A Revised Dedicated β-beam Linac concept

presented by

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Involved key persons:

H. Podlech, U. Ratzinger, A. Schempp

Outline

- Review on our 1st order β-beam linac concept
- General changes required to do 64 mA ^{8}Boron
- Coupled CH-Cavities
- Some remarks on RFQ design
- Conclusion / Outlook

Former starting point

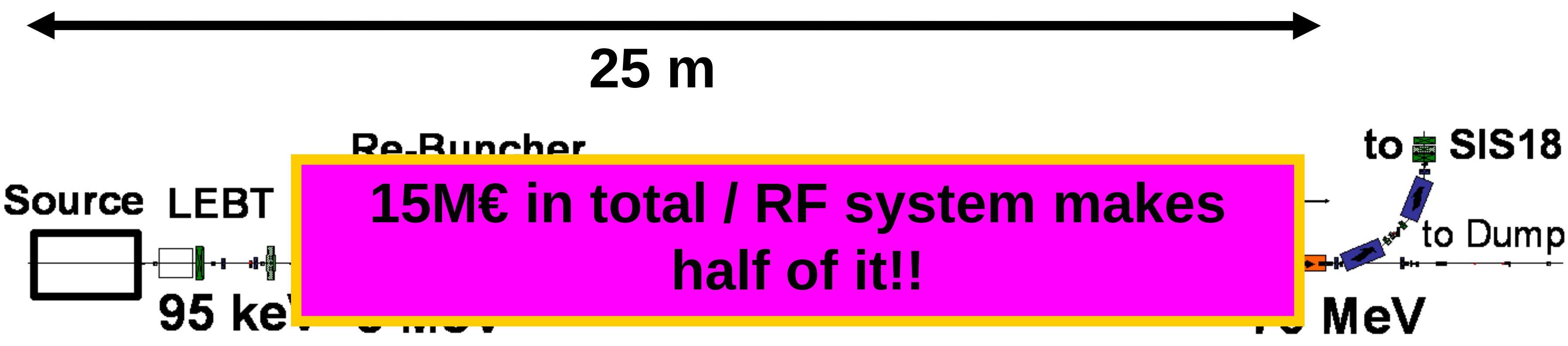
input energy	8 keV/u
Final energy	100 MeV/u
mass to charge ratio	≤ 3
duty cycle	0.05 %
beam current	50 mA
Input emittance (rms, normalized)	0.2 π mm mrad
momentum spread $\Delta p/p$	10^{-4}

First conclusions from that:

beam loading quite high (above 200 kW/cavity assuming at least 4 MV gain each pulsed) $\rightarrow$ normal conductivity. So one would need big Klystrons anyhow.

Operating costs are cheap at r.t. due to low duty cycle (very small thermal loads).

In comparison: FAIR - Facility for Antiproton and Ion Research



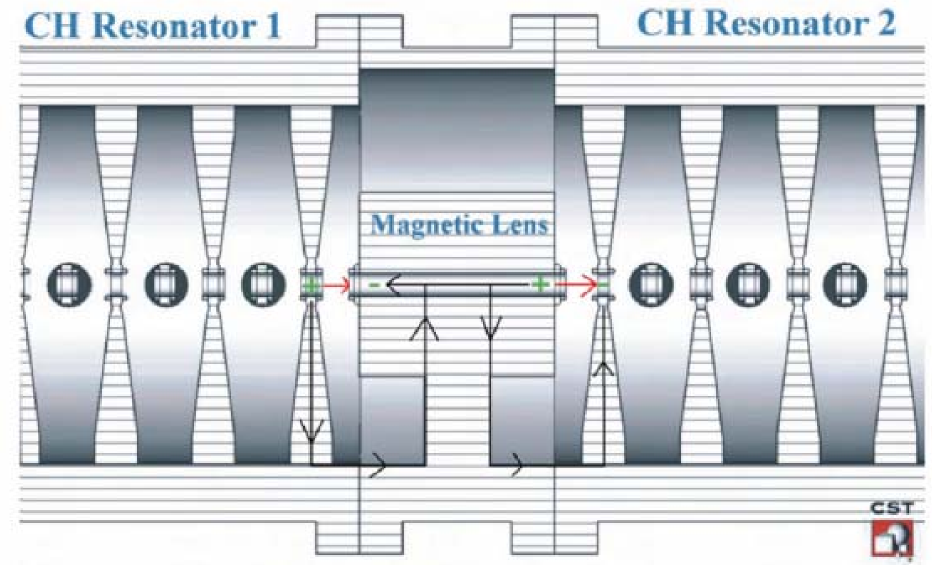
15M€ in total / RF system makes half of it!!

