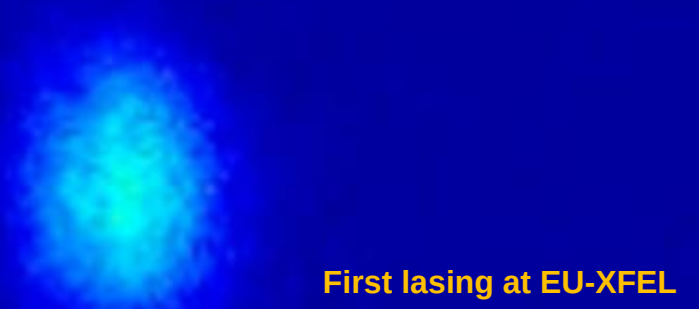
Proposal for R&D and value engineering

SRF activities for the ILC



Olivier Napoly (CEA)

CEA Activities on SCRF

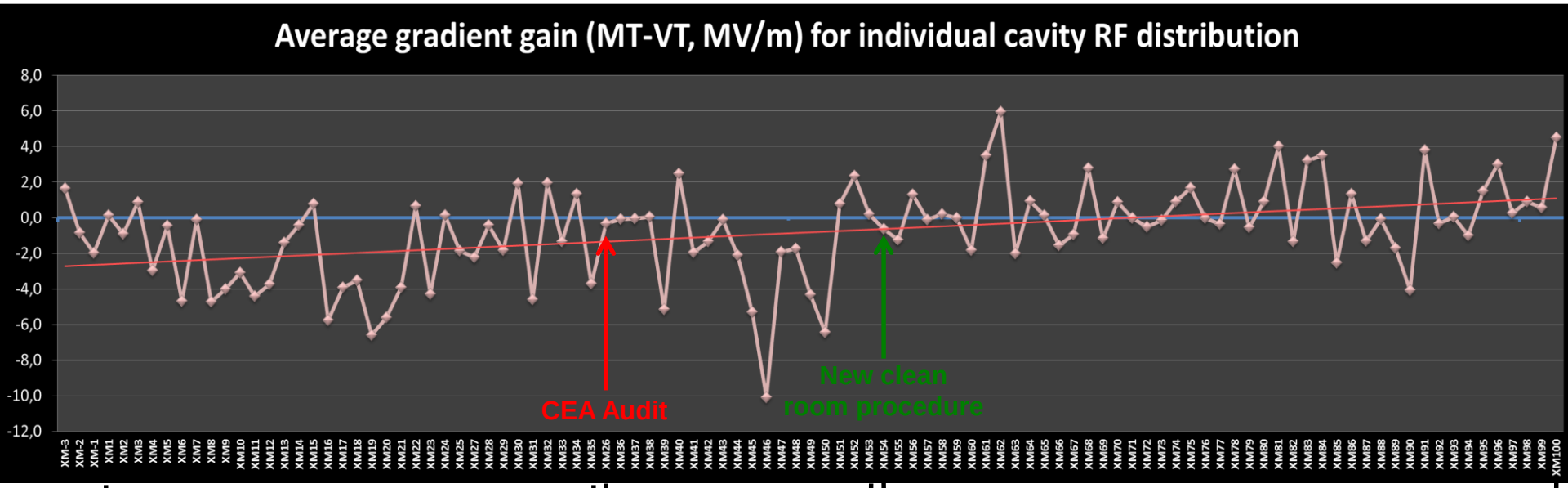
After the completion of the 103 E-XFEL modules assembly in July 2016, CEA is mostly involved in the construction of SRF linacs:

- IFMIF/LiPAC : one 8-HWR-cavity cryomodule (176 MHz)
- ESS : 30 medium and high beta cryomodules (704 MHz)
- SARAF : four 7-HWR-cavity cryomodules (176 MHz)

CEA is therefore naturally inclined to improve module assembly process w.r.t. quality, productivity and cost.

R&D programs need a new boost !

