BPMs for E-Coolers and E-Lenses at CERN

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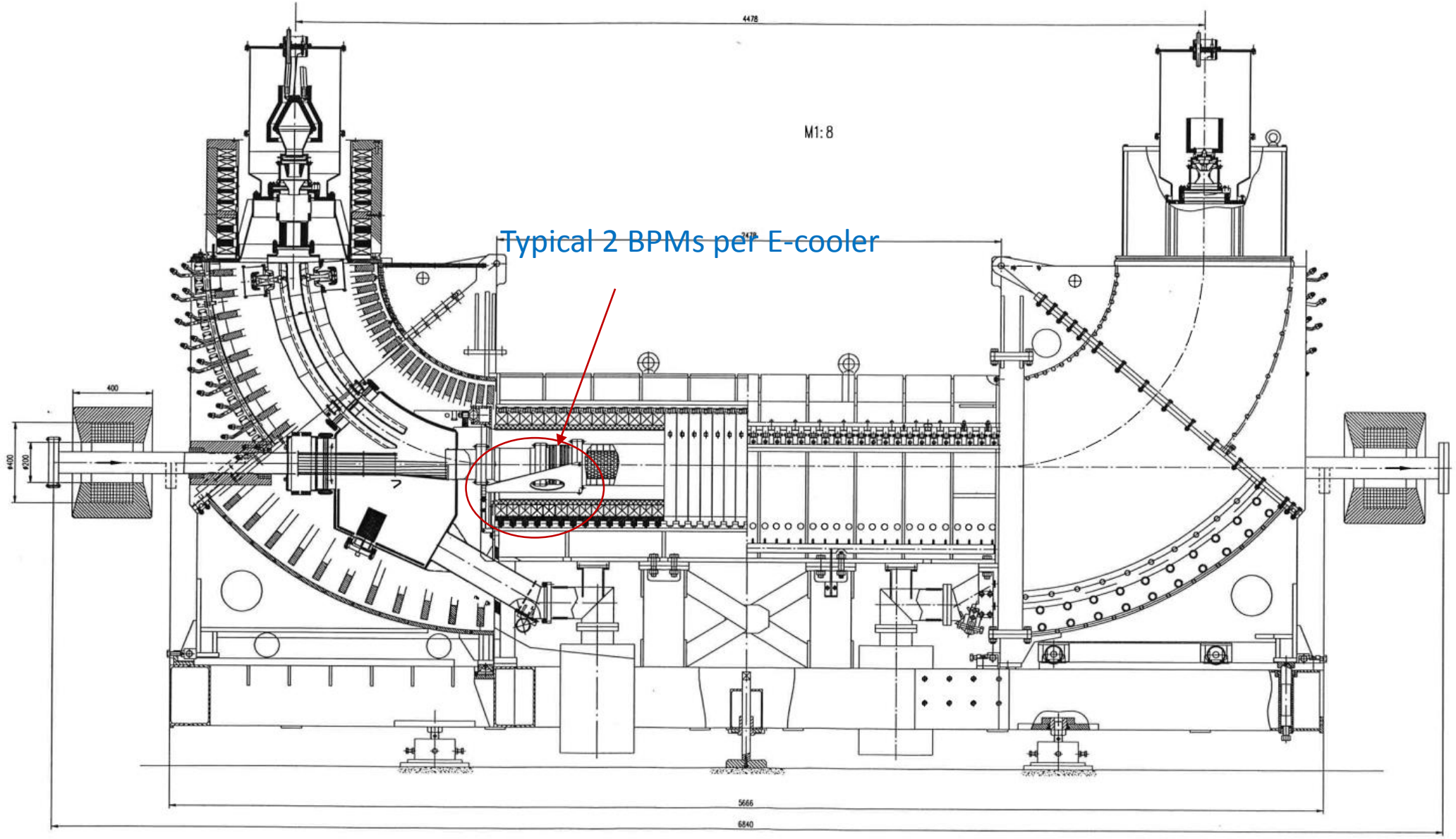
Outline

