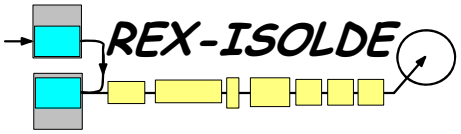
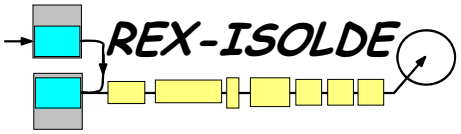


REX operation 2005 and future plans and upgrades

Didier Voulot



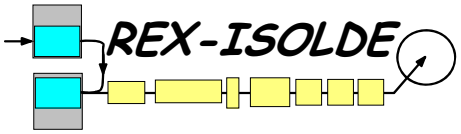
Outline

Operation and Development in 2005

- Low energy part
- linac

REX Upgrade

- Minimove
- 5.5MeV/u upgrade
- Towards 10 MeV/u
- A SC linac for REX?



Some Practical News

Operator status
- Didier Voulot (contact person)
- Fredrik Wenander (contact person)
- Richard Scrivens
- Pierre Delahaye

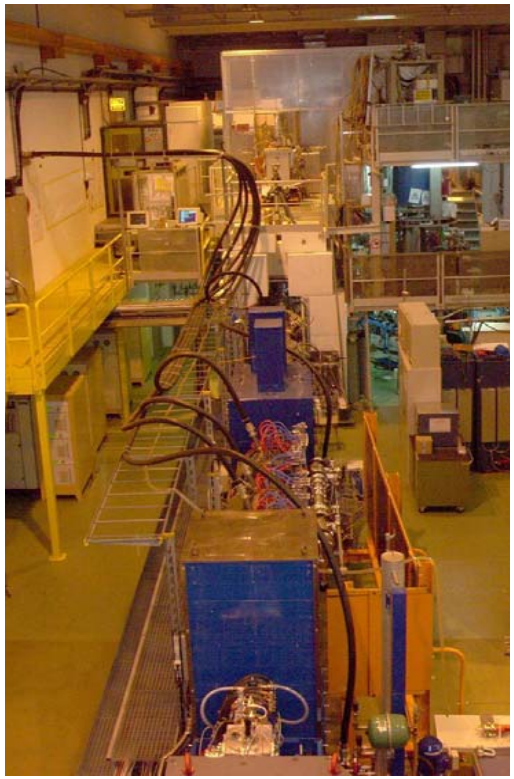
Departed
- Thomas Sieber
- Romain Savreux

For the users:

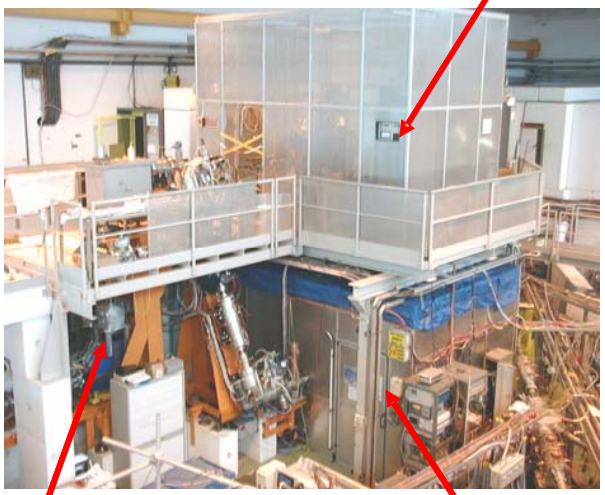
details for each run in the machine, summary found at:
www.cern.ch/ISOLDE (click on REX-ISOLDE, bottom first page)