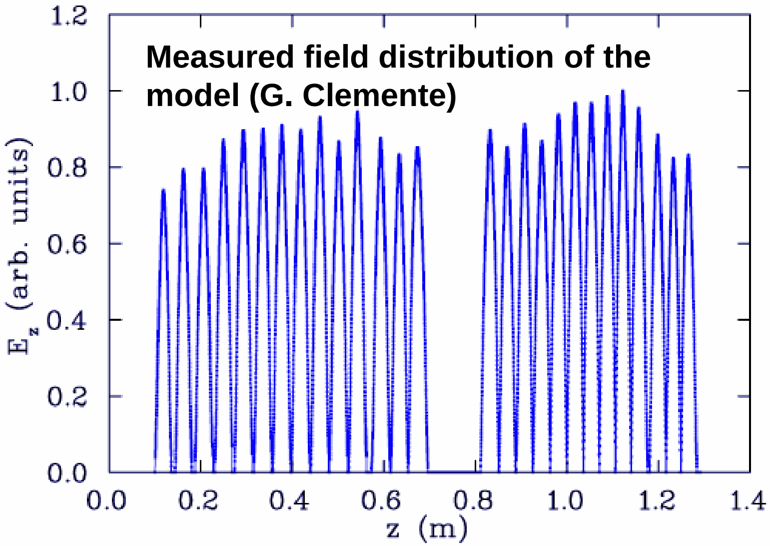
Particles	Protons	RF drivers (6x)	2.5 MW Klystrons
Current (mA)	70	Puls power (MW)	4.9
Energy (MeV)	70	Beam pulse length (μs)	36
Frequency (MHz)	325.224	Repetition rate (Hz)	4
RF structures (6x)	r.t. CH	Linac length (m)	25

High gradients (3-7 MV/m), low duty cycle → r.t. CH-structures

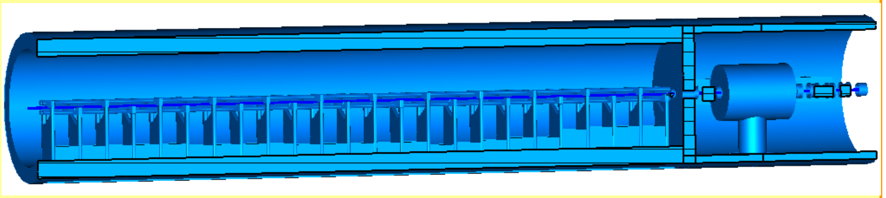
real estate gradient = 2.8 MV/m

Coupled CH-Cavities





Coupling of 4-rod RFQ and IH-structure for FRANZ



MWS simulations by H. Liebermann

A dedicated normal conducting β-beta beam linac concept (paper at EPAC06)

EURISOL Design Study

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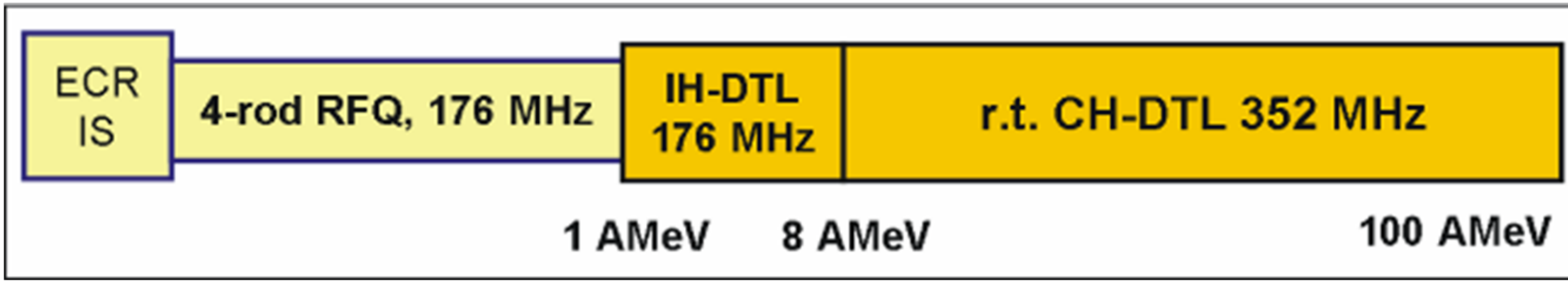
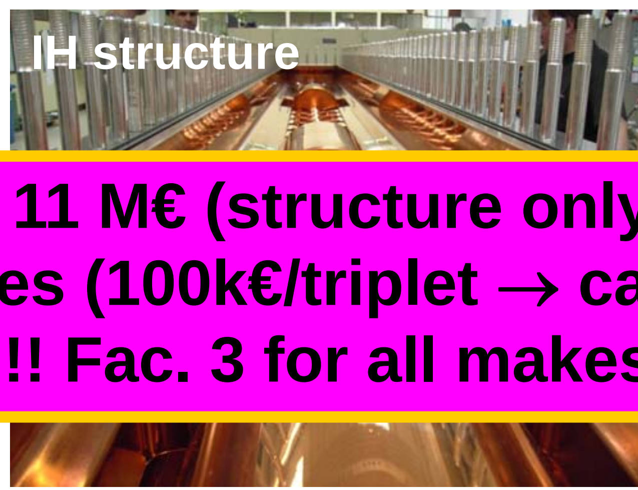
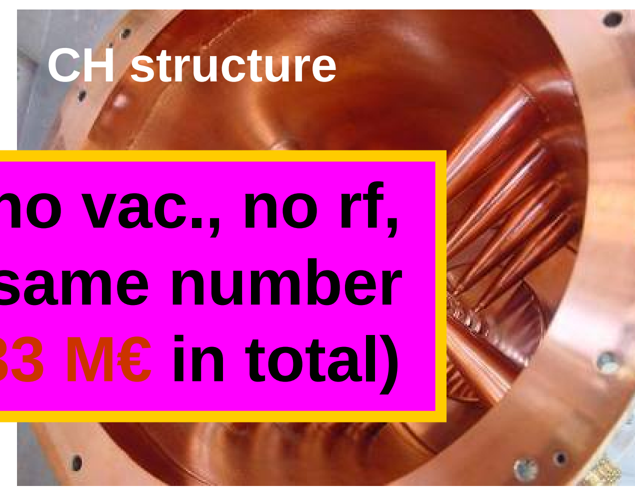


about 110 m.

