Fermilab Personnel Contributing to EXA-001

Beams Division
- Merrill, Designers
- Jim Jablonksi and Simmice
- Fabrication & Procurement
- Paul Olden and Mark Stieneke
- Mechanical GC
- Ted Beale and Rob Riley
- Greg Koblishka
- Engineer
- Christian Boffo, Mechanical Design Engineer
- Evgenii Borrisov, Mechanical Engineer
- Chi

Fermilab, Lead Technician
- Brian Smith
- Lead and FEA analysis
- Ivan Gonin, RF Calculations
- Measurement Automation
- Tarcy Khabiboulline, RF Engineer
- Gymnady Romantov, Lead RF
- Engineer
- Tug Arkan, Production
- Engineer
- Harry Carter, LC Project
- Physicist
- Nikolay Soljak, LC Project
- Manager
- Dave Elmsley, LC Project
- Technical Division
Applying what we learned to our next structure

What we learned

RP Measurements

Mechanical Measurements

Measurement of Structure

Construction Details

Description of FXA-001

Lessons learned from FXA-001
at Alpha Breeze in Fresno, California

All brazing operations were conducted in a hydrogen furnace

RF surfaces (in the iris area)

Couplers are precision machined with some diamond-turned

Disks are precision machined (no diamond turning)

This is an all-brazed structure (no diffusion bonding)

Brazing grooves in disks

Design is identical to SLAC T20VG5 structure (except for

FXA-001 is a 20-Disk High Gradient test structure

FXA-001 is the first structure produced by Fermilab

Description of FXA-001
FXA-001 RF DISK

2a, 2b, thickness, (length), and round iris.

 FXA-001 Construction: Disk Details

All iris dimensions

Disk #1: 20 = 8.879 mm
Disk #20: 20 = 8.544 mm

DIM 24

DIM 1

constant thru Disk #1 to #20

I = 1.66 mm

DIM 2b
Not to Scale

- Wide land: 0.038 mm x 1.0 mm
- Wide annular region: 0.038 mm x 8.64 mm
- Groove: 0.75 mm dia. Cuski Wire
- 1.0 mm dia. (combined)

FXA-001 Construction: Disk-to-Disk Breeze Joint Details
Gradient tests

45 mm OD disks for high

Coupler main body, partly diamond turned.

Some brazing materials etc.

Couplers, Disks, Brazing Materials for FXA-001
Braze Temp./Time: 1896°F (1035°C) / 4 min.
Brazing Alloy: 35 Gold/65 Copper
Fixturing: Machined Carbon Blocks
Coupler Subassembly Brazing

FXA-001 Assembly Details
RF Flange-to-Coupler Brazing

FXA-001 Assembly Details
FXA-001 Assembly Details

- Brazed Temp./Time: 1475°F (802°C)
- Brazing Alloy: Cusil (28 Cu/72 Ag)
- Fixturing: Machined Carbon Blocks
- Weight Used: # plus Carbon Block

Disk Stack & Coupler Brazing
Leak Check Prior to Adding Water Cooling Tubes

FXA-001 Assembly at Alpha Breeze (Fresno, CA)
Brazing Temp./Time: 1350°F (732°C) / 3-4 min.
Brazing Alloy: Inconel (61.5 Al/23.5 Cu/15 In)
Water Cooling Tube-to-Structure Brazing

FXA-001 Assembly Details
Multiplex leak checks

Couplers to one another

Rotational alignment of

to coupler body

RF flange perpendicularity

Disk Stack

Beam tube concentricity to

bodies to cover plates

Parallelism of I/O Coupler

Couplers to Disk Stack

Perpendicularity of I/O

Structure Straightness

Measurements Conducted

Mechanical Measurements of FXA-001
RF Measurements on FX4-001

- Inclined Coupler Tuning
- Assembly Plunger Tuning
- Including Structure Disk
- Brazed Assembly Bead Pull
- Unbrazed Disk Stack Plunger
- Single Disk
- Measurements Conducted
high quality, high performance structures
assurance procedures in order to reliably produce
procedures, parts cleaning procedures, and quality
We must develop technical specifications, assembly

information transfer between FNAL and SLAC.
We must improve communications and technical
help them produce the best product possible.
We must work closely with our disk suppliers to
learning curve----but we are learning!
We are still low on the structure manufacturing

What We Learned
treatment processes to our parts
Understanding and applying the best cleaning and performance
Mechanical features of disks on their electrical RF
Improving our understanding of the influence of the
Revising our assembly sequence to improve accuracy
We have room for improvement of our brazing fixtures
Improving our fixtureing to improve assembly accuracy
Will be greatly facilitated by our new vacuum furnace
Brazing and bonding studies to improve our techniques

Moving up the Learning Curve

Applying what we learned to our next structure
overall lower disk cost should be realized. More experience, the sampling rate could be reduced and incorporated in a structure. As the manufacturer gains under the single-disk RPS measurements before being measured, only two of the three disks. The third disk would only be non-destructive (and destructive if needed) testing on their own mechanisms QC and to permit us to conduct our numbers in a stack to permit the manufacturer to conduct future disk orders will include "triplets" of selected disk.

Disk Production

Applying What We Learned to Our Next Structure
tomorrow afternoon

will also be addressed in engineering teams talk

A major topic of this workshop

assurance

Developing specifications, procedures, and quality

afternoon

To be addressed in engineering teams talk tomorrow

Information transfer between FNAL and SLAC

Improving communications and technical

Applying what we learned to our next structure
the future. Collaborative effort between Fermilab and SLAC in
We will make every effort to establish a stronger
our first effort.
we have learned from FXA-001, it will be better that
By the end of the calendar year, and based on what
We will be producing our next structure, FXA-002,
turned out pretty good!
Fermilab has produced its first structure—and it

Conclusion
Vendor #2 looks "not good" here.

Vendor #1 looks "good" here.

due to large disk to disk variations.

... but would not pass single disk RP GC

... but single disk RP GC showed very

... but single disk to disk control.

What we learned: It's not just 2a, 2b and 1
Our New Small Vacuum Furnace

The small furnace in place in IB4.

(March 2002)
- Assemblies
- X-Band furnace for final
- Need full-sized
  - Assemblies
  - Make X-Band sub-
    - WILL be used to
      - Brazing studies
      - Bonding and
        - WILL be used for