Development of a Cask for Interim Storage and Final Geological Disposal in Switzerland

Approach, Challenges and Realization

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Acknowledgement

Presented in the name of and dedicated to all the members of the working group taking over responsibility for

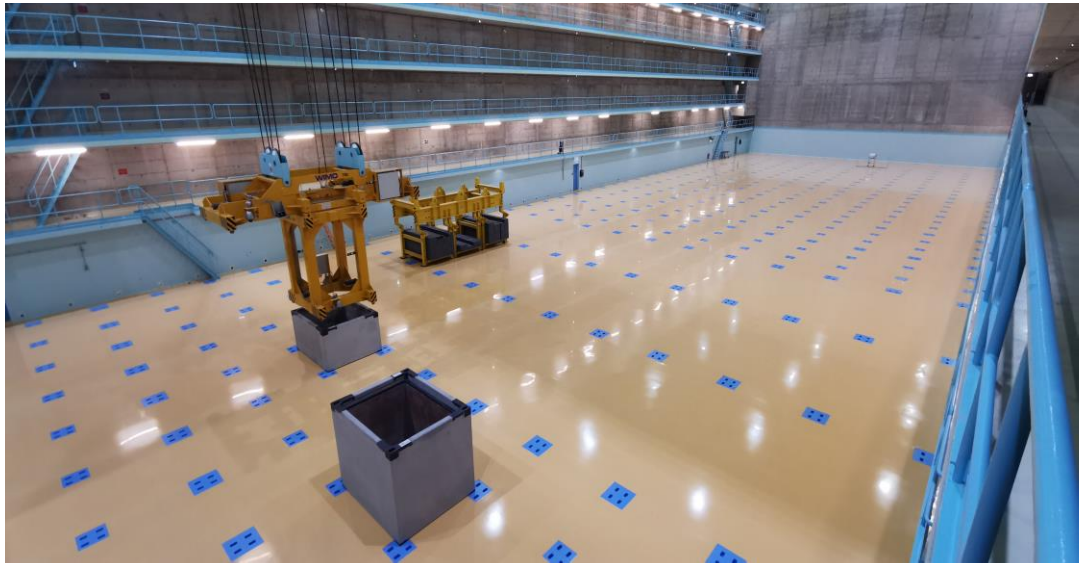
- their ideas and constructive input as well criticism,
- the creation of the concept and it's optimization,
- the production of the new container and
- the testing / qualifying according to the requirements for interim storage, final repository and transport

but especially to **Harald Maxeiner (Nagra),** in retirement but still the father of the product

Introduction

- Decision in 2013 → Shut Down of the NPP Mühleberg end of 2019
- Immediate dismantling starting in the beginning 2020
- Waste packages for interim storage and final disposal necessary

→ **2015 starting of the project «LC-84/86»**



Stakeholders in the process:

- Nagra as planner for the final repository
- Zwilag as NPP interim storage for SMA wastes
- NPP (Beznau, Gösgen, Leibstadt, Mühleberg)
- Ensi as authority for conditioning and transport of the radioactive waste

