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Arbeitsnotiz	**Nr**: IAP-ACCC-140907
BNL IH Cavity: X-Rays, RF power, Sub Frame, Plungers	
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1. Introduction

According to the phone conversation held on 23rd of August 2007 this note gives answers to the questions which were discussed.

2. Estimate of X-Ray levels around the cavity.

The cavity has design gap voltage amplitudes close to 600 kV. This can be compared with measurements on tank 2 of the CERN LINAC 3 at a level of 548 kW rf input power. At 1 Hz, 200 µs flat top operation the results from measurements are the following:

Table1: Measured X-ray radiation levels at 1Hz, 200 µs operation of tank2, CERN LINAC3; gap voltages comparable with BNL – case [1].

2 mSv/h	**maximum level**	**spot on tank surface**
200 µSv/h	**in 0.4m distance**	**from surface in horizontal dir.**
40 µSv/h	**in 1 m distance**	**from surface in horizontal dir.**
4 µSv/h	**in 4 m distance**	**from surface in slight backward dir.**

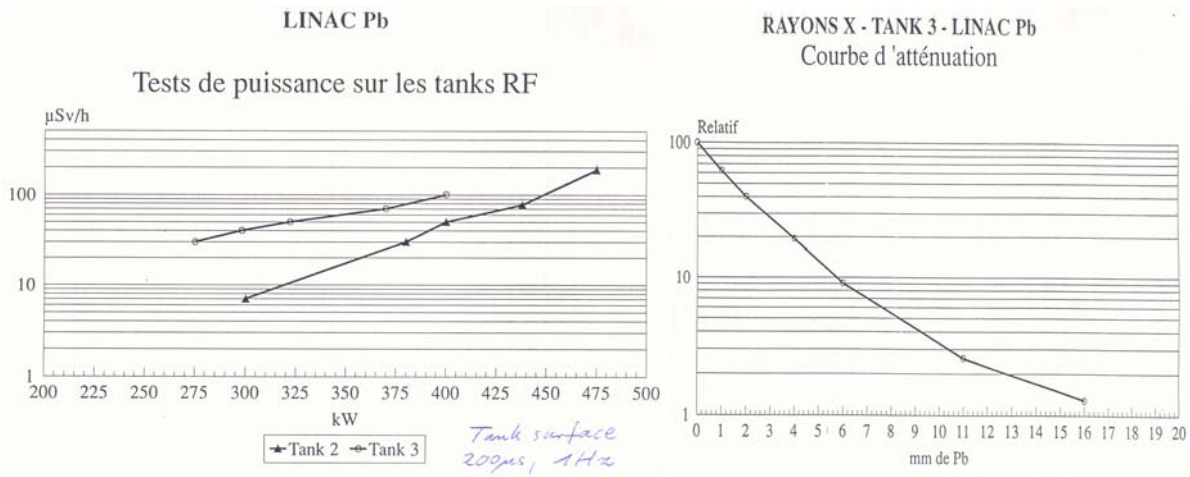

Fig.1: Left :Radiation levels on the surface of CERN LINA3, tanks 2 and 3. The BNL-design operation field level will correspond to an rf power near 600kW [2].
Right: Radiation shielding by lead sheets in front of the detector at 400kW in tank3, corresponding to gap field amplitudes around 500 kV.

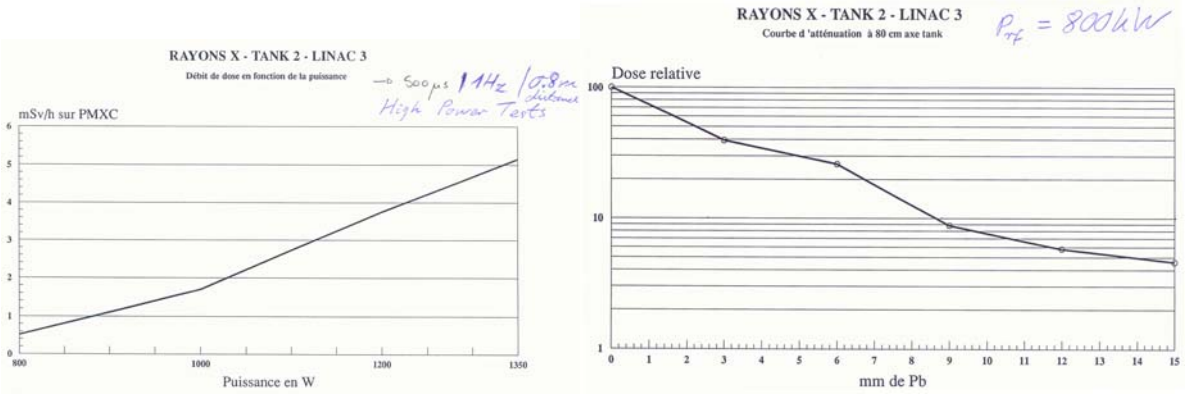

Fig.2: Left:High power RF test at CERN LINAC3 tank2 far above design levels [3].
Right: Radiation shielding with lead sheets at an rf power level of 800 kW, corresponding to gap field amplitudes around 700 kV in tank2 [4].

