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PUSHING THE LIMITS OF THE SRF TECHNOLOGY FOR LOW AND MEDIUM VELOCITY APPLICATIONS

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Message of this talk

- **Low- and medium-velocity applications exist.**
- **For a very long time, performance level achieved in low/medium velocity structures has been similar to that achieved in high velocity structures.**
- **Low velocity applications can also benefit from advances in the technology.**
- **Wider application and implementation of srf will depend as much on technical advances as on better understanding of the underlying physics.**

Applications of low- and medium-β superconducting structures

	High Current	Low/Medium Current
CW	Accelerator driven systems waste transmutation energy production	Nuclear structure studies Production of radioactive ions
Pulsed	Pulsed spallation sources	

High-current cw accelerators

- Beam: p, H^-, d
- Technical issues and challenges
  - —Beam losses (~ 1 W/m)
  - —Activation
  - —High cw rf power
  - —Higher order modes
  - —Cryogenics losses
- Implications for SRF technology
  - —Cavities with high acceptance
  - —Development of high cw power couplers
  - —Extraction of HOM power
  - —Cavities with high shunt impedance
  - —Low surface resistance
  - —Efficient refrigerators

High-current pulsed accelerators

- Beam: p, H^-
- Technical issues and challenges
  - Beam losses (~ 1 W/m)
  - Activation
  - Higher order modes
  - High peak rf power
  - Dynamic Lorentz detuning
- Implications for SRF technology
  - Cavities with high acceptance
  - Development of high peak power couplers
  - Extraction of HOM power
  - Development of active compensation of dynamic Lorentz detuning

Medium to low current cw accelerators

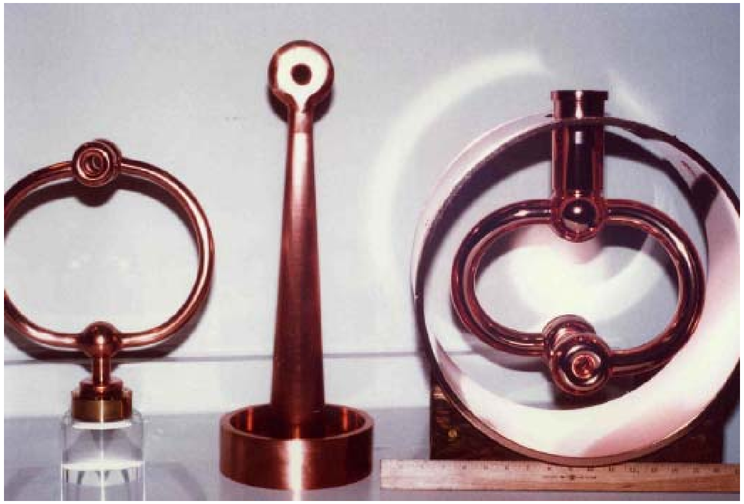
- **Beam; p to U**
- **Technical issues and challenges**
  - — Microphonics, frequency control
  - — Cryogenic losses
  - — Wide charge to mass ratio
  - — Multicharged state acceleration
  - — Activation (in some cases)
- **Implications for SRF technology**
  - — Cavities with low sensitivity to vibration
  - — Development of microphonics compensation
  - — Cavities with high shunt impedance
  - — Low surface resistance
  - — Efficient refrigerators
  - — Cavities with large velocity acceptance (few cells)
  - — Cavities with large beam acceptance (low frequency, small frequency transitions)

Common considerations

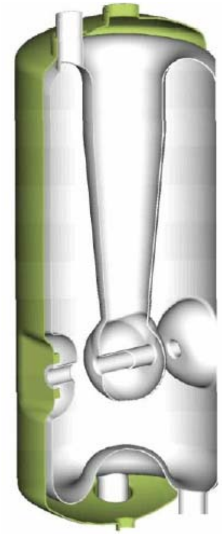
- Intermediate velocity applications usually do not require (or cannot afford) very high gradients
- Operational and practical gradients are limited by
  - Cryogenics losses (cw applications)
  - Rf power to control microphonics (low current applications)
  - Rf power couplers (high-current applications)
- High shunt impedance, low surface resistance, and efficient refrigeration are often more important
- The ability to operate with higher surface field would enable new geometries with higher shunt impedance and acceptance
- To various degrees, beam losses and activation are a consideration

