



Newsletter of the INTEGRAL Science Operations Centre



No. 11

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Foreword

Christoph Winkler - Project Scientist

INTEGRAL is performing very well and we have witnessed a number of key events in the recent months which will be addressed in more detail below. Consequently this issue of the ISOC Newsletter is a bit longer than usual.

The 5th INTEGRAL Workshop was held in Munich, between the 16th and 20th February 2004. It was organized by the members of the gamma-ray group of the Max-Planck-Institut für extraterrestrische Physik located in Garching and was jointly sponsored by ESA, NASA, DLR, MPE and INTA. It was an exciting week during which around 230 participants from all over the world, displayed and discussed their scientific results obtained by INTEGRAL during the first year of nominal mission operations. In particular the large number of young people attending the workshop was very encouraging. The proceedings will be published by ESA (as ESA SP-552) in early Summer 2004.

INTEGRAL has resolved the long standing question as to the nature of the diffuse glow of soft gamma-rays seen from the central region of our Galaxy. INTEGRAL observations have shown that most of the emission is produced by individual point sources. Results and more details have been published by F. Lebrun et al. in March 2004 (Nature, Vol. 428, p. 293).

Since the last ISOC Newsletter #10, four more GRB's have been observed in the FOV of the main instruments including GRB 040106 of 60 s duration whose location (within a 3.'2 error)

and trigger time has been distributed by IBAS just 15 s after the event, a record of speed *and* accuracy.

Mission Status

Rudolf Much - Deputy Project Scientist

The 3rd SPI annealing cycle lasted 15 days in total and was completed on November 26, 2003. The duration of the baking period was increased from 36 hours (used for the first two annealing cycles) to 126 hours in this cycle. The SPI energy resolution was fully recovered and therefore no residual radiation damage was seen in the energy resolution after one year in orbit. The post-annealing energy resolution was even slightly better than after initial switch-on.

Unfortunately, the counting rate of the SPI Germanium detector #2 (GeD#2) dropped to 0 counts on December 6, 2003. Despite several attempts the detector could not be recovered. A careful inspection of the data around the breakdown has shown that the counting rates of the nearby detectors 16, 5 and 0 were exceptionally high just before the breakdown of GeD#2. High counting rates were also measured at some neighboring detectors immediately after the breakdown. The input section of the pre-amplifier has been identified as a possible failure area. Even after a careful review of the electronic design and of the detailed signature of the breakdown by independent experts within ESA and CNES, neither an obvious reason for the breakdown, nor a design problem could be identified. At the moment a component failure is thought to be the most likely origin of the GeD#2 breakdown. The loss of this

detector reduces the SPI sensitivity by about 5% (continuum), and by few% for line studies, possibly as high as 10% at 511 keV.

JEM-X operations have stabilized. In the last 9 months only 2 additional anodes were lost (out of 256 per detector unit) and the rate of anode losses is now considered acceptable. The JEM-X2 gain has increased by more than a factor 2 assuming that the high voltage on the detector was kept constant. However, to maintain the instrument gain in a narrower band, the high voltage has been lowered four times since December 2002. The effect of the gain increase is thought to originate in the area around the electrodes, but is not yet fully understood. Additional ground tests are underway with the flight spare detector.

The energy resolution of JEM-X2 has degraded from 9.4% at 22 keV to 12% since February 2003. This may be related to variations in the local gain close to the anode strips. Ground tests have demonstrated that the detector gain exhibits spatial variations after illumination by a strong source. The gain locally shows a temporal evolution, especially after strong illumination. Efforts are made to obtain updated gain maps based on the internal Xe-fluorescence line. However, these maps will only provide the gain correction averaged over a longer period and do not correct for short term variations (as seen after illumination by a bright source).

At the January INTEGRAL Science Working Team meeting it was decided to swap the operation of JEM-X2 and JEM-X1. Up to March 4, 2004 only JEM-X2 was operated and from March 8 onwards only JEM-X1 is being operated. In the period of the March Crab calibration both JEM-X units were operated so that suitable calibration data were obtained from both units.

