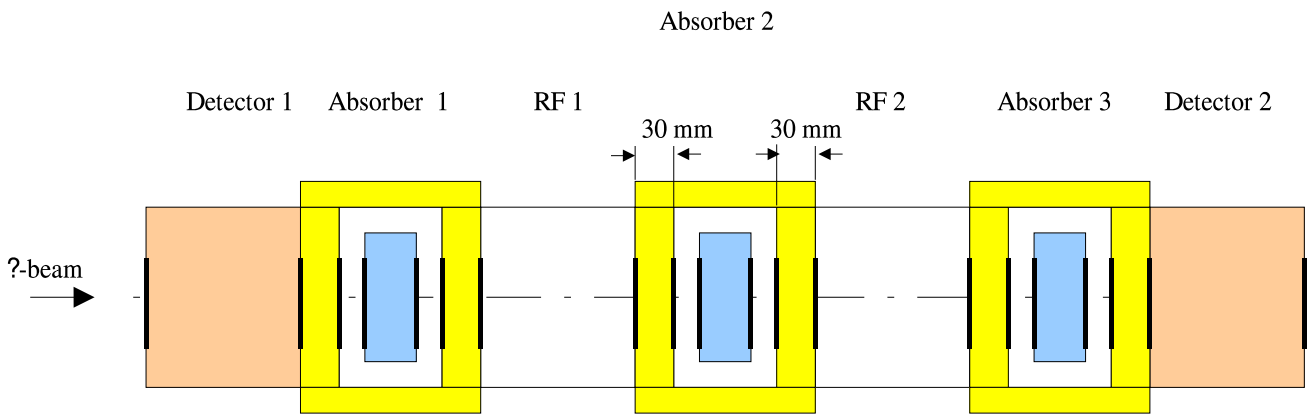
MICE Option 3

Windows in MICE : Option 3

Is it what we need from the LH2 safety point of view?



Vacuum

LH_2

He

Detector gas

Window
(20 windows in total)

RAL's comment:

This scheme is the closest one to the design of RAL hydrogen moderators which have been approved by RAL/ISIS Safety officers.

Questions remains to be answered:
if the LH_2 window breaks and a jet of cold hydrogen touches the intermediate safety window which is warm, how does the latter one behave?

Cooling Materials and Windows

The Effects of Different Cooling Materials and Windows, Palmer, Fernow, Gallardo: MUC-Note 233, March 2002

Table 1: Energy loss, radiation length, Q values for absorber materials and windows.

Material	$(dE/dz)_{\text{min}}$ (MeV/cm)	L_R (cm)	$Q(\text{mat})$ (mm mrad/cm)
Liq. H_2	0.286	865	38
Liq. He	0.242	755	52
Gas He	$3.22\,10^{-4}$	$5.67\,10^{5}$	51
LiH	1.52	102	61
Be	2.95	35.3	90
Al	4.36	8.9	243

Cooling material, cont'

$\epsilon_{\text{equilib}} = \beta_\perp \; F(E) \; Q(\text{mat})$ where $F(E) = \left(\frac{1}{\beta_v \frac{(dE/dz)}{(dE/dz)_{\text{min}}}} \right)$

$Q(\text{mat}) = \left(\frac{E_s^2}{2 \; m_\mu c^2 L_{\text{R}} (dE/dz)_{\text{min}}} \right)$ and $E_s \approx 14.1$ MeV,

$m_\mu c^2 = 105.6$ MeV, and all other units are mks; $F(E)$ for our cases is close to unity. For an extended channel with average momentum loss $\frac{dp}{d\ell}$

$$\epsilon_n = \epsilon_{\text{equilib}} + \left(\epsilon_{\text{initial}} \epsilon_{\text{equilib}} \right) \; e^{-\frac{dp}{dl} \frac{l}{p}} \tag{1}$$

and the initial rate of emittance reduction is seen to be:

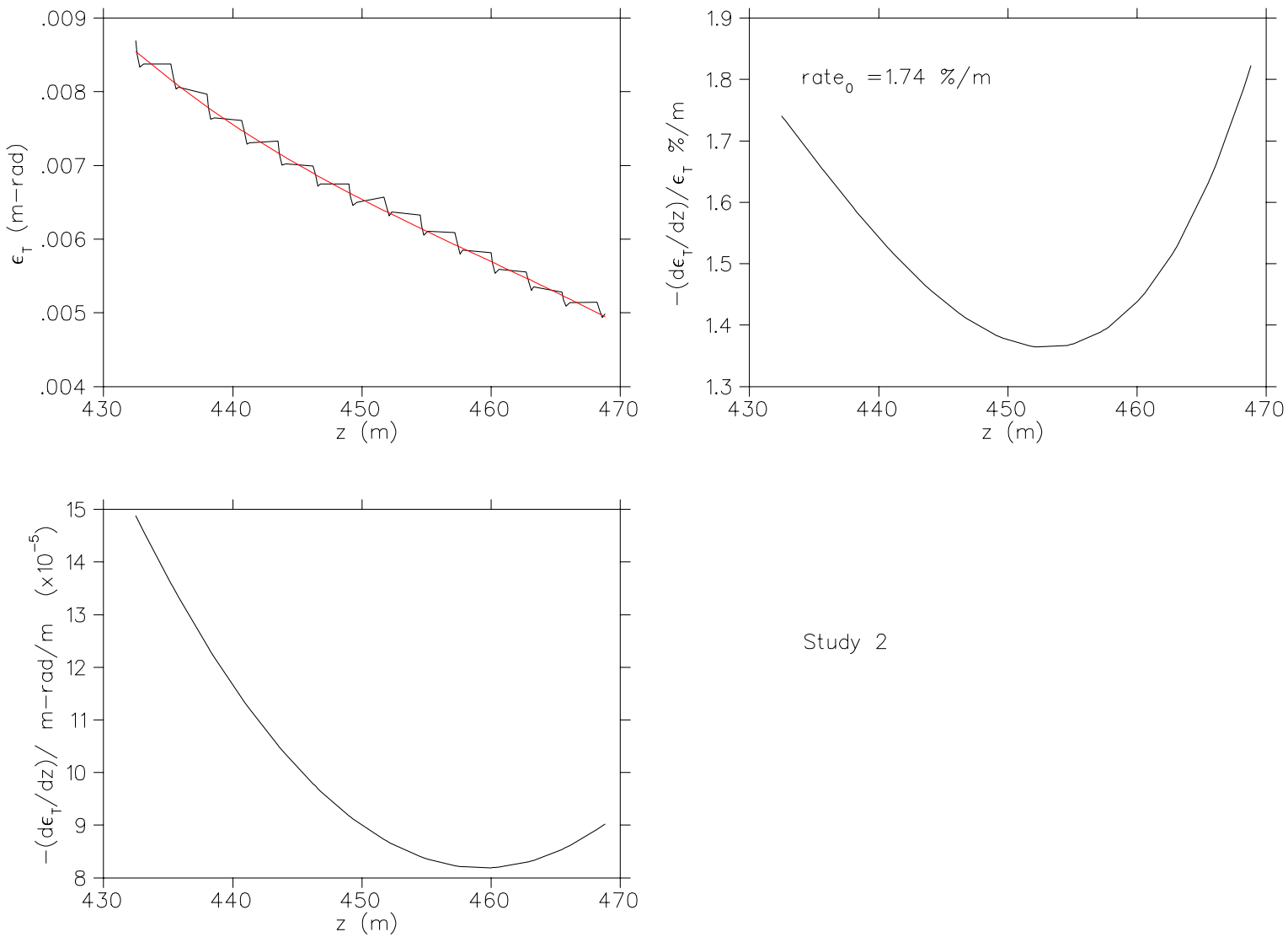
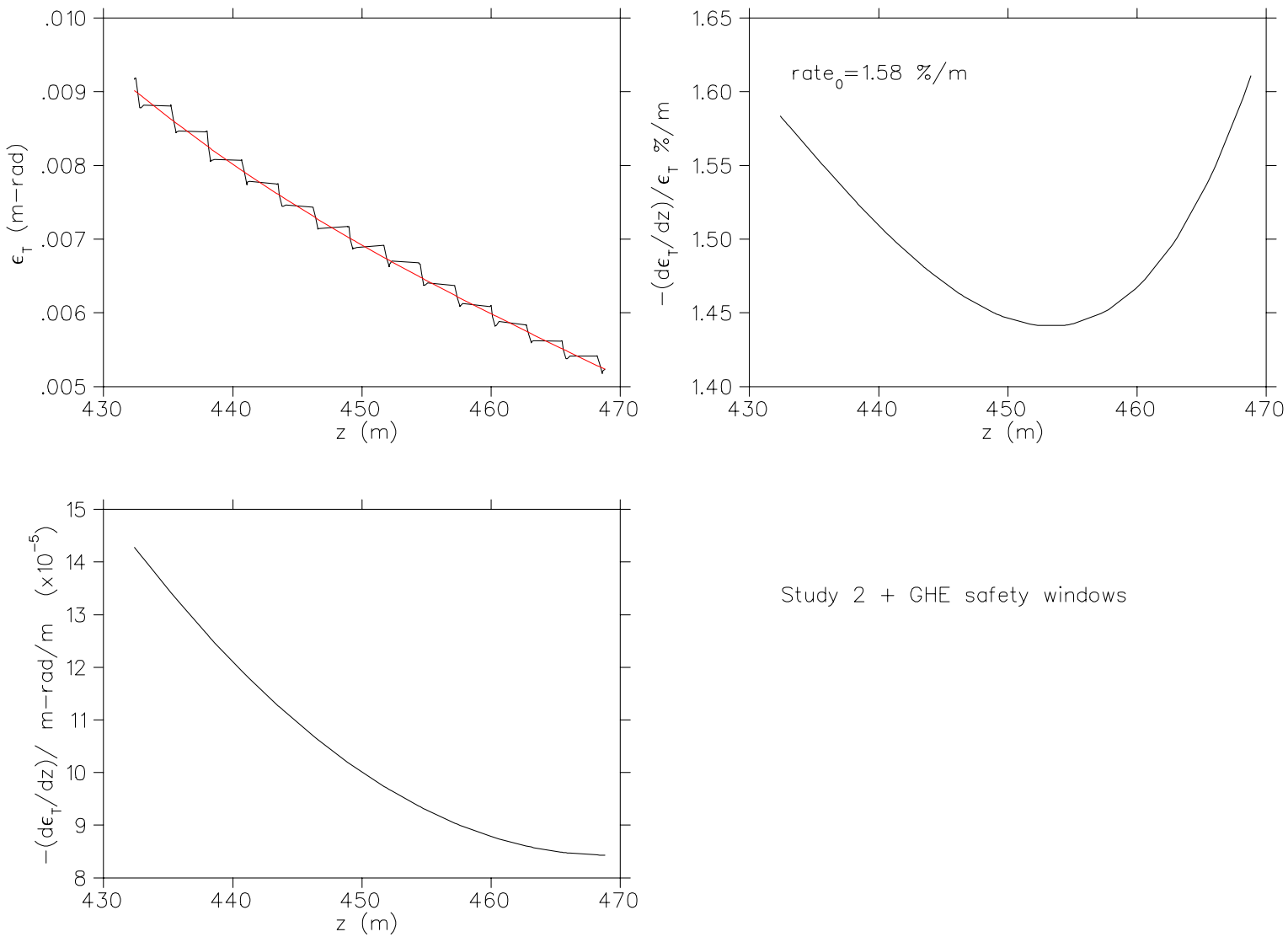
$$\left(\frac{1}{\epsilon_n} \frac{d\epsilon_n}{d\ell} \right)_{\text{initial}} = -\frac{1}{p} \frac{dp}{d\ell} \; \left(1 - \frac{\epsilon_{\text{equilib}}}{\epsilon_{\text{initial}}} \right) \tag{2}$$

Results from ICOOL runs

Table 2: (A)Study 2; (B) +4$\times$ Al windows; (C) GHE+safety wind.; (D) Study 2 with LHE; (E) Study 2 with LIH

	[μ/p] %	ϵ_T	ϵ_L	ϵ_6	rate$\|_0$
(A)	21.9	2.54	27.2	0.18	1.74
===>(B)	20.4	2.98	28.5	0.27	1.63
===>(C)	20.7	2.9	28.4	0.26	1.58
(D)	16.9	3.24	31.1	0.31	1.00
(E)	15.8	3.23	27.2	0.30	1.33

ϵ_T evolution and cooling rate



ϵ_T evolution and cooling rate