IIFC-IUAC Overview

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Presentation Plan

- Introduction
- Single Spoke Resonators – SSR1
- 1.3 GHz Single Cell Cavities
- 1.3 GHz 5-Cell Cavity
- Future Plans

Introduction

- IUAC, located in New Delhi, is an Inter-University Centre for providing basic research facilities in the areas of nuclear physics, materials science, atomic & bio physics to universities and other educational institutions in India.
- The Centre provides heavy ion beams from a few KeV energy to hundreds of MeV using several different accelerators.
- The 15 UD Pelletron Accelerator and the Superconducting Linear Accelerator booster employing niobium quarter wave resonators, are the large facilities.

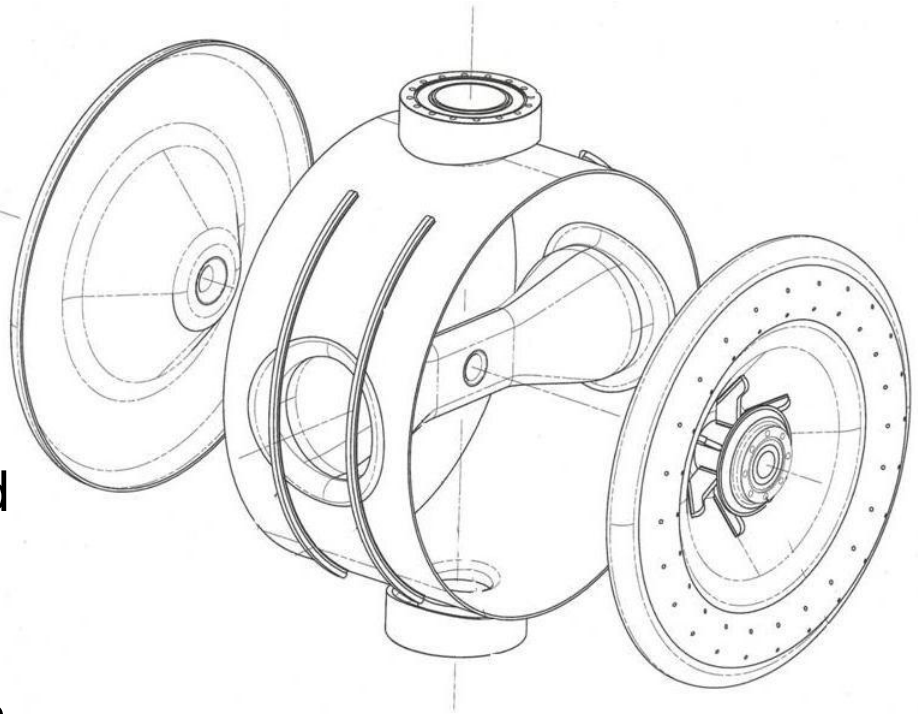
IUAC has in-house facilities for fabricating superconducting niobium resonators. Presently it is the only Centre in India where such facilities exist.

Apart from designing and building superconducting niobium resonators for its own projects like the High Current Injector, IUAC is also involved in other collaborations, most notably under the Indian Institutions and Fermi Lab Collaboration (IIFC).

The works performed by IUAC under the IIFC collaboration are highlighted in the following slides.

