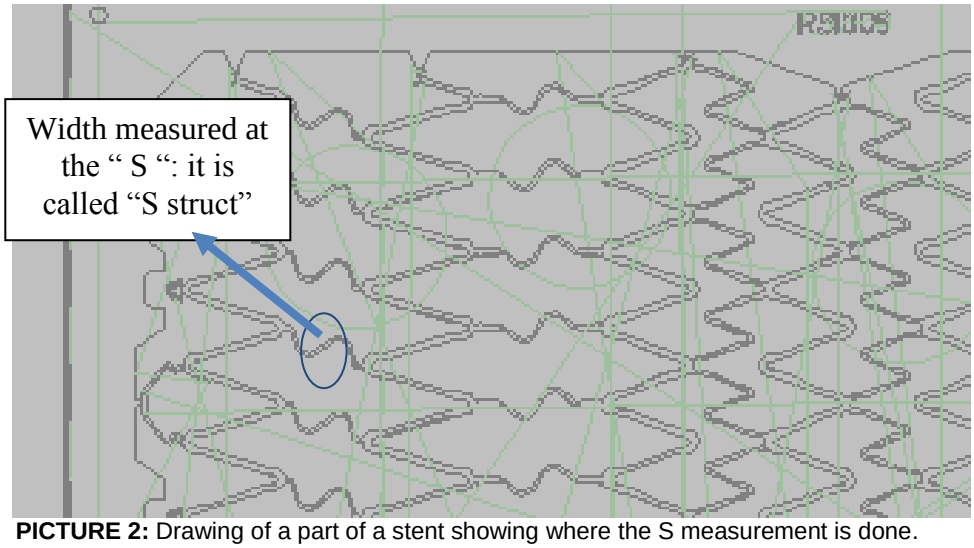
	**SYSTEM**	Machine type	LCS300
		Fixture	Clamped
	**MICROJET® PARAMETER**	Nozzle diameter	30 *µm*
		Kerf width	27 *µm*
		Water pressure	450 *bar*
		Working distance	8 *mm*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L71IR
		Wavelength	1064 *nm*

3. RESULTS

- The expected quality (Front/back side of the samples, process times, and repeatability of stents "arms" thicknesses) has to be the same as shown in report 0611-6.
- The cutting accuracy had to be lower than ± 10 µm.
- The 100 µm-CoCr foils have been processed (according to nc #178081700revd and # 178080800revc) on 25.06.13.
- The 215 µm-NiTi foils have been processed (according to nc #130005400reva) on 25.06.13.
- The 400 µm-NiTi foils have been processed (according to nc #130005400reva for testing and # R51006) on 26.06.13.
- The widths at different places in the stents have been measured (see the Image 1 and 2 below)



PICTURE 1: Picture of a part of a stent showing 2 measurements done.



PICTURE 2: Drawing of a part of a stent showing where the S measurement is done.

Please find below the table which summarize the measurements done on stents cut with the machine M180.

