Status of Phase II Detector production TG02

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Reminder

- 37.5 kg Enriched Germanium with 87% ^{76}Ge first delivered to Munich, now stored underground in the HADES UGL (Geel).
- 50 kg of depleted GeO_2 also delivered to MPI is being used for purification and crystal pulling tests
- In 2007 new purification test started at PPM Pure Metals (Langelsheim, DE)
- June 2007: first test with depleted Ge completed
- October 2007: start of crystal pulling R&D contract with IKZ
- December 2007: a second purification test completed

Purification tests at PPM

- The first purification test at PPM Pure Metals GmbH (Langelsheim) was performed in May-June 2007.
- Second test August-December 2007
- Both tests were completed. The results are summarized in a report: GSTR-08-001
- After 3 steps of ZR total yield of 6N material 90%, no isotopic dilution effect, no dangerous contamination levels
- Solution was found for underground storage during purification
- Further tests postponed until the results of PTIS and Hall-effect measurements arrive

Crystal characterization

Last meeting at IKZ 28.02.2008

- Important milestones were agreed on:

1. Acquire large crucible. (done)
2. Pull first crystals with CZ start with 6N commercial Ge (with 4” crucible). (done)
3. Demonstrate characterization (PTIS, Hall effect at low T). (done, almost)
4. Grow crystals (pedestal, float-zone) from zone-refined depleted Ge (from PPM) to determine impurities. Goal 1.4.08, delayed
5. Grow a small diameter (2”) crystal which satisfies requirements: crystal dislocation density, impurity density, impurity profile.
6. Make small detectors to test charge trapping, etc (LBL, other site ?). (After the crystal requirements have been met. Goal 1.11.08)
7. Determine yield for high quality crystals versus crystal dimensions. Aim for 1.9.08)
8. Produce 3 detector grade crystals from depleted materials (Goal 1.1.09)
9. Build detectors at Canberra from detector grade crystals. (Goal 1.3.09)
10. Produce detector grade crystals from enriched materials (new contract in 09).

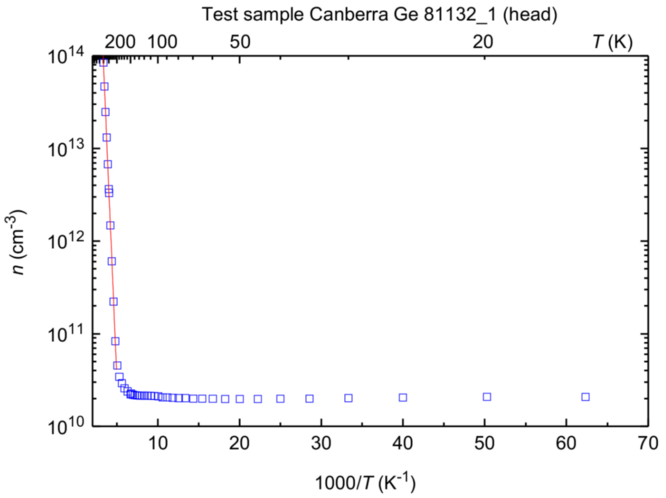
Crystal characterization

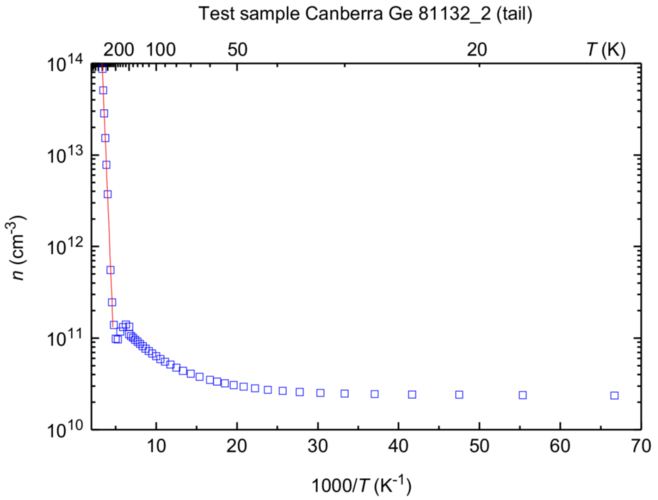
IKZ demonstrated the ability to do Hall-effect measurement and PTIS

