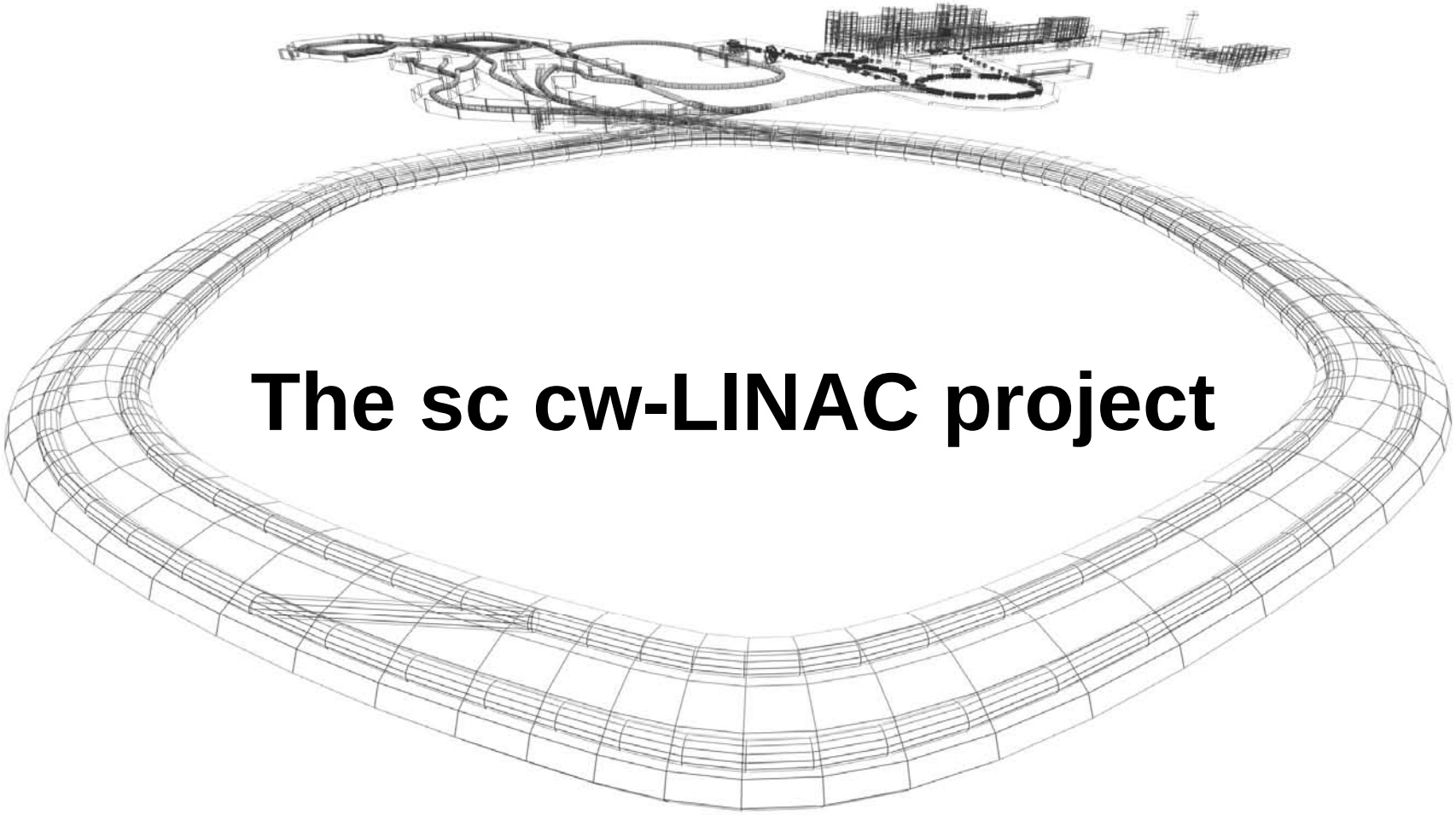

The sc cw-LINAC project

What is the status of the cw LINAC?

1. Motivation
2. HLI-Upgrade
3. cw-LINAC
4. cw-LINAC-Demonstrator
5. Perspective of a cw-LINAC @GSI
6. Summary

How to increase the beam intensity in terms of SHE?

S. HOFMANN[†], D. ACKERMANN[‡], W. BARTH, L. DAHL, F.P. HESSBERGER,
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(EXON 2004)

After a cost-benefit analysis
a sc cw LINAC in combination with the upgraded HLI at GSI
fits the requirements for SHE at best.

Where is the HLI located at GSI?

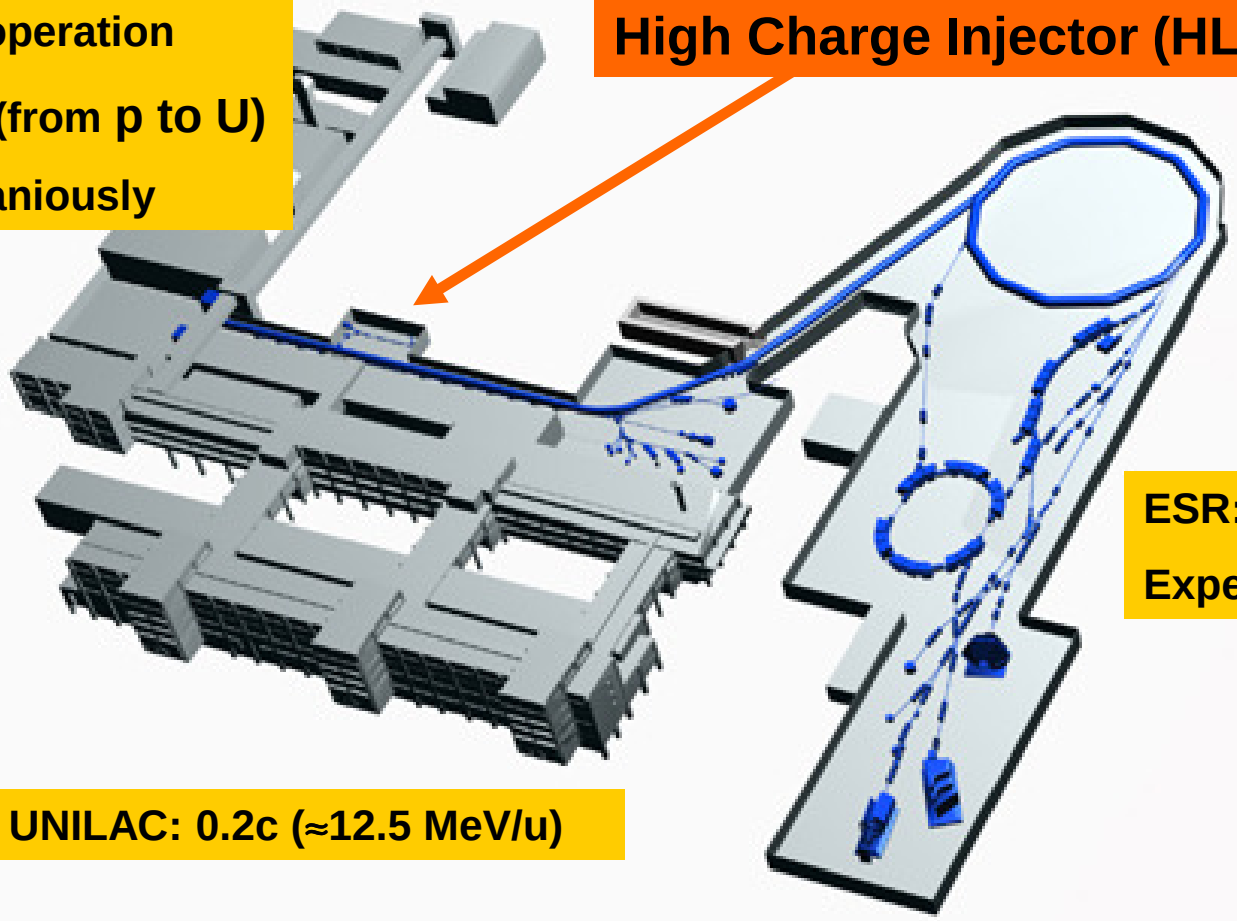
from 1992 on:

