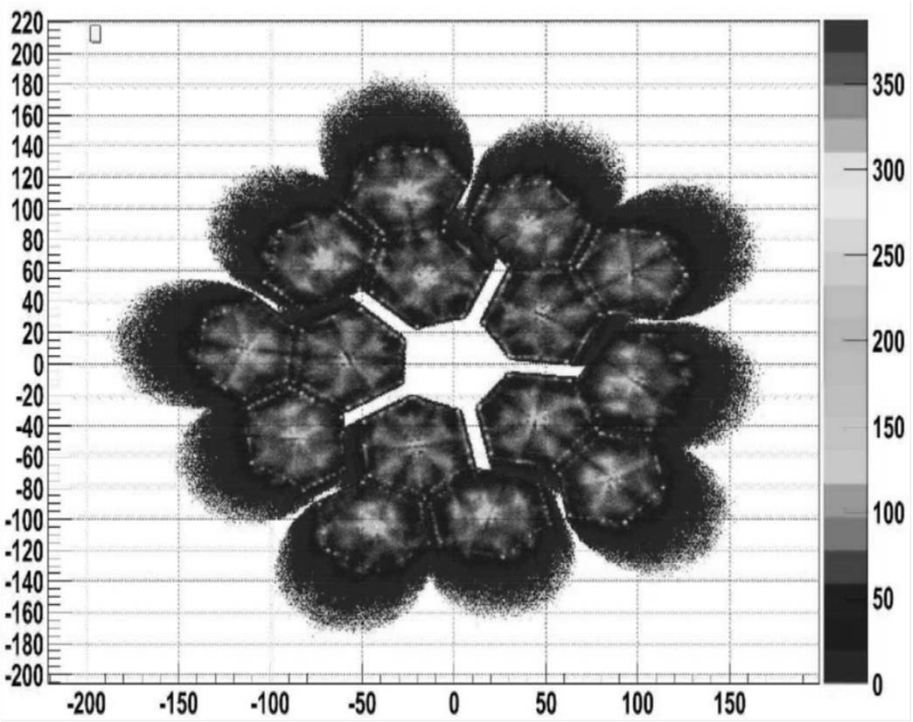
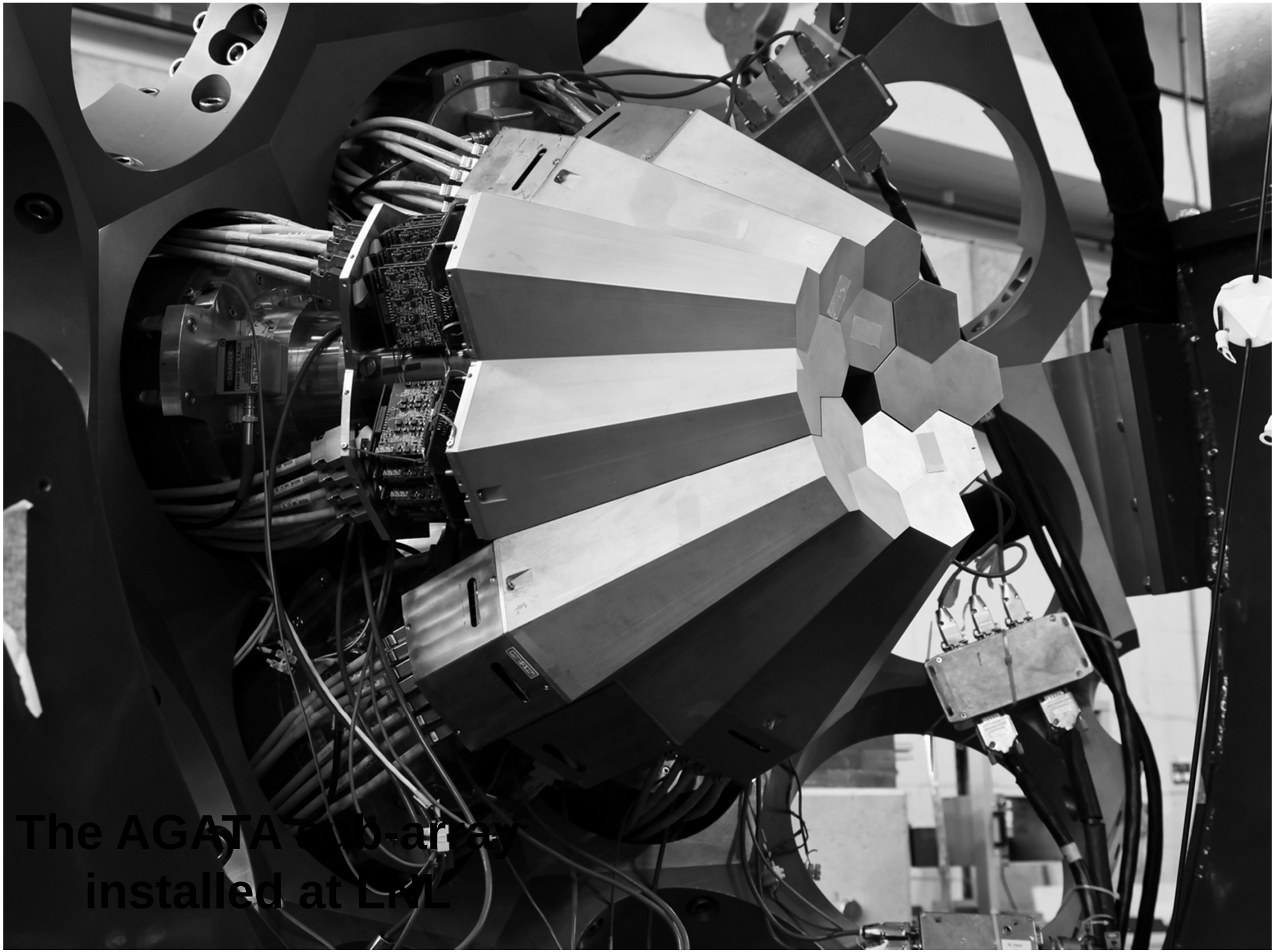
AGATA detectors summary report



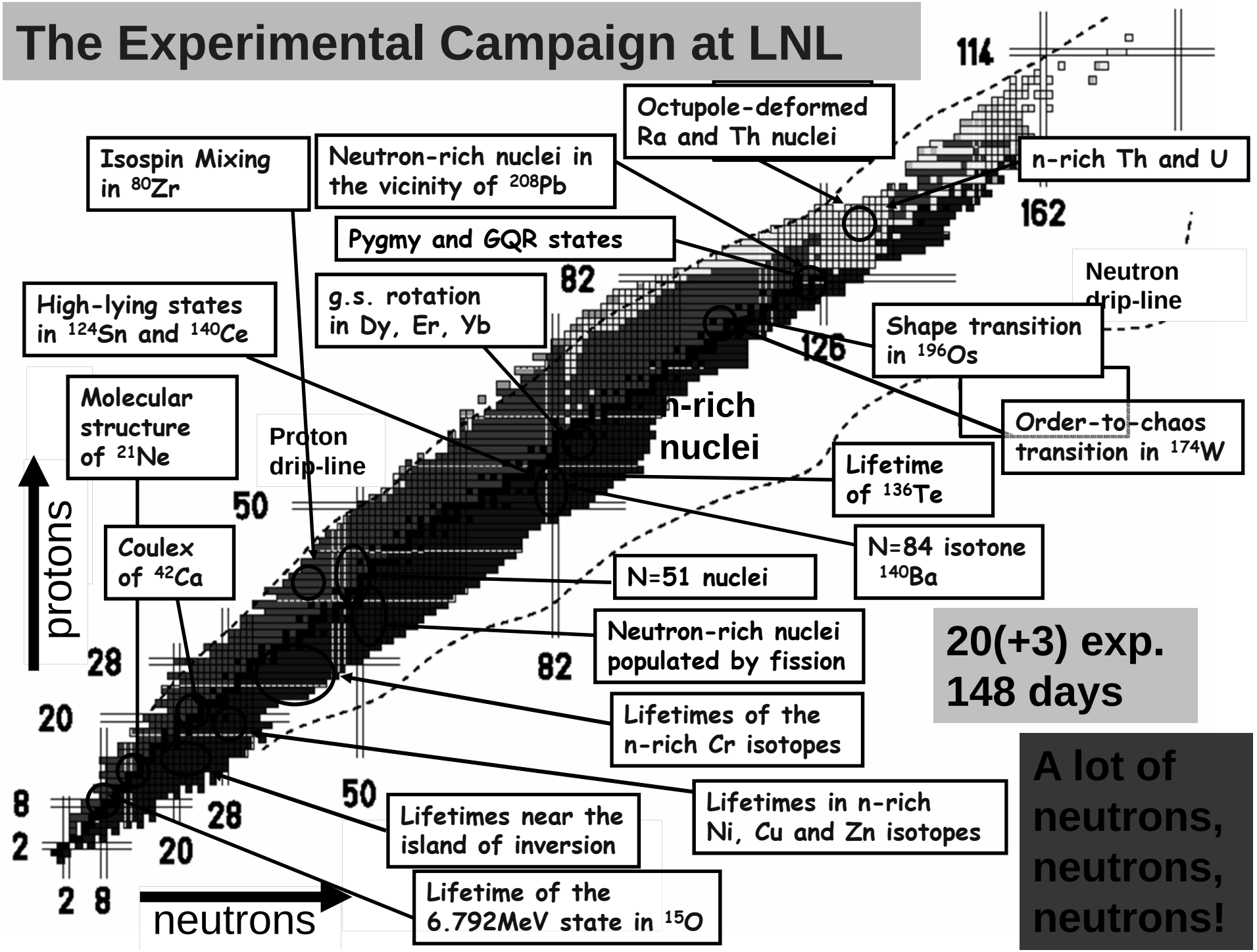
Peter Reiter for the AGATA detector working group