CANBERRA: Crystal 81132, diameter 20 mm,

	head	tail
ND-NA ($10^{10}/cm^3$)	2.85	3.20
Hall mobility ($10^4 cm^2/Vs$)	2	1.9
Disloc. dens. ($10^3/cm^2$)	3.15	3.05

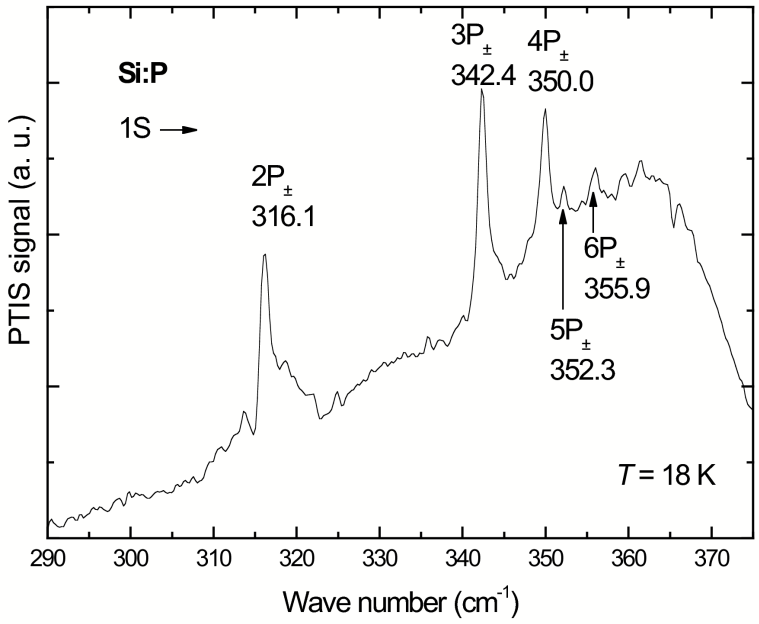
Single crystal grown by the pedestal technique from polycrystaline Ge from PPM-Pure Metals ND-NA measured 10^{11} at the seed side but typically 10^{12}impurities/cm^3

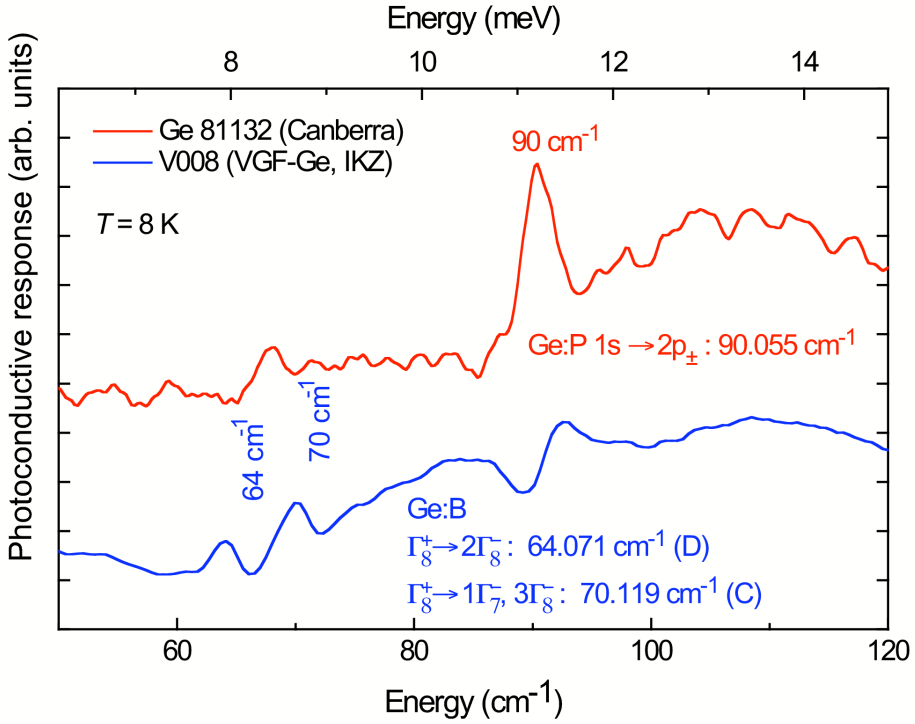




Crystal characterization

PTIS measurements:

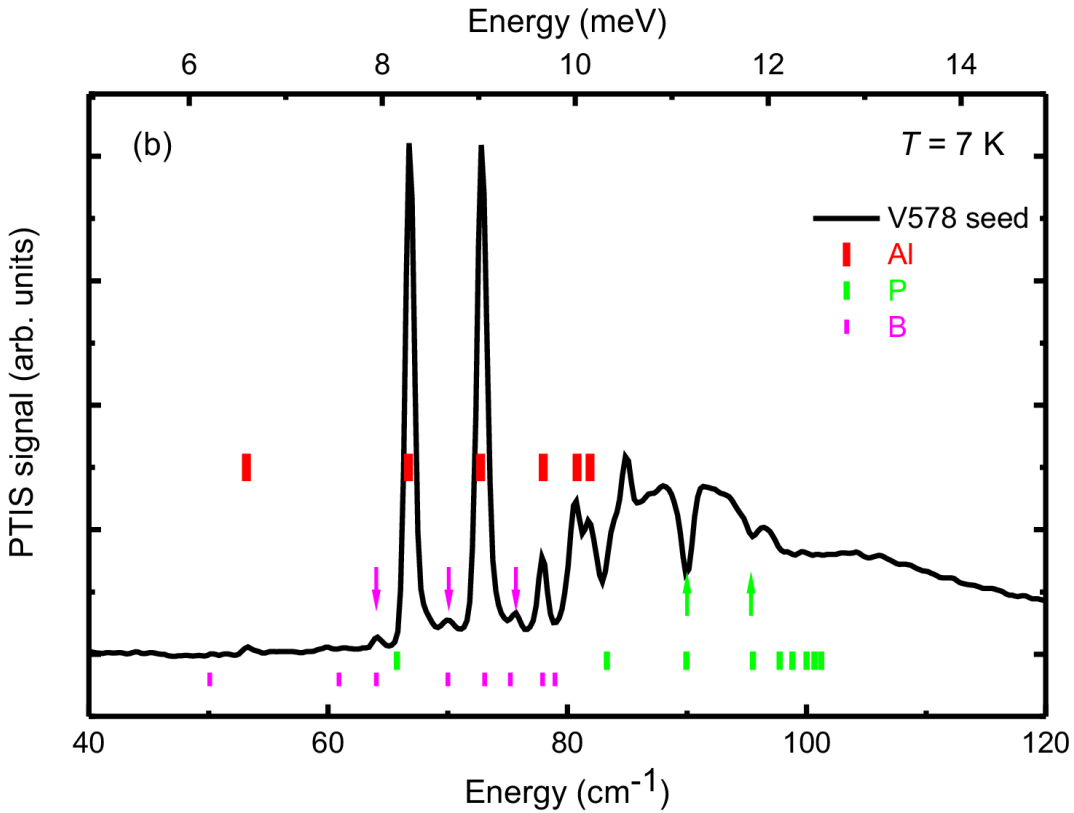




Left: PTIS specrum of a Si sample, right: Canberra HPGe sample + unidentified sample

Crystal characterization

Just received (Friday 06.06.08)
Crystal grown (last year) from PPM material was measured with PTIS.



