Cooling Connections Development: PRR Status Report

July 10, 2001

N. Hartman, E. Anderssen, M. Gilchriese, F. Goozen, T. Johnson, J. Taylor, T. Weber, J. Wirth

Pixel Detector

Recent Developments

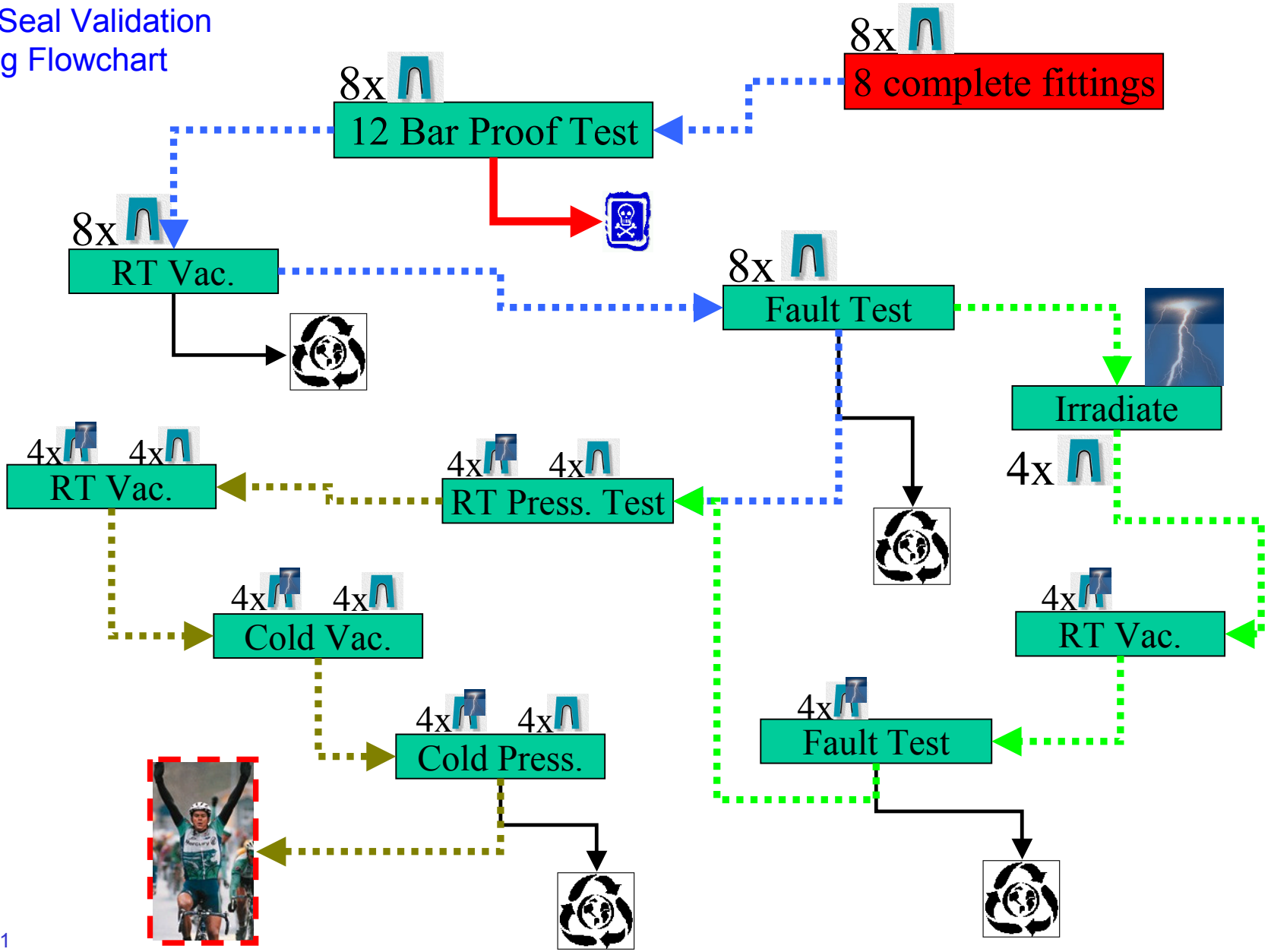
- **Fitting testing regimen begun**
  - Specific tests and sequence defined
    - Vacuum He leak test
    - Proof test at 8 bar, 1 hour
    - 1 bar pressure He leak test
    - Cold versions of above tests
    - 25 mrad Irradiation
  - New apparatus constructed and tested
    - Ability to Internally pressurize fitting with he and leak check (to > 10 bar)
    - Ability to cool fittings (to about –20 C) and perform same tests
- **Seals and Joining Methods tested**
  - Seals
    - Variseals (baseline)
    - Luer Lock
  - Joining Methods
    - Laser Welding (baseline)
    - Gluing

