Manpower and Financial Structure of ELENA Construction and AD Consolidation

Vacuum System

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Main topics

- ELENA vacuum system feasibility
- Proposed technical solution
- Costs
- Manpower needs

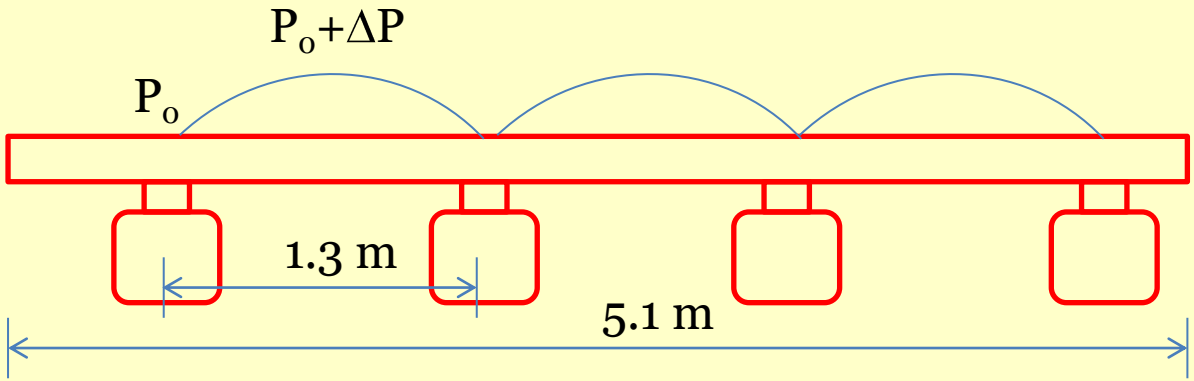
- AD consolidation
- Costs and manpower

ELENA Vacuum System feasibility

The vacuum chamber diameter will be 70mm.

Pressure requirement	10^{-12} Torr	
Total surface area of the ring	About 10 m^2	
Gas load after bakeout non-fired st. Steel (H_2)	$2x10^{-7}$ Torr l s^{-1}	Required S for (H_2): $2x10^{5}$ l s^{-1} -> unfeasible
Gas load after bakeout fired stainless steel (H_2)	$2x10^{-8}$ Torr l s^{-1}	Required S for (H_2): $2x10^{4}$ l s^{-1} -> feasible
Conductance of a ID 70 beam pipe aperture (H_2)	1693 l s^{-1}	
Maximum applicable effective S (H_2) in the beampipe (lump pump)	about 800 l s^{-1}	
Minimum number of pumps needed	25	4 to 5 per straight section

ELENA Vacuum System feasibility



$P_o = Q/S = 5.7x10^{-10} / 800 = 7.1x10^{-13}$ Torr
$\Delta P = Q/8C = 7.5x10^{-10} / (8x118) = 6.0x10^{-13}$ Torr
$P_{max} \approx 1.3x10^{-12}$ Torr

Effective pumping speed at the pressure maximum:
$1/S_{eff} = 1/S + 1/C_{(half\ pipe)} = 1/800 + 1/236$
$S_{eff} = 182$ l/s

Maximum gas load of installed monitors and devices:
$Q_{max} = 1.10^{-12} \times 182 \times 2 =$ 3.6 x 10^{-10} Torr l/s

NEG coating solution

Ti-Zr-V thin film coating onto all inner walls of the vacuum chambers.
Total pumping speed for H2:
$S=A\ C_{H_2}\ \alpha_{H_2}=10^5 \times 44 \times 8\ 10^{-3}=35200\ l\ s^{-1}$
$P=Q/S=2\ 10^{-8}/3.5\ 10^4=6x10^{-13}$ Torr

(this is an upper limit because the outgassing rate of a NEG coated surface is much lower than that of a bare surface).

