GERDA TG4 – Cryogenic Vessel

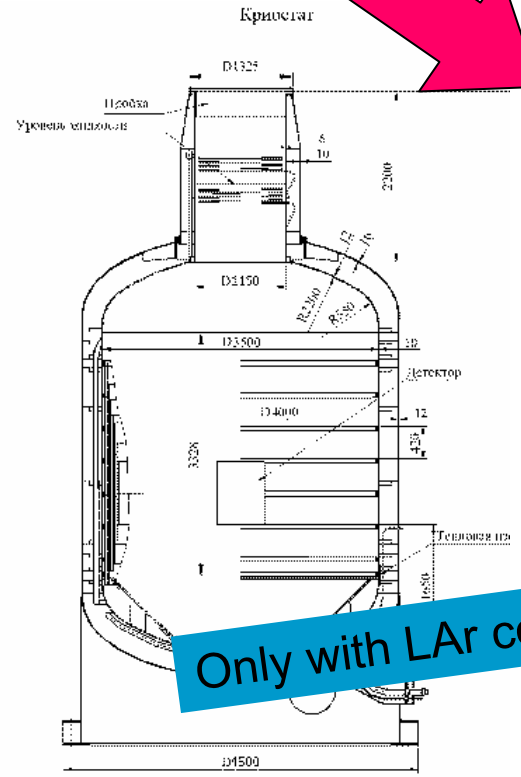
Status Report

K.T.Knöpfle
MPI Kernphysik, Heidelberg
ktkno@mpi-hd.mpg.de

GERDA Collaboration Meeting at LNGS
26 – 28 June 2006

Outline

Baseline Design: Copper cryostat for LN2 / LAr with superinsulation + 3rd wall requested by LNGS



WHY ?

Backup Design:
Stainless steel cryostat with superinsulation & internal Pb/Cu shield + 3rd wall !?

Only with LAr cost effective

Outline

Why ?

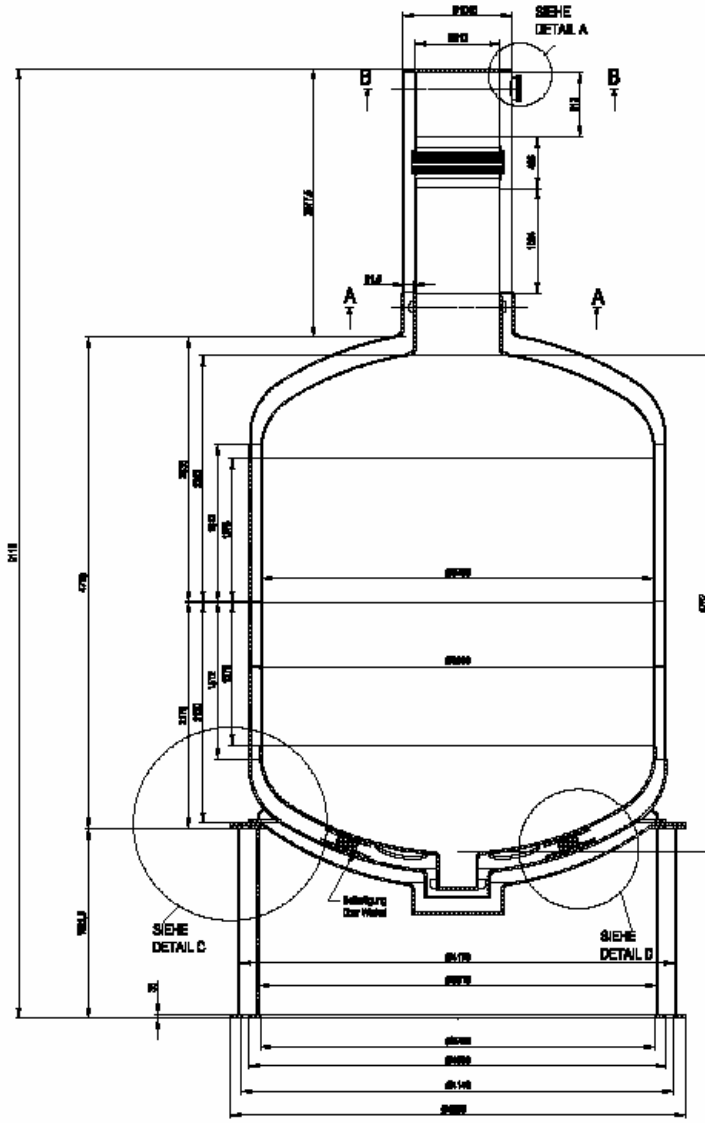
New Design

Material Constraints

Other Implications

Safety

Status Copper Cryostat & 3rd Wall



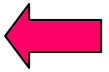
- drawings: cryostat - ready except for parts of skirt
  3rd wall - ready
- production planning:
  cryostat - ready
  3rd wall - not yet considered
- orders: cryo/3rd wall - 70t OFE copper
  - rolling arranged
  now on hold
- delivery time: cryostat :
  Nov06 if immediately ordered
  (Feb07 now more realistic)
  3rd wall: not yet discussed

far too expensive ▶

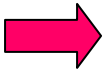
Cost Copper Cryostat & 3rd Wall

copper 75t	410	quote
15t back	-45	oral quote
pressing	100	scaled quote
rolling	150	oral quote
superinsulation	75	oral estimate AA
fabrication	1028	quote
EB welding 250		
jigs & work 778		
transport	50	oral quote Schlopp
	1768	k€
project engineering done	80	(1000 hrs)
dto. to be still done	100	estimate
fabrication skirt		
design 3rd wall	25	quote
fabrication 3rd wall	??	
cryoinfrastructure	175	educated guess
lead 50t	100	estimate LME
LN2 / LAr	50	
misc.	50	

was <30% before



already beyond MPI HD budget



more than 2.3 M€ !

