GERDA TG4 – Cryogenic Vessel

Status Report

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GERDA Collaboration Meeting at Milano
13 – 15 November 2006

Outline

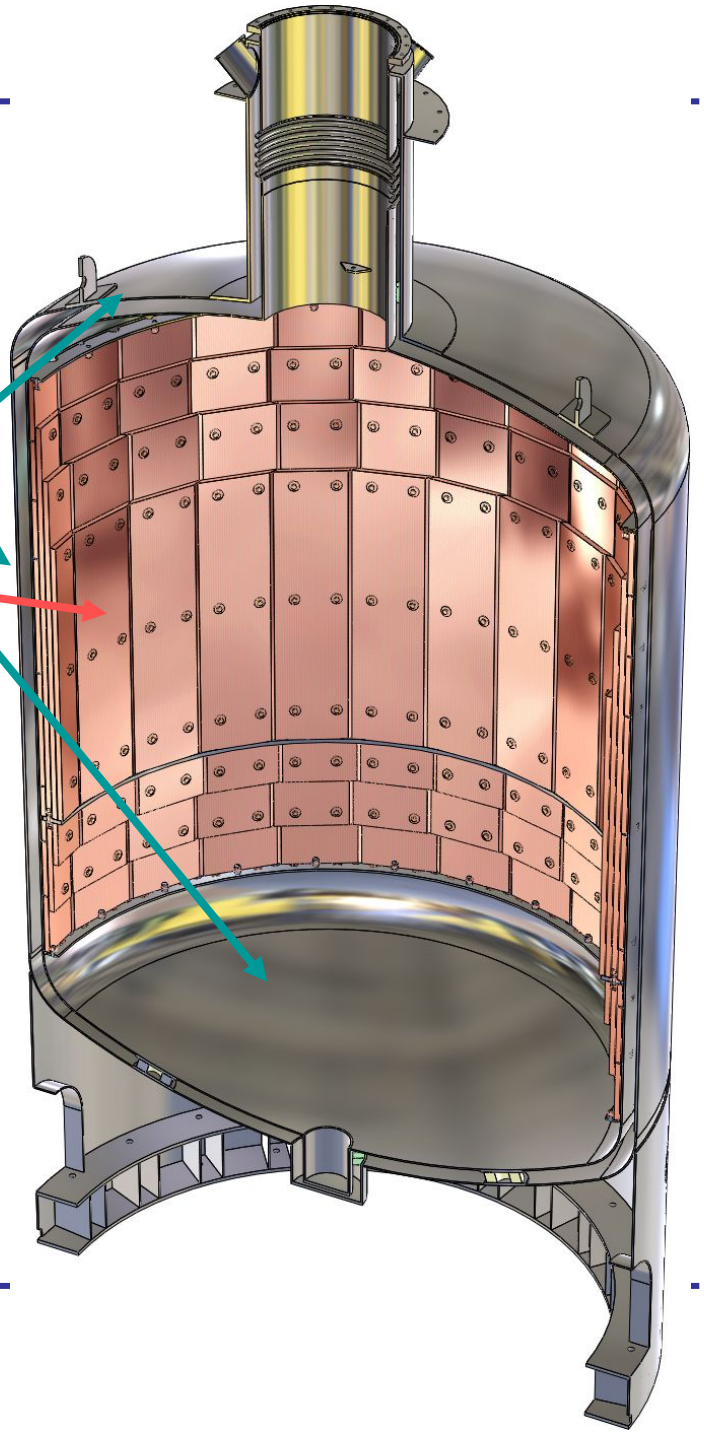
Tender & Order Process

Procurement of stainless steel sheets
Internal Copper shield

Interface Cryostat – Lock - WT
Chevron(s)

Safety Review

Schedule



Tendering Process

- Jun 7 : TED publication 2006 / S106 – 113359
  Prior Information Notice on (1) cryostat, (2) Multi Layer Insulation (MLI), (3) Copper Shield Mounting Tools, and (4) mounting
- Aug 11 : TED publication 164333-2006 for tender of dto. **based on** Technical Specification V1.0 of August 08 (www.mpi-hd.mpg.de/GERDA/NTS-V10.pdf with drawing GC-1001-2006-5.pdf(dwg))
- Sep 29 : Deadline for quotes, 5 quotes for cryostat received, 1 for MLI
- Oct 06 : Quotes evaluated by ad-hoc committee
- Oct 10 : Visit of favoured company
- Oct 19 : Order for cryostat, mounting tool and mounting awarded
- Nov 06 : Contract signed by MPI
- Nov 11: Contract signed by awarded company

Evaluation of Tenders

- Committee of 5 people:
  one expert from CERN, FZ Karlsruhe, and 3 MPI physicists

Criteria	T1	T2	T3	T4	T5
Cost	o	+	-	-	-
Copper mount included?	Y	Y	N	N	Y
Refs. & experience	+	+	+	+	+
Detailed Schedule?	+	-	-	-	+
Answers to our questions	+	-	o	o	+

... and the winner is ?

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Detailed Schedule?	+	-	-	-	+
Answers to our questions	+	-	o	o	+

... and the winner is, unambiguously, T1: SIMIC S.p.A., Camerana, Italy

More on Orders for Cryostat

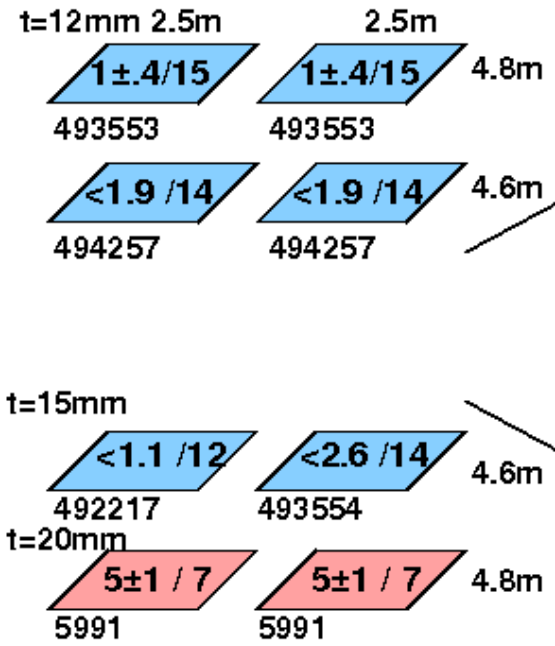
- Jul 25 : Order of 1.4571 sheet material for vessel heads and walls sheets, ~ 23 tons, at Nironit .
  - ► Almost all material available and screened.
  - ► Contract allowed to return material if Th-228 activity is NOT <5 (10) mBq/kg for cylindrical wall (vessel head) material!
- Aug 8 : Order of vessel heads at Antonius, NL.
  - ► Production time 7 weeks after delivery of material; material delivered Nov 8 (a bit late) !
- Nov 10 : Order of 20 tons of copper at NA for internal shield
  - ► Profile of shield still to be determined.