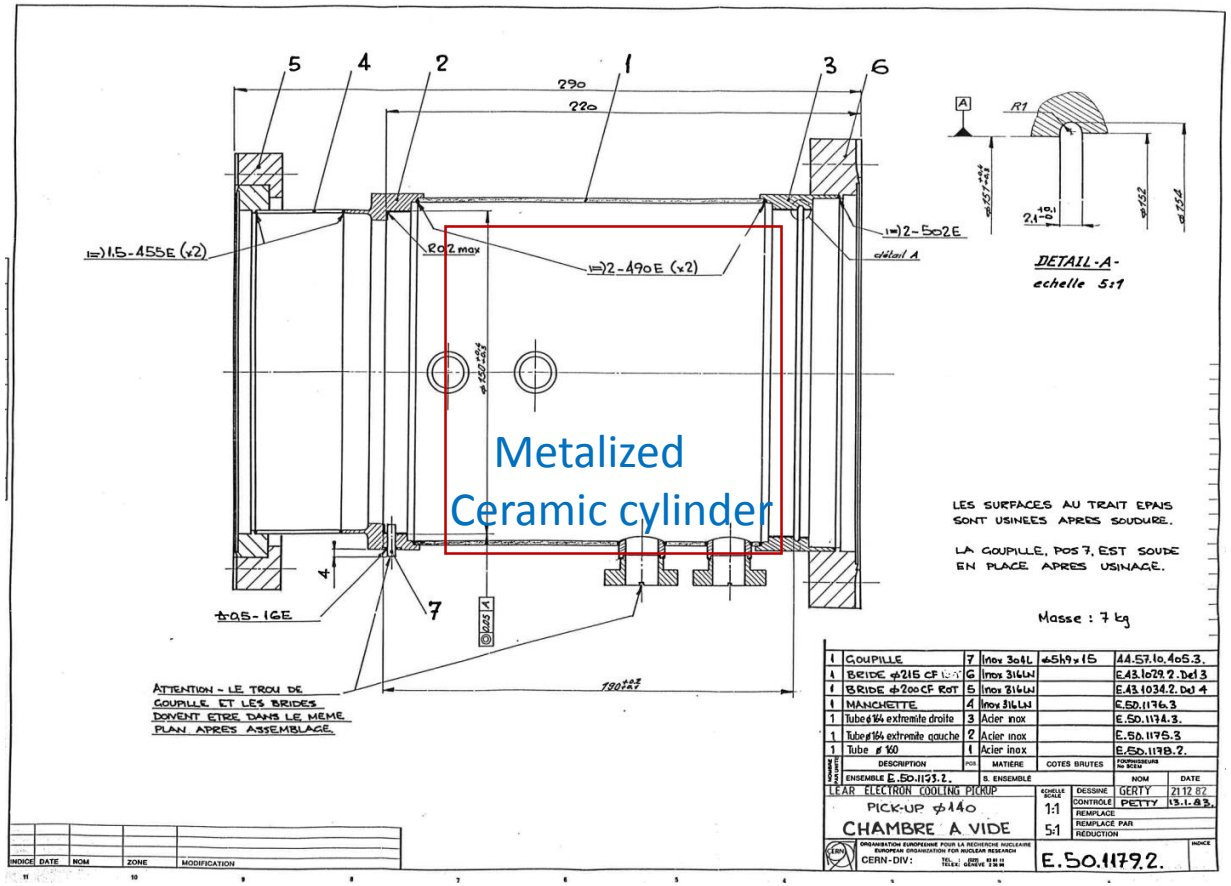
- Status of Ecooler BPMs
- Status of CERN HEL BPM design
  - BPM
  - Acquisition system
- Proposal for Test stand BPM
- Summary