Since the initial switch-on of JEM-X, six periods of instrument configuration can be defined until today. The response matrix for each of these periods is different. The quality of the available response matrix depends on the availability of Crab calibration data and whether these data were analyzed for the specific instrument configuration. Note that at $E > 10$ keV the detectors are well described by the pre-launch specifications. Details are provided below.

JEM-X configurations

(1) 27 Oct 2002 until 09 Nov 2002:

Operation with nominal high-voltage settings. Neither Crab calibration data nor good response matrix are available. Further calibration effort not intended.

(2) 09 Nov 2002 until 25 Nov 2002:

Start of operations with reduced detector high voltage. No suitable Crab calibration data are available. A good response matrix is not currently available. However, further calibration effort is intended by the PI team in the future.

(3) 25 Nov 2002 until 25 Feb 2003:

Only JEM-X2 was in operation (as of Dec 2002) with changes to the onboard settings. Crab calibration data are available. The response matrix will be available in summer 2004. The uncertainties are $\sim 10\%$ - 20% at $E < 5$ keV.

(4) 26 Feb 2003 until 04 Mar 2004:

Only JEM-X2 was operated. Crab calibration data are available and the response matrices are implemented in OSA V3, and of better quality than the previous ones.

(5) 05 Mar 2003 until 07 Mar 2004:

Crab calibration operating JEM-X1 and JEM-X2.

(6) As of 08 Mar 2004:

JEM-X1 operations only. Crab calibration data available. The response matrix is in the process of being generated with delivery to ISDC by mid April.

An improved version of the IBIS on-axis response is currently undergoing final testing. The improved response produces good spectra for strong sources such as the Crab as well as weaker sources. Now that a reliable on-axis response matrix will shortly be available, as is needed for the analysis of strong sources, more emphasis will be given to the calibration of the off-axis response. The IBIS off-axis response changes quickly up to an offset angle of 2 degrees. It shows discontinuities for offset angles between 2 and 5 degrees and is flatter for larger offset angles. The spectral extraction is affected by this behavior, as not all features are yet included in the response matrix. Therefore, a series of off-axis measurements were made during the recent Crab calibration from March 5 to 7, 2004. A total of 50 off-axis pointings were executed to allow the IBIS off-axis response to be modeled in detail. In addition a 5x5 dither pattern centered on the Crab was executed to confirm the SPI calibration.

During the first year of OMC operations an increase in the detector contamination was observed. Recently, the contamination has stabilized. The OMC flat field response is unchanged and an outbaking of the OMC CCD is not required.

Science Highlights

Astrid Orr, Tim Oosterbroek - Operations Scientists

(1) New sources and transients

At the end of November 2003 Vela X-1 was caught in a very bright outburst during a deep Core Programme observation of the Vela region (Krivinos et al., ATEL #211). The

source reached a flux level of 7 Crab (40-60 keV).

A new source, IGR J06074+2205, was detected with JEM-X (Chenevez et al., ATEL #223) at a level of 7mCrab, using calibration data obtained in February 2003. Two new sources in another observation in the same month were found by Tomsick et al. (ATEL #224) using a new version of the INTEGRAL software (OSA 3.0): IGR J15479-4529 and IGR J16418-4532. Fourteen new unidentified sources were reported by Walter et al. (ATEL #229) in all-sky mosaics made from Core Programme data obtained between February and October 2003. First detection of hard X-ray emission (> 20 keV) from additional 17 sources were reported by Bassani et al. (ATEL #232) using the same data.

In February 2004 the Galactic Centre region once again became visible for INTEGRAL and the GCDE pointings started. As expected, several flaring sources have been reported over the last two months. The well-known transient GX339-4 was detected by INTEGRAL (JEM-X and IBIS/ISGRI) on February 18 in a bright state (Kuulkers et al., ATEL #240). The brightening of the source 4U 1724-307 on February 17 and 18 was confirmed by Bodaghee et al. (ATEL #241) with JEM-X data. Towards the end of February 2004 the LMXRB GX 354-0 was observed flaring in hard X-rays (Zurita et al., ATEL #248): a flux increase to 0.2 Crab (20-60 keV) was followed by a decrease over a period of a week to about 40 mCrab. Chernyakova et al. (ATEL #251) reported the transition to a hard state (using INTEGRAL and XMM-Newton data) of the ROSAT source 1RXJ J130159.6-635806, close to PSR B1259-63. On February 7 it reached a flux level of 11 mCrab in the 18-60 keV band; an observation 12 days later failed to detect the source at a significant level. The source IGR J17544-2619, which was discovered by INTEGRAL in September 2003, underwent another outburst

on March 8, 2004 (Grebenev et al., ATEL #252), reaching a peak of 160 mCrab (17-45 keV). This observation shows that the source is a recurrent transient.