12th AGATA week
11-13 June 2012
GSI Darmstadt, Germany



The AGATA sub-array installed at LNL

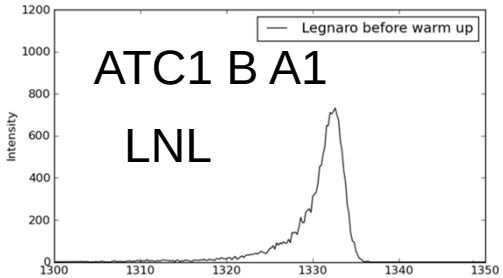
The Experimental Campaign at LNL

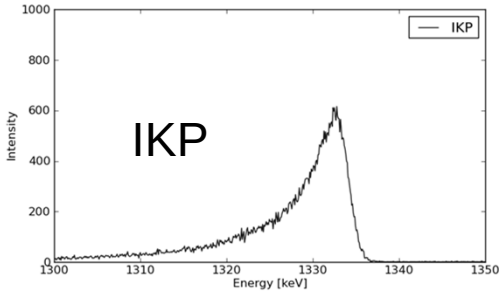


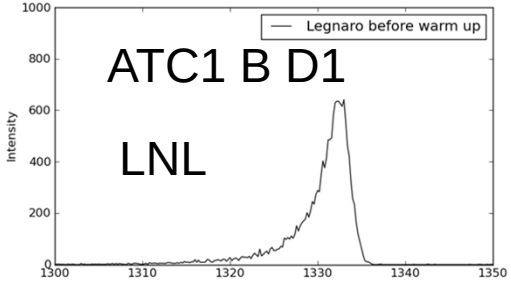
20(+3) exp. 148 days

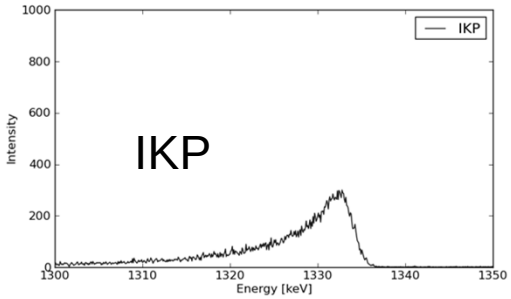
A lot of neutrons, neutrons, neutrons!

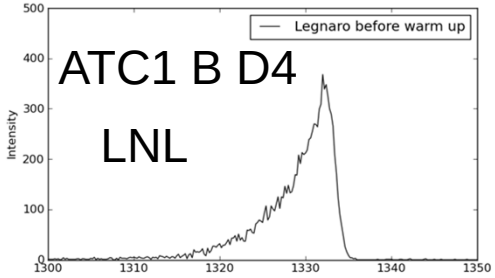
Status after LNL campaign: before (LNL) and after warm up (IKP), no annealing

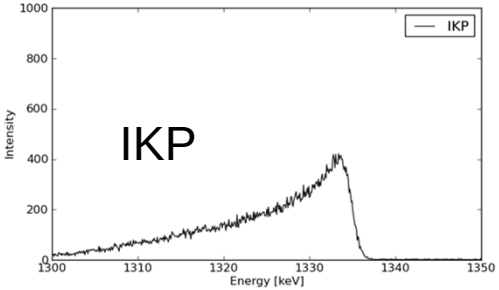


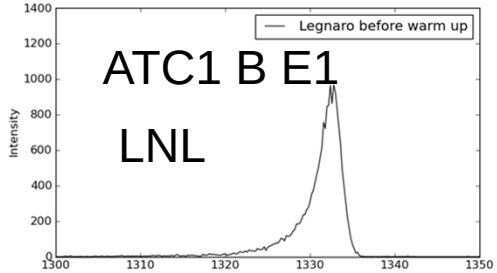


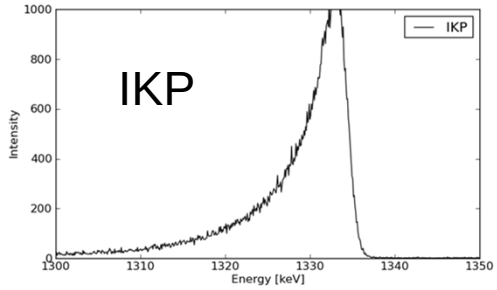


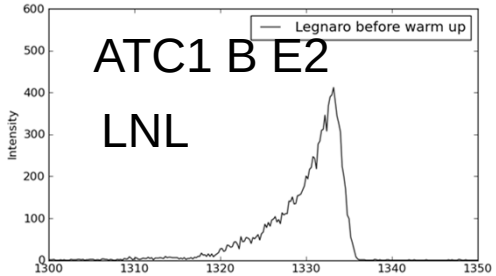


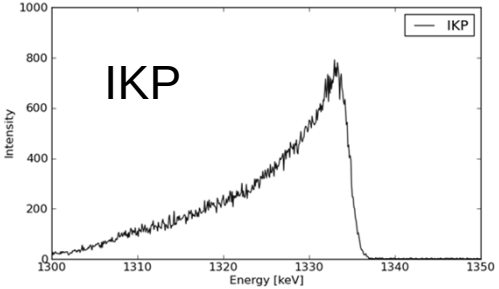


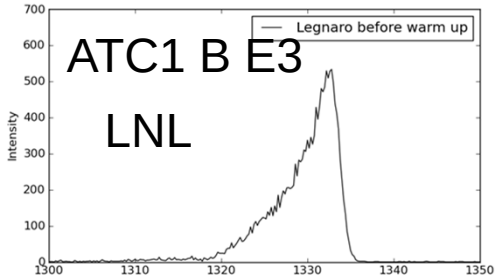


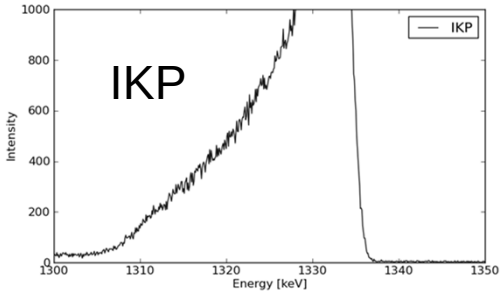




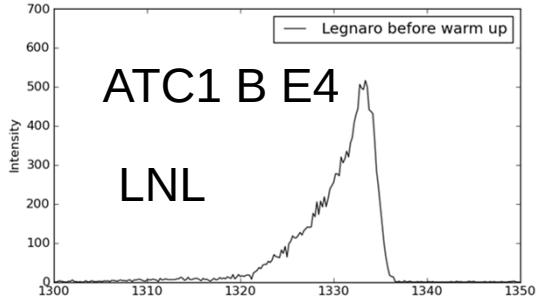


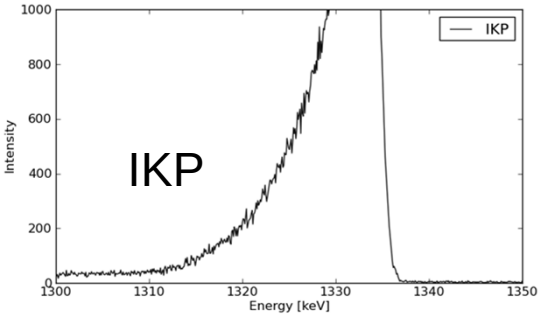


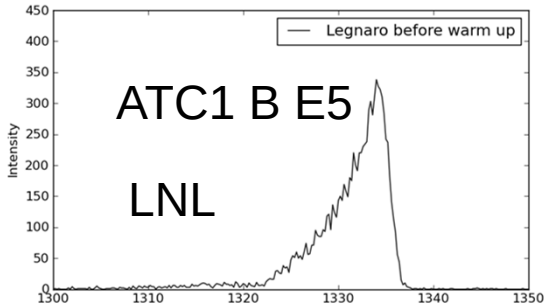


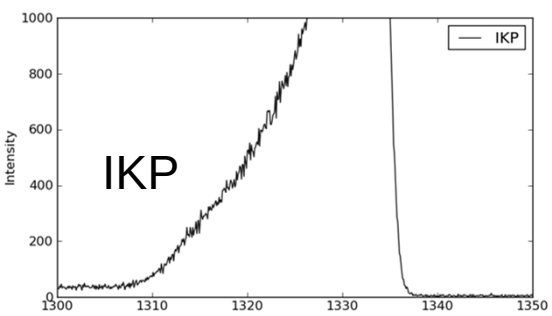


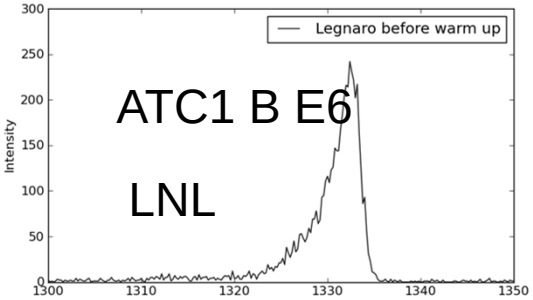
Status after LNL campaign: before (LNL) and after warm up (IKP), no annealing

