# GERDA TG4 - Cryogenic Vessel

# Status Report

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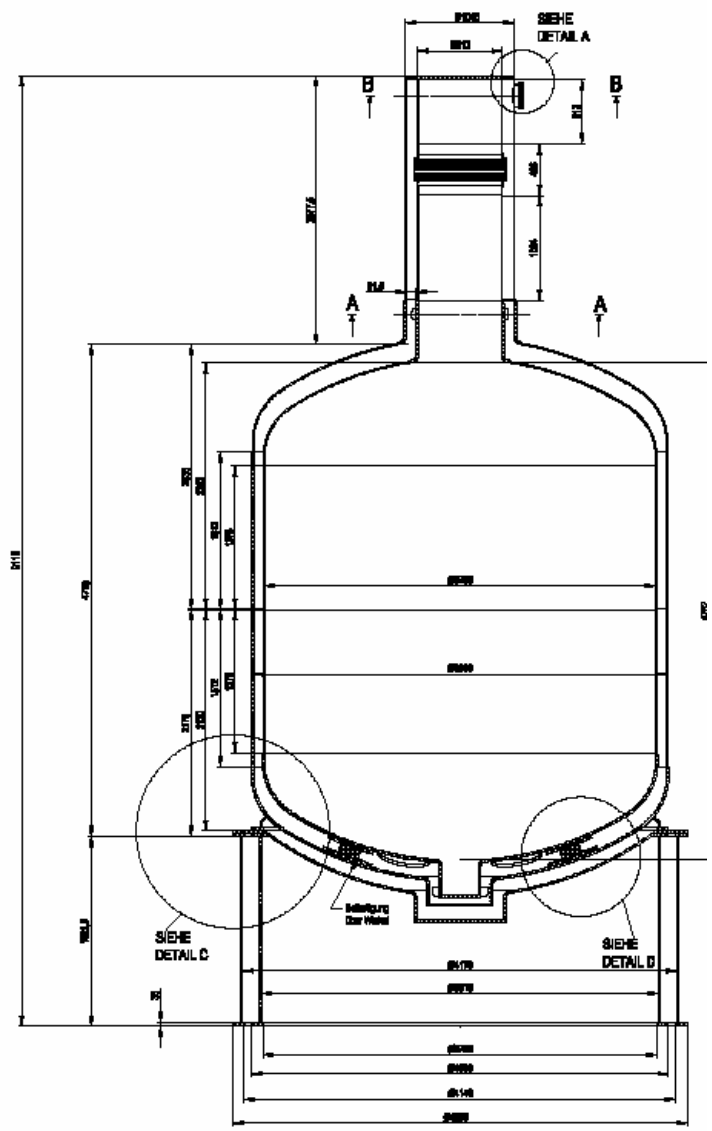
GERDA Collaboration Meeting at Heidelberg
20 – 22 February 2006

# Outline




production

expenditures

# Outline, continued

Electron Beam Welding Certification

EB Welding Plan for Cryostat Construction

Fabrication Plan

Open Issues

Next Steps

Conclusions

# EB Welding Certification pro-beam Facility

630 m³ vacuum chamber of pro-beam AG & Co KGaA at 39288 Burg

B x H x L (eff) = 4.5 x 6 x 12 m³

EB welding robot

# EB Welding Certification Sample Preparation

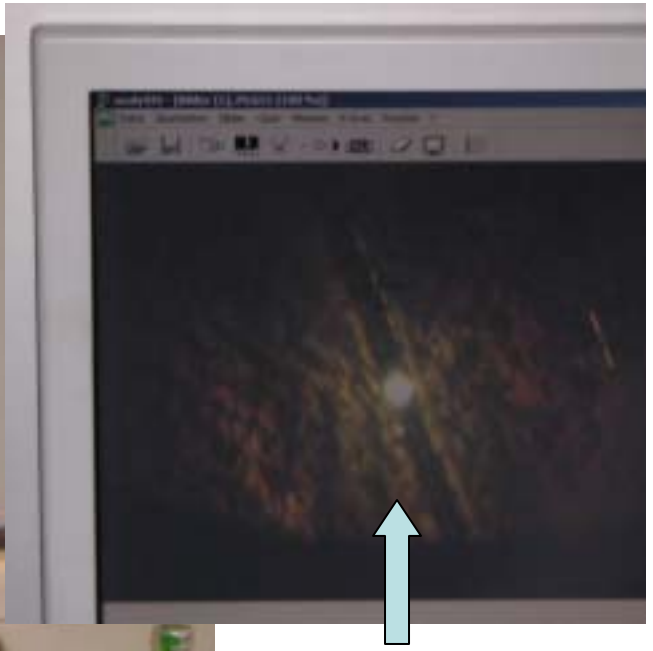
TÜV welding expert present

EB gun


December 6, 2005 (scheduled for KW45)