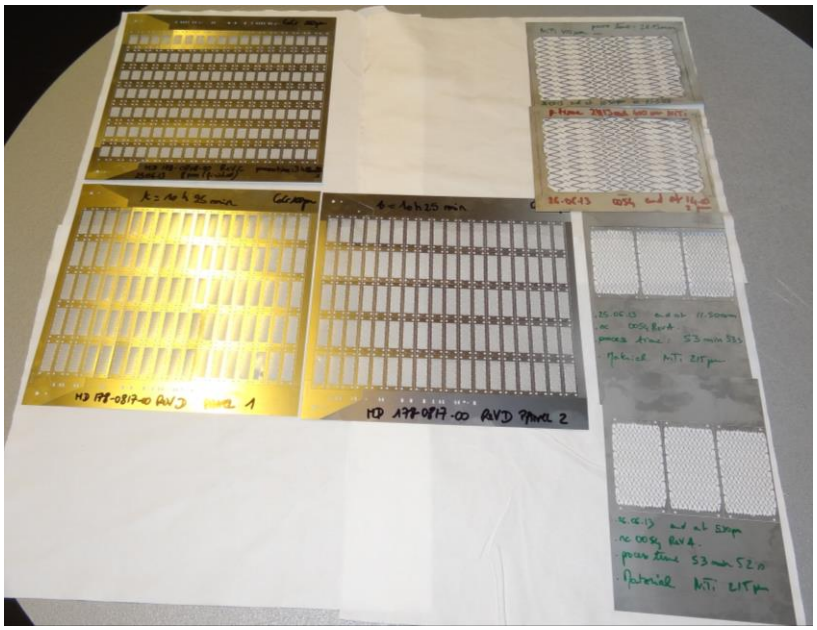
Material	Type	Panel #	Stent #	small strut [mm]	large strut [mm]	S strut	cutting time
CoCr100	178081700revd	1	A1	0.048	0.084	NA	10h 44min
	178081700revd		C10	0.048	0.084	NA	10h 44min
	178081700revd		E18	0.05	0.086	NA	10h 44min
	178081700revd	2	A1	0.05	0.084	NA	10h 44min
	178081700revd		C10	0.049	0.084	NA	10h 44min
	178081700revd		E18	0.05	0.082	NA	10h 44min
	178080800revc	1	F4	0.053	0.085	NA	3h 18min
	178080800revc		A10	0.053	0.086	NA	3h 18min
	178080800revc		C18	0.052	0.086	NA	3h 18min
	178080800revc		E5	0.05	0.086	NA	3h 18min
NiTi215	130005400reva	1	1	0.1176	0.176	NA	53min
	130005400reva		2	0.1176	0.1764	NA	53min
	130005400reva		3	0.1274	0.1764	NA	53min
NiTi400	R51006	1	1	0.197	0.36	0.197	2h13min
	R51006		1	0.197	0.355	0.197	2h13min
	R51006		1	0.192	0.36	0.197	2h13min
	R51006	2	1	0.197	0.355	0.192	2h13min
	R51006		1	0.192	0.365	0.187	2h13min
	R51006		1	0.187	0.355	0.192	2h13min
	130005400reva	2	1	0.123	0.1764	NA	53min
	130005400reva		2	0.1225	0.172	NA	53min
	130005400reva		3	0.125	0.174	NA	53min

Accuracy

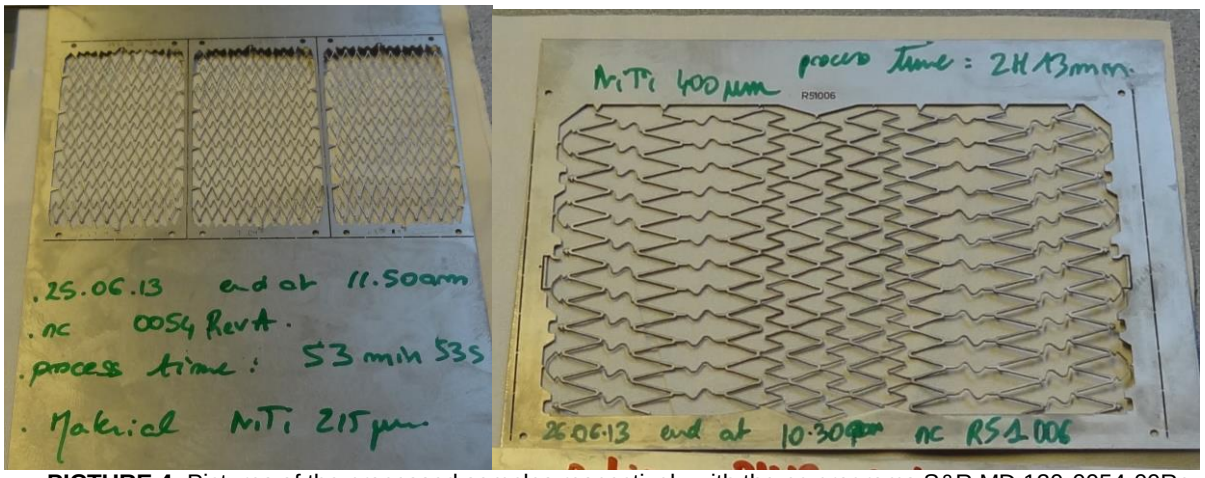
All measurements have been done on the same device by the same operator.
The accuracy is given by a ± 1 graduation X factor (function of the objective used).
In the following table, you have a summary of the different measurements accuracies

