

BNL-105201-2014-TECH

Booster Technical Note No. 157;BNL-105201-2014-IR

TEST OF H-20 SEPTUM WIRES

E. Rodger

February 1990

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

TEST OF H-20 SEPTUM WIRES

BOOSTER TECHNICAL NOTE NO. 157

E. RODGER and V. BADEA

FEBRUARY 28, 1990

ALTERNATING GRADIENT SYNCHROTRON DEPARTMENT BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK 11973

Description of Tests

During the months of October and November 1989 tests of 0.002 in dia x 4 in length tungsten wires were performed.

- a) The wires were taken out from H-20 electrostatic septum after being exposed to the beam. Residual radiation level was 0.8 m R/HR @ 12 in. Location of wires removed was as follows:
 - 1. One piece from upstream (specimen 1)
 - 2. One piece from the middle (specimen 2)
 - 3. One piece from downstream (specimen 3)
- b) In addition a number of 6 samples of virgin wires was tested under similar conditions to determine whether any changes occurred due to the beam exposure.
- c) The tests performed followed the General Tensile Test Procedure of: Automated Materials Testing system U4.05a (see annexes # 1 & 2).
- d) Several attempts were made to determine whether changes took place in the structure of tungsten wire after being exposed to the beam. To accomplish that, the wire samples were photographed as follows: (see annexes A, B, C, D & E).
 - wire unmounted mag. 400x, photo A (photo taken $\approx 3/4$ " from end of wire of an untouched area by the beam.)
 - wire unmounted mag 400x, photo B, C & D (photos taken \approx at center, area touched by the beam)
 - wire mounted and polished mag 400x, photo E. (Photo taken 1 1/2" from end).

The wires were then tensile tested to destruction.

Results

I. Breaking stress was higher for tungsten wires exposed to beam than unexposed (virgin) wire as follows:

Stress for exposed wire:

- upstream = 461,600 PSI mean
- middle = 444,400 PSI + 453,000 PSI

Description of Tests

During the months of October and November 1989 tests of 0.002 in dia x 4 in length tungsten wires were performed.

- a) The wires were taken out from H-20 electrostatic septum after being exposed to the beam. Residual radiation level was 0.8 m R/HR @ 12 in. Location of wires removed was as follows:
 - 1. One piece from upstream (specimen 1)
 - 2. One piece from the middle (specimen 2)
 - 3. One piece from downstream (specimen 3)
- b) In addition a number of 6 samples of virgin wires was tested under similar conditions to determine whether any changes occurred due to the beam exposure.
- c) The tests performed followed the General Tensile Test Procedure of: Automated Materials Testing system U4.05a (see annexes # 1 & 2).
- d) Several attempts were made to determine whether changes took place in the structure of tungsten wire after being exposed to the beam. To accomplish that, the wire samples were photographed as follows: (see annexes A, B, C, D & E).
 - wire unmounted mag. 400x, photo A (photo taken $\approx 3/4$ " from end of wire of an untouched area by the beam.)
 - wire unmounted mag 400x, photo B, C & D (photos taken \approx at center, area touched by the beam)
 - wire mounted and polished mag 400x, photo E. (Photo taken 1 1/2" from end).

The wires were then tensile tested to destruction.

Results

I. Breaking stress was higher for tungsten wires exposed to beam than unexposed (virgin) wire as follows:

Stress for exposed wire:

- upstream = 461,600 PSI mean
- middle = 444,400 PSI + 453,000 PSI

Stress for virgin wire:

- $\max = 427,200 \text{ PSI} \text{ mean}$
- $-\min = 324,700 \text{ PSI} \quad 384,484 \text{ PSI}$

Variation \rightarrow + 17.8% (higher stress for exposed wire)

II. Displacement at peak was higher for virgin wire than for exposed wire as follows:

Displacement for exposed wire:

```
- upstream = .03900 in mean

- middle = .04000 in .0395 in
```

Displacement for virgin wire:

```
- \max = .05300 \text{ in } \text{ mean for } 6

- \min = .03800 \text{ in } \text{ samples} = .048 \text{ in}
```

variation - 21.5% (greater displacement for virgin wire)

III. No reliable results were obtained regarding the structure because mounting and polishing with present methods were unrealistic and for initial viewing the photos taken don't show the real shape of wire because the wires were not flat (see metallography report #3).