High Charge Injector (HLI)

pulse operation

3 Ions (from p to U)

simultaniously



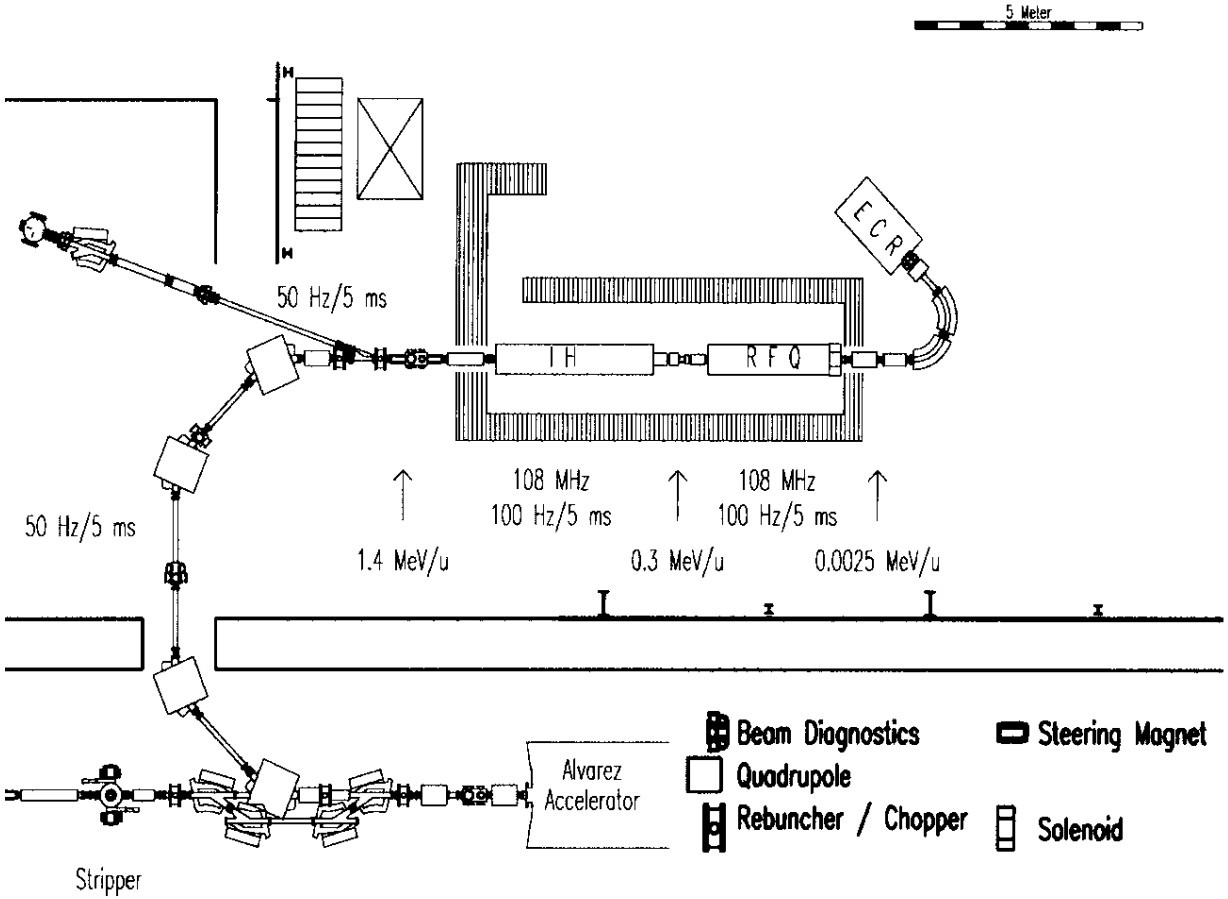
SIS: 0,9c (1-2 GeV/u)

ESR:

Experimental Storage Ring

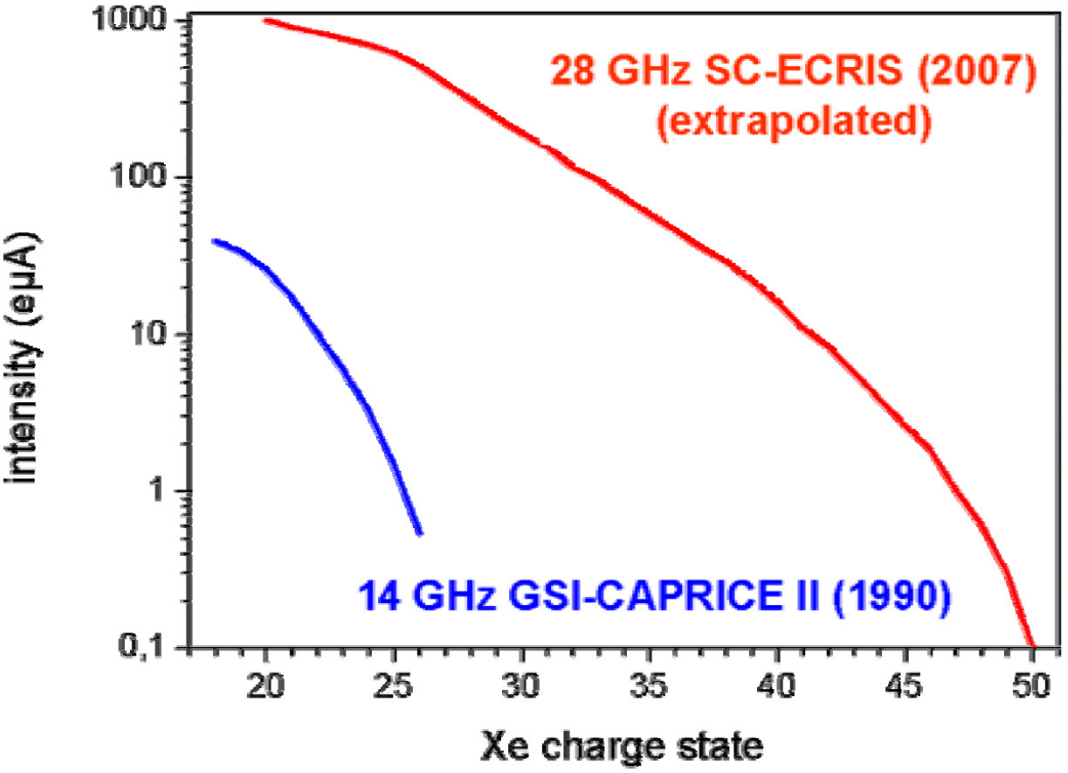
UNILAC: 0.2c (≈12.5 MeV/u)

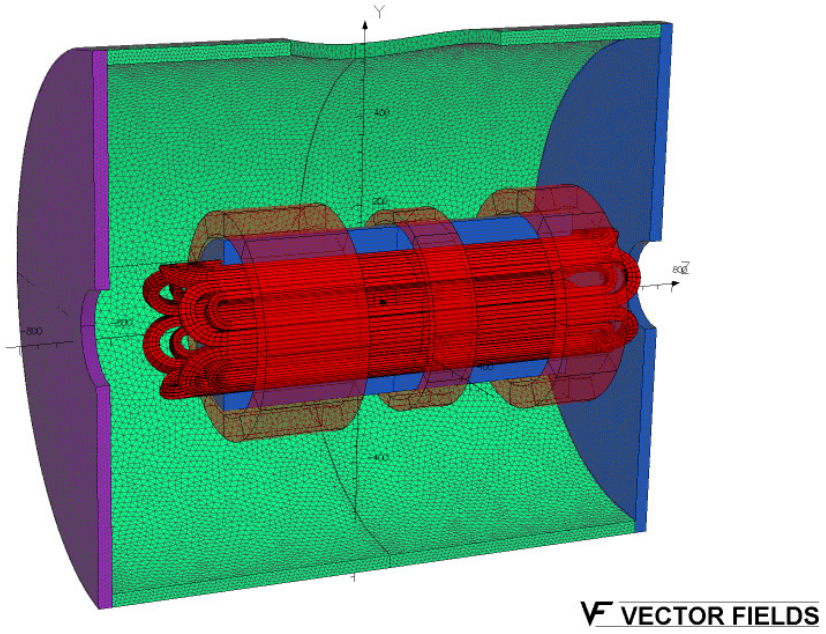
What are the HLI upgrade measures?