Ad Hoc Meeting at Munich , March 29

- Established feasibility of LAr as cryostat filling from physics point of view;
  opens possibility of stainless steel cryostat with internal copper shield;
  acceptable thickness of copper shield if steel activitiy < 10 mBq(Th-228)/kg

- To do: Explore various possibilities for cost reduction !

- To do: Study back-up solution, stainless-steel cryostat, in more detail !
  Prepare for tendering !

- Munich, May 29 : decide upon cryostat option

How to Reduce COST?

Reduction of fabrication cost

- Meeting with pro-beam & Prämab (Mar 14)
  - ► no way to reduce cost; emphasized that present quote does still not include all cost items!

- Alternative (EB welding) companies
  - ► Techmeta (Metz-Tessy), visit Apr 04 ; positive impression, 1 year of delivery later: production cost estimate ok with our budget !!-??
  - ► Possible production at Nantes by DCN / Techmeta
    Visit May 22, impressive plants, but doubts that time schedule and price tag will hold.

- Conventional MIG welding ?
  - ► Explored by SDMS, Grenoble: too expensive

- Stainless-steel instead of copper cryostat
  - ► backup solution: ++ more than one or two suppliers
    cost estimate at Mar 23: 350 k € without MLI and copper shield –
    delivery time 6 months - perhaps both too optimistic!

Ad Hoc Meeting at Munich , May 29

- Decision for stainless steel cryostat with internal copper shield

.

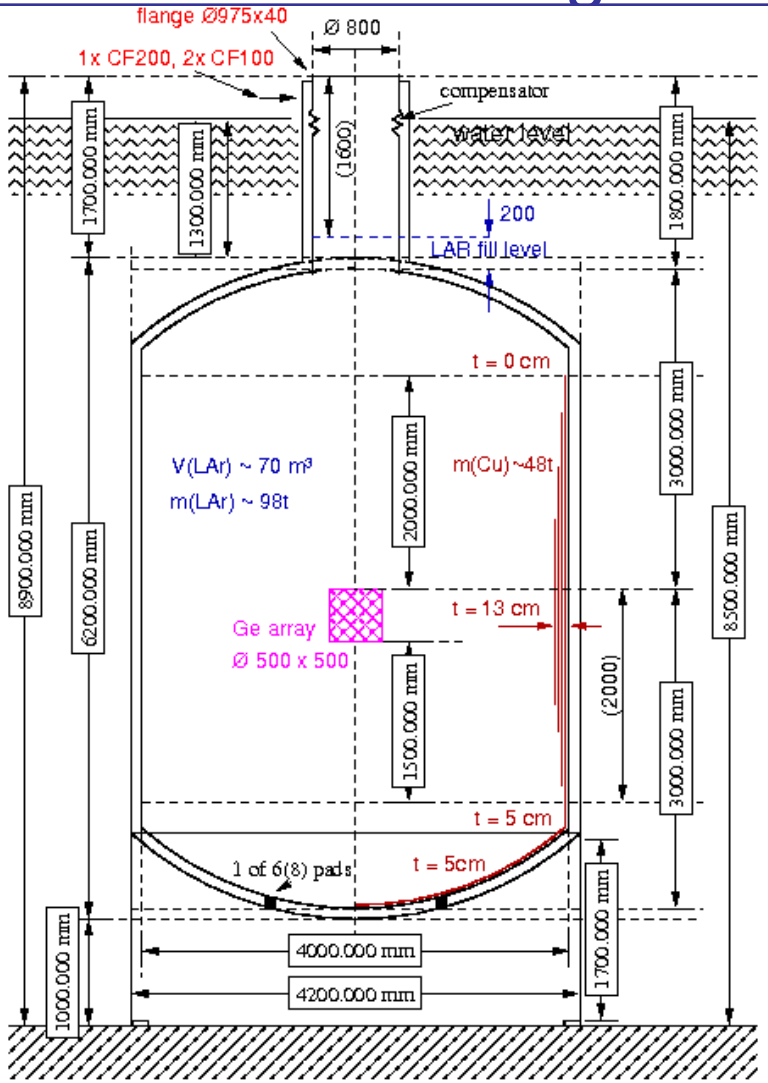
.

.

.

- May 11: Finalize stainless steel cryostat design at TÜV Hamburg
- Jun 07: Start of tendering process based on drawing GC-1001-2006-5
- Jun 15: First safety review at LNGS

