

Radon Trapping Facility Status









- Adsorption of ²²²Rn in a charcoal column vessel
- Radon trapping for dummies
 - 222 Rn half time = 3.8 day \rightarrow 1000 reduction if we can keep Rn in vessel for 38 day
 - Lowering temperature increase the adsorption efficiency





- Situation in 2018 (before merging with LPSC)
 - RTF unreliable
 - Charcoal column was not compliant to pressure vessel regulations
 - Flow rate needs to be improved (target 300m³/h)
 - Price for the upgrade was estimated to ~150k€
- mid-2018 (LPSC interim)
 - IN2P3 provide 80k€ for RTF, preparation of a first tender
 - 9/2018 : Asking for quotation to ATEKO \rightarrow dead-letter
 - 10/2018 : SuperNEMO meeting in Prague, ATEKO provide a quotation without contacting LSM
 - 415k€ ...
 - Proposed system not adapted (power consumption, cooling)
 - 11/2018 : SuperNEMO french members proposed an IN2P3 development of the RTF
- 2019
 - New option with a french company (COMEX)
 - Call for tender written in may and sent to CNRS for approval and publication
 - CNRS unable to publish the tender in 2019

2020 - Pandemics

- No progress on the tender
- Meeting with IN2P3 direction in March
 - Tender for scientific equipment (> 150 k€) will not reach this year ...
 - Technical director ask us to manage the project @ LSM :
 - Tender (~50k€) for studies and dimensioning
 - Purchase and installation of separate equipment
- Phasing
 - Replacing ASAP the out-of-order refrigeration system with provision for upgrade
 - Replacing the compressor-dryer in a second phase
- Contact with companies with more detailed specifications (focus on the cooling)
 - ATEKO visit 10/2020 but did not provide better offer (150k€ without taking into account new specs)
 - Lack of interest of most companies
 - Angelantoni (ACS) visit 05/2021 but finally decide to withdraw in july
 - → decision for in-house study

2020 - Technical issues

- Cooling
 - Power consumption increased from 27kW to >60kW to provide 300m³/h
 - Air cooling is no longer an option and free water is not available @ LSM
 - A solution proposed by LSM (fire water loop) was refused by tunnel
 - Water consumption estimated to 100 m³/day → not allowed by tunnel and 100k€/year just for water operation costs
- Compressor power consumption has to be reduced
 - Reduction of working pressure (is 8 bars required or optimal ?)
 - Reduction of dryer losses (almost 100m³/h is used for dryer regeneration)
 - Reduction of needed flow rate by increasing radon reduction
 - Better charcoal (can be expensive for large charcoal column)
 - Lower temp
- Ice formation in the refrigeration system
 - Lowering charcoal column temperature could greatly improve radon reduction
 - -50°C was already a limit with regular failure of heat exchanger due to ice formation
 - Defrosting system needed to ensure reliability

Working Pressure

- Low pressure advantage :
 - No pressure vessel regulations under 4 bar
 - Better compressor efficiency :
 - Same compressor, 45kW : 540 m³/h @ 4 bar vs 410 m³/h @ 8 bar
- High Pressure advantage :
 - Increasing pressure in charcoal column decrease volume flow rate
 - Better Rn reduction but saturation effect
 - Losses in dryer : 30 % @ 4 bar vs 17 % @ 8 bar (-70°C dew point)
 - So for 45 kW : 380 m³/h @ 4 bar > 340 m³/h @ 8 bar
- 4 bar option
 - No periodic verification due to state regulations
 - Better flow rate / Power ratio
 - dedicated, low pressure compressors can even be more efficient



Dryer losses and ice formation

- Experience shows that ice formation occurs with aging dryer
- Management of ice formation in heat exchangers
 - Two rotating exchangers circuits :
 - Cooling circuit \rightarrow ice formation is allowed
 - Defrosting circuit \rightarrow ice sublimation
 - Heat exchanger rotation period is an additional parameter to improve efficiency and relax drew point
 - Charcoal column temperature can be lower than -50°C, option to go down to -80°C



- Study and schematics of refrigeration SKID done
 - Major components ordered
 - Slow control and instrumentation subcontracted to external company
 - Final mechanical design and manufacturing to be complete @ LPSC
 - 75k€ invested in 2021



- Refrigeration unit
 - Specifications defined and tender written
 - At least two company identified
 - Waiting for tender publication
 - Uncertainty about lead time
- Compressor and dryer
 - Second phase of the upgrade
 - Validation of the refrigeration unit is needed to complete specifications
 - Adjustment of drew point to reduce dryer losses
 - Critical risk : possible need of more cooling capacity @ LSM
 - Lead time should not be an issue (if off-the-shelf products comply)

Conclusion

- Replacing LSM Radon Trapping Facility was not as straightforward as expected
 - ATEKO offers are over budget and does not provide solutions to technical issues
 - Difficulty with CNRS headquarter to publish invitation to tender
 - Off-the-Self solutions for asked flow rate exceed power dissipation capability
- Alternative solution has to be found
 - It take time, project goes back and forth ... and pandemics did not help !
 - Industry has no interest in developing such solutions
 - Limited manpower available @ LSM (~0.5 FTE)
- Stable design achieved in 09/2021
 - First orders 10/2021
 - Involvement of LPSC technical teams
- Planning uncertainties
 - Tender for refrigeration unit
 - Lead times