Leak rate calc

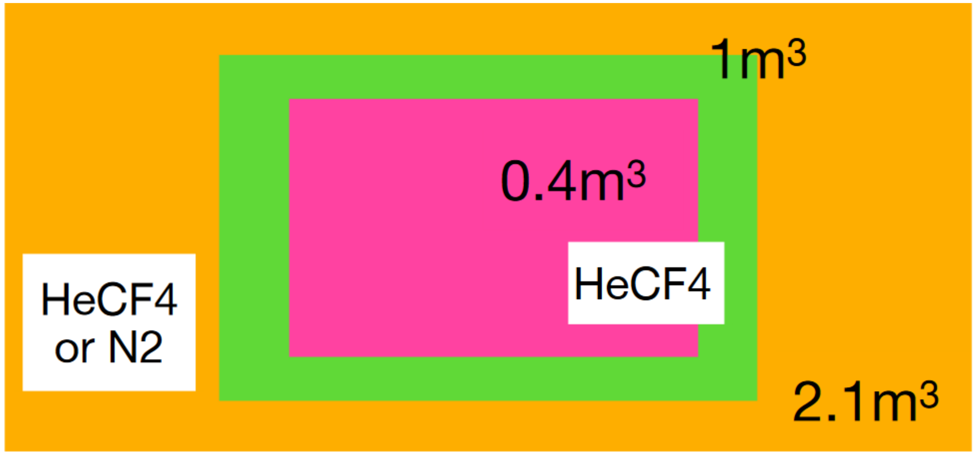
agenda.infn.it/event/41524/contributions/232008/attachments/123144/180479/renga_cygno_jul24.pdf

- From Renga's presentation, the asymptote of the concentration due to leak and radioactive decay is

$$\gamma_{det} = \gamma_{air} \frac{\phi_{Air}}{\phi_{fresh} + \lambda V}$$

- We can try to estimate the decay per year in Cygno-04 due to ^{222}Rn infiltrating through the leakages as:

$$D_{CY04} = \gamma_1 V_{04}$$



D_{CY04}	Events per year in sensitive volume of CYGNO-04
γ_1	Events per year per m^3 in sensitive volume 1 (green and magenta)
V_{04}	Magenta volume -> 0.4 m^3

Leak rate calc

- γ_1 can be evaluated by the Renga estimation considering the air inside the copper vessel entering the PMMA one

$$D_{CY04} = \gamma_1 V_{04} = V_{04}\gamma_2 \frac{\phi_{Leak1-2}R + (1-\varepsilon)\phi_{rec}}{\phi_{fresh} + \varepsilon\phi_{rec} + \lambda V_1}$$

γ_2	Events per year per m^3 in sensitive volume 2 (orange)
$\phi_{Leak1-2}$	Leak rate of the PMMA box to the volume2 -> Estimated equivalent to LIME: 0.4 l/h = 6,67 sccm
R	Ratio between leak rate and air which enters the PMMA box (volume 1). Estimated from LIME data by Renga at 0,022
ε	Efficiency in purification from Rn of filters -> 0.95
ϕ_{rec}	Recirculation flow
ϕ_{fresh}	Fresh gas flow
λ	Decay rate of ^{222}Rn half-life-> 3,8432 d -> 1,26 10^{-4} 1/min
V_1	Green and purple volume -> 1 m^3

- Big if: will R be the same in Cygno-04 with respect to LIME?
- This way we include the new fresh gas, the cleaned and not cleaned recirculated and the decay of the Rn

Leak rate calc

- γ_2 can be evaluated again by the Renga estimation considering the outside air entering the copper vessel

$$D_{CY04} = \gamma_1 V_{04} = V_{04}\gamma_2 \frac{\phi_{Leak1-2}R + (1-\varepsilon)\phi_{rec}}{\phi_{fresh} + \varepsilon\phi_{rec} + \lambda V_1} =$$

$$= V_{04} \frac{\phi_{Leak1-2}R+(1-\varepsilon)\phi_{rec}}{\phi_{fresh}+\varepsilon\phi_{rec}+\lambda V_1} \frac{\phi_{Leak2}R+\delta\phi_{Leak1-2}}{\phi_{N2}+\lambda V_2} \gamma_{Air}$$

γ_{Air}	Events per year per m^3 in air in LNGS -> 10^6 events/y/l = 10^9 ev/y/m^3
ϕ_{Leak2}	Leak rate of the copper box to the outside
ϕ_{N2}	Flux of nitrogen
V_2	Volume inside copper vessel excluding the PMMA (orange) -> 1,1 m^3
δ	Ratio of γ_1 over γ_{Air}

- Same as before but I need to include the leak coming from the PMMA which is dirty into the copper vessel.
- This term is rescaled considering that the Rn contamination inside V1 is lower than air (delta).
- Obtained with recursive methode in a conservative configuration -> $\delta = a\phi_{Leak2}$ con a = 1.44 10^{-6}