Generic Design of Stainless Steel Cryostat



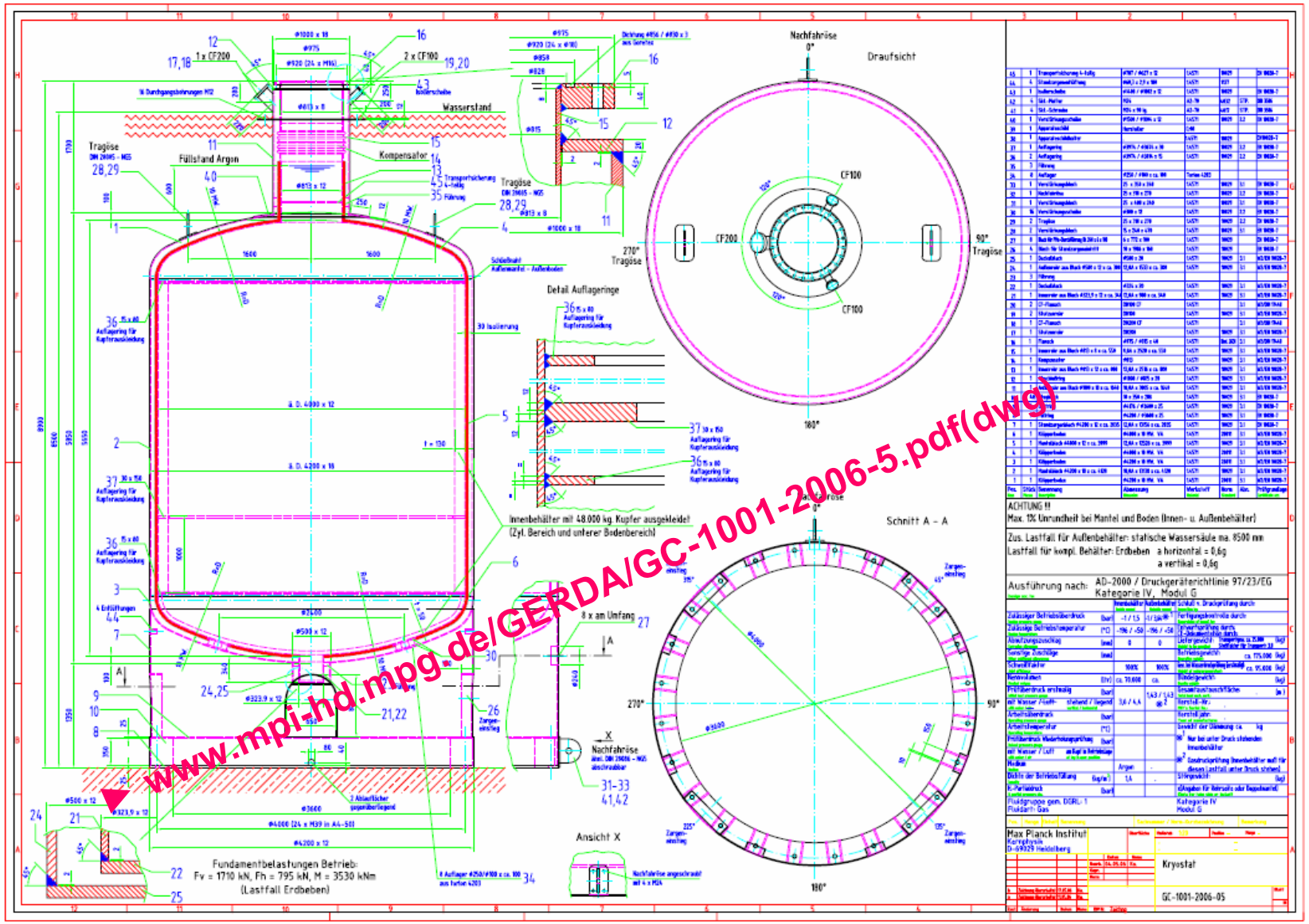
in SKIRT: (1) 4x manhole 700x500 with cover
(2) 8x Ø 240 for PMs, 4 off in manhole covers

ktk–2006/04/04

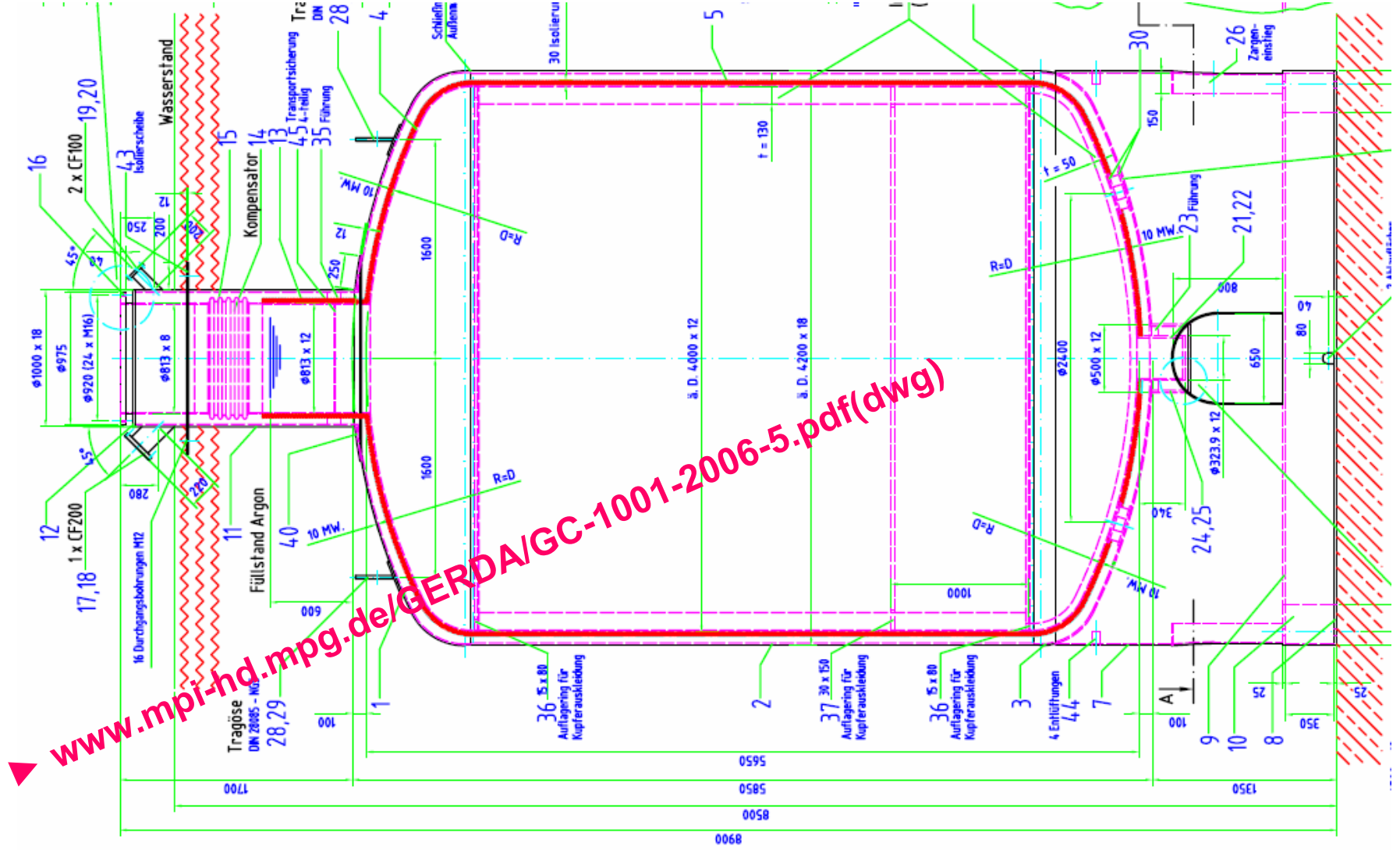
- independent inner & outer containers
- inner container resting on pads
- 1.4571 material or equivalent
- 70 m³ LAr
- designed for 48 tons of Cu shield
- 175 tons total weight