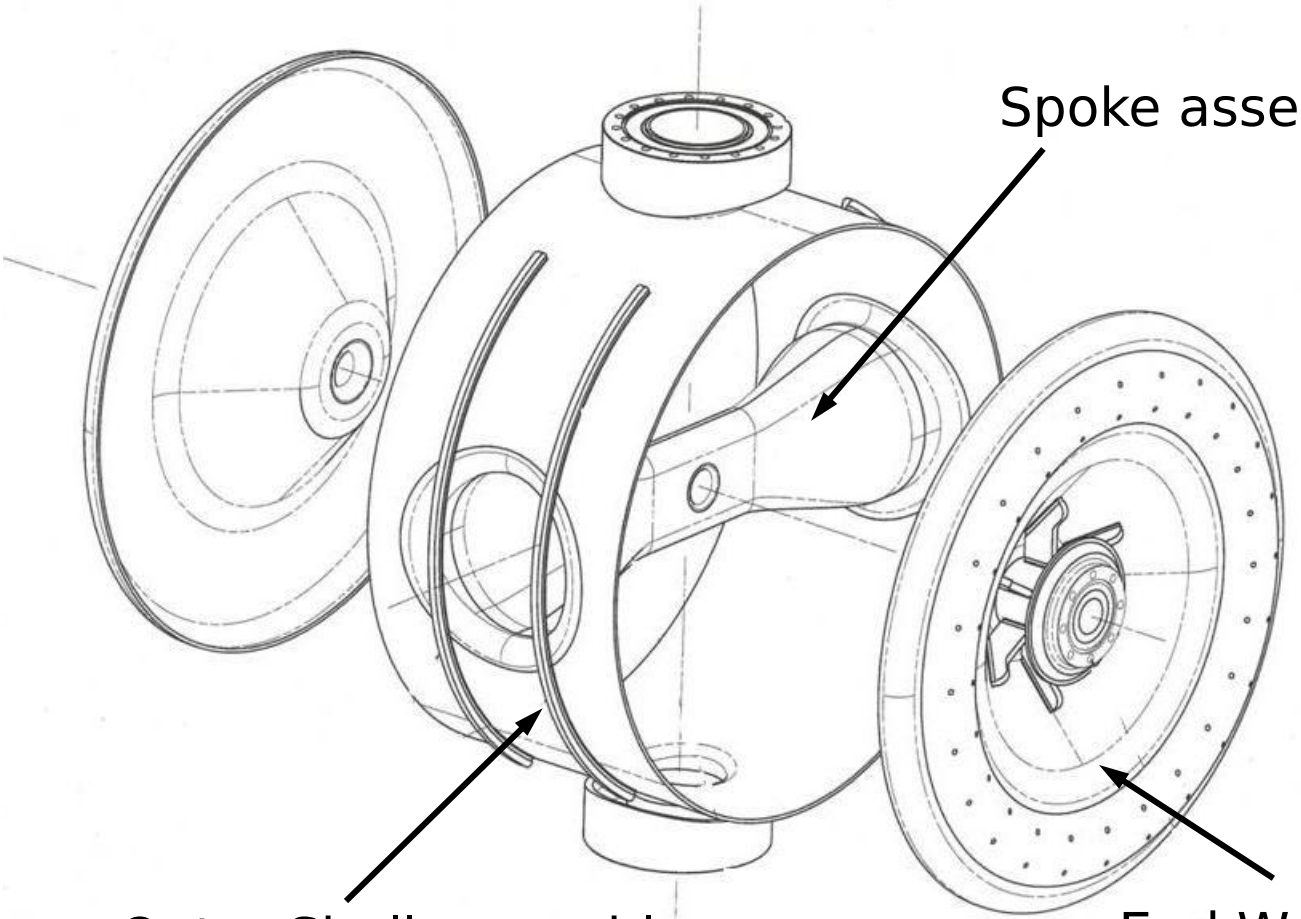
Single Spoke Resonator – SSR1

- This Project started as a collaboration between IUAC and FNAL. It was subsequently added in the scope of IIFC work.
- IUAC is building two niobium Single Spoke Resonators based on the design and drawings supplied by Fermi Lab.
- The niobium material has been supplied by Fermi Lab.
- IUAC has developed all the required tooling for constructing the resonators.