Design Criteria

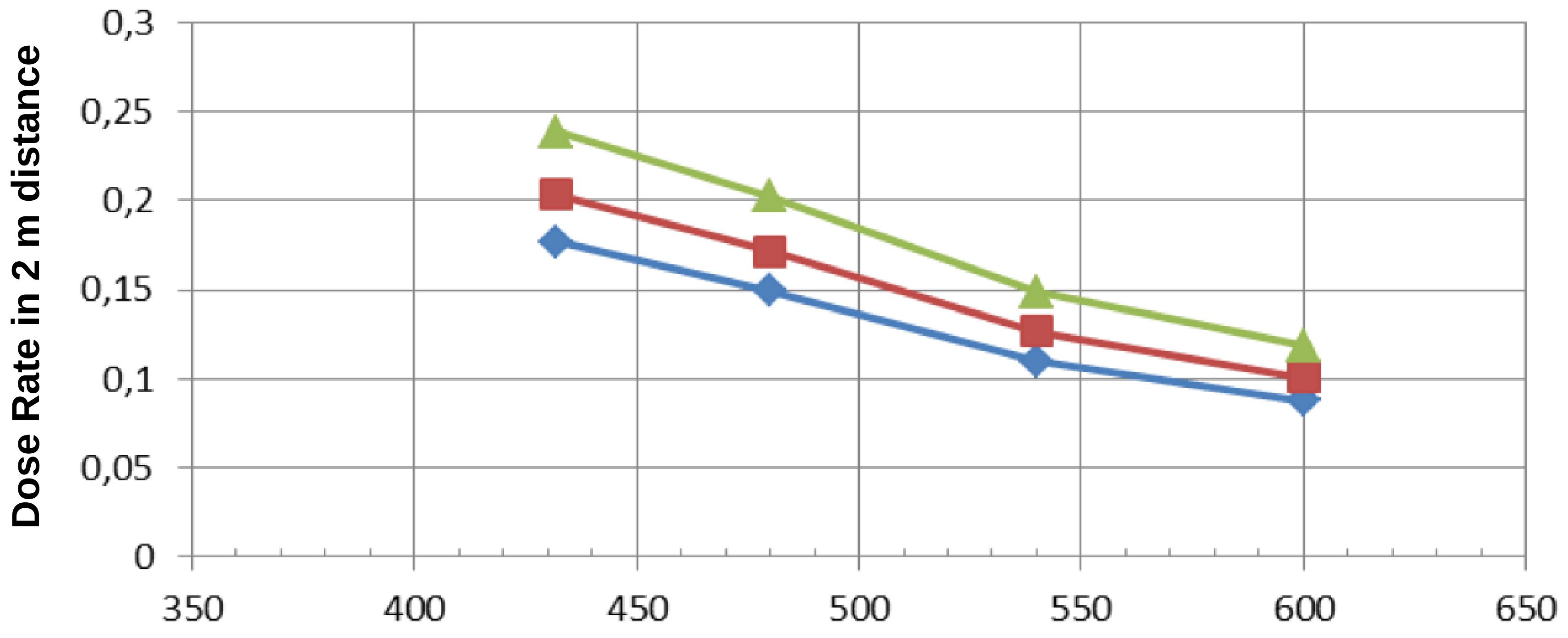
- **Concrete as construction material →** minimizing gas production in the deep geological final repository (opalinus clay)
- **Gross mass limitation to 25 t →** efficient handling & standard road transport
- **Two different sizes→** metallic waste (high density) & concrete rubble (low density)
- **10-fold stacking →** criteria Zwilag for interim storage
- **Transport →** design as IP-II package in line with ADR-requirements (estimated wall thickness 15 cm (shielding gamma ray Co-60).

LC-84 → i.e. for metallic waste

LC-86 → i.e. for concrete rubble

Basic Design Study

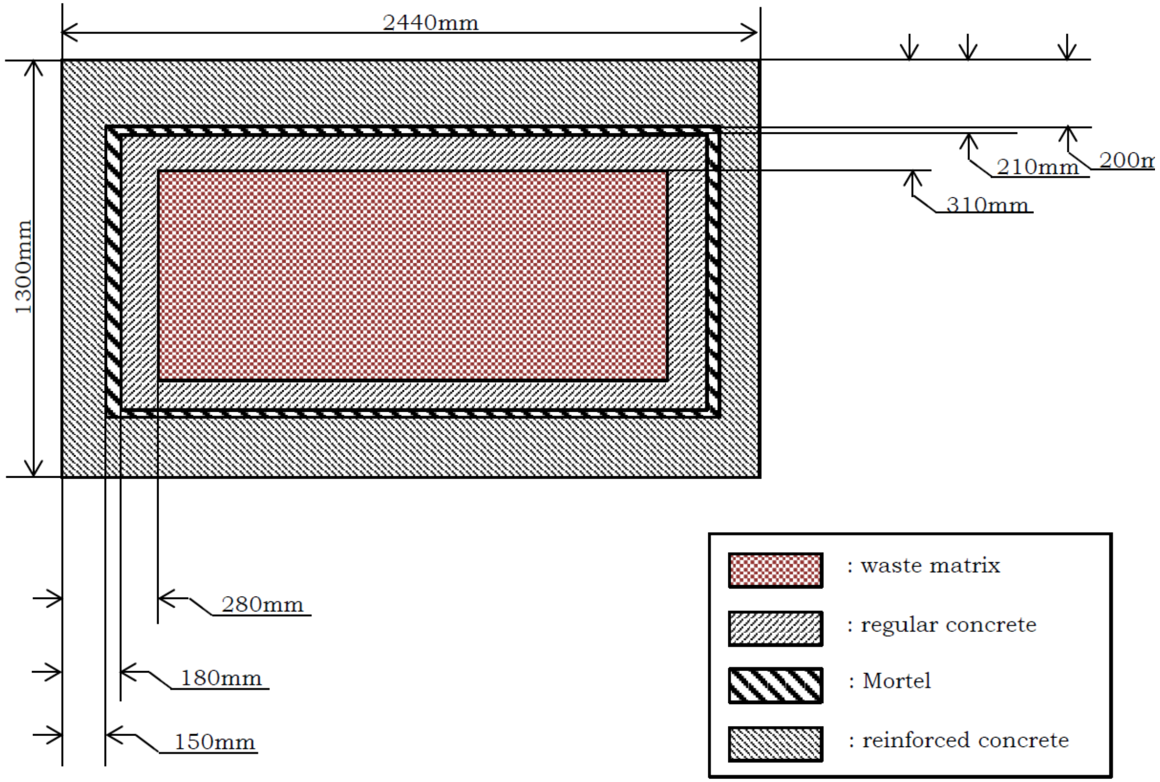
Dose rate calculations based on the proposed maximum activity contents of 2 E+11 Bq Co-60 for evaluating the thickness of the concrete container walls under loaded conditions, depending on different assumed filling heights representing different density of materials