- AD 2000 , pressure vessel code
  97/23/EG, K IV, M G
- 0.6 g v/h earth quake tolerance
-

Engineering Design for TÜV & Tendering



Engineering Design for TÜV & Tendering



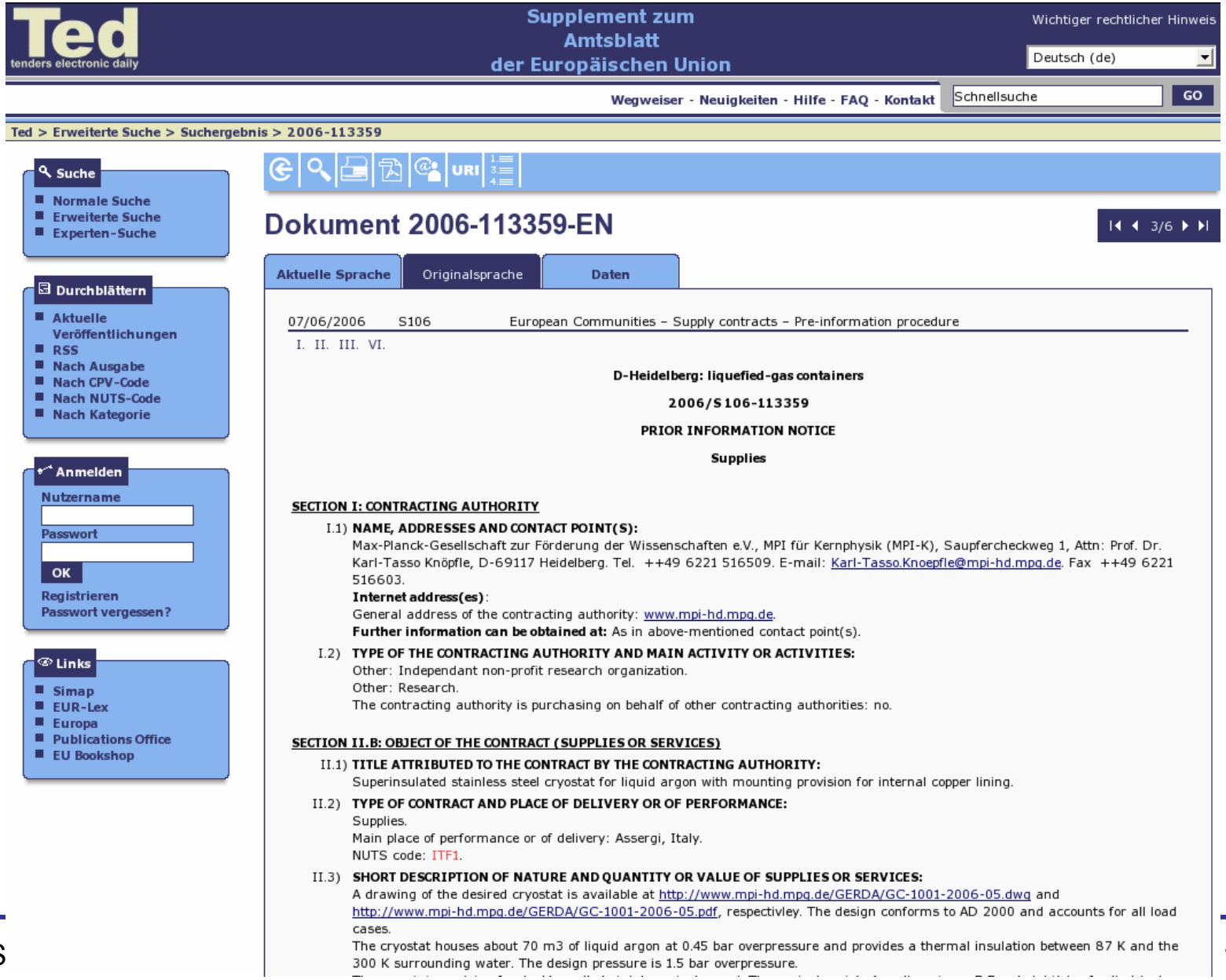
Radiopurity of Construction Materials

units : mBq / kg

Material	K-40	Co-60	Th-228(232)	Ra-226(228)	U-238(235)	Meth.
Steel [spec]			< 10			-
AISI 321(Cry)	< 4.2	4 ± 0.5	< 1.7	< 1.6 (< 1.0)	-	G
			0.5 & 0.9		-	MS
Tueb	< 2.7	16 ± 1	1.8 ± 0.4	1.6 ± 0.4	-	G
1.4429(Kat)	< 2.3	4	5	2.3	-	G
MLI [spec]			< 20			
alum. Teflon	≤ 16.2	≤ 1.7	≤ 6.3	$\leq 4.2(\leq 8.1)$		G
	64 ± 1		(1.1 ± 0.05)		1.46 ± 0.05	MS
NAC-2	81 ± 20		5.0 ± 3.4	23.0 ± 2.8		G
	87 ± 5		(7.2 ± 0.3)		23.4 ± 0.9	MS
Coolcat 2 NW	150 ± 30		2.3 ± 0.6	$1.1(1.8) \pm 0.5$	$\leq 59(1.8)$	G
	137 ± 4		(0.5 ± 0.02)		1.42 ± 0.09	MS
Pads [spec]			5			-
Torlon	≤ 0.93		≤ 41	≤ 37		NAA
Copper [spec]			< 0.02			-
NOSV(Lens)	≤ 0.088	≤ 0.01	≤ 0.012	≤ 0.016		G

stainless steel: hope to find material with ≤ 5 mBq(Th-228)/kg - save copper !
MLI : uncritical
Torlon (pads) : ok – better measurement needed

Start of Tendering



Ted
tenders electronic daily

Supplement zum Amtsblatt der Europäischen Union

Wichtiger rechtlicher Hinweis

Deutsch (de)

Wegweiser - Neuigkeiten - Hilfe - FAQ - Kontakt

Schnellsuche GO

Ted > Erweiterte Suche > Suchergebnis > 2006-113359

Suche
- Normale Suche
- Erweiterte Suche
- Experten-Suche

Durchblättern
- Aktuelle Veröffentlichungen
- RSS
- Nach Ausgabe
- Nach CPV-Code
- Nach NUTS-Code
- Nach Kategorie

Anmelden
Nutzername
Passwort
OK
Registrieren
Passwort vergessen?

Links
- Simap
- EUR-Lex
- Europa
- Publications Office
- EU Bookshop

URI

Dokument 2006-113359-EN

3/6

Aktuelle Sprache | Originalsprache | Daten

07/06/2006 S106 European Communities – Supply contracts – Pre-information procedure

I. II. III. VI.

D-Heidelberg: liquefied-gas containers

2006/S 106-113359

PRIOR INFORMATION NOTICE

Supplies

SECTION I: CONTRACTING AUTHORITY

I.1) **NAME, ADDRESSES AND CONTACT POINT(S):**
Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V., MPI für Kernphysik (MPI-K), Saupfercheckweg 1, Attn: Prof. Dr. Karl-Tasso Knöpfle, D-69117 Heidelberg. Tel. ++49 6221 516509. E-mail: Karl-Tasso.Knoepfle@mpi-hd.mpg.de. Fax ++49 6221 516603.
Internet address(es):