Conclusion

The energy at break decreased for exposed wire by 30% from:

```
.024650 Lbs-in (mean value for virgin wire) to .018895 Lbs-in (mean value for exposed wire)
```

This change is probably not significant in that the wires are suspected to break as a result of high temperature induced by direct impingement of the beam. The temperature reached is unknown at this time. The stress induced from the mounting spring tension is $115,000 \pm 10,000$ psi., therefore, the room temperature safety margin is 3.34 for the virgin wire and 3.94 for the exposed wire. It may be possible to reduce the mounting spring tension but an estimate or measurement of the maximum temperature, the wire reaches when hit by the beam is needed to determine if it can withstand the spring tension at high temperature.

Finally, in order to determine a lower value for the spring tension, one has to further investigate the field variation when the wires tend to bow due to reduced tension.

ANNEX I A

DEPARTMENT OF APPLIED SCIENCE Materials Science Division Test Report # 2058

General Tensile Test - US Customary Units

Test type:

Tungsten wire exposed to beam.

Instron Corporation

Series IX Automated Materials Testing System v4.05a

Operator name: Don Horne

Test Date: October 3,1989

Sample Identification: 1EXWIRES

Interface Type: 4200 Series Machine Parameters of test:

> Sample Rate (pts/sec): 10.00 Crosshead Speed (in/min): .500

Sample Type: wire

Humidity (%):

Temperature (deg. f): 73

Tested for

Viorel Badea

Acc't #

08455

ILR #

Dimensions:

Spec. 1 Spec. 2

Diameter (in)

.002000 .002000

Gauge length (in)

2.0000 2.0000

Sample comments: Both samples broke away from grips.

- •	cimen ber	lexwires	Load at 0.2% Yield (lbs)	Stress at 0.2% Yield (psi)	Displement at 0.2% Yield (in)	% Strain at 0.2% Yield (%)	Load at Peak (lbs)	Stress at Peak (psi)	Disploment at Peak (in)	% Strain at Peak (%)	Load at Break (lbs)
N'D'ST MiDDLE	1 2		1.396	444400.	.03443	1.721	1.450 1.396	461600. 444400.	.03900 .04000	1.950 2.000	1. 4 50 1.396

Specimen Number	Stress at Break (psi)	Displement at Break (in)	% Strain at Break (%)	Rnergy at Yield (lbs-in)	Energy at Break (lbs-in)
1	461500.	.03610	1.805	.01775	.02011
2	444400.	.04028	2.014	.01768	.01768

General Tensile Test - US Customary Units

Test type:

Tungsten wire

Instron Corporation

Series IX Automated Materials Testing System v4.05a

Operator name: Don Horne Test Date: September 19,1989

Sample Identification: 1WWIRE

Interface Type: 4200 Series Machine Parameters of test:

Sample Rate (pts/sec): 10.00 Crosshead Speed (in/min): .500 Sample Type: wire

Humidity (%): 50

Temperature (deg. F): 73

Tested for Viorel Badea

ACC t

Dimensions:

Spec. 1 Spec. 2 Spec. 3 Spec. 4 Spec. 5 Spec. 6

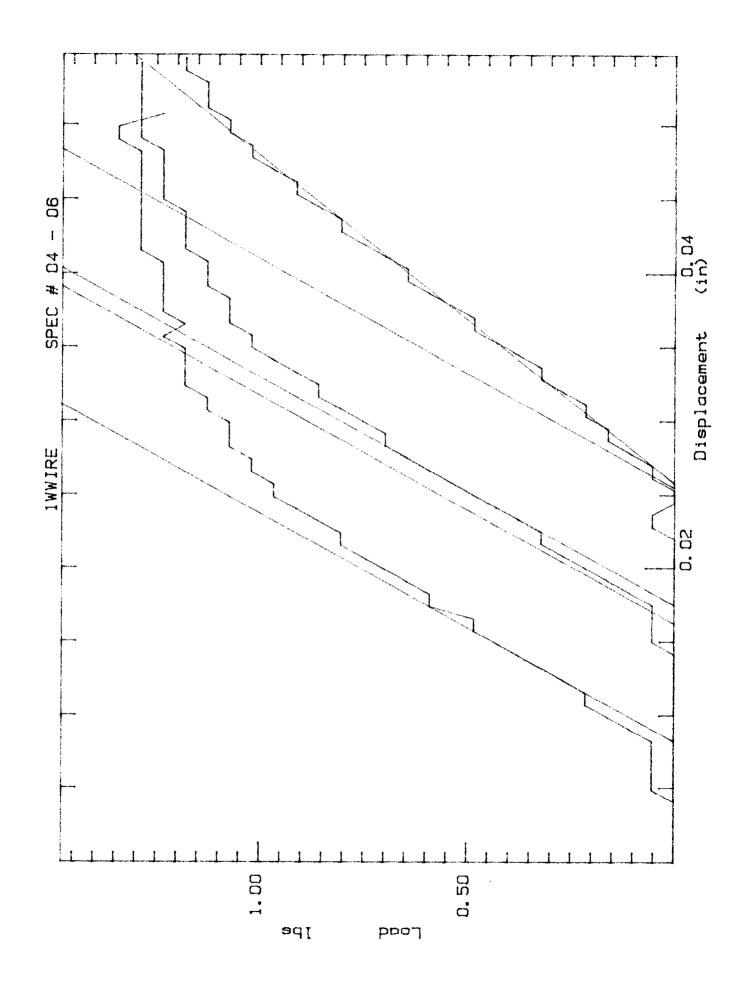
Diameter (in)
Gauge length (in)

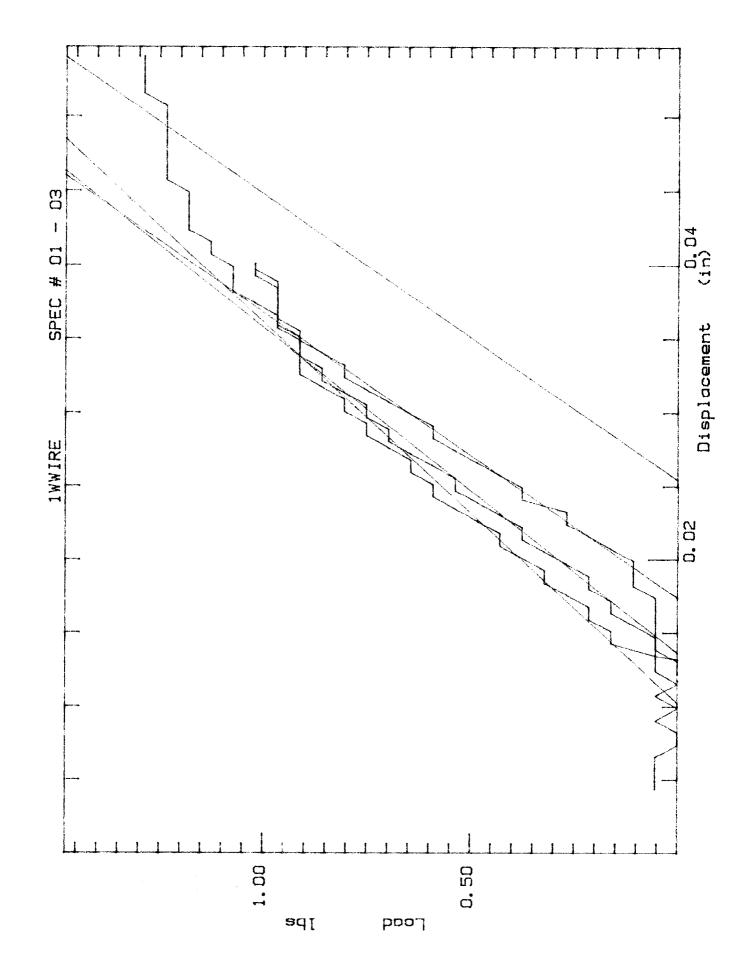
.002000 .002000 .002000 .002000 .002000 .002000 4.0000 4.0000 4.0000 4.0000 4.0000 4.0000

Out of 6 specimens, 0 excluded.