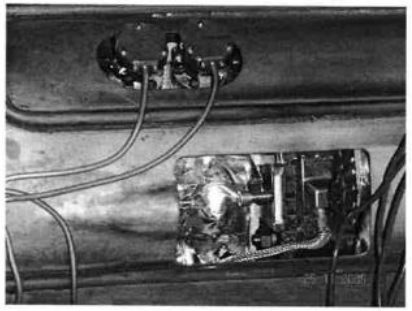
A CERN E-cooler

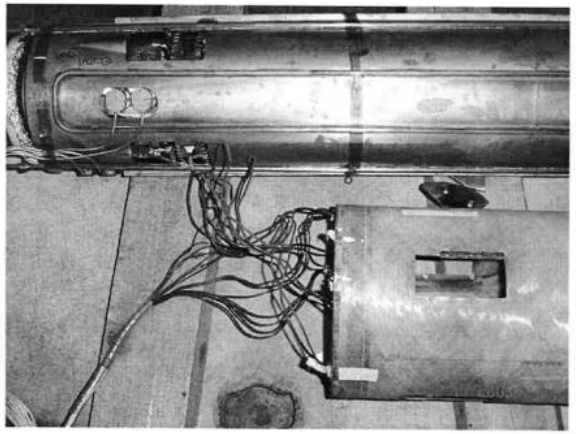


Pbar (Pb) and electron beams in same direction

AD E-cooler BPMs

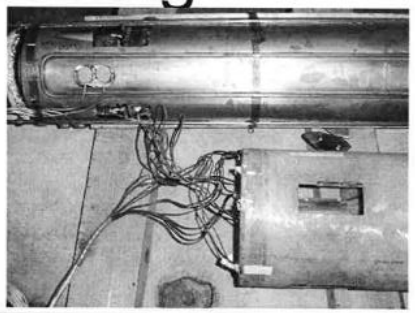


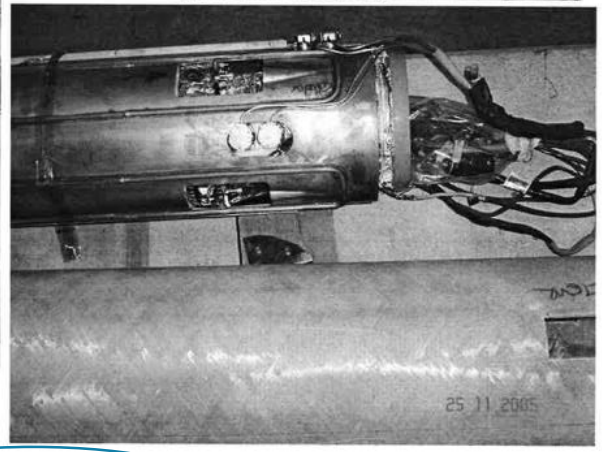




Drift tube with bakeout equipment and coil

AD e-cooling





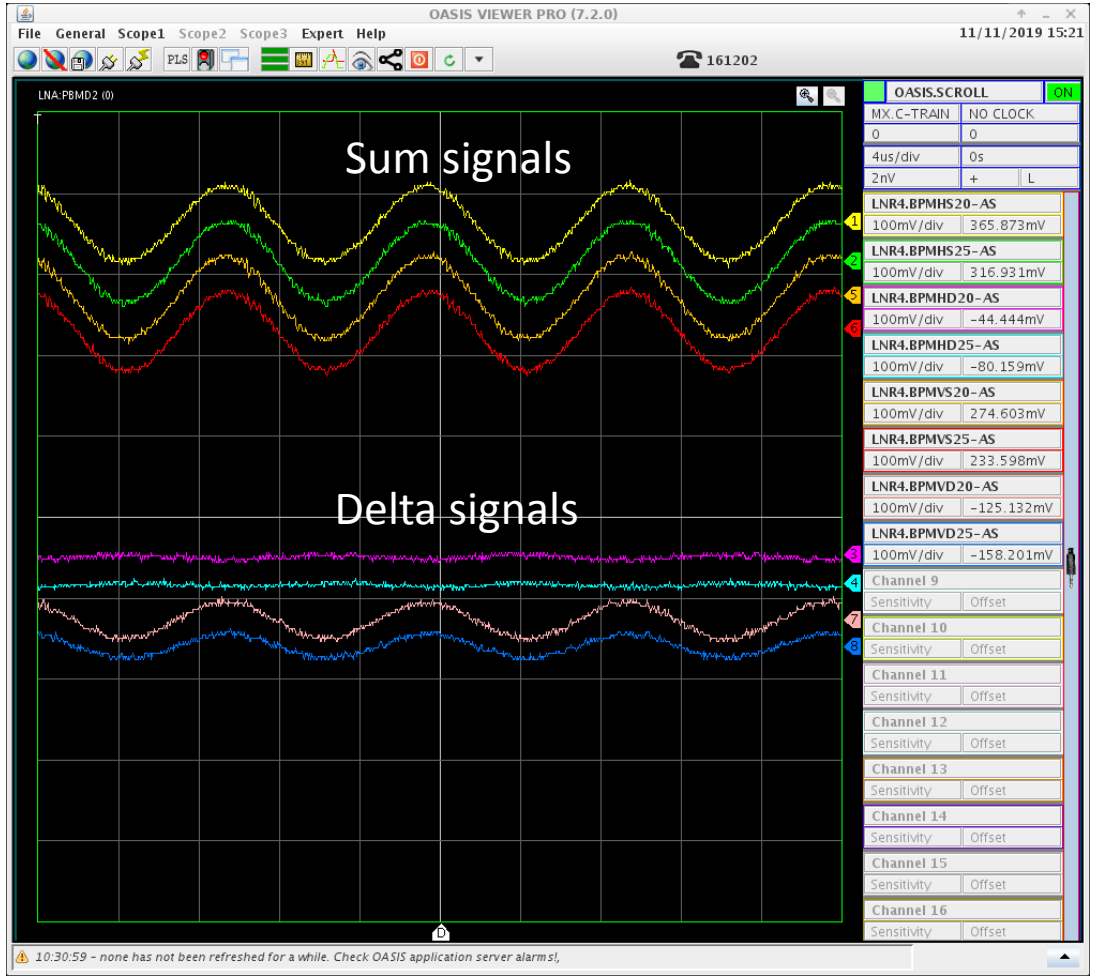
Dismantling of AD ecooling
25112005 (jh)