Single Spoke Resonator - SSR1 (niobium portion), β=0.22, f=325 MHz. The Outer Shell diameter is ~0.5 m

Major Nb Components of SSR1

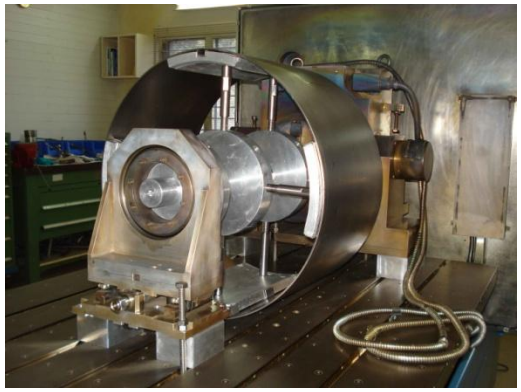


SSR1 - Outer Nb Shell

Rolling

Rolled Shells

Seam Machining



EBW of Shell seam

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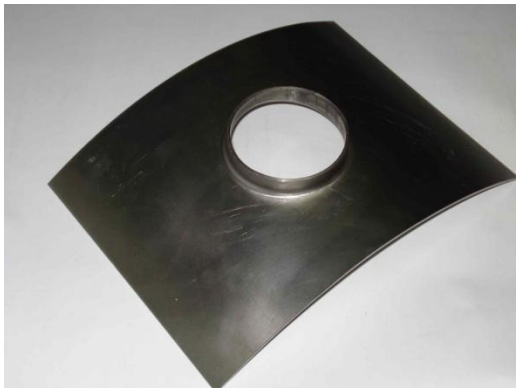


Coupler Port pullout development

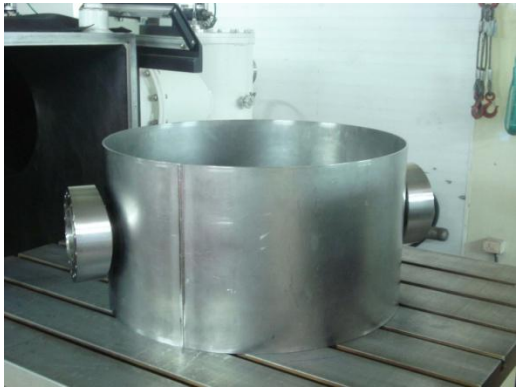
Coupler Port pullout in the Shell

SSR1 - Outer Nb Shell

Outer Shell with Coupler Port pullouts

Brazed Coupler Port Flange

Coupler Port to Shell EBW



Outer Shell with Coupler Ports

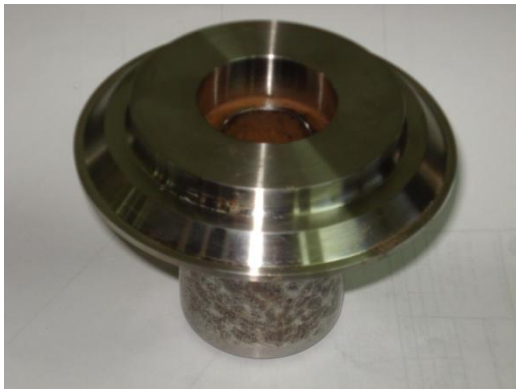
Outer Shell electropolishing setup

Shell diameter measurement

SSR1 - Nb End Wall

End Wall forming

End Wall after forming



Beam Port brazed assembly

Beam Port to End Wall EBW

End Wall along with Beam Port

Donut Rib after forming

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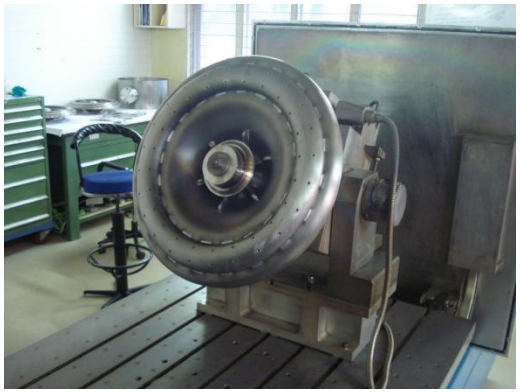
SSR1 - Nb End Wall

End Wall to Daisy Ribs EBW



End Wall to Donut Rib EBW

An End Wall assembly

Four End Walls

End Wall electropolishing setup

Electropolished End Wall

SSR1 - Nb Spoke

Half Spoke forming

Half Spoke after forming

Half Spoke after trimming

Spoke tacking setup

Spoke EBW

Welded Spoke

SSR1 – Spoke to Shell Collar

Spoke to Shell Collar (STSC) development using copper material

STSC development using niobium material

Four niobium Spoke to Shell Collars formed recently (November ’12) for completing both the Spoke assemblies

SSR1 – The Road Ahead

1. Complete the Spoke assembly by joining the Spoke to the STSCs. Fixtures for assembling and welding the Spoke assembly are almost ready.