real estate gradient = 2.73 MV/m

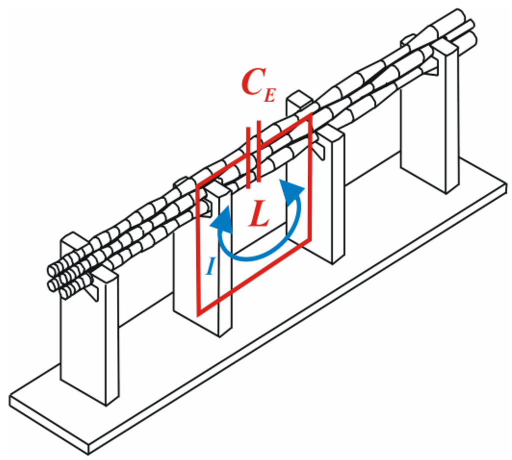




- **Costs: 11 M€ (structure only, no vac., no rf, no lenses (100k€/triplet → ca. same number as cav.!!! Fac. 3 for all makes 33 M€ in total)**

Comparison of the 4-rod and the IH RFQ structures

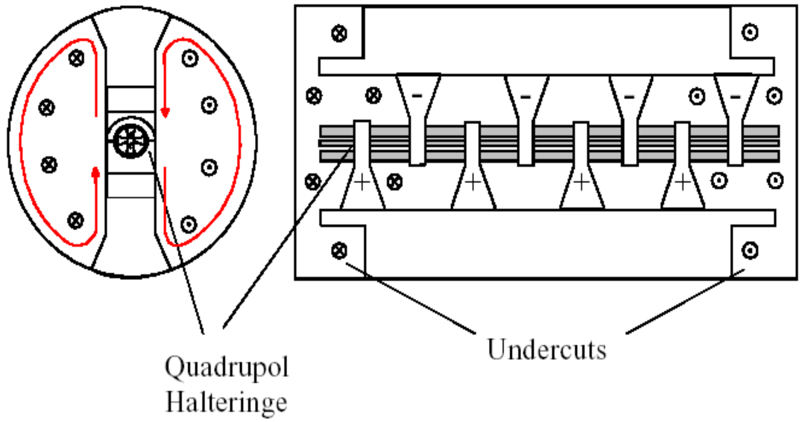
Scheme of the 4-rod RFQ



Advantages:

easy mechanical accessibility - cheap production of parts - lots of RF tuning opportunities (Flatness), thermal expansion in only one direction.

Scheme of the IH RFQ

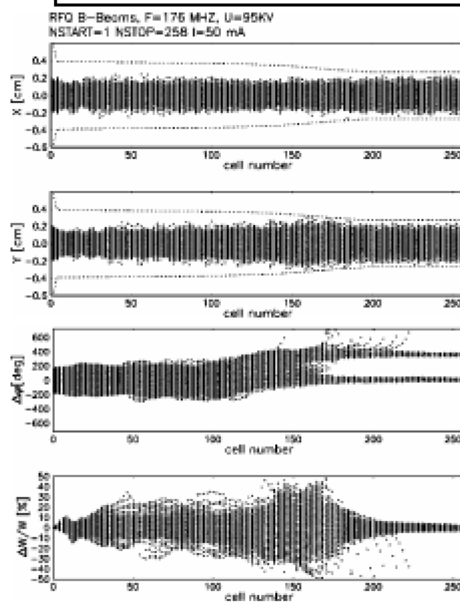


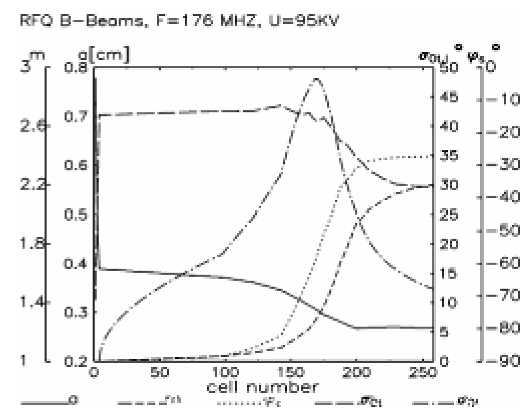
Advantages:

less power consumption - advantageous power dissipation on electrodes (10% inst. 30%) - less dipole - easy adjustment.