Internal Copper Shield

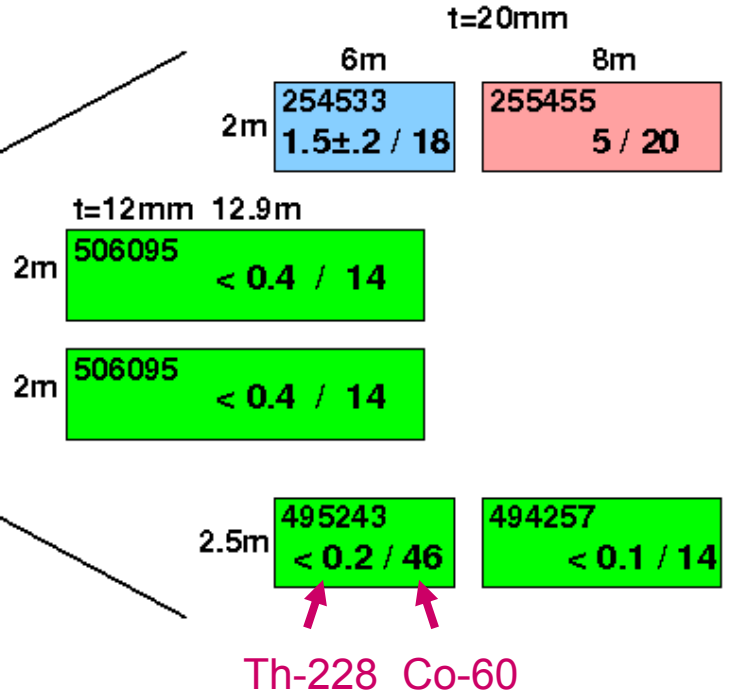
Amount of copper shield determined by radiopurity of ss sheet material:
typically 8, 23, 41 tons for 1, 3, 10 mBq(Th-228)/kg !

MEASURED ACTIVITY of SHEET MATERIAL for

vessel heads (<10 mBq/kg! – MPI HD)



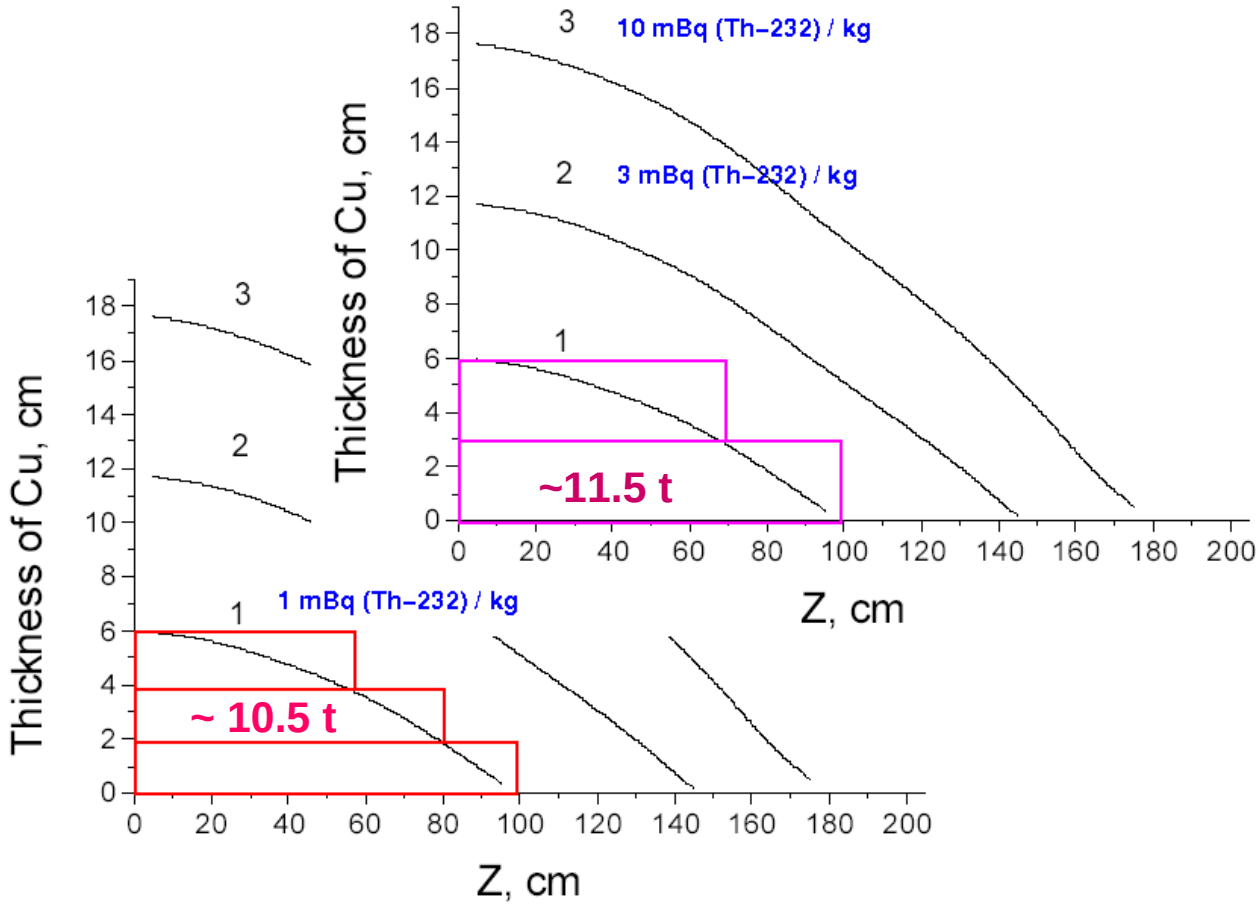
cylindrical walls (<5 mBq/kg! - LNGS)



25.... Arconi
49.... Ilsenburg
50.... Ugine
59.... Industeel

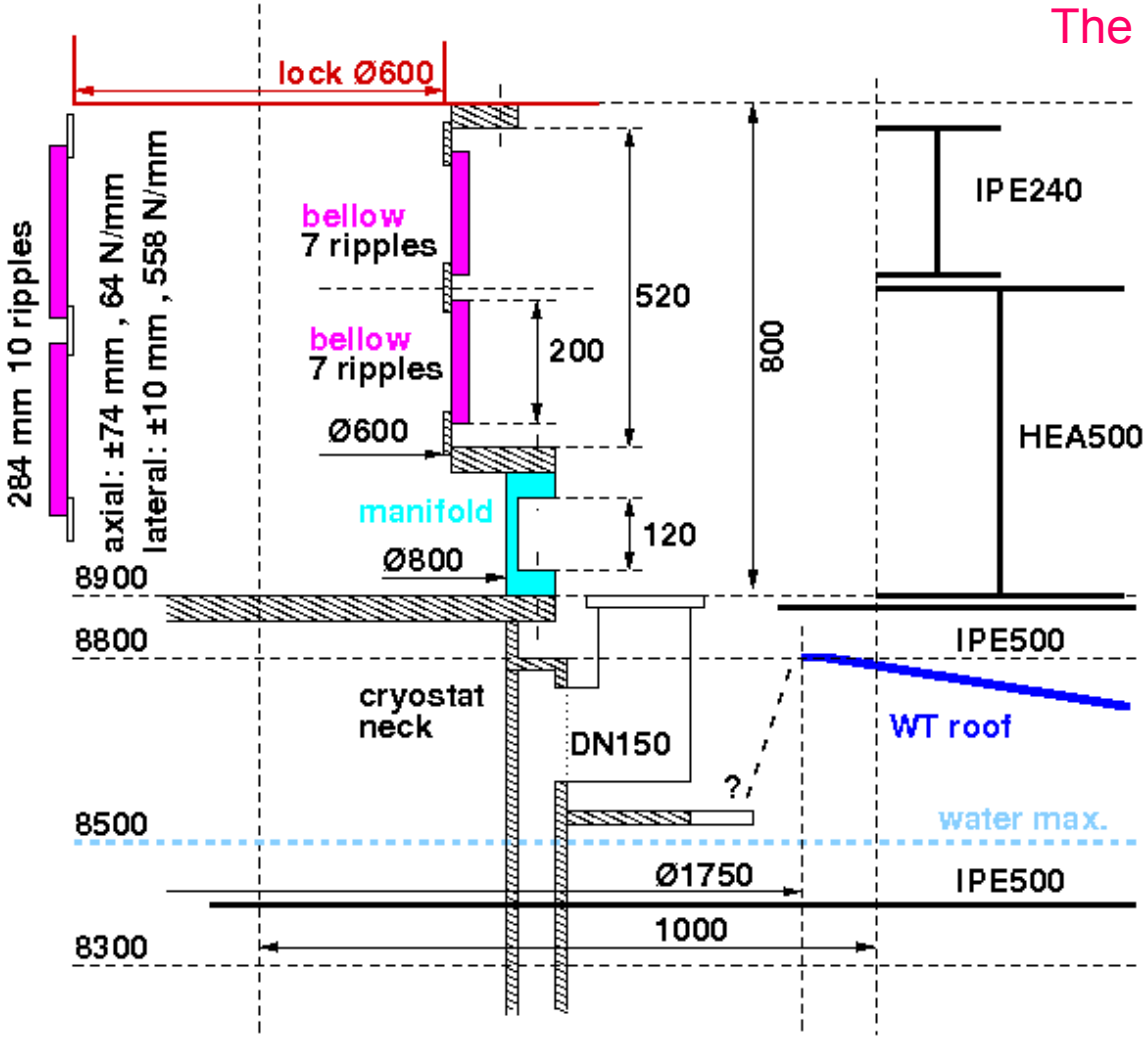
Big γ counting project at LNGS and HD ► Many thanks to Matthias and MPI team!

