

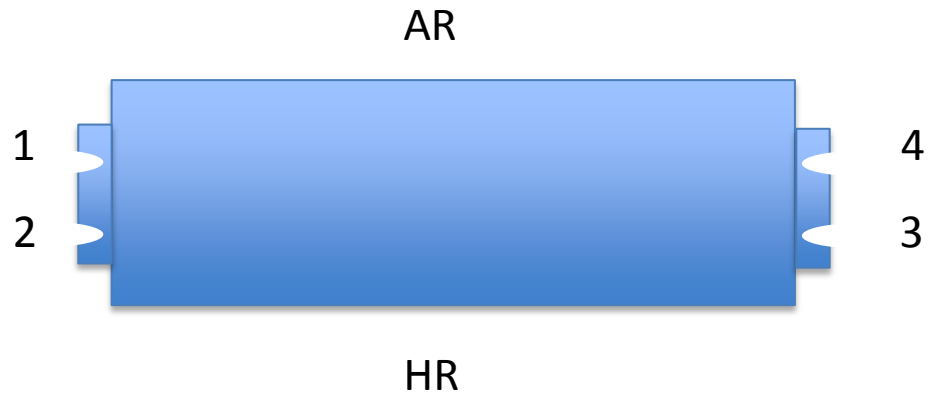
Compared analysis of payload failures

Helios Vocca

&

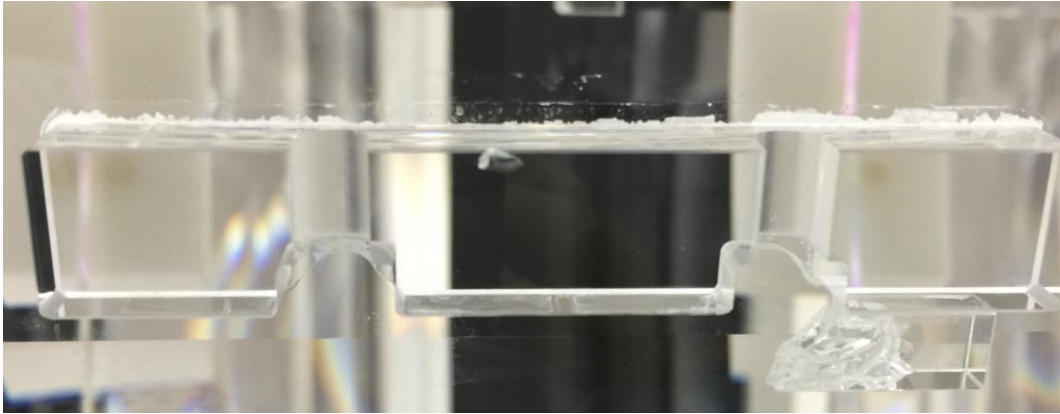
Flavio Travasso

Mirror reference system



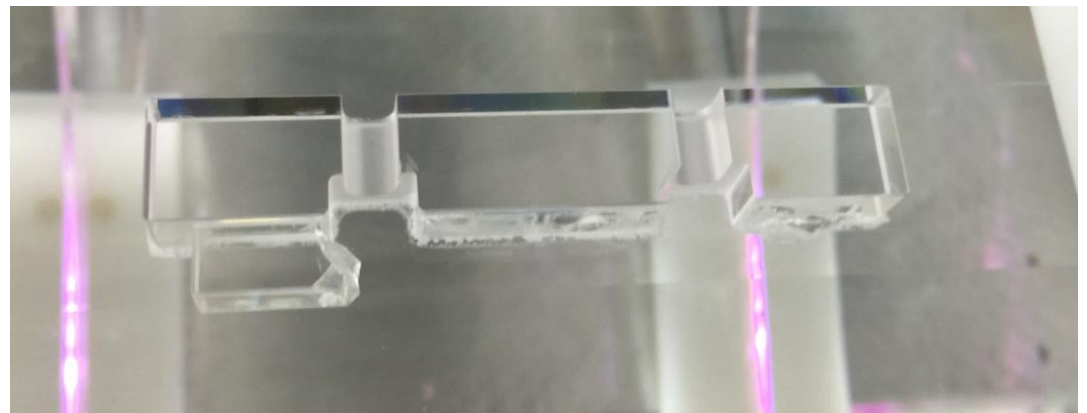
View from the top

WI - Ears view after the crash



1

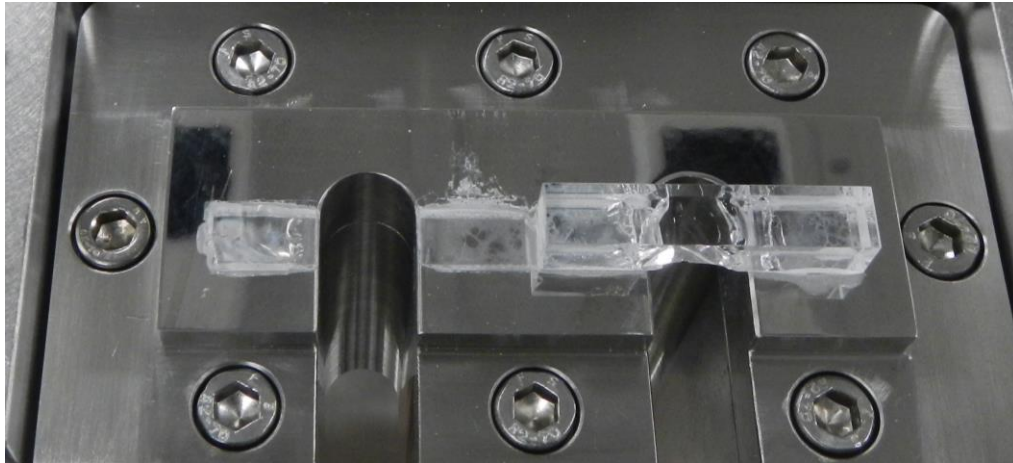
2



3

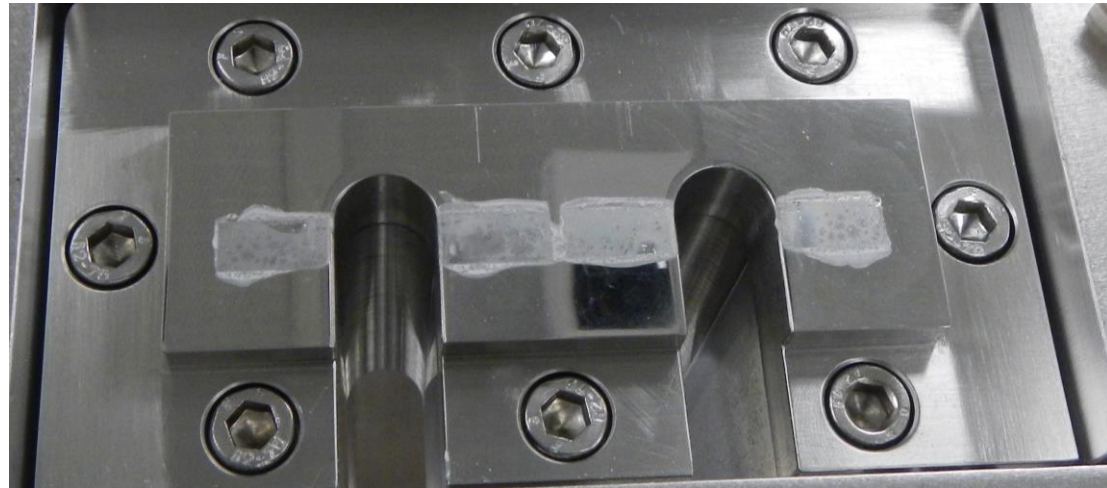
4

WI - Marionetta view after the crash



1

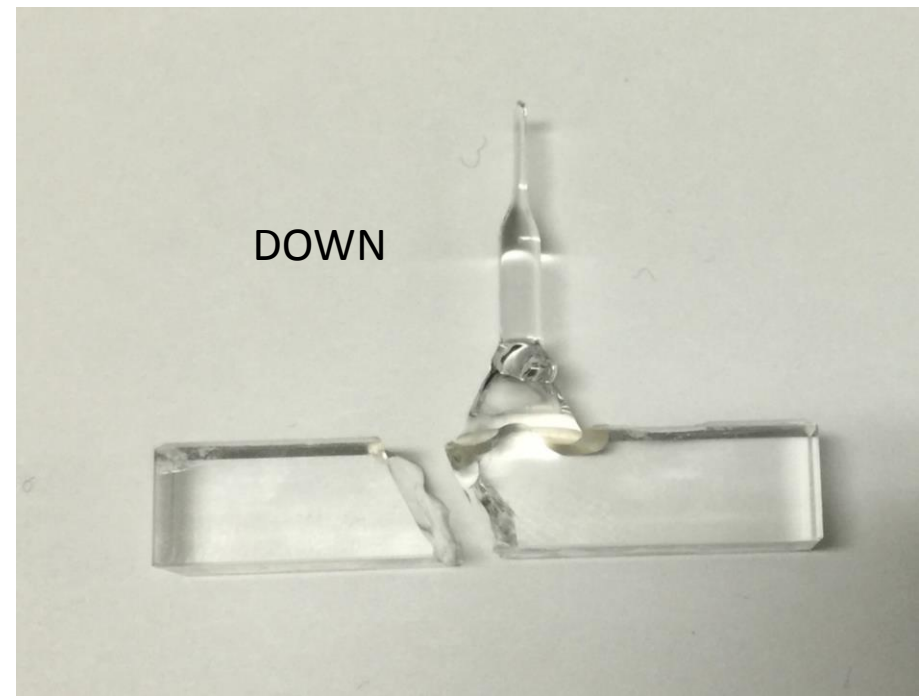
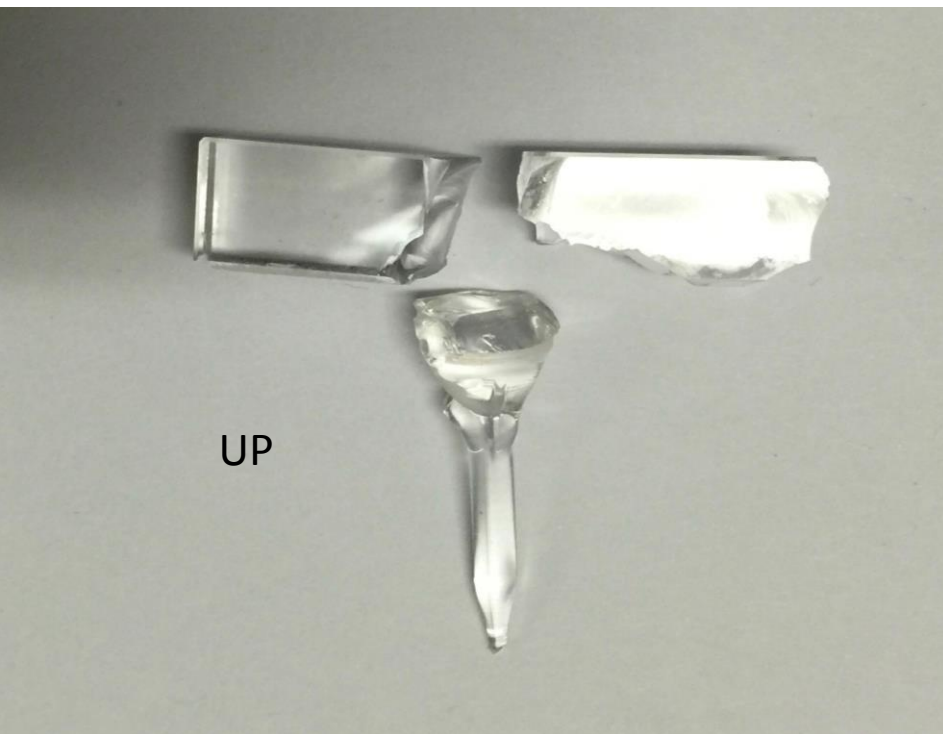
2



3

4

WI - Anchors n°1



WI - Anchors n°2

UP



DOWN



WI - Anchors n°3



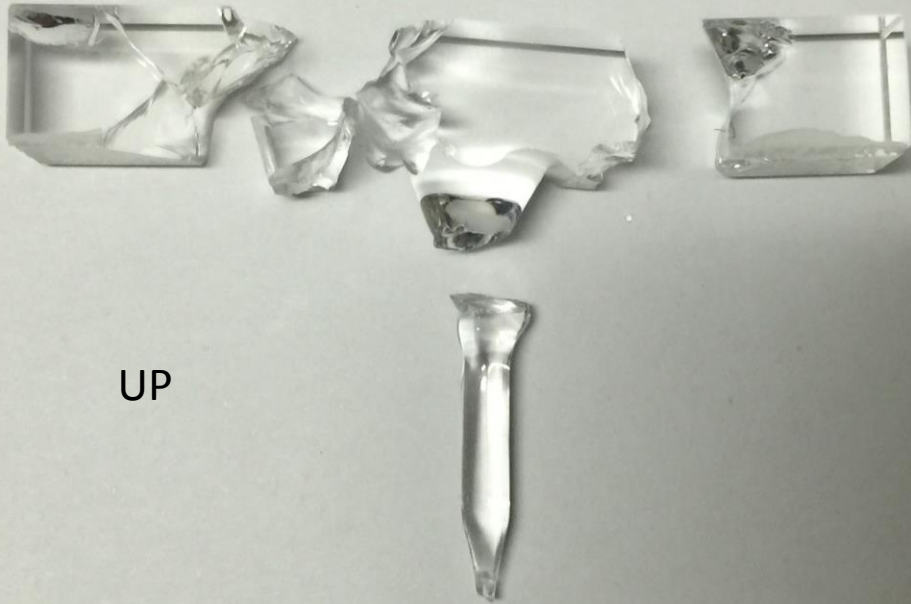
UP

According to the data the crash begun from this fiber: it can be started from the lower cone (or at least from the upper welding...).