General address of the contracting authority: www.mpi-hd.mpg.de.
Further information can be obtained at: As in above-mentioned contact point(s).

I.2) **TYPE OF THE CONTRACTING AUTHORITY AND MAIN ACTIVITY OR ACTIVITIES:**
Other: Independant non-profit research organization.
Other: Research.
The contracting authority is purchasing on behalf of other contracting authorities: no.

SECTION II.B: OBJECT OF THE CONTRACT (SUPPLIES OR SERVICES)

II.1) **TITLE ATTRIBUTED TO THE CONTRACT BY THE CONTRACTING AUTHORITY:**
Superinsulated stainless steel cryostat for liquid argon with mounting provision for internal copper lining.

II.2) **TYPE OF CONTRACT AND PLACE OF DELIVERY OR OF PERFORMANCE:**
Supplies.
Main place of performance or of delivery: Assergi, Italy.
NUTS code: ITF1.

II.3) **SHORT DESCRIPTION OF NATURE AND QUANTITY OR VALUE OF SUPPLIES OR SERVICES:**
A drawing of the desired cryostat is available at http://www.mpi-hd.mpg.de/GERDA/GC-1001-2006-05.dwg and http://www.mpi-hd.mpg.de/GERDA/GC-1001-2006-05.pdf, respectivley. The design conforms to AD 2000 and accounts for all load cases.
The cryostat houses about 70 m3 of liquid argon at 0.45 bar overpressure and provides a thermal insulation between 87 K and the 300 K surrounding water. The design pressure is 1.5 bar overpressure.

Tendering Process

- Jun 7 : TED publication 2006 / S106 – 113359
  Prior Information Notice on
  Cryostat,
  Multi Layer Insulation
  Copper Shield Mounting Tools

  (so far answers from Air Liquide, MAN DWE, SDMS, Simic, Cryogenmash, and more to come …..
  visits: MAN DWE Jun 20, AirL Jul 4, SDMS Jul 5)

- Prepare Technical specifications

- +52 days : Publication for Tendering

- +22 days: Place order

► **next slide**

- + ?? months: delivery of cryostat

Delivery Time of Cryostat?

- Estimates based on company quotes:

steel rolling	10 to 12 weeks
head fabrication	8 to 16 weeks
vessel fabrication	8 to 24 weeks
total	26 to 52 weeks
	16 to 40 weeks if steel sheets available

Delivery Time of Cryostat?

- Estimates based on company quotes:

steel rolling	10 to 12 weeks	perhaps too optimistic!!
head fabrication	8 to 16 weeks	
vessel fabrication	8 to 24 weeks	
total	26 to 52 weeks	
	16 to 40 weeks	if steel sheets available

► No reliable time estimate yet possible !!!