report from weekly meeting, click on Committees & Meetings

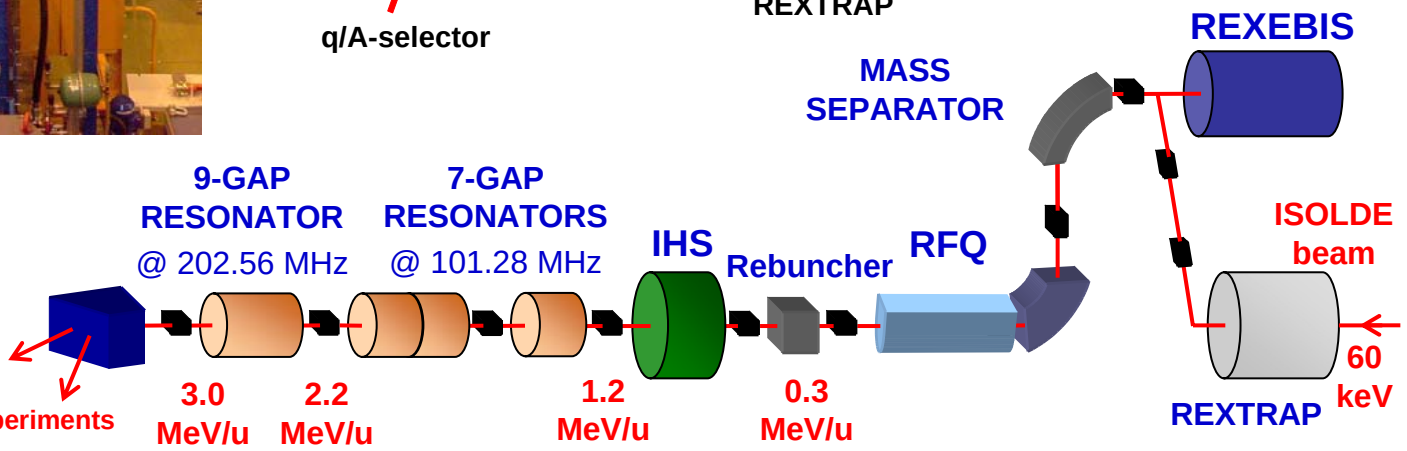
REX-Isolde



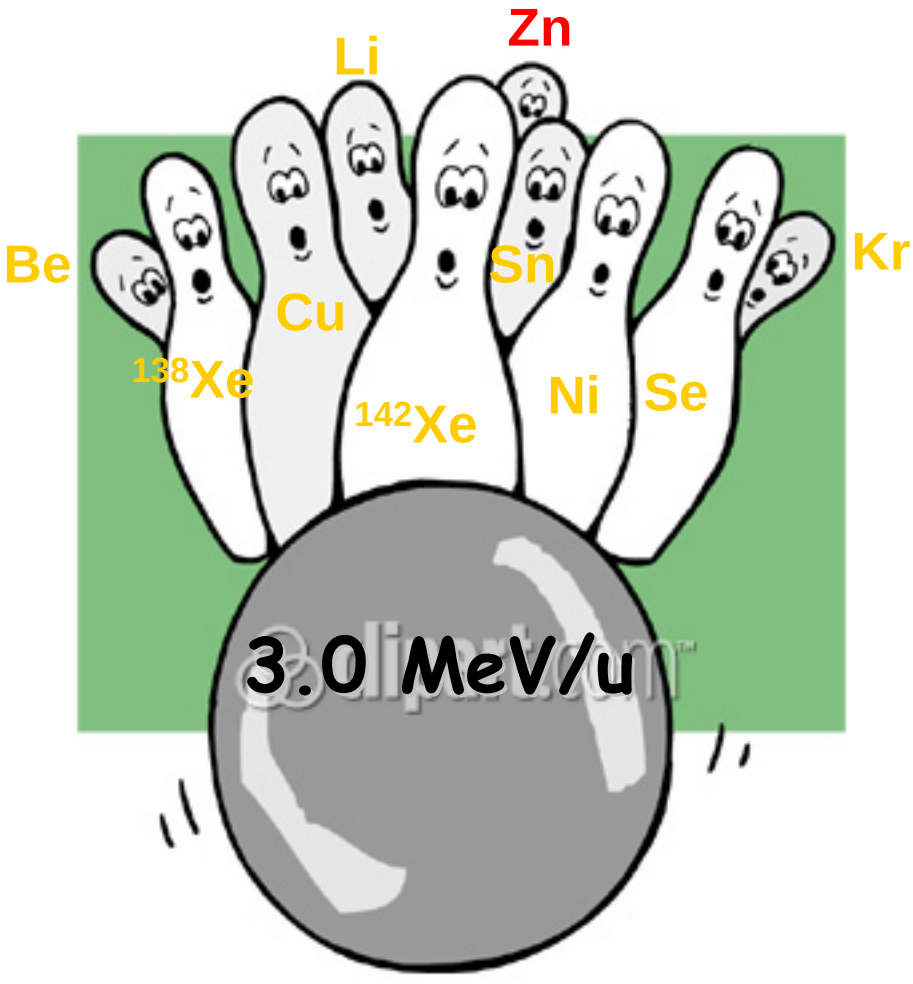
Charge Breeder



Accelerator



2005 Highlights



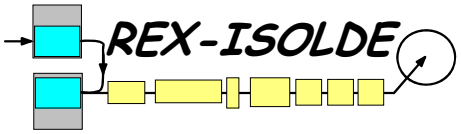
☺ 9/10 successful beam times (accelerated beam delivered to the experiment)

☺ 13 new radioactive isotopes post-accelerated in 2005:
^{11,12}Be, ^{68}Ni, ^{68,69,70}Cu, ^{70}Se, ^{92}Kr, ^{108}In, ^{108}Sn, ^{138,140,142}Xe

☺ Regular efficiencies - trap 40-50%, EBIS 5-10%, Linac 85%

☺ Molecular beam, $^{70}Se^{19+}$, delivered to experiment

☹ Zn run cancelled due to broken RF amplifier



Summary of 2005 – Low Energy Part

Improvements

-High TRAP and EBIS eff, 50% and >5%, respectively

-EBIS -> no interruptions for the complete period of operation

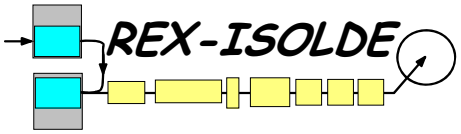
-New Labview based control system for REXTRAP with improved features (R. Savreux)