# EB Welding Certification

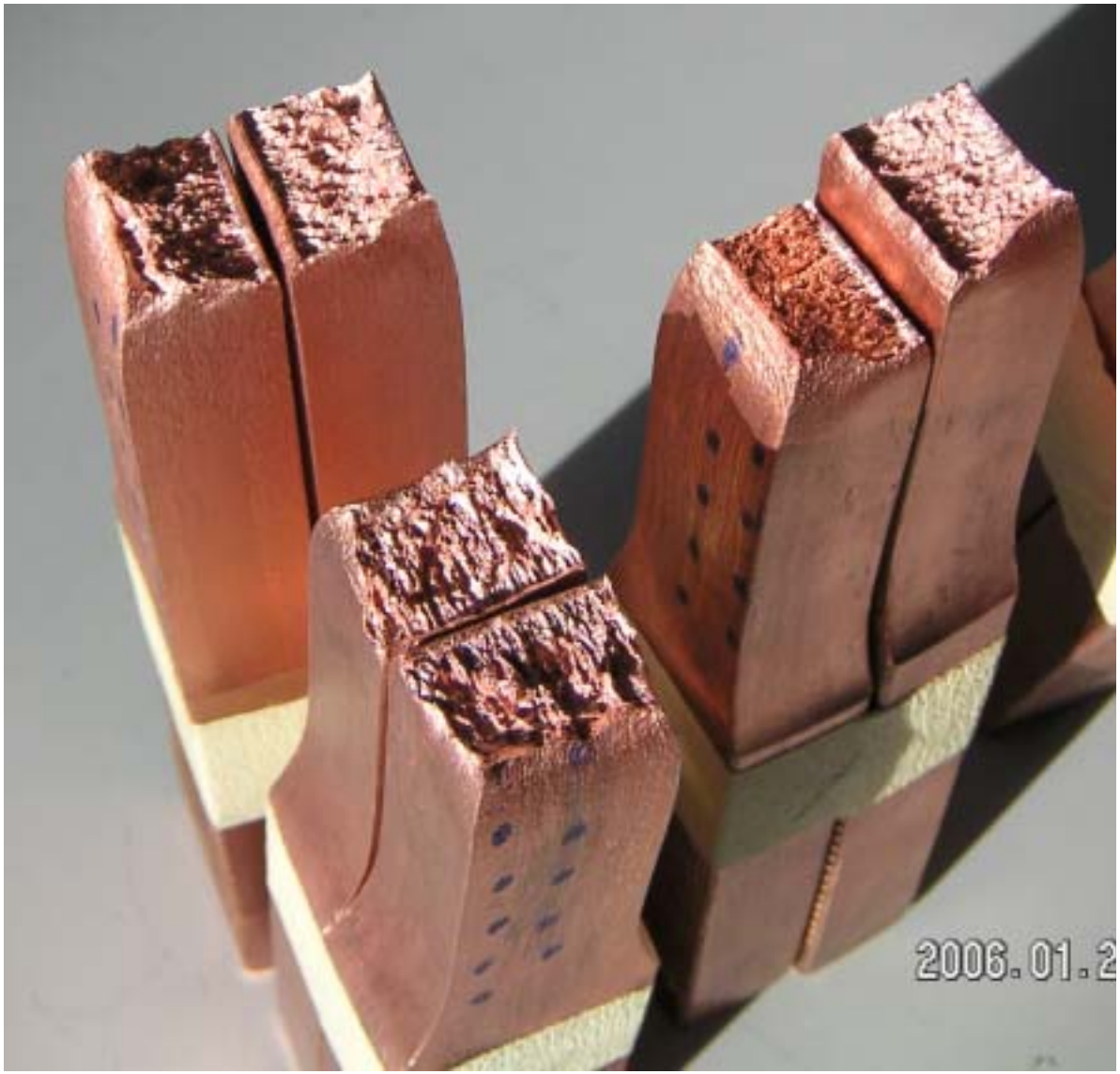
## EB Control Room

e beam

# EB Welding Certification Rupture Tests

weld


all tests performed by
TÜV Nord

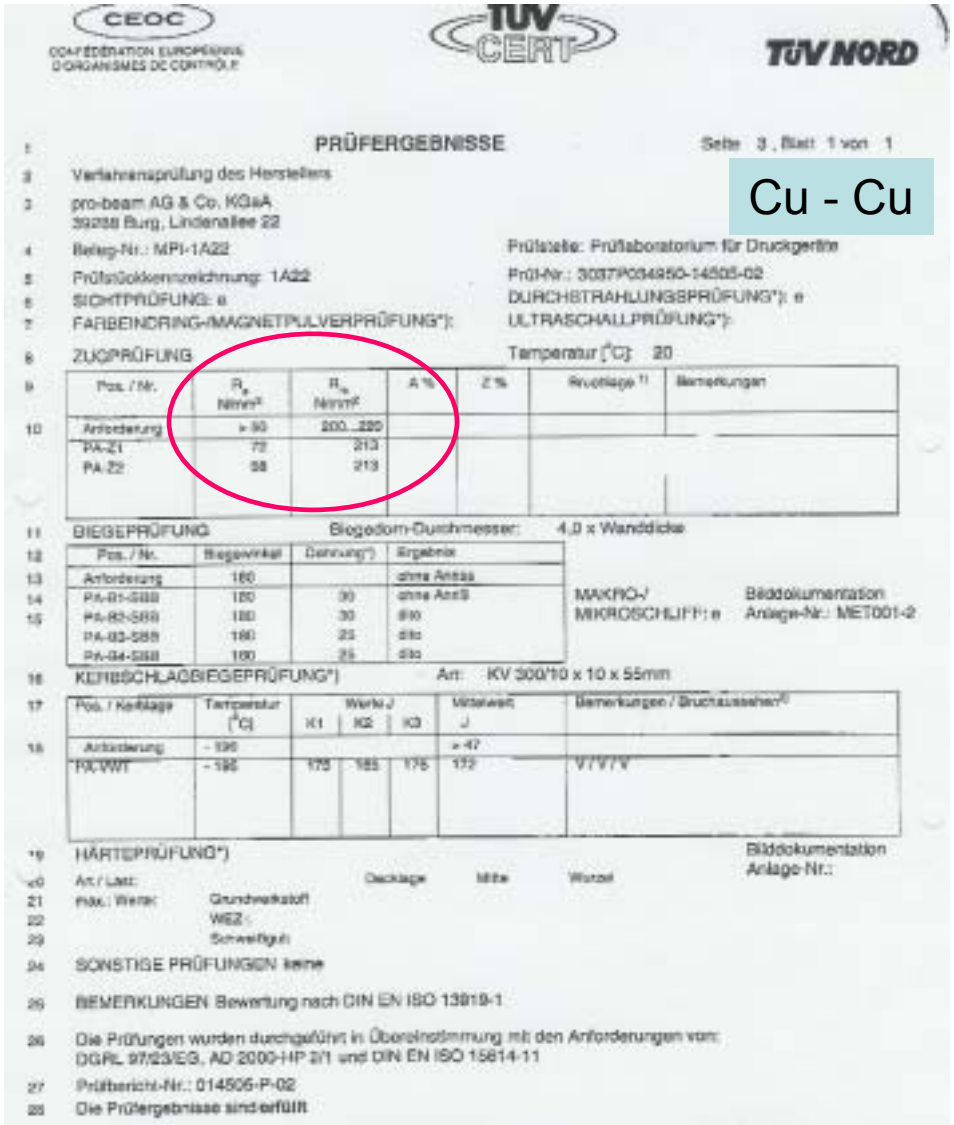
# EB Welding Certification Head Pressing Tests



Pressing tests of
EB welded 20 mm OFE copper sheets

# EB Welding Certification

# TÜV Certificates



CEOC
CONFÉDÉRATION EUROPÉENNE D'ORGANISMES DE CONTRÔLE

TÜV CERT

TÜV NORD

PRÜFERGEBNISSE

Seite 3 , Blatt 1 von 1

Cu - Cu

Verfahrensprüfung des Herstellers

pro-beam AG & Co. KGaA
38268 Burg, Lindenallee 22

Beleg-Nr.: MPI-1A22

Prüfstelle: Prüflaboratorium für Druckgeräte

Prüfstückkennzeichnung: 1A22

Prüf-Nr.: 3037P034950-14505-02

SICHTPRÜFUNG: o

DURCHSTRAHLUNGSPRÜFUNG*): o

FARBEINDRING-/MAGNETPULVERPRÜFUNG*):

ULTRASCHALLPRÜFUNG*):

ZUGPRÜFUNG

Temperatur [°C]: 20

| Pos. / Nr. | $R_e$ N/mm² | $R_m$ N/mm² | A % | Z % | Bruchlage 1) | Bemerkungen |
|---|---|---|---|---|---|---|
| Anforderung | > 90 | 200...220 | | | | |
| PA-Z1 | 72 | 213 | | | | |
| PA-Z2 | 98 | 213 | | | | |

BIEGEPRÜFUNG

Biegedorn-Durchmesser: 4,0 x Wanddicke

| Pos. / Nr. | Biegewinkel | Dehnung*) | Ergebnis |
|---|---|---|---|
| Anforderung | 180 | | ohne Anriss |
| PA-B1-SBB | 180 | 30 | ohne Anriß |
| PA-B2-SBB | 180 | 30 | dto |
| PA-B3-SBB | 180 | 25 | dto |
| PA-B4-SBB | 180 | 25 | dto |

MAKRO-/ MIKROSCHLIFF: o

Bilddokumentation Anlage-Nr.: MET001-2

KERBSCHLAGBIEGEPRÜFUNG*)

Art: KV 300/10 x 10 x 55mm

| Pos. / Kerblage | Temperatur [°C] | Werte J K1 | K2 | K3 | Mittelwert J | Bemerkungen / Bruchaussehen*) |
|---|---|---|---|---|---|---|
| Anforderung | - 196 | | | | > 47 | |
| PC-WT | - 196 | 175 | 185 | 175 | 178 | V / V / V |

HÄRTEPRÜFUNG*)

Bilddokumentation Anlage-Nr.:

Art / Last:

max.: Werte: Grundwerkstoff / WEZ: / Schweißgut:

Decklage / Mitte / Wurzel

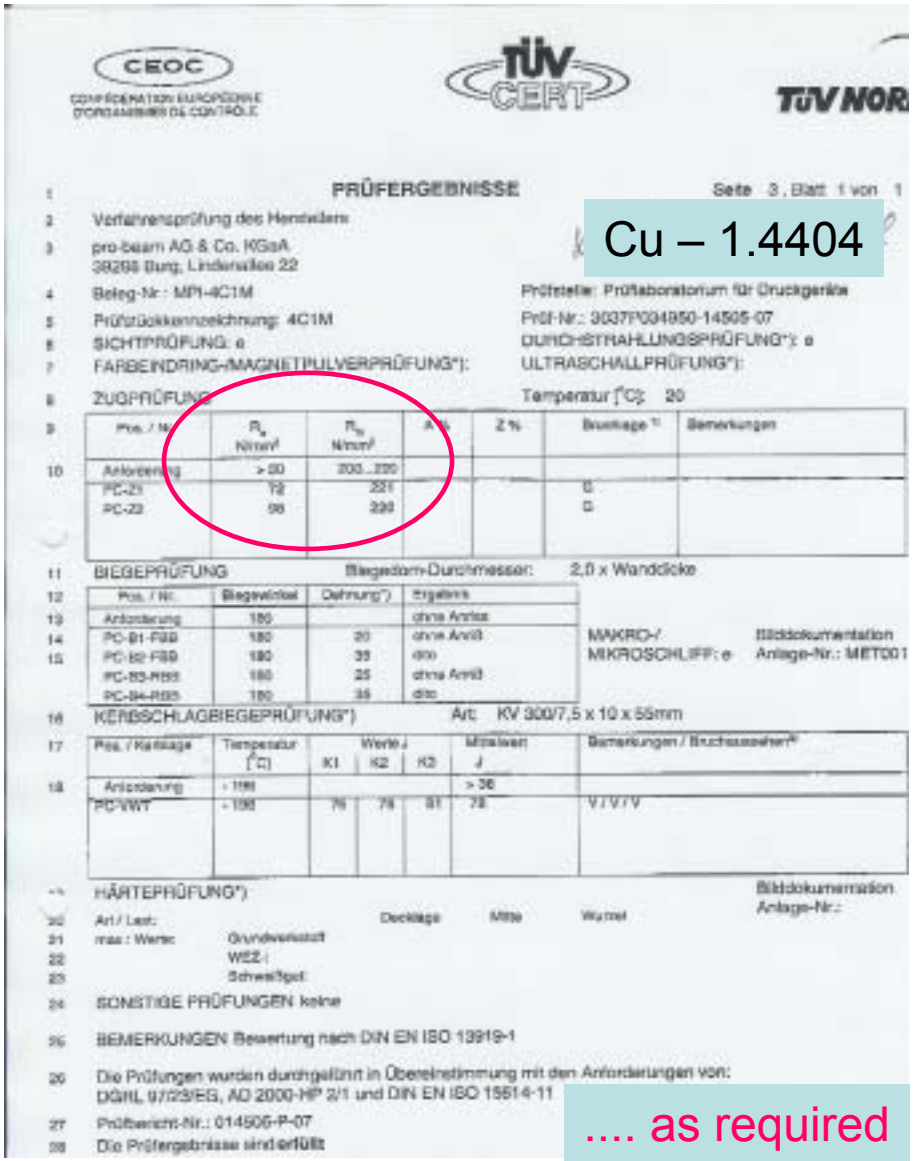
SONSTIGE PRÜFUNGEN keine

BEMERKUNGEN Bewertung nach DIN EN ISO 13919-1

Die Prüfungen wurden durchgeführt in Übereinstimmung mit den Anforderungen von: DGRL 97/23/EG, AD 2000-HP 2/1 und DIN EN ISO 15614-11

Prüfbericht-Nr.: 014505-P-02

Die Prüfergebnisse sind erfüllt



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TÜV CERT

TÜV NOR

PRÜFERGEBNISSE

Seite 3 , Blatt 1 von 1

Cu – 1.4404

Verfahrensprüfung des Herstellers

pro-beam AG & Co. KGaA
38268 Burg, Lindenallee 22

Beleg-Nr.: MPI-4C1M

Prüfstelle: Prüflaboratorium für Druckgeräte

Prüfstückkennzeichnung: 4C1M

Prüf-Nr.: 3037P034950-14505-07

SICHTPRÜFUNG: o

DURCHSTRAHLUNGSPRÜFUNG*): o

FARBEINDRING-/MAGNETPULVERPRÜFUNG*):

ULTRASCHALLPRÜFUNG*):

ZUGPRÜFUNG

Temperatur [°C]: 20

| Pos. / Nr. | $R_e$ N/mm² | $R_m$ N/mm² | A % | Z % | Bruchlage 1) | Bemerkungen |
|---|---|---|---|---|---|---|
| Anforderung | > 90 | 200...220 | | | | |
| PC-Z1 | 72 | 221 | | | G | |
| PC-Z2 | 98 | 220 | | | G | |

BIEGEPRÜFUNG

Biegedorn-Durchmesser: 2,0 x Wanddicke

| Pos. / Nr. | Biegewinkel | Dehnung*) | Ergebnis |
|---|---|---|---|
| Anforderung | 180 | | ohne Anriss |
| PC-B1-FBB | 180 | 20 | ohne Anriß |
| PC-B2-FBB | 180 | 35 | dto |
| PC-B3-RBB | 180 | 25 | ohne Anriß |
| PC-B4-RBB | 180 | 35 | dto |

MAKRO-/ MIKROSCHLIFF: o

Bilddokumentation Anlage-Nr.: MET001

KERBSCHLAGBIEGEPRÜFUNG*)

Art: KV 300/7,5 x 10 x 55mm

| Pos. / Kerblage | Temperatur [°C] | Werte J K1 | K2 | K3 | Mittelwert J | Bemerkungen / Bruchaussehen*) |
|---|---|---|---|---|---|---|
| Anforderung | - 196 | | | | > 36 | |
| PC-WT | - 196 | 76 | 76 | 81 | 78 | V / V / V |

HÄRTEPRÜFUNG*)

Bilddokumentation Anlage-Nr.:

Art / Last:

max.: Werte: Grundwerkstoff / WEZ: / Schweißgut:

Decklage / Mitte / Wurzel

SONSTIGE PRÜFUNGEN keine

BEMERKUNGEN Bewertung nach DIN EN ISO 13919-1

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Prüfbericht-Nr.: 014505-P-07