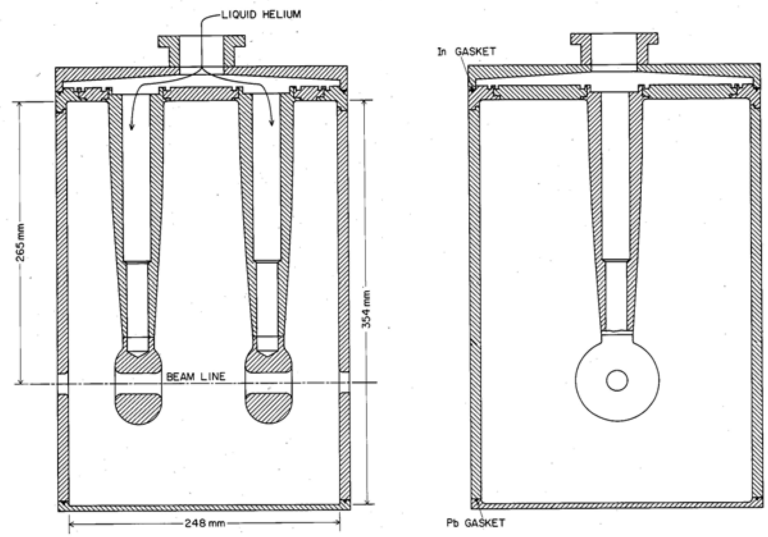
TEM-class geometries (λ/4)

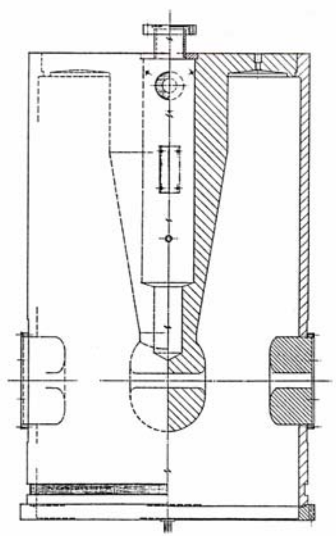


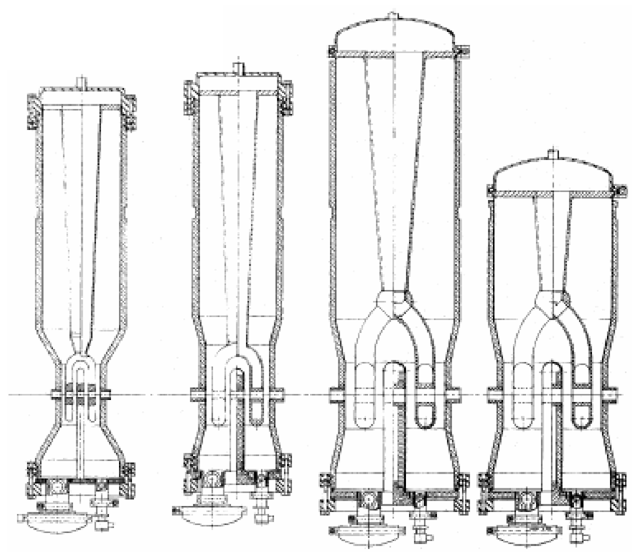



TEM-class geometries (λ/4)

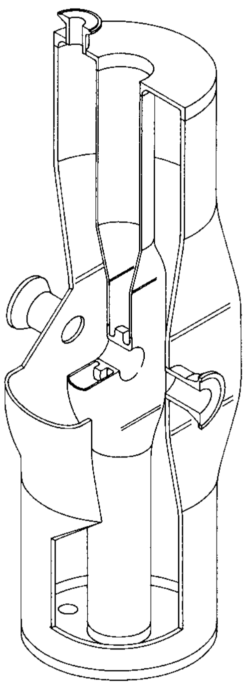




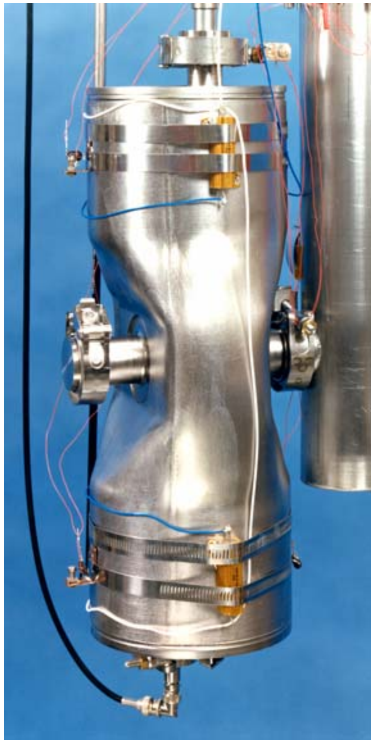




TEM-class geometries (λ/2 coaxial half-wave)