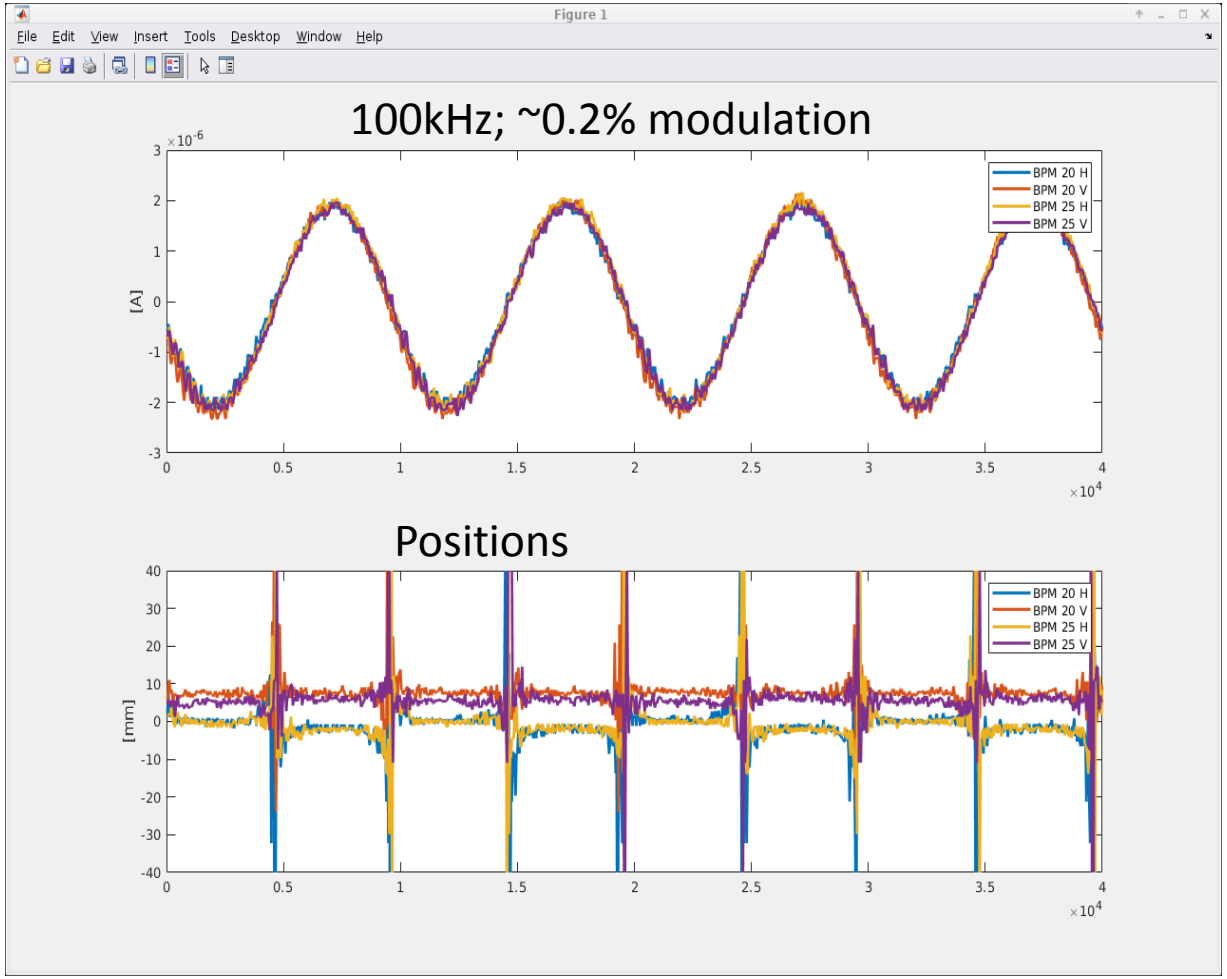
BPMs in CERN E-coolers

	LEIR		AD		ELENA	
	E-Beam	Pb beam	E-Beam	Pbar beam	E-Beam	Pbar beam
Current	1-2.5A	1E11 Ch	1-2.5A	4E7 Ch	2-5mA	1E7
Energy	2.3keV	4.2-72 MeV	27keV-3.1keV	3.5-0.1 GeV/c	355-55eV	5.3-0.1 MeV
BPM	Electrostatic; ~500 pF		Electrostatic, ~700pF		Electrostatic, 20pF	
Dimensions	ID=140mm	L=190mm	ID=140mm	L=190mm	ID= 51mm	L= 100mm
Front-end	High imp. voltage amp.		High imp. voltage amp.		Charge amplifier	
In Orbit acquisition	Yes		No, but on the way		Yes	
Ebeam modul.	(Intensity) and energy		Energy modulation only		Intensity and energy	
E-beam acq.	Yes, oscilloscope/OASIS		No, but on the way		Yes OASIS+APP	

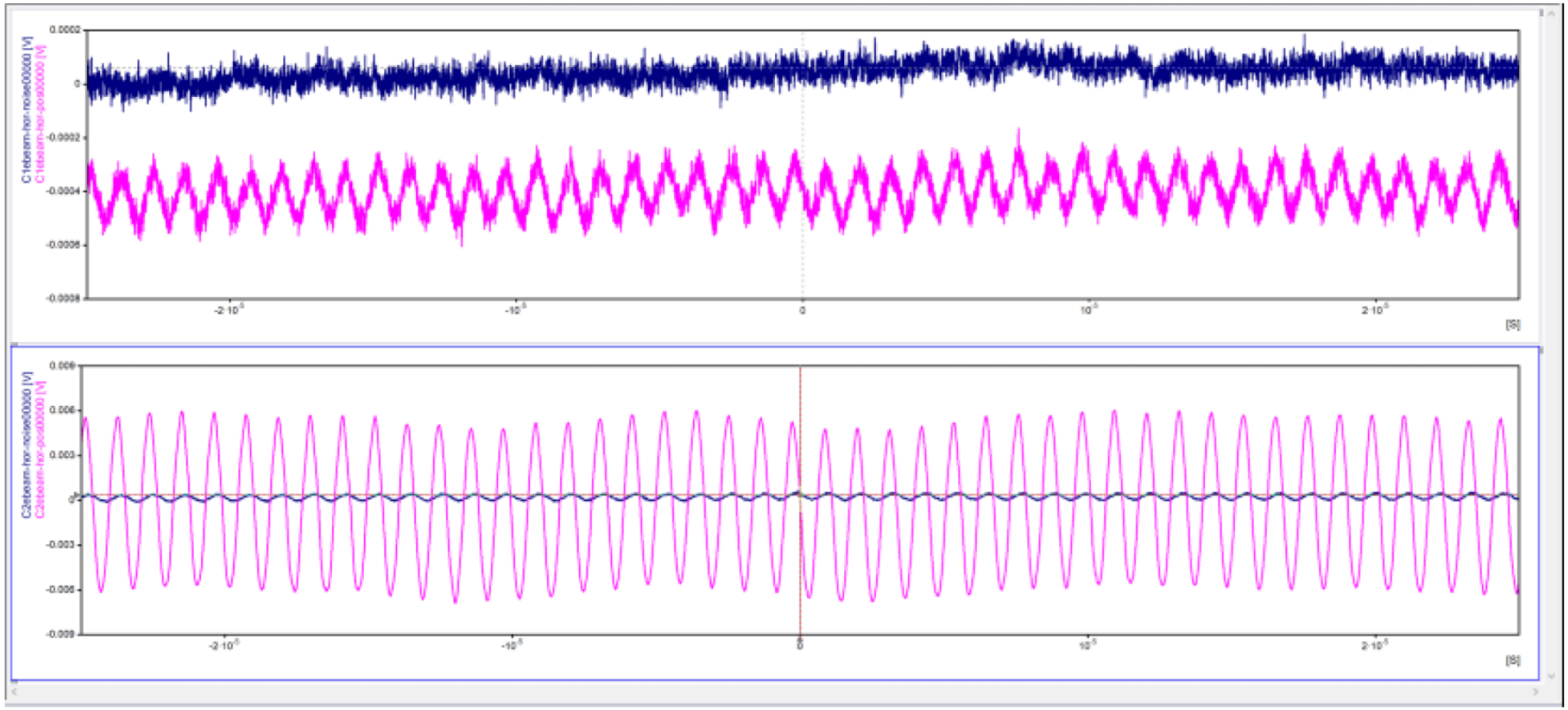
- Electrostatic BPMs used everywhere.
- E-coolers works with un-bunched beams, but bunching of Pbar (Pb) beams needed to determine position inside the e-cooler.
- Modulation of E-beam needed to measure E-beam position.
- Measurements of two beams done separately, slow process.
- ELENA is at present, only system operational with intensity modulation (100kHz with transformer from LEIR)
- If intensity modulation on revolution frequency can be implemented, acquisitions can easily be integrated into acquisition systems of the 3 machines.