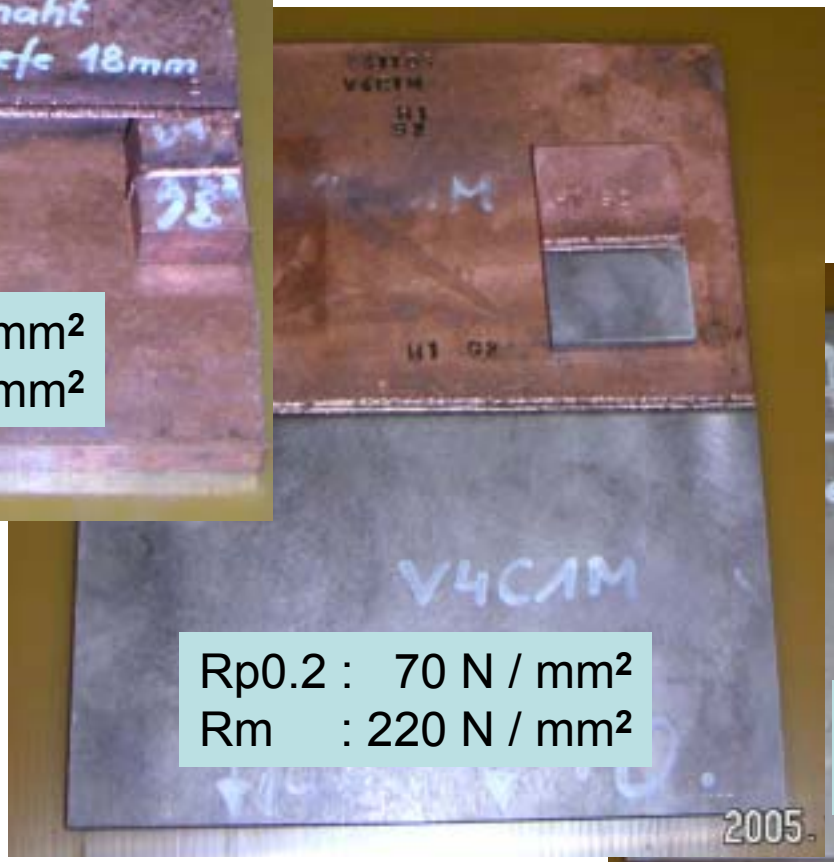
Die Prüfergebnisse sind erfüllt

.... as required

# EB Welding Certification — Results


Rp0.2 : 65 N / mm²
Rm : 200 N / mm²

OFE copper – 1.4404
8 mm – 8 mm




Rp0.2 : 70 N / mm²
Rm : 220 N / mm²

1.4404 – 1.4404
8 mm – 8 mm


Rp0.2 : 280 N / mm²
Rm : 600 N / mm²

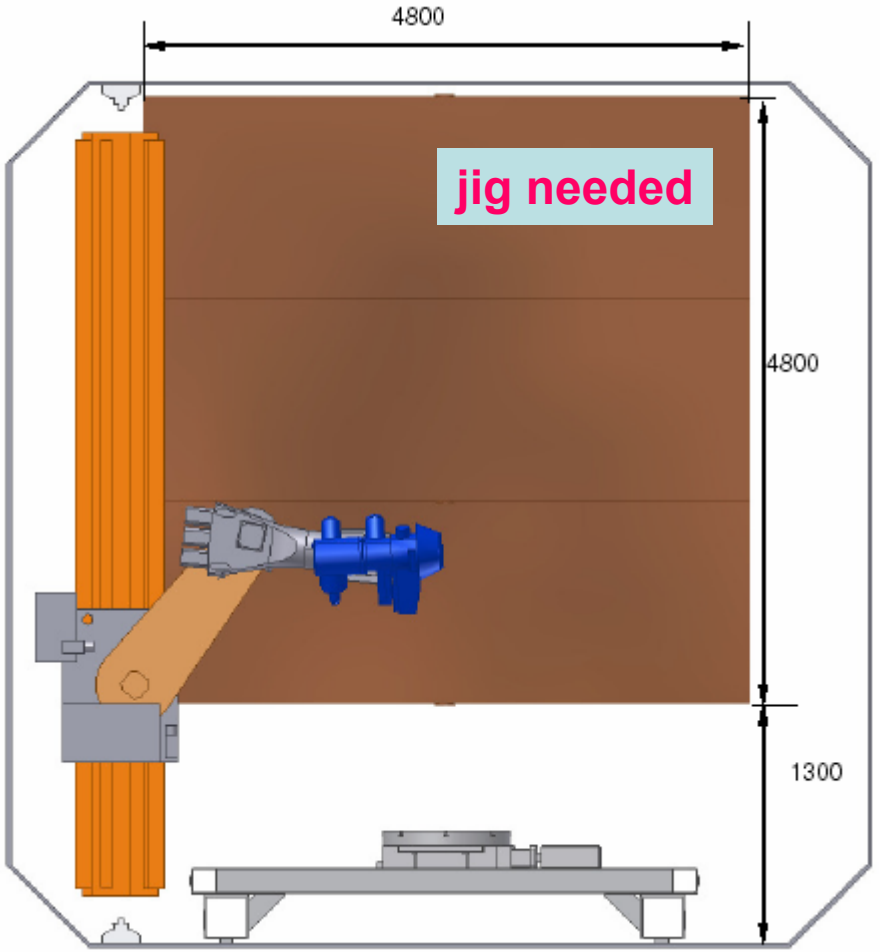
SOFT
OFE – OFE copper
[5 mm]
12 mm
20 mm

# EB Welding Plan

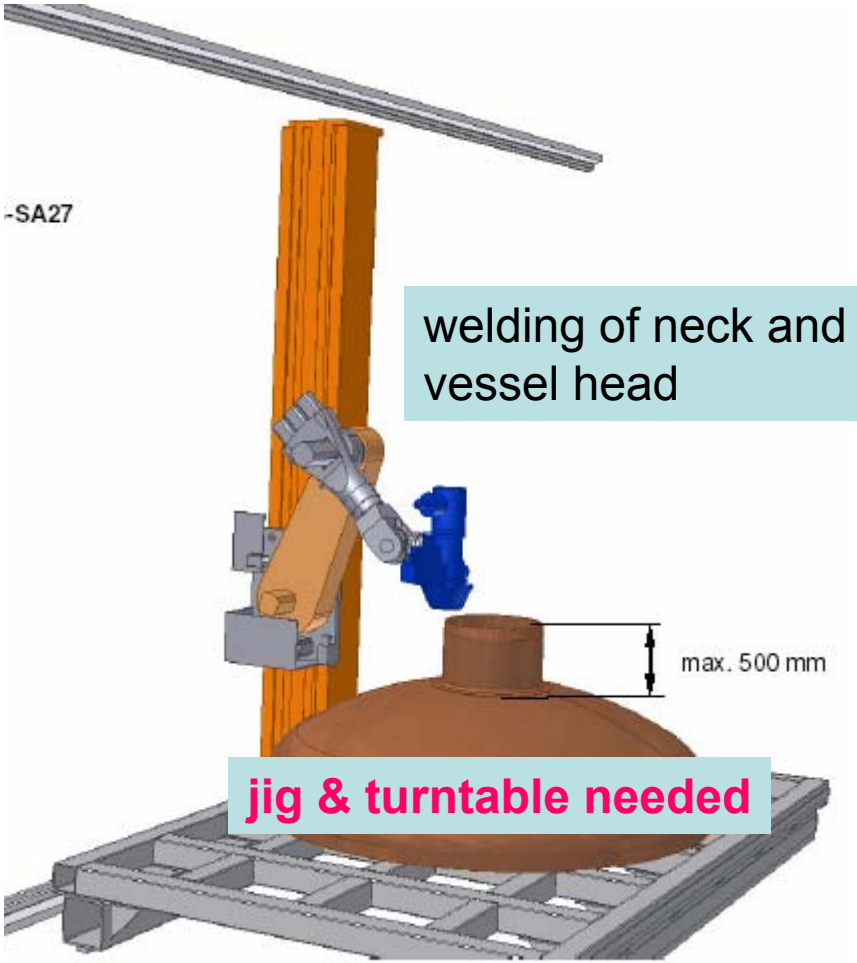
- under preparation by pro-beam project engineer
- used to investigate
  - ► how available cryostat design can be adapted to constraints of EB welding
    (remember only head-head, “I-Stoβ”, EB welds are straightforward!)
  - ► orientations of cryostat parts for optimum welding
  - ► jigs needed for fixation of the various cryostat parts for EB welding
- February 1&2, 2006
  - ►Two days meeting at Burg with all involved parties including representatives of a company with expertise in the construction of vessels and jigs.