A DEDICATED β-BEAM RFQ CONCEPT

DEDICATED β-BEAM RFQ PARAMETERS	
length l	275 cm
frequency f_0	**176 MHz**
mass to charge ratio A/q	≤3
input energy W_{in}	8 keV/u
output energy W_{out}	1 MeV/u
electrode voltage V_{el}	95 kV
input emittance total	50 mm mrad **(?)**
transmission T (50 mA for A/q =3)	97%





http://linac-world.de
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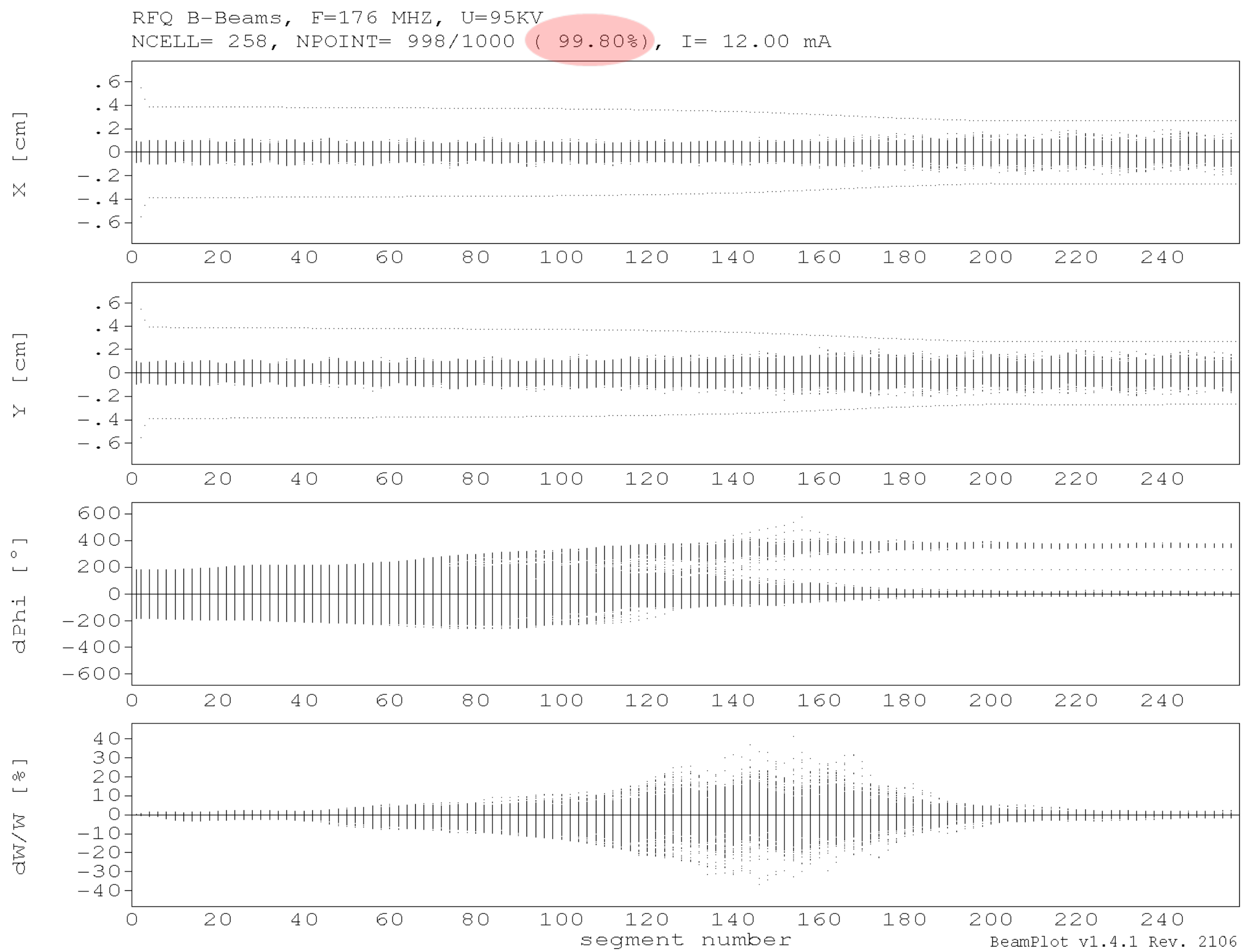
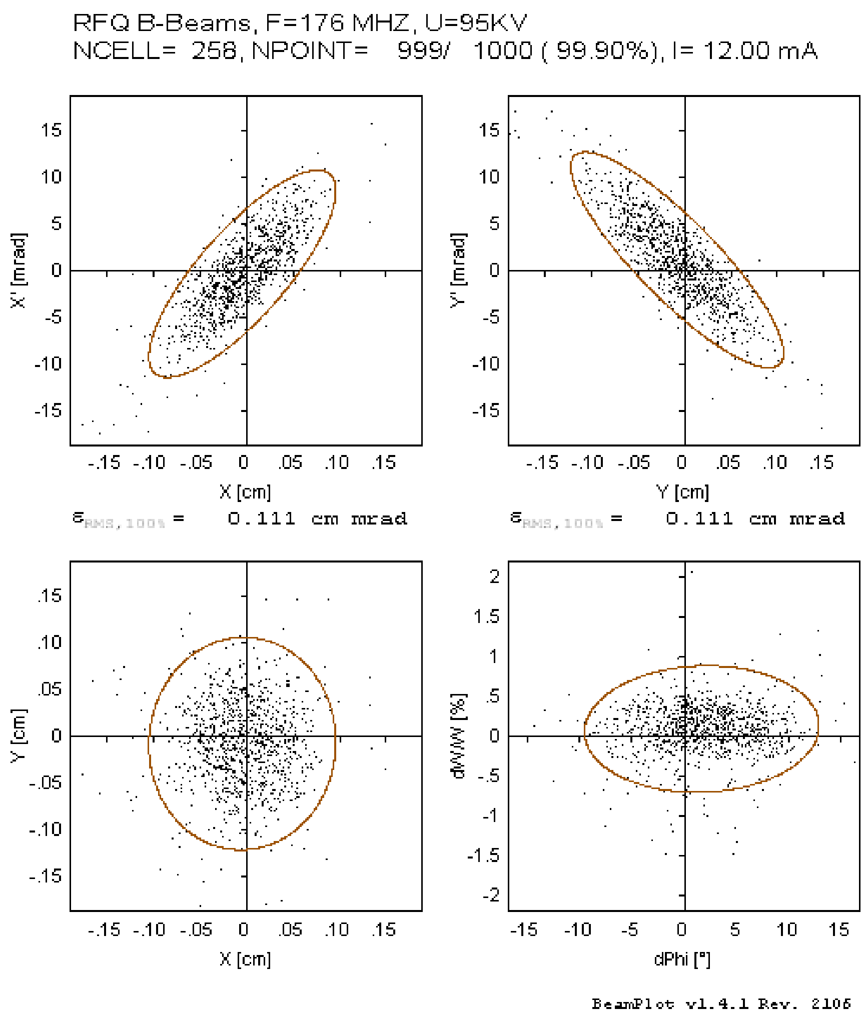
($^{6}He^{2+}$) A/q = 3 @ 12 mA, U(el.) = 95 kV