1. 2nd sc 28GHz ECR -> New LEBT
2. Cw capable RFQ (A/Q=6) & cw capable IH

1.) New 28 GHz ECR-Ionsource





MSECRIS – Status and Perspectives
(Klaus Tinschert)

Main challenges of a fully superconducting magnet system of a 28 GHz ECRIS:

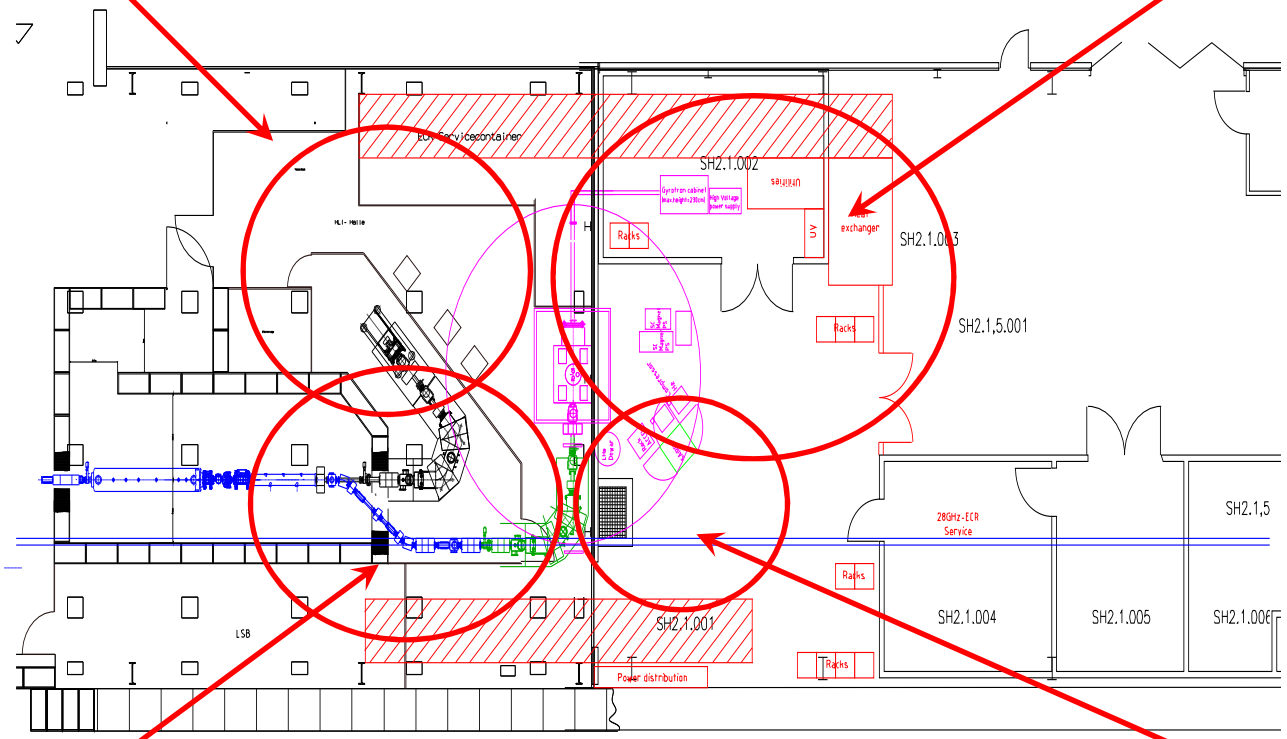
- The superposition of the 3 solenoid fields with the hexapole field generates a very complex pattern of magnetic forces exerted on the coils and on the clamping structure.
- The magnetic nature of the clamping structure used for MSECRIS enhances the magnetic flux considerably but increases the effect of these forces.
  ➔ forces of 30 tons but tolerable movement of conductor in the range of µm.

Coupled electromagnetic and structural analysis of the magnetic forces and experimental investigations for an optimization of the clamping technique.

The new HLI-LEBT Design

Existing 14 GHz-ECR (CAPRICE)

New 28 GHz-ECR (+supplying system)

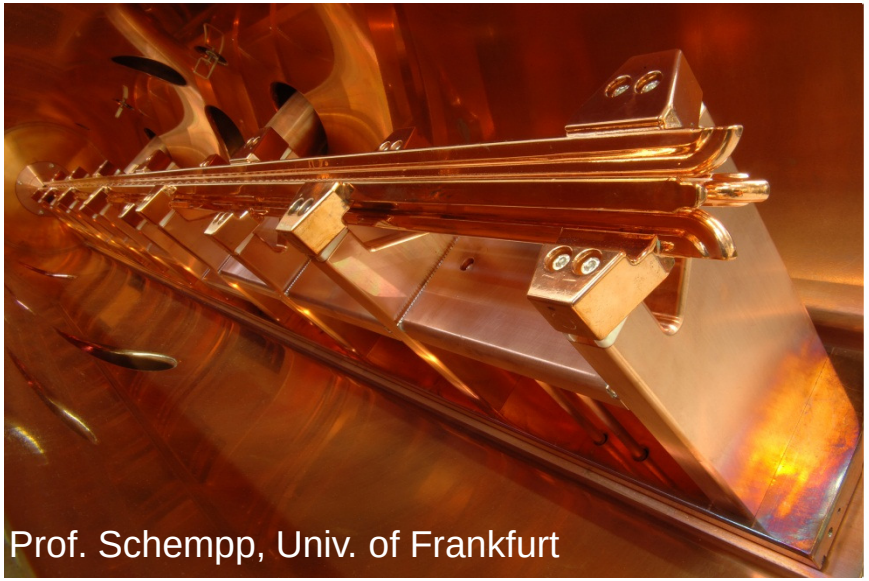


HLI-LINAC

new Low Energy Beam Transport (LEBT)

Analysing Magnet

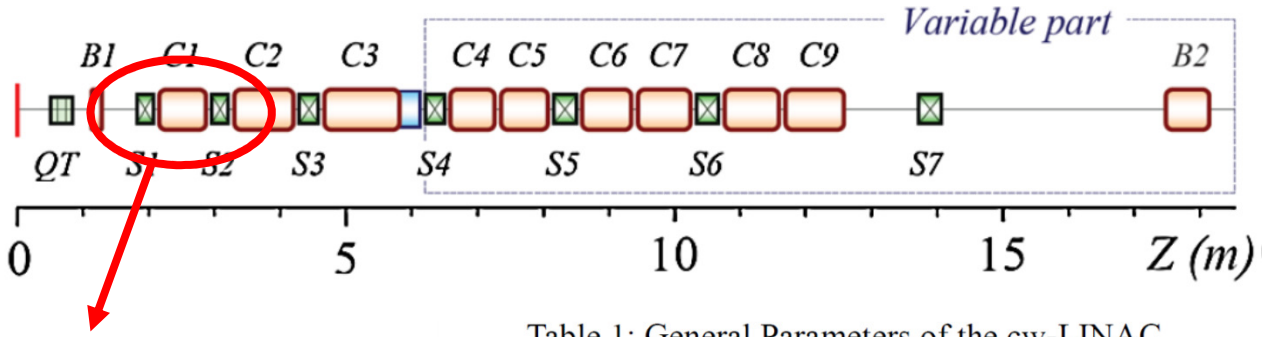
2.) cw capable RFQ



No cw-operation established so far
-> very sensitve to thermal load

What is the sc cw-LINAC?