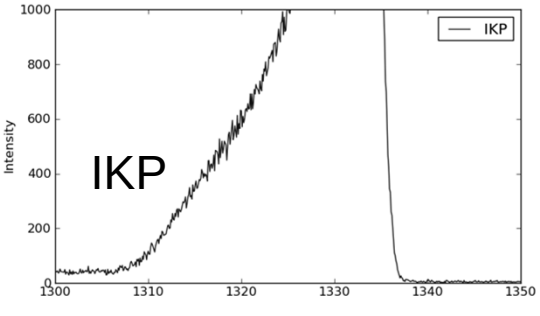


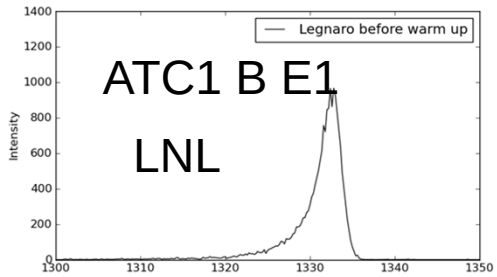


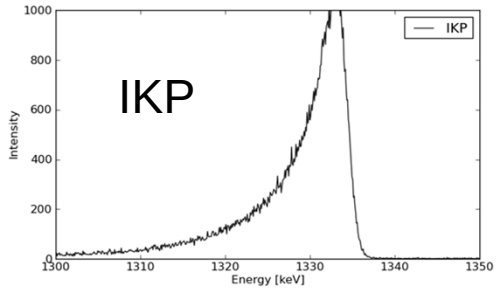


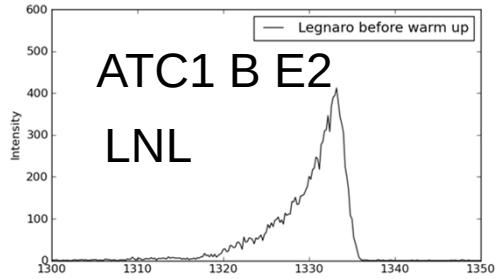


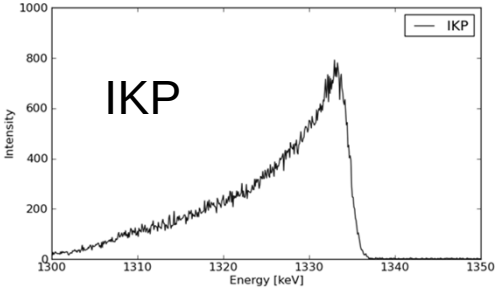


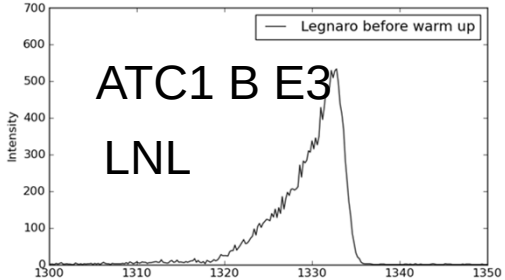


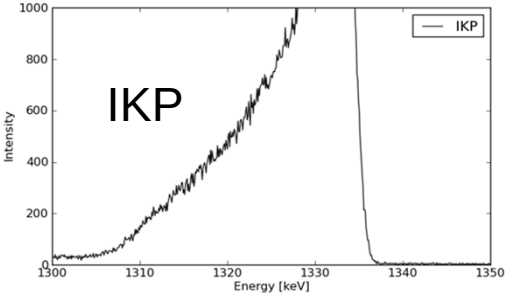




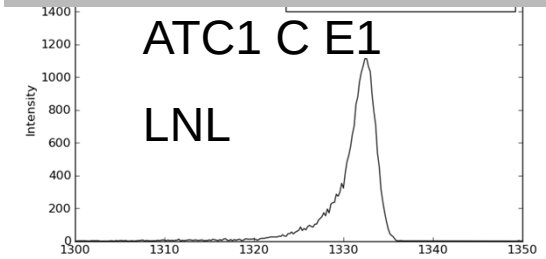


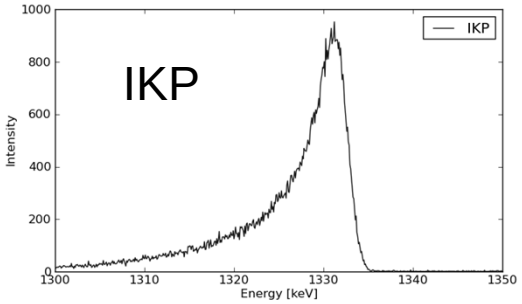


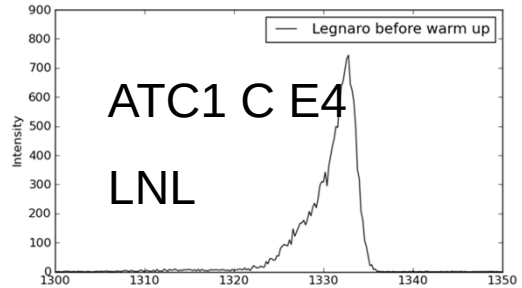


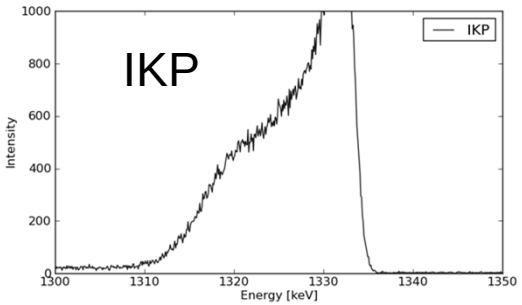


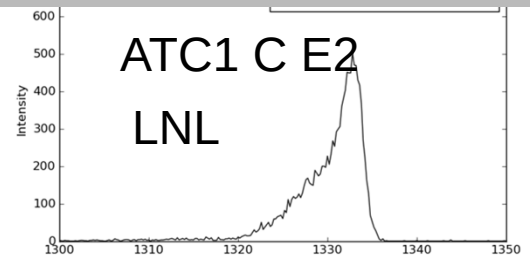
Status after LNL campaign: before (LNL) and after warm up (IKP), no annealing