These measurements were made with a PMXC type ionization chamber. Further measurements were taken around the cavity surface mainly by TLD´s. From the measurements with lead shielding it can be deduced, that 7 mm thick lead will reduce the radiation level by one order of magnitude at EBIS-linac design voltage levels. If one assumes 5 Hz operation at 1 ms flat top one would reach a factor 25 higher X-ray levels than given above.
Wall thickness of CERN LINAC 3 tank 2, upper and lower half shell:
9 mm steel and 6 mm copper.

Planned for BNL-IH cavity half shells:
50 mm steel, rectangular cross section like used for the Med-IH for Heidelberg.

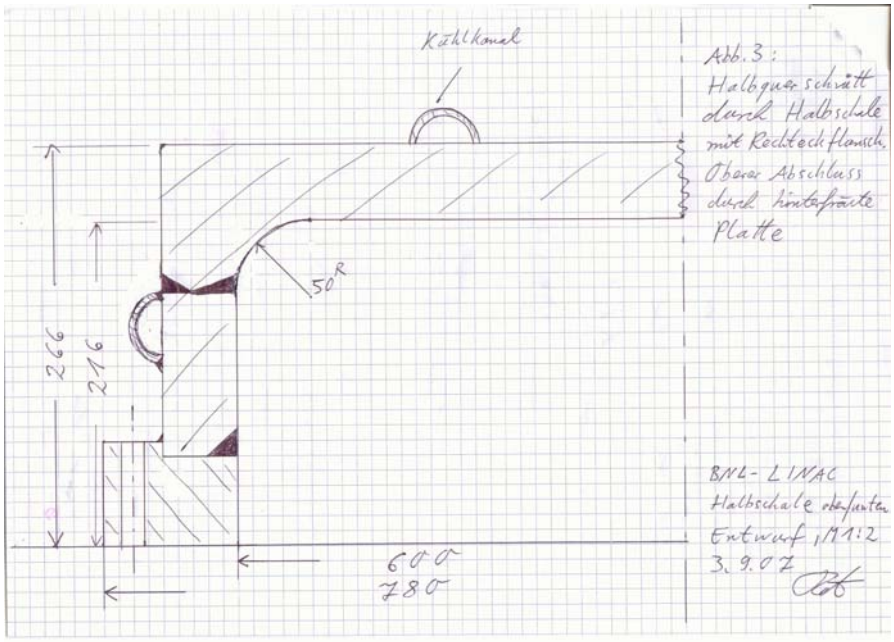

Fig.3: Sketch of the half sectional cross section of the upper half shell. The wall is 50 mm thick. Water cooling is provided by three waterpipes along the half shell.

This should give a reduction of around a factor 25 – 50 against the CERN case. So I would expect, that the radiation levels as given in the table above could be reached at BNL at 5 Hz, 1ms, design rf level operation. That means 200 µSv/h in a distance of 0.4 m

from the tank walls. Furthermore, it is assumed that reduction of the flat top down to 200 µs would still guarantee full performance as the requested beam pulse for synchrotron injection is much shorter. This would certainly bring the X-ray levels further down.

3. RF Power requirement

The rf parameters can easily be deduced from experimental data known from previous projects like the GSI High Charge State Injektor GSI-HLI (108.4 MHz) or the CERN LINAC3 tank1 (101.28 MHz).

Table 2: Key data of the BNL-IH-cavity

Energy range	0.3 – 2.0	AMeV
A/q-ratio	6.2	
length	2.25	m
Q-value	21000	
Total no. of rf periods	17	
RF periods for lenses	4	
Z – reduction factor F	0.58	

This results in an effective shunt impedance

$$\mathbf{Z_{eff} = 253\ M\ \Omega/m}$$

when comparing and scaling to measured tank parameters.
The needed rf power is then given by the formula:

$$P_{rf} = \frac{V_{gain}^2}{Z_{eff} \cdot l};$$

With V_{gain} = 10.6 MV and at a tank length of 2.25 m we get then:

$$\mathbf{P_{rf} = 198\ kW.}$$

4. Tank sub frame

The fully equipped tank mass is expected to be about 3000 kg. To get long term stability and robustness, it is suggested to use the concept of a welded steel construction from rectangular or quadratic hollow profiles with transverse dimensions around 100 mm, like documented in the figures (218 MHz IH-cavity, 3.7 m long).