Changes to Testing Regimen

- **Addition of "Proof" Test for Mechanical Integrity**
  - Binary test (explode or pass) – no leak rate measured, no time limit
  - Test conducted at 1.5 Times MAXIMUM FORESEEABLE PRESSURE: 12 bar
  - Conducted on bare sector/stave tubes, type 0 tubes, and type 1 tubes (to PP1) – before assembly
  - Simply Implies that fittings will never damage surrounding structure/personnel
- **Current "proof" test renamed to "fault condition leak test"**
  - Conducted at Maximum Foreseeable Pressure: 8 bar
  - Leak Rate measured under internal pressure
  - Test duration 1 hour

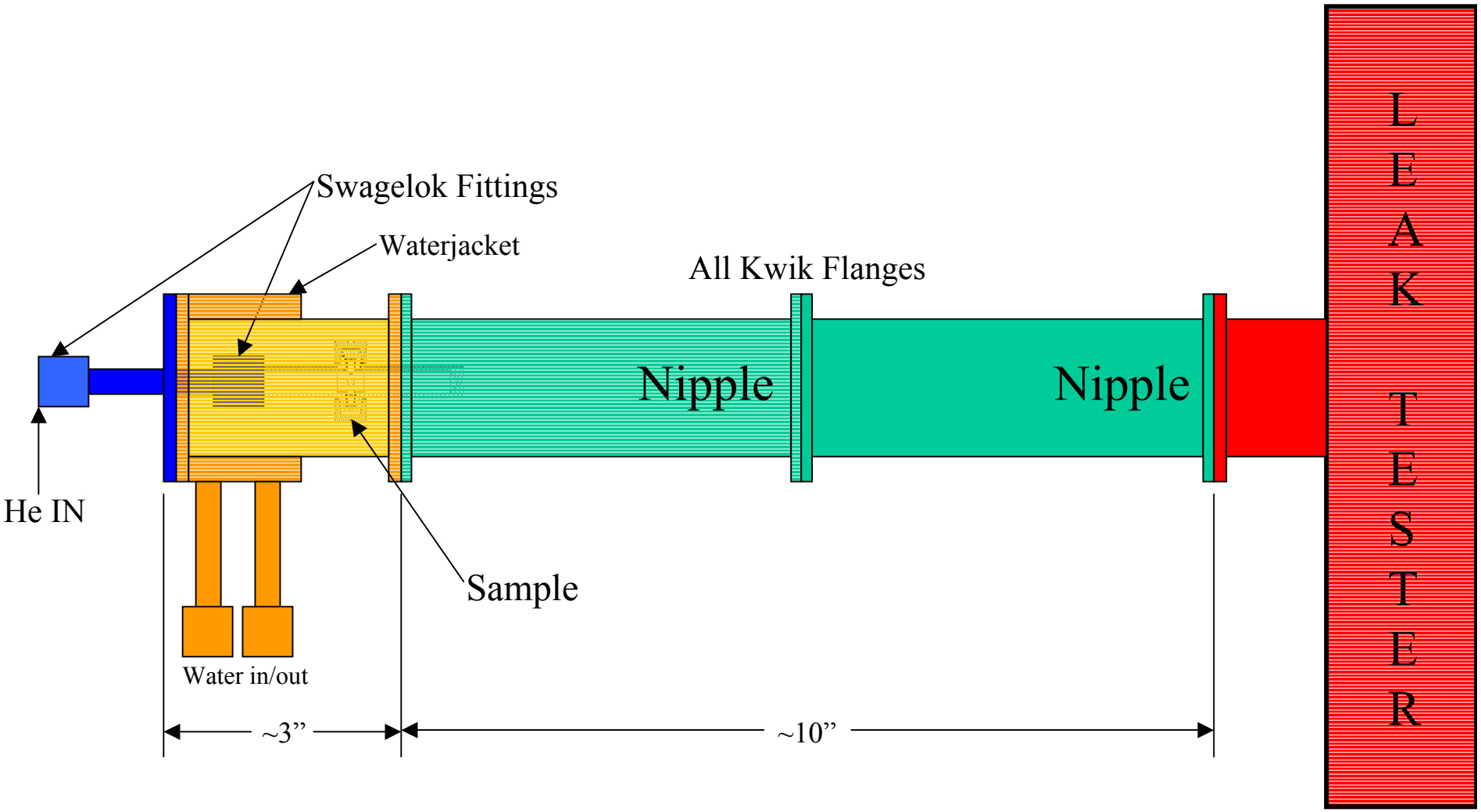
Pixel Detector

NEW Seal Validation Testing Flowchart



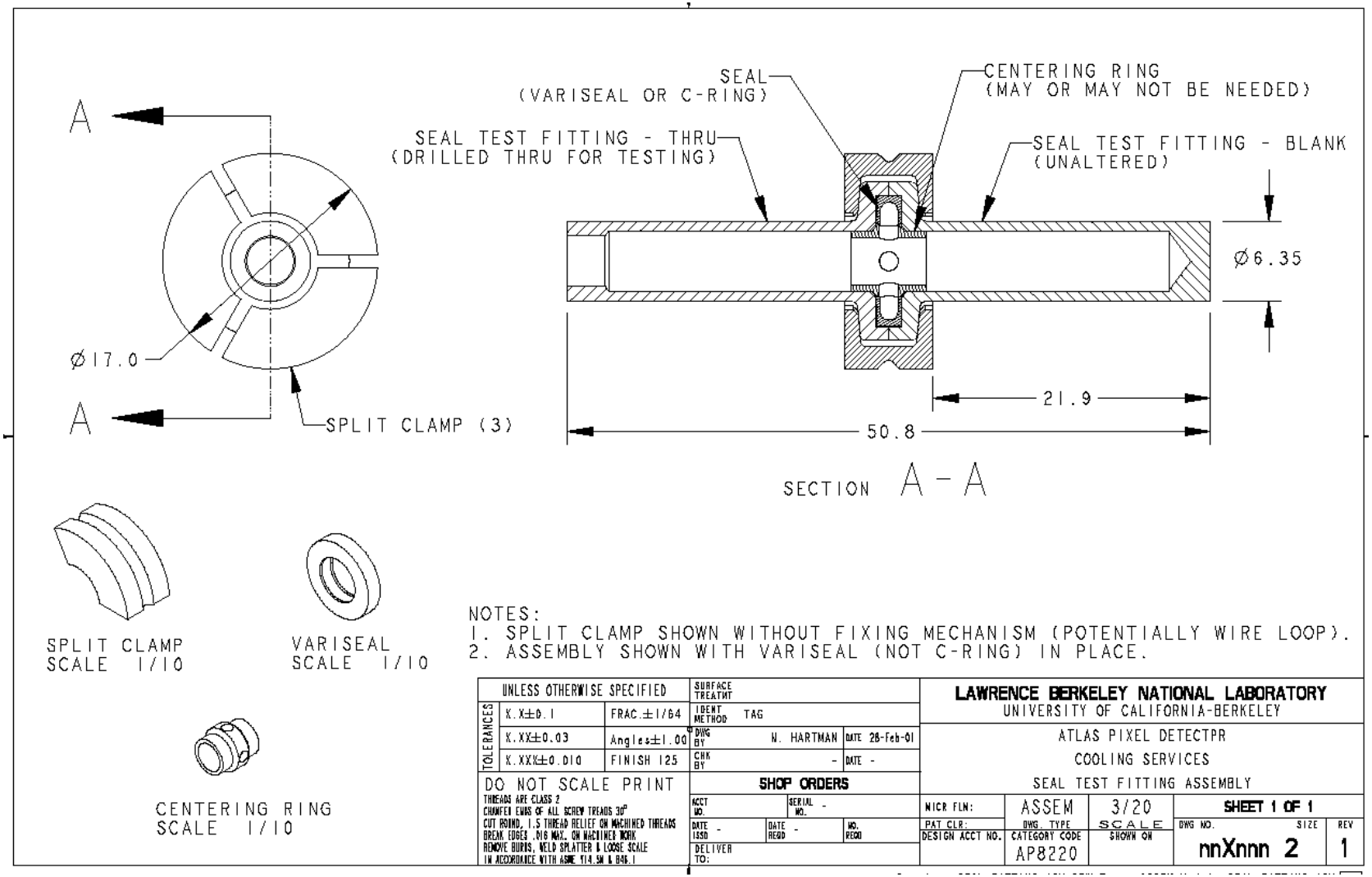
Pixel Detector

He Pressurized Leak Testing Setup