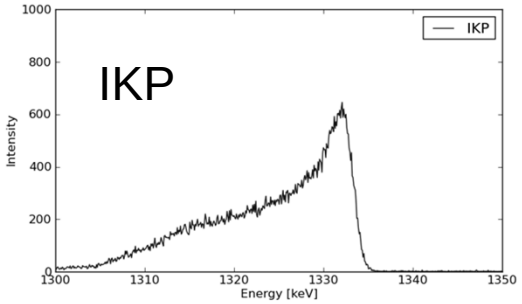


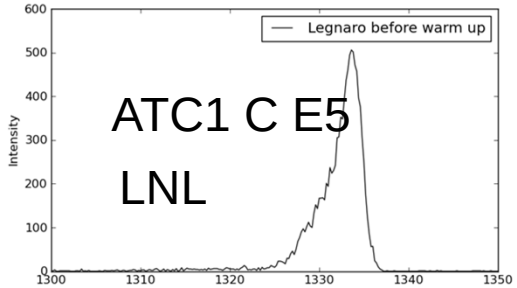


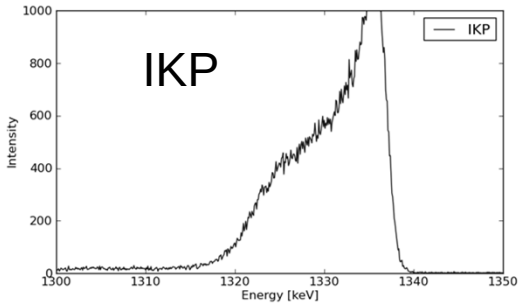


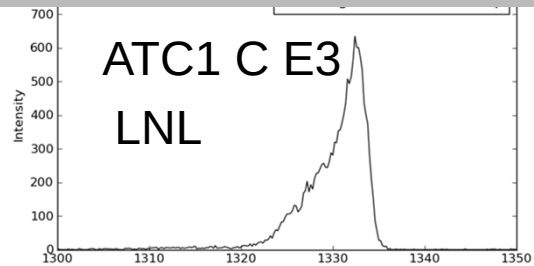


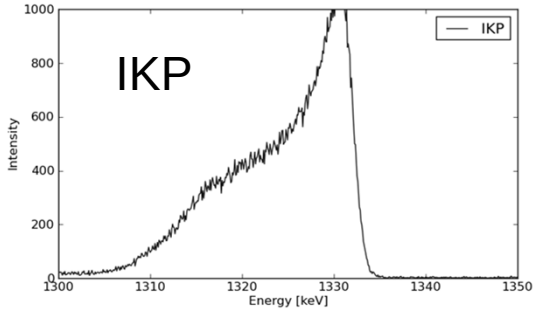


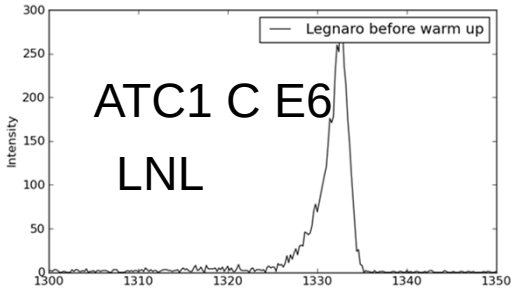


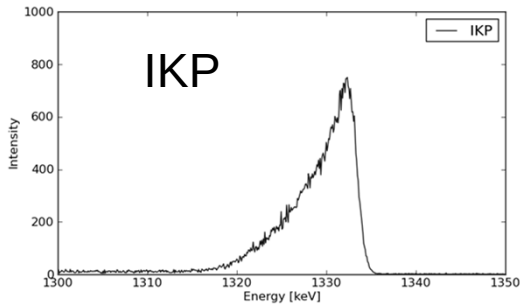










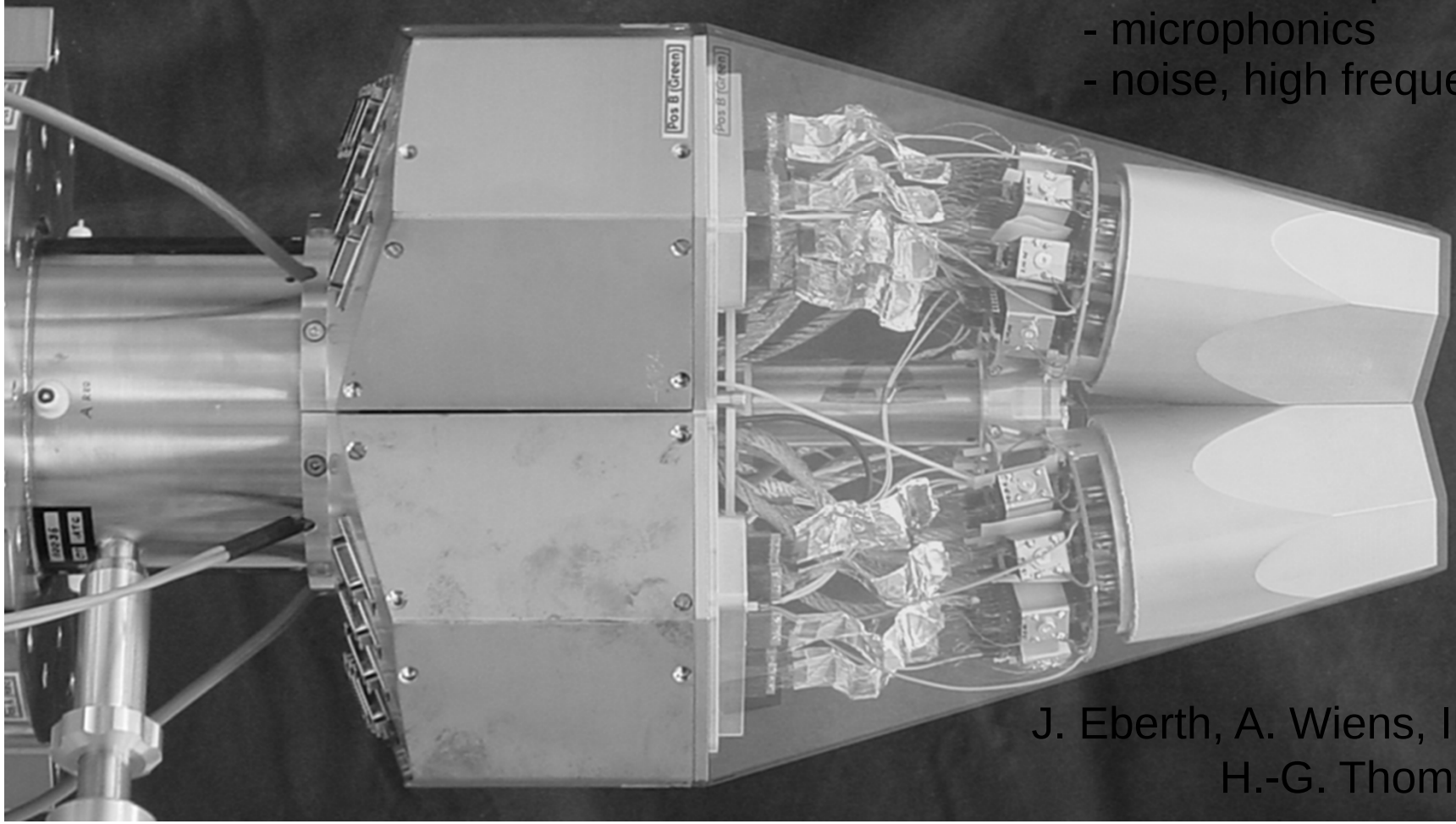


It’s difficult to determine the FWHM due to the peak shapes, varies between 5 and 20 keV.

Disassembly and Reassembly of five AGATA Triple Cryostat @ IKP

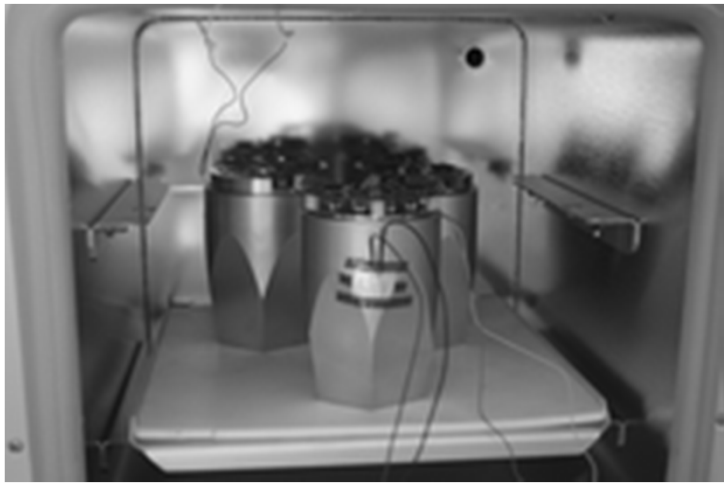
- integration of 111 high resolution spectroscopy channels
- cold FET technology for all signals

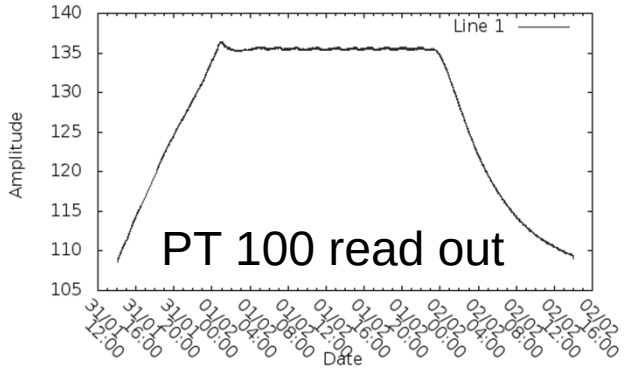
- mechanical precision
- heat development
- LN2 consumption
- microphonics
- noise, high frequencies

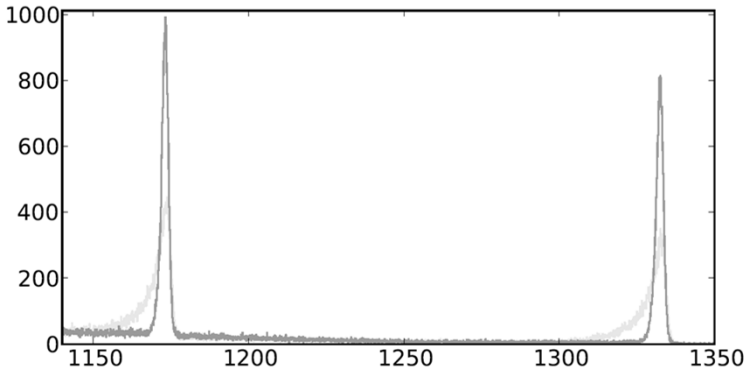


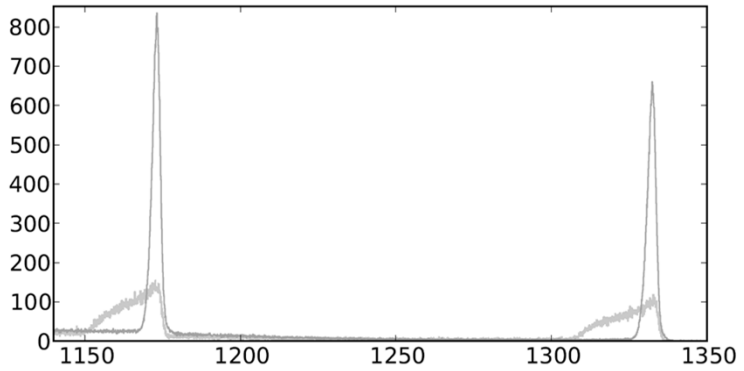
J. Eberth, A. Wiens, IKP Köln
H.-G. Thomas, CTT