Since the last newsletter, 4 GRBs and one SGR have been detected by the IBAS system. The GRBs were all quite long: 20 seconds in December (Gotz et al., GCN 2459: GRB 031203); 60 seconds in January (Mereghetti et al. GCN 2505: GRB 040106) and another long GRB in February, reported by Gotz et al. (GCN 2525): GRB040223; and 20 s (GRB 040323, Mereghetti et al., GCN 2551). The Soft Gamma-ray Repeater SGR 1806-20 has been active throughout March (GCN 2541).

(2) The 5th INTEGRAL Workshop

The 5th INTEGRAL Workshop was held in Munich, between the 16th and 20th February 2004. Below are some selected highlights from this most interesting week. The workshop opened with a session devoted to nucleosynthesis studies.

INTEGRAL results confirm previous ^{26}Al detections in the Cygnus region and make it possible to measure with a much better precision the flux and spectral profile of the 1809 keV line. There are now hints of large-scale motions within this active star-forming region (Knoedelseder et al.). The first map of 511 keV emission obtained by SPI shows symmetric (about 10 deg in diameter) diffuse emission from the Centre of our Galaxy (Jean et al.). The emission cannot be explained by a single source. There appears to be no emission from the Galactic plane or from higher latitudes in contrast to earlier reports. The new data impose strong constraints on the production rate of positrons.

The next topic to be discussed in the workshop was that of X-ray binary stars. One very exit-

ing result from the INTEGRAL Galactic Plane Scan (GPS) programme is the discovery of a new class of highly obscured X-ray binary sources which had so far escaped previous detection (Walter et al.). These new sources are mainly located within one of the spiral arms of our galaxy (the “Norma” arm) and are enshrouded in a “Compton-thick” environment.

INTEGRAL was also pointed at the Centre of our Galaxy. Goldwurm et al. reported on the discovery of a source, IGR J17456-2901, coincident with the Galactic Nucleus Sgr A* to within 0.9'. The new INTEGRAL source cannot unequivocally be associated to the Galactic Nucleus. But this is the first report of significant hard X-ray emission from within the inner 10' of the Galaxy.

Because of the strong absorption by the gas inside our Galaxy, it is difficult to observe extra-galactic sources located in the direction of our galactic plane. Despite this, a few AGN have been detected during the GPS and Galactic Centre Deep Exposure (GCDE). However, their numbers are slightly lower than expected. This difference is not yet understood (Bassani et al.).

After one year in orbit, a systematic and consistent analysis of the INTEGRAL/IBIS Core Programme survey data has been made (Bird et al.), incorporating data from both the GPS and the GCDE covering revolutions 46 to 120. Using strict statistical criteria 111 sources have been detected in two energy bands, of which 20 are HMXB's, 49 are LMXB's, 3 pulsars, 7 AGN and 32 are yet of unknown nature.

Terrier et al. reported the detection of 91 gamma-ray sources towards the direction of the Galactic Centre, of which 26 are new discoveries (see March 2004 issue of Nature, Vol 428, p. 293, F. Lebrun et al.). The few compact sources known previously to emit in the soft

gamma-ray range were insufficient to account for the observed Galactic emission; explanations involving diffuse interstellar sources did not fit the observations. The sources detected by INTEGRAL account for the whole of the Milky Way's emission of soft gamma-rays, leaving only a minor role for diffuse processes.

Last but not least the workshop included a session devoted to Gamma-ray bursts (GRBs). It was shown that the INTEGRAL Burst Alert System (IBAS, Mereghetti et al.) currently gives the best GRB localizations, in terms of both speed *and* accuracy. IBAS has the capability of handling not only GRBs, but also flaring events from Soft Gamma-ray Repeaters and known transient sources. At the time of the workshop 8 GRBs had been detected within the INTEGRAL field of view of the main instruments. These are all so-called "long bursts" (Kulkarni et al.).