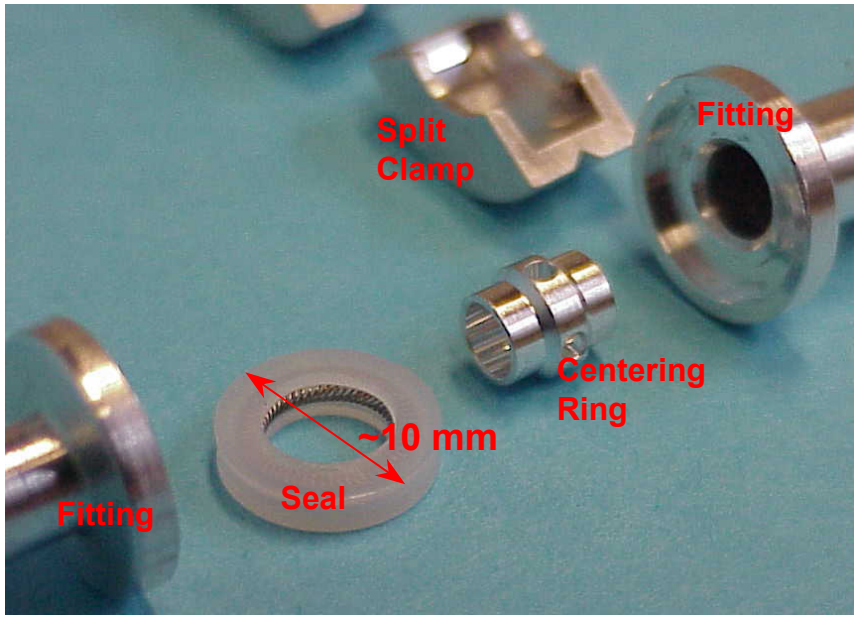


Pixel Detector

Fitting Geometry – Variseal Type

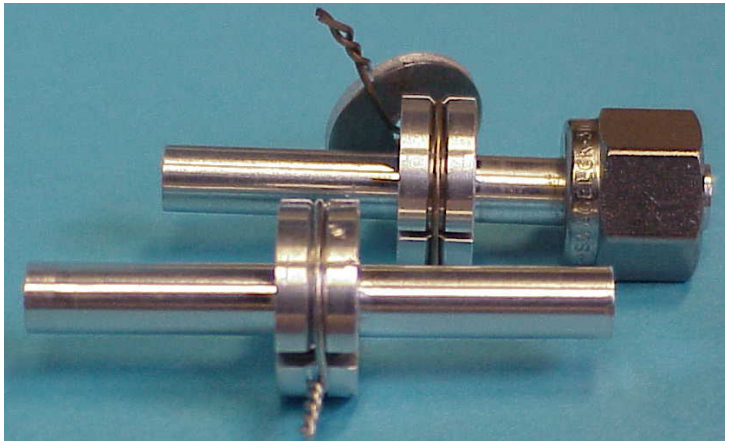


Fitting Test Specimens – Variseal Type



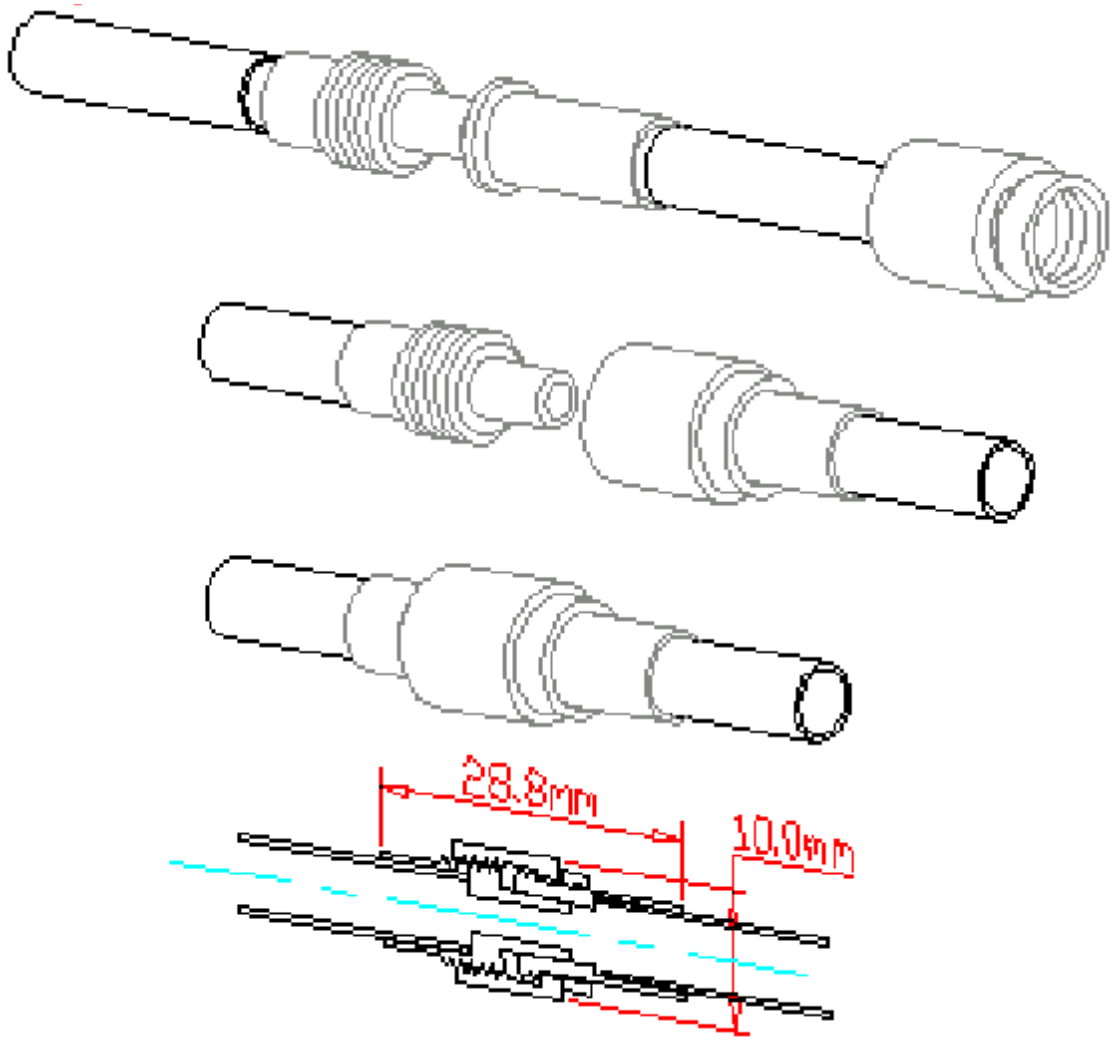
Fitting Pieces shown disassembled.