Copper Shield Profile for LAr



Profile calculations for LAr by I.Barabanov

Interface Cryostat – Lock – Water Tank



The most crowded place of GERDA?

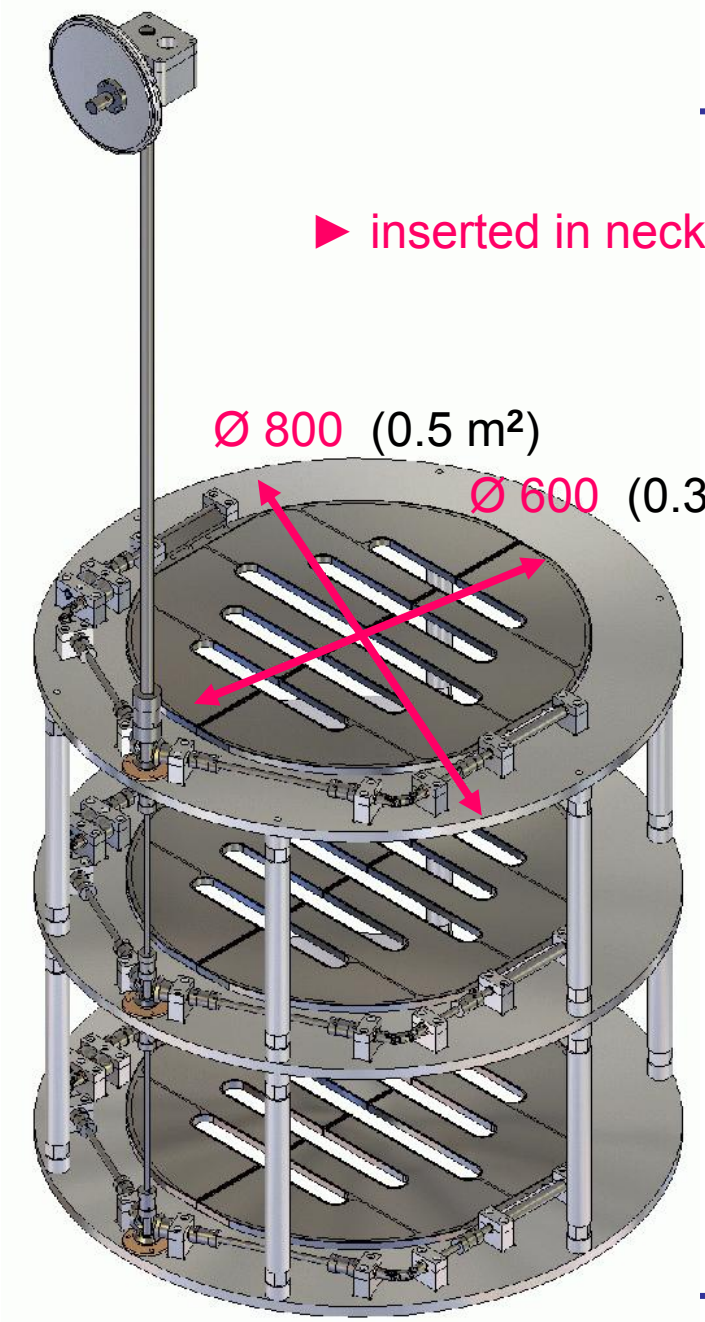
Bellow:
soft and flexible ► as long as Possible

Manifold:
Exhaust gas line out, Ø200 mm
Active cooling in / out
LN2/LAr fill line (2x)
Pressure sensor lines
Temperature sensor lines
Windows for TV (2 at least)
Chevron control
Chevron emergency access

Cryostat:
Up to 4 CF160/200 flanges for
(1) pumping isolation vacuum
(2) safety valve, (3) pressure sensors,
Air-tight connection to WT roof

Chevron(s)

► inserted in neck to shield against thermal radiation (RT: 500 W / m² !)



- Test in prototype neck
  (available by end of Nov.):

  1) How big is the shielding effect ?
     How many chevrons are needed ?

  2) Optimum chevron plate material ?

  3) Is mechanics ultra-reliable ?

  4) Other solution – reduced solid angle?

New Safety Review

- May 29: A. Scaramelli outlines need for new safety review, new system! Proposes NIER Engineering, Bologna, which did review for many other LNGS experiments.
- Work on Version 0.2 of Technical Proposal for Safety Review in progress ► www.mpi-hd.mpg/GERDA/TPRO.html ►slide
- Jun 15: Safety meeting at LNGS, with LNGS safety experts, NIER representatives & GERDA representatives ► focus on study of top events.
- Jul 20 : Meeting with NIER at Bologna; preliminary report:
  ► 3rd wall helpful but not indispensable!
- Sep 19: Meeting at CERN, announced as final – but new information
  ► evaporation rate must be less than 10000 m³/h (by factor 3 reduced)
  ► request to provide more information on time dependence of rate
- Oct 05: Report on evaporation rate and its reduction to 10000 m³/h delivered
  ►heat transfer for LAr deduced from experiments done at MPI HD
  ►**GERDA will implement thermal shields and outer plastic skin!**
- Nov 16: Final NIER report
  ► fast water drainage by flooding Hall A not recommended!