Upgraded HLI +



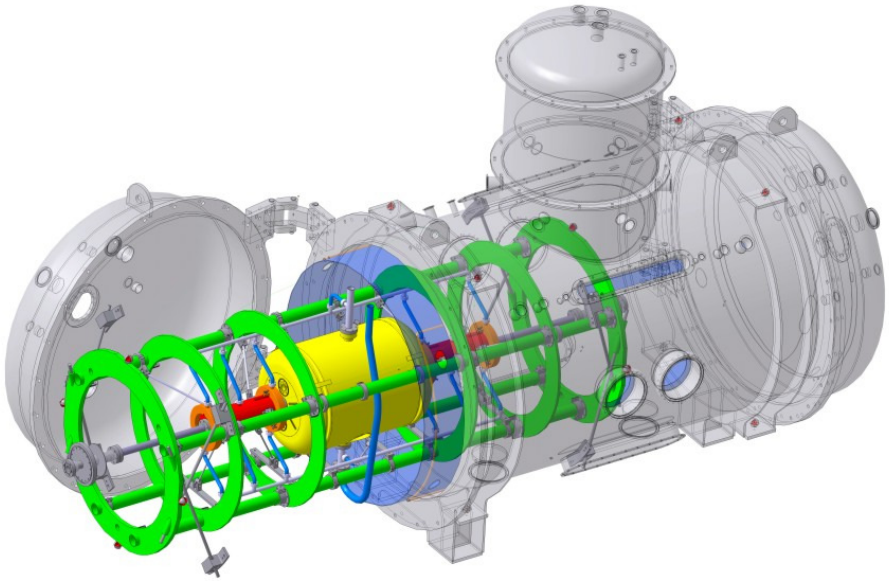


Table 1: General Parameters of the cw-LINAC

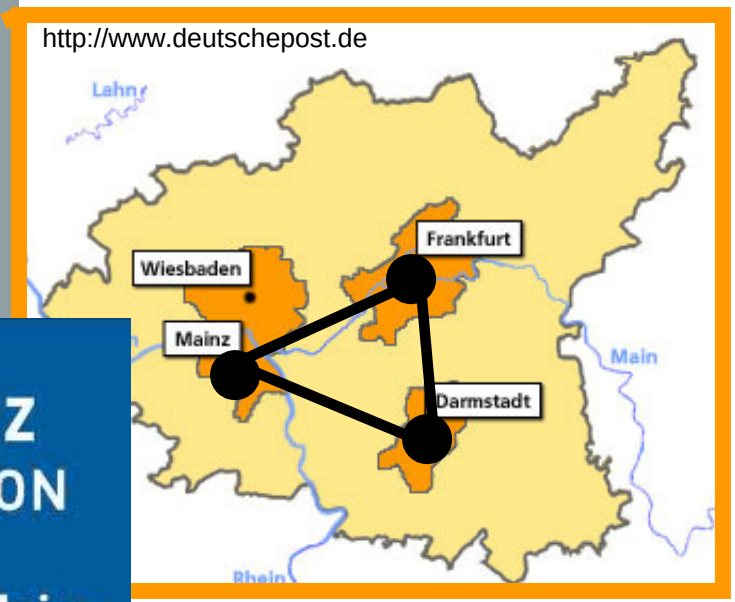
Mass/Charge		6
Frequency	MHz	217
max. beam current	mA	1
Injection Energy	MeV/u	1.4
Output energy	MeV/u	3.5 – 7.3
Output energy spread	keV/u	+- 3
Length of acceleration	m	12.7
Sc CH-cavities		9
Sc solenoids		7

Minaev et al (IAP, 2009)

Collaboration-Project

IAP

test



HELMHOLTZ ASSOCIATION

Helmholtz Institute Mainz

GSI

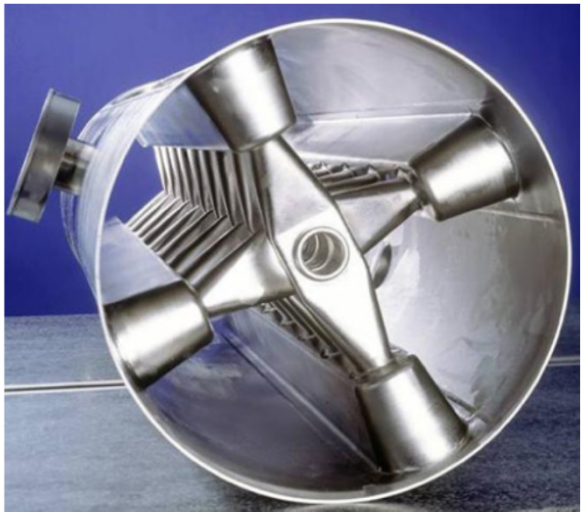
ARD-Program of the Helmholtz-Gemeinschaft

GSI	1x Postdoc
IAP	1x PhD
HIM	1x Postdoc 1x PhD 1x Engineer

What is the aim?