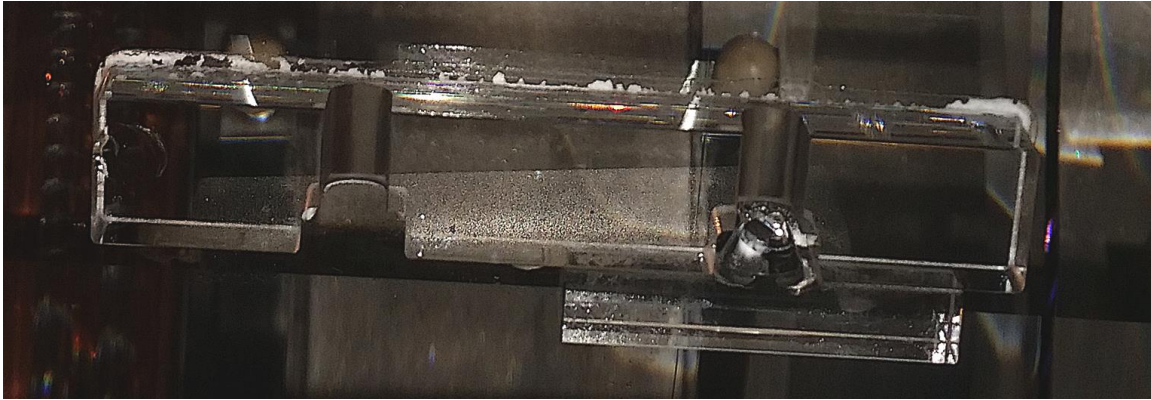


DOWN

WI - Anchors n°4

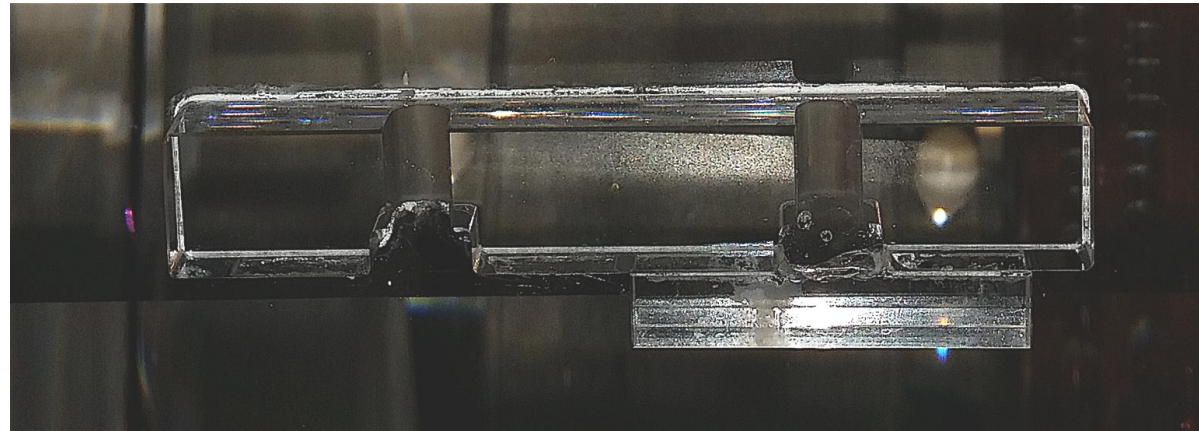


NI - Ears view after the crash



1

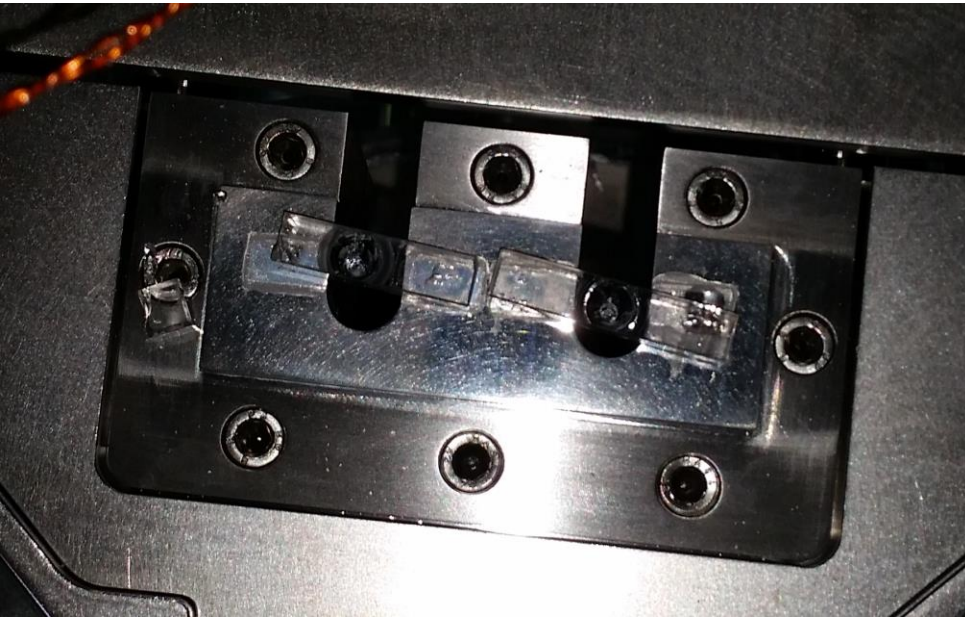
2



3

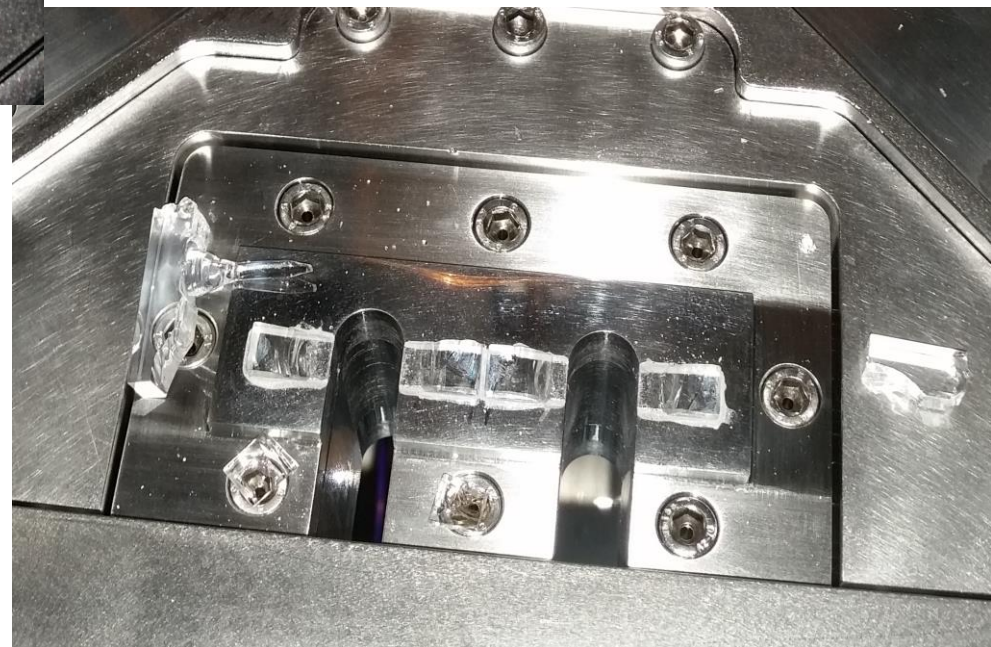
4

NI - Marionetta view after the crash



1

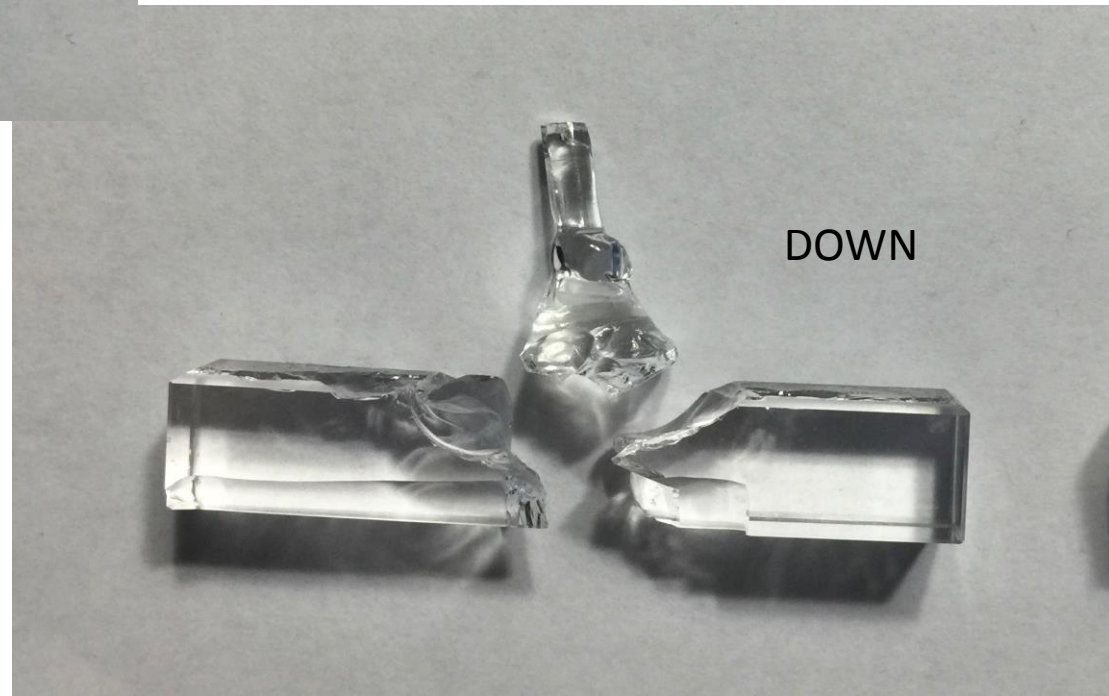
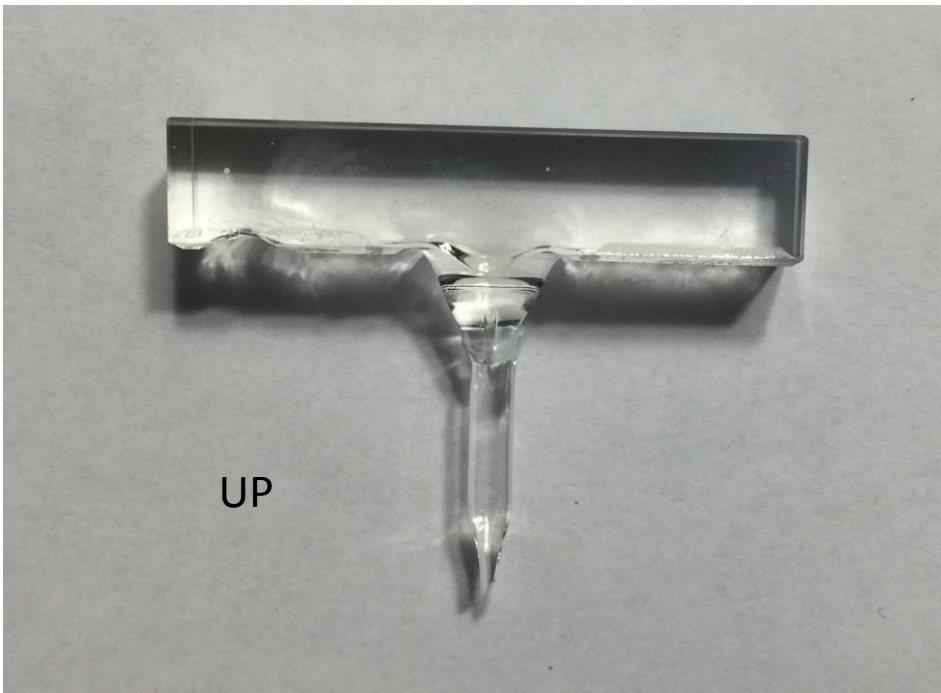
2



3

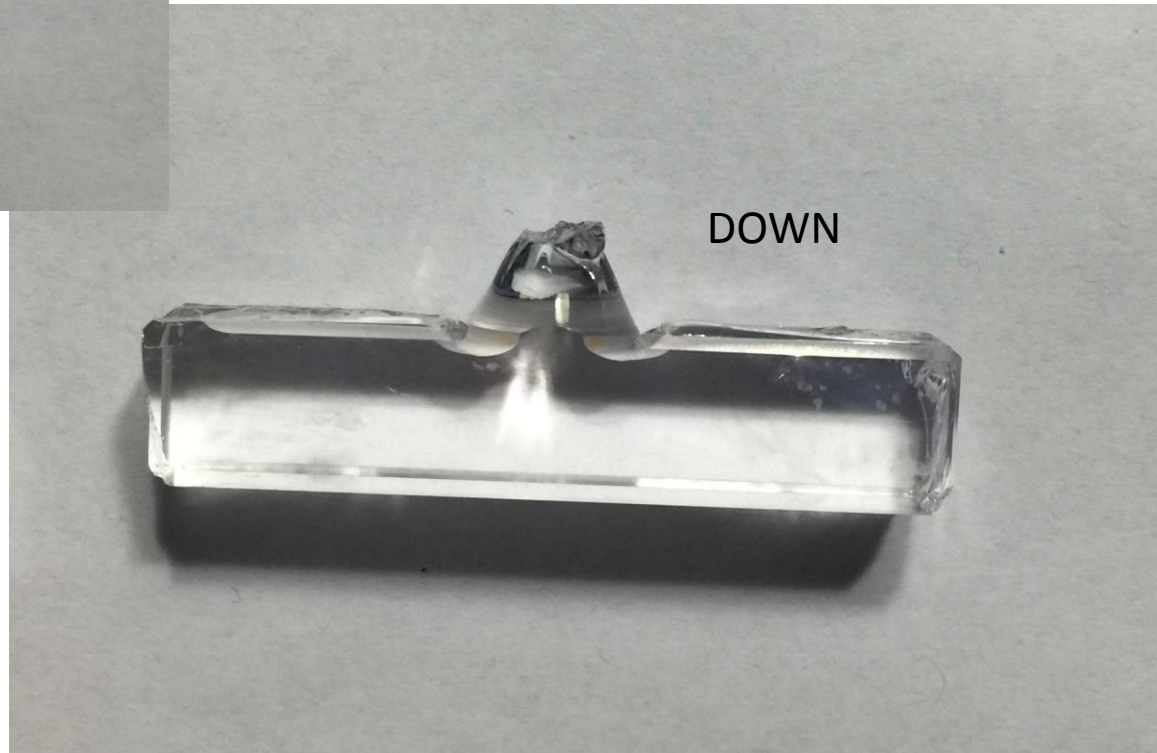
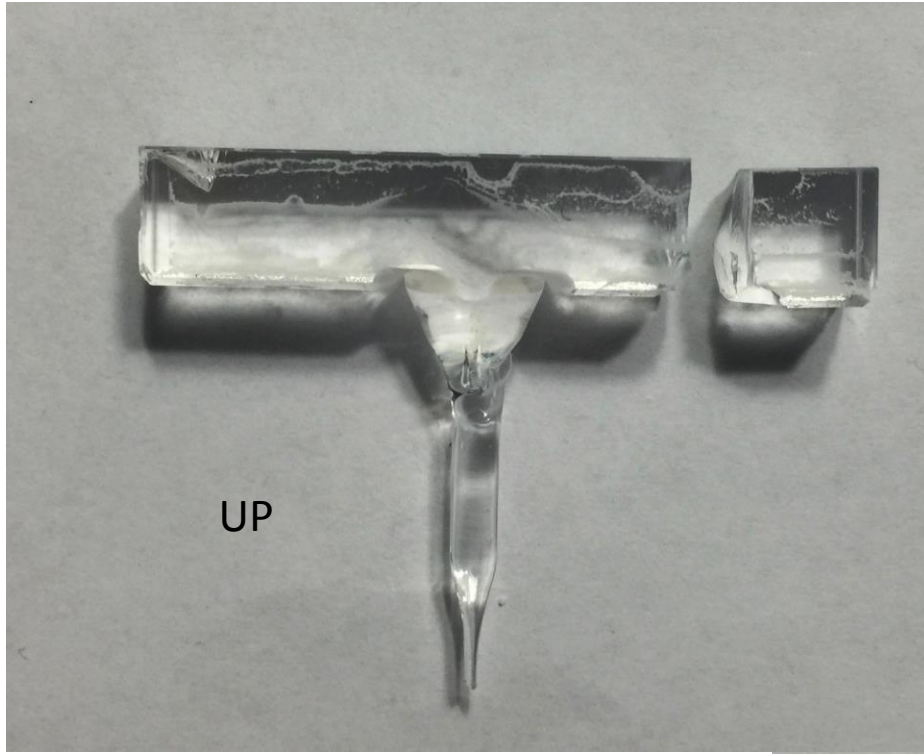
4