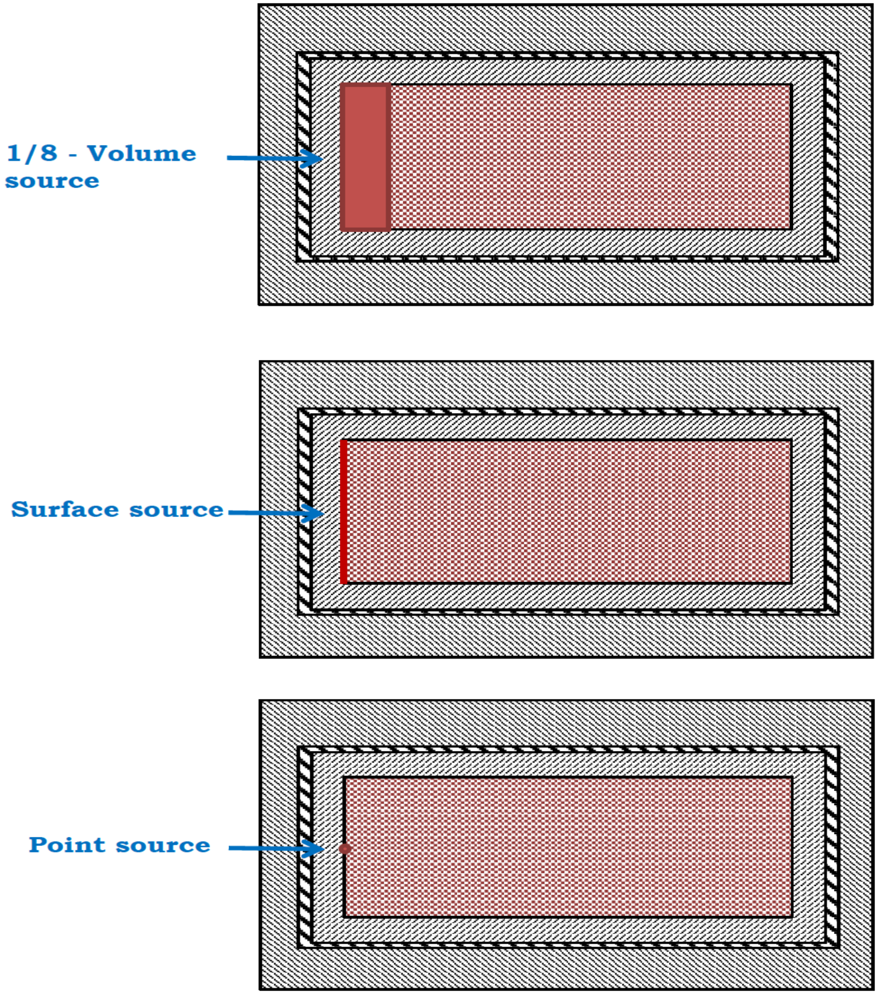


Multiplication thickness and density of the container wall kg/m²
Filling of container up to 40% - 30% - 20%

