# The Rn emanation and the shroud

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Background from radon emanation of the GERDA cryostat

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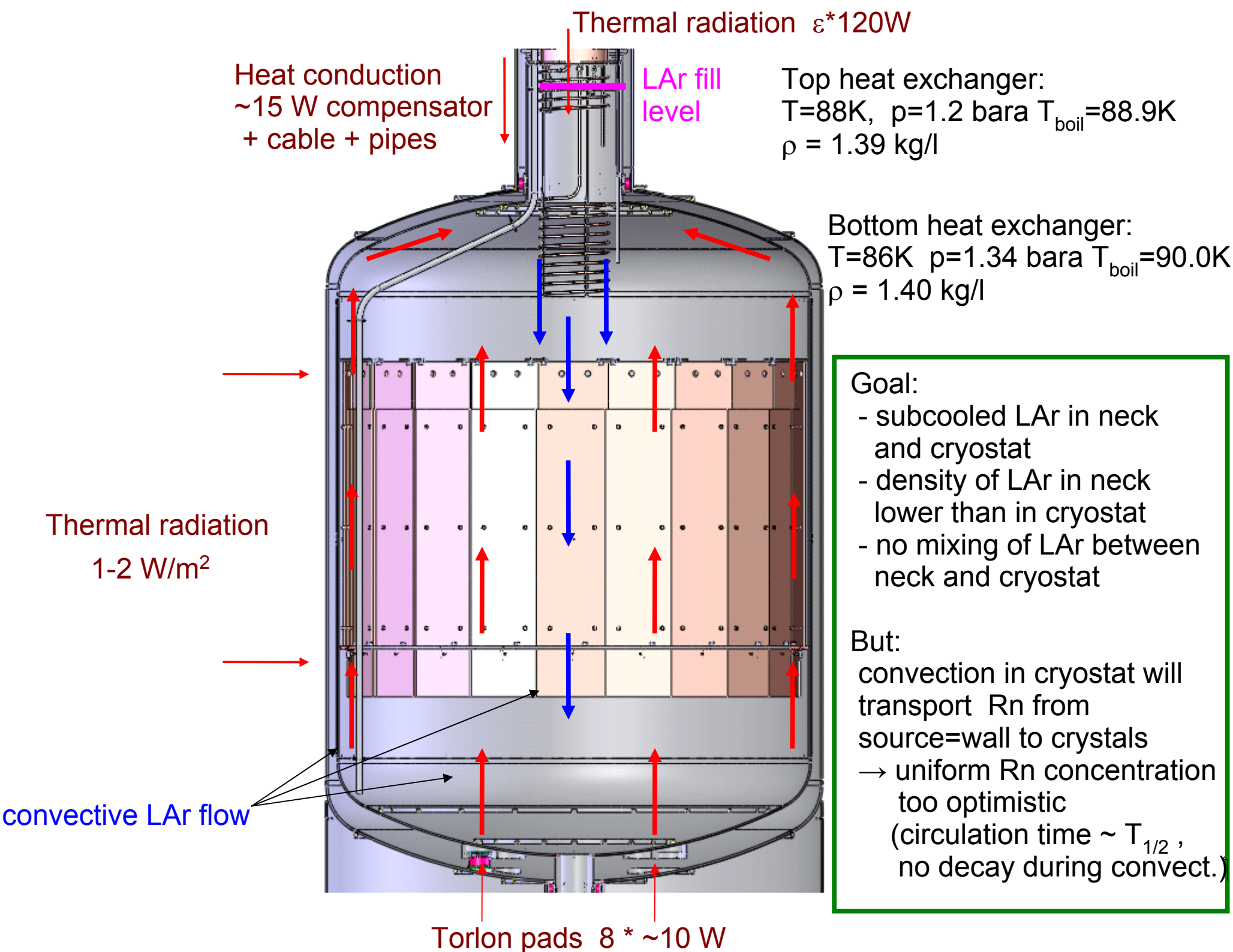
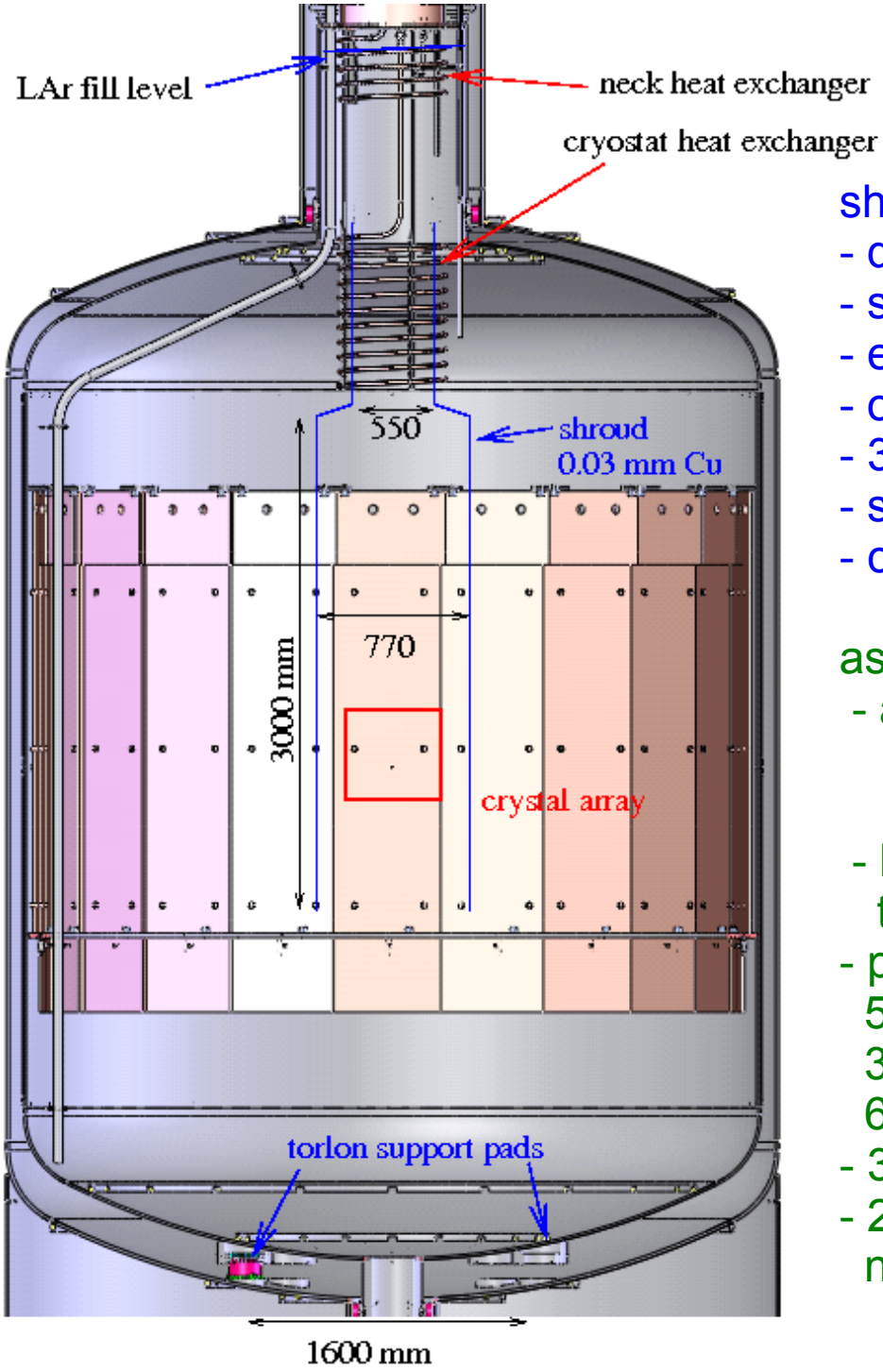
# Cryostat Rn emanation measurements with MOREX (in mBq)

