LIPAc Grounding Network
Requirements and functional description

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IFMIF

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Outline

- Introduction to LIPAc
  - Description of LIPAc
  - Features of LIPAc

- Introduction to IFMIF/EVEDA

- Introduction to the Broader Approach Agreement

- LIPAc electrical background
  - Electrical Distribution: Outline diagram
  - LIPAc grounding network: Outline diagram

- LIPAc present status of installation activities
LIPAc (Linear IFMIF Prototype Accelerator) is a 125 mA CW and 9 MeV deuteron beam Linac presently under installation in Japan for a total beam average power of 1.125 MW.

It will validate the concept the accelerator of IFMIF (International Fusion Material Irradiation Facility) a 40 MeV deuteron beam Linac accelerator for fusion materials testing.

LIPAc subsystems are delivered by in-kind contribution from European Laboratories under the Broader Approach (BA) agreement between Japan and Europe (EU).
Description of LIPAc

Equipment designed and constructed in Europe
Installed and commissioned in Rokkasho

Injector + LEBT
RFQ
RF Power
MEBT
SRF Linac
HEBT
BD
Diagnostics

36 m

CEA Saclay
INFN Legnaro
IAEA Tokai
CEA Saclay
CIEMAT Madrid
CEA Saclay
CIEMAT Madrid
CIEMAT Madrid
CIEMAT Madrid
CIEMAT Madrid
SCK Mol

KNASTER, J. et al., Installation and Commissioning of the 1.1 MW deuteron prototype Linac of IFMIF, IPAC 2013 Shanghai
In 1999 LEDA (Los Alamos) reached **100 mA** continuous wave at 6.7 MeV protons at the exit of the RFQ

Many of the lessons learnt have been implemented in LIPAc

**LIPAC** will accelerate:

- **125 mA** at 5 MeV CW deuteron beam at the exit of the RFQ
- **9 MeV** CW deuteron beam at the exit of the SRF Linac

This will validate the operation at higher energies for IFMIF
IFMIF
International Fusion Materials Irradiation Facility

EVEDA
Engineering Validation & Engineering Design Activities

A fruitful Japanese- European International collaboration
with 7 countries involved
with the involvement of research labs in Europe and main universities in Japan
The Design of IFMIF is broken down in 5 Facilities

Accelerator Facility
Lithium Target Facility
Test Facility
Post-irradiation and Examination Facility
Conventional Facilities

to maximize dpa's on tested materials
the availability of the full IFMIF >70% has demanded careful RAMI analysis for each Facility

Enric and Jose Manuel know well about it...

Availability of the Facility >70%
14 MeV neutrons through stripping reactions

- Neutrons would be mainly produced through their stripping from a deuteron beam

- Li(d,xn) Accelerated deuterons would react with Lithium to generate neutrons in the forward direction typically with an energy $0.4 E_{\text{inc}}$

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Existing neutron sources do not provide the needed answers

- $^{56}\text{Fe}(n,\alpha)^{53}\text{Cr}$ and $^{56}\text{Fe}(n, p)^{56}\text{Mn}$ presents transmutation thresholds $>3$ MeV

Fission reactors $n$ average energy $\sim 2$ MeV

No efficient $p^+$ or $\alpha$-particle generation

Spallation sources present a wide spectrum with tails in the order of hundreds of MeV Generation of light isotopes in the order of ppm
Introduction to the Broader Approach Agreement
Steady State Electrical Network:
About 3.5 MVA continuous power
Main consumers:
• Cooling water system
• Radio Frequency chains, HEBT, Cryoplant
• Building services

Pulsed Power Electrical network:
About 6 MVA peak pulse
Main consumers:
• Radio Frequency
LIPAc grounding network, scenario faced

- Two independent grounding networks were installed
  - The two grounding networks were unified possibly because of misunderstanding of the TN-S distribution system not frequent in Japan.

- The impedance of the grounding network has not been assessed
  - The ground resistance is about 2,5 $\Omega$

- No specific EMC recommendations were observed
EU acceptance test conditions are not necessarily the same to those of the LIPAc installation:

- The electromagnetic interference (EMI) environment is different.
- The grounding network design in each EU Laboratory is different.
- Electrical power quality can be different.

Thus, EMC performance in LIPAc can be different...

How can we combine this facts?
LIPAc grounding network: Tackling uncertainties

Understand the problem

- EMI and EMC affects reliability. How?
  - Common mode...
  - Leak currents, induced voltages, thunderbolts

Tackle uncertainties

- Know your grounding network
- Agree on standards to apply: IEC-61000-5-2
- Create your own working guidelines and use them
- Upgrade your grounding network to cope with EMC
- Protect your electronics or be ready to lose them
**Upgrading the grounding network**

- Create a grounding network mesh or interconnect the chassis creating a mesh

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Bouches de masse de grande surface

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Forte impédance commune

=> dcp entre les équipements
Protect your electronics creating multiple paths for CM currents

Intercept your signals close to the receiver

PFZ8586-15A
LIPAc Present status of installation

- Ion source and LEBT under commissioning on $p^+$ on-going
- Ion source and power supplies cooling skids are running
- RF power system (RFQ, MEBT and SRF Linac) starting June 2015

HV deck, ECR source  Accelerator column  LBET and Diagnostics
Conclusions

- The Lipac commissioning has started at good progress
- The grounding network at Lipac will be updated to include EMC considerations
- The lack of an own EMC guideline makes it the usual excuse to explain faults, downtime and signal distortion
- However, simple solutions can still be implemented to protect the electronics against the observed EMI issues
Thank you for your attention