Safety

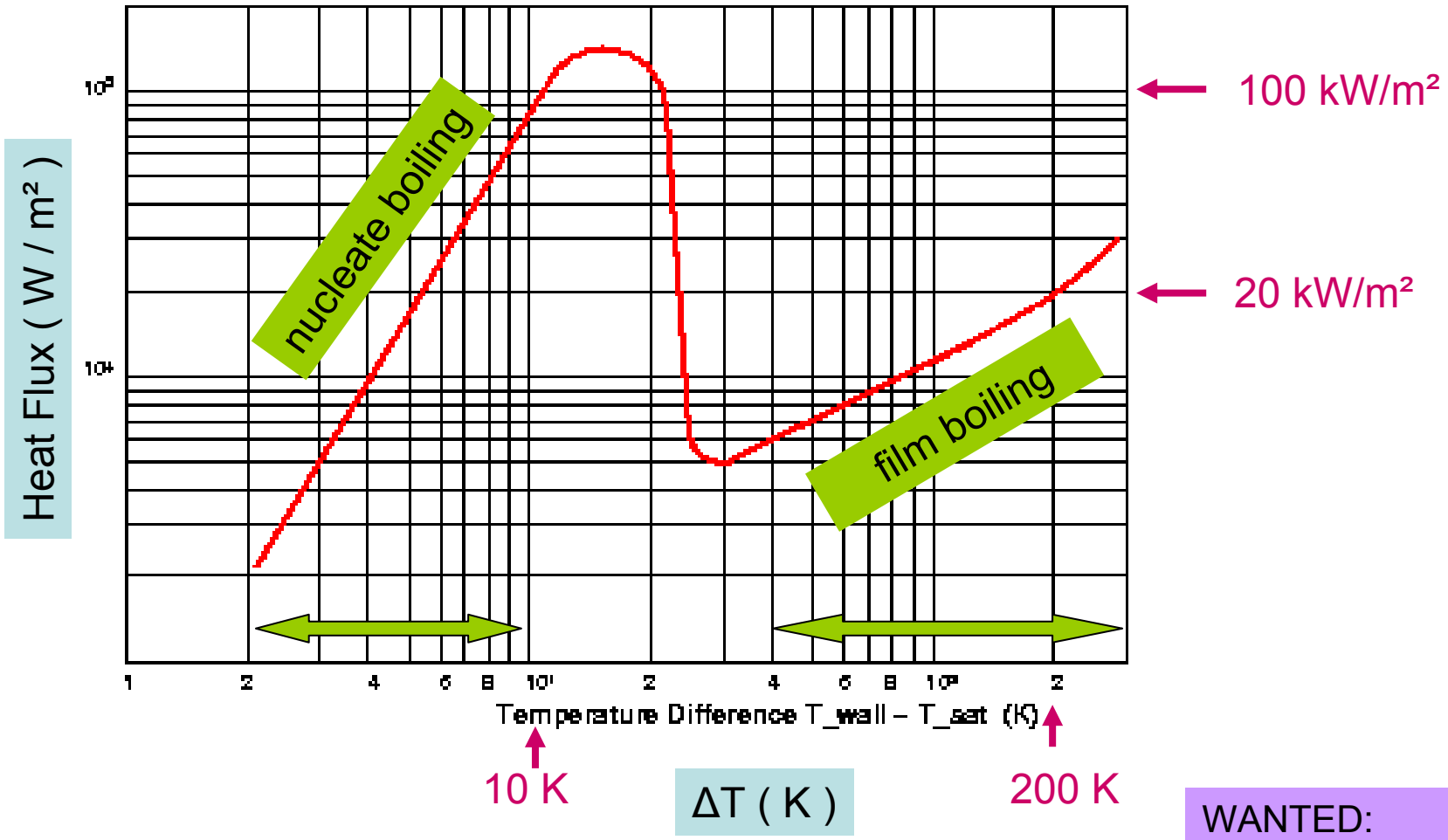
- New chapter in V0.2 of Technical Proposal

  ► Evaporation rates for
  (i) loss of insulation vacuum
  (ii) loss of one wall
  are manageable, i.e. below 30000 m³ / h.

  ► Simultaneous failure of both container walls in presence of water not credible due to
  (i) significant safety margins in design,
  (ii) high fabrication & quality control standards,
  (iii) possibility to drain water in less than 1.5 hours.