| | | |
|---|---|---|
| after 1st cleaning | Nov 07 | 16.9±1.6±3.0 |
| | | 29.8±2.4±5.8 |
| after 2nd cleaning | March 08 | 13.6±0.7±2.7 |
| | | 13.7±0.7±2.7 |
| after copper mount | June 08 | 33.0±2.8±7.0 |
| | | 35.7±2.9±8.8 |
| after 3rd cleaning | Dec 08 | 33.2±3.5±1.9 |
| | | 31.3±4.6±3.4 |
| | | 27.3±2.4±0.7 |

GSTR 07-20: For uniform $^{222}$Rn distribution of 8 mBq bkg = $10^{-4}$ cts/(keV kg y) for phase I
→ current Rn emanation factor 2-3 above the limit


Thermal radiation ε*120W
Heat conduction
~15 W compensator
+ cable + pipes
LAr fill
level
Top heat exchanger:
T=88K, p=1.2 bara $T_{boil}$=88.9K
ρ = 1.39 kg/l
Bottom heat exchanger:
T=86K p=1.34 bara $T_{boil}$=90.0K
ρ = 1.40 kg/l
Thermal radiation
1-2 W/m²
Goal:
- subcooled LAr in neck and cryostat
- density of LAr in neck lower than in cryostat
- no mixing of LAr between neck and cryostat
But:
convection in cryostat will transport Rn from source=wall to crystals
→ uniform Rn concentration too optimistic
(circulation time ~ $T_{1/2}$ , no decay during convect.)
convective LAr flow
Torlon pads 8 * ~10 W