-REXEBIS solenoid heat leak reduced -> longer LHe holding time

Still to improve

- Move REXTRAP roughing pumps enable higher beam intensities from ISOLDE

-Slow extraction from EBIS up to 1 ms extracted pulse



Summary of 2005 - Linac Part

Improvements

-Machine is getting more stable no interruptions due to power supplies or optics in the last 5 runs

-100MHz RF more reliable (apart from interlocks problems)

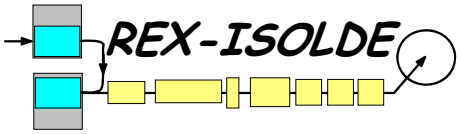
-New control system for Linac RF and beam optics (AB support same CS as ISOLDE)

Still to improve

-Repair/consolidate 200MHz RF amplifier

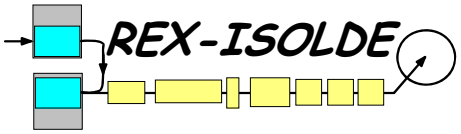
-Improve vacuum control on the experimental beamlines

-New control system for beam diagnostics



REX upgrade

Isolde Workshop 2006
Didier Voulot



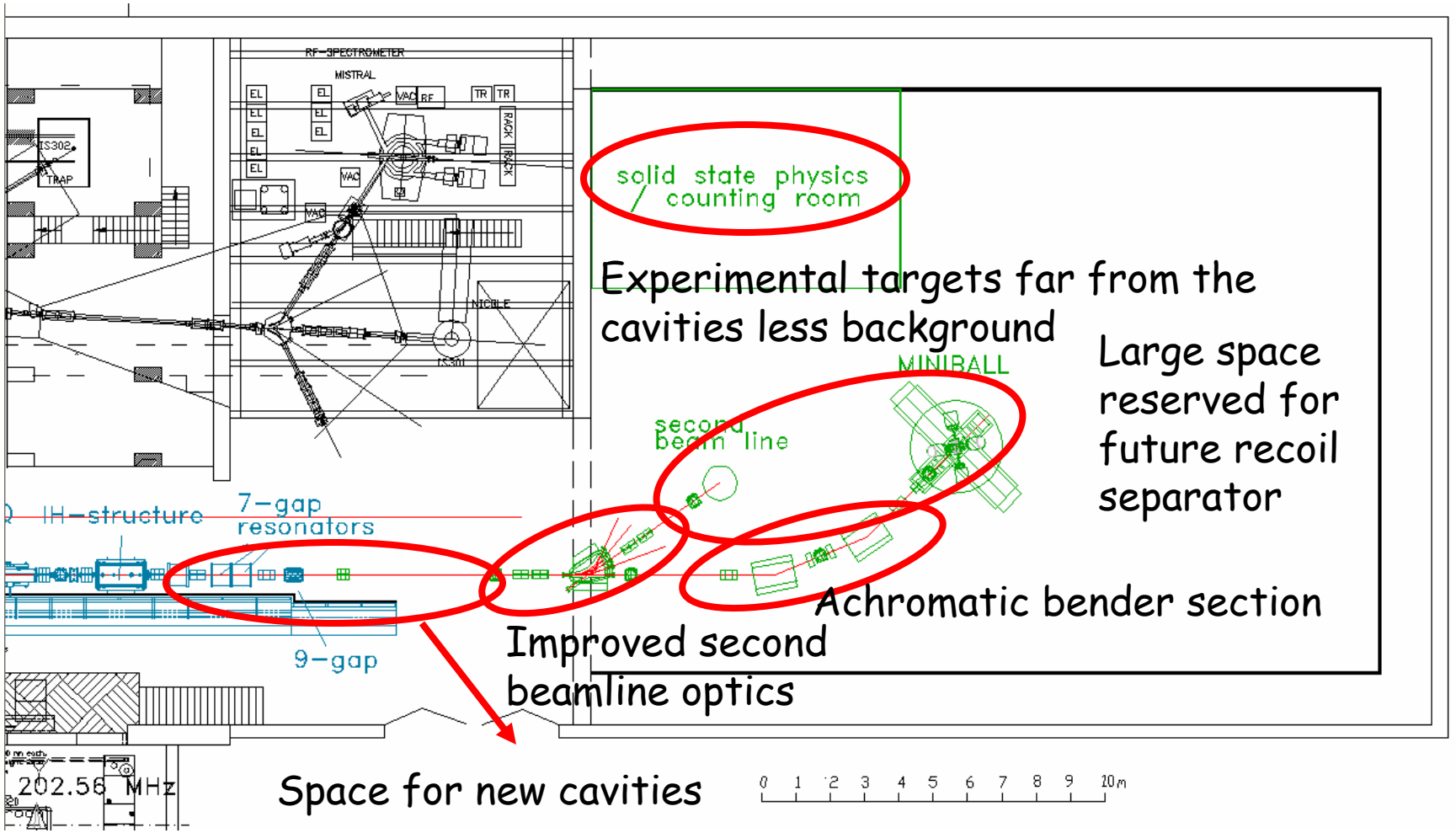
REX upgrade milestones (IH option)