	small structure [mm]	large structure [mm]	S structure [mm]
CoCr100	0.050±0.01	0.086±0.01	N/A
Nitinol215	0.121±0.015	0.176±0.015	N/A
Nitinol400	0.192±0.02	0.362±0.03	0.192 ±0.02

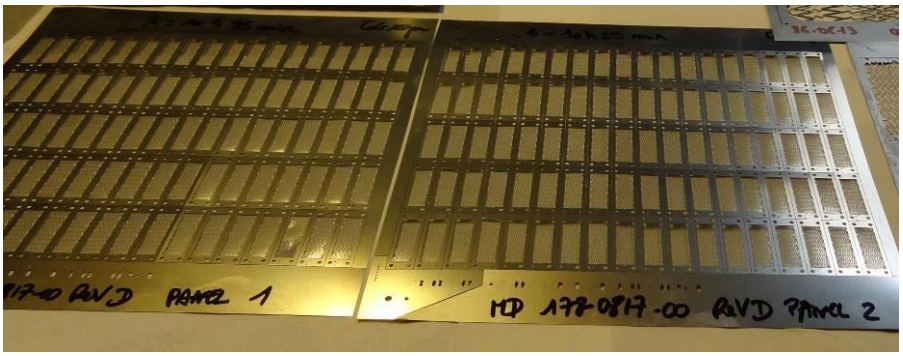
Please find below some macroscopic pictures of the processed samples.



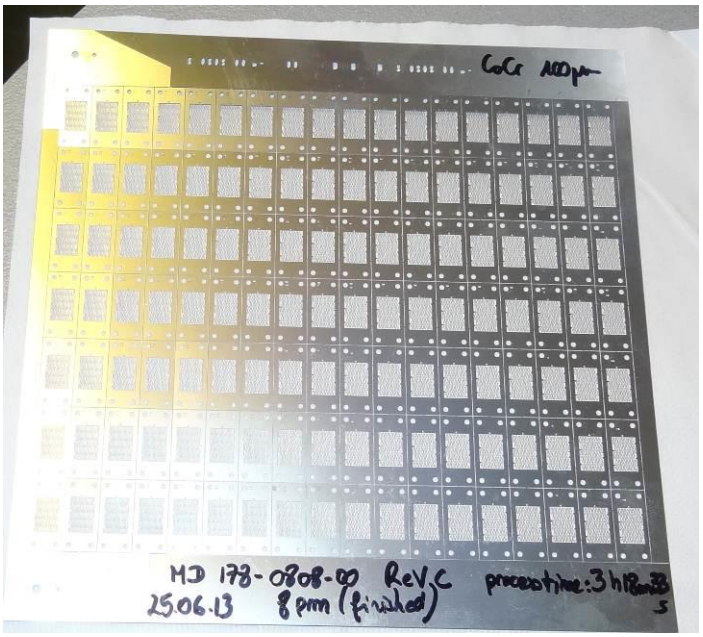
PICTURE 3: Picture of the processed samples.