Maximum pumping speed of the beampipe aperture:

$S_{H_2}= \sigma(\alpha) \times 1693 = 0.17 \times 1693 = 288\ l\ s^{-1}$

Maximum allowed outgassing rate of any device installed in the beampipe:
$Q_{MAX}= 10^{-12} \times 288 \times 2 = 6 \times 10^{-10}$ Torr l s^{-1}

For 3×10^{-12} Torr -> **$Q_{MAX}= 1.8 \times 10^{-9}$ Torr l s^{-1}**

Proposed Technical Solution

1. The pressure requirement is within our reach. The proposed solution can be based on either:

   a. vacuum fired beampipes pumped by NEG lump pumps, or

   b. NEG coated vacuum chambers.

   A safety margin can be obtain by combining the two solutions.

2. ***A severe limitation must be imposed to the outgassing rate of any device installed in the vacuum system*** ($Q<1x10^{-9}$ Torr l s^{-1}) including kickers and beam position monitors.

Ion pumps

Rough estimation of the CH_4 gas load:

$Q_{CH4} \approx 5x10^{-16}$ Torr l s^{-1} cm^{-2} x 10^5 cm^2 = 5 x 10^{-11} Torr l/s

Estinated pumping speed for CH_4 :
$S_{min} = Q_{CH4} / 1x10^{-12} = 50$ l/s ≈ 3 'VACION-PLUS 40 starcell' installed in the ring.

Costs of ELENA's Ring

Total cost of the Elena ring and injection lines' vacuum system

Items	Cost [KCHF]	Comment
Studies and prototyping	170	Mechanical design and integration not included
Vacuum chambers, bellows and supports	400	Including surface and thermal treatments, NEG coating
Local pumps and power supplies	120	NEG cartridge and ion pumps
Valves	225	
Vacuum instruments	90	Pirani-Penning + Bayard-Alpert, including power supplyes
Bakeout equipment and control	175	
Commissioning	140	Including TMP group and leak detector
Control, cabling, interlock	160	
Quality control and acceptance tests	35	

Total cost ≈ 1.5 MCHF

Manpower for ELENA's Ring

Manpower FSU [KCHF]	TE-VSC FTE [MY]	Needed manpower contribution FTE [MY]
100	3	2

TE-VSC APT line

	2012		2013		2014	
	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3
ELENA Project			1	1	1	2

Experimental Lines (Vacuum)

Beam lines to transport the 100-keV antiprotons to the experimental areas

Total length of **63 m**:

- 15 m common ejection line from ELENA to the beam switchyard
- 15 m ASACUSA line to entrance of the present RFQD
- 20 m ALPHA line
- two 3-m long beam-lines for the two ATRAP zones
- 8 m AEGIS line

Effective beam aperture: 60 mm (70 mm on both sides used for in-vacuum electrodes and insulation).

Beam pipe diameter: 200 mm (CF250).

Vacuum: 10^{-9} – 10^{-12} Torr depending on the position.

Experimental Lines (Vacuum) Cost an Manpower Estimation

The estimation was done by Masaki Hori.

The vacuum layout should by reviewed by TE-VSC in the next months.

Cost estimation (Vacuum system only)*	TE-VSC FTE [MY]*	Needed manpower contribution FTE [MY]*
1557 KCHF (not in TE-VSC APT)	0	3

* Excluded from Masaki Hori's estimation: electrostatic steering system, beam profile monitors and magnetic shielding.

We need expertise and manpower for the new experimental lines

AD consolidation

TE-VSC APT line

	2011		2012		2013		2014		2015		2016		2017		2018		2011-2015		
	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Cat2	Cat3	Total
AD consolidation					0.2	0.2	0.1	0.3	0.1	0.2							0.4	0.7	1.1

	2011		2012		2013		2014		2015		2016		2017		2018		2011-2015		
	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Mat	IS	Total
AD consolidation					130	100	100	100	100	105							330	305	635

The TE-VSC group activity for AD consolidation is mostly focused on the **replacement of power supplies of ion pumps and instrumentation**.

The final aim is the full integration of AD in the PVSS system.

The estimated cost is **635 KCHF** (Material: 330, FSU: 305)

The consolidation will be undertaken entirely in the TE-VSC group.

A machine shut-down longer than 5 months is needed.

Conclusions

To tackle the ELENA project we need help from the collaborations, in particular for the experimental lines, in the period 2012-2014:

Beam line	Needed FTE [MY]
ELENA ring	2
Experimental lines	3