- Mini-move (2006-2007)
  - Move Miniball and the "second beamline" in the new hall
  - Make some space and prepare for the extension of the linac

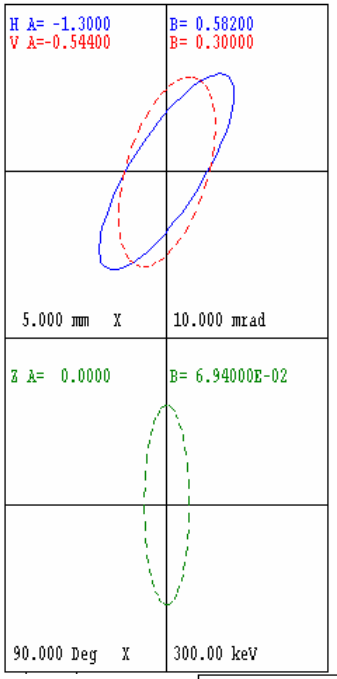
- 5.5MeV/u upgrade (2006-2009)
  - Beam dynamics at 5.5MeV/u (6 months to 1 year)
  - Design of new cavities (6 months to 1 year)
  - Fabrication (1 year)
  - Tests and commissioning (6 months)

- 10MeV/u upgrade (after 2010)

Minimove


RF-SPECTROMETER
MISTRAL
solid state physics
counting room
Experimental targets far from the
cavities less background
Large space
reserved for
future recoil
separator
MINIBALL
second
beam line
IH-structure
7-gap
resonators
9-gap
Achromatic bender section
Improved second
beamline optics
Space for new cavities
202.56 MHz
0 1 2 3 4 5 6 7 8 9 10m

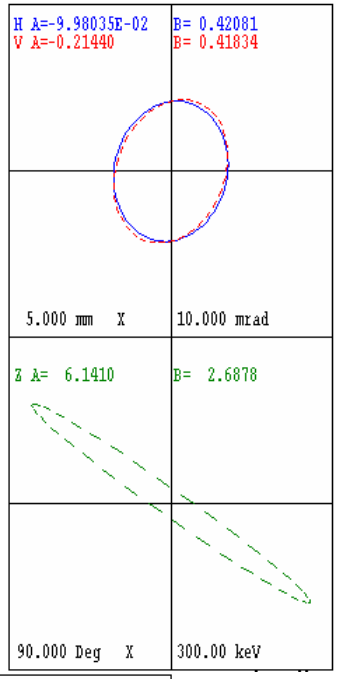
Beam optics Miniball

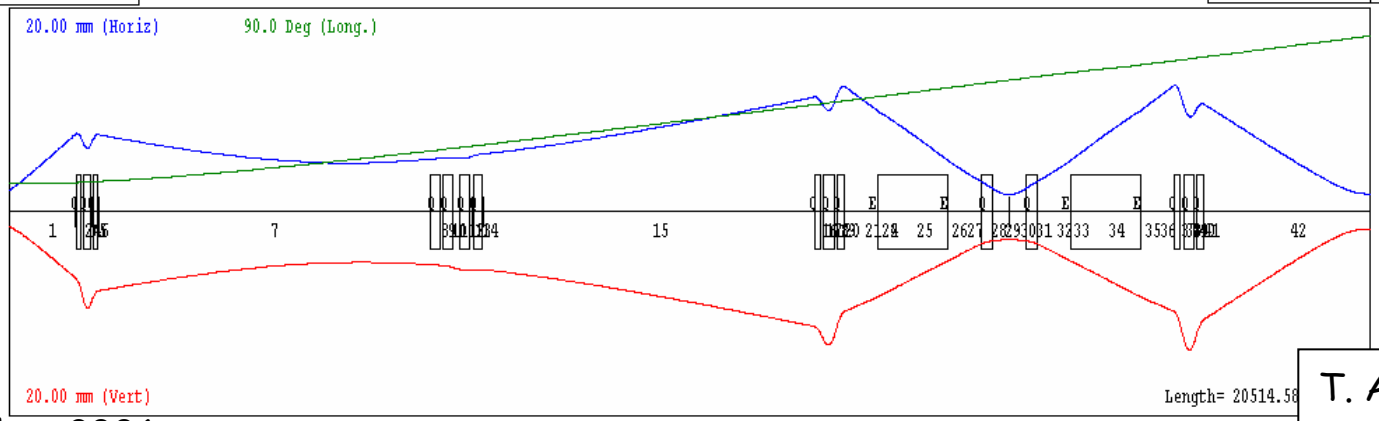


3MeV/u A/q 4.5

Emittance : 0.6 pi.mm.mrad normalised
(Beam filling full RFQ acceptance)
Energy spread: ± 0.5%
Phase spread: ± 12.5°