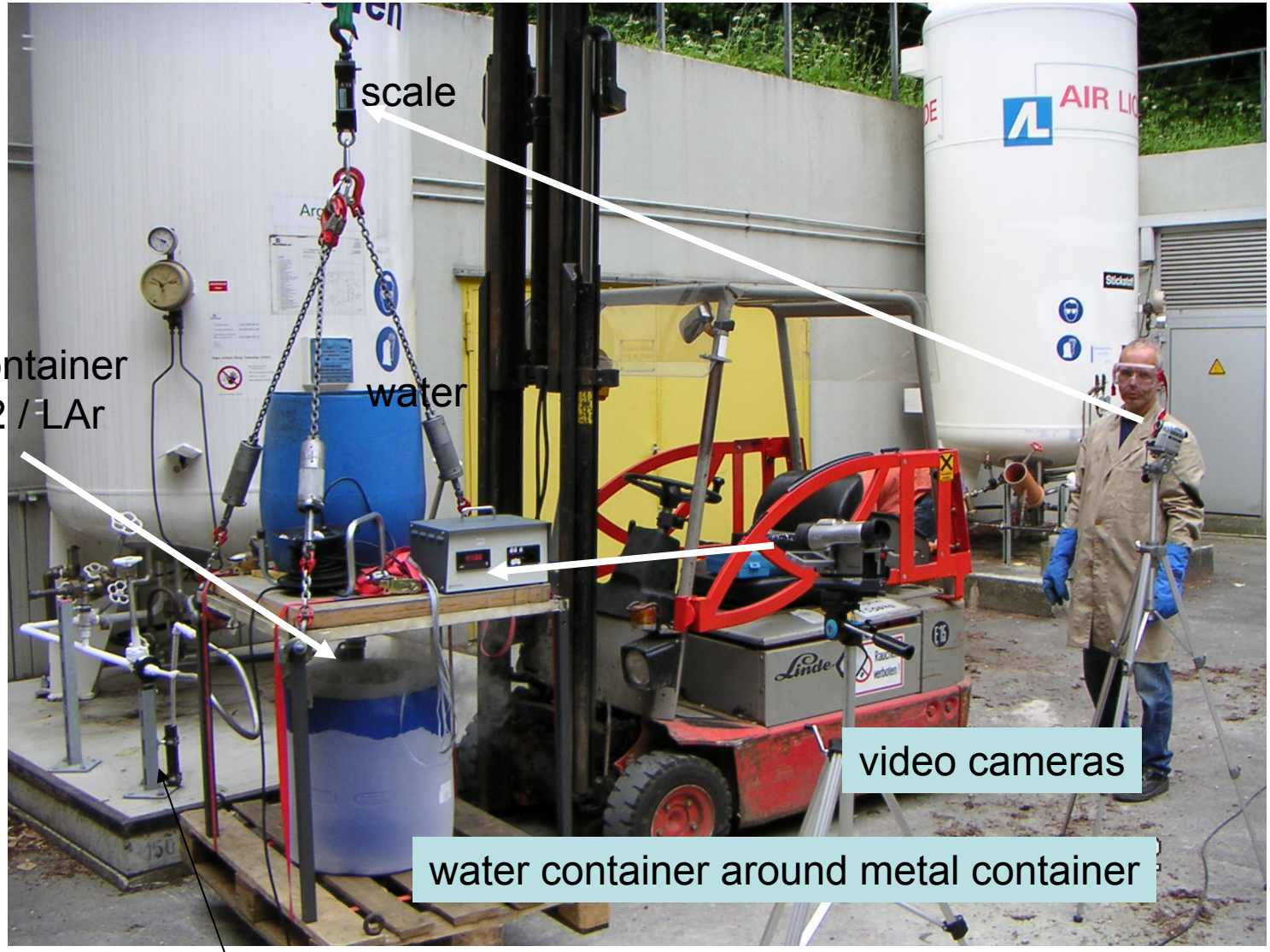
Safety – Evaporation Rates

LN2 pool boiling heat transfer characteristics



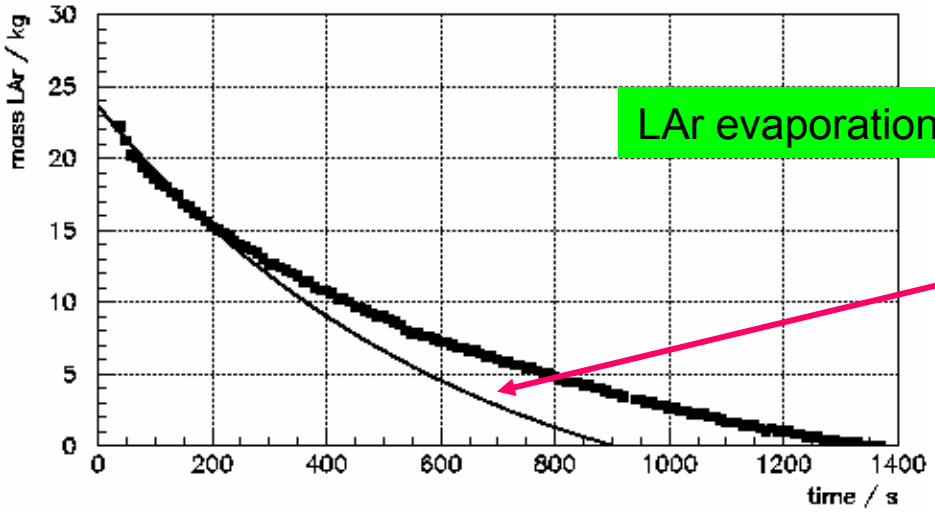
WANTED:
same plot for LAr!

Safety – Evaporation Rate & Heat Transfer Studies



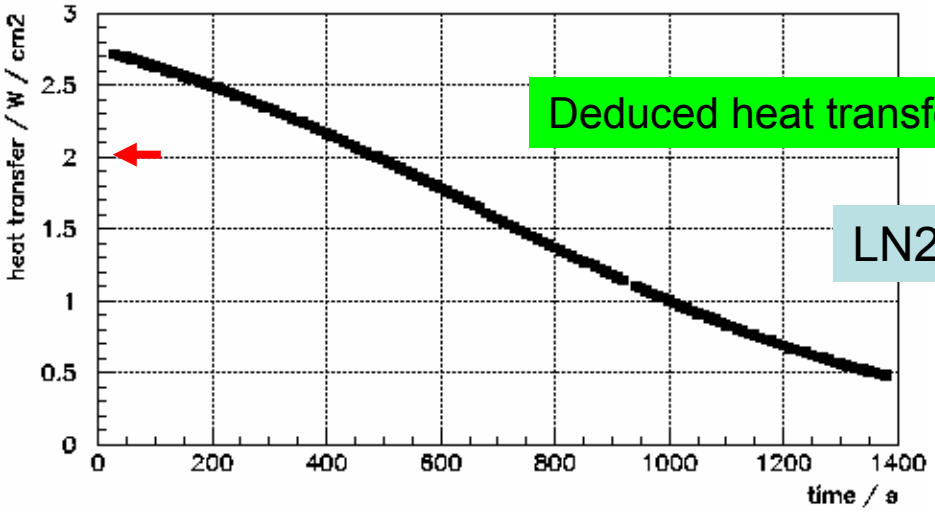
measure : mass & temperature as function of time after water flooding

LAr data: evaporation rate & deduced heat transfer



LAr evaporation mass vs time

from simple model calculated; no free parameter except heat transfer;
►adjusted to 27 kW / m².



Deduced heat transfer vs time

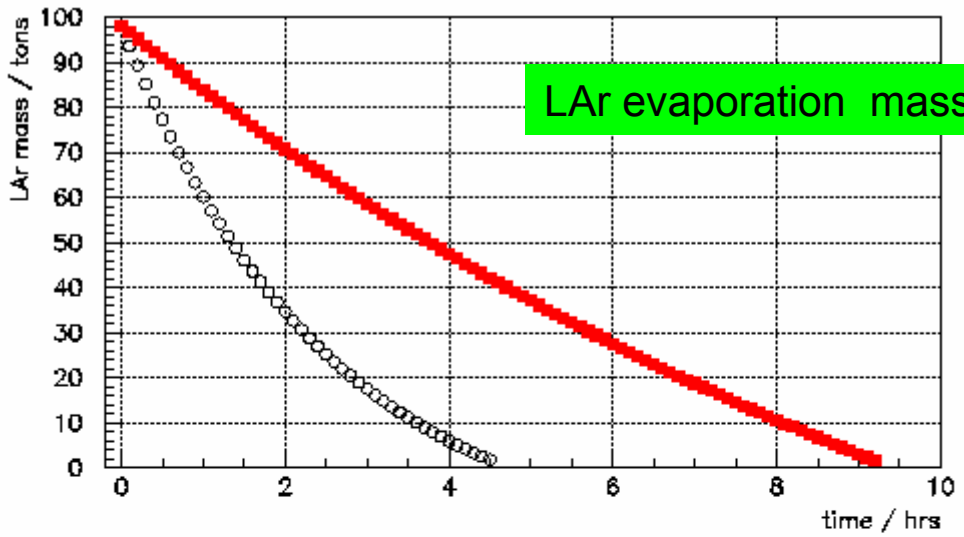
LN2 boiling curve: 2 W/cm² at ΔT ~ 200 K