Test of ZR material

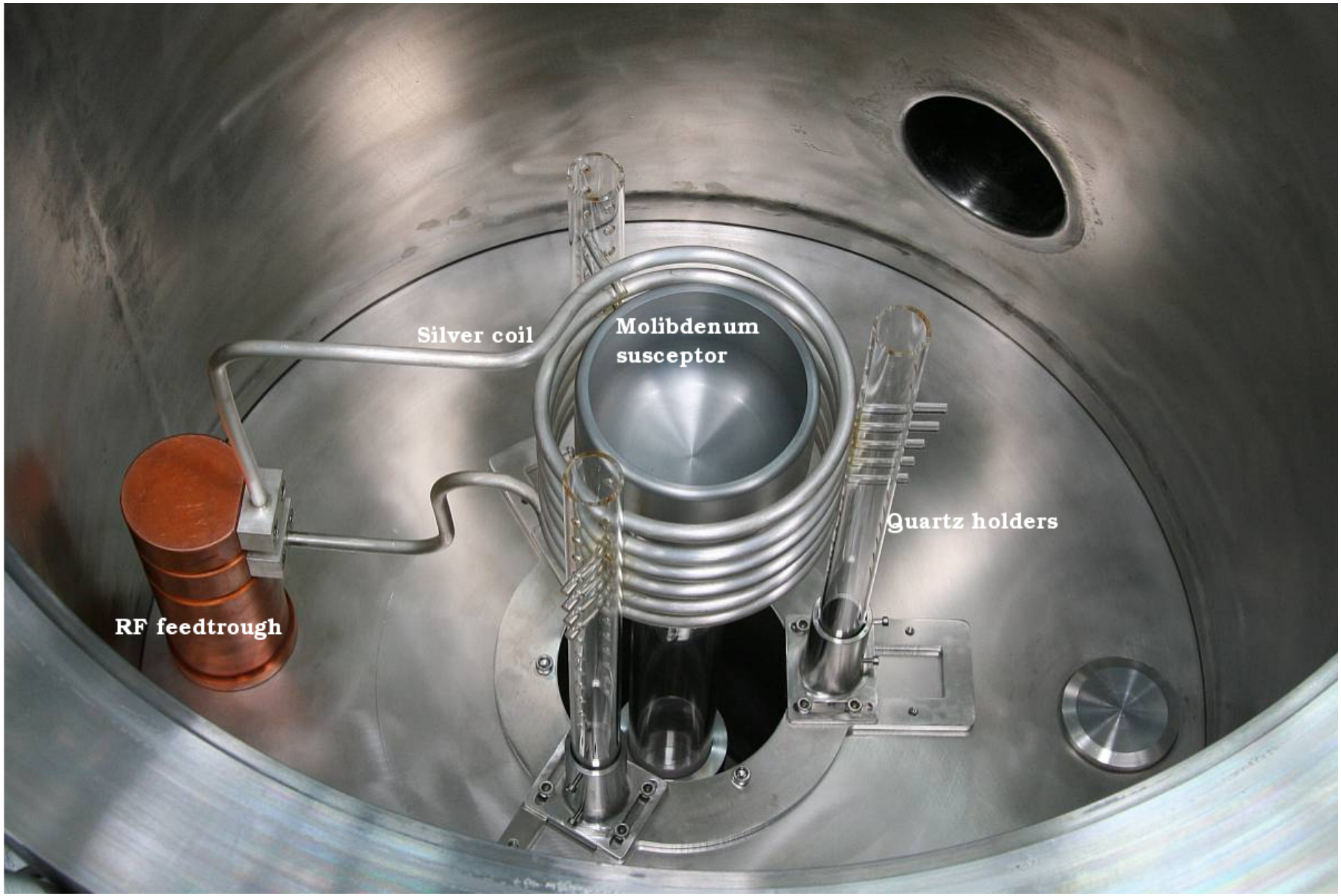
- IKZ promissed (2007) to grow (with the pedestal method) crystal from the dep. Ge, directly from the zone-refined ingot from the first test at PPM
- Neither pedestal nor float-zone method seems to work, they failed to grow a crystal large enough (directly from the zone-refined ingot)
- However they made one successful attempt and grew a 7 mm diameter and about 60mm long crystal (used for Hall-effect and PTIS measurement)
- Instead directly Czochralski crystal will be grown with the new high purity crucibles
- All 6N Ge from PPM shipped to IKZ before the next Czochralski crystal growth
-

