a linac based positron source

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Outline:
• Motivation: antimatter gravity
• $e^+$ energy spectrum & rate @ low E high I
• The linac and electron beam
• $e^+$ selector (SOPHI)
• Saclay installation
• Outlook
Motivation: $\tilde{g}$ experiment

use $\overline{H}^+$ cooled to few $\mu K$

$\overline{H}^+$ formation

\[
\begin{align*}
\bar{p} + Ps & \rightarrow \overline{H} + e^- \\
\overline{H} + Ps & \rightarrow \overline{H}^+ + e^-
\end{align*}
\]

Needs high intensity slow positron beam!

Y. Sacquin – JPOS09 – 26/03/09
e$^+$ production with 5.5 MeV electron Linac

- W moderator $\varepsilon = 10^{-4}$
  - $> 10^7$ slow e$^+$/$s$
- Ne moderator
  - $> 10^8$ slow e$^+$

Fast e$^+$ transport efficiency and beam size
Commercial Linac (1)

\[ E_c (e^-) = 5.5 \text{ MeV} \text{ (< neutron activation threshold)} \]
\[ \nu_{\text{max}} = 200 \text{ Hz} \]
\[ I_{\text{max}} = 0.2 \text{ mA} \]
Bunch length 4 \( \mu \text{s} \)
Magnetron 1.9 MW peak
Total electric power 35 kVA
RF frequency 3 GHz
Acceleration length 21 cm
Beam diameter 1 mm, 6 mm at target
Overall dimensions 1 m x 1 m x 0.8 m

Installed November 2008
Commercial Linac (2)

$e^-$ beam:
Ec = 5.5 MeV
$I_{\text{max}} = 0.2$ mA
Linac commissioning (Dec ’08)

Beam spot Ø ~ 1 cm @ 80 cm from end of acceleration section

- 1 mm @ 10 cm

Ec ~ 5.5 MeV
Linac commissioning (Mar.’09)

Jan’09: new impregnated cathode, new profiler
Measured intensity: from 8 → 140 μA

Beam position scan with new Cu profiler:
Beam size $\sigma = 5$ mm at target

Next steps: stability test (8h running at 200 Hz); better positioning of positron detector (noise due to backscattering and HF)
Simulated energy spectrum of $e^-$
Fast $e^+$ selector for cryo-moderation

http://www-dapnia.cea.fr/Phocea/Vie_des_labos/Ast/ast_technique.php?id_ast=784
$e^+/e^-$ selector

Temporary $e^+$ detector

For cryogenic moderation in a later step
Installation at Saclay

Simulation for radiological safety
Installation (nov’08)

Linac

e⁺/e⁻ selector

Dedicated water temperature regulation for magnets and linac
Outlook

2009 milestones: Linac final commissioning and W Moderation

Starting or continuing in 2009:
- Systematic studies of mesoporous SiO$_2$ for $P_s$ production (at Cern)
- Cryogenic moderation
- Design and building of a high field Penning trap adapted to linac for $\bar{H}$ physics
- Low field trapping for material science (needs a more extended time structure)