► rather similar to LN2

Data by Nico Klein

Prediction of Evaporation Rates for Top Event

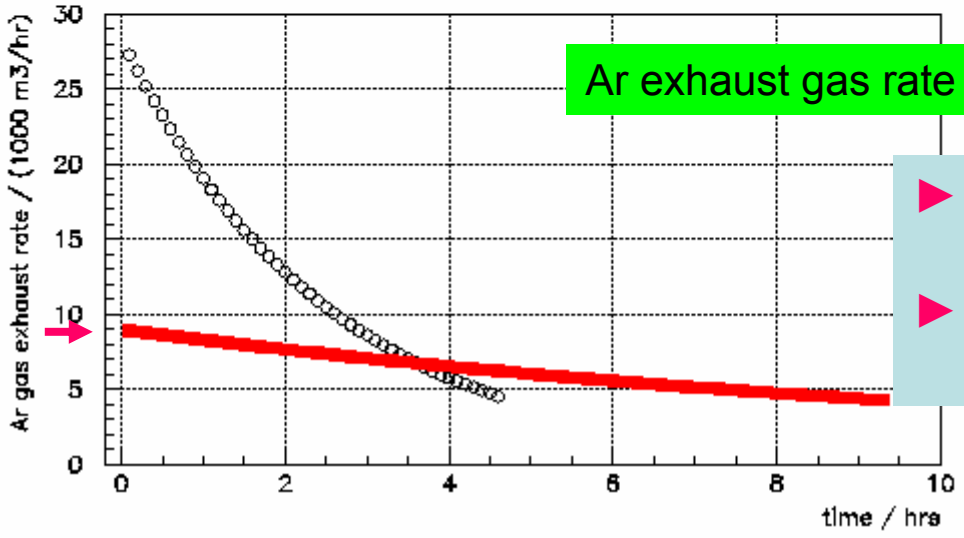
SUDDEN LOSS of ONE WALL



LAr evaporation mass vs time

○○○ 27 kW / m² heat transfer

○○○ 5 kW / m² heat transfer in cylindrical walls
27 kW / m² at bottom



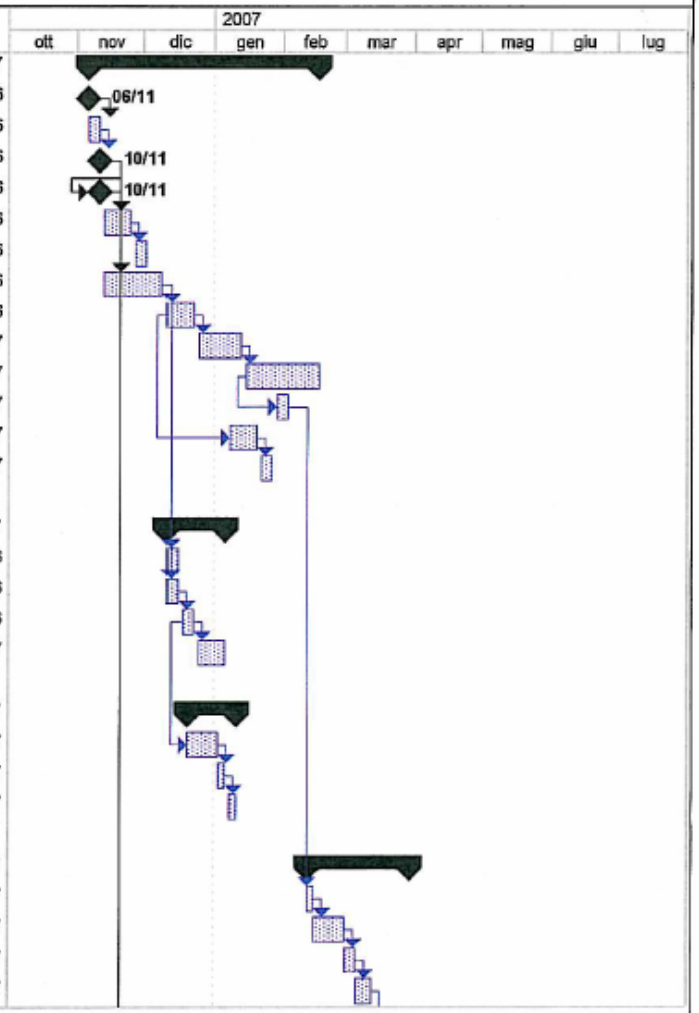
Ar exhaust gas rate vs time

- reduced heat transfer yields requested exhaust gas rate!
- cover cylindrical walls with suitable thermal insulation, e.g. ~5 mm Lexan

Schedule (1)

SIMIC S.P.A. GERDA CRYOSTAT FABRICATION & COPPER PLATE INTEGRATION ON SITE pROVISIONAL GENERAL PLANNING OFFER 183-05

ID	Nome attività	Durata	Inizio	Fine
1	**Prelinary activities**	**75 g**	**lun 06/11/06**	**ven 16/02/07**
2	Order receiving	0 g	lun 06/11/06	lun 06/11/06
3	Contract review	1 s	lun 06/11/06	ven 10/11/06
4	Order acceptance	0 g	ven 10/11/06	ven 10/11/06
5	Materials by MPI availability	0 g	ven 10/11/06	ven 10/11/06
6	Quality Control Plan issue	2 s	lun 13/11/06	ven 24/11/06
7	Quality Control Plan approval by MPI	1 s	lun 27/11/06	ven 01/12/06
8	Materials by MPI delivery	4 s	lun 13/11/06	ven 08/12/06
9	Shopdrawings issue	2 s	lun 11/12/06	ven 22/12/06
10	Workshop readiness	3 s	lun 25/12/06	ven 12/01/07
11	Materials providing	5 s	lun 15/01/07	ven 16/02/07
12	Plates check by MPI	1 s	lun 29/01/07	ven 02/02/07
13	Welding procedure qualification	2 s	lun 08/01/07	ven 19/01/07
14	Welding sample cryogenic test by MPI	1 s	lun 22/01/07	ven 26/01/07
15				
16	**Fabrication and test**	**20 g**	**lun 11/12/06**	**ven 05/01/07**
17	Heads holes machining	1 s	lun 11/12/06	ven 15/12/06
18	Plates cutting	1 s	lun 11/12/06	ven 15/12/06
19	Plates bending	1 s	lun 18/12/06	ven 22/12/06
20	Outer vessell shells welding	2 s	lun 25/12/06	ven 05/01/07
21				
22	**Outer Vessel fabrication**	**16 g**	**mer 20/12/06**	**mer 10/01/07**
23	Welding of shells, skirt and bottom head	2 s	mer 20/12/06	mar 02/01/07
24	Outer Vessel X-Ray check	3 g	mer 03/01/07	ven 05/01/07
25	Outer Vessel Surface treatment	3 g	lun 08/01/07	mer 10/01/07
26				
27	**Inner Vessel fabrication**	**34 g**	**lun 12/02/07**	**gio 29/03/07**
28	Rings and stiffeners cutting	3 g	lun 12/02/07	mer 14/02/07
29	Welding of shells, rings, stiffeners, heads and compensatirs	2 s	gio 15/02/07	mer 28/02/07
30	Inner Vessel X-Ray check	3 g	gio 01/03/07	lun 05/03/07
31	Inner Vessel surface treatment	1 s	mar 06/03/07	lun 12/03/07



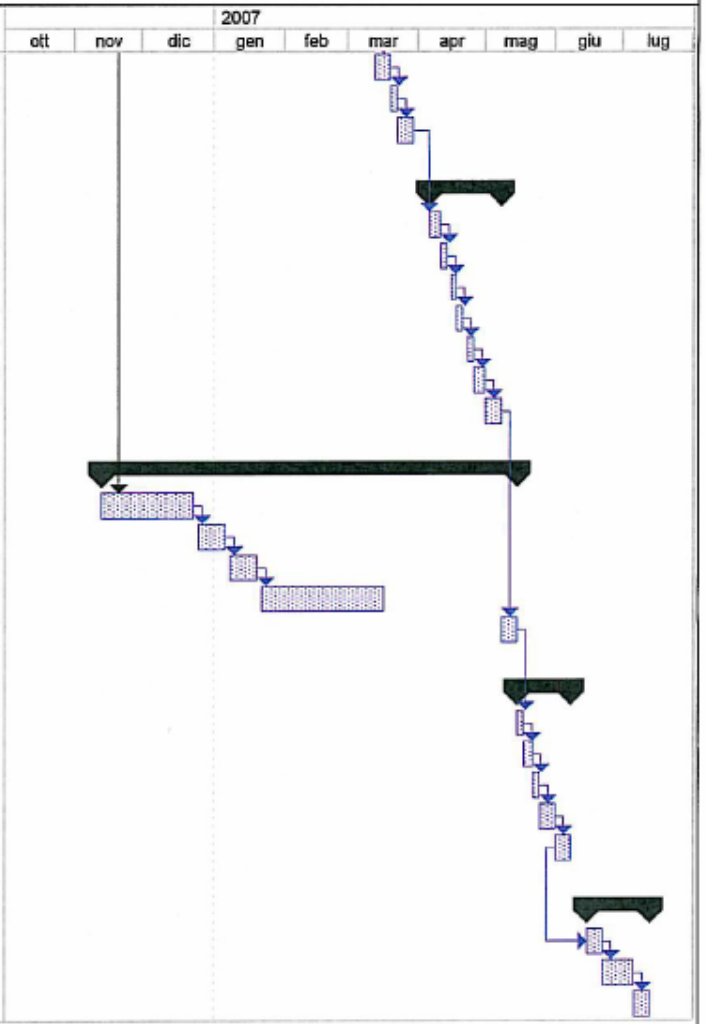
Progetto: &GERDA CRYOSTAT
Data: lun 25/09/06