100kHz intensity modulation of E-beam in ELENA





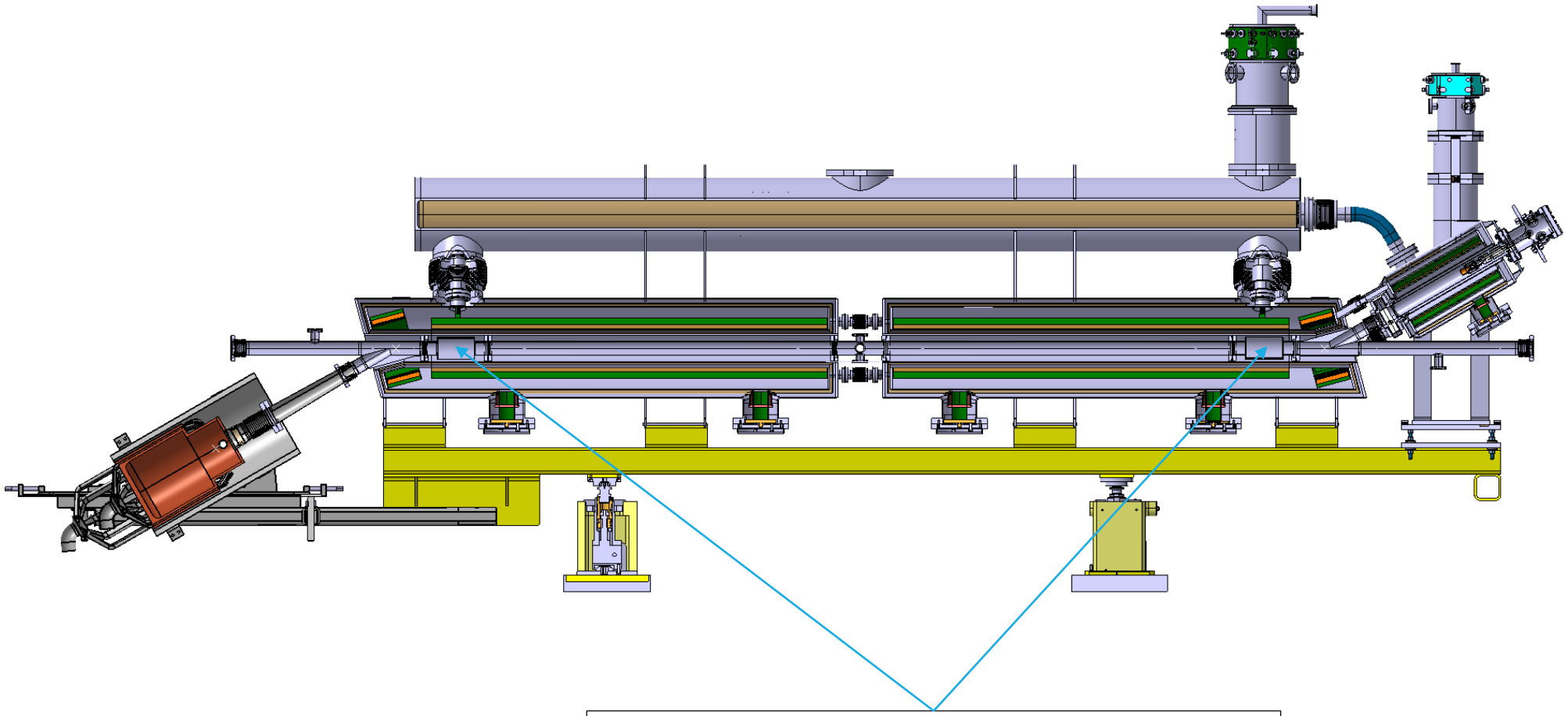
LEIR E-Beam BPM measurements (Intensity mod.)



