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The INTERIM XMM-LSS catalogue

A status report

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Abstract. I report on the recently released INTERIM catalogue, giving reference information similar to the published XLSS catalogue or to what provided in internal reports for the XMDS catalogues. The catalogue tables contain X-ray results from all observations up to AO5 included, and associated optical and IR information.

Key words: LSS

1. Introduction

The *published* catalogues deriving from the XMM-LSS so far have been only the XMDS/VVDS 4σ catalogue (Chiappetti et al., 2005) with just 286 entries, and the XMM-LSS catalogue version 1 hereafter XLSS (Pierre et al., 2007) with 3385 entries. They are supplemented by a number of papers describing other samples of AGN (Tajer et al., 2007; Polletta et al., 2007; Garcet et al., 2007) or clusters (Pierre et al., 2006; Pacaud et al., 2007) extracted sometimes from (larger) working catalogues available internally in the Milan database (or elsewhere).

Various versions of such working catalogues for the XMDS, or more precisely, for the results of the analysis of XMDS fields (so called G fields) done with the Milan pipeline (Baldi et al., 2002), for a total of 1358 detections and 1168 independent X-ray sources, have been documented in internal reports (Chiappetti , 2006a,b, 2007, 2008).

Contrary to this, the database tables and working catalogues derived from the results of the analysis of all fields (B fields *and* G fields) with the Xamin Saclay pipeline (Pacaud et al., 2006) have not been documented so far, and this report intends to fill such gap.

I therefore present here the INTERIM catalogue with 6395 entries, corresponding to the Xamin analysis of all XMM-LSS fields obtained up to AO5, plus the SXDS fields (Ueda et al., 2008) which are located in a "hole" of the XMM-LSS. This catalogue has just been released for internal use, and will remain the *interim* reference (hence the name), until the complete reanalysis with the most recent Xamin version of all data (including AO7 observations executed in summer 2008 or planned for early 2009), which is announced for spring 2009.

In section 2 I list the input database tables used as starting point, namely X-ray data (2.1) and optical-IR data (2.2), while other ancillary tables contained in the Milan database are briefly mentioned in section 2.3, and the astrometric correction in section 2.4. The procedure used to create the INTERIM catalogue is described step-by-step in the various subsections of section 3, with particular regard to the X-ray tables (3.3), to the X-ray/optical catalogue (3.4) and to the data products (3.6). Section 4 discusses perspective for future identification work and presents some prototypal tools which could assist it. Section 5 gives some summary statistics on the catalogues.

2. Data sources

The starting point for the INTERIM X-ray catalogue proper have been the existing X-ray tables (described in 2.1). For the INTERIMOPT virtual table (and the astrometric correction, see 2.4 !) some other recently ingested or pre-existing optical and IR tables have been used (described in 2.2). All used physical tables are listed in Table 1.

The ending point, analogous in this to what done for the XLSS catalogue version I (Pierre et al. (2007), hereafter the XLSS paper), are a number of *glorified correlation tables* (GCTs; tables of pointers into a predefined combination of database tables, each one correlated with the main X-ray table with a "standard" correlation radius or criterion), above which the catalogue *virtual tables* are based.

2.1. X-ray data

I started from three physical tables (nov06 with the data of GTO, AO1 and AO2 observations, which was also the starting point for the XLSS catalogue; jul07 with AO5 observations; subaru with SXDS observations).

Table	Update	Content	History	(5)	(6)
nov06*	**Aug 08**	X-ray sources from the Saclay pipeline, band merged within 6″	Used in XLSS catalogue (Pierre et al., 2007); **new:** fixed off-axis and position error bug ; fixed coordinate bug and *added* revised astrometry	6″	a
jul07*	**Aug 08**	X-ray sources from the Saclay pipeline, band merged within 6″	AO5 observations, unpublished, originally ingested in Sep 07; **new:** fixed coordinate bug and *replaced* revised astrometry	6″	a
subaru*	**Aug 08**	X-ray sources from the Saclay pipeline, band merged within 6″	SXDS observations analysed by us, originally ingested in Oct 07; **new:** fixed zero-exposure bug and coordinate bug and *replaced* revised astrometry	6″	a
d1t4	**Aug 08**	CFHTLS D1 field release T004 supplied by Saclay	**new!! added Jan 08**	6″	
w1t4	**Aug 08**	CFHTLS W1 fields release T004 supplied by Saclay	**new!! added Jan 08**	6″	
swiredr6	**Aug 08**	SWIRE DR6 supplied by IPAC	**new!! added Jan 08**	6″	
ukidss	**Apr 08**	UKIDSS DR3plus public release	**new!!** old version entirely overwritten	6″	
simbad	Aug 08	SIMBAD sources	present since 2003 and regularly updated	20′	b
ned	Aug 08	NED sources	present since 2003 and regularly updated	20′	b
usno	Oct 07	USNO A2 catalog as kept at ST-ECF.	present since 2005 and regularly updated	6″	
tajer07	Apr 07	Tables A.1, B.1, B.2 from Tajer et al. paper		n/a	c
polletta07	Apr 07	Table I from Polletta et al. paper		n/a	d
garcet07	Nov 07	Table 4 from Garcet et al. paper		n/a	e
ueda08	**Jul 08**	Table 2 and 3 from Ueda et al. paper		n/a	f

Table 1. Database tables used as input to the present INTERIM catalogue

(5) column (5) is the correlation radius used to populate the GCT with the object around the X-ray sources
(6) column (6) refers to the notes indicated below

a the radius in column (5) is used for band merging and overlap removal (see 3.2) in the case of X-ray tables
b SIMBAD and NED may also include objects from some of our catalogues (radio and XLSSC).
c Tajer et al. (2007)
d Polletta et al. (2007)
e Garcet et al. (2007)
f Ueda et al. (2008)

The ingestion and band merging for such tables was done long time ago, and not repeated, except for the SXDS full exposures for which new data were supplied. In particular band merging was done as described in section