Attività
Divisione
Cardine
Riepilogo
Attività esterne
Cardine esterno

Schedule (2)

SIMIC S.P.A. GERDA CRYOSTAT FABRICATION & COPPER PLATE INTEGRATION ON SITE pROVISIONAL GENERAL PLANNING OFFER 183-05

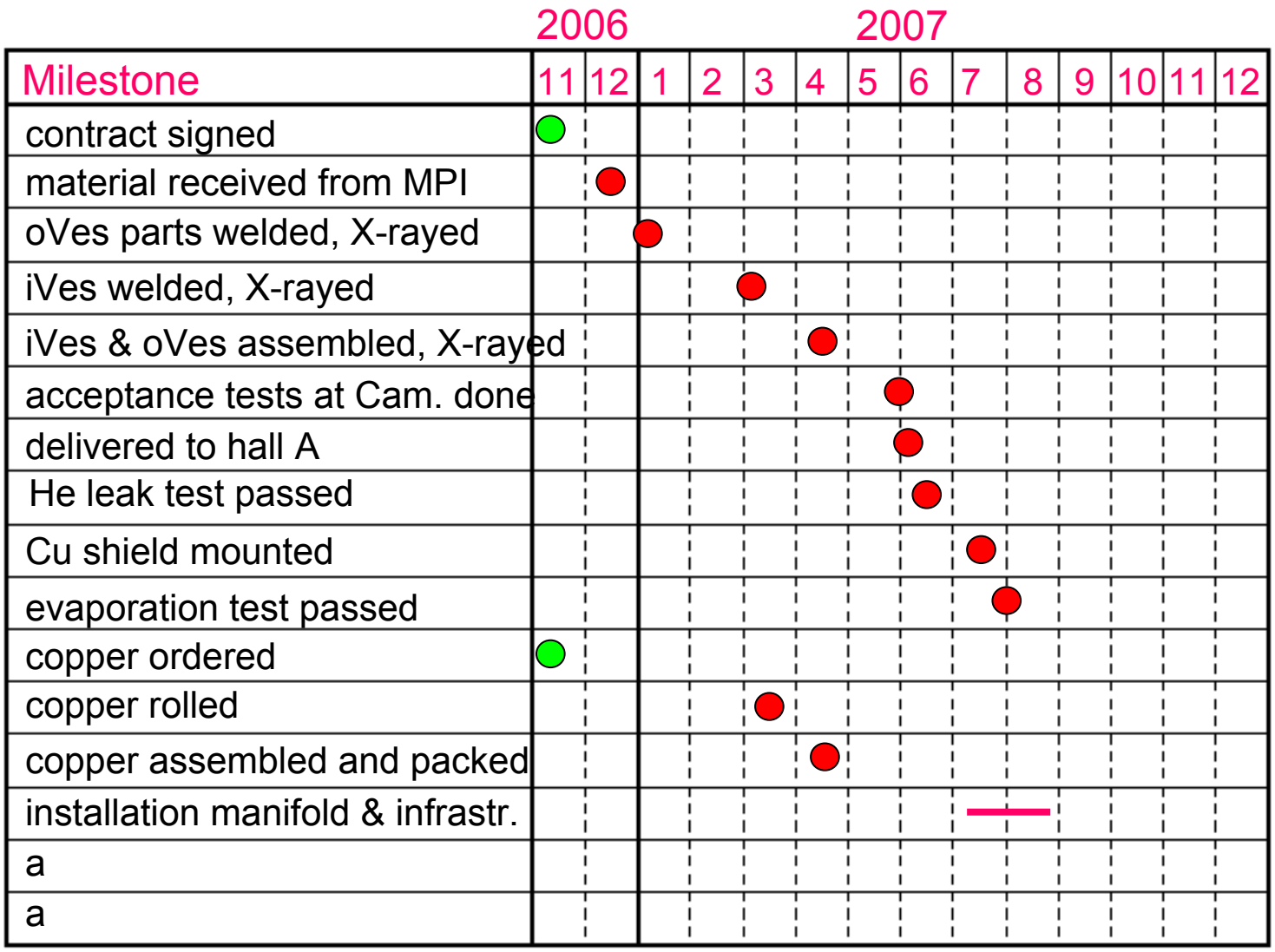
ID	Nome attività	Durata	Inizio	Fine
32	Pressure test	1 s	mar 13/03/07	lun 19/03/07
33	He leak test	3 g	mar 20/03/07	gio 22/03/07
34	Super insulation integration	1 s	ven 23/03/07	gio 29/03/07
35				
36	**Cryostat integration and tests**	**22 g**	**ven 06/04/07**	**lun 07/05/07**
37	Inner Vessel integration in the Outer Vessel	3 g	ven 06/04/07	mar 10/04/07
38	Top head welding	3 g	mer 11/04/07	ven 13/04/07
39	Top head welding US check	2 g	lun 16/04/07	mar 17/04/07
40	Cryostat sealing	3 g	mer 18/04/07	ven 20/04/07
41	Outer Vessel He leak test	3 g	lun 23/04/07	mer 25/04/07
42	Outer Vessel Nitrogen pressure test	3 g	gio 26/04/07	lun 30/04/07
43	Evaporation rate test	1 s	mar 01/05/07	lun 07/05/07
44				
45	**Tooling fabrication**	**131 g**	**lun 13/11/06**	**lun 14/05/07**
46	Tooling and top platform design	6 s	lun 13/11/06	ven 22/12/06
47	Tooling approval by MPI	2 s	lun 25/12/06	ven 05/01/07
48	Design rewieu after MPI's comments	2 s	lun 08/01/07	ven 19/01/07
49	Tooling and platform manufacturing	8 s	lun 22/01/07	ven 16/03/07
50	Copper plate integration test	1 s	mar 08/05/07	lun 14/05/07
51				
52	**Readiness for dispatch**	**18 g**	**mar 15/05/07**	**gio 07/06/07**
53	Dimensional check	3 g	mar 15/05/07	gio 17/05/07
54	Surface treatment check	2 g	ven 18/05/07	lun 21/05/07
55	Internal spaces inerting by gas	3 g	mar 22/05/07	gio 24/05/07
56	Packing	1 s	ven 25/05/07	gio 31/05/07
57	Delivery at Assergi site	1 s	ven 01/06/07	gio 07/06/07
58				
59	**On site activities**	**20 g**	**ven 15/06/07**	**gio 12/07/07**
60	Mounting tooling installation	1 s	ven 15/06/07	gio 21/06/07
61	Copper plates integration	2 s	ven 22/06/07	gio 05/07/07
62	Mounting tooling dismounting	1 s	ven 06/07/07	gio 12/07/07