Basic Design Study

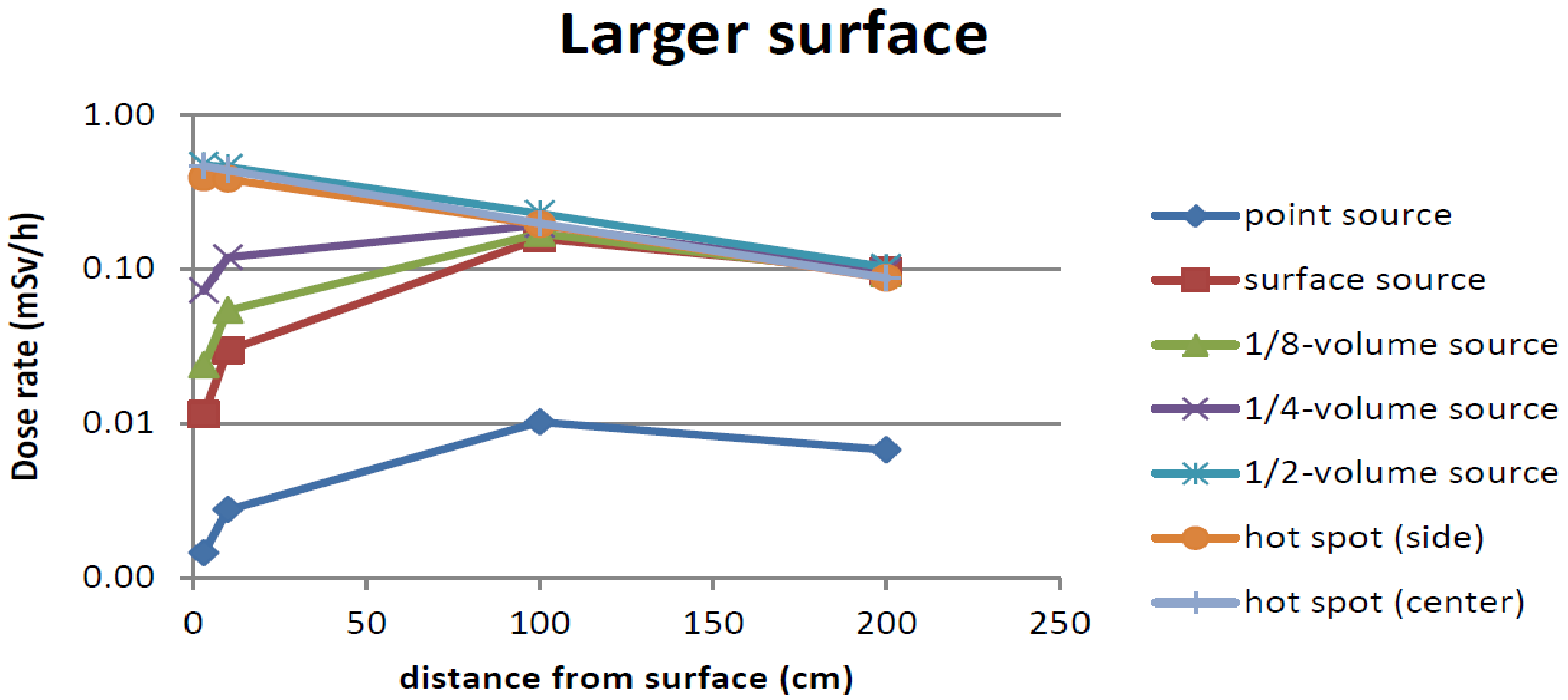
Inhomogeneous activity distribution in a LC (with concrete inlayer as additional shielding)





Basic Design Study

Dose rate in different distances of the LC-84 package depending on activity distribution, large vertical side of LC-84



Prototype

- Aspects for clarification:

– Final conditioning with wastes inside (cementation = heat production)

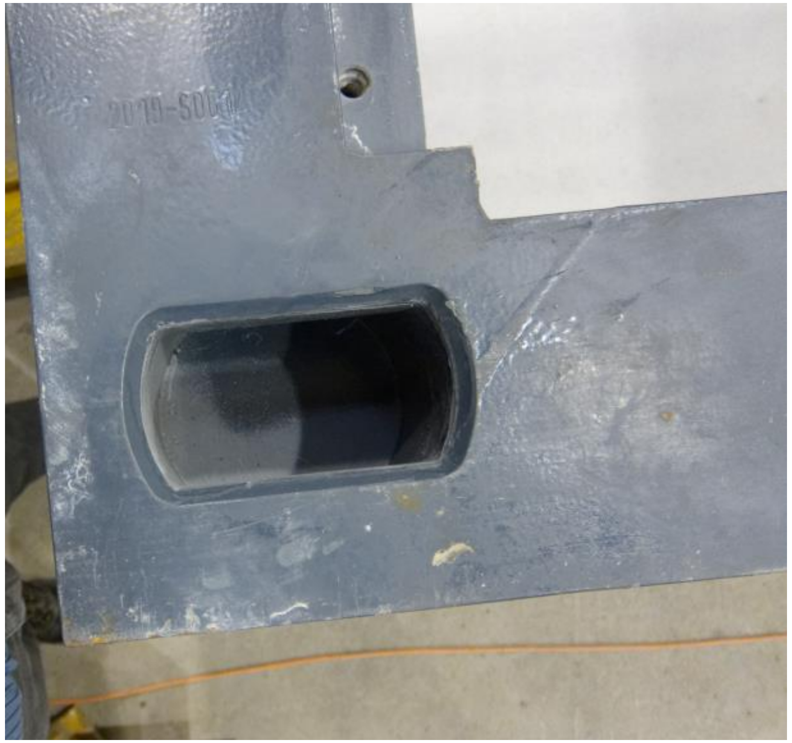
– Decontamination of the concrete surface, painting necessary?