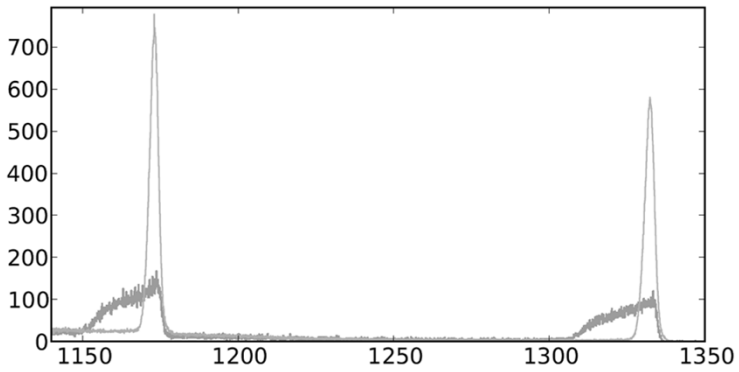
24 hours annealing of ATC 1 detectors

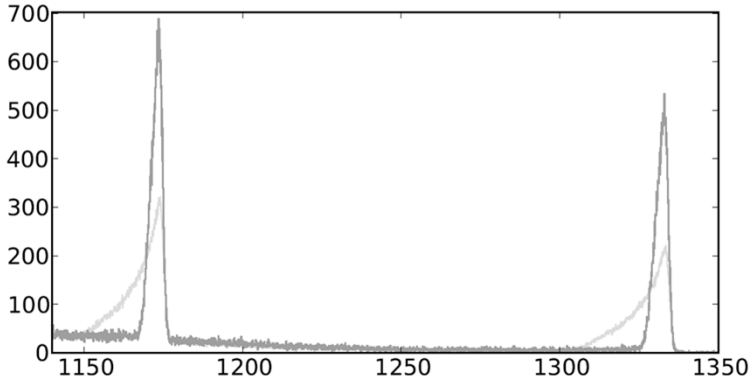




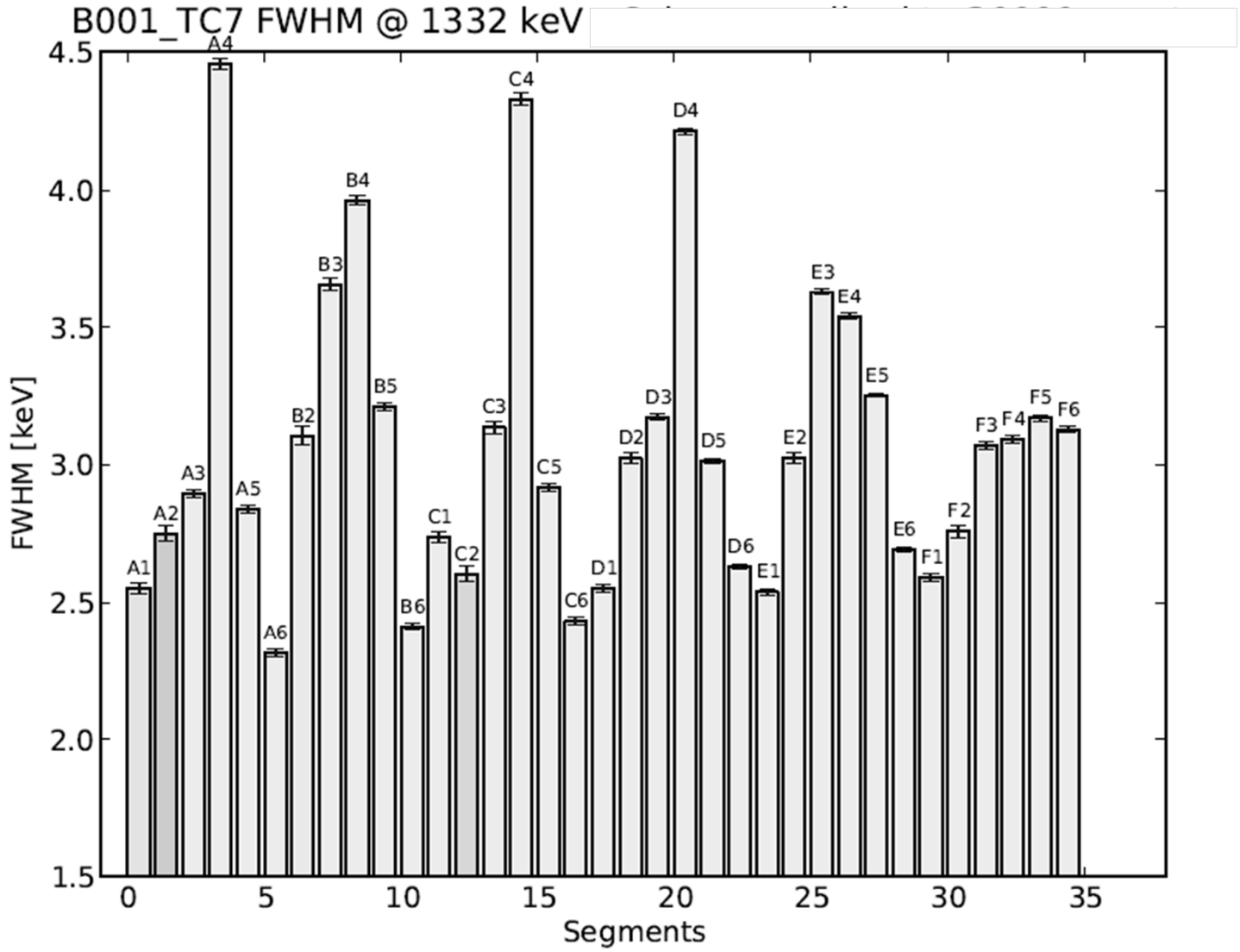








Energy resolution after 24 hours of ATC 1 B001 detector
Conclusion: insufficient annealing period



Test of ATC2 with A003, B003, C005 after 96 hours annealing period

A003, HV=4500V Core resolution at 59.6keV: 1.53keV, at 60Co: 2.43keV

Segment resolution at 59.6keV in keV:

A1	1.16	B1	1.11	C1	1.11	D1	1.14	E1	1.19	F1	1.15
A2	1.00	B2	0.99	C2	1.04	D2	1.03	E2	1.04	F2	1.14
A3	0.97	B3	1.02	C3	1.08	D3	1.16	E3	1.09	F3	0.95
A4	1.12	B4	1.08	C4	1.31	D4	1.24	E4	1.20	F4	1.13
A5	1.10	B5	1.16	C5	1.06	D5	1.35	E5	1.20	F5	1.21
A6	0.99	B6	0.97	C6	0.97	D6	1.03	E6	1.05	F6	1.09

B003, HV=4500V Core resolution at 59.6keV: 1.51keV, at 60Co: 2.37keV

Segment resolution at 59.6keV in keV:

A1	1.11	B1	1.18	C1	1.05	D1	1.12	E1	1.11	F1	1.05
A2	0.98	B2	1.08	C2	0.94	D2	0.98	E2	0.94	F2	0.94
A3	1.04	B3	1.07	C3	1.00	D3	1.02	E3	0.96	F3	1.02
A4	0.99	B4	1.10	C4	1.06	D4	1.08	E4	1.06	F4	1.02
A5	1.09	B5	1.08	C5	1.01	D5	1.03	E5	1.10	F5	1.07
A6	0.97	B6	0.93	C6	0.93	D6	0.97	E6	0.97	F6	1.05

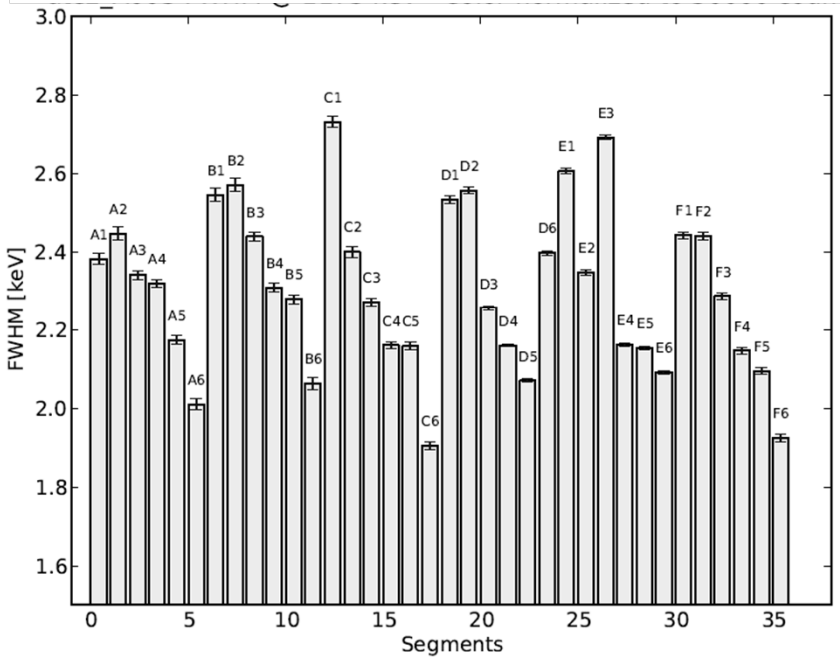
C005, HV=4000V Core resolution at 59.6keV: 1.46keV, at 60Co: 2.36keV

Segment resolution at 59.6keV in keV:

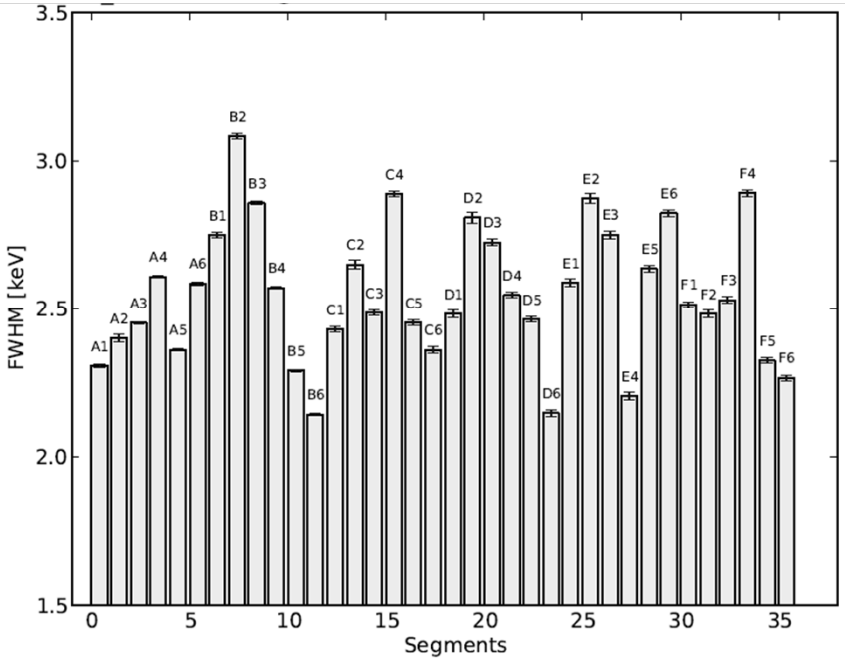
A1	1.08	B1	1.01	C1	1.05	D1	1.10	E1	1.10	F1	1.05
A2	1.01	B2	0.91	C2	0.93	D2	0.95	E2	0.95	F2	0.94
A3	1.00	B3	0.97	C3	0.94	D3	0.97	E3	1.02	F3	0.94
A4	1.19	B4	1.24	C4	1.30	D4	1.03	E4	1.36	F4	0.90
A5	1.00	B5	1.03	C5	1.07	D5	1.10	E5	1.00	F5	1.05
A6	1.07	B6	0.93	C6	0.96	D6	1.00	E6	1.16	F6	3.20

4 days annealing: energy resolution ATC 2

A003 detector



B003 detector



Energy resolution of ATC 2 at 1.3 MeV after 96 hours annealing

Conclusion: improved resolution, but is annealing period sufficient?