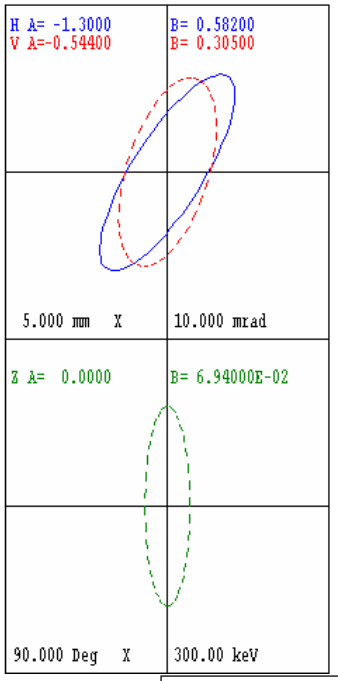
-> emittance growth in bender : < 0.3%
-> Beam spot at exp. target :
3.6mm×3.6mm





T. Aronsson

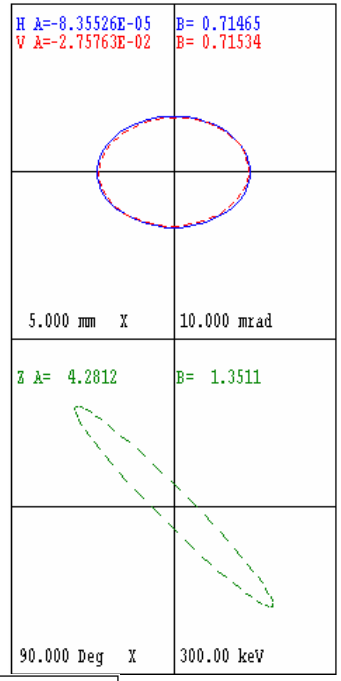
Beam optics Second beamline

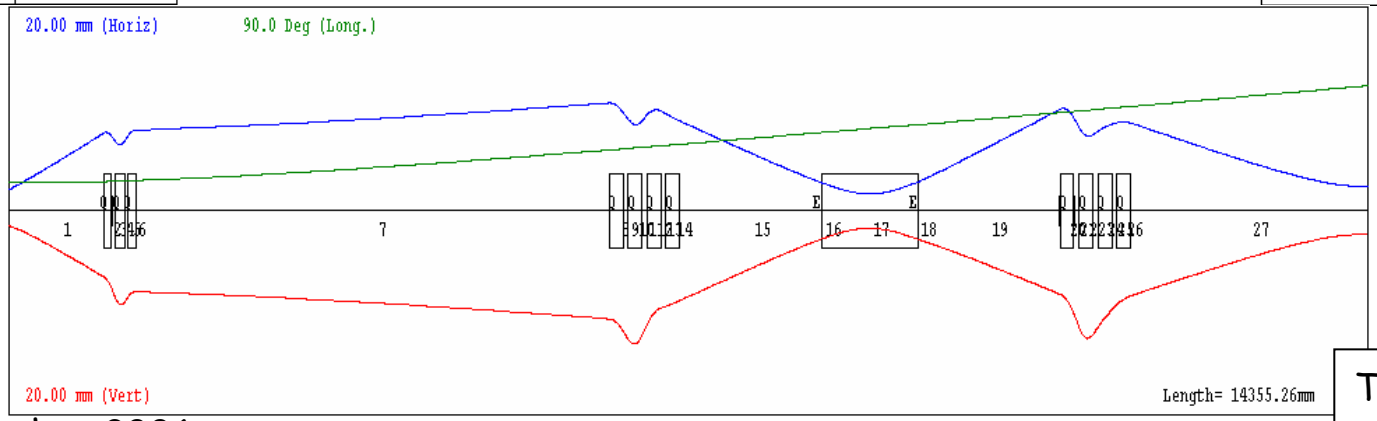


3MeV/u A/q 4.5

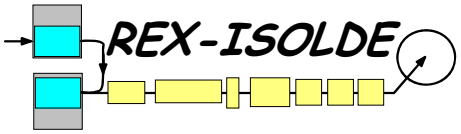
Emittance : 0.6 pi.mm.mrad normalised
(Beam filling full RFQ acceptance)
Energy spread: ± 0.5%
Phase spread: ± 12.5°