NI - Anchors n°1

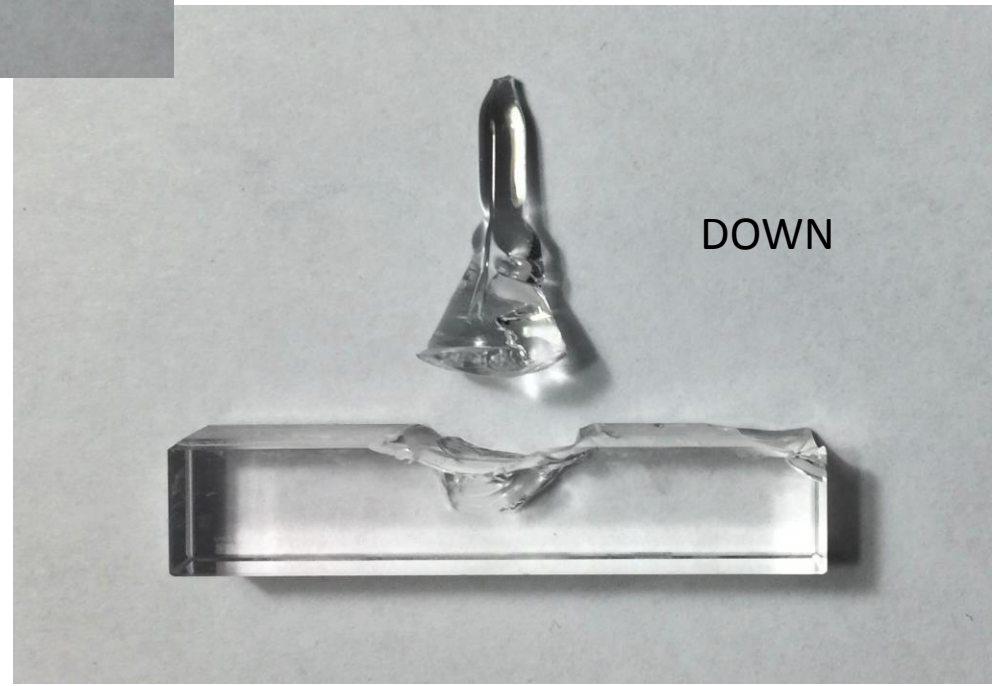
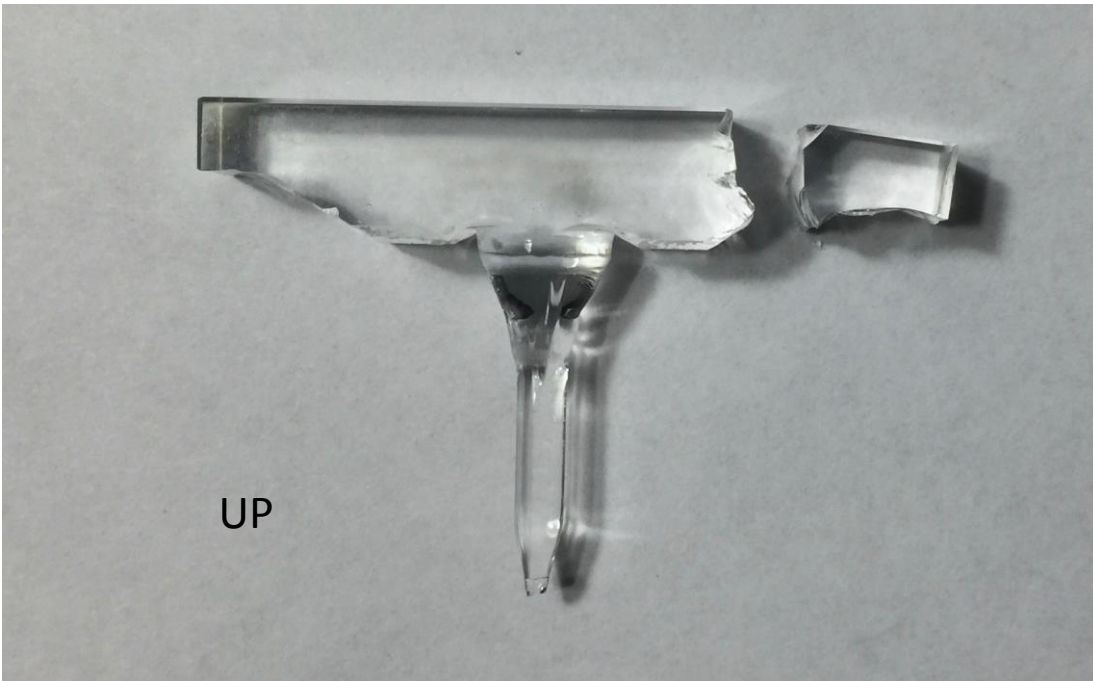


NI - Anchors n°2

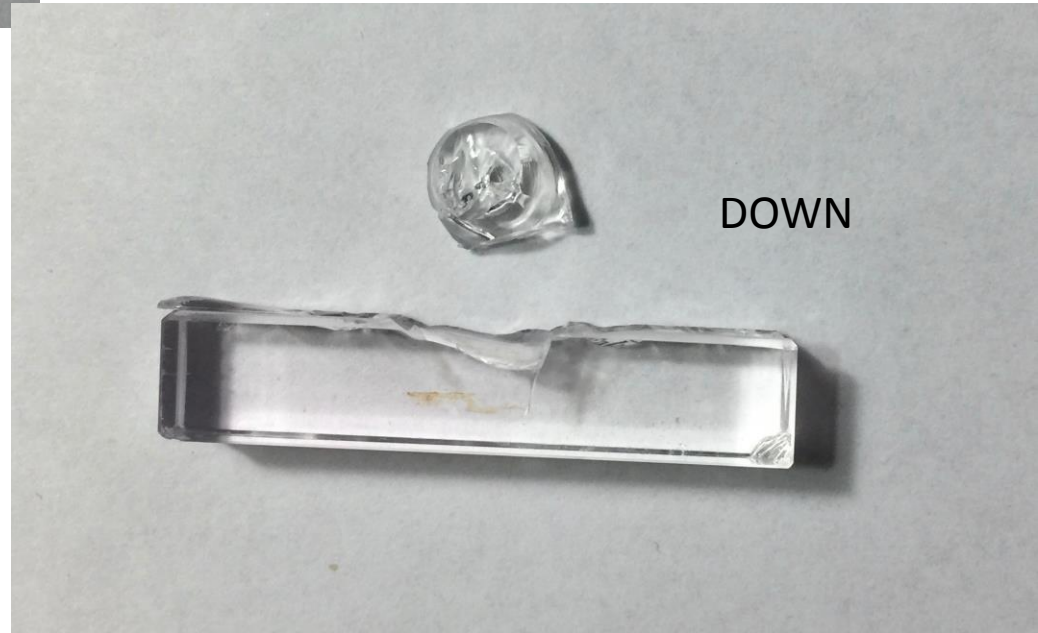
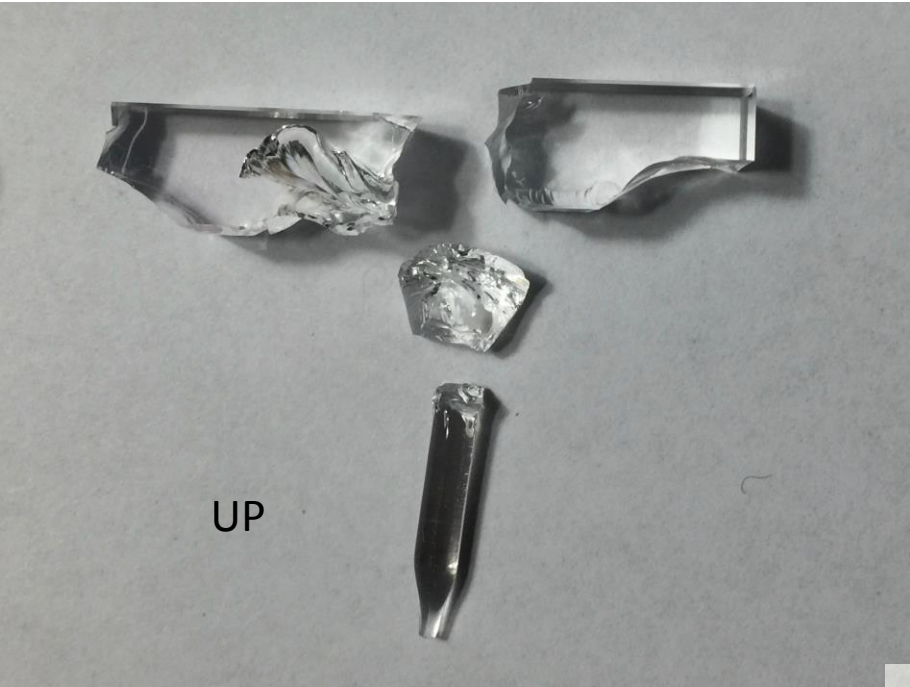
According to the data the crash begun from this fiber



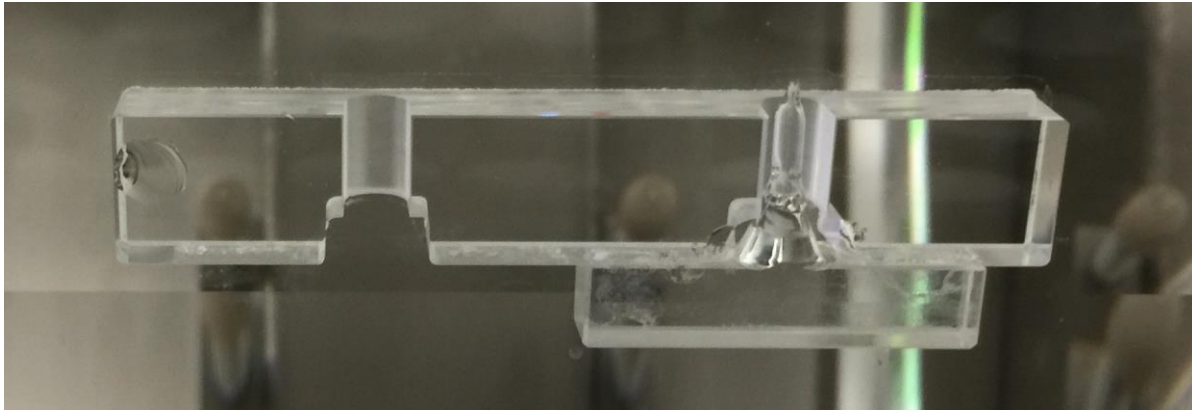
NI - Anchors n°3



NI - Anchors n°4

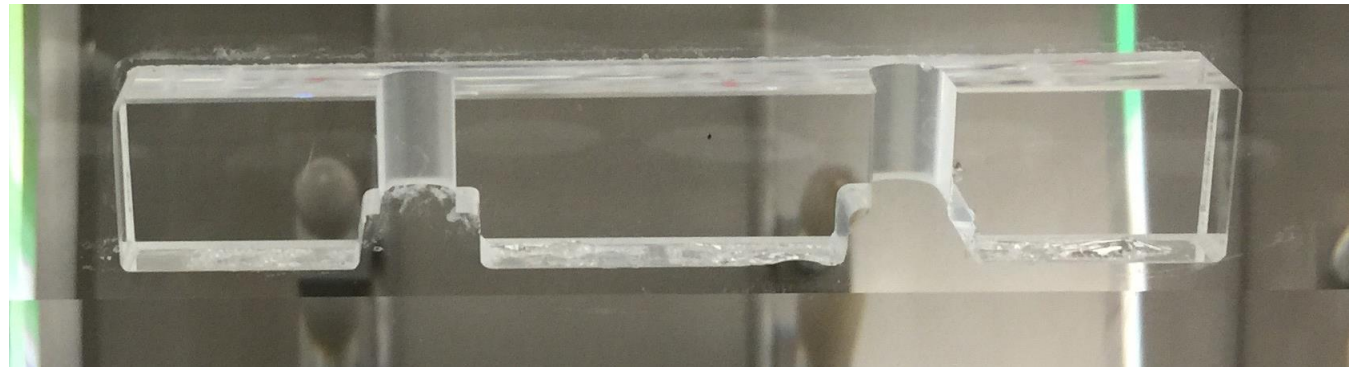


2° NI - Ears view after the crash



1

2



3

4

2° NI - Marionetta view after the crash

2

1

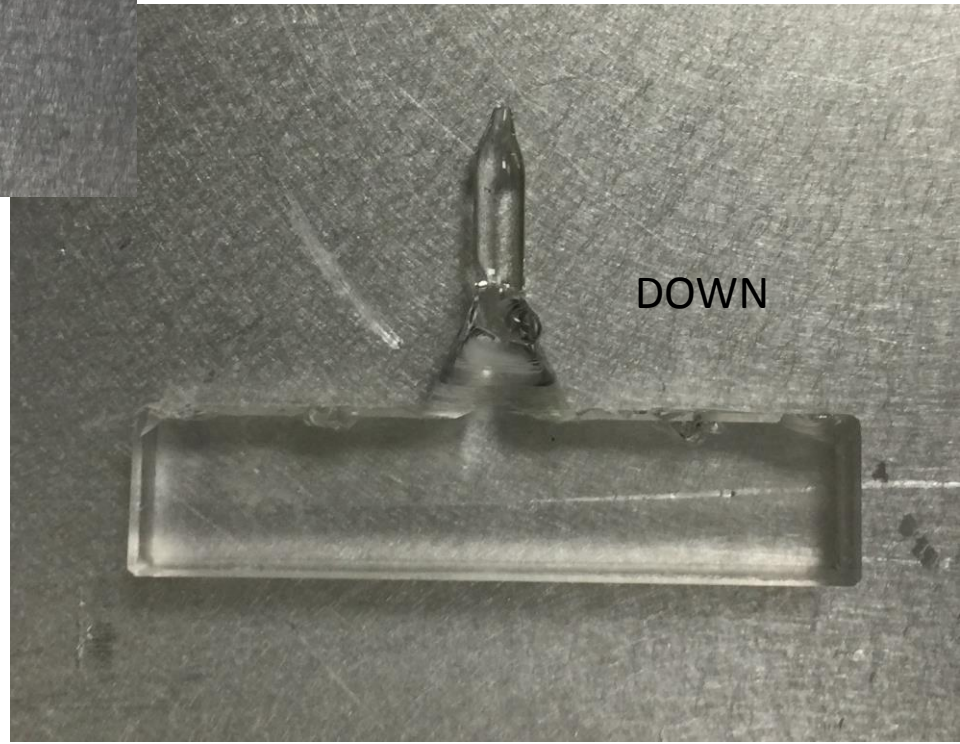
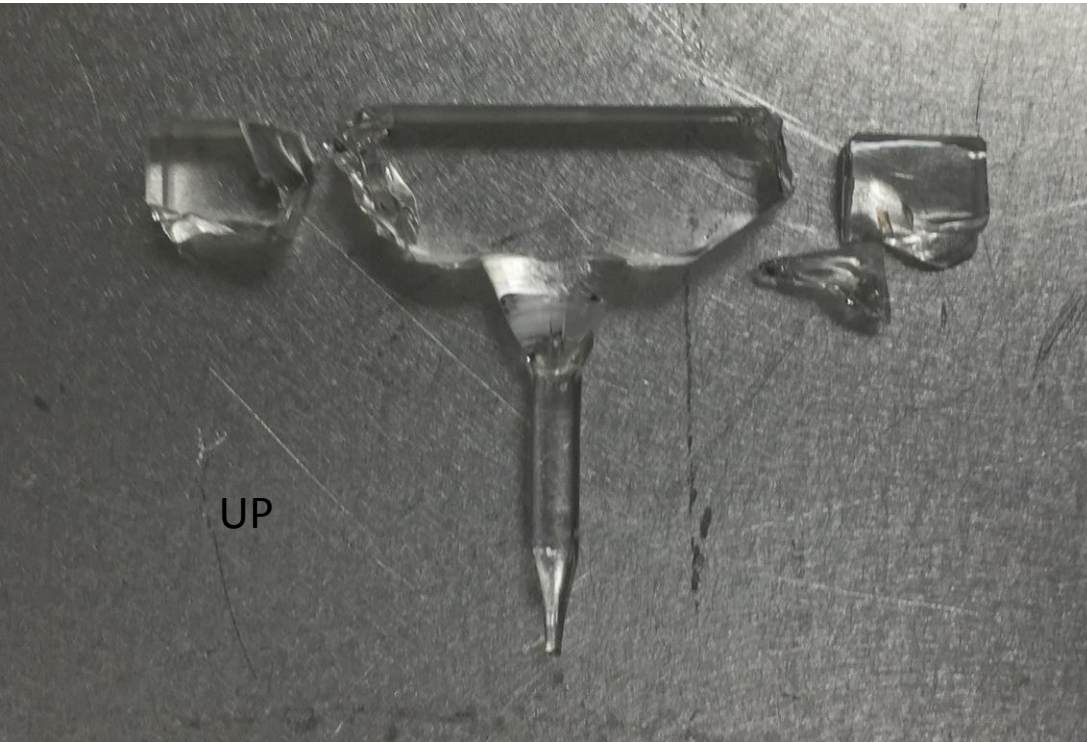