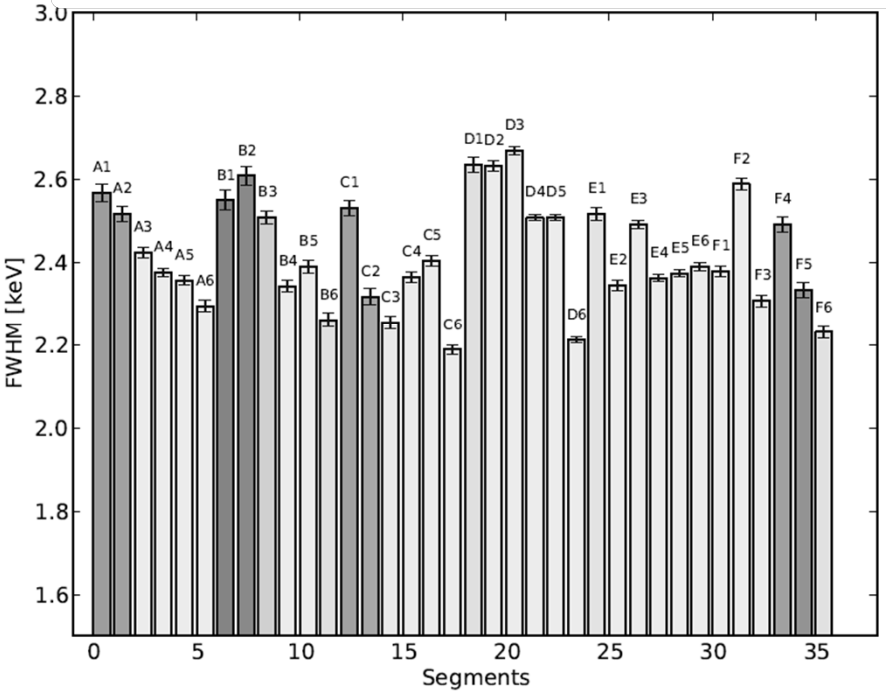
5 days annealing: energy resolution ATC 4

Results of A001 after annealing for 120h
Core 59,5keV: 1,22 keV

Seg.	59,5keV	Seg.	59,5keV
A1	1,18	D1	1,22
A2	1,22	D2	1,05
A3	1,09	D3	1,05
A4	1,10	D4	1,07
A5	1,07	D5	1,30
A6	1,03	D6	1,05
B1	1,13	E1	1,29
B2	1,08	E2	1,00
B3	1,07	E3	1,04
B4	1,12	E4	1,12
B5	1,12	E5	1,21
B6	1,19	E6	1,10
C1	1,19	F1	1,21
C2	1,11	F2	1,08
C3	1,13	F3	1,11
C4	1,18	F4	1,07
C5	1,19	F5	0,96
C6	1,00	F6	0,98

- Energy resolution at low energies reproduced electronic noise properties of detector ok

at ^{60}Co: 2.27keV



- Energy resolution at 1.3 MeV clearly reduced with respect to new detector (next page)

-Even 120 hours of annealing do not recover neutron damage!

Energy resolution of new A001 detector

Segment resolution [keV] at 59.6 keV:

	A	B	C	D	E	F
1	1,21	1,13	1,12	1,15	1,15	1,16
2	0,98	1,14	0,98	0,97	1,04	1,04
3	1,06	1,10	1,07	0,98	1,09	1,06
4	0,99	1,18	1,13	1,03	1,09	1,11
5	0,94	1,05	1,18	1,14	1,16	1,12
6	0,92	1,07	1,10	1,07	1,05	1,10

Segment resolution [keV] at 1332.5 keV:

	A	B	C	D	E	F
1	2,35	2,35	2,34	2,34	2,35	2,37
2	2,03	2,02	1,88	1,91	1,95	2,33
3	2,20	2,22	1,94	1,91	2,09	1,96
4	1,96	2,20	2,01	2,15	2,01	2,02
5	1,88	2,05	2,16	2,05	2,03	2,24
6	1,96	1,96	2,00	2,01	2,07	2,01

AGATA – status of detectors

Working detectors delivered in cluster cryostats to GSI:

ATC1:	A008, B001, C003	was at GSI, now IKP Cologne 16.5.12
ATC2:	A003, B003, C005	at GSI
ATC3:	A002, B010, C001	at GSI
ADC1:	B008, C006	at GSI
ADC2:	B012, C010	at GSI
ADC3:	B011, C008	at IKP, ready for GSI

Working detectors available at IKP:

A001, A004, A006
B002, B004

missing C-type detectors, assembly of cluster detectors is stopped, waiting for C009

Detectors being tested (CAT):

A007 (Liverpool)
C009 (Saclay)

20 detectors are available
2 CAT results pending

ATC 1 accident at GSI

28. March 2012, ATC 1 at GSI:

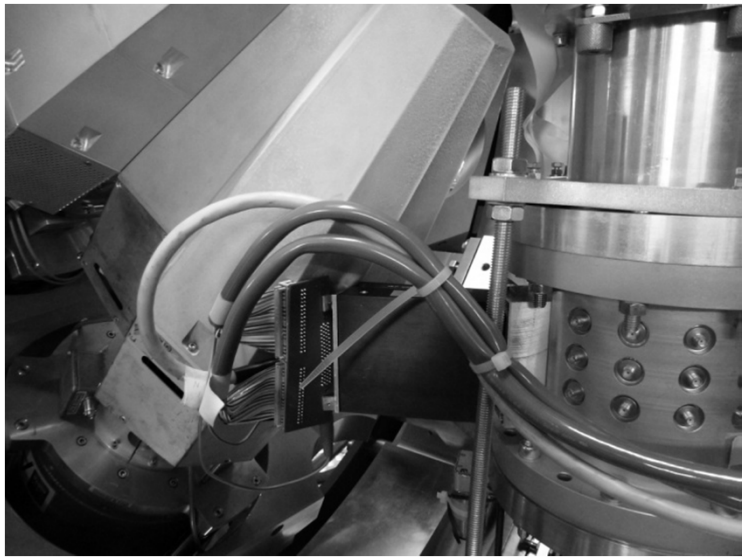
Core RED: 1.41 keV 2.41 keV
Core GREEN: 1.38 keV 2.42 keV
Core BLUE: 1.35 keV 2.45 keV

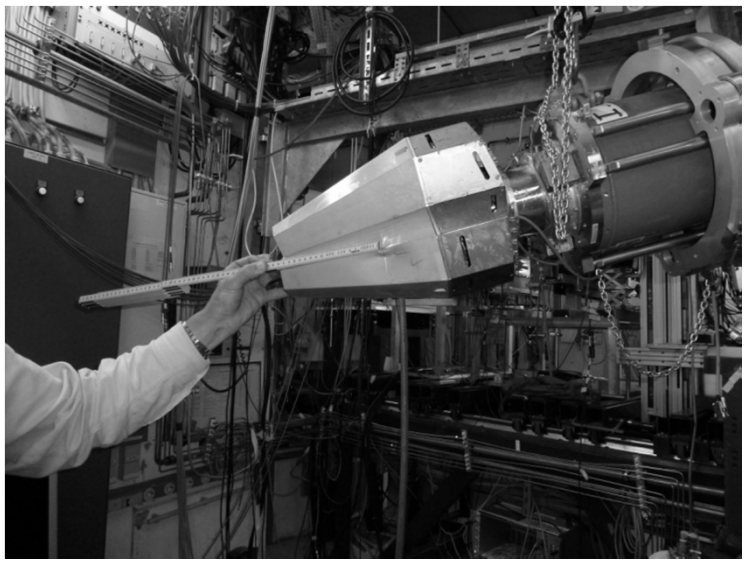
selected segments at ^{60}Co energies:

	RED Row B	GREEN Row C	BLUE Row D
1	2.12/2.40	3.26/3.24	3.09/3.20
2	2.00/2.11	2.95/3.25	2.98/3.24
3	2.20/2.27	3.17/3.37	2.89/3.20
4	2.15/2.29	3.22/3.10	2.57/2.78
5	2.32/2.43	3.10/2.84	2.50/2.72
6	2.04/2.24	2.80/2.79	2.26/2.32

- ATC1 is affected by mechanical damage.
- Three detectors were tested at IKP after accident to be within specs.
- Reassembly is ongoing with new end cap

10. May 2012, ATC 1 at GSI:





AGATA – status of detectors

Detectors with leakage current stored at IKP:

A005 (leakage current at LNL after warm-up to room temperature)
B005 (leakage current after annealing)
B009 (leakage current of segm. A1 at LNL, increased current of A1 after annealing)
C002 (leakage current at LNL of segm. A5, leakage current of D6 after annealing
C004 (leakage current of segm. B4 after annealing)