Crystal pulling status

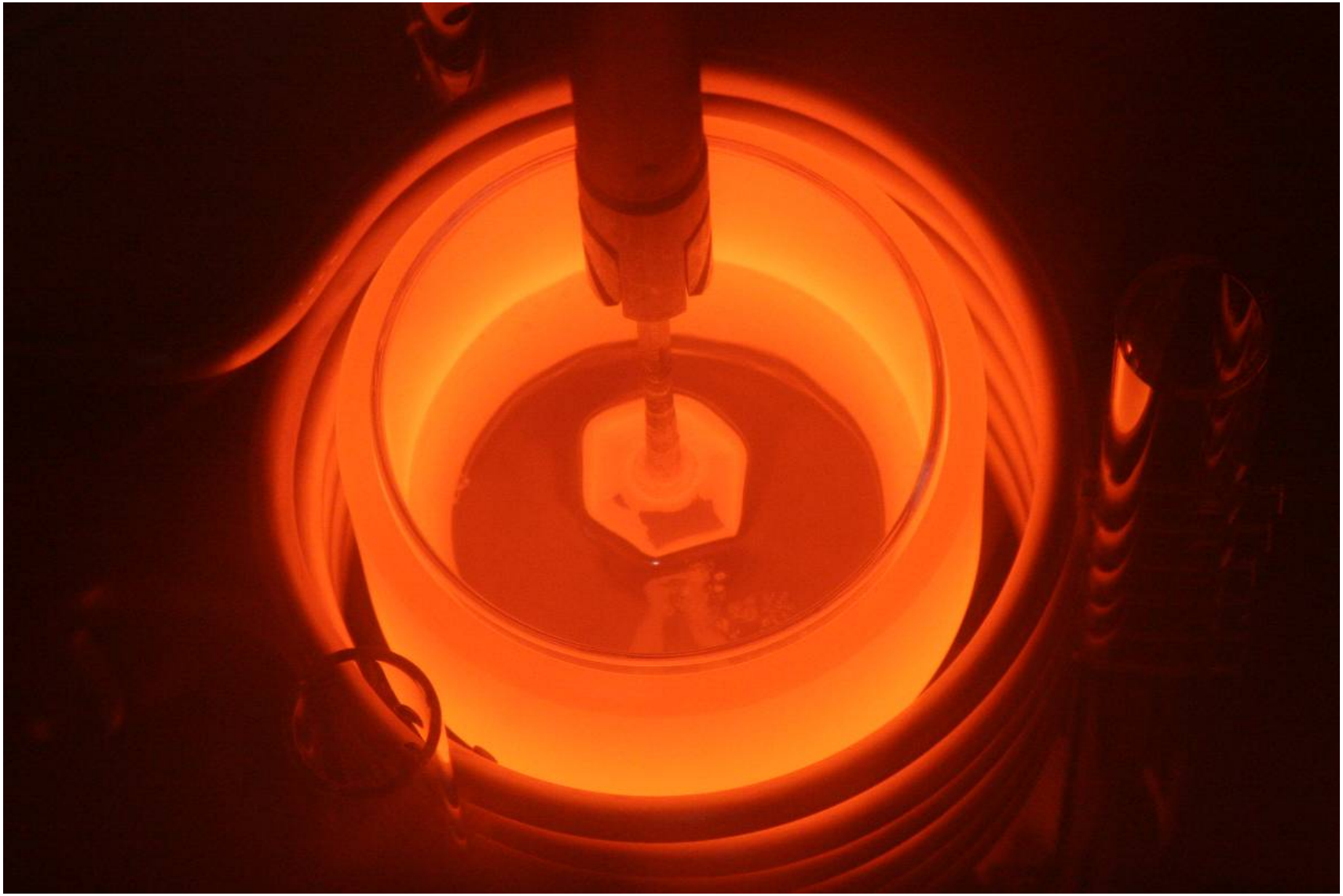
Czochralski puller is operational, many components have been modified:

- Inductive heating with silver coils
- Molybdenum susceptor
- New RF feedthrough
- 4” and 6” ultra high purity crucibles
- Operated with success first on April 7