Cryomodule Performance: VT vs. MT



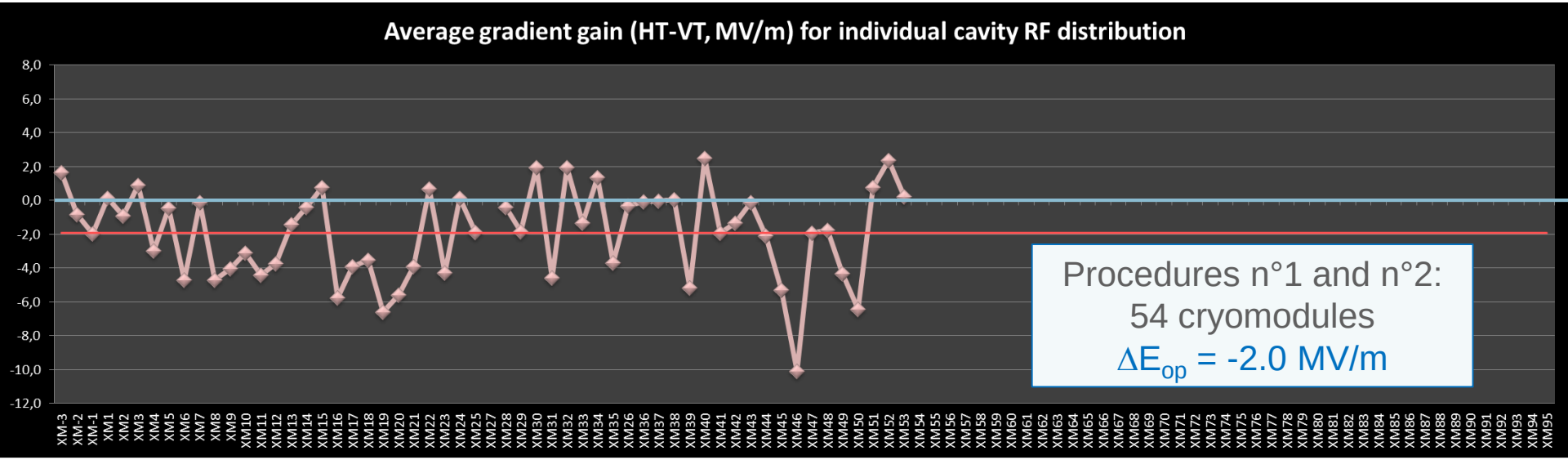
1st sample of 34 series CM
ΔE_{op} = -2.1 MV/m

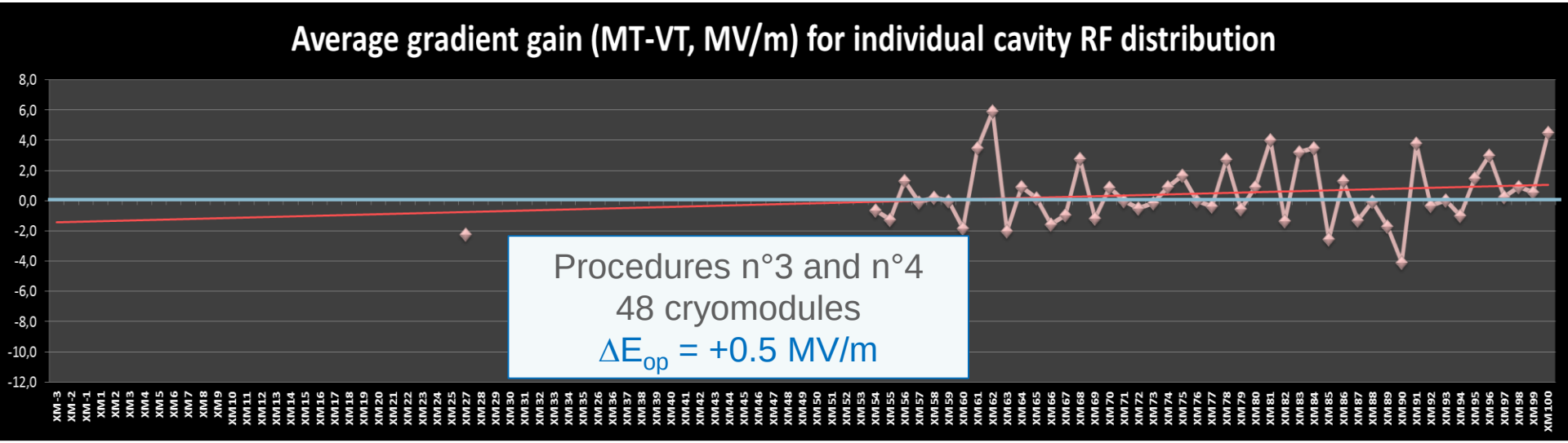
2nd sample of 19 series CM
ΔE_{op} = -1.7 (-0.9) MV/m

last 47 series CM
ΔE_{op} =+0.5 MV/m

- Significant gradient degradation from XM6 to XM23, while CEA and Alsyom put all their effort in achieving production goal of 1 CM/week: an audit of string and module assembly was conducted by CEA on XM26
- A simplification of the clean room procedures was introduced at XM54: **no degradation after**