The next INTEGRAL Workshop, the 6th of its kind, will be held in St Petersburg (Russia) in June 2006. By then INTEGRAL will surely have delivered many more impressive discoveries.

AO-2 Status and Long Term Plan

Erik Kuulkers - Operations Scientist

The AO-2 open time observing programme started in revolution 144 (2003, Dec 18). The first one and a half months were, however, devoted to remaining open time AO-1 targets (e.g., Cas A, SN 1987A, SN 1006), for which the corresponding proposals (all grade A) were carried over to AO-2 as they were not completed during AO-1. Almost all carried-over AO-1 proposals have now been completed. From the link on the ISOC homepage ("Scheduling Information" which can be found at http://www.rssd.esa.int/integral_webapps/index.jsp) there is detailed information on the executed revolutions, as well as on-going

observations and observations scheduled in the near-term future (typically up to one month in advance). All these observations are indicated by red bars in the long term plan as shown in Figure 1 below.

INTEGRAL has already executed two TOO observations (GX 339-4 and PSR B1259-63) and had a Crab calibration campaign in the beginning of March (revolution 170). As of now, about 2.3 Msec have been spent on the Core Programme (GCDE, GPS) and 5.7 Msec on the Open Time Programme. On the left of the graph in Figure 1 the target names are indicated. Those in grey are carried over from AO-1. A triangle next to the name indicates whether it is flagged as a coordinated observation (with, e.g., XMM-Newton or RXTE). The targets are grouped into five categories; the first four are, from top to bottom, Compact Objects, Extragalactic Objects, Nucleosynthesis and Others (corresponding to the categories of the proposals). The last group includes TOO's and calibration targets.

In Figure 1 the visibility periods are shown as horizontal lines. Times when a target will be affected by the so-called "SPIBIS" effect (see ISOC Newsletter #5, August 2002) are indicated by horizontal dotted lines. The first vertical dashed line indicates the ongoing revolution at the time of writing. The second vertical line indicates the current last scheduled observation in the near future. AO-2 will end in revolution 286 (2005, Feb 17). The long-term plan timeline at the time of writing up to that date can also be found in Figure 1. Planned observations are indicated with blue bars. For more details please refer to the link "Long Term Plan" via the ISOC homepage¹. The long-term plan is currently driven by: the Core Programme (GCDE, GPS), those AO-2 observations making up for the under-return of