Output for $^{6}He^{2+}$ @ 12 mA



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(^{18}Ne) A/q = 1.8 @ 18 mA, U(el.) = 57 kV

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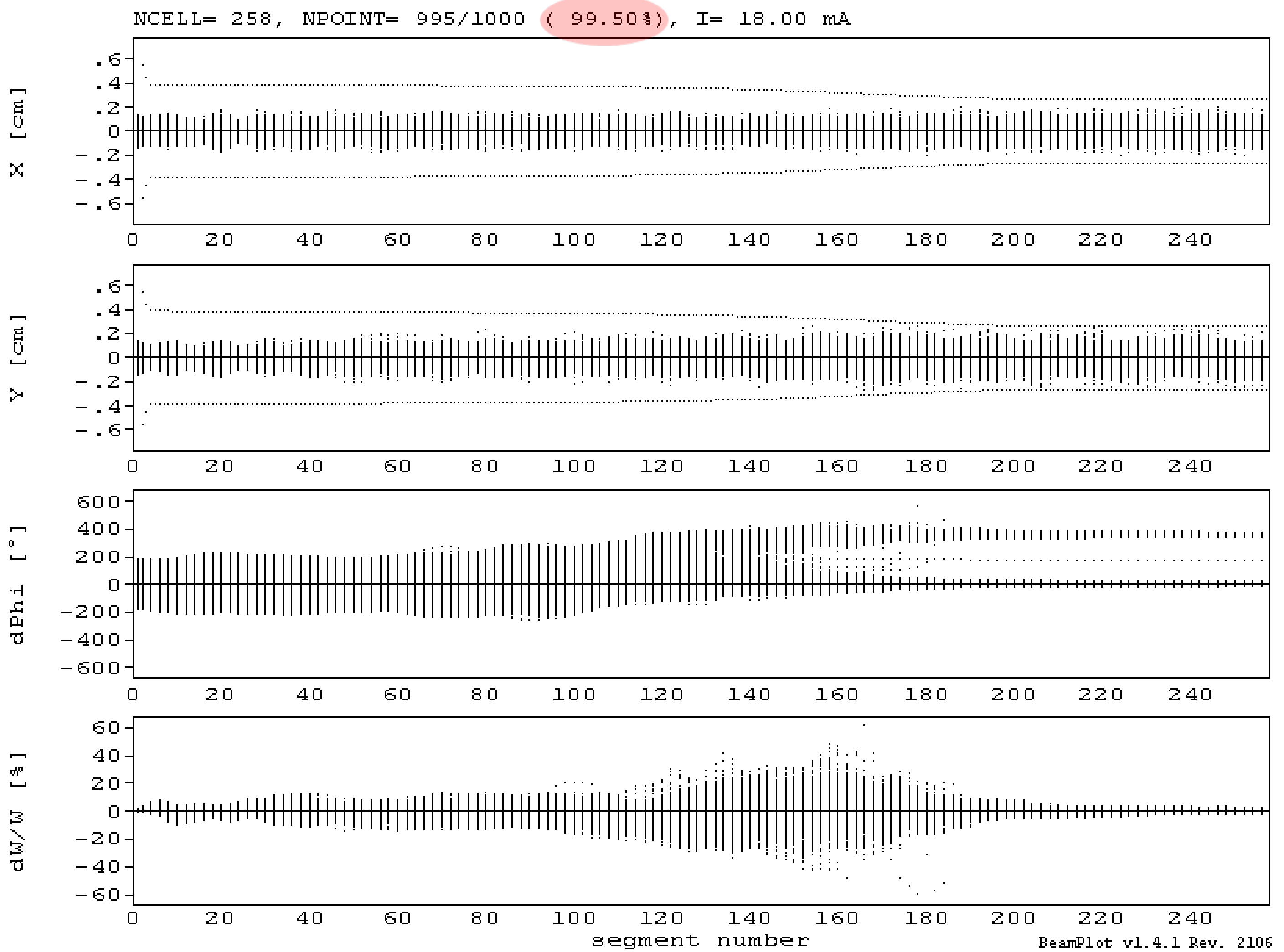
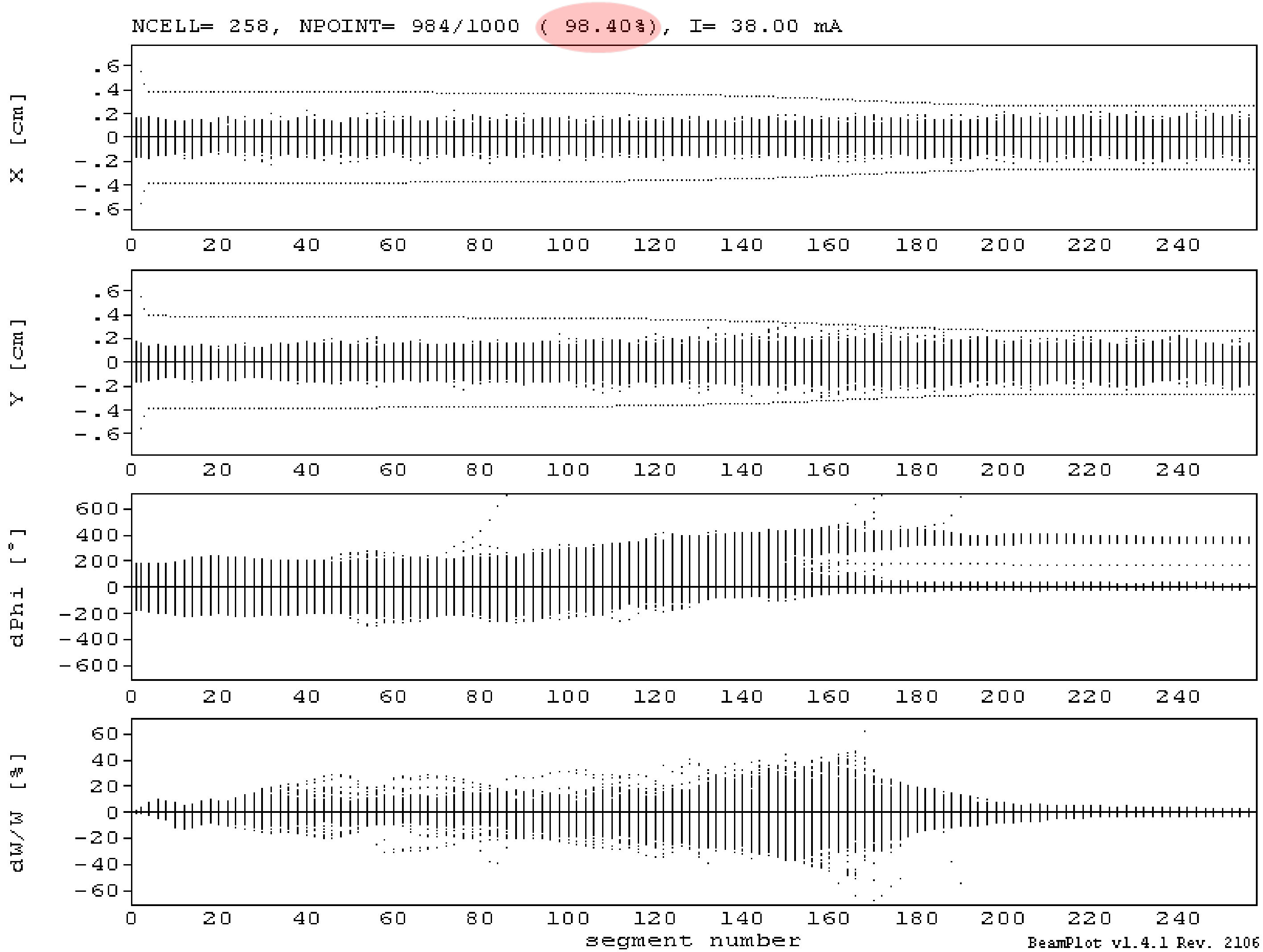
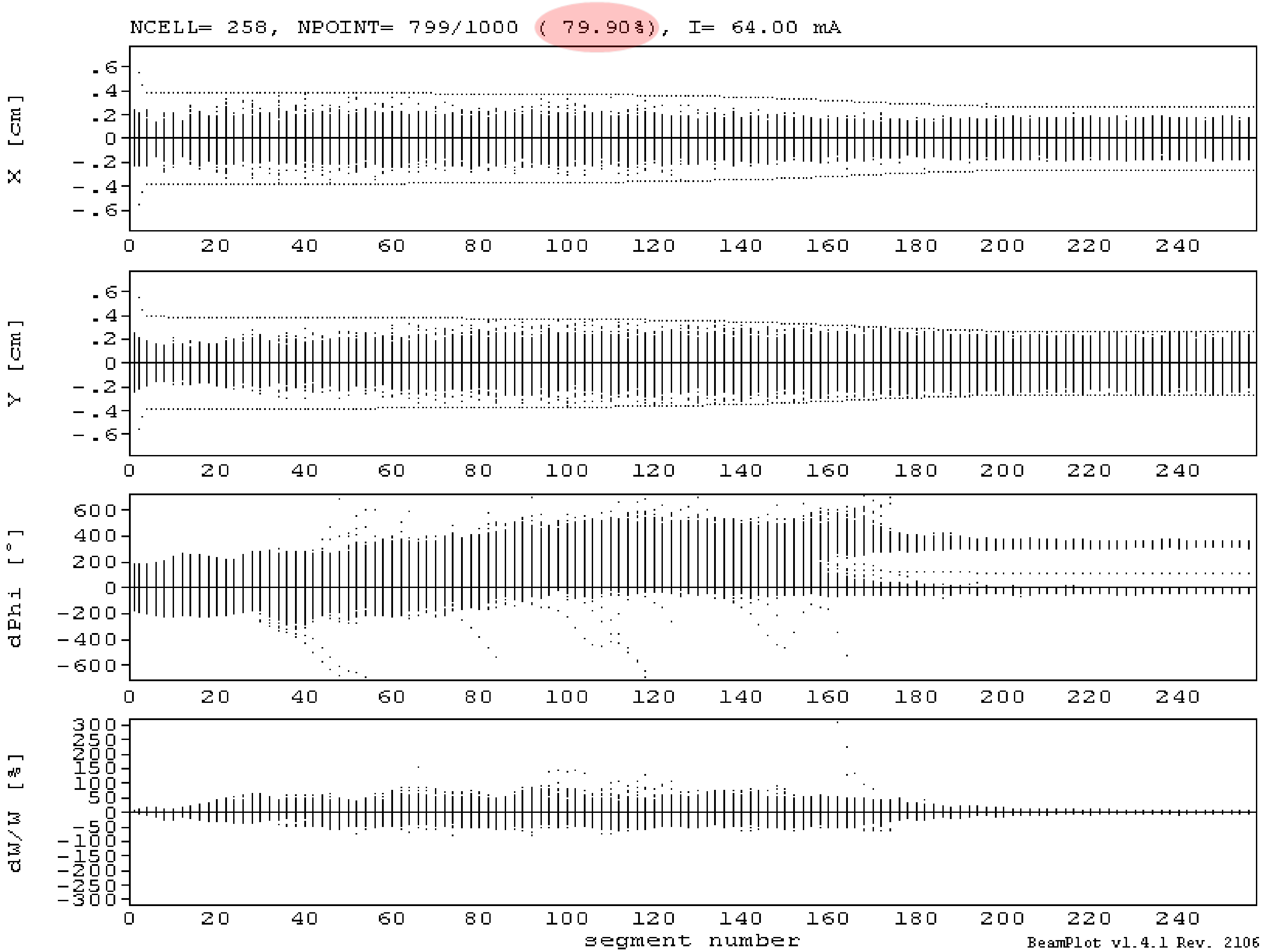