Assembled Fitting (one shown with Swage lock connector).

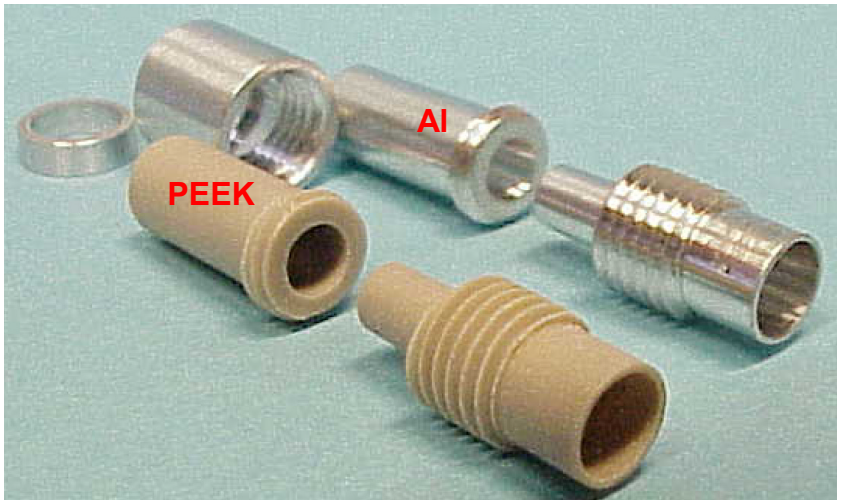


Pixel Detector

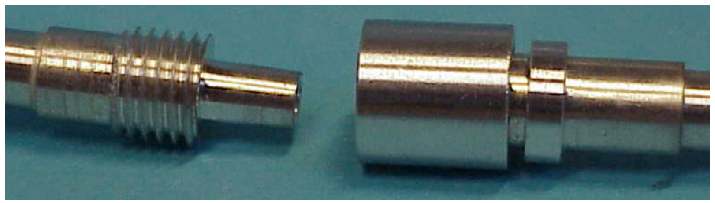
Fitting Geometry – Luer Lock Type



Fitting Test Specimens – Luer Lock Type



Luer Lock Pieces (PEEK and Aluminum).



Assembled Fitting.

Recent Seal Tests

- **Variseals**
  - Current Seal Tests
    - Fittings made slightly undersize
    - 7 samples assembled
    - 7 samples passed vac check at < 5e-10 (Torr-L/sec)
    - 7 samples passed proof test (<5% pressure change at 8 bar)
  - Irradiated Samples – 25 Mrad
    - 3 samples – all passed vac check at < 1e-9 (Torr-L/sec)
    - All samples passed proof test
    - 2 samples passed high pressure He test at < 1e-7 (Torr-L/sec), 1 sample failed at 2 bar
    - 1 sample passed cold high pressure He test at < 5e-10 (Torr-L/sec), 1 failed at 1 bar
  - Control Samples
    - All 4 samples passed vac check at < 1e-8 (Torr-L/sec)
    - All 4 samples passed high pressure He test at < 3e-7 (Torr-L/sec)
    - 3 samples passed cold high pressure He test at < 3e-7 (Torr-L/sec)
- **Luer Lock seals**
  - Only initial testing has been conducted (bubble tests in alcohol)
    - Al/Al samples seem to seal well with some torque
    - PEEK seals are too soft
  - Full testing regimen has not yet begun