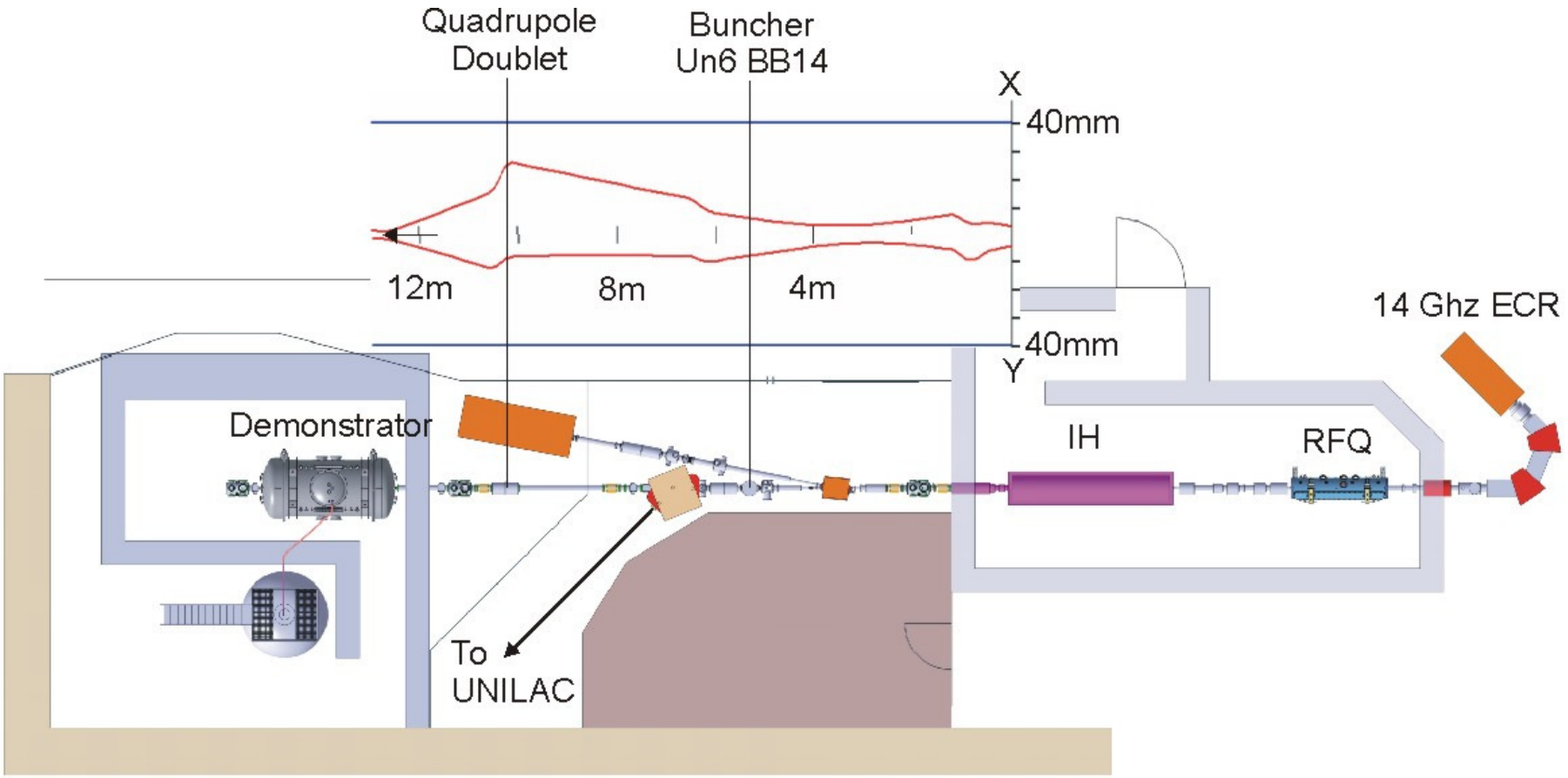
Full performance test of an sc CH-Cavity with Heavy Ion Beam.

CH: Crossbar H-Mode

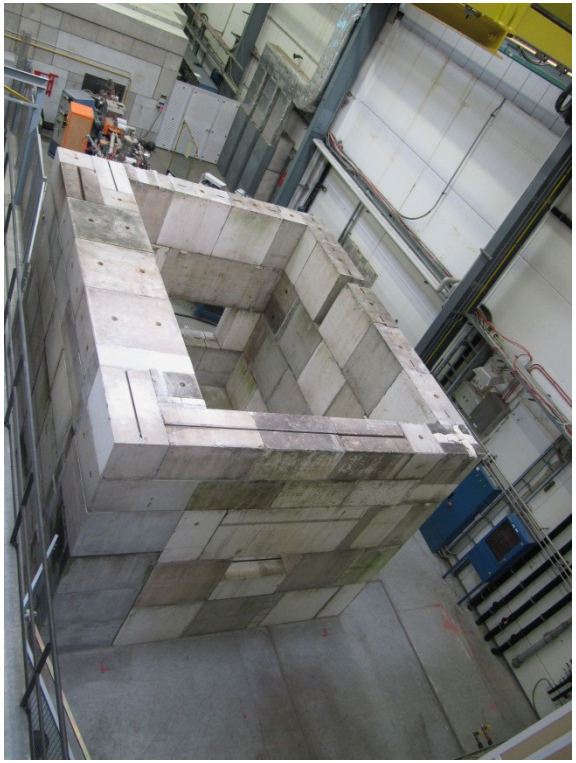


Where is the Demonstrator located @ GSI?

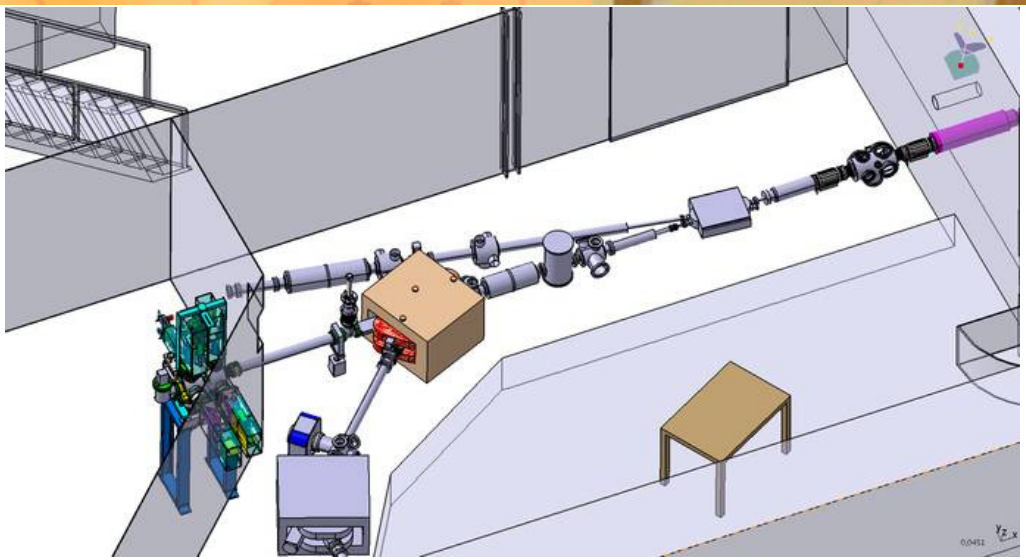
High Charge Injector (HLI), 1.4 AMeV, 108 MHz



What is the status of the Demonstrator?



27.07.2012



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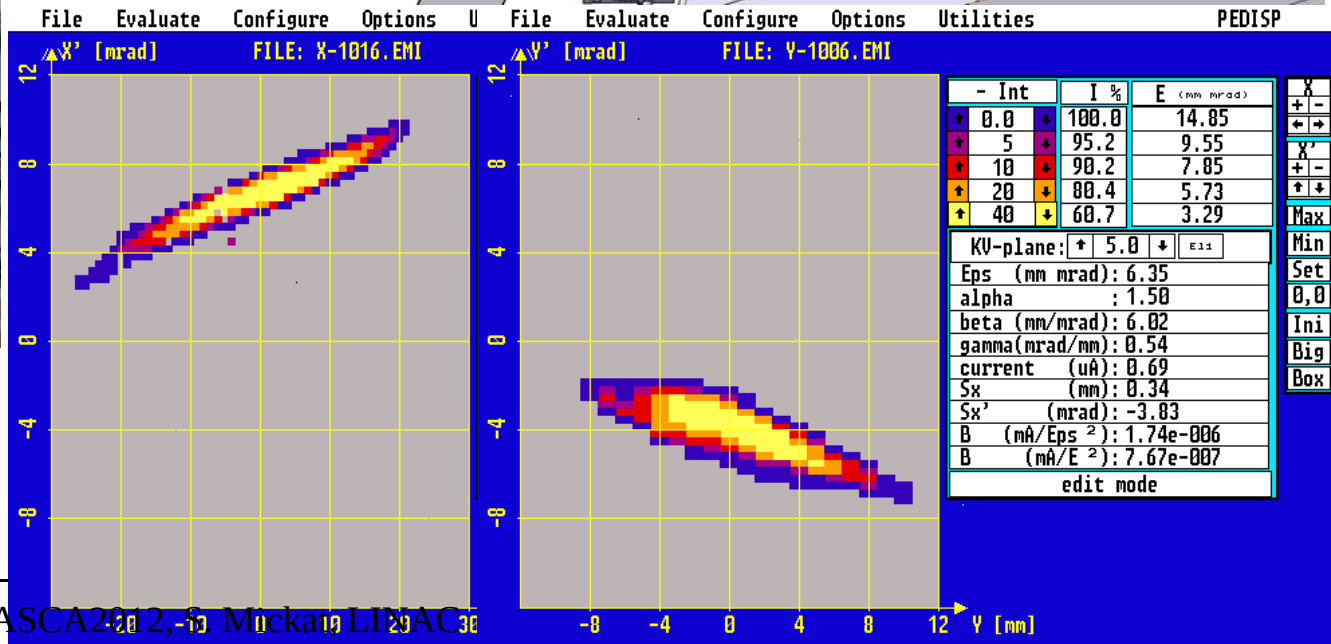


What is the timetable?