PICTURE 4: Pictures of the processed samples respectively with the nc programs S&R MD 130-0054-00RevA and R51006

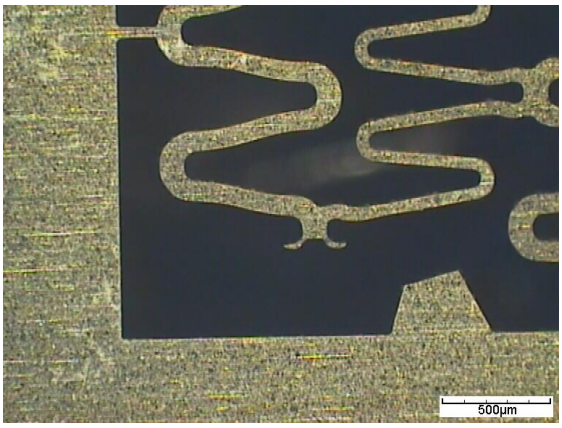


PICTURE 5: Picture of the processed sample with the nc program Double panel MD 178-0817-00RevD

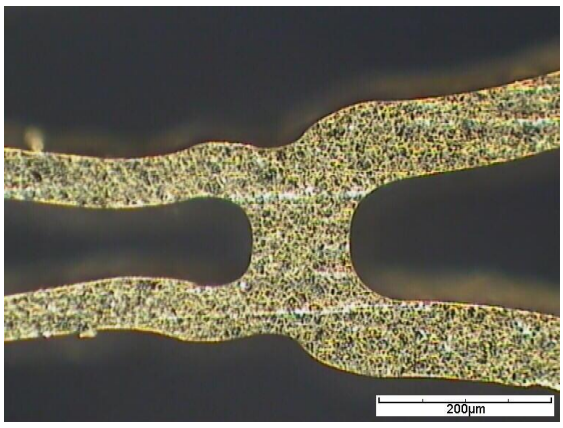


PICTURE 6: Picture of a processed sample: nc program simple panel MD 178-0808-00RevC

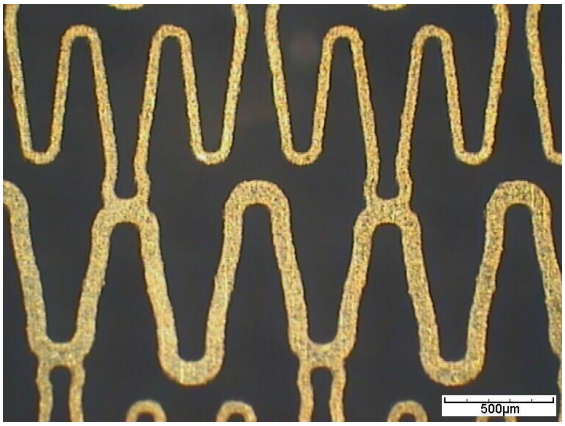
You can see below the pictures related to the previous tests.



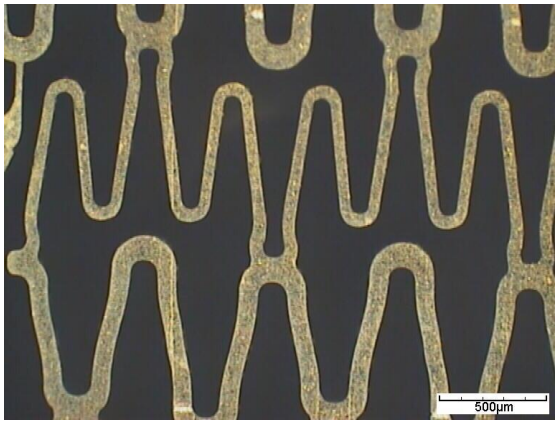
PICTURE 7: Microscope image of 178-0808 (CoCr) (front side view)



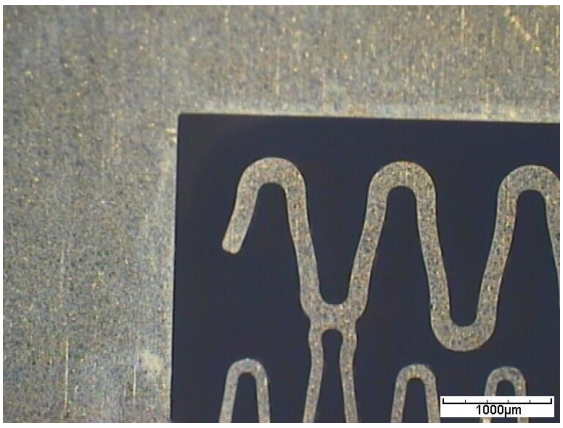
PICTURE 8: Microscope image of 178-0808 (CoCr) (front side view)