# EB Welding Plan

## Examples

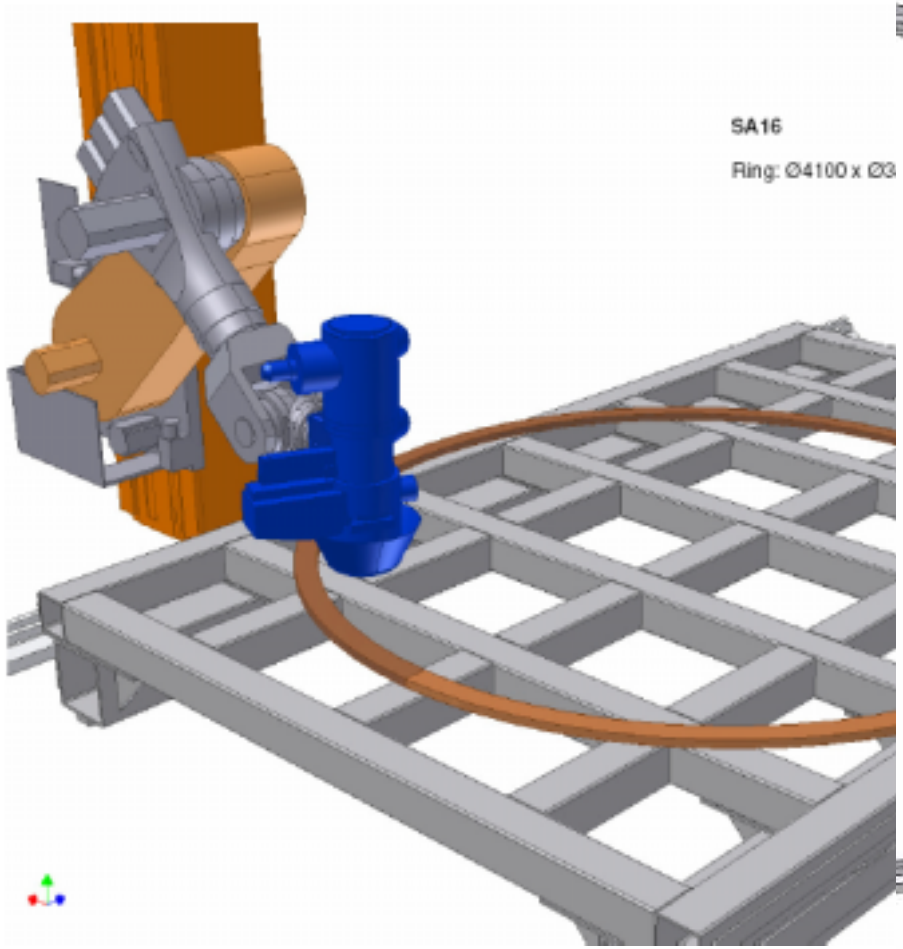



assembly of Ø5m disk from 3 sheets
►needed for vessel head fabrication

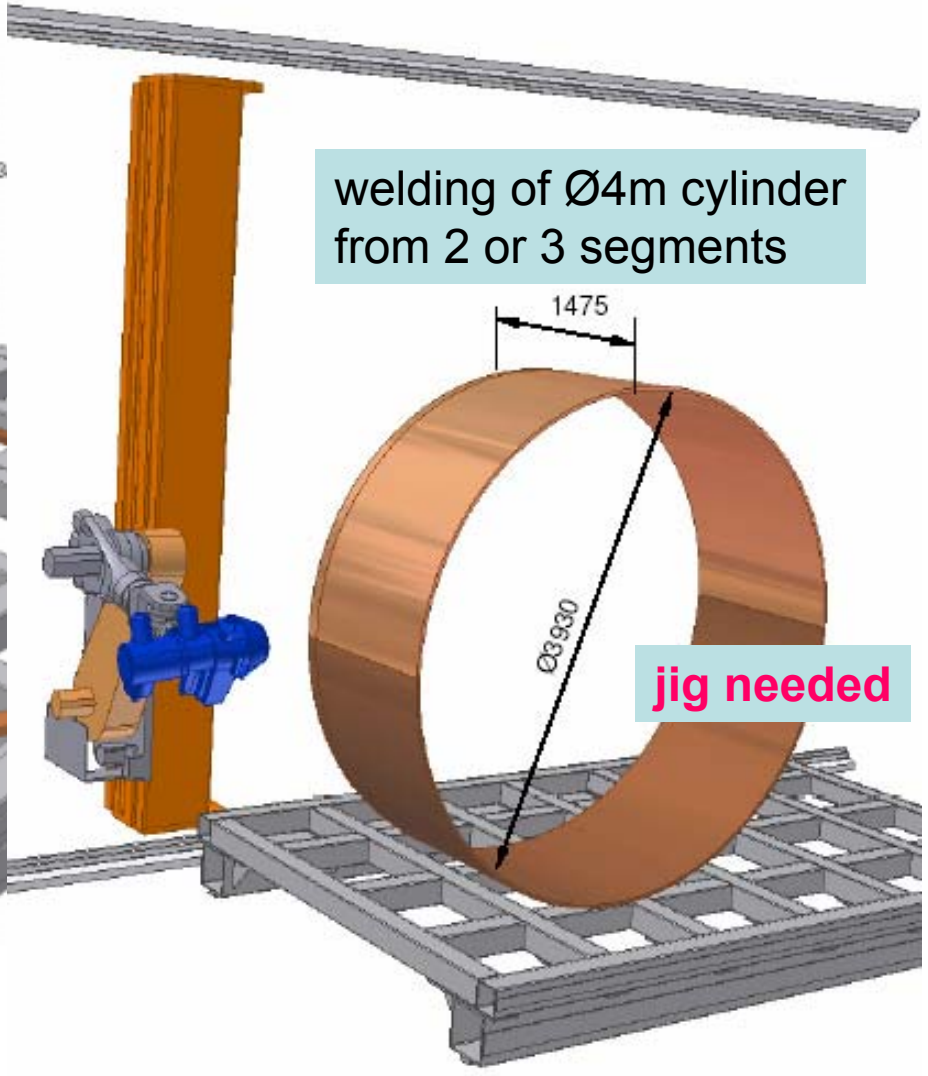


# EB Welding Plan

## Examples



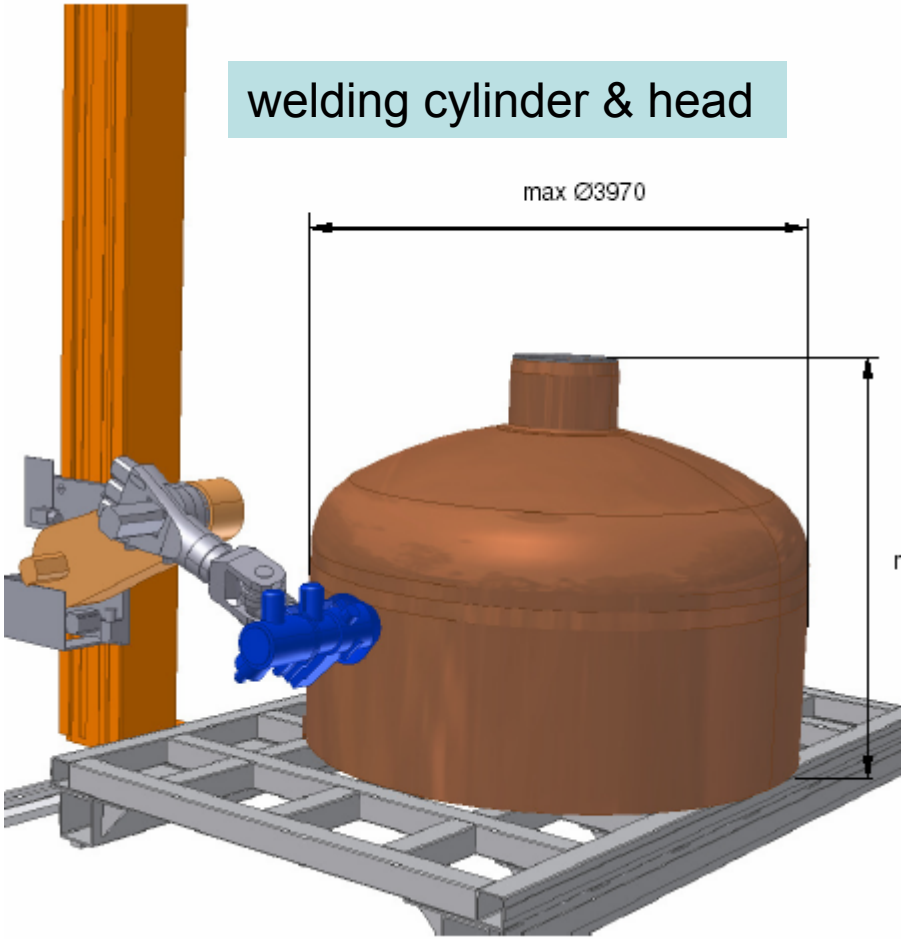

assembly of Ø4m flange from many segments




welding of Ø4m cylinder from 2 or 3 segments

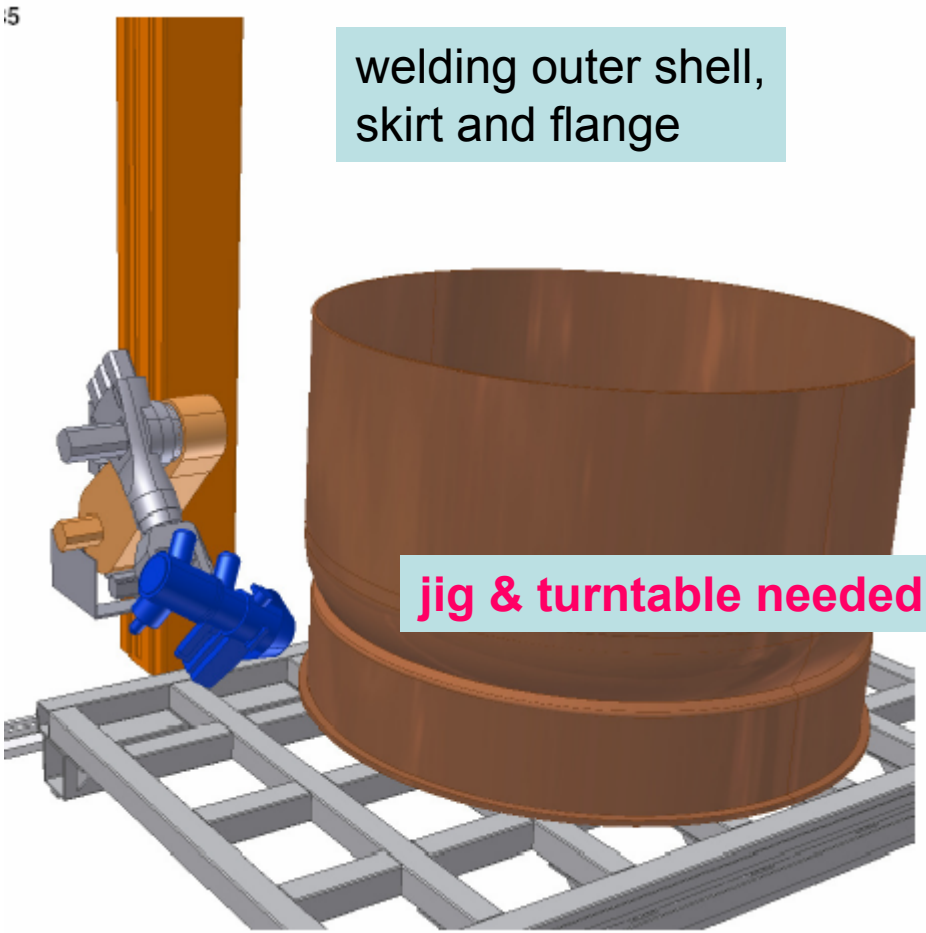
**jig needed**

welding cylinder & head

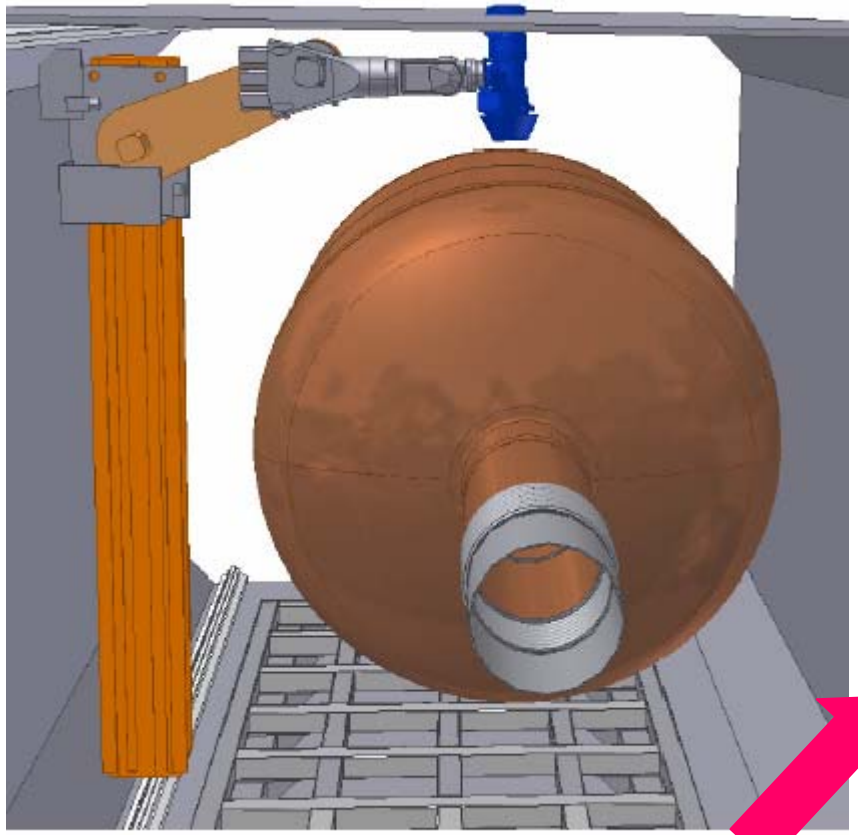


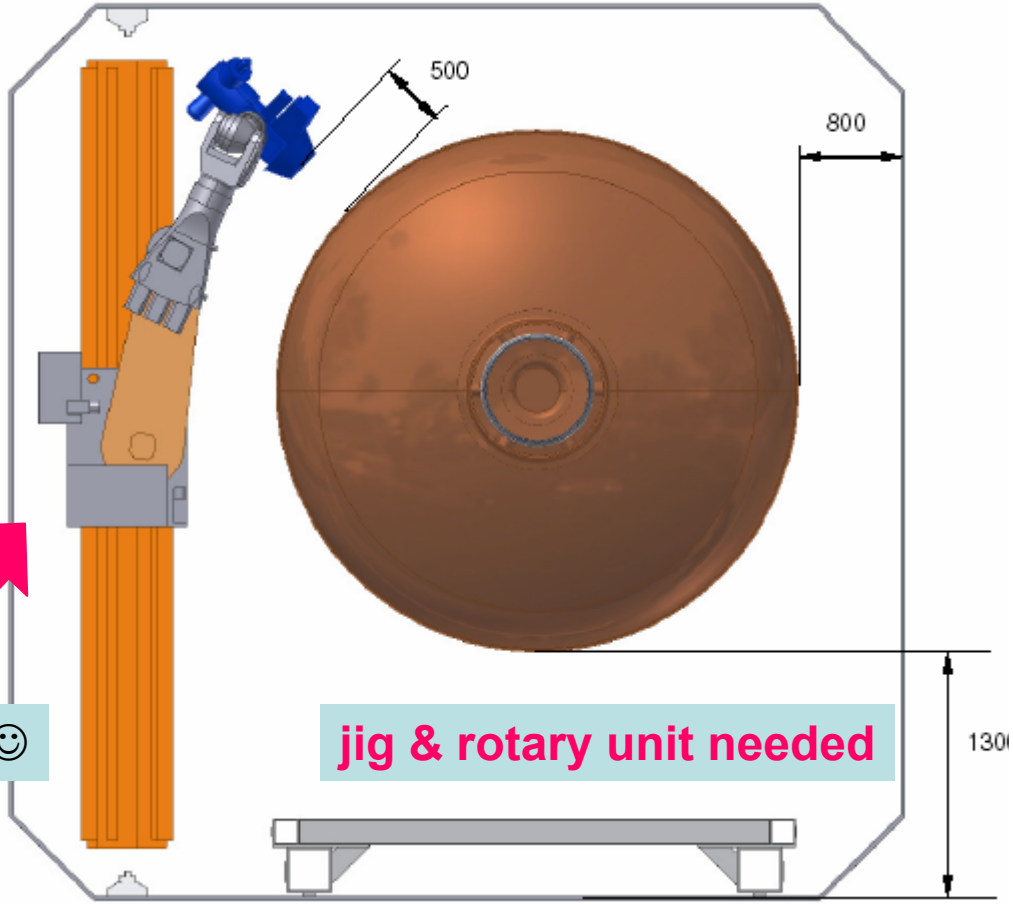

jig & turntable needed

welding outer shell, skirt and flange



jig & turntable needed