Pixel Detector

Preliminary Seal Test Results

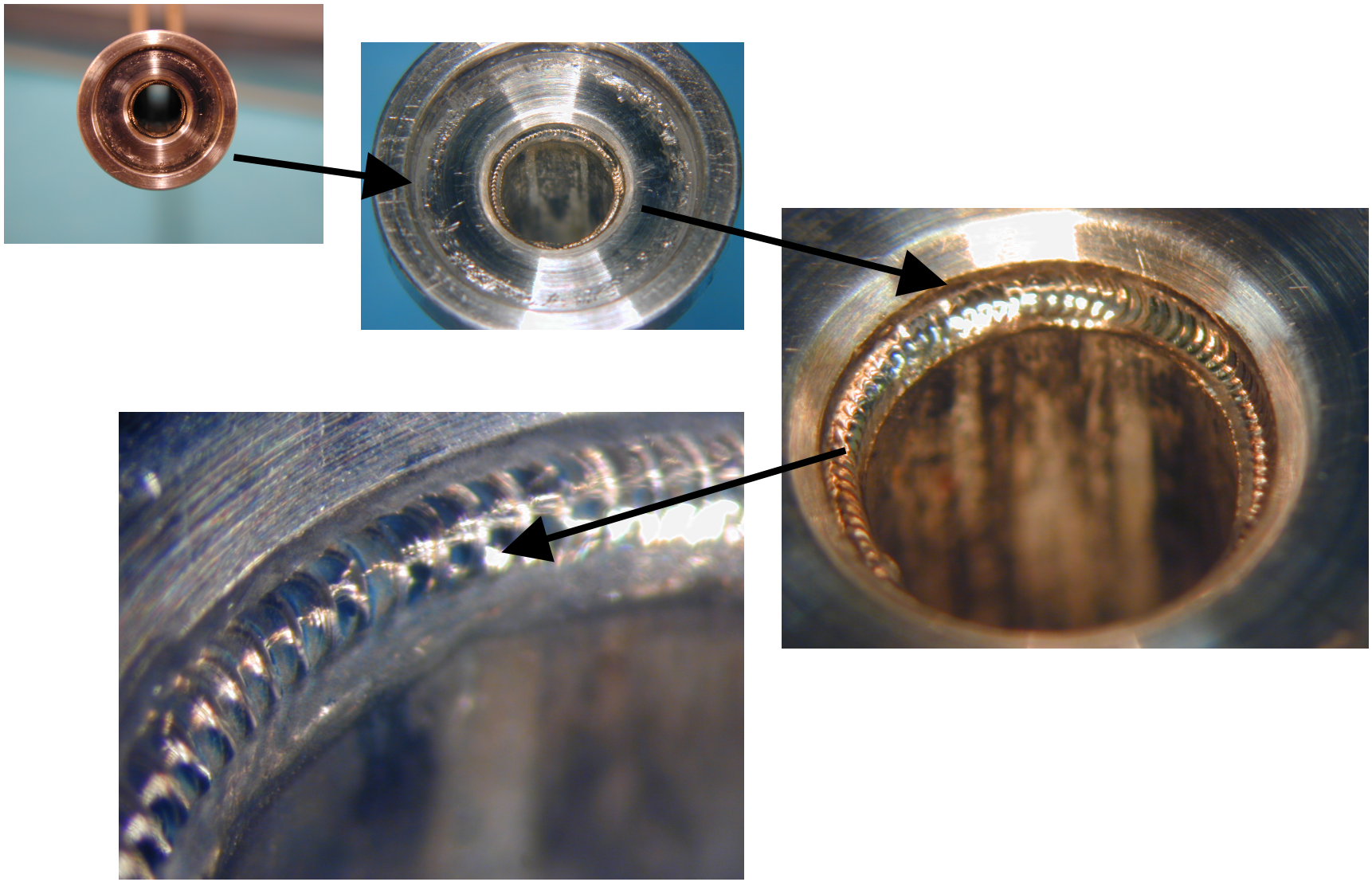
TEST RESULTS - UNDER LEAK SPECIFICATION OF 5E-7 ATM-CC/SEC. INTERNAL PRESSURE OF > 4 BAR ABSOLUTE.							
TEST FITTING	TEST CATEGORY (TESTS ARE SEQUENTIAL LEFT TO RIGHT)						
	He VAC	8 Bar Fault	Irradiation	He VAC	8 Bar Fault	RT Press.	Cold Press.
Variseal (1)							
A*			CTRL.		N/A		
C*			CTRL.		N/A		
H*			CTRL.		N/A		
I*			CTRL.		N/A		
E*			50 MRAD		A		
F*			50 MRAD	C	N/A	N/A	N/A
B*			50 MRAD				
D*			50 MRAD		A		
Variseal (2)							
M			25 MRAD				B
N			25 MRAD				
P							
R			25 MRAD			C	N/A
W			CTRL.		N/A		
X			CTRL.		N/A		
Y			CTRL.		N/A		
Z			CTRL.		N/A		C
Luer-Lock (1)							
1			N/A		N/A		
2			N/A		N/A	C	N/A
3			N/A		N/A	C	N/A
Inidium Seal (1)							
1^	C	N/A	N/A	N/A	N/A	N/A	N/A
2^			N/A		N/A		
3^			N/A		N/A		