Need for New Safety Review

- Correspondence with LNGS - asking for input for May 29 Munich meeting
  Status of GERDA cryostat (4 pages)
  Memorandum (1 page)

- Munich, May 29: A. Scaramelli outlines need for new safety review since stainless steel cryostat is a new system. Proposes NIER, Bologna, which did review for many other LNGS experiments

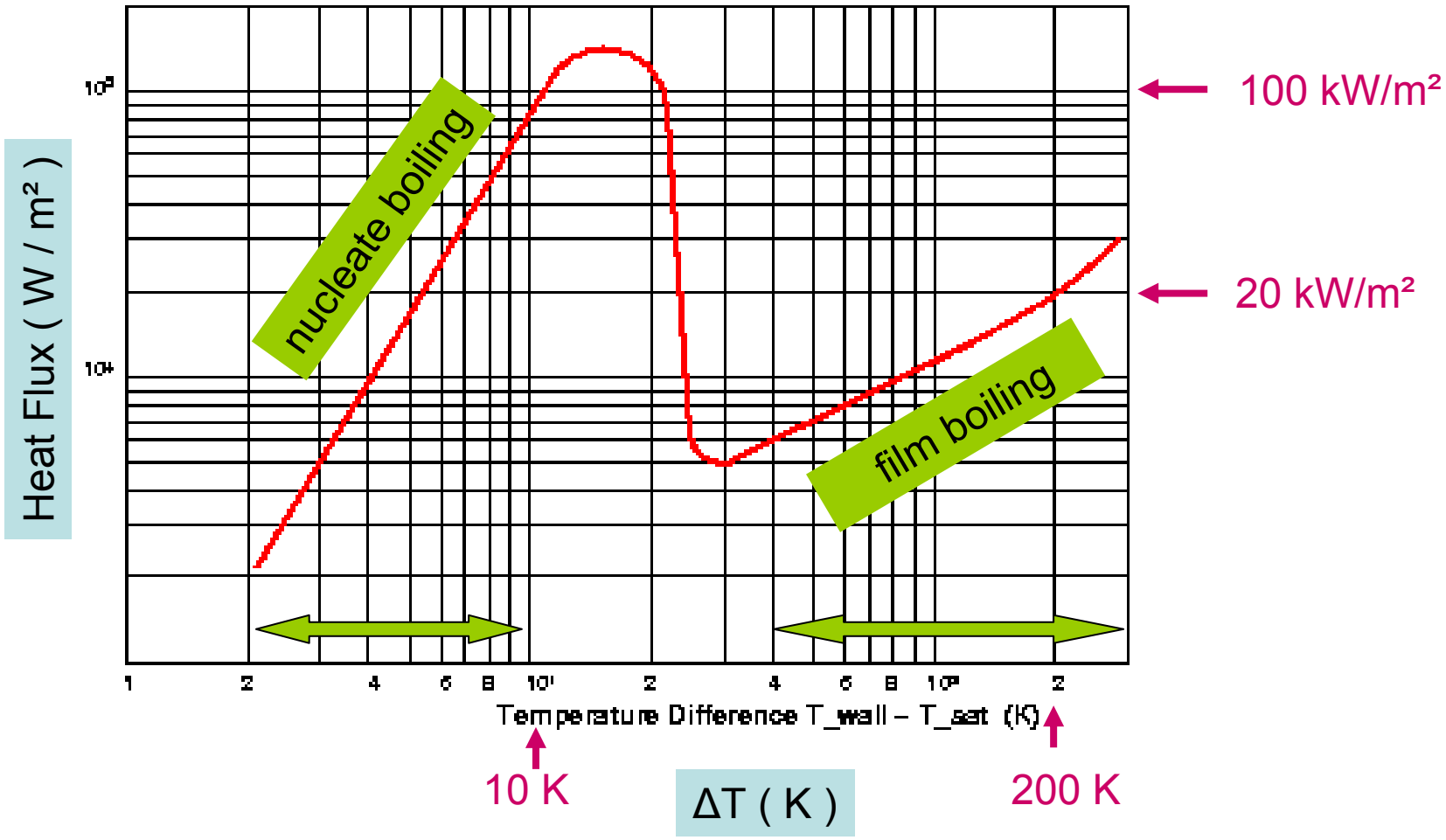
- Work on Version 0.2 of Technical Proposal for Safety Review in progress ► www.mpi-hd.mpg/GERDA/TPRO.html

- LNGS, June 15: Safety meeting at LNGS, with LNGS safety experts, NIER representatives & GERDA representatives
  ► focus on study of top events, quote due last week, study will take months, **however :**

