EURISOL
beta-beam related tasks

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The beta-beam in EURISOL

- **Target tasks**: 100 kW, solid fission target and MW targets
  - CERN
- **Beam preparation**: 60 GHz ECR source
  - IN2P3-LPSC
- **Heavy-ion accelerator**: acceleration up to
  - 100 MeV/u
  - GANIL
- **Physics**: Low energy beta-beam
  - IN2P3-Orsay
- **And more...**
Target tasks

• Development of targets for 6He production and 18Ne production
  - Oxid targets
    • BeO and MgO in baseline
  - Converter technology
    • Solid converters
    • Liquid converters

• Open questions:
  - Intensities
  - Life time
  - Release time (structure)
  - Transport to ECR source
  - Isobaric contaminations

• Workpackage leaders: Jacques Lettry (CERN), Luigi Tecchio (LNL, INFN) and Yacine Kadi (CERN)
$^6$He production by $^9$Be($n,\alpha$)

Converter technology:
(J. Nolen, NPA 701 (2002) 312c)

Layout very similar to planned EURISOL converter target aiming for $10^{15}$ fissions per s.

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**Mercury jet converter**

H. Ravn, U. Koester, J. Lettry, S. Gardoni, A. Fabich

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Production of $\beta^+$ emitters

- Spallation of close-by target nuclides: $^{18,19}$Ne from MgO and $^{34,35}$Ar in CaO
  
  - Production rate for $^{18}$Ne is $1 \times 10^{12}$ s$^{-1}$ (with 2.2 GeV 100 mA proton beam, cross-sections of some mb and a 1 m long oxide target of 10% theoretical density)
  
  - $^{19}$Ne can be produced with one order of magnitude higher intensity but the half life is 17 seconds!
Beam preparation

- Magnetic separation, Low-energy transport, ionization and bunching with a 60 GHz ECR source
- Questions
  - Bunch length
  - Charge state distribution
  - Losses
  - Purification in cryo-trap
- Workpackage leader: Ari Jokinen, Jyvaskyla
- Workunit leader: Pascal Sortais, LPSC, IN2P3
1 - To bunch the gas in short time
   \[ \sim > 20 \, \mu s \]

2 - To ionize (>1+) with a time smaller than the effusion time
   \[ n_e \approx 10^{14} \, e/cm^3 \approx 60 \, GHz \, ECR \, discharge \]
   + strong axial magnetic field during the discharge (\approx 2T)

3 - To deliver a beam with a repetition rate compatible with the lifetime of the ions

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Very high density magnetized plasma $n_e \sim 10^{14}$ cm$^{-3}$

Target

Arbitrary distance if gas

Rapid pulsed valve ?

UHF window or « glass » chamber (?

2.0 – 3.0 T pulsed coils or SC coils

Small plasma chamber $\phi \sim 20$ mm / $L \sim 5$ cm

20 – 100 μs
20 – 200 mA
$10^{12}$ per bunch with high efficiency

60-90 GHz / 10-100 KW
10 – 200 μs / $\lambda = 6$ – 3 mm
optical axial coupling

optical radial (or axial) coupling (if gas only)

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ECR activity for radioactive ion production at LPSC

A - CW charge breeding

- Beam matching
- Technological developments

B - Pulsed charge breeding and the Beta-beam project

Three « orders of magnitude » to find :

- intensity \( \times 10 \)
- rising time \( / 10 \)
- bunching/efficiency \( \times 10 \)
Heavy-Ion accelerator

- Acceleration to 100 MeV/u
- Open questions:
  - Can the EURISOL baseline heavy-ion accelerator be used?
    - Intensity
    - Simultaneous use for Nuclear Physics
    - Multiple charge state acceleration
- Work package leader: M-H. Moscatello, GANIL

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Physics

• Low energy beta-beam
• Open questions
  - Physics potential
  - Special beta-beam facility required
  - Test ring using existing facilities
    • AD ring at CERN
    • FAIR storage ring
• Work package leader: Rob Page, Liverpool
• Work unit leader: Cristina Volpe, IN2P3
• High energy beta-beam physics case to be handled by BENE work package (Mauro Mezzetto, INFN)
High energy fragmentation:
EURISOL high intense easy beam (e.g. $^{132}$Sn)
+ post-acceleration to GeV region in PS
+ IF or direct
= A major step further towards more exotic nuclei

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Conclusions

• Essential with strong and efficient coordination with other EURISOL tasks
  - Milestones for beam parameters in 2005
• Heavy-ion acceleration of ions for beta-beam will possible have to be done in dedicated linac
• The beta-beam is fully integrated in EURISOL
  - Expect that the nuclear physics community will be interested in other nuclei at high energies