Cryomodule Performance: n°1-2 vs. n°3-4





Clean Procedures: Comparison

Number of vacuum operations for a complete cryomodule assembly

Procedure	n°1	n°2	n°3	n°4
# Angle valve to pipe connections	20	22	14	14
# Angle valve open/close cycles	29	21	13	13
# N2 blowing after an opening	17	17	9	9
# Leak checks	48	40	32	23

Two assembly ‘parameters’ could be correlated to module results :

1) The clean room operator invasiveness
2) The vacuum operation invasiveness (mostly but not only in the clean room)

Robotization

From E-XFEL experience, the cost of module assembly for ILC 500 GeV is in the ballpark of 200 M€, almost entirely in labour cost.

→ **Automation and Robotization**

- Once the vacuum groups are connected to the cavities, vacuum operations (pumping, venting, flushing, leak checking) should be **fully automated,** to include slow pumping and venting, and valve opening.
- **Robotization** could be implemented e.g.
  - Ionized N2 cleaning
  - Cold coupler assembly
  - String assembly
  - Warm coupler assembly

Robotization

Robotization will be beneficial with respect to :

- Reducing labour cost
- Reducing the assembly mistakes and non-conformities
- Uniformization of assembly procedures across the 3 or 4 regional assembly plants
- Introducing some ‘plug-compatibility’ in the module design

Cavity Fabrication and Preparation

This activity could be led by DESY in Europe.

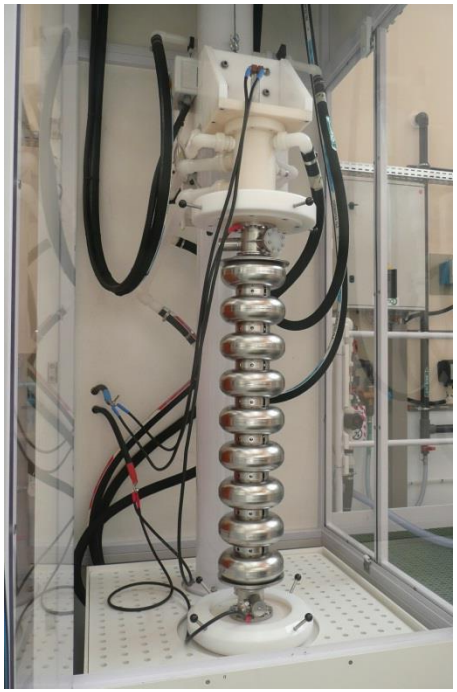
It would be focused on:

- the cost reduction of the cavity fabrication process,
- the better reproducibility and higher yield of cavity performance at the design gradient,
- new preparation procedures to reach higher gradient and Q0,
- the knowledge and technology transfer to industry of the most promising developments.

Cavity Fabrication and Preparation

CEA will continue investigation on **surface preparation**:

- Electropolishing, and in particular Vertical EP
- 120°C baking, and in particular N2-infusion recipe



CEA can join in an international collaboration on these topics.

RF Coupler: R&D and Value Engineering

This activity could be led by CNRS-Orsay.

It would be focused on value engineering of the RF coupler production, including potential re-design or re-evaluation of specifications.

New industrialisation studies could be undertaken encompassing fabrication, clean room preparation, RF conditioning and assembly in order to minimize the overall cost and risk of this highly complex component.

This effort would be directed towards making the coupler production and assembly more efficient, streamlined and cost-effective.

RF Coupler: R&D and Value Engineering

Possible themes of work:

- In-depth investigation on the lightening observed during the RF conditioning in some XFEL couplers: Origin, impact on coupler and how to supress it.
- Test on a “new” multipactor suppressor thin layer on ceramic: Cr2O3.
- Impact of different finishing processes (Brushing, glass bead blasting, burnishing…) on copper plated surface roughness, RRR and SEY.
- Coupler cleaning-rinsing-drying procedure automatization: to avoid operator dependence, guarantee the process repeatability and save time and money.
- Mechanical design, thermal and RF studies of coupler operating in CW mode.