1. http://www.rssd.esa.int/Integral/isoc/html/schedules_AO2_Long_Term_Plan.html

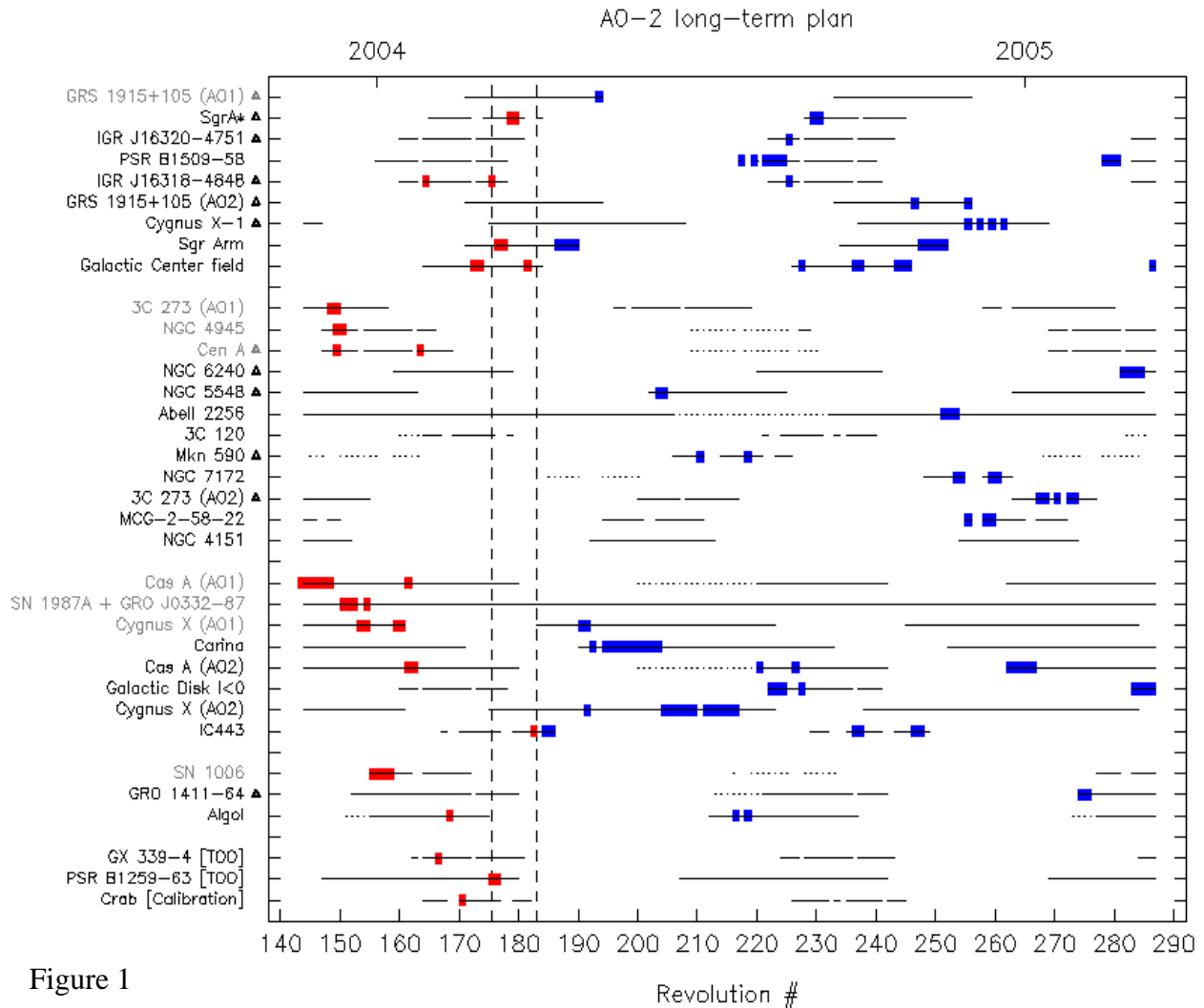
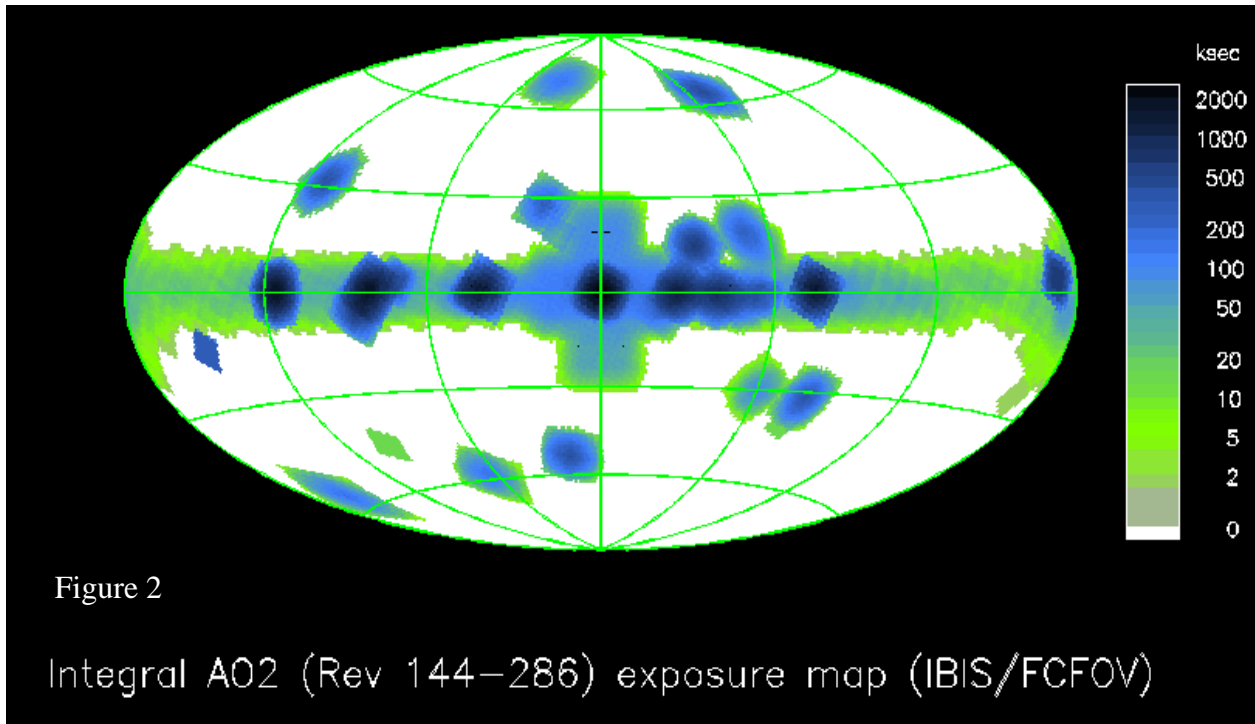