2010-12	**Tendering & Ordering**
	order of CH-cavity is placed to RI, Germany order of cryostat & solenoids is placed to Cryogenic, UK
2011	**Delivery**
	5kW-Amplifier (DB Elettronica, Italy), 3000 ltr LHe-Tank (Cryoanlagenbau, Germany) 25m^3 He-Recovery Balloon (Bieri-Zeltaplan, Germany)
2013	**Test environment at GSI HLI is assembled** **Delivery of the cavity** **1st tests (warm & cold) @IAP**
2014	**Delivery of the cryostat and the solenoid** **Starting full performance tests @GSI-HLI**

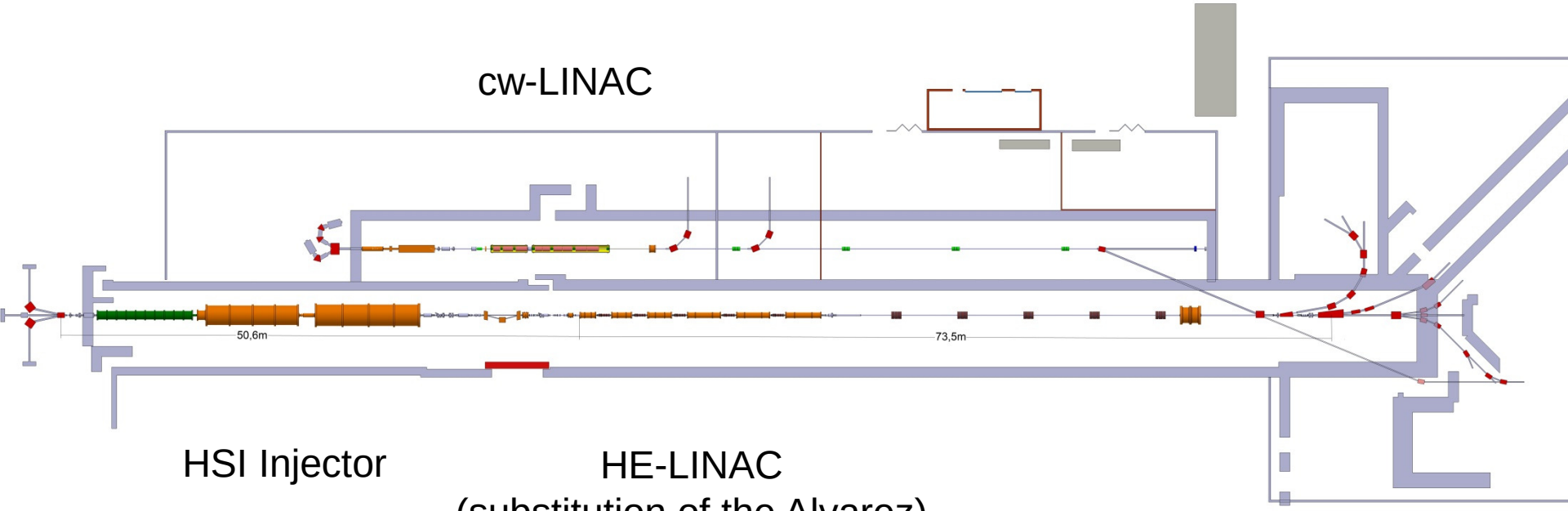
What is the perspective of a cw-LINAC @GSI?

- 1st proposal and follow-up proposal were evaluated "excellent" by HGF
- but NO funding at the moment
- proof of principle on the technology
  -> successful Demonstrator-project
- strong user community @ GSI has to be picked up, not only SHE, requesting long pulse operation and energies in the Coulomb barrier range
- Checking the existing design with respect to the requirements of a broad community: max. energy, A/Q, …
- Conceptual Design Report (CDR)
  – Technical Design Report (TDR) is needed

What is the timetable for the new LINAC?

2015	**Results of the Demonstrator Project**
	Applying for funding (TDR should be ready)
2016	**Tendering for components**
2017	**Placing orders**
2019	**Delivery of components**
	Assembling the accelerator
2020	**Commissioning**

How could the GSI look like?



What is the status of the cw-LINAC?

- Development of the new 28GHz ECR source
  with the aimed intensities is challenging
- New RFQ was commissioned in 2010, cw operation is not established
- New LEBT is designed beam dynamically
- Demonstrator project is in progress and in time
- Funding for an sc cw-LINAC
  depends on the results of the Demonstrator project
- A strong user community has to call for a new cw-LINAC
- CDR / TDR for a cw-LINAC is needed

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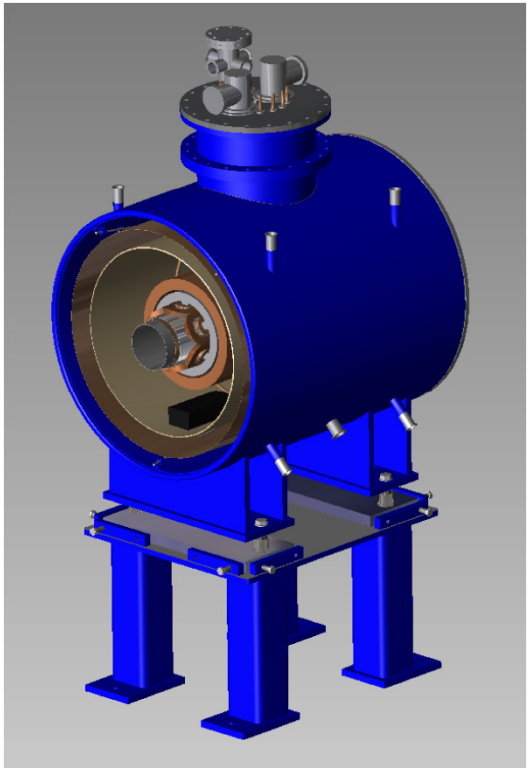
Hartmut Vormann
Stepan Yaramishev