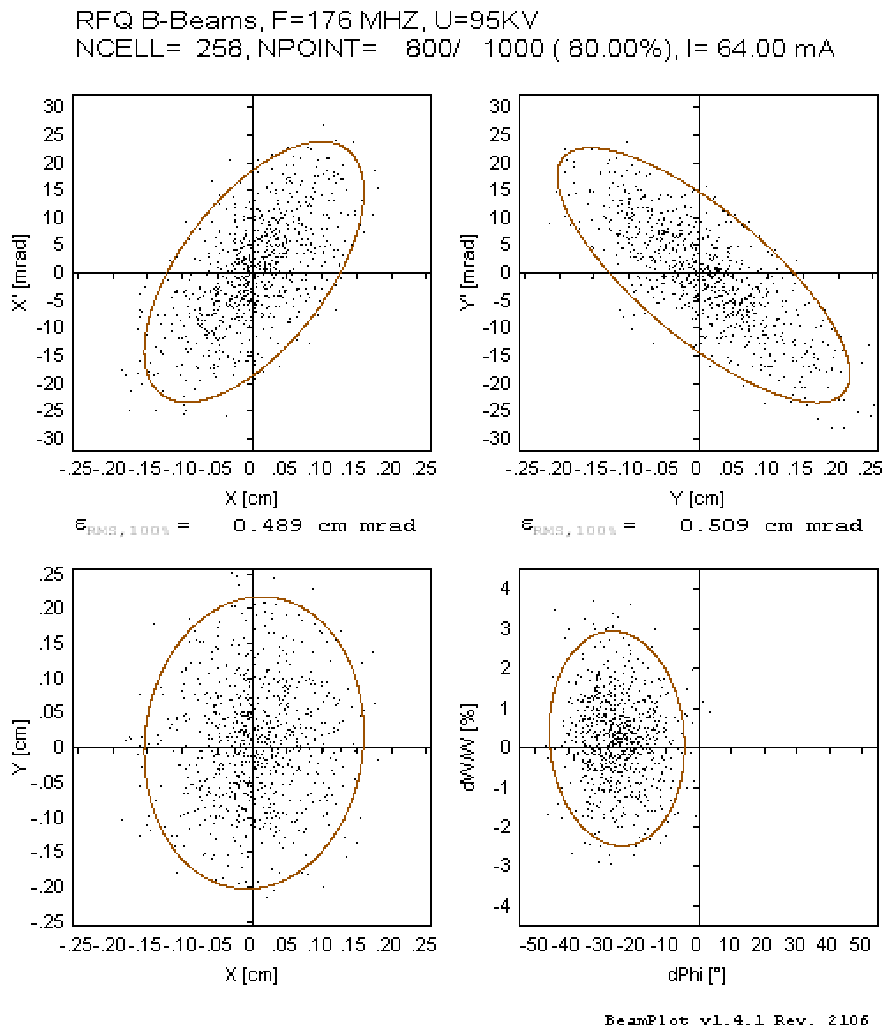
($^{8}Li^{3+}$) A/q = 2.7 @ 38 mA, U(el.) = 84.4 kV