Fig4: Sub frame of an IH structure. This construction was extended longitudinally to support the MEBT at the entrance (left). The used profile is quadratic, hollow 80 mm width; beam axis 1.4 m above ground.

The mechanical adjustment is provided by four standard adjusting devices on ground level, allowing for correcting in all three directions. The cavity would be fixed by screws onto the sub frame.

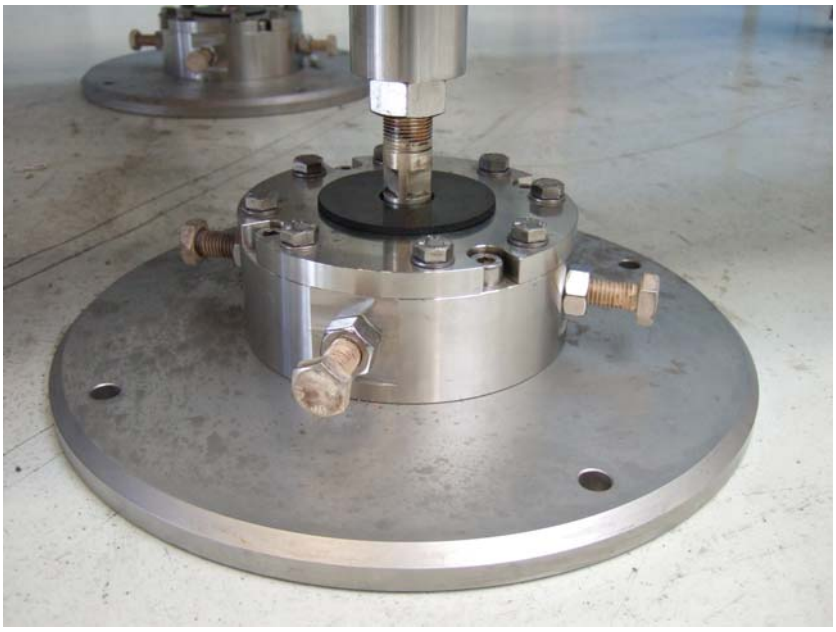

Fig 5: Adjusting foot on ground floor.

5. Plunger drives

A standard was developed during many years, which is mounted on a CF 63 flange, and is in operation at several IH-cavities and RFQ´s. The mechanical variation is about ± 50 mm, the absolute positioning within the cavity can be defined by the final layout of the plunger body, made from massive copper. Photos show a plunger drive mounted on an IH cavity.

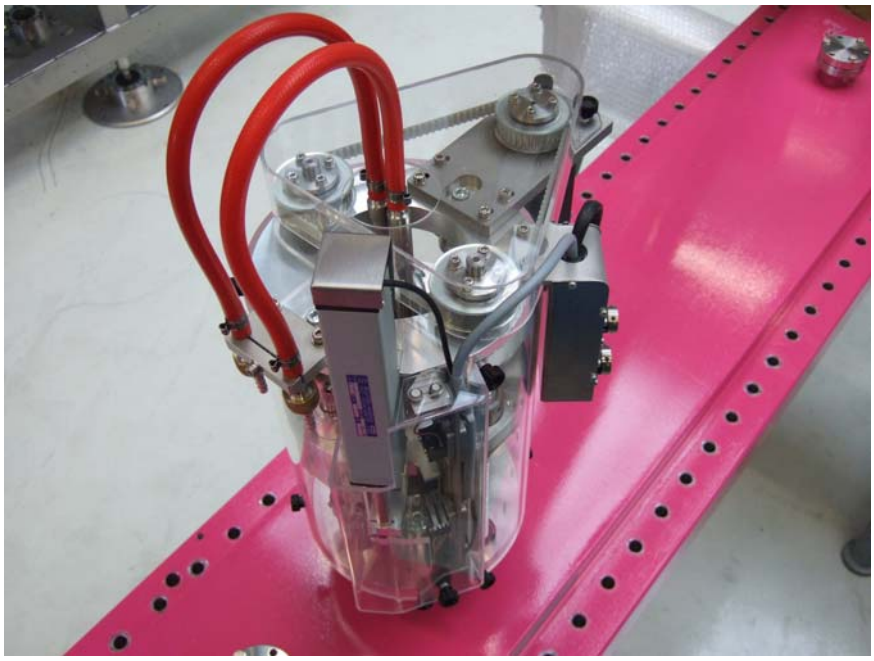

Fig 6: Plunger drive mounted on the upper half shell of an IH tank.