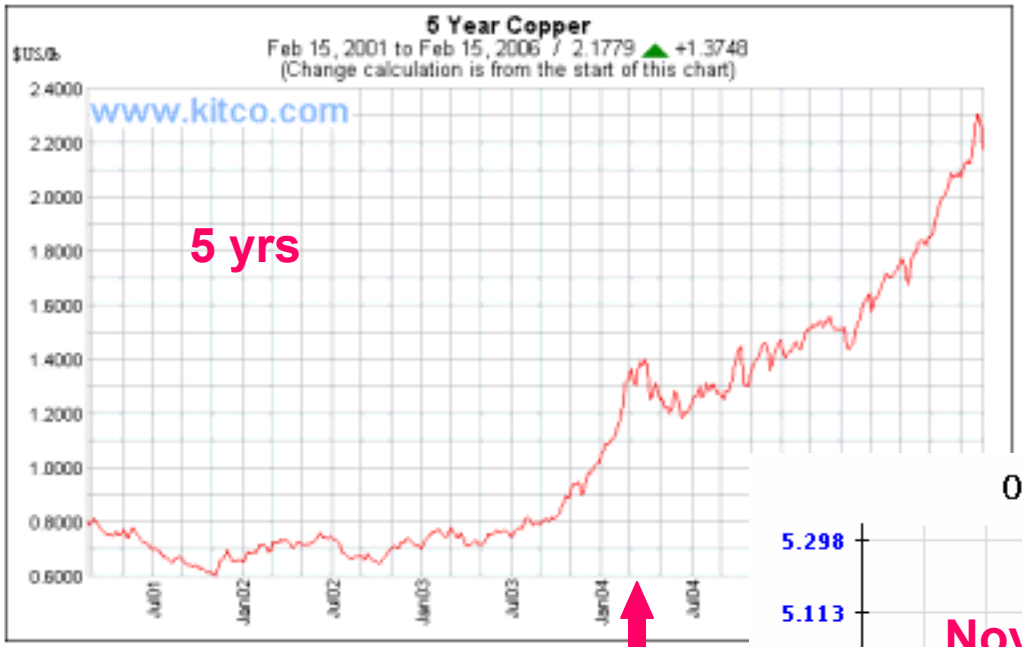

final weld – not straightforward but ok ☺

**jig & rotary unit needed**

# Fabrication Plan – vry shrt vrsn

- order OFRP copper material ► done (70t)
- roll copper sheets ► tender being published
- cut / mill copper sheets
- EB weld plates for cylinders & vessel heads
- roll cylinder shells and press vessel heads
- cut / mill shells and heads
- clean all pieces
- assemble / pressure test / clean inner container
- mount superinsulation onto inner container
- assemble skirt & lower part of outer container, ‘eggcup’
- assemble upper part of outer container