Different scales

HOR CH01 (delta) and CH02 (sum) noise measurement and with electrons

HEL BPM



2 BPMs for Hollow Electron Lens

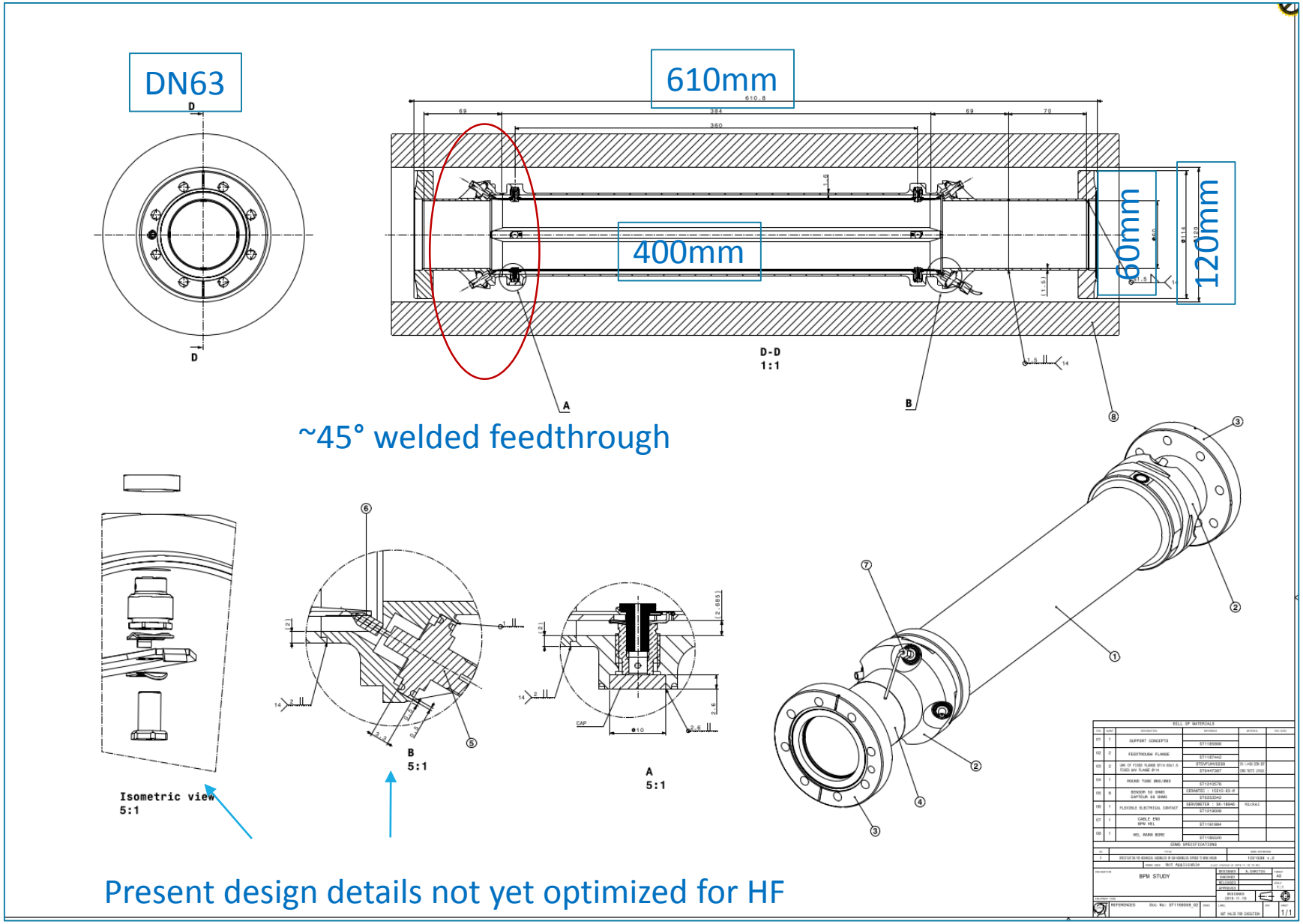
Proton and electron beams counter rotating

HEL BPM Specifications:

	Proton beam	Electron beam	Comments
Intensity	5E9 (2.1A) / 2.5E11 (63A)	1 / 5A	
Bunch / Pulse length	1ns	1-86us	P=4σ; E_beam off 3us; tr = 200ns
Relativistic β	1	0.19-0.24	E_{Beam} Low β ~ 5 * charge density
Resolution	100um / 20um	100um / 20um	
Relative accuracy	100um		Between beams
Absolute accuracy	500um	500um	
Max beam displacement	4mm	4mm	
Time resolution	>1s?	>1s?	
Inner diameter	60mm		
Max. outer diameter	120mm		

- Functional specifications :
  - E_beam on/off, 1 to 3 times per turn
  - E-beam on/off either between LHC trains or within their internal structure coming from the SPS.
  - Injection and on high energy stable beams
  - Single bunch and pilot