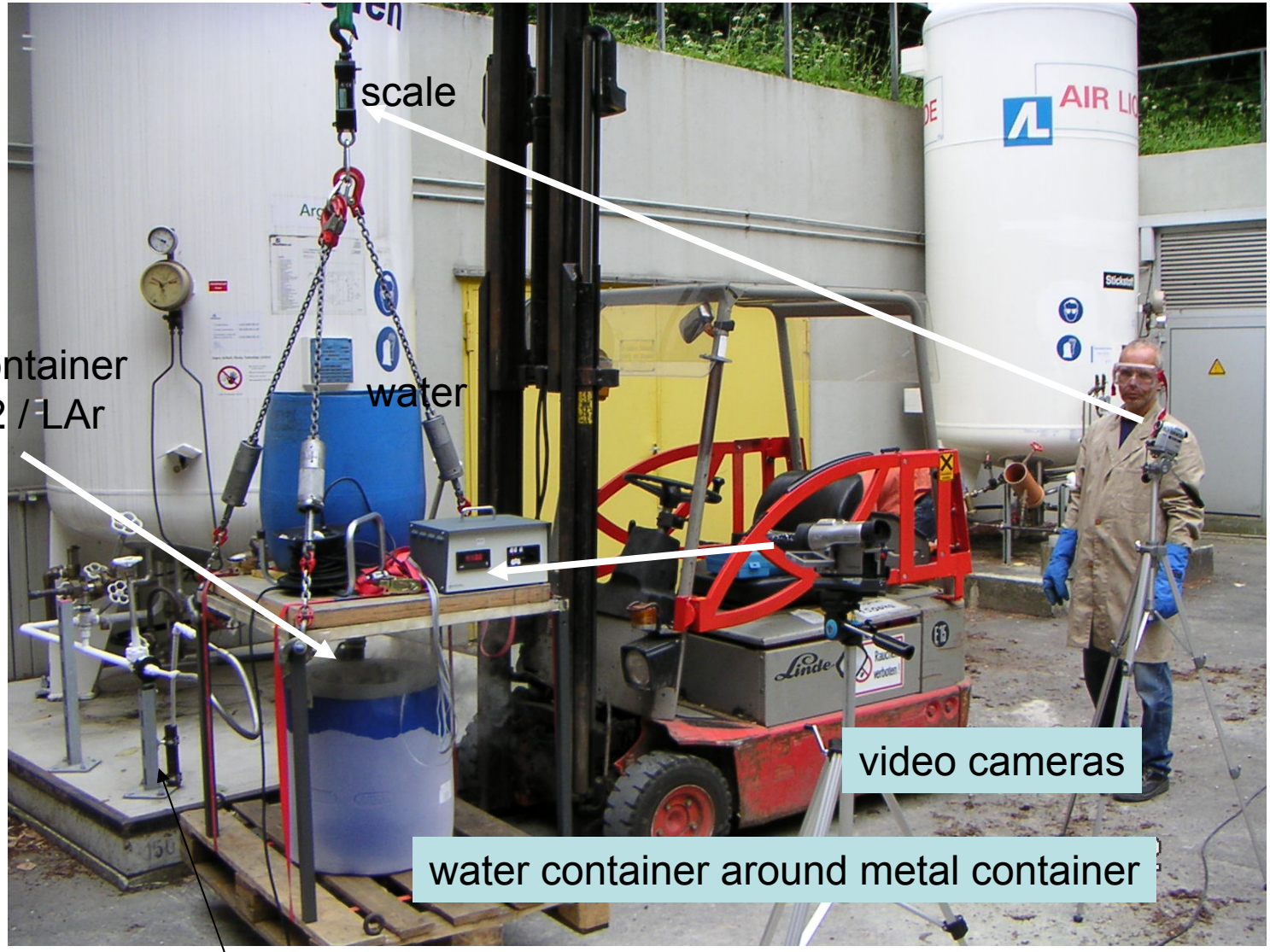
- Bologna, July 20: Intermediate meeting with NIER, 1st results?

Safety – Evaporation Rates

LN2 pool boiling heat transfer characteristics



Safety – Heat Transfer & Evaporation Rate Studies

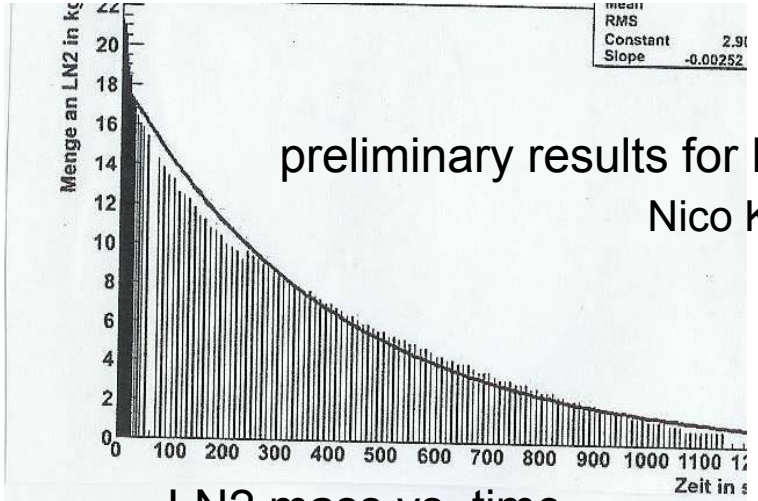


measure : mass & temperature as function of time after water flooding

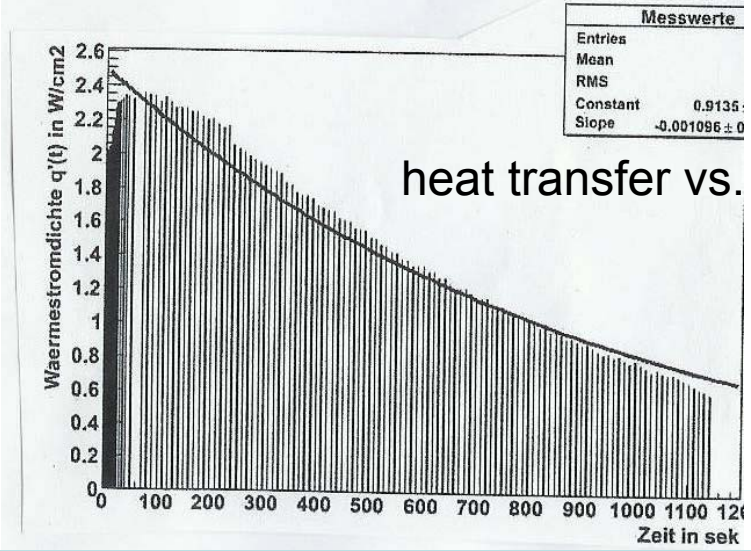
Safety – Heat Transfer & Evaporation Rate Studies

preliminary results for LN2

Nico Klein



LN2 mass vs. time



heat transfer vs. time

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

Safety

- New chapter in V0.2 of Technical Proposal

  ► Evaporation rates for
  (i) loss of insulation vacuum
  (ii) loss of one wall
  are manageable.