(^{8}B) A/q = 1.6 @ 64 mA, U(el.) = 76 kV

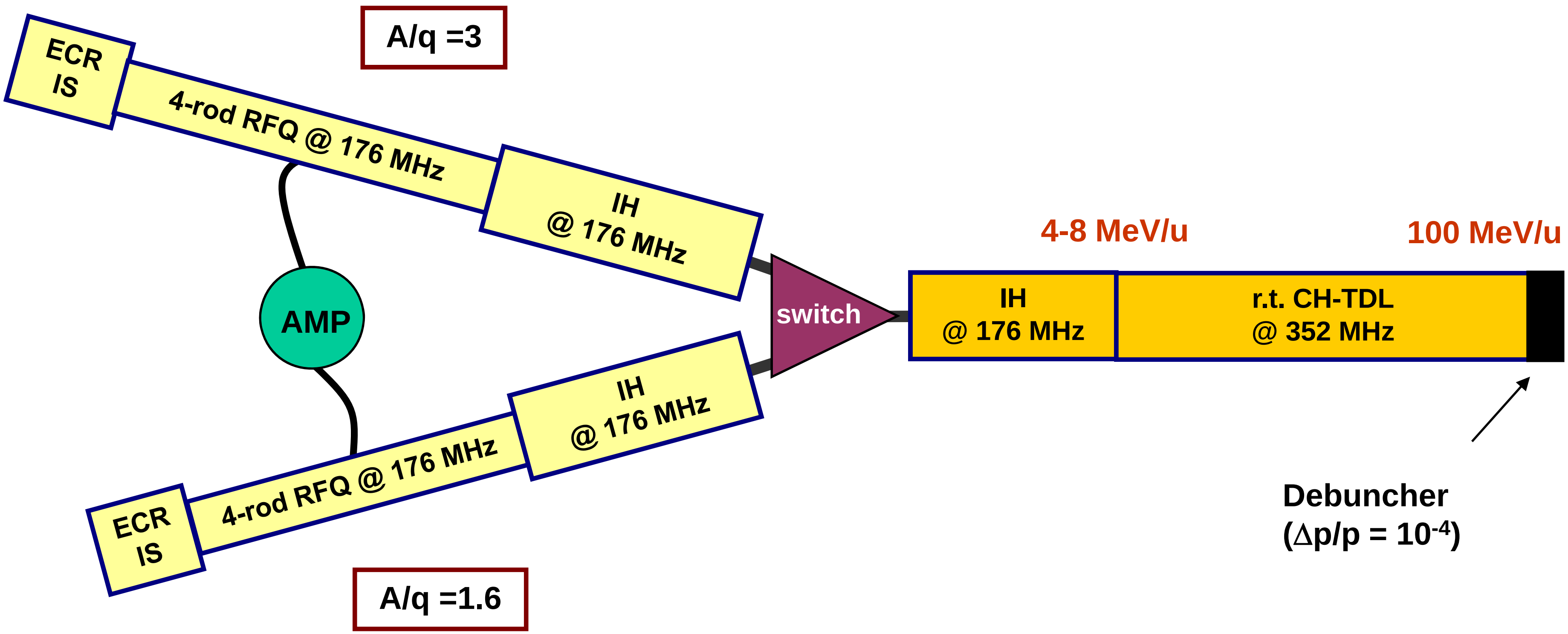


Output for $^{8}B^{5+}$ @ 64 mA



➡ $\Delta p/p = 10^{-4}$?

Suggestion: A Doubled pre-Injector!



Conclusions

- Going down with A/q by a factor 2 decreases the beam current limit by approximately the same factor.

- One has to check if the introduction of a second injecting sequence at the beginning of the Linac would be reasonable. Especially in order to guarantee $\Delta p/p = 10^{-4}$.

- What emittances would one expect from the ion source e.g. after the LEBT at the RFQ entrance?

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