Fresh gas 5 l/h, Rec gas 50 l/h, N2 flux 30 l/h

Leak rate calc

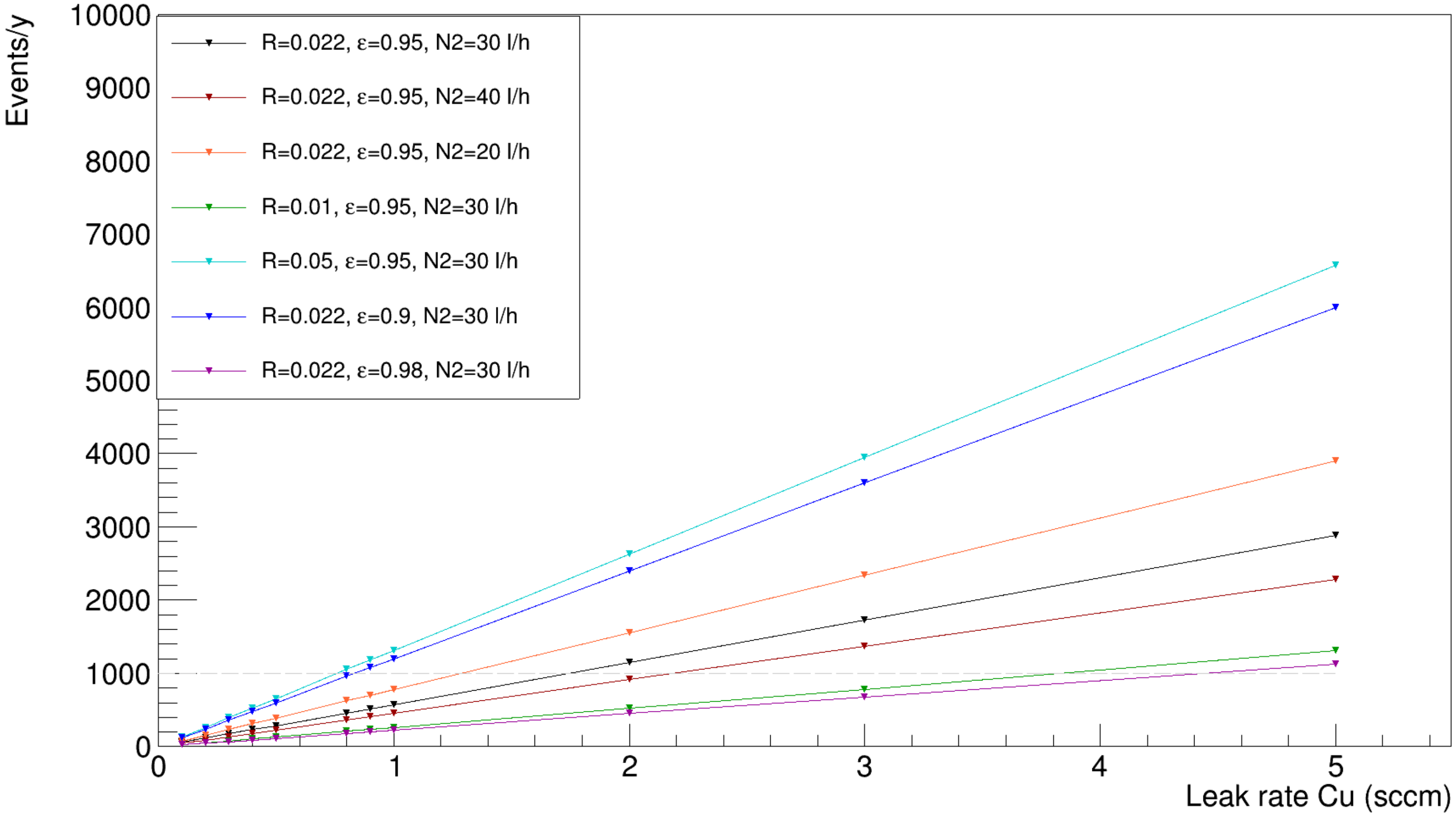
- THUS

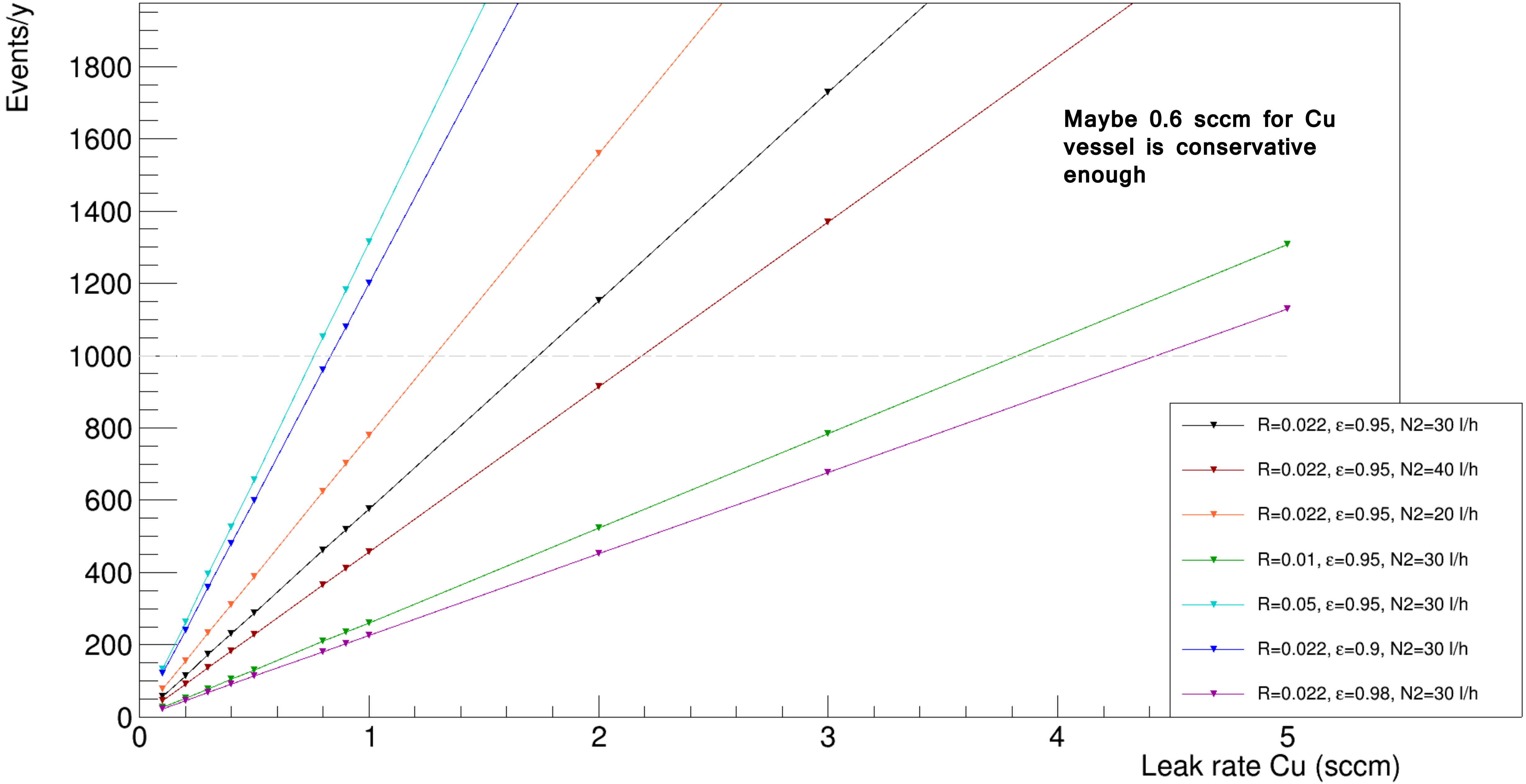
$$D_{CY04} = \gamma_1 V_{04} = V_{04}\gamma_2 \frac{\phi_{Leak1-2}R + (1-\varepsilon)\phi_{rec}}{\phi_{fresh} + \varepsilon\phi_{rec} + \lambda V_1} =$$

$$= V_{04} \frac{\phi_{Leak1-2}R + (1-\varepsilon)\phi_{rec}}{\phi_{fresh} + \varepsilon\phi_{rec} + \lambda V_1} \frac{\phi_{Leak2}(R + a\phi_{Leak1-2})}{\phi_{N2} + \lambda V_2} \gamma_{Air}$$

Examples

- If I fix:
    - Recirculation flux to 50 l/h
    - Fresh flux to 5 l/h
- I can then vary:
    - Efficiency in Rn purification: (0.9 to 0.98)
    - N2 flux (20 -> 40 l/h)
    - R (0.01 -> 0.05)
    - Leakrate of Cu vessel




Events/y
1800
1600
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
5
Leak rate Cu (sccm)
Maybe 0.6 sccm for Cu vessel is conservative enough
R=0.022, ε=0.95, N2=30 l/h
R=0.022, ε=0.95, N2=40 l/h
R=0.022, ε=0.95, N2=20 l/h
R=0.01, ε=0.95, N2=30 l/h
R=0.05, ε=0.95, N2=30 l/h
R=0.022, ε=0.9, N2=30 l/h
R=0.022, ε=0.98, N2=30 l/h