  ► 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.

Conclusions

- New baseline design:
  stainless steel cryostat with LAr filling and internal copper shield
- Design available - tendering process started
- Stainless steel supply might be difficult – drives time schedule
  no realistic estimate yet possible
- New round of safety reviews started
- Draft version of Technical Proposal V0.2 contains update on cryostat, cryogenic infrastructure and safety
- New experimental results on LN2 / LAr heat transfer and evaporation rates for water – metal wall – cryoliquid systems to be available soon.

Concluding Remarks (1)

Price tag for copper cryostat fabricated by pro-beam is
by factor of ~2 beyond the budget of MPI HD.

Possible solutions:

- Raise more funds – yes, desirable, but might be better spent on detectors
- Reduce fabrication cost - under investigation,
  answers available within a few weeks
- Resort to backup design > ss cryostat - under investigation
  physics performance primary issue

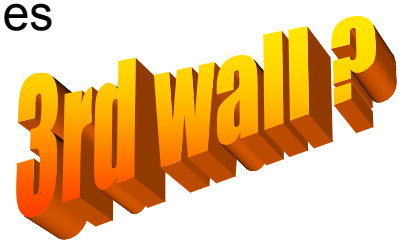
Implications on time schedule:

- Copper cryostat : available not earlier than by spring 2007
- stainless steel cryostat : if tendered in May/June – might be available
  by the end of 2006 or early in 2007

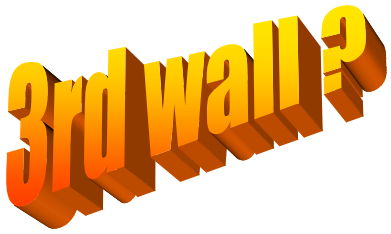
Concluding Remarks (2)

Ongoing activities at MPI HD:

- Explore alternative EB welding company (Techmeta)
  - ► compare price tags for welding and jigs
- Explore alternative copper welding technology (MIG welding @ SDMS)
  - ► prepare radiopurity screening of Cu/Sn electrodes
  - ► clarify price, delivery time, ...
  - (► prepare test welds, ...)



- Prepare tendering of stainless steel cryostat
  - ► prepare construction drawings based on copper cryostat design
  - ► find out potential suppliers –
    separate tenders for vessel and superinsulation envisaged
    one major tendering criterion : production time



Backup Solution – Estimates*

Cost

► assuming vessel weight of 30t:

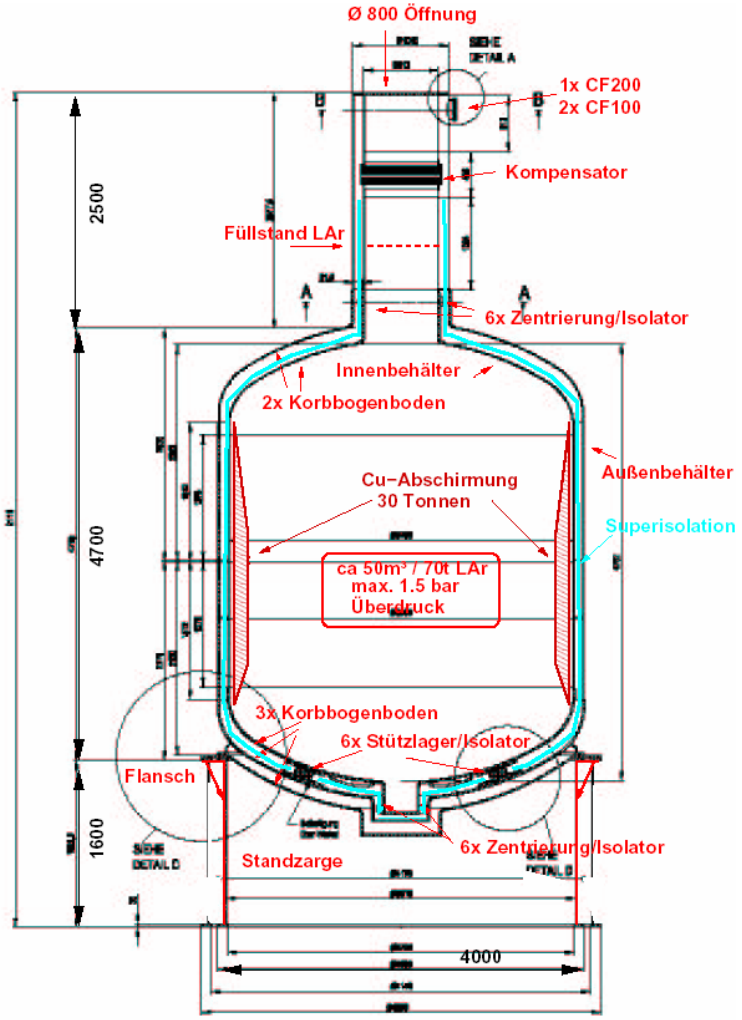
1.4571 material	180
fabrication 5E/kg	150
----------	----------
	~350 k

(superinsulation, copper not included)

Delivery time

tendering	30 – 53 days
vessel heads (Korbbogenböden)	3 – 4 months
fabrication	2 months

► assuming everything is settled at order time!



* from contact with large commercial company for “Behälterbau”.