Specimen Number	1Wwire	Load at 0.2% Yield (1bs)	Stress at 0.23 Yield (psi)	at 0.2%		% at	Stress at Peak (psi)	Displement at Peak (in)	% Strain at Peak (%)	Load at Break (1bs)
1 2 3 4 5		1.235 1.181 1.181	393100, 376000, 376000.	.04553 .03488 .04195	1.1380 .8720 1.0490	1.020 1.020 1.342 1.342 1.342 1.181	324700. 324700. 427200. 427200. 427200. 375900.	.04000 .03800 .05500 .05500 .05300 .05200	1.0000 .9500 1.3750 1.2500 1.3250 1.3000	1.020 1.020 1.342 1.342 1.289 1.181
Mean: Standard Deviation:						1.208 158	38 45 00. 50390.	.04800	1.2000	1.199
		Specimen Number	Stress at Break (psi)	Displement at Break (in)	% Strain at Break (%)	found s fodure (ksi)	Energy at Yield (lbs-in)	Energy at Break (lbs-in)		
		1 2 3 4 5	324700. 324700. 427300. 427300. 410200.	.03928 .03751 .05220 .04905 .05028	.9820 .9378 1.3050 1.2260 1.2570	49140. 51440. 61610. 87010.	.01449 .01382 .02558 .01964 .01996	.01449 .01382 .03413 .03752 .03043		

6	376000.	.04926	1.2310	57450.	.01754	.01754
Hean:	381700.	. 04626	1.1570	85650 .	.01851	.02465
Standard Deviation:	47930.	.00622	. 1555	1 9750.	.00430	.01058

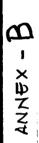




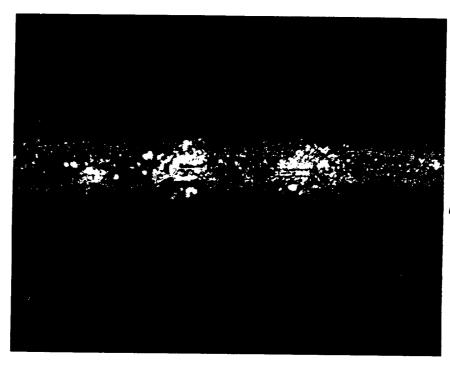
METALLOGRAPHY REPORT

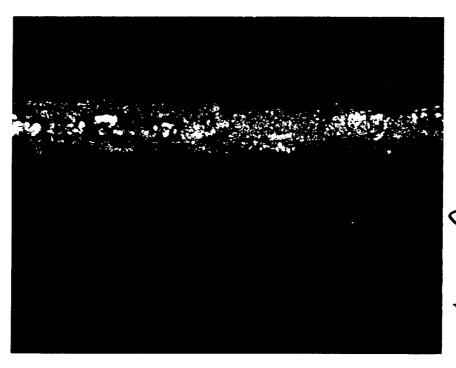
Requested by	: Viorel Badea Date 12-15-89	
DESCRIPTION_T	ingsten Wire 0.002 in Dia	
<u>Fi</u>	-20 Septum Wires radiation level 0 &	imR/hr@12in
	hotographed wire (initial viewing)	
mounter	I wire to enable polishing, etching,	
longitu	dinal cross-section viewing	
	<u> </u>	
OBSERVATIONS	initial viewing was difficult because	wire
was n	of flat. Took several photos (ABC	(D)
• .		
Mountin	ig and polishing unrealistic with pr	esent
method	5. Procedure followed but due to sm	alldiameter
	polishing caused wire to pull out of	
	ieto was taken (E)	
<u> </u>		
PHOTO	Description	Mag
A	Wire unnounted	
	Photo taken 2 3/4 inch from end	400 x
_B)	Luire, unmounted	
<u> </u>	Photos taken = at center	400 x
D)	,	
<u> </u>	Wire, mounted & polished	400 x
	Photo taken = 1/2 inch from end	
	prepared by: K.V	<u>Varburton</u>











ANNEXIC