Detectors being repaired at Canberra:

A009

Returned for repair Feb. 2012
Diagnostic planned for June
Delivery scheduled late June 2012

B006

Returned for repair Jul 2009
Delivery scheduled Nov 2011
Delivery re-scheduled April 2012
Failed May 2012
Delivery re-scheduled July 2012
(repair time >3 years)

B007

Returned for repair April. 2011
Delivery scheduled March 2012
Delivery re-scheduled June 2012
(repair time >14 months)

C007

Returned for Repair Sep. 2011
Delivery scheduled Jan 2012
Delivery re-scheduled April 2012
Delivery re-scheduled May 2012
Delivery re-scheduled July 2012
(repair time >10 months)

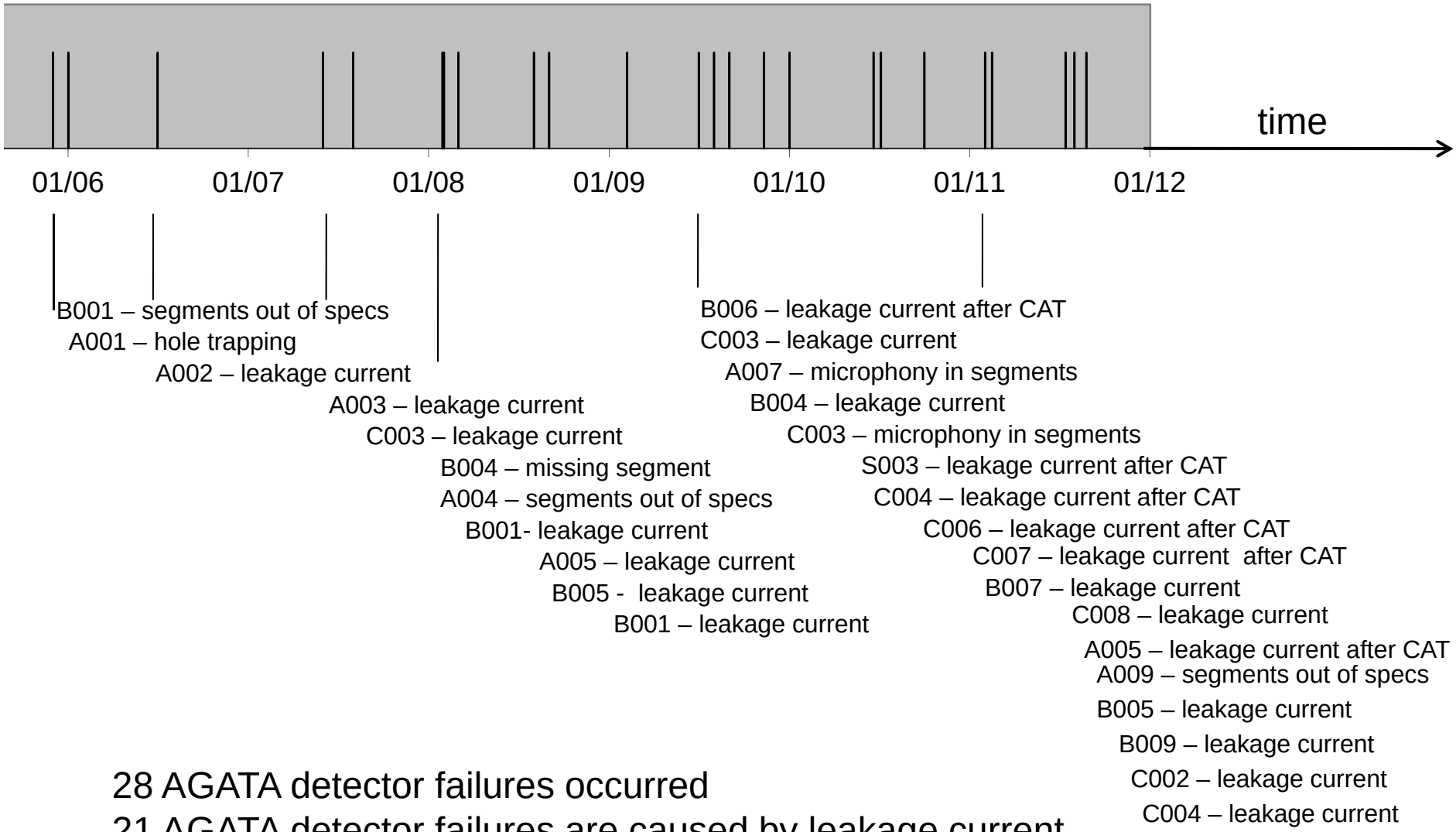
Detectors to be delivered by Canberra:

B013

Due since end 2011
Delivery scheduled Nov 2011
Failed May 2012
Delivery re-scheduled early July 2012