4

3

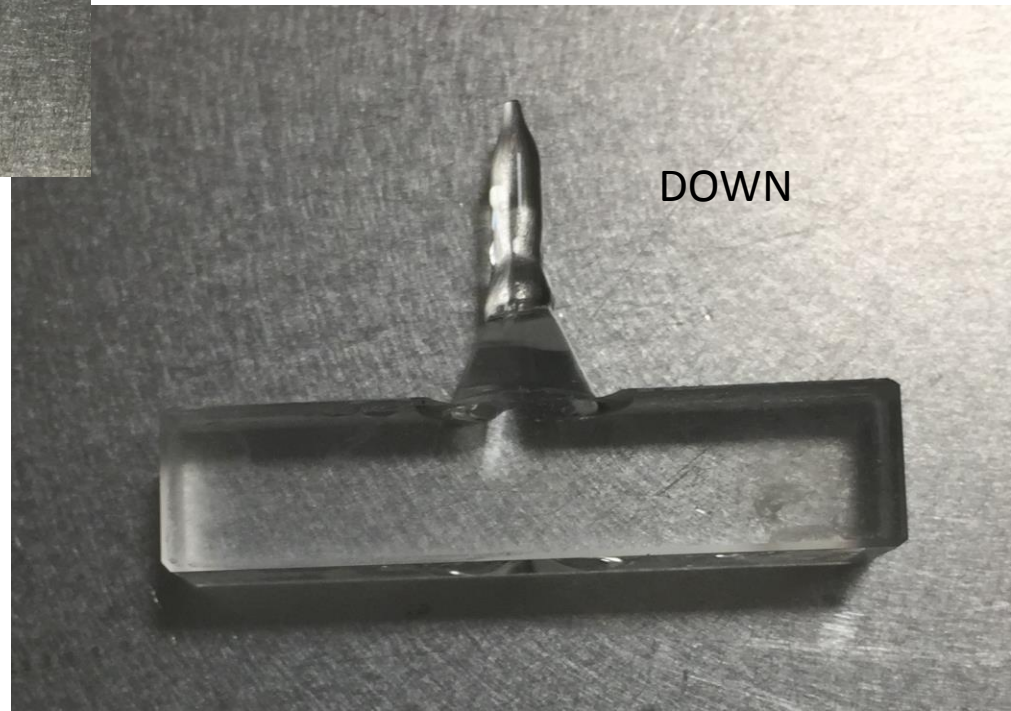
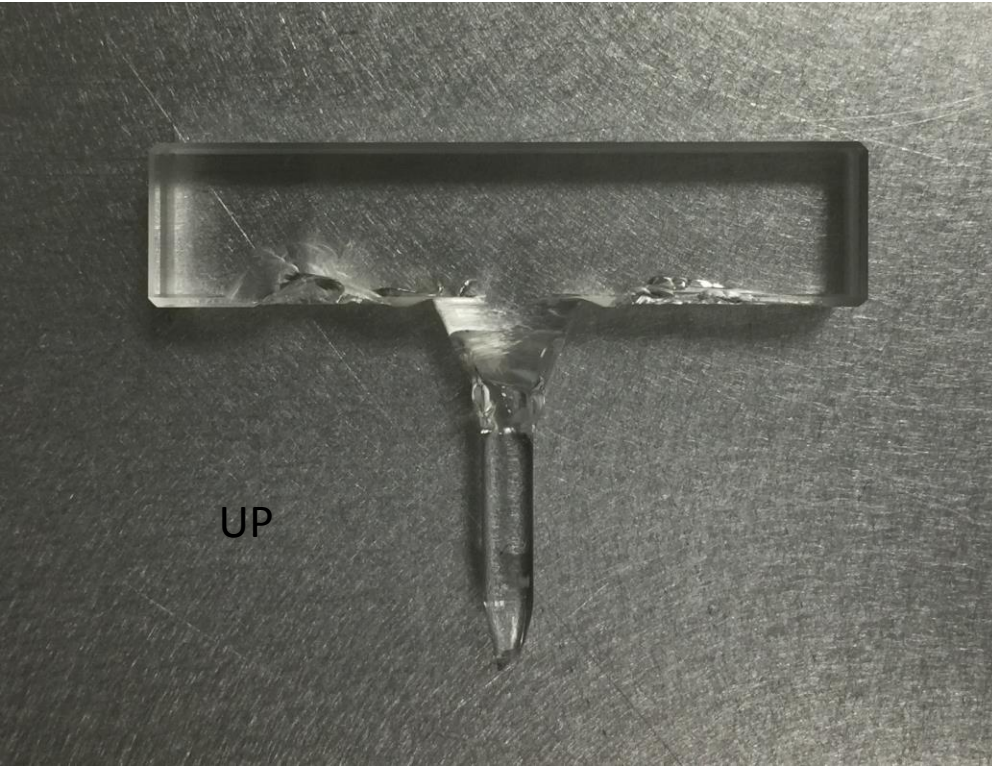


2° NI - Anchors n°1

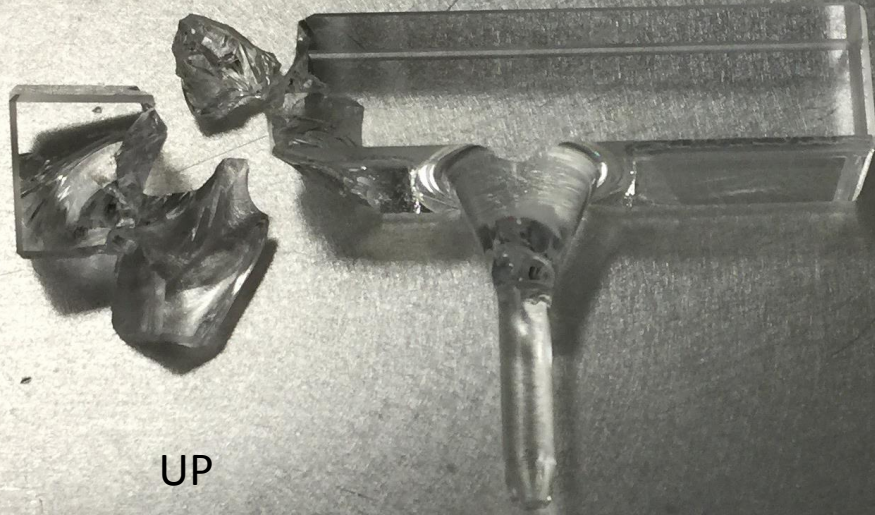


2° NI - Anchors n°2

According to the data the crash begun from this fiber

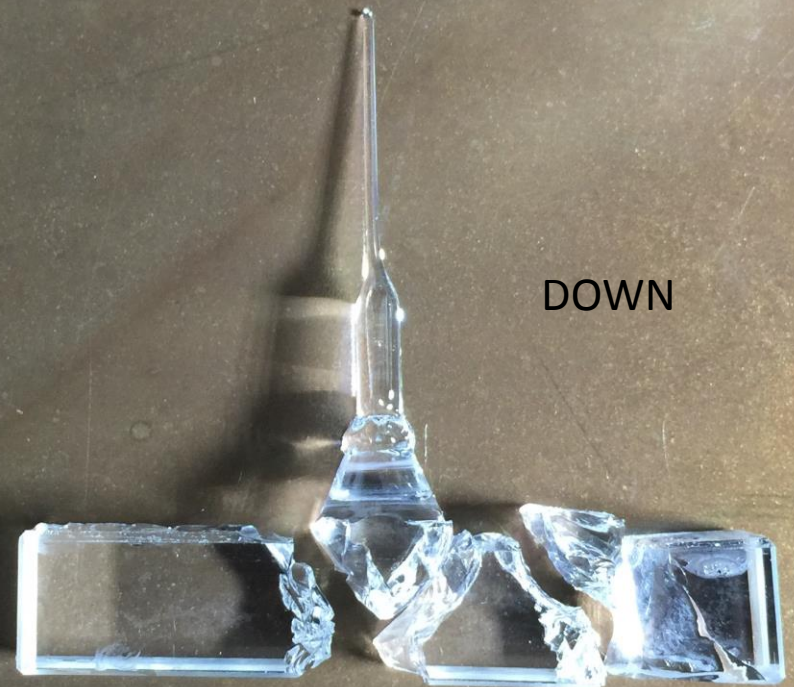


2° NI - Anchors n°3



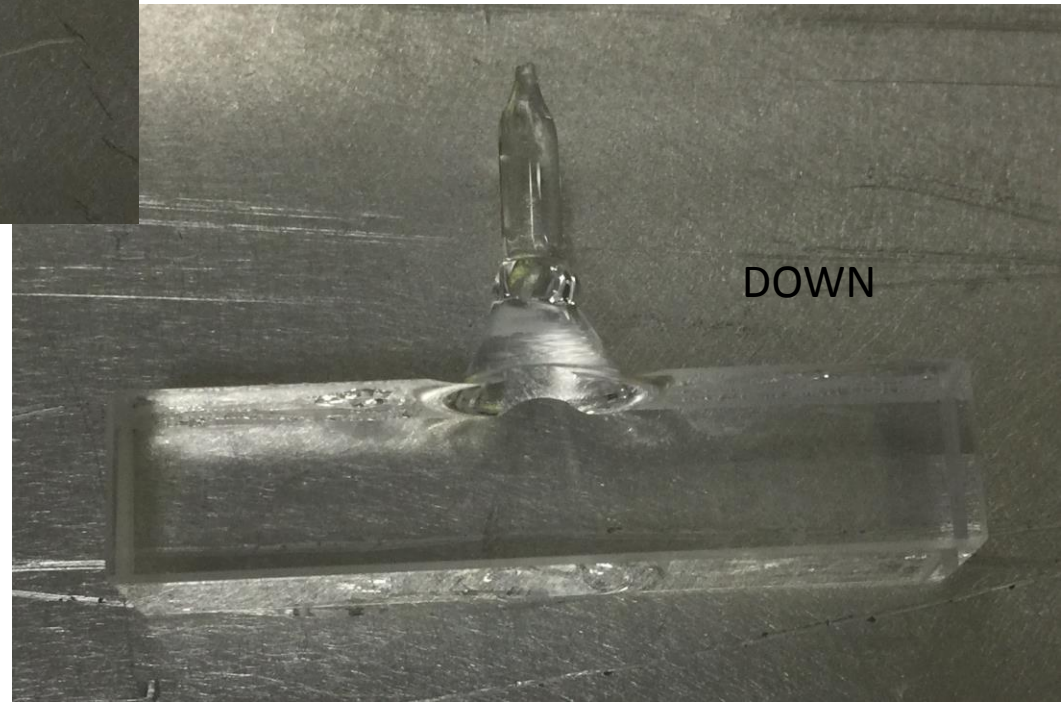
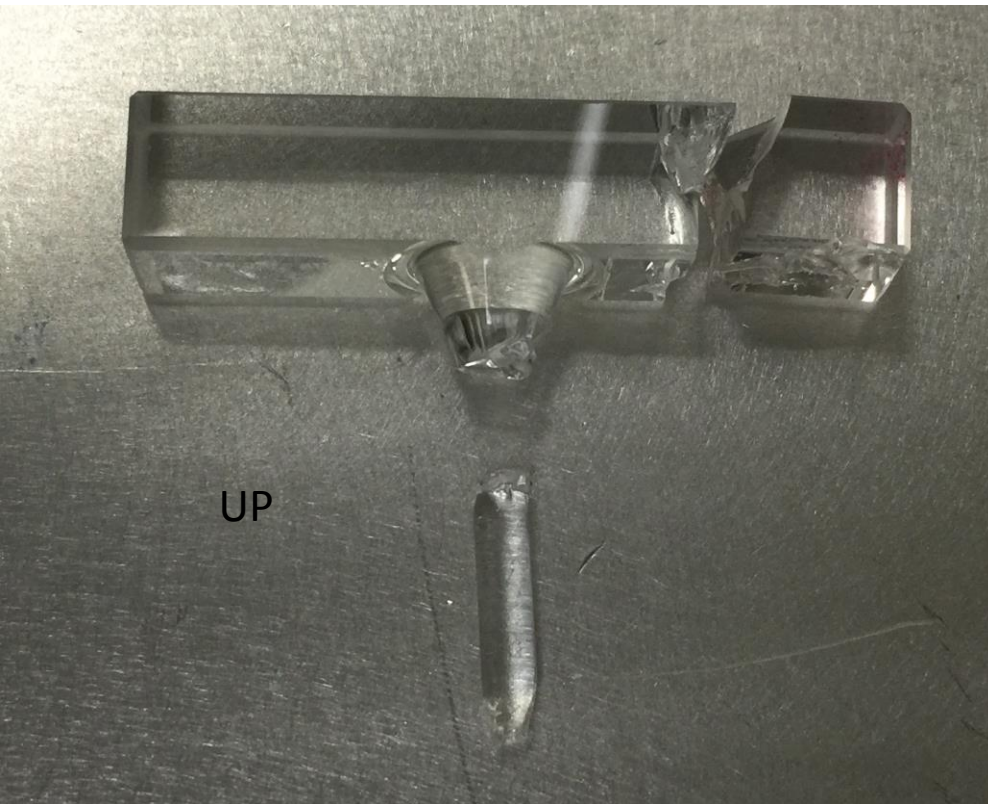
UP

In this suspension the anchors performed as expected.