Crystal pulling status

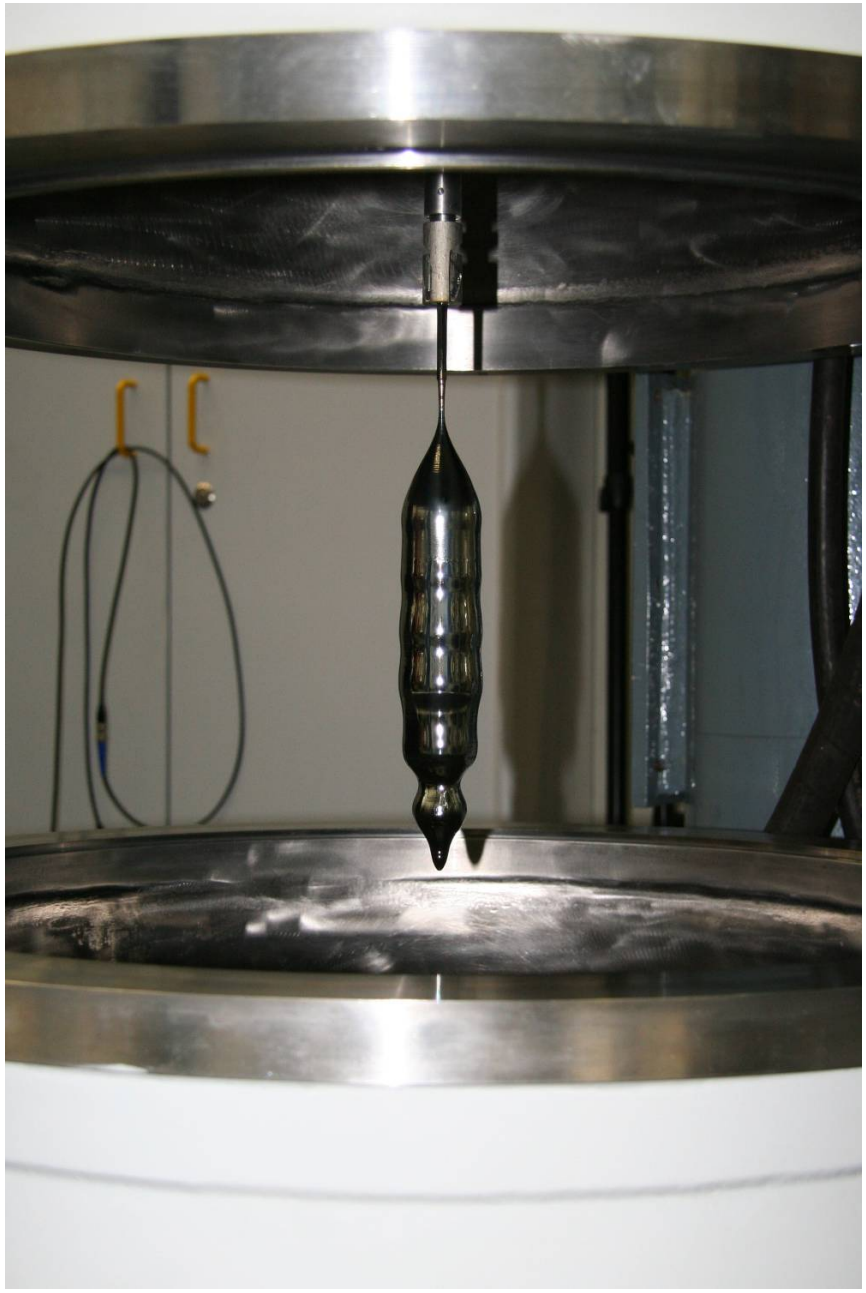


Czochralski puller at work



Crystal pulling - First crystals

- Already two crystalpulling attempts were made using 6N Ge bought from Umicor
- The first one was partially successful (see right)
- The position of the crucible inside the coil was modified
- Shortly after the second one is perfect