9 detectors are broken
1 new detector pending

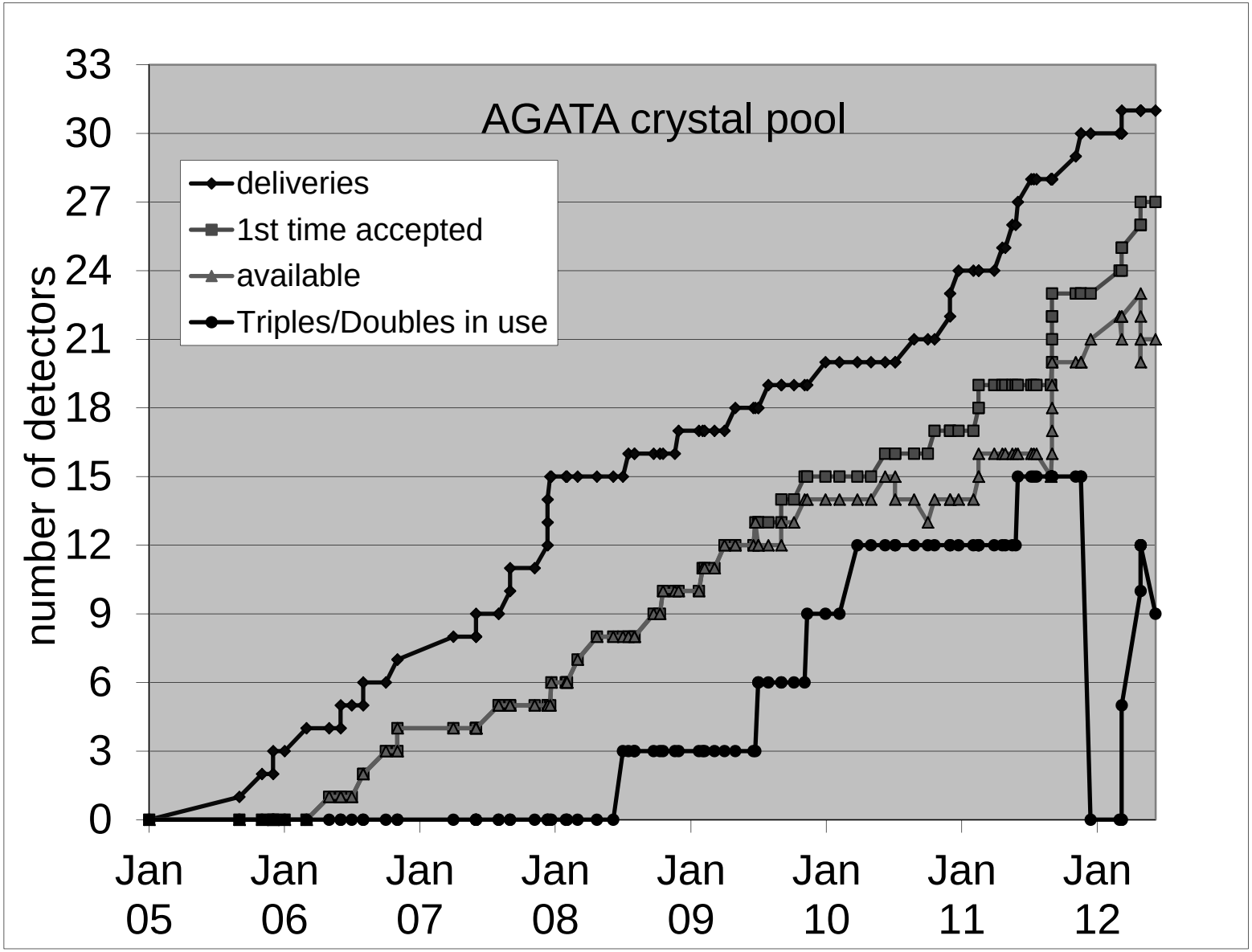
Crystals & Failures



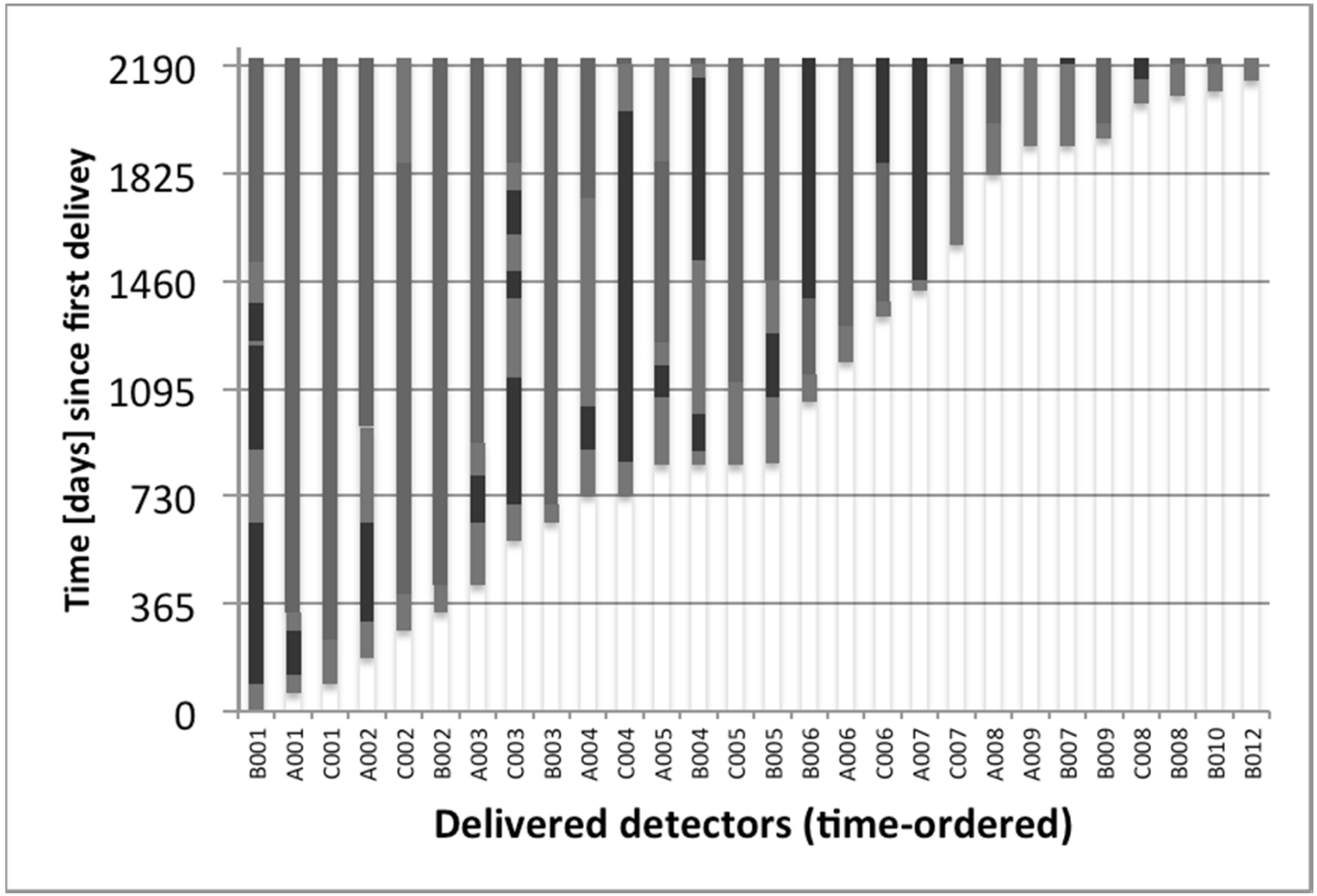
28 AGATA detector failures occurred

21 AGATA detector failures are caused by leakage current

AGATA crystals - evolution



Repair time



- *CAT periods (purple), repair time periods (blue), operation time (green).*
- *Time line starts with detector B001 in September 2005 and ends in September 2011.*
- *Did not improve during last months.*

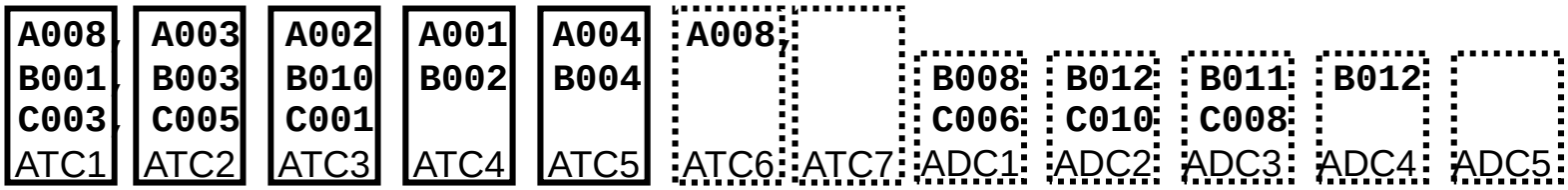
AGATA crystals - overview

31 detectors were **delivered**:

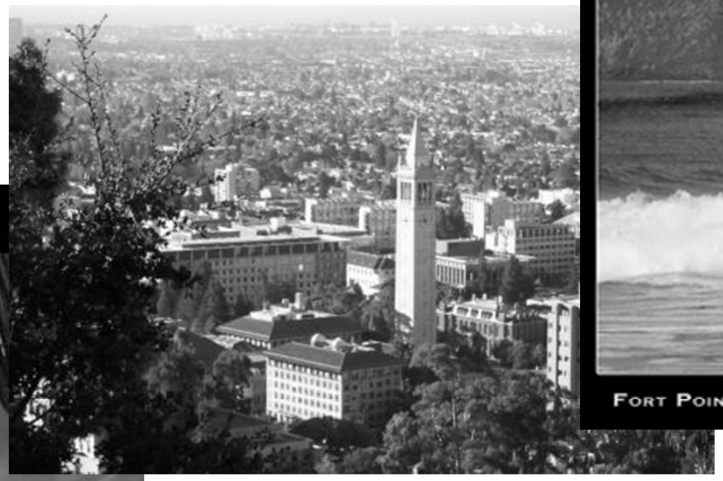
A001,A002,A003,A004,A005,A006,A007,A008,A009
B001,B002,B003,B004,B005,B006,B007,B008,B009,B010,B011,B012
C001,C002,C003,C004,C005,C006,C007,C008,C009,C010

Colorcode:
Working
broken
CAT pending

Usage of the available detectors:



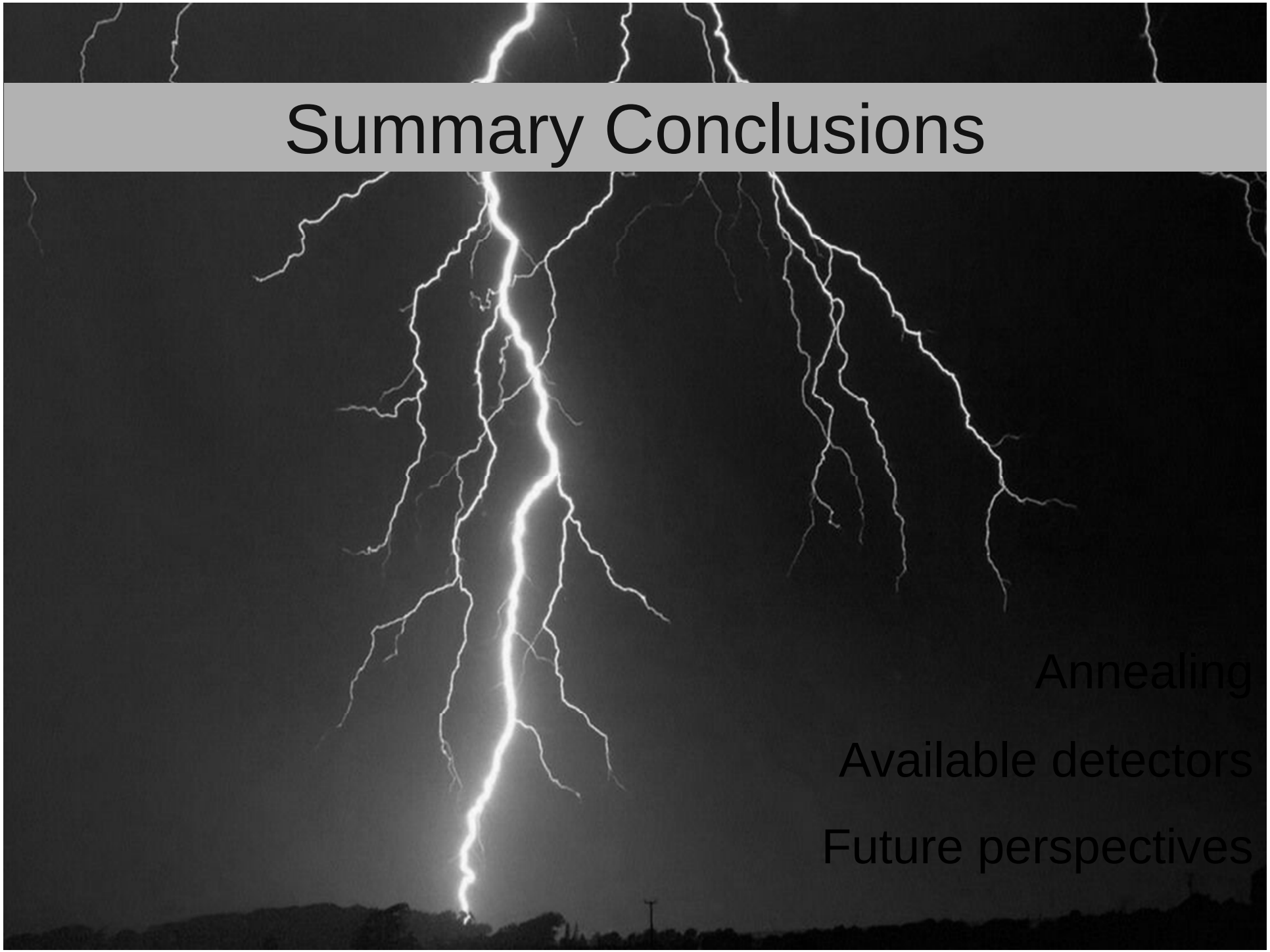
Efficiency is limited by available C-type detectors.



Many Thanks to Andreas

hang loose

Summary Conclusions



Annealing

Available detectors

Future perspectives