MT:
Claus Schröder
Hans Müller
Carsten Mühle

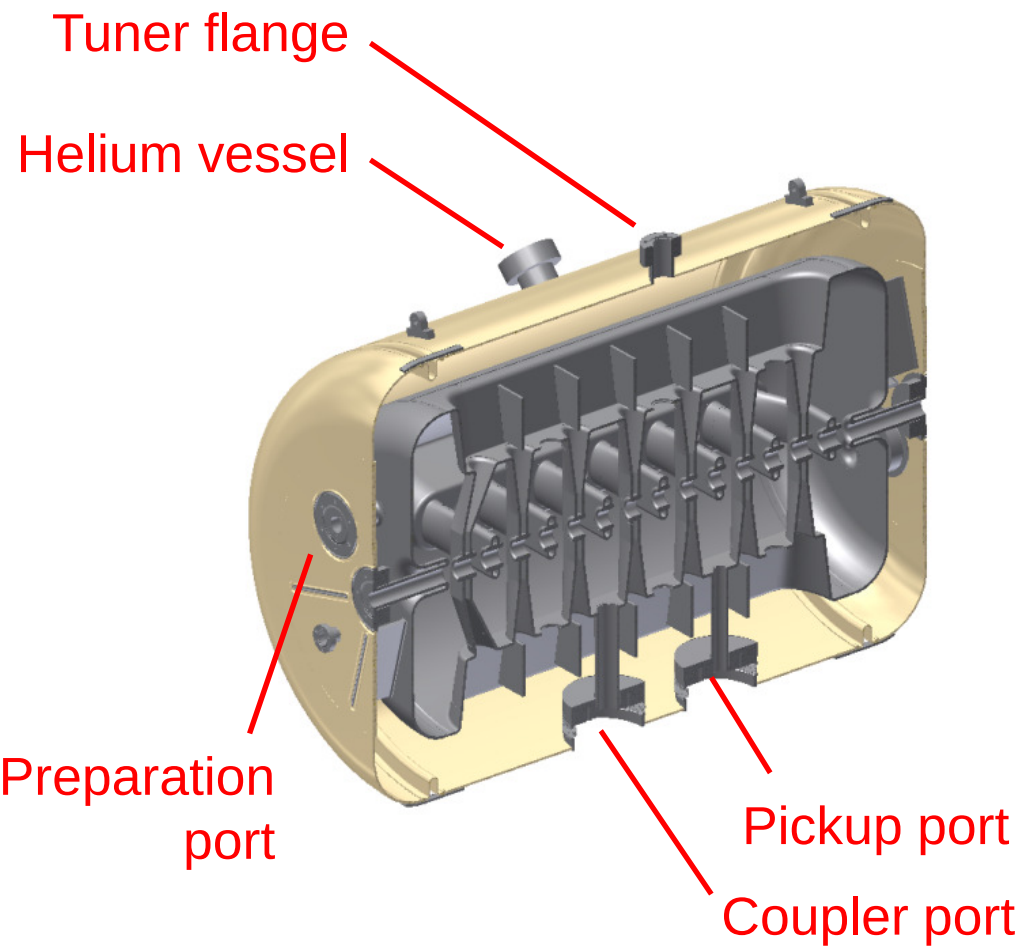
ZT:
(Dietrich Schäfer, VBE)
Wilfried Sturm

Layout and Design Parameters



Microwave Frequency	28 GHz
Maximum RF power	10 kW
B (radial) at r = 90 mm	2.7 T
B_1 (injection)	4.5 T
B_2(extraction)	3.5 T
Diameter of Plasma chamber	180 mm
Diameter of Cryostat	1200 mm
Length of Cryostat	1350 mm
Extraction Voltage	up to 40 kV
LHe consumption	0

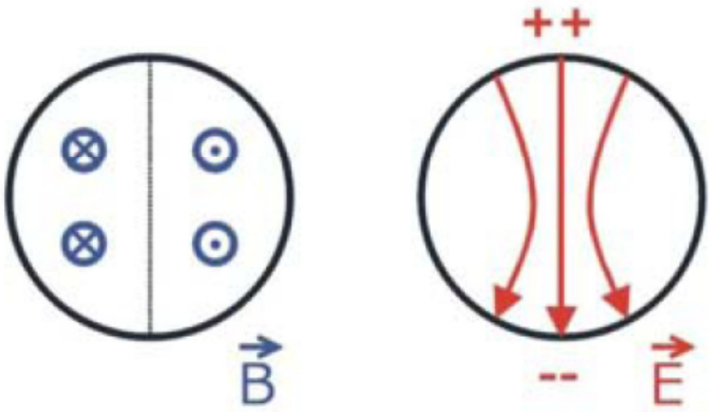
What a cavity is used?



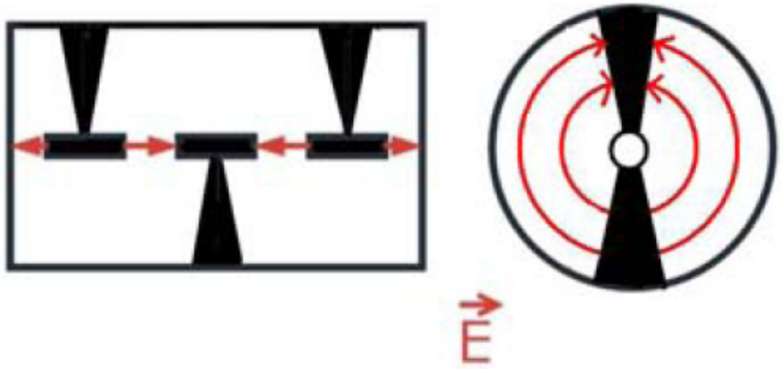
Parameter	Unit	
Beta		0.059
Frequency	MHz	216.816
Gap number		15
Total length	mm	687
Cavity diameter	mm	409
Cell length	mm	40.82
Aperture	mm	20
Energy gain	MeV	2.97
Accelerating gradient	MV/ m	5.1
Static tuner		9
Dynamic bellow tuner		3

How the accelerating field looks like?

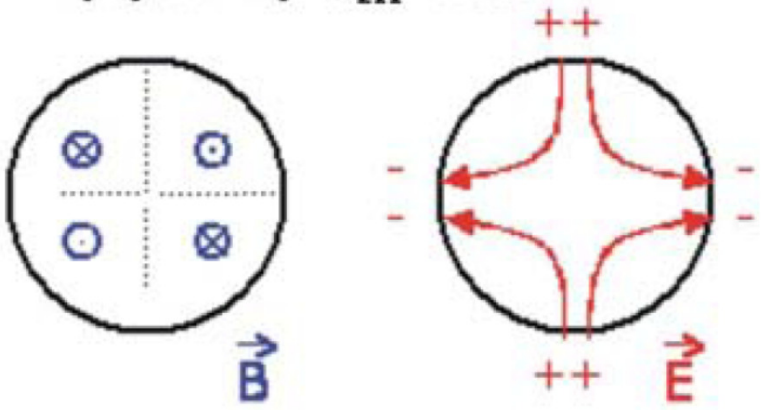
H_{111} - Empty Cavity

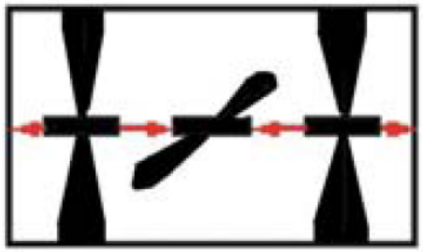


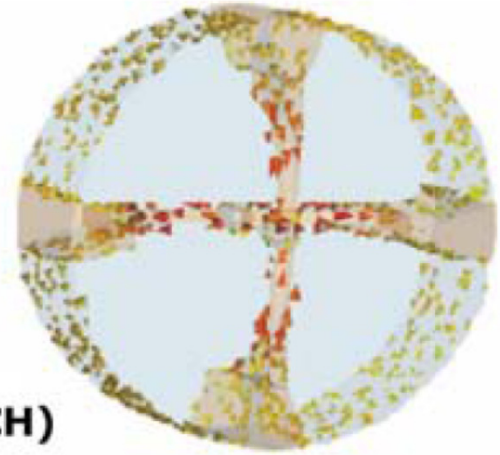
Interdigital H-Mode (IH)