-> emittance growth in bender : ~ 5%
-> Beam spot at exp. target :
4.8mm×4.7mm





T. Aronsson



Beam optics Summary

-> Improved beam spot and emittance for both beamlines

-> More focusing elements <-> more flexibility

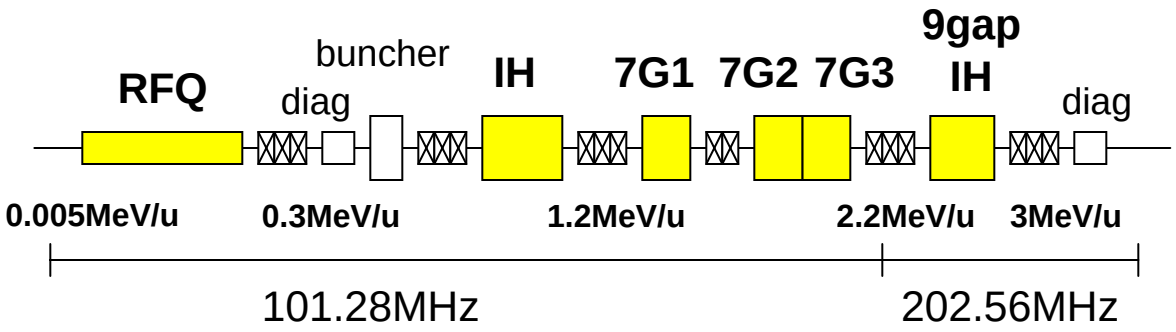
-> Can transport beams at 5.5MeV/u up to A/q 4.5

-> Lower energy beams can also be transported (down to 1.2MeV/u)

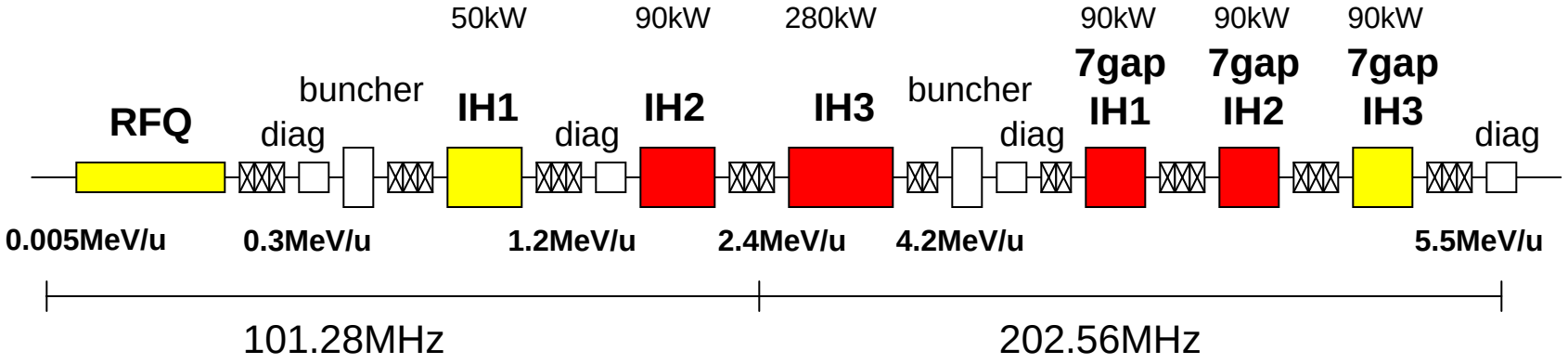
-> Dipoles can bend 10MeV/u beams (A/q 4.5)

-> Use mostly existing equipment and free magnets from GSI

REX upgrade 5.5MeV/u



Present energy range:
1.2-3MeV/u
Upgraded linac:
3.1-5.5MeV/u
2.1-3.1MeV/u (7G->9G)

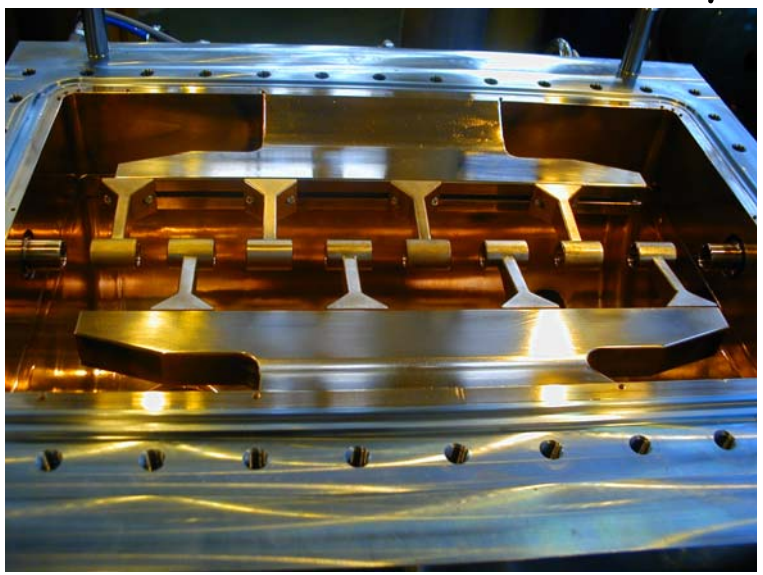


Short rf-Resonators

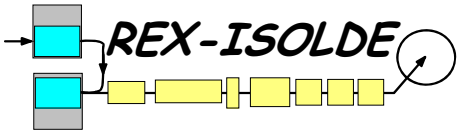
REX 7-Gap Spiral Resonator

Fixed Structure!
f = 101.28 MHz
Zeff = 53 MΩ/m
Q = 5400 – 5600
1,6 MV @ 90 kW

MAFF/REX short IH Cavity



Drift Tube Structure can be changed!
f = 202.56 MHz
Zeff = 100 MΩ/m
Q = 9800
2,1 MV @ 90 kW