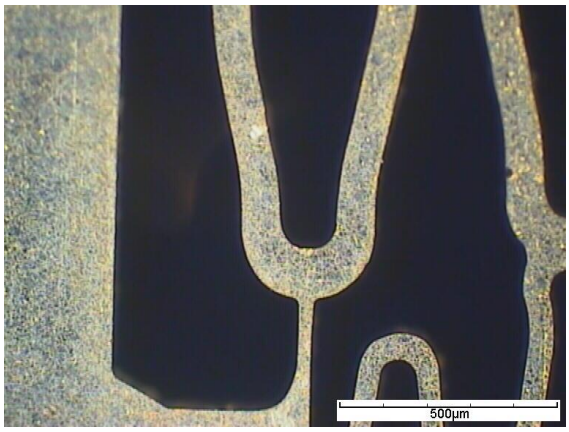
PICTURE 7: Microscope image of 178-0817 (CoCr) (back side view)



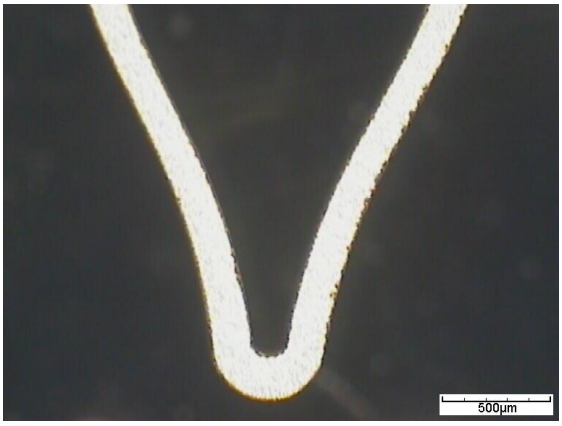
PICTURE 8: Microscope image of 175-0817 (CoCr) (simple side view)



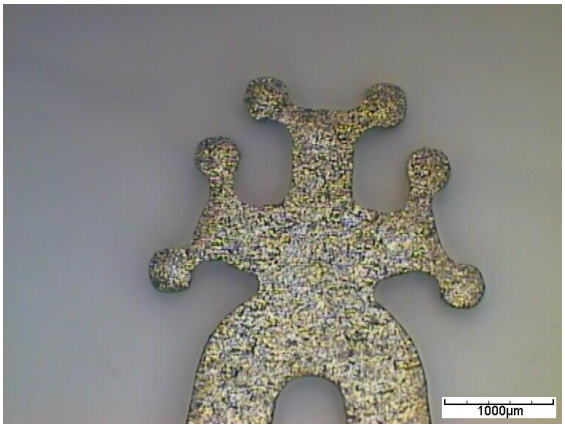
PICTURE 9: Microscope image of 175-0817 (CoCr) (front side view)



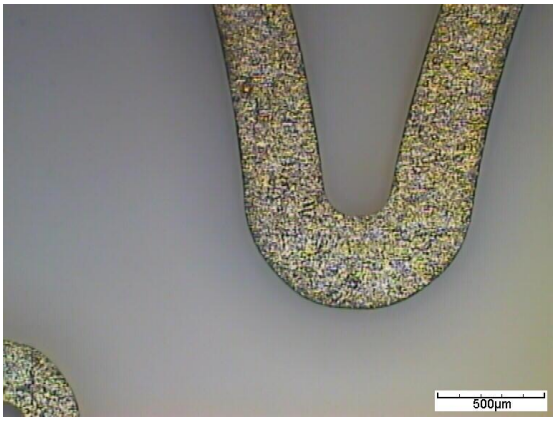
PICTURE 10: Microscope image of 175-0817 (CoCr) (front side view)