DOWN

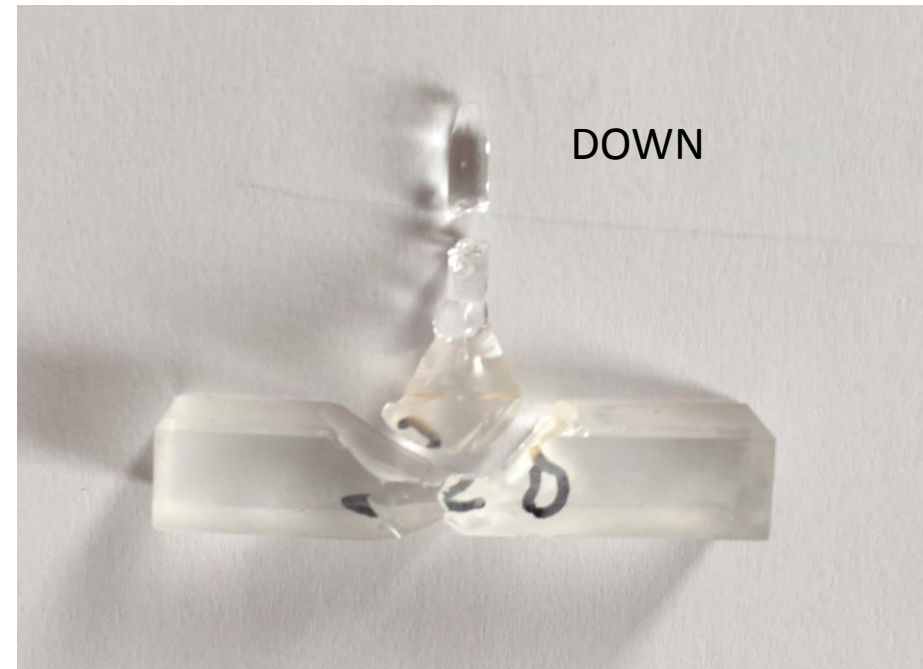
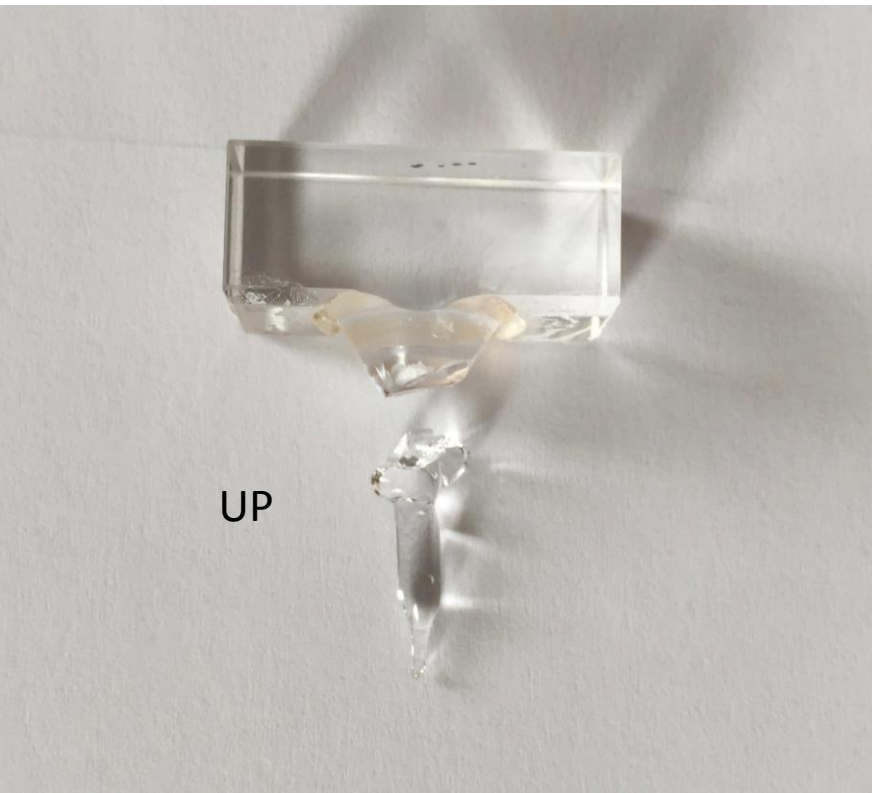
2° NI - Anchors n°4



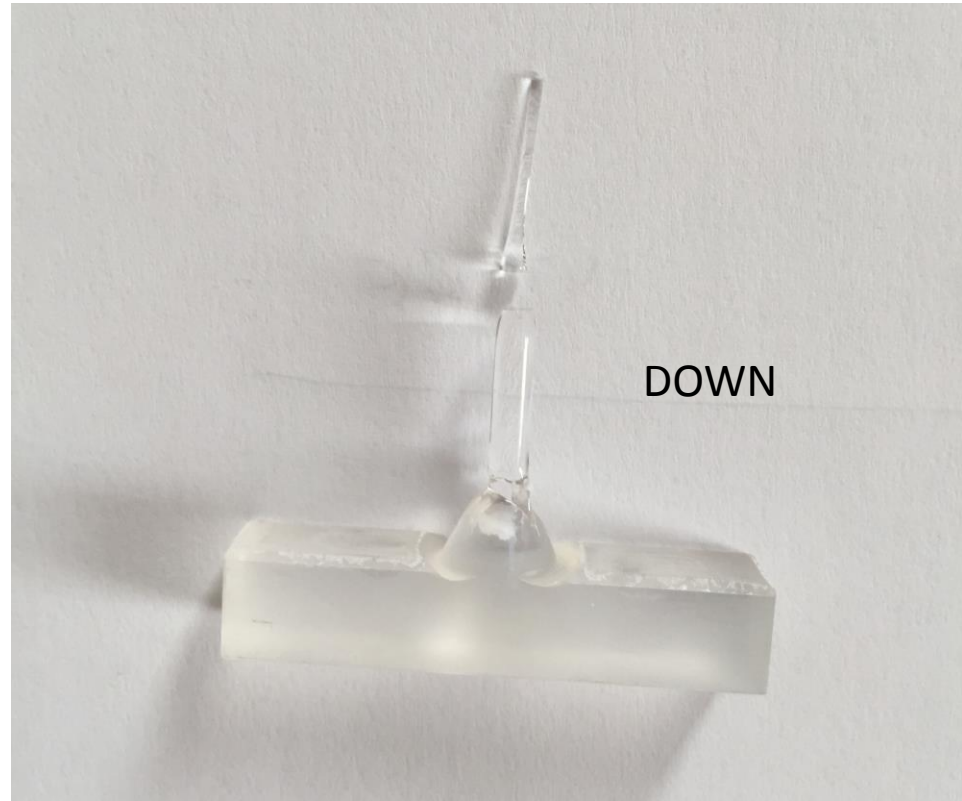
WI - DUMMY

The fiber 3 and 4 survived,
while fibers 1 and 2 were
broken!

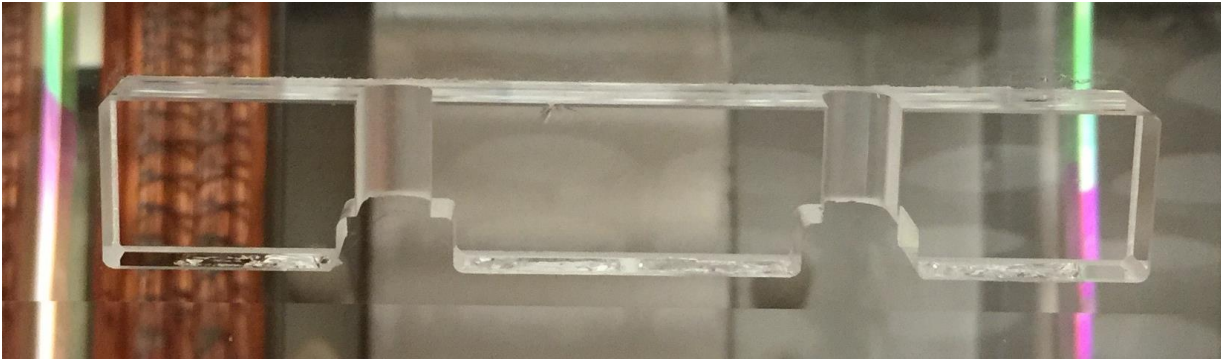
WI dummy- Anchors n°1



WI dummy- Anchors n°2

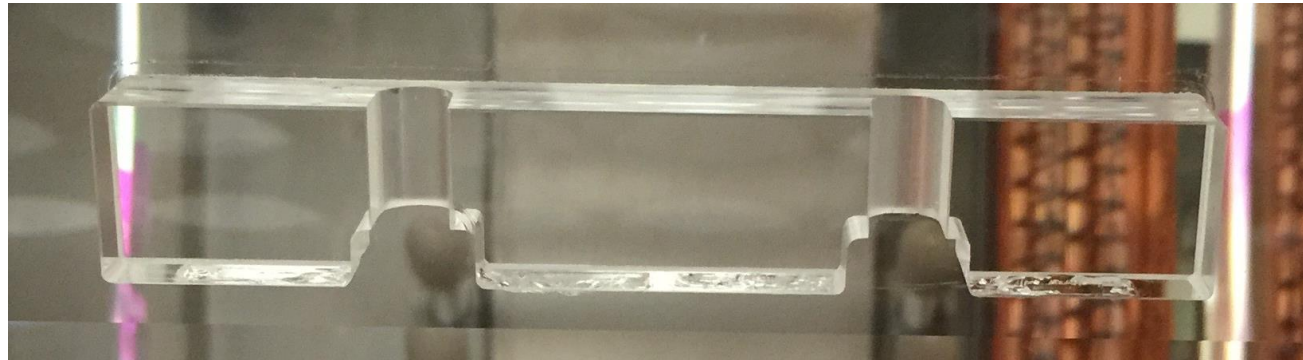


2° WI - Ears view after the crash



1

2



3

4

2° WI - Marionetta view after the crash

1

2

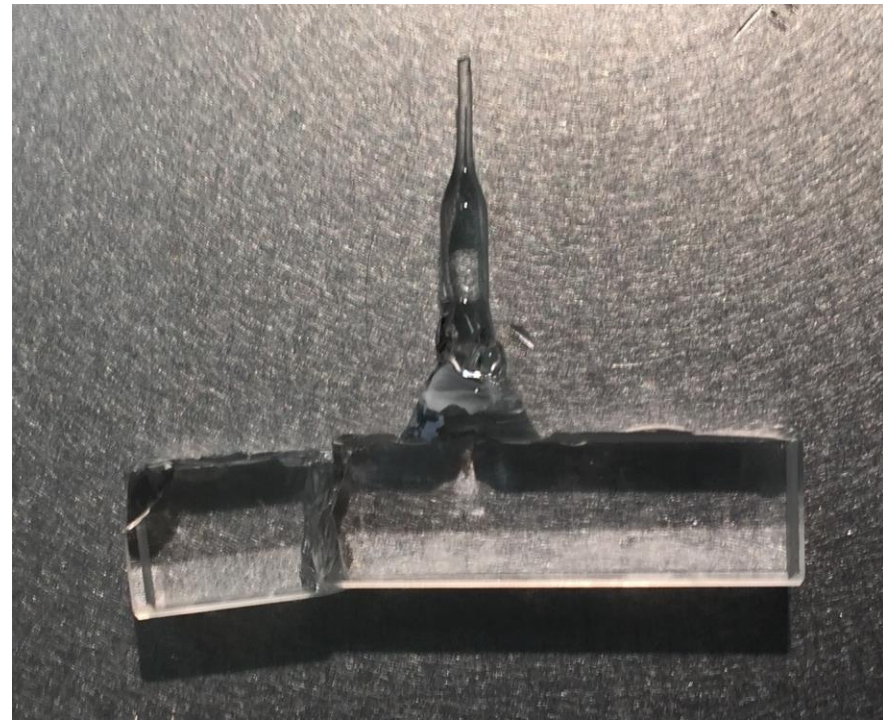
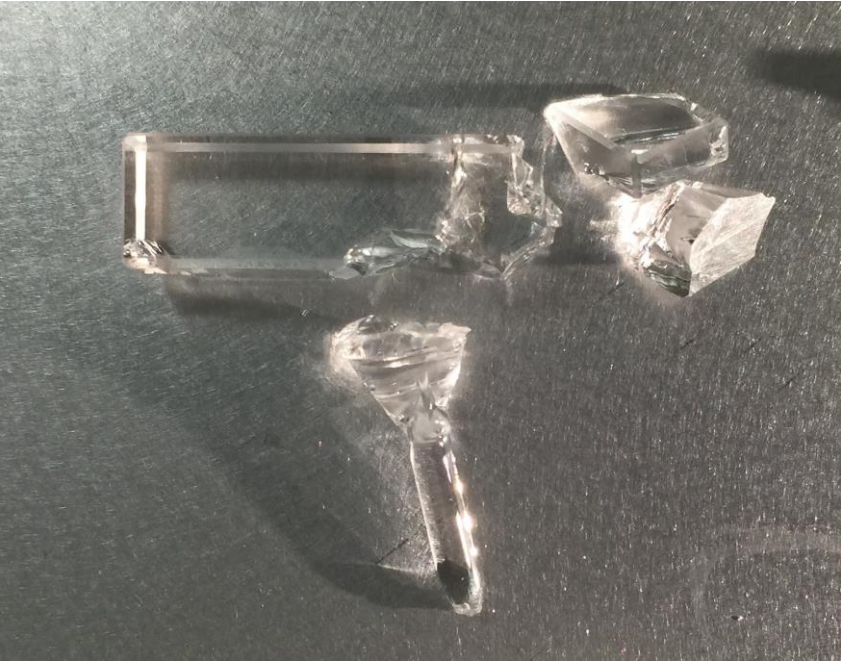