- test / clean outer container parts
- introduce (vertically) inner container into ‘eggcup’
- close assembly by upper part of outer container
- rotate assembly into horizontal orientation
- do final weld ► fall 2006 envisaged in Feb 01/02-meeting
- vacuum & cryogenic tests,....., ship to LNGS

**► so far, time schedule determined by design and construction of jigs ◄**

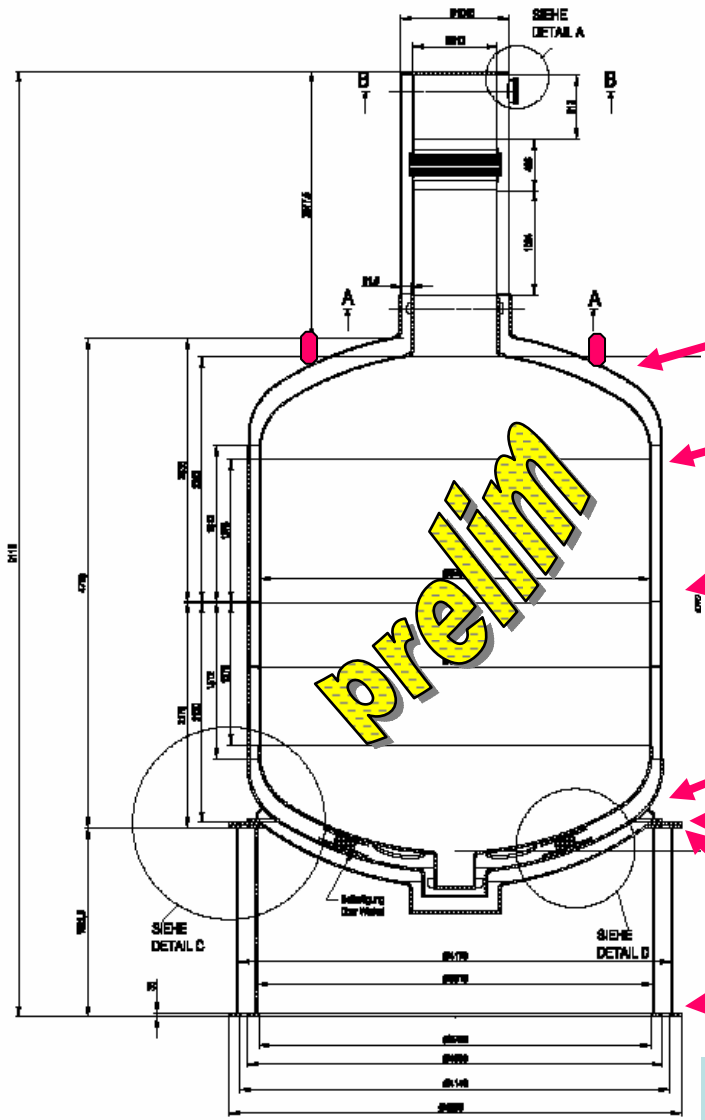



copper price almost doubled since July 2004


GERDA LOI

at present:
~10k€ / 1t Cu metal sheet

[ don't forget 3rd wall (~12t) ]




Several seemingly elegant solutions did not work out as iniyially envisaged ....