HEL BPM design



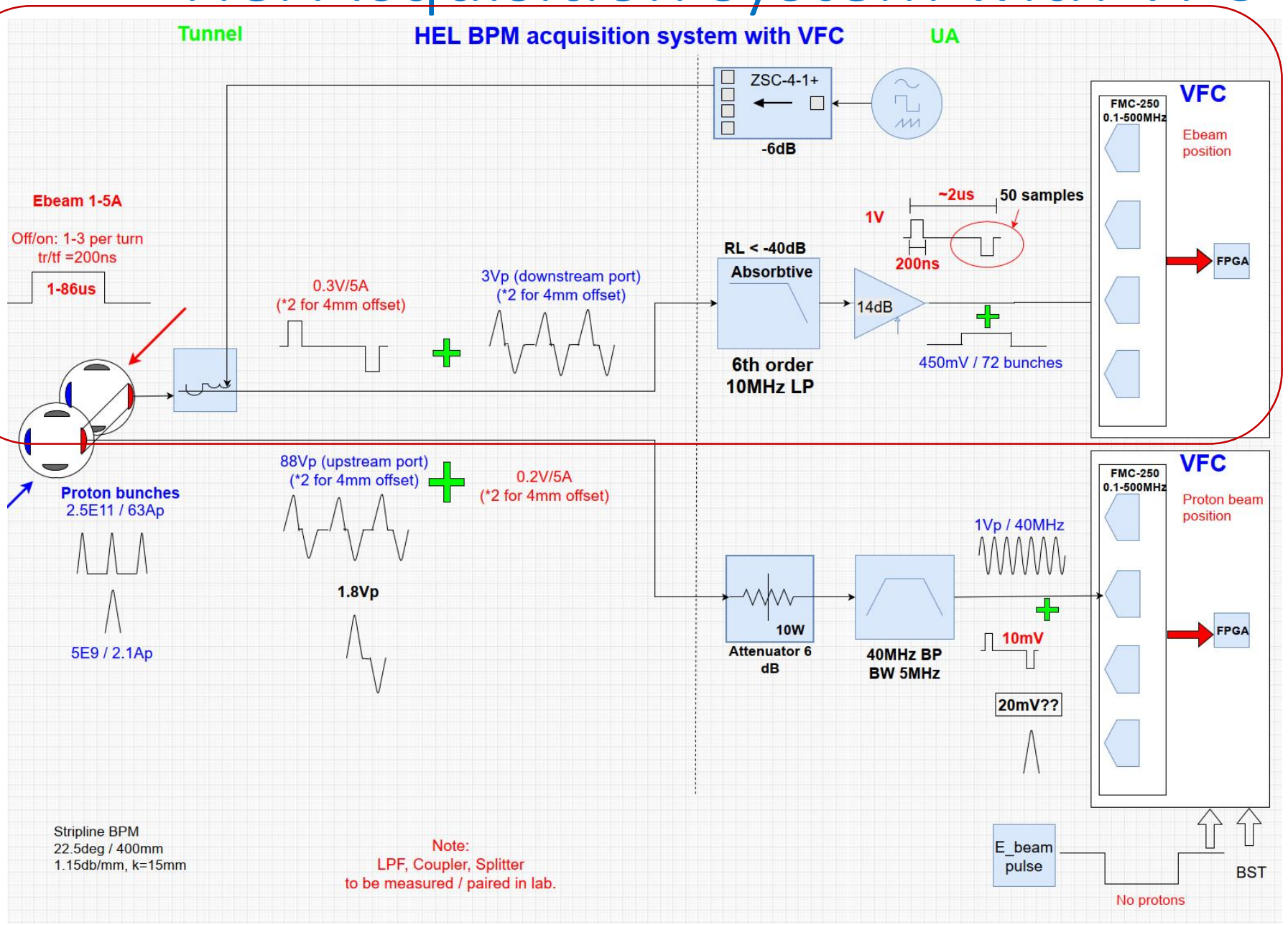
50 ohm strip line

- Profit from counter rotating beams and directivity.
- First simulations on 3D design done by Manfred.
- Improvements in RF performance needed.

BPM signal summery

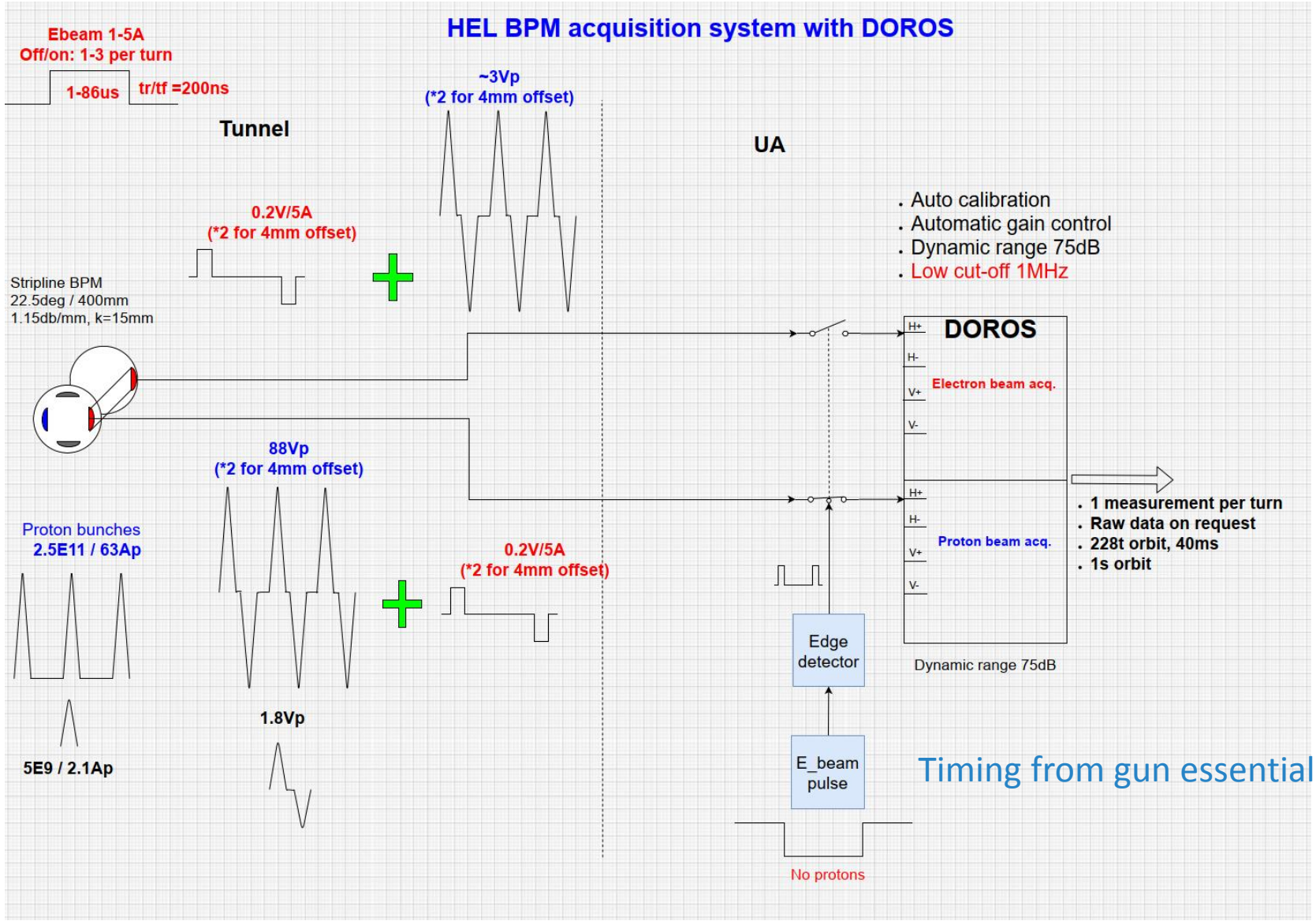
BPM	Electron beam on/off	Gaussian 2.5*10^11, 0.25ns	Gaussian, 2.5*10^11 with ~25MHz LP filter
Button	0.04vp	63Vp	~0.65V
Strip line (0.2m, 45^{o})	0.22Vp	200Vp	~0.45Vp
Strip line (0.4m, 23^{o})	0.2V	88Vp	0.2V
Electrostatic (75^{o})	0.8Vp	~200Vp	~0.4Vp