NOTES:	
	Passes test at better than 5e-7 atm-cc/sec.
A	Pressure drop > 1% (~4%) per hour. (Not clear that this is a failure.)
B	Started leaking at RT between tests. (Cause unknown.)
C	Leak rate exceeded 5e-7 Leak Spec (atm-cc/sec).
	Test yet to be conducted.
*	Fittings made undersize - out of drawing specification.
^	Fittings had to be re-tightened to pass test.

N. Hartman LBNL

Pixel Detector

Joining Methods – Laser Welding



Recent Joining Tests

- **Laser Welding**
  - 5 samples fabricated at EB industries in Massachusetts
    - Weld penetration approximately 2 times wall thickness
    - Leak checked to < 1e-10 Torr-L/sec
    - Vendor has given “okay” to actual tube shape and size
    - Method is inexpensive (average cost of 80 CHF per sector)
- **Gluing**
  - 4 Glue samples fabricated
    - All samples leak checked to < 1e-10 Torr-L/sec
    - Samples irradiated to 25 Mrad in C_3F_8
    - All samples passed leak check after irradiation (< 1e-10 Torr-L/sec)
    - However, glue showed strange “spots” that must be investigated
      - C_3F_8 used in test had already been dosed to > **150 Mrad** (in previous testing)

Pixel Detector

On-Going Plans

- **Variseals**
  - Perform more irradiation tests
  - Investigate cold behavior problems
- **Luer Locks**
  - Conduct further testing
- **Laser Weld**
  - Test laser welding with stave fittings and tubing
  - Laser weld prototype sector tube in bent shape
- **Glue**
  - Irradiate “neat” glue samples and look for “spots” (but with new C_3F_8)
- **Other**
  - Investigate indium seal design

Conclusions – For Now

- **Permanent Joints (Laser Welding – Baseline)**
  - High level of confidence in laser method
  - Must test real geometry
  - No problems foreseen
  - Gluing also works well in all cases, but must be sure about radiation hardness
- **Removable Connections (Variseal – Baseline)**
  - Leak Spec is ~5e-7 Torr-L/Sec
    - Variseals often pass, but not in all circumstances
    - Performance is sporadic
  - Luer Lock seems desirable (or indium) – BUT we have no data to support this, and initial tests have not always been promising
    - When more data becomes available, we will re-evaluate baseline
  - Right now, Variseal is the only choice