Figure 1
 Nucleosynthesis observations during AO-1, as well as the (oversubscribed) region in and around the Galactic Centre. Note from Figure 1 that almost all planned targets are of highest TAC priority grade A (some of them are amalgamated targets), and that almost all of the AO-2 time has already been allocated. Various targets already have fixed dates, since they will be coordinated with, e.g., XMM-Newton or RXTE (such as Sgr A* and NGC 6240). These sources are identified with a triangle next to the target name. Note that the future plan is the best long-term information currently available. When scheduling, it is intended to follow the long-term plan as closely as possible. However, the schedule may change, whenever necessary. For instance, in our long-term plan we

have not yet taken into account future instrument and calibration activities, such as SPI annealing and more Crab calibrations.

In Figure 2 below the exposure map as expected at the end of AO-2 is shown in Galactic coordinates. The map takes into account the fully coded (9 deg x 9 deg) IBIS FOV. The exposure includes executed and scheduled observations in AO-2 as well as those planned for the future, as given in Figure 1. As can be seen in Figure 2, the AO-2 programme is concentrated towards the Galactic plane. The GCDE and GPS patterns are clearly evident, as are the dedicated observations of the Galactic Centre. Other deep exposures are concentrated



on Cas A, the Cygnus X and Carina regions, PSR B1509-58 and the Sagittarius Arm.

ISOC Relocation to Spain

Lars Hansson - ISOC Manager

AO-3 Schedule

Paul Barr - Resident Astronomer

ISOC has begun detailed planning for AO-3. The following dates and deadlines may be of interest to the scientific community (Table 1). The duration of the AO-3 programme will be eighteen months, i.e. until August 2006, in order to decouple from XMM-Newton AO's.

Table 1: INTEGRAL AO-3 Schedule

Release AO-3	13 Sep 2004
Proposals due	29 Oct 2004
TAC Meeting	06-10 Dec 2004
Notification of TAC results	03 Jan - 05 Feb 2004
AO-3 observing cycle	18 Feb 2005 - 17 Aug 2006

ESA's Science Programme Committee has recently decided to extend the mission until December 2008 (see ISOC Newsletter #10, November 2003). As part of this decision it was also decided to move the ISOC from ESTEC (the Netherlands) to VILSPA (Spain) to benefit from co-location with the XMM-Newton science operations team. The plan is to assume full ISOC operations from VILSPA at the start of AO-3 observations, i.e. 18 February 2005. In the meantime ISOC will continue to fully support the INTEGRAL operations during the extended mission, and during the move to VILSPA. An important availability requirement on ISOC is to be able to respond in the case of a TOO event within 8 hours. This requires continuously available operational hardware so the ISOC operational system will be duplicated in VILSPA. Less critical parts of the ISOC, such as the development system and the science archive will be physically moved to VILSPA. Detailed planning for the move and

liaison with XMM-Newton team at VILSPA
are well under way.

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Kuulkers, E.	Operations Scientist	6145	SCI-SDG
Oosterbroek, T.	Operations Scientist	3612	SCI-SDG
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Treloar, J.	Software Engineer	4528	SCI-SDG
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