3

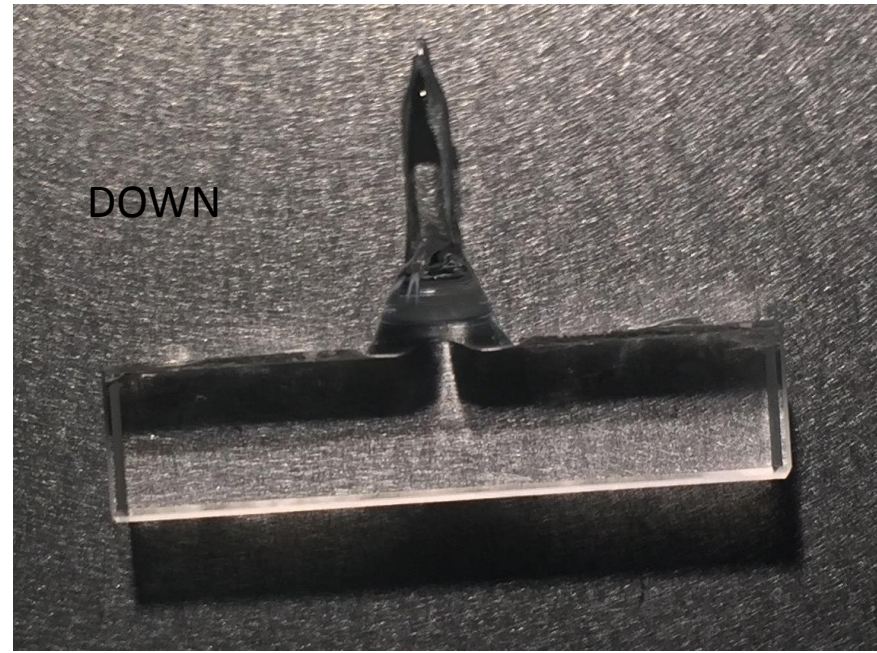
4



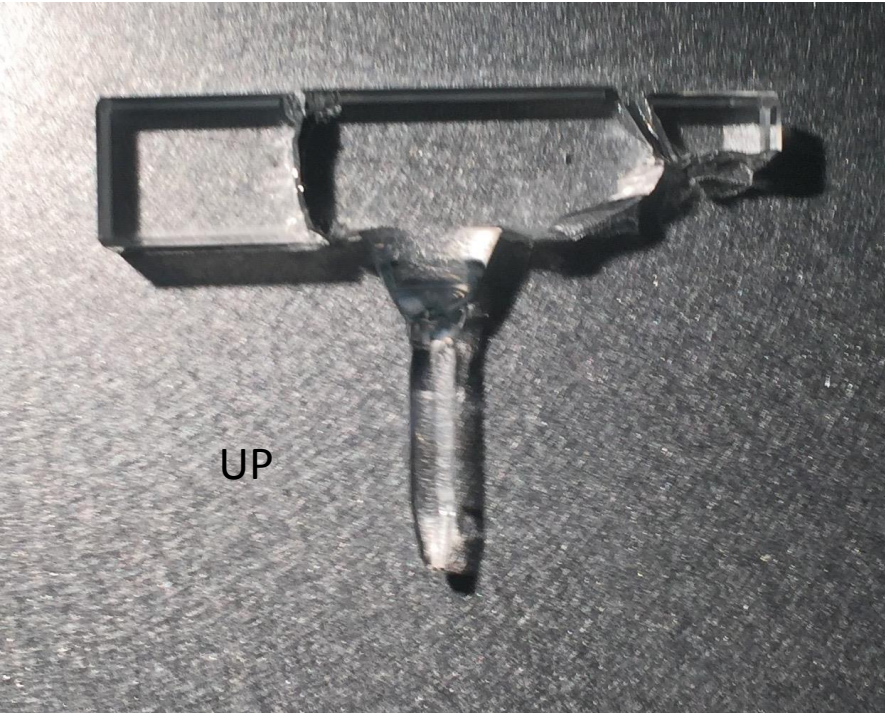
2° WI - Anchors n°1



2° WI - Anchors n°2



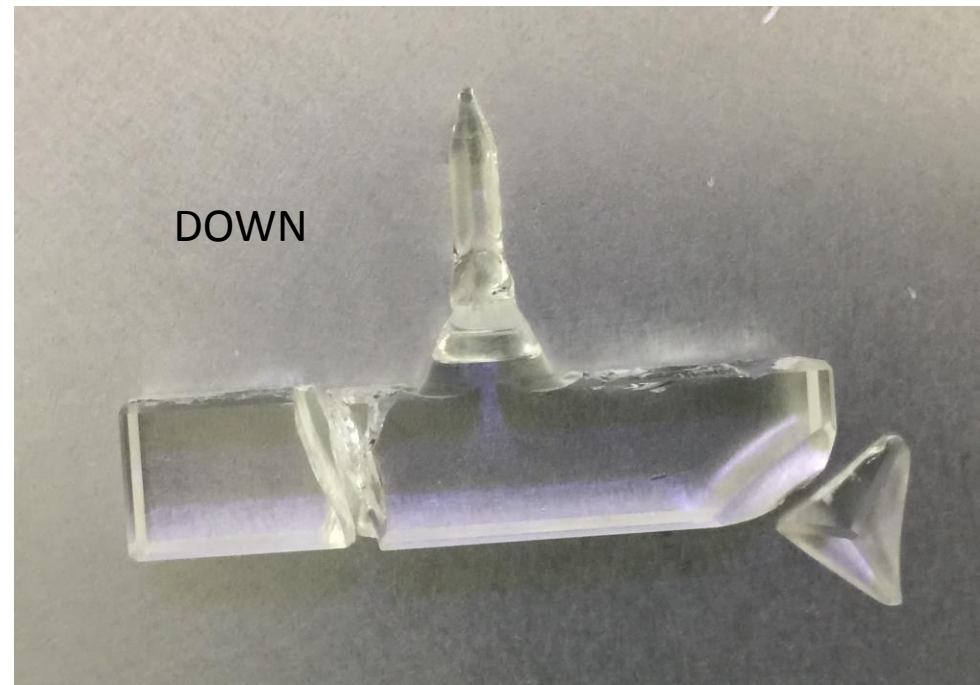
2° WI - Anchors n°3



According to the data the crash begun from this fiber. The anchors performed as expected. The failure started at the level of the fiber (or at the level of the 3mm bar close to the welding).



2° WI - Anchors n°4

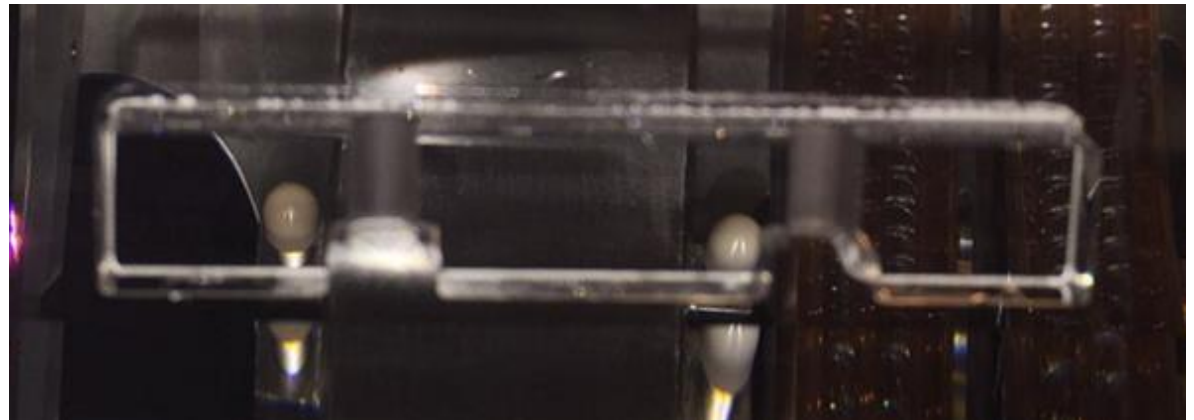


WE - Ears view after the crash



1

2



3

4

WE - Marionetta view after the crash



1

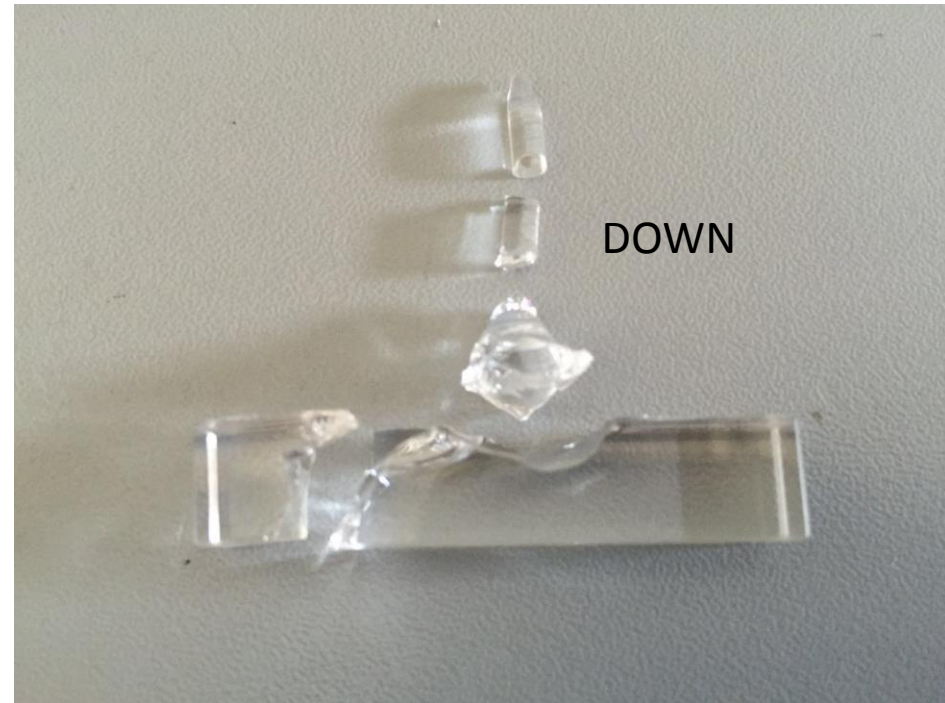
2



3

4

WE - Anchors n°1



WE - Anchors n°2

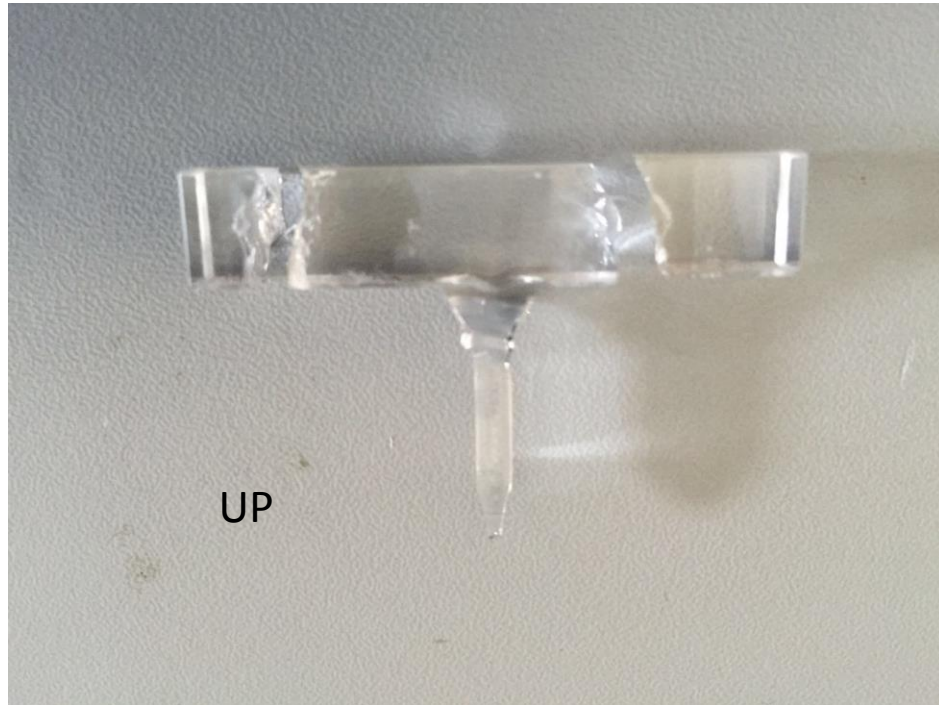


UP

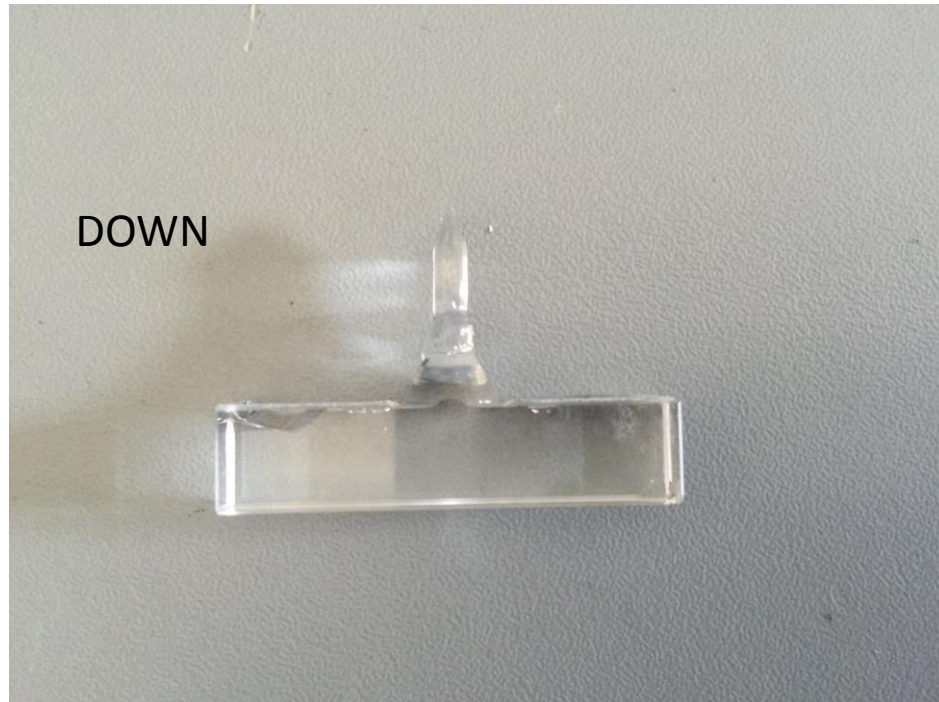


DOWN

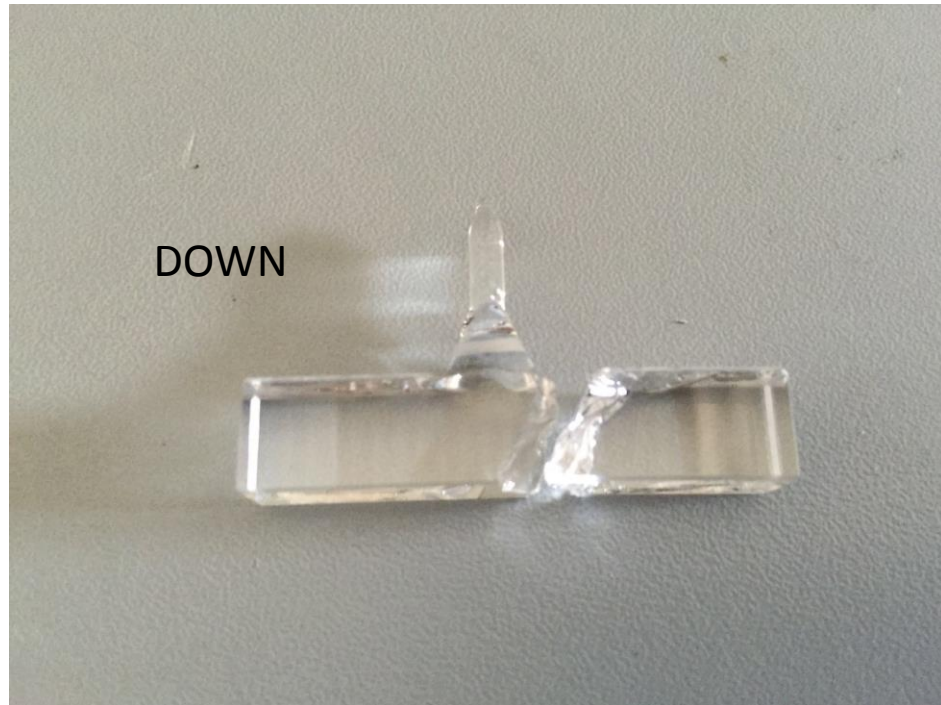
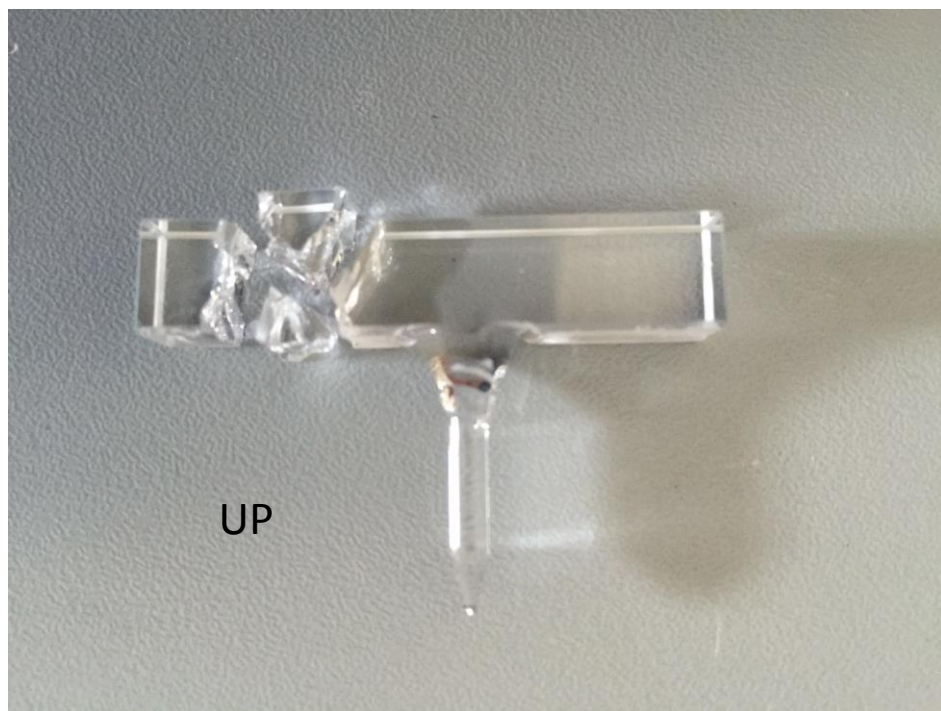
WE - Anchors n°3