Crystal pulling - First crystals

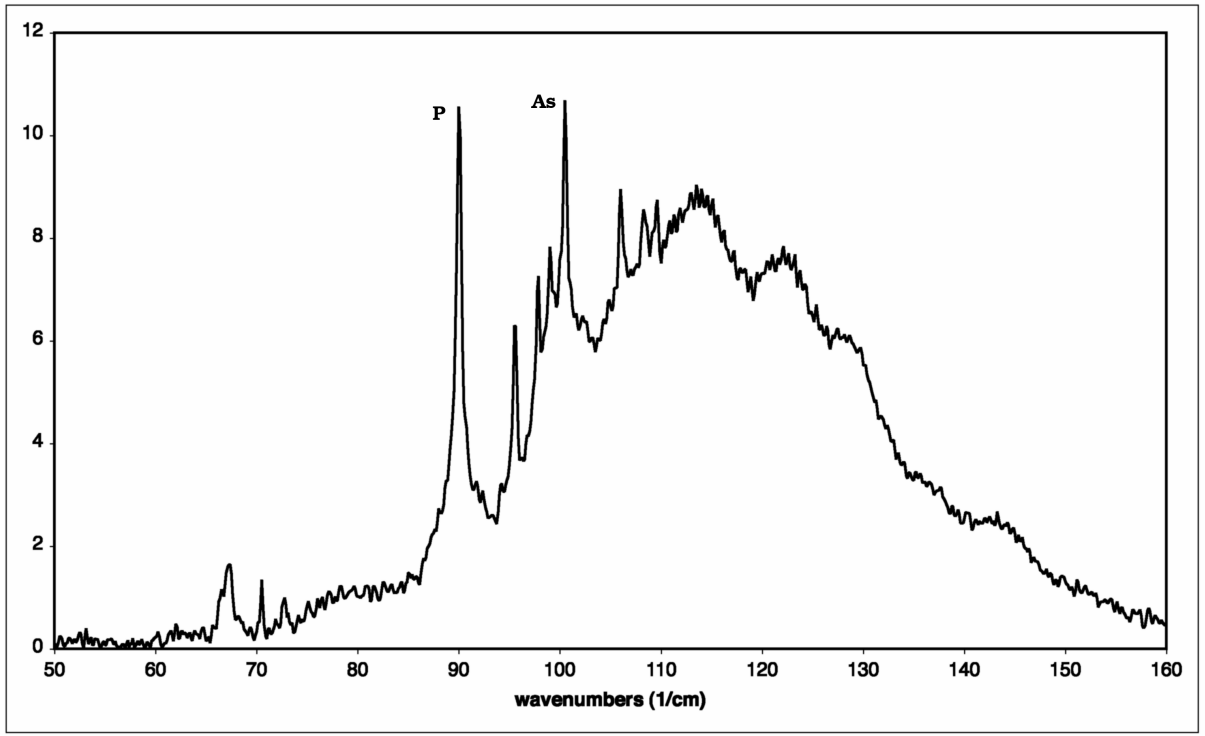
- The second crystal was already cut and samples were prepared for Hall-effect and PTIS measurements
- Samples were sent to Berkeley (already arrived)
- PTIS at IKZ is suffering a short delay because of a broken Hg lamp, but is coming soon
- So far only dislocation density was measured, it was found to be $6 \times 10^3 / cm^2$ close to the Canberra samples
- We are expecting the measurements from Berkeley and IKZ anytime soon

Crystal pulling - Hot News

First measurements from Berkeley arrived

Net charge carrier concentration $n = 1.45 \times 10^{13}/cm^3$, in the PTIS spectrum P and As lines are dominant, Al lines were detected as well.

Remember, this is just a test of crystal pulling, no H_2 atmosphere, no ultra high purity crucibles and is not PPM material



Crystal pulling - near future - conclusion

- Crystal pulling tests will continue with the new, high purity crucibles + H_2 in the forming gas
  (should happen these days)
- One of the next crystals will be grown from the depleted Ge purified at PPM (to assess the purity of the zone-refined material)
- Analysis ongoing at Berkeley and IKZ in parallel
- No conclusion yet on the purity achieved, interpretation of the results should be given by the experts
- Further steps depend on the purity of the crystals grown
- The goal of having detector grade crystals in early 2009 is still within reach