How to handle finished cryostat ? ► lifting lugs?

No!

get final wall thicknesses

Support between inner & outer shell needed here?

How to do this EB weld? ►'Komma-Naht' ok?

Design of skirt / flange considering additional non central weight from 3rd wall.

How to EB weld flanges and cylindrical shells?
What is the thickness of the respective flanges?

►No principle problems – but need to be solved fast!

# Next Steps

IF welding test milestone passed : ◄ DONE

- determination of cryostat's wall thickness ◄ almost DONE
- certification of design by TÜV Nord ◄ will be fast , ~2 weeks
- cryogenic review of cryostat design ◄ almost DONE
- 'order' of cryostat ◄ waiting for answer
- tender / order of installation of superinsulation } ◄ in progress
- tender / order of cryogenic infrastructure

Open issues, e.g.:

- selection of superinsulation (~~teflon sample not yet delivered~~) } ◄ see next slide
- cleaning of copper surface / cryostat
- layout of clean infrastructure at e-beam welding facility ◄ not yet done
- time schedule for cryostat production, installation ◄ in progress
- procedure for installation, implications of 3rd wall ◄ see talk on 3rd wall



this slide is a copy from the report given at Tübingen, Nov 05

# More Open Issues Close to be Resolved

- **Superinsulation**

  teflon sample w/o spacer tested at HD
  ► Th-228 / Ra-226 activity < 6.3 / 4.2 mBq/kg, (better limits needed).

  Alternative: 10 layer laser-cut 'blanket' samples from AA being screened with GeMPI – first results to be available during this meeting -
  ► IF activity < 2 / 10 mBq(Th-228 / Ra-226)/ kg THEN OK! for our needs.

- **Cleaning of Copper Cryostat – present conclusions / opinions / plans**

  1) electro-polishing very expensive (>200k) – would be reasonable only after pressing & rolling and/or after welding.
  2) Since pressing & rolling will be rather dirty operations first thorough cleaning after these procedures;
     ► pickling with $H_2SO_4$, rinsing with (de-ionized ?) water.
  3) Large part of surfaces to be covered during EB welding.
  4) After EB welding careful cleaning with (hot? high pressurized?) detergent followed by rinsing with de-ionized water.
  5) Measure then Rn emanation and conclude on next steps – if needed.

# Conclusions

- Progress

  ► EB welding certification by TÜV Nord done.
  ► major milestone passed
  ► Review of cryogenic cryostat design done.
  ► Detailed welding plan by pro-beam developed.
  ► 70t of OFE high purity copper ordered.
  ► Details of rolling procedures clarified, tendering in progress.
  ► Tendering will NOT limit progress in cryostat production.
  ► Good candidate for superinsulation being screened.
  ► Progress in understanding surface contaminations
  (► M.Wojcik, G.Zuzel) has led to first plans for cryostat cleaning.

- Critical items

  ► next slide

- Time Schedule

# Conclusions

- Progress

- Critical items

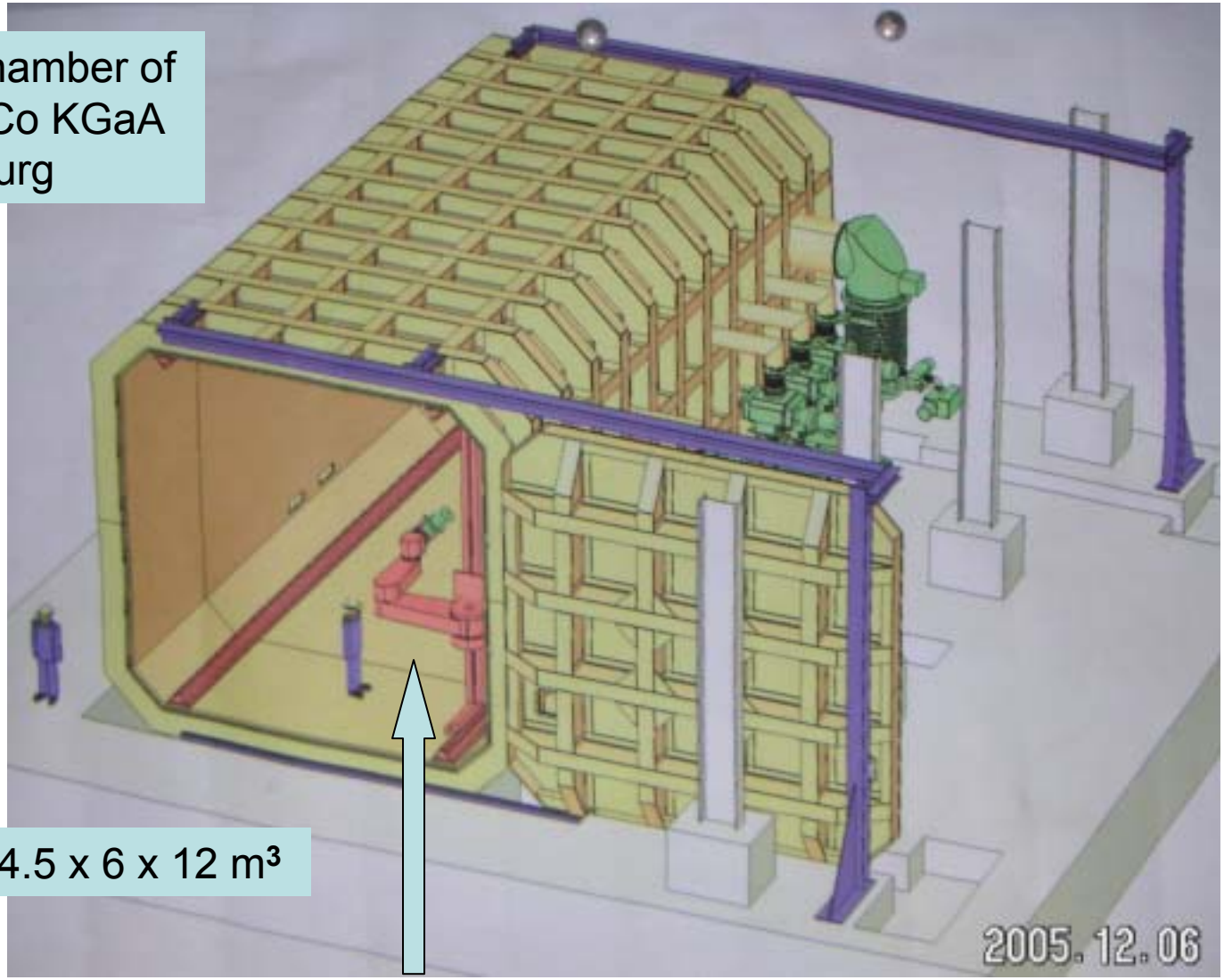
  - ► Timely finalisation of cryostat design.
  - ► Timely cost estimate for design & construction of welding jigs.
  - ► Timely start of design & construction of welding jigs.
  - ► Funds (roaring copper price, additional cost by 3rd wall) – top priority to all items needed for cryostat (and 3rd wall) fabrication.

- Time Schedule

  - ► Present infos from companies indicate that cryostat could be delivered by fall this year ► 50% CL from past experience. More reliable estimates promised for last week, now announced for this week.

# EB Welding Certification pro-beam Facility

630 m³ vacuum chamber of
pro-beam AG & Co KGaA
at 39288 Burg

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EB welding robot