2. The Spoke assembly will then be electropolished.

3. Development of EBW parameter for the Spoke to Outer Shell. For doing this IUAC plans to draw some niobium material from its stock and use the first STSC piece.

4. The Spoke will then be welded to the Shell.

5. The resonators will then be tuned as per details supplied by Fermi Lab. Tuning fixtures have already been made.

6. The last step would be the EBW of the End Wall to the Outer Shell.

SSR1 – Time Chart

The time chart for completing the remaining work on the two niobium SSR1s is shown below.

COMPLETION SCHEDULE FOR THE TWO SINGLE SPOKE RESONATORS SSR1 AT IUAC						
S.No	Item	November '12	December '12	January '13	February '13	March '13
1	Spoke to Shell Collar (STSC) forming					
2	Assy & EBW Fixtures for Spoke & STSC					
3	EBW of Spoke to STSC + EBW of Beam Port					
4	Electropolishing of the Spoke assembly					
5	EBW of Spoke to Shell					
6	Tuning of SSR1s					
7	Fixture for End Wall to Outer Shell EBW					
8	EBW of End Walls to Shell assembly					
9	EBW of Bridge Ribs to Shell					
10	Shipment of 2 SSR1 Resonators					

After the completion of the two niobium Single Spoke Resonators (presently being built), IUAC will build 4+1 SSR1s for Fermi Lab under the IIFC collaboration. Unlike the first two resonators, the next set of resonators will have their stainless steel helium vessels also built in India. This work will be done by VECC, Kolkata.

For the next set of resonators there are a couple of issues that need to be addressed.

1. For IUAC the question is the supply of niobium material for the project, under IIFC.
2. For VECC the concern is finalization of the design of the Helium Vessel for SSR1 so that they can start the work on their part.

1.3 GHz Cavities

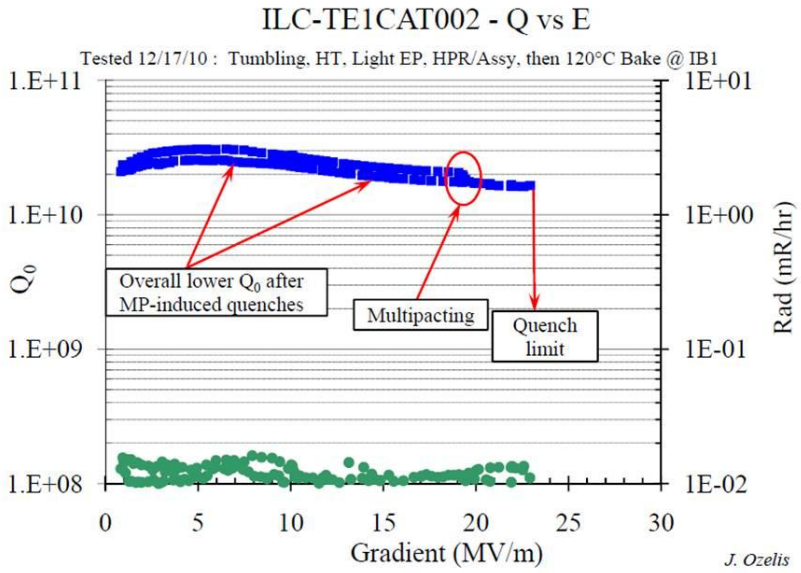
Under the IIFC collaboration, RRCAT, Indore has collaborated with IUAC to build 1.3 GHz Single Cell Cavities. IUAC has extended the crucial Electron Beam Welding facility and provided its expertise in building the Cavities. Recently a 1.3 GHz 5-Cell Niobium Cavity has been successfully built by RRCAT-IUAC. This Cavity is awaiting testing at Fermi Lab. There are plans of building 650 MHz Cavities along with RRCAT and VECC.