ANL 1988

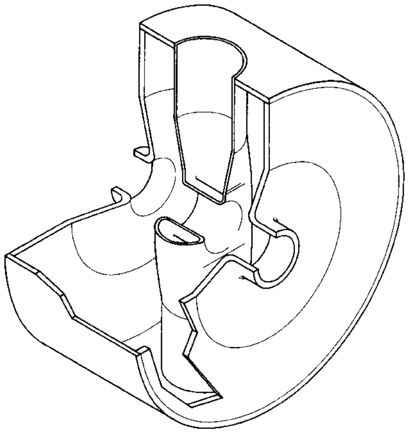


ANL 1990

MSU 2003

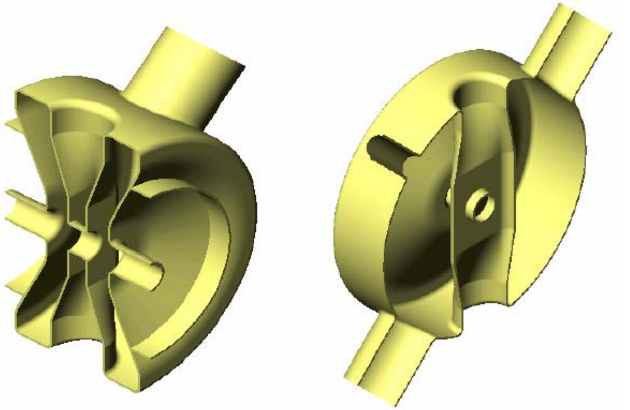
ANL 2003

TEM-class geometries (λ/2 single spoke)



ANL 1988

ANL 1991

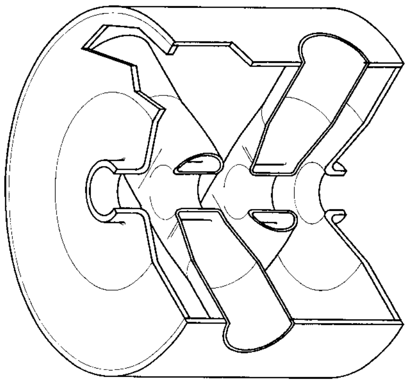


LANL 2001

ANL 1998

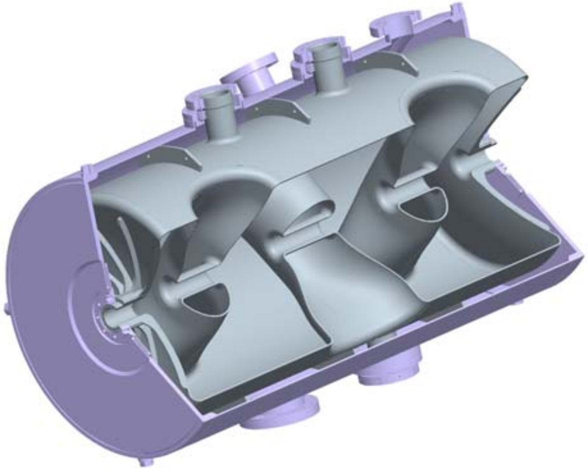
Orsay 2002

TEM-class geometries (λ/2 multi-spoke)



ANL 1988

ANL 2003

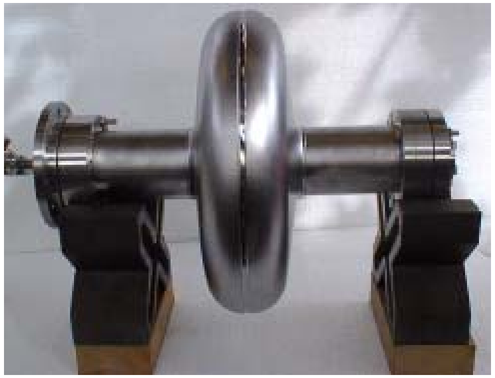


Juelich 2001

Juelich 2003

ANL 2004

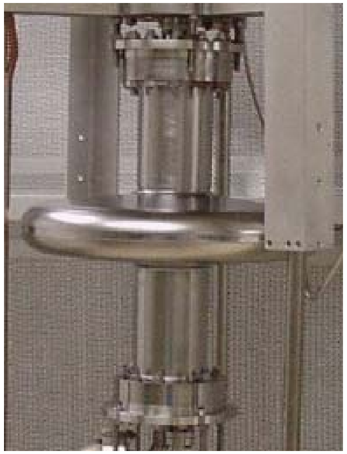
TM-class geometries (single cell)



Saclay 1999

CERN 1997

INFN 2001



JLab/MSU 2001

TM-class geometries (multi-cell)

JLab/SNS 2001

JLab/MSU 2001

KEK/JAERI 2003

Orsay 2003

LANL 2001

Non exhaustive wish list

- **Low cryogenics losses**
  - — **High R_{sh} /Q * Q R_s, low R_s**
  - — **Efficient refrigerators**
- **High gradient (sometimes)**
  - — **Low E_p/E_{acc}**
  - — **Low B_p/E_{acc}**
- **Large velocity acceptance**
  - — **Small number of cells**
  - — **Low frequency**
- **Frequency control**
  - — **Low sensitivity to microphonics**
  - — **Low energy content**
  - — **Low Lorentz coefficient**
- **Large beam acceptance**
  - — **Large aperture (transverse acceptance)**
  - — **Low frequency (longitudinal acceptance)**

Summary

- **Low- and medium-velocity applications exist.**
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