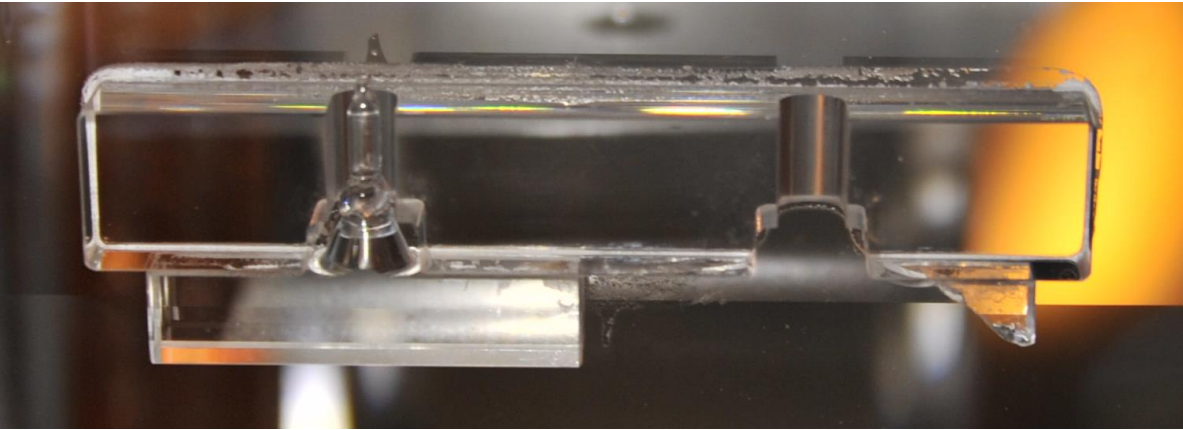
According to the data the crash begun from this fiber..it seems that the failure was induced by the fiber



WE - Anchors n°4

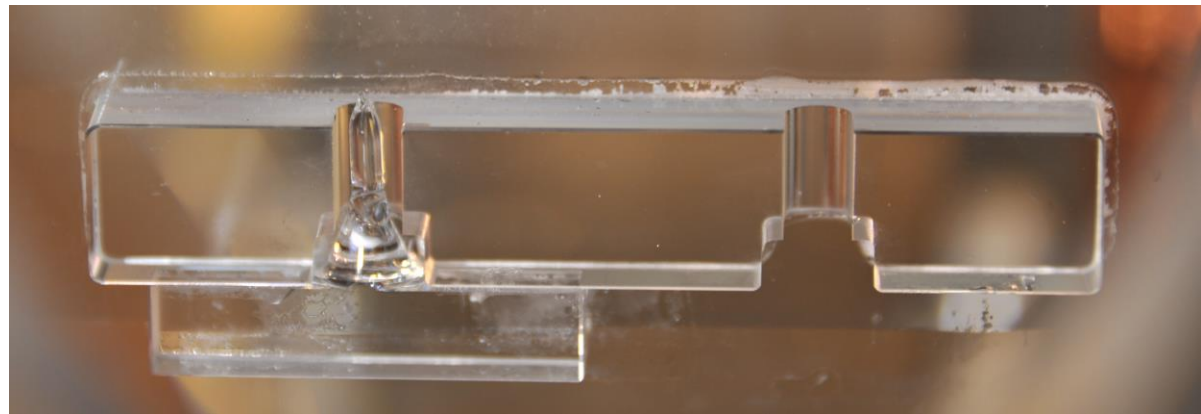


NE - Ears view after the crash



1

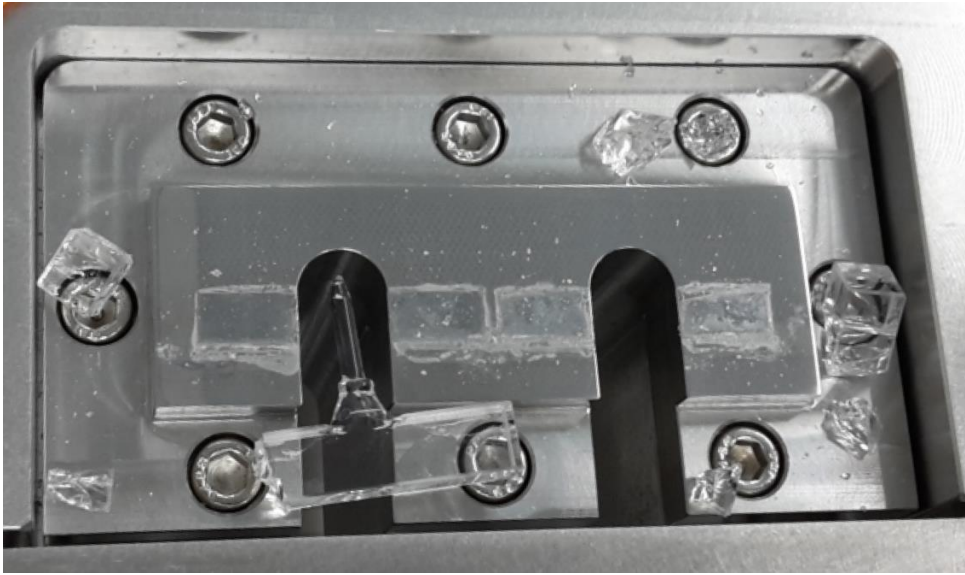
2



3

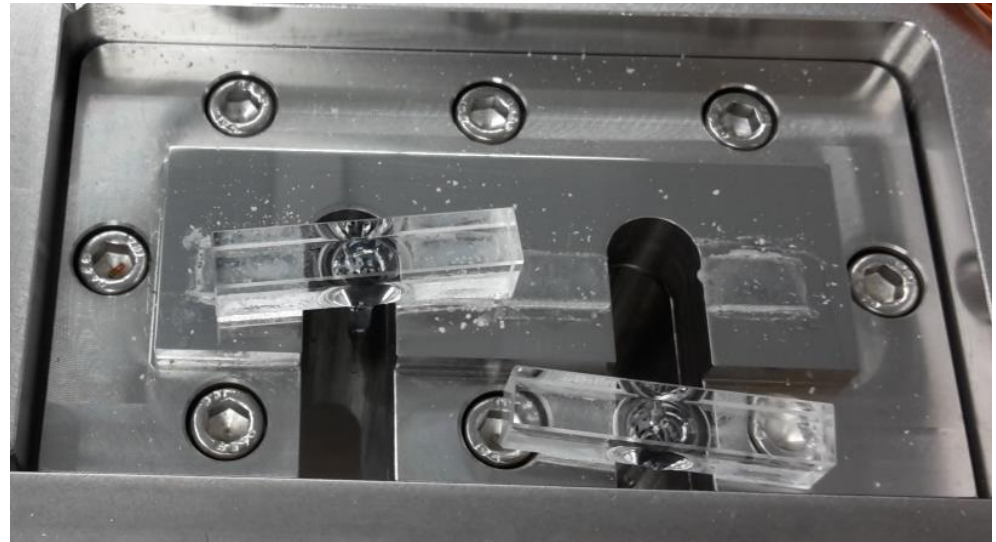
4

NE - Marionetta view after the crash



1

2



3

4

The samples are under spectroscopy analysis and these pictures are temporary but not the conclusions.

NE - Anchors n°1

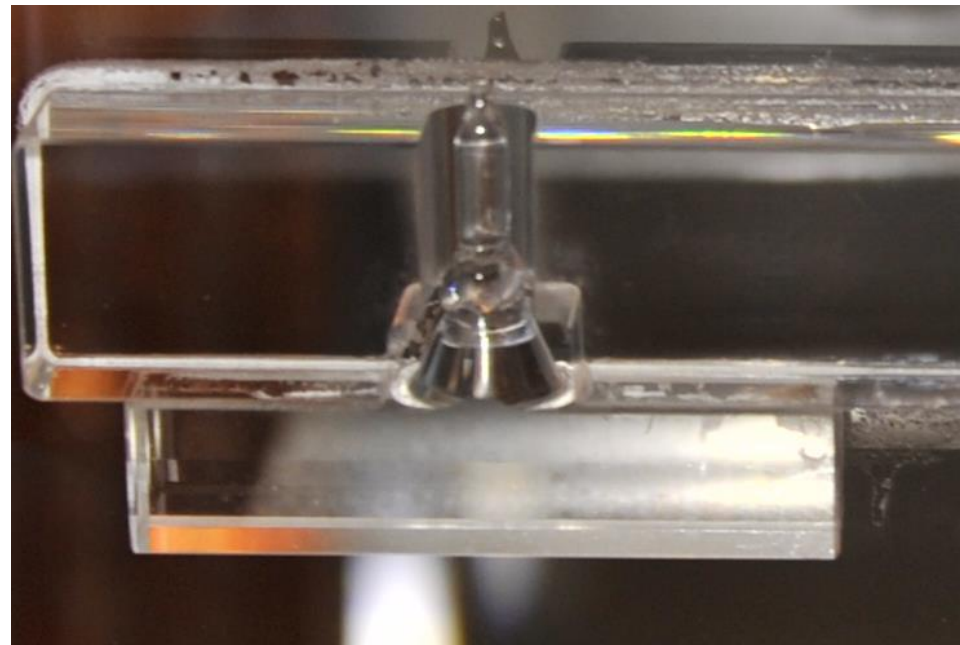


UP

(Almost) intact on
the Marionetta

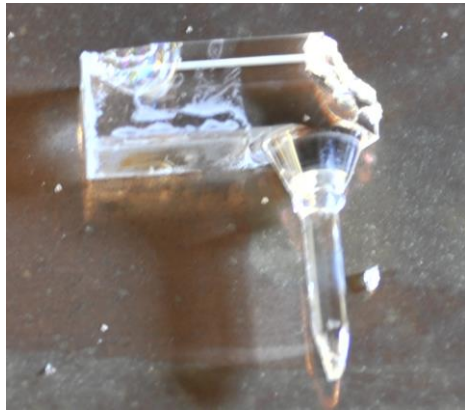
Intact on the Ear

DOWN



NE - Anchors n°2

Felt on the flange



UP



The other parts broken on the marionetta

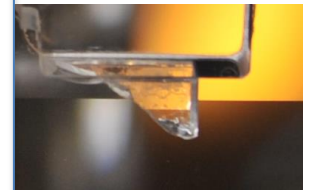
According to the data the failure started from this fibre caused with high probability by the fibre itself, in a region far from the bottom (because of the big energy released on the lower anchor to brake it on the ear and then on the cradle).

DOWN

Parts broken below the mirror, on the cradle. The breakings appears induced by the impact.



On the ear



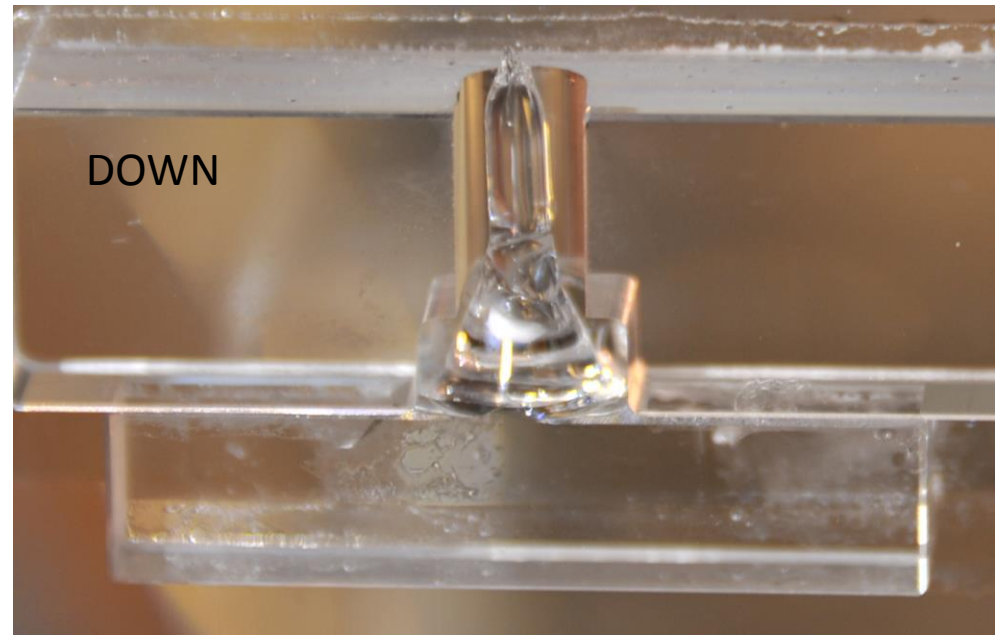
NE - Anchors n°3



UP

Intact on the
Marionetta

Intact on the Ear



DOWN

NE - Anchors n°4

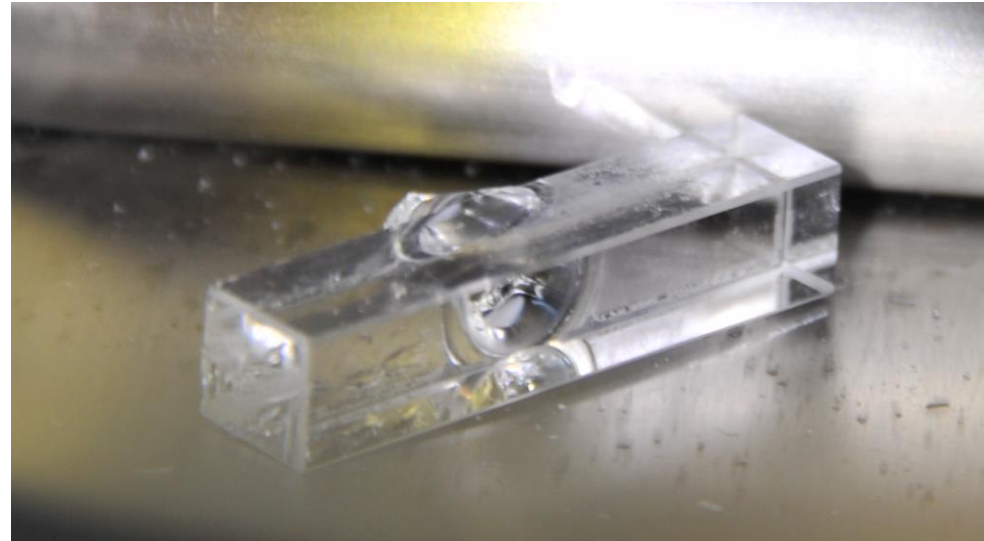


UP

Intact on the Marionetta

DOWN

Intact on the cradle below the mirror, with the exception of the bar probably because of the impact on it.