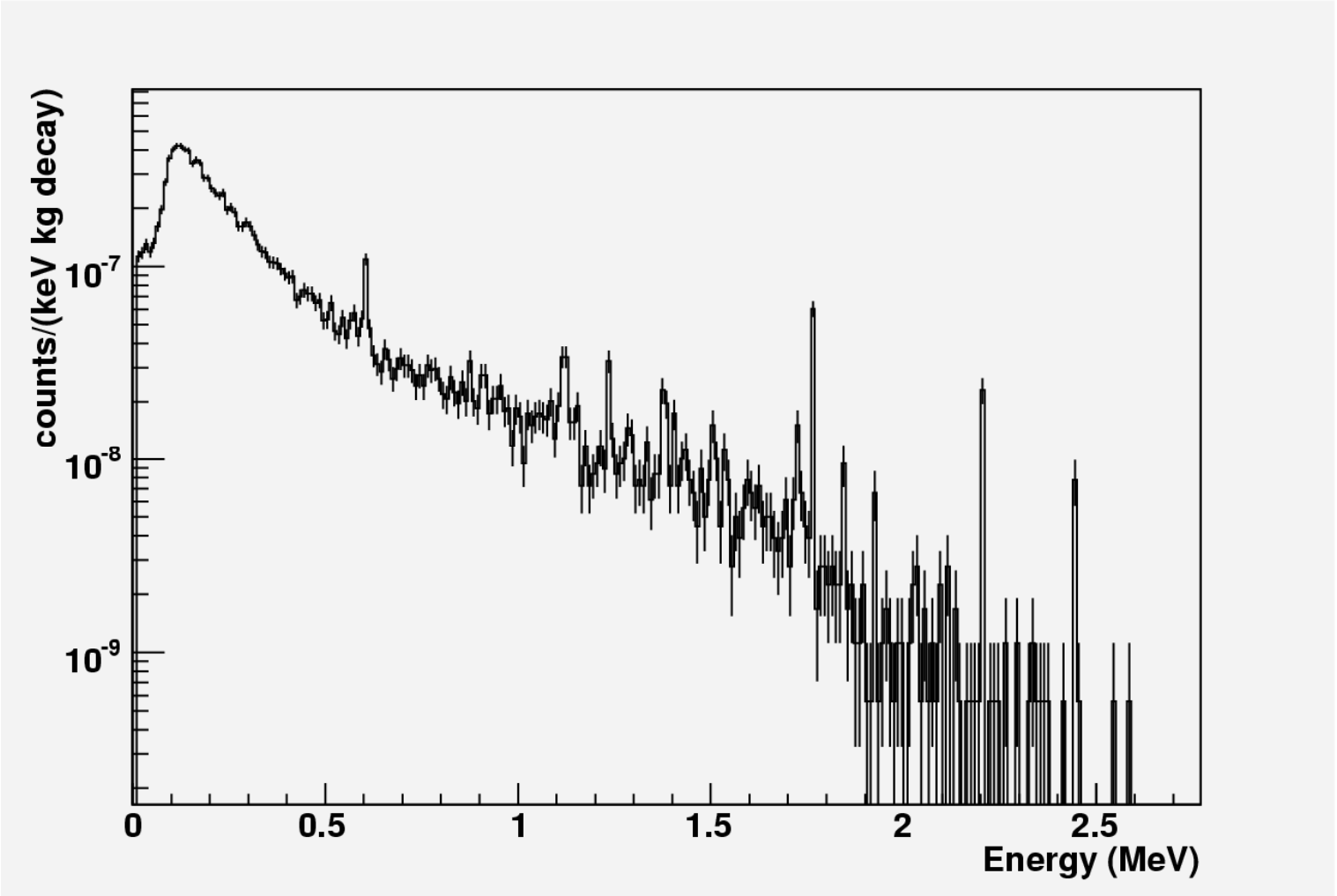
# Proposal: copper shroud to keep Rn away from crystal array




shroud design:
- diameter 770 mm
- starts 10 cm “above cryostat”
- ends 1 m below crystal array
- open on top and bottom
- 30 micron copper foil, 3 m high
- stainless steel fixation at top
- copper ring at bottom

assumptions for simulation:
- all Rn in
  10 cm thick layer at wall and
  20 cm thick layer around shroud
- homogeneous Rn concentration in this volume of 13.3 $m^3$
- phase I array:
  5 Heidelberg-Moscow +
  3 IGEX +
  6 GeniusTF detectors
- 30 mBq emanation
- 2 separate LAr volumes (no mixing): neck and cryostat

# $^{214}$Bi spectrum in $^{enr}$Ge diodes




bkg index = 1,4 x $10^{-4}$ cnts/(keV kg y) without anti-coincidences
1.1 x $10^{-4}$ cnts/(keV kg y) with detector anti-coincidences

bkg from $^{232}$Th of copper foil (20 μBq/kg) = 0.17 x $10^{-4}$ cnts/(keV kg y)
(Rn emanation of foil will be measured in HD)

without shroud: factor ~10 larger bkg index → not acceptable even for 8 mBq em.

# Conclusion

- cleaning in November did not (significantly) reduce Rn emanation

- due to convection Rn will be transported from wall/copper to crystal array
  → non-homogeneous concentration

- the shroud will keep a minimal distance between Rn and diodes

- due to different cooling temperatures of upper and lower heat exchangers
  no/little mixing of LAr from neck and cryostat
  → shroud design ok?

- simulation → expect a background index ~ 1.5 x $10^{-4}$ cnts/(keV kg y)
  (if copper foil has low $^{232}$Th concentration and little Rn emanation)