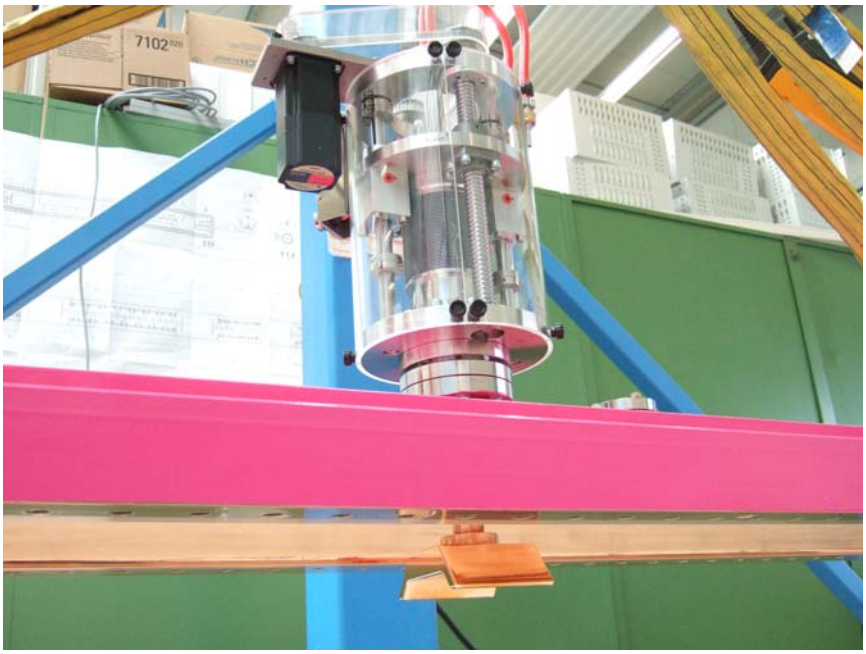

Fig. 7: Side view on the plunger drive and the driven plunger (below) from massive copper.

Fig 8: Plunger driver connectors for motor and end switches of linear potentiometer.

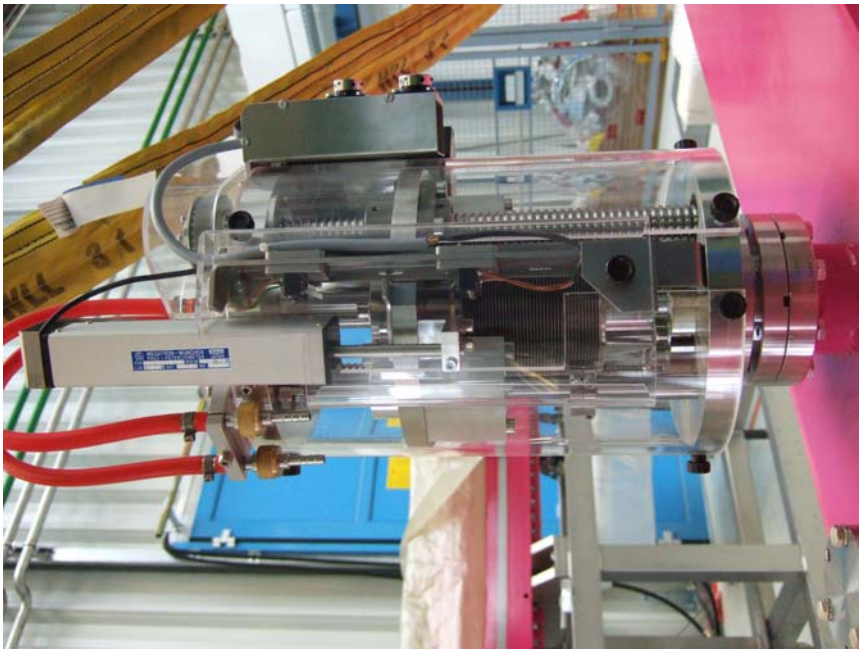

Fig. 9: Side view of the plunger drive.

Lit.:
[1]: J.-M. Hanon, CERN Rapport RSR/PS/94-3/jmh
[2]: J. –M. Hanon, CERN Rapport RSR/PS/94-13/jmh
[3]: J. Broere et al. , Proc. Of the LINAC98 Conf., Chicago, p. 771
[4]: J.-M. Hanon, CERN Rapport RSR/PS/98-02/jmh