Empty Cavity H_{211} - Mode

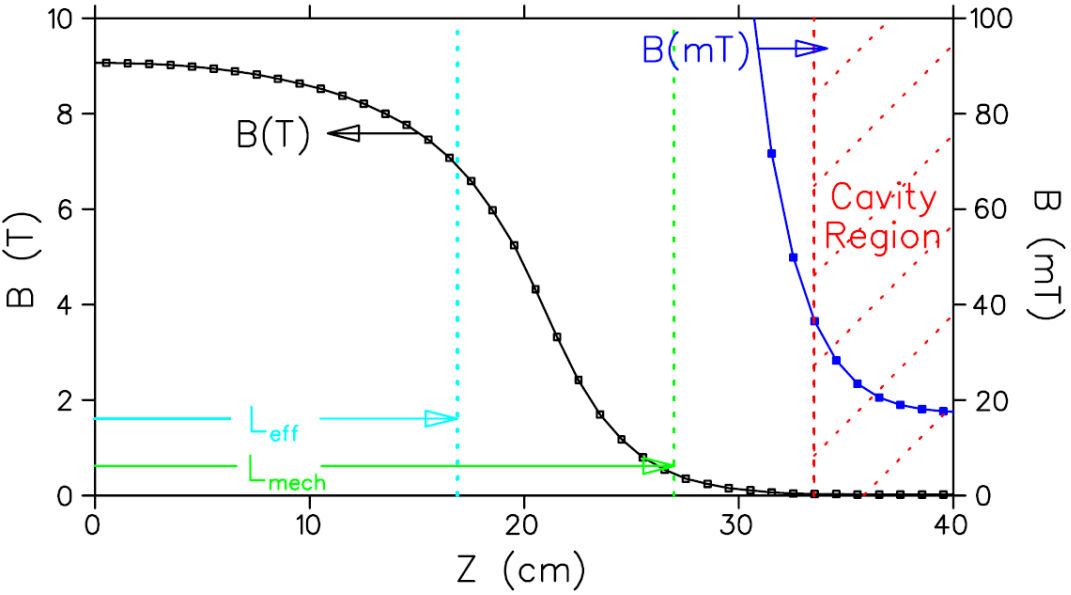






Crossbar H-Mode Linac (CH)

sc solenoid design



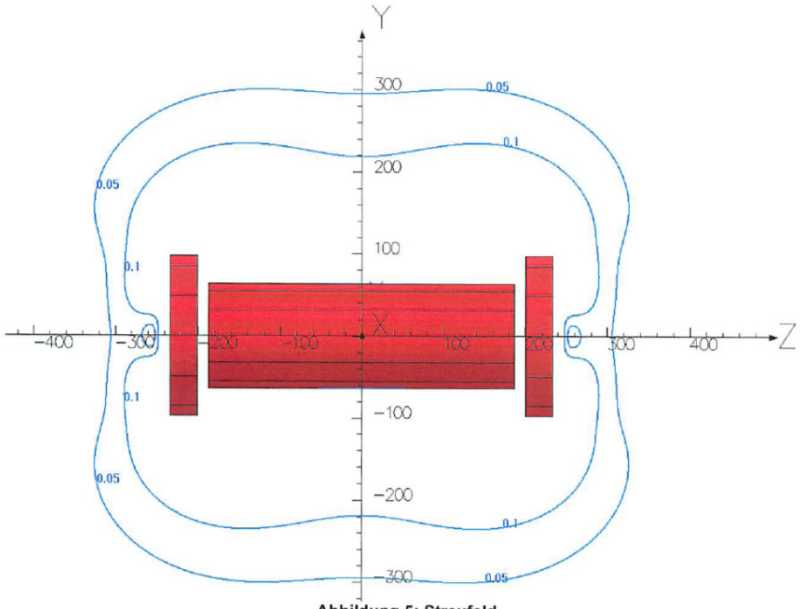


Abbildung 5: Streufeld

Magnetic field studies in the ISAC-II cryomodule ☆

R.E. Laxdal [a,*], B. Boussier [a], K. Fong [a], I. Sekachev [a], G. Clark [a], V. Zvyagintsev [a], R. Eichhorn [b]

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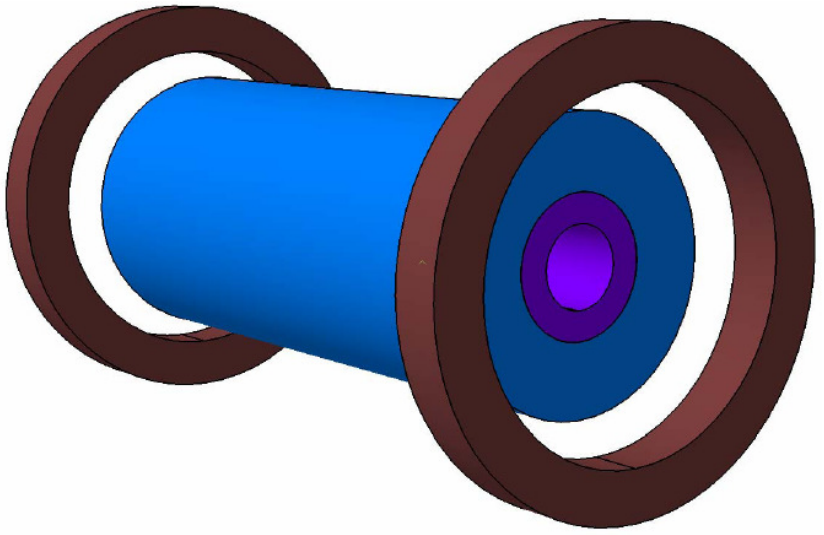
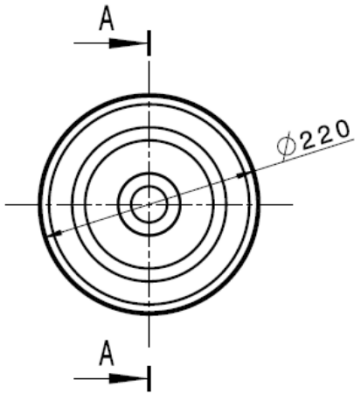
Available online 8 May 2006

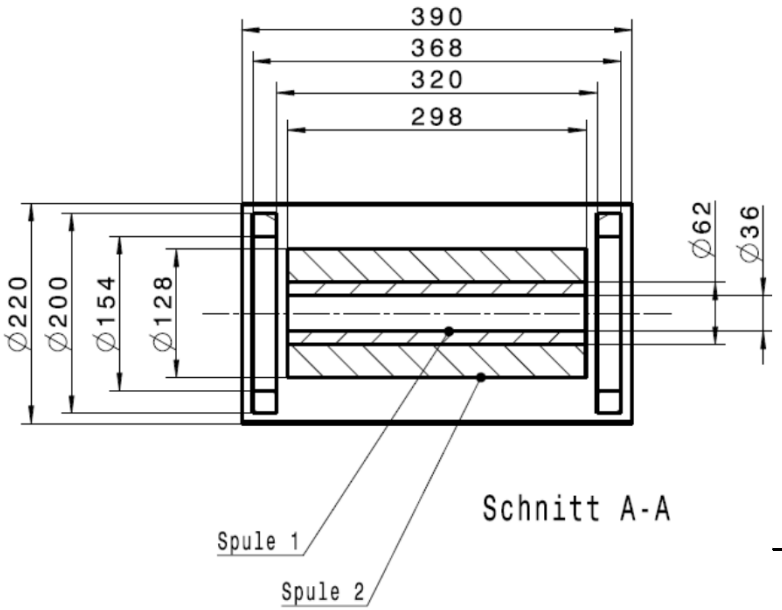
1st layout of the solenoids

J. Pürschel (IAP)

Bmax	9,323T
B*L	2,635 Tm
L	0,28 m
Bohrunsradius	17,5 mm
Außenradius	0,38 m







Summary

- an accelerator upgrade is needed to keep the SHE-research @ GSI competetive
- a cw stand alone LINAC adapted to the SHE requirements is the most effective solution
- a sc CH-cavity is the key component of the a sc cw LINAC
- full performance tests in 2013 @GSI HLI with the cw-LINAC Demonstrator is an important milestone towards a new LINAC in >2017
- the accelerator upgrade program has already started (ECR and HLI-RFQ upgrade)