– Optimization of reinforcement
  → Reduction of the steel mass
  → Simplification of manufatoring

– Lid construction for different uses
  → Transport of raw materiel (non conditioned waste)
  → Transport of final conditioned waste
  → Different lids depending on the options direct conditioning and conditioning at Zwilag

Construction

Construction



Iso-Edge on top and correlating pin at the bottom of a cask

Final design data of the concrete casks

	LC-84 V1	LC-86 V1
Länge	2’438 mm	2’438 mm
Breite	1’978 mm	1’978 mm
Höhe Betonkörper *)	1’290 mm	1’940 mm
Höhe Total *)	1’300 mm	1’950 mm
Wandstärke (L) **)	210/220 mm	210/226 mm
Wandstärke (B) **)	180/190 mm	180/196 mm
Bodenstärke	180 mm	180 mm
Lichte Innenhöhe	945 mm	1’595 mm
"Nutzhöhe"	ca. 895 mm	ca. 1'545 mm
Aussenvolumen (Betonkörper)	6.22 m^3	9.36 m^3
Innenvolumen	3.03 m^3	5.07 m^3
theor. Nutzvolumen	ca. 2.87 m^3	ca. 4.94 m^3
Behälterhülle (inkl. Beton-Gussdeckel D4)	ca. 7’990 kg	ca. 10’710 kg
Raumgewicht Beton armiert	ca. 2.5 t/m^3	ca. 2.5 t/m^3

*) Die Höhe des Betonkörpers ist 10 mm geringer als die Gesamthöhe. Diese 10 mm entsprechen der über den Betonkörper herausragenden Auflageplatte am Schubzapfen. Die Schubzapfenlänge selbst ist hier nicht berücksichtigt.

**) Die angegebenen Abmessungen für die Wandstärken gelten jeweils in Höhe Unterkante Deckel, bzw. Oberkante Boden.

Pilot lot and first small series

- Challenges for the industrial but still manual production:
  - Tolerances
  - Interface management (steel/concrete manufacturer)
  - Effective quality assurance
  - Financial aspects / optimization

Pilot lot and first small series

Open casing with metal inlet, top down production

Closed casing ready for cementation

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Pilot lot production

Pilot lot production, first industrial produced LC-86 in October 2019

Testing

- Both kind of containers with different configurations
  - Lids (concrete, metallic)
  - Final conditioned
  - Raw / loose material (non conditioning)
  - Masses (15.8 – 25 Mg)
  - Falling heights
    - First minimum necessary height,
    - afterwards same container with double the minimum necessary height and more

- Results
  - Just small damages, even after the second fall of the same container from double height
  - No loss of activity to be assumed
  - Qualification as Type A Container according regulations of the ADR possible

Testing

Falling height about 1m

Small damage to the pin, first fall, stacking possible

Small crack on top

Damage to the pin, second fall, stacking still possible

Overpack

- Development based on a 10'Container in parallel to the LC
- Qualification as type A package necessary, back up plan in case LC do not fulfill type A transport requirements
- Net mass max. 25 t for transport on lorry, therefore gross mass container maximum 3 t

- Results
- Ready in time of the first transports of LC

  Type A tests successful

  Back-up solution in case of damaged LC and loss

  of the type A qualification during handling

Conclusion

- Necessary to develop in more than one step
  - Basic design
  - Detailed design
  - Prototype
  - Pilot production
- Time for feedback and changes in the layout
- Interfering different layout conditions, finding the optimum for all stakeholder in the process (production of the cask, filling with waste, conditioning, transport, interim storage, final repository)
- Next step today:
  - Industrial production of larger amounts of LC by non nuclear committed companies,
  - Decreasing manual work and still increasing quality,
  - Decreasing of costs

Thank you for your attention