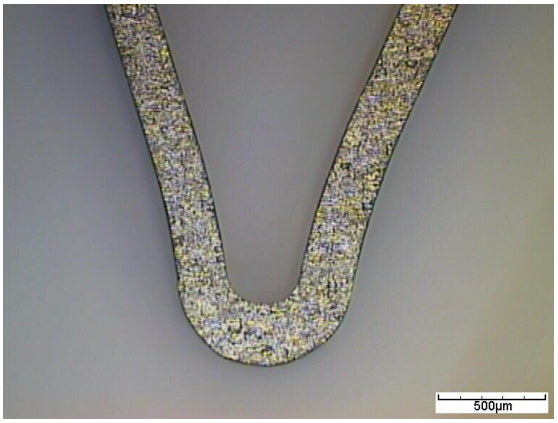
PICTURE11: Microscope image of MD130-0054 RevA (NiTi) (back side view)



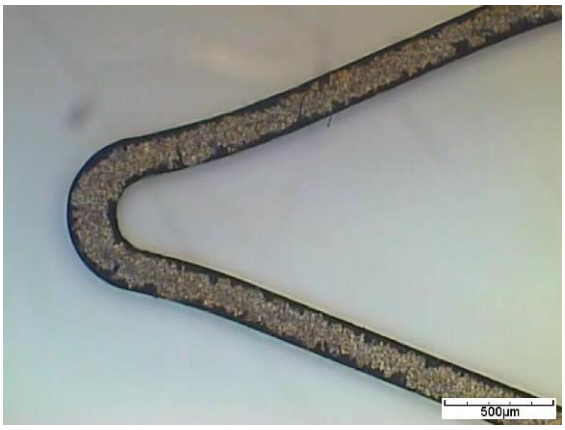
PICTURE 12: Microscope image of MD130-0054 RevA (NiTi) (front side view)



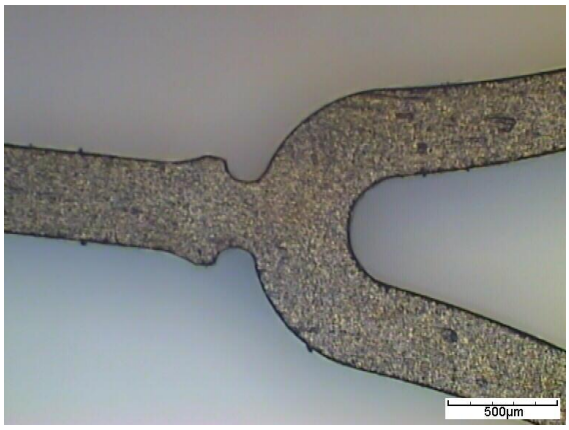
PICTURE 13: Microscope image of MD130-0054 RevA (NiTi) (front side view)



PICTURE 14: Microscope image of MD130-0054 RevA (NiTi) (front side view)



PICTURE 15: Microscope image of R51006 (NiTi) (back side side view)



PICTURE 16: Microscope image of R51006 (NiTi) (back side side view)

CONCLUSION

The cutting of stents in Nitinol and CoCr has been processed on your SYNOVA LCS 300 #180.
The cutting quality (frontside, back side, edge, process time) matches with your expectations.
So, this machine is able to provide the cutting quality than you actually obtain with the 3 previous machines #61, #73 and #74.

These tests show that:

- The repeatability of the machine is excellent (< 2 µm shift)
- The quality matches with your expectations.
- The process and the cutting quality are strictly the same than the ones you actually have on your previous machines.

We are open to further discuss your needs regarding:

- The process development: with a more powerful laser setting, some development can lead to a relative gain of time (20% at least). An upgrade should be necessary on your other machines for using the same programs for the production on all machines.

We thank you for your interest in our technology and we hope our results meet your requirements.
We would be glad to obtain a feedback about the analysis of these results.