rf - Requirements

IH Tank No.	Frequency (MHz)	Length (m)	η_{eff} MΩ/m	P_{rf} (kW)	E. Gain (MeV/u)	V_{eff} (MV)	Amplifier
IH1	101.28	1.5	235	50	0.9	4.1	IH 1
IH2	**101.28**	1.85	190	**90**	1.1	4.8	**SP7G-1**
IH3	**202.56**	165	160	**280**	1.9	8.6	**Linac3**
IH7G-1	**202.56**	0.5	100	**90**	0.45	2.1	**SP7G-2, mod.**
IH7G-2	**202.56**	0.5	100	**90**	0.45	2.1	**SP7G-3, mod.**
IH7G-3	202.56	0.5	100	90	0.45	2.1	IH 9 Gap

Price of the LINAC upgrade in k€

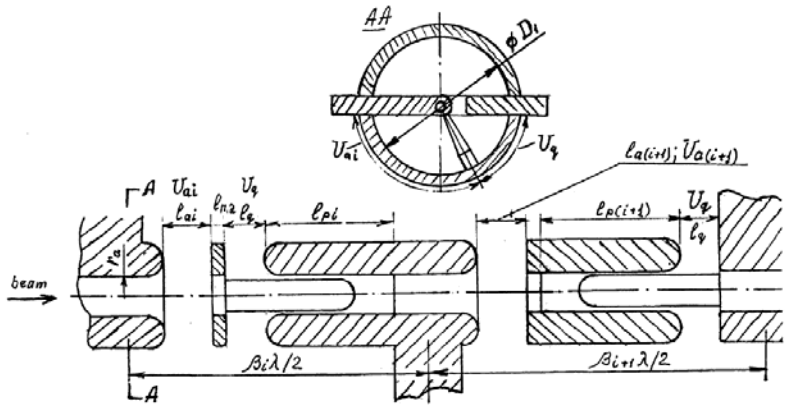
Modification of existing RF Systems

	IH2	IH3	IH 7gap 1	IH-7gap2	IH-7gap3	price of components
rf-Amplifier	0	230	200	200	0	**630**
Low level rf-modules + SIMATIC, crates	0	20	20	20	0	**60**
electronics (vacuum, control, SIMATIC, PCs, ADCs, DACs, Profibus)	0	20	20	20	0	**60**
vacuumsystem (valves, gauges, pumps)	40	40	20	20	10	**120**
tuning plungers, structure	10	15	10	10	5	**45**
resonator tank (material and production)	150	150	90	90	0	**480**
cooper plating (tank, structure)	15	20	15	15	0	**65**
support stands	5	5	5	5	5	**20**
magnetic lenses+power supply	50	50	50	50	0	**200**
price of the structures	**270**	**550**	**430**	**430**	**20**	**1680**

10 MeV/u

- 5.5MeV/u with IH + RFQ-DTL
  - 5.5 to 10 MeV/u
  - IHEP Protvino (ISTC)
  - Tentative design ready

  but
  - No energy variation



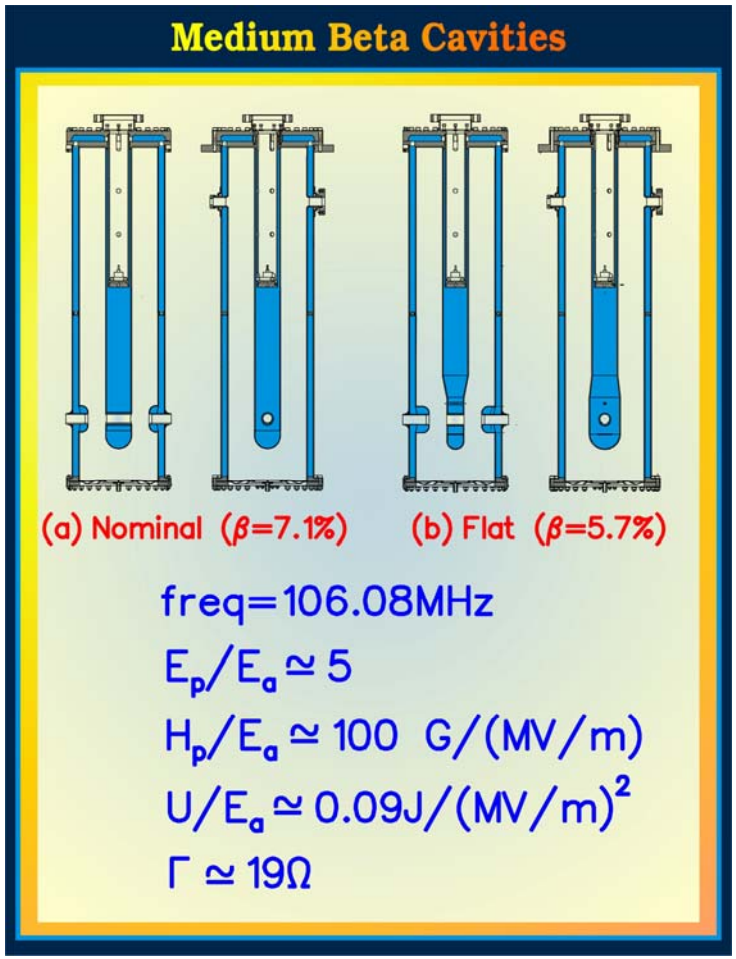
- Superconducting linac from 5.5 to 10MeV/u