Hel Acquisition system with VFC+FMC

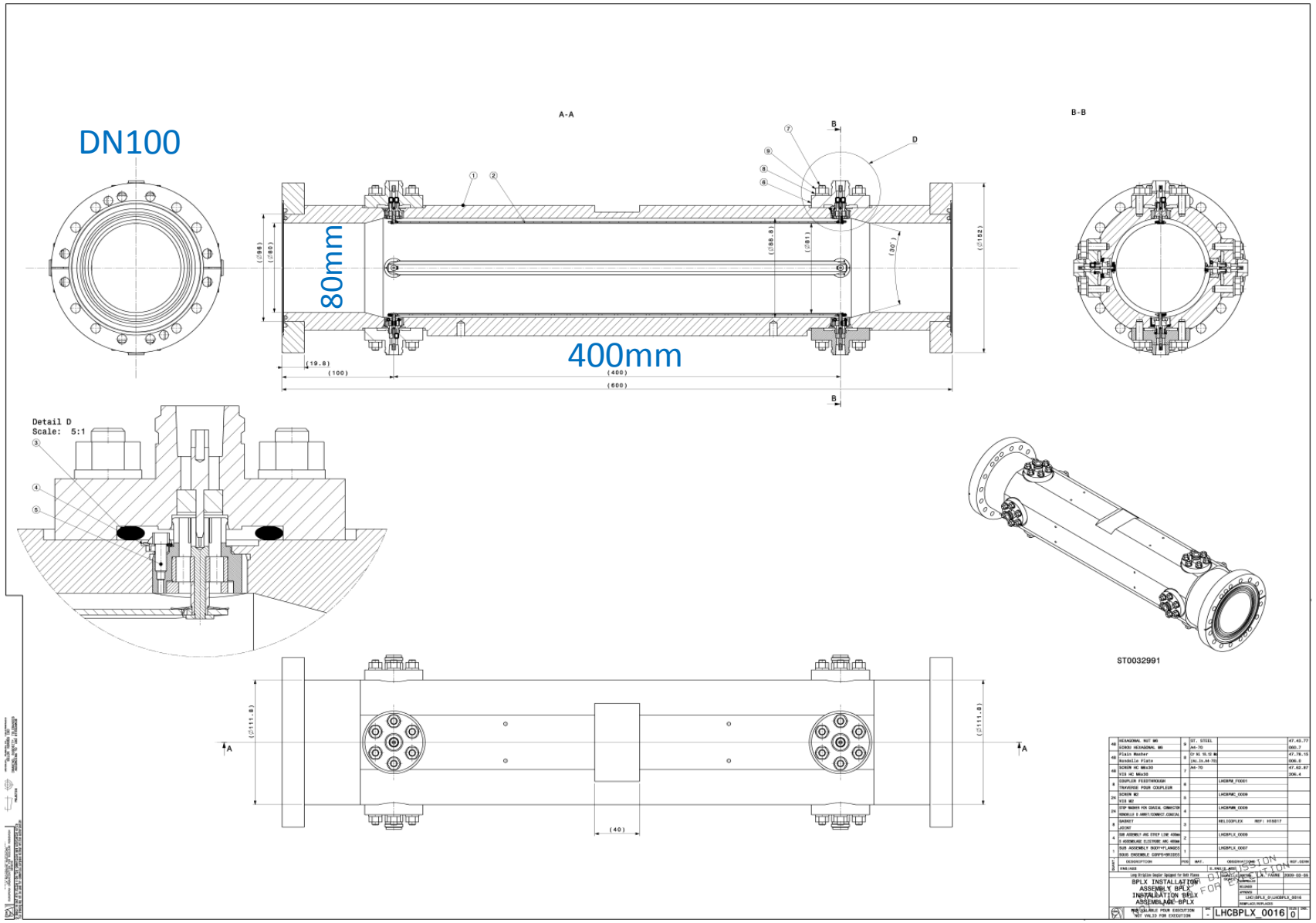


- Need to measure two beams simultaneously
- Frequency separation not possible
- Measure electrons when no Proton's.
- Need timing from gun

Hel Acquisition system with DOROS



Test stand BPM: LHCBPLX



- Two spares on stock
- Dimensions close to HEL design
- Acquisition with oscilloscope

Summary:

- Injector E-coolers:
  - Use electrostatic BPMs
  - Only ELENA is operational with intensity modulation
  - Intensity modulation at revolution frequency would enable E-beam position acquisitions
    - Need to buy 2 more transformers
  - AD analogue acquisition system being completed
- HEL BPM
  - 3D design exist and has been simulated.
  - Needs to be improved
  - 2 Proposals for acquisition systems
- Test stand BPM
  - Spare LHCBPLX will be installed in March
  - Acquisition with oscilloscope