Progetto: &GERDA CRYOSTAT
Data: lun 25/09/06

Attività
Divisione
Cardine
Riepilogo
Attività esterne
Cardine esterno

Milestones for Cryostat and Copper Shield



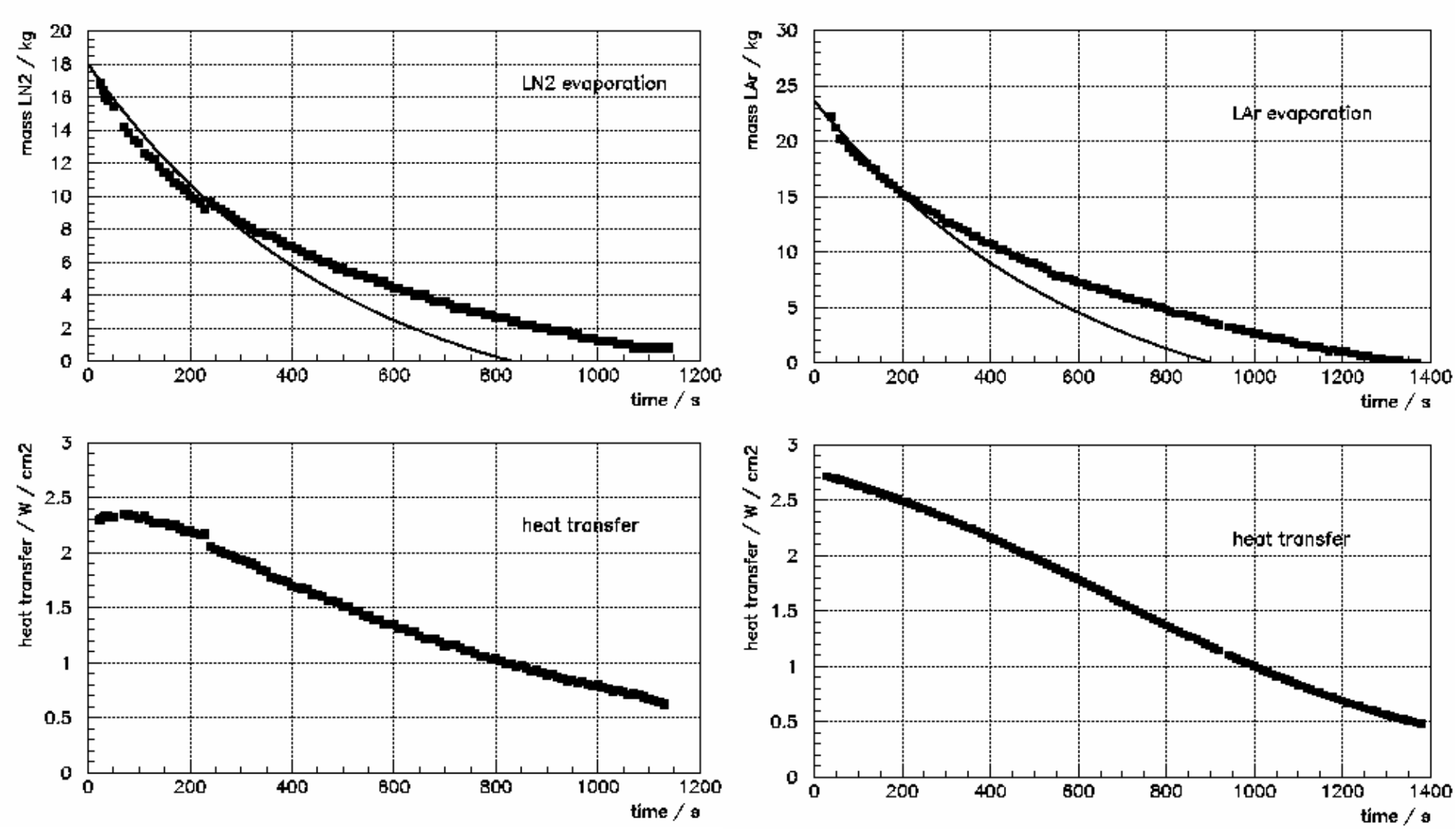
Concluding Remarks

- Cryostat ordered; delivery due by mid of July;
  - ► rather agressive schedule.
  - ► open issues: support/centering pad design details
    profile of copper shield

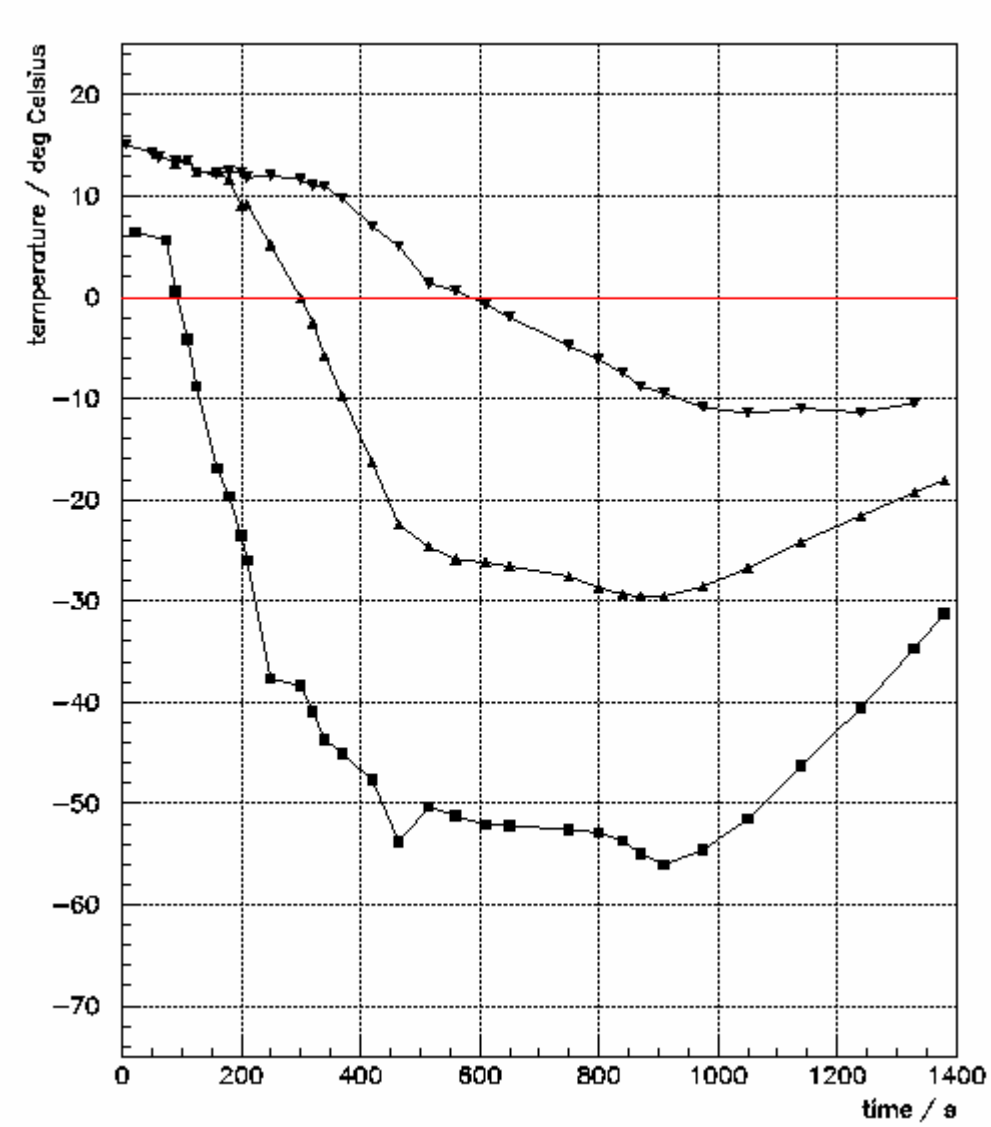
- New safety review almost done;
  GERDA safety concept accepted by LNGS;
  - ► waiting for final NIER report;
  - ► GERDA safety report by LNGS.

- Turning now focus at cryogenic infrastructure and system integration.

LN2 / LAr data: evap. rates & heat transfer



LAr data


temperature / deg Celsius
20
10
0
−10
−20
−30
−40
−50
−60
−70
0
200
400
600
800
1000
1200
1400
time / s