1.3 GHz Single Cell Cavities

- In the first phase of this project two Niobium Cavities were built.
- At 2 K these cavities produced moderate accelerating gradients of ~20 and 23 MV/m.
- Based on the lessons learned from this work, two more Niobium Single Cell Cavities were built in the second phase.
- At 2 K these Cavities produced accelerating gradients of >35 MV/m, with one of the reaching 40 MV/m at 1.8 K.

First 1.3 GHz Single Cell Niobium Cavity built in India

1.3 GHz Single Cell Cavities



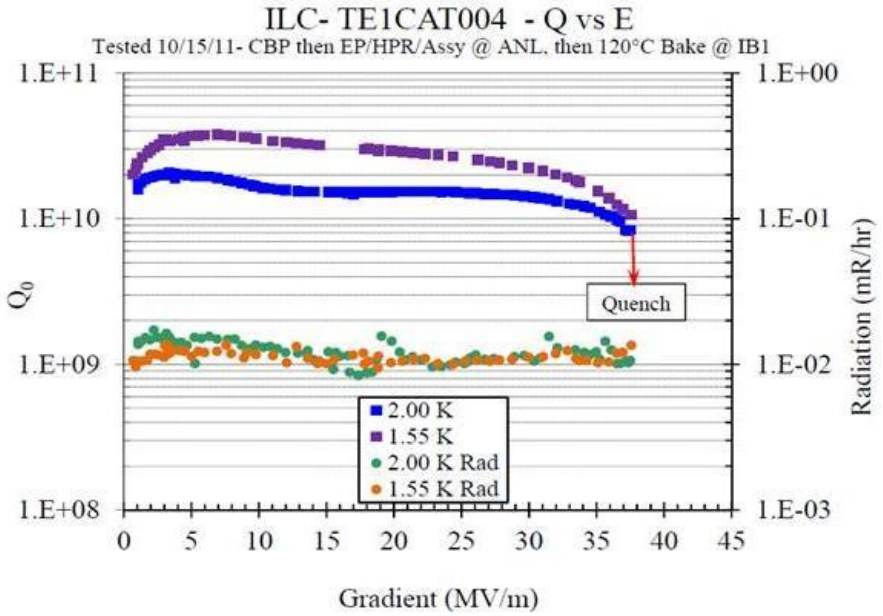


Figure 1. Q_0 vs E @ 2K.

2 K test results of one of the cavities built in the first phase (left), and performance of one of the cavities built in the second phase (right). The highest accelerating gradient achieved in the cavity on the right is 37.5 MV/m.

1.3 GHz 5-Cell Cavity

- Encouraged by the results achieved in the second set of 1.3 GHz Single Cell Cavities, the RRCAT-IUAC collaboration embarked on the development of a 1.3 GHz 5-Cell Cavity with simple End Groups.
- The first 5-Cell Niobium Cavity has been successfully built. It has not been tested as yet though.

First 1.3 GHz 5-Cell Niobium Cavity built in India

Future Plans

IUAC will continue R & D activities in SRF for its many programs and also participate in IIFC as it provides enough challenges in this field.

Following are the future plans at IUAC under the IIFC collaboration.

- 4+1 SSR1 Resonators. IUAC would make the niobium portion of the resonators and VECC would make the stainless steel helium vessels. They would also be integrated, before shipping to Fermi Lab.
- Develop β=0.9, 650 MHz Single Cell Niobium Cavity (RRCAT-IUAC).
- Develop β=0.9, 650 MHz 5-Cell Niobium Cavity (RRCAT-IUAC).
- Develop β=0.6, 650 MHz Single Cell Niobium Cavity (VECC-IUAC).

Team Members

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Thank you !!