Summary

AR



AR



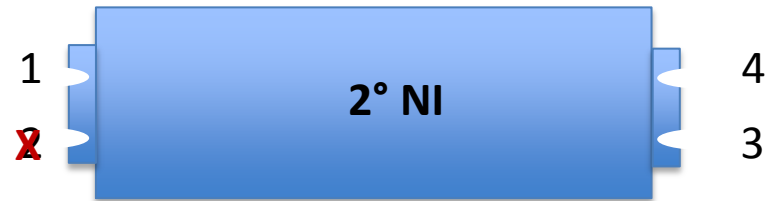
HR

HR

AR



AR



HR

HR

AR



AR



HR

HR

AR



HR

Drawing 1.6 (AdV2)

Producer: Impex

Material: KU-1 (first vendor)

Groove: no polished

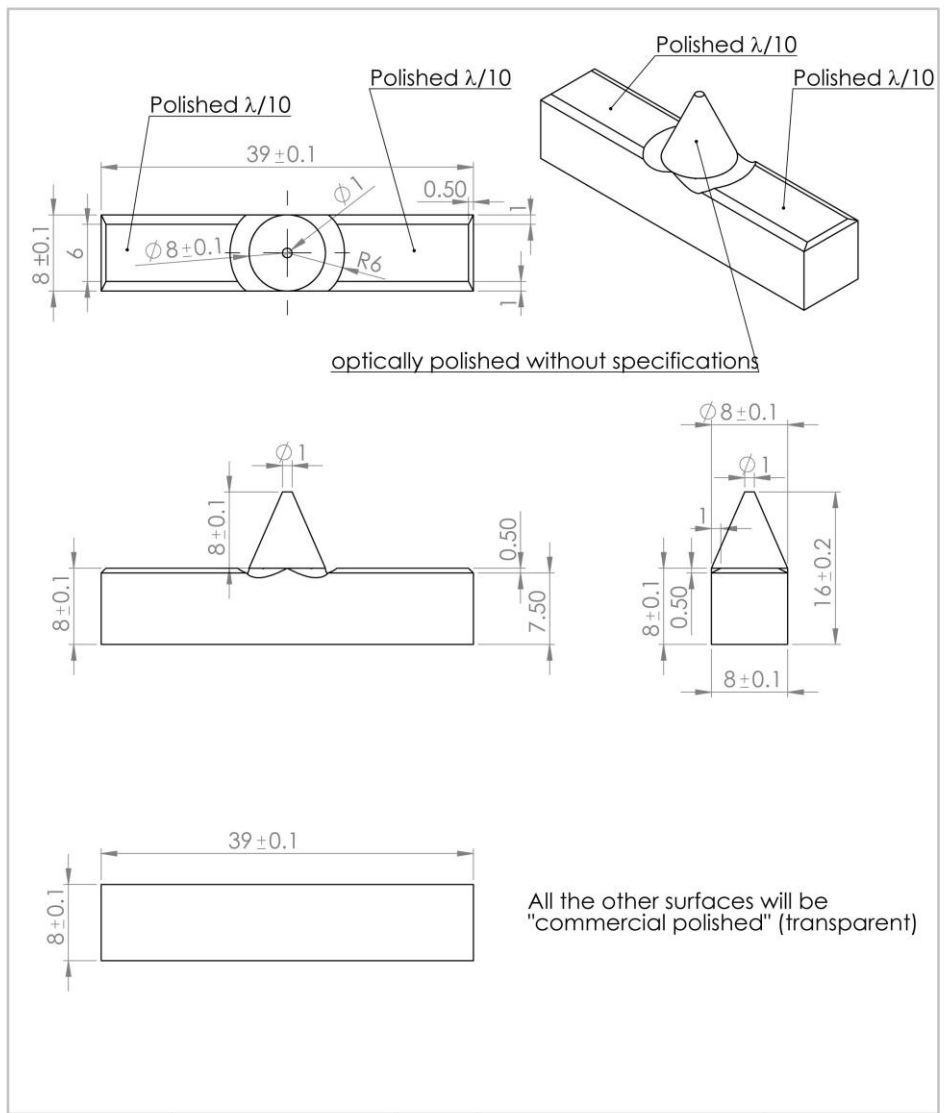
Flame polishing: no

Annealing: no

Thickness: 8mm

Length: 39mm

Towers: WI1, NI1



						Revision of 22.07.14	
						IMPEX HighTech	
						Fused Silica plate with nose	
						Drawing No.: 029-036-39-16-8-03	
						A4	

Stazione Sperimentale del Vetro

The SSV experts analyzed the anchors from the first failed fibers of each payload:

- *the breakages of the anchor-bar are probably secondary (i.e. occurred after the suspension's failure), as attested by the estimated breakage stress level and the observed fracture path (Table II);*
- *no breakage began from the lower-surface nor from the sides of the anchor-bar;*
- *the breakages that had started from the rod, at the first thinning ($1.9 \text{ mm} < \phi < 3 \text{ mm}$) and at the welding zone, were secondary, as attested by the breakage stress level (higher than the expected/nominal ones) and the resulting fracture path (flexural vs. uniaxial).*
- *The breakages stresses of the 3 failures occurred at the rod's thinning ($0.8 \text{ mm} < \phi < 1 \text{ mm}$) were comparable to the expected ones. Anyway, only sample "WI I 3D" showed a fracture morphology consistent with an uniaxial stress field at failure, whereas in the remaining two cases a bending stress field was inferred.*

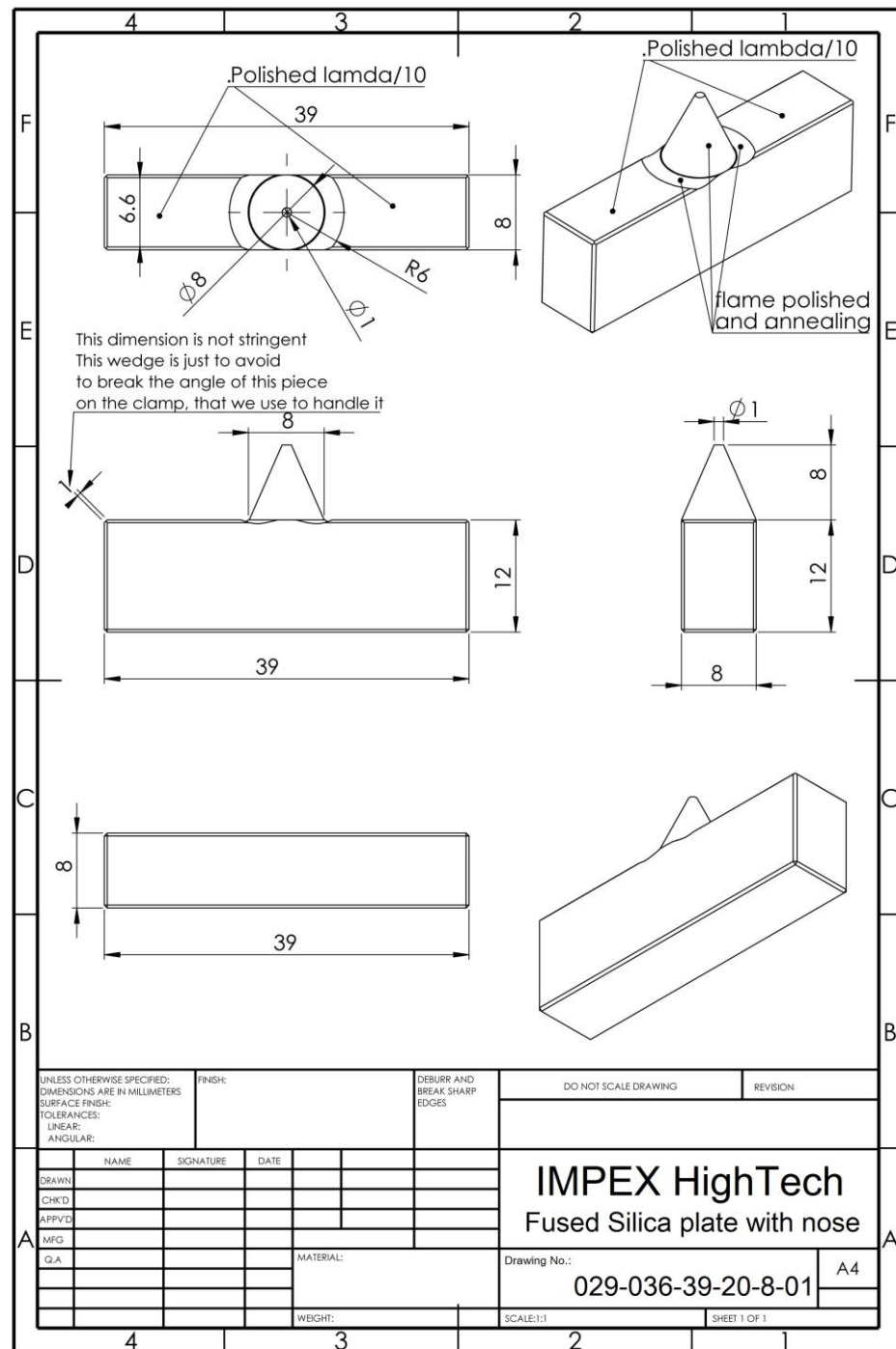
The absence of unquestionable leader fracture origin in any cases but one, strongly suggests that the failures should have started from the missing fragments, i.e. the thinner part of the rods ($\phi < 0.8 \text{ mm}$) or on the 0.4 mm fiber.

Summary

Mirror failed	Failure date	Logbook entries	Time in air	Time in vacuum	Failed Fiber	Anchor type	Primary failure	Air duct side	Last venting with payload
WI	Nov 18 th , 2015	32908	5 months	7 days	3	Draw 1.6 (Adv2)	Fiber	3.4	none
NI	Dec 18 th , 2015	33028, 33035	4.5 months	5 days	2	Draw 1.6 (Adv2)	Fiber	1.2	Dec 17 th
NI	Mar 1 st , 2016	33330	1 week	5 days	2	Draw 1.7 (Adv3)	Fiber	1.2	none
WI dummy	Apr 26 th , 2016	33591, 33676	1 week	11 days	2	mixed old	Fiber	3.4	Failure during venting
WI dummy	No failure		2 days	2 weeks		mixed old	No failure		3 ventings
WI	Jun 25 th , 2016	34132, 34153	1 month	30 days	3	Draw 1.7 (Adv3)	Fiber	3.4	none
WE	Jun 28 th , 2016	34158	7 months	18 days	3	Draw 1.7 (Adv3)	Fiber	3.4	none
NE	Oct 13 th , 2016	33676, 35038	6 months	4 months	2	Draw 1.7 (Adv3)	Fiber	1.2	Few sec before failure

Drawing 1.9

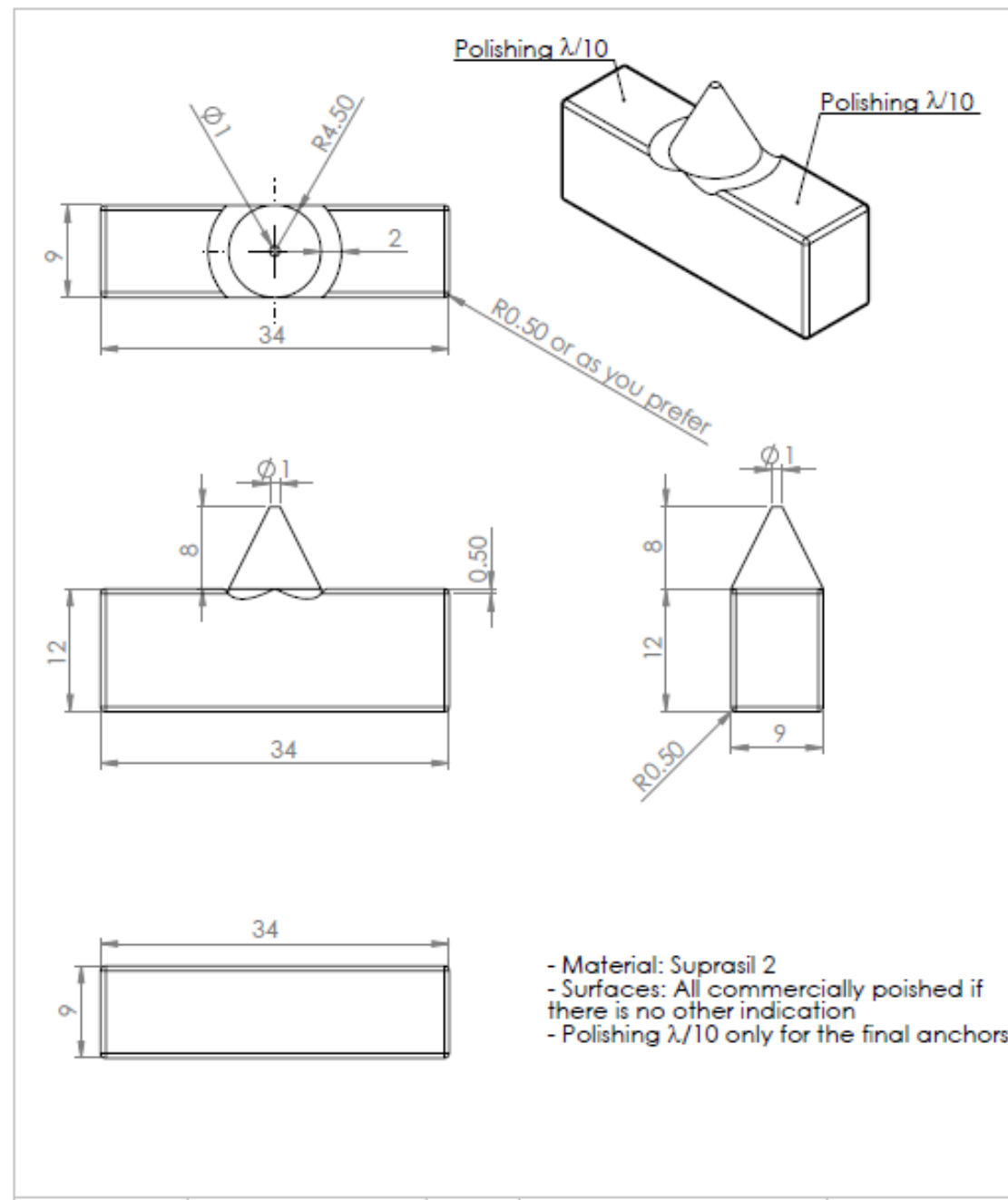
- Producer: Impex
- Material: Suprasil2 (Heraeus)
- Groove: thinner and mechanically polished
- Flame polishing: yes
- Annealing: yes
- Thickness: 12mm
- Length: 39mm
- Towers: Used for tests



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS		FINISH:		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING		REVISION	
SURFACE FINISH: POLISHED		TOLERANCES: LINEAR: ANGULAR:							
DRAWN		NAME		SIGNATURE		DATE		IMPEX HighTech Fused Silica plate with nose Drawing No.: 029-036-39-20-8-01	
CHK'D									
APP'VD									
MFG									
G.A.									
						MATERIAL:		A4	
						WEIGHT:		SHEET 1 OF 1	

Drawing 2.7

Producer: Impex
Material: Suprasil2 (Heraeus)
Groove: yes
Flame polishing: yes
Annealing: yes
Thickness: 12mm
Length: 34mm
Towers: In production



Drawing 2.8

Producer: Gestione Silo

Material: Suprasil2 (Heraeus)

Groove: no

Flame polishing: yes

Annealing: yes

Thickness: 12mm

Length: 34mm

Towers: In production