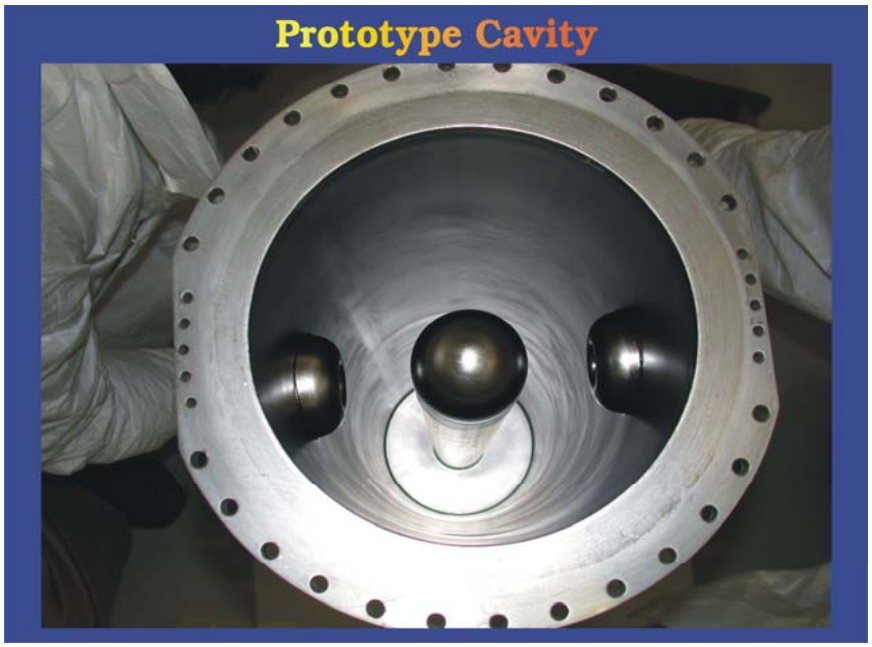
- Superconducting linac all the way from 1.2MeV/u to 10MeV/u!!!

Superconducting linac for heavy ions?

- SC linac = Array of small independent resonating cavities, equipped with their own small power amplifier (<1kW).
- Small cavities -> wide velocity acceptance : large range of A/q ratio can be accelerated very efficiently
- They provide very high field at c.w. operation with little power consumption.

State-of-the-art SC cavities used for radioactive heavy ions accelerators





$E_{acc}T$= 6MV/m over a length of 18 cm

= 1.08 MV @ 7W power dissipation on LHe.

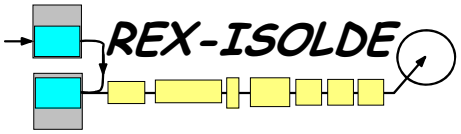
Courtesy of B. Laxdal, TRIUMF

Some reason to go SC

- Higher flexibility
- Possibility of having large aperture -> very high transmission
- Effective voltage always available, so lighter ions can be accelerated to higher energy
- CW operation possible (ECR charge breeder)
- CERN infrastructure (chemical polishing, clean room, cryogenic plant)
- In the last years, SC linac demonstrated their reliability and all the new planned facilities foresee SC post-accelerators (EURISOL)

"Back of the envelopes calculation"

- Energy upgrade from 1.2 to 10 MeV/u for a A/q=4.5 means an effective voltage of 39.6 MV
- Assuming 1 MV per cavity 40 cavities are needed
- Cryostats 2 meters long can contain 4-5 cavities, (depending on the focusing scheme) so 10 MeV/u can be reached in 20m



Outlook

Minimove
- 2006 installation of the extended beamlines and preparation work for the linac upgrade (power, cooling, infrastructure)
- Shutdown 2006/2007 move Miniball and second beamline
- 2007 runs at 3MeV/u in the new hall

Linac

->review of linac technolody : 1st May 2006

If IH option :
- Shutdown 2007/2008: Installation of the first cavities of the 5.5Mev/u
- 2008 runs at 4.2MeV/u with cavities that do not need RF modifications
- Shutdown 2008/2009 finish installation of cavities for the 5.5MeV/u linac
- 2009 first runs at 5.5MeV/u

If SC linac all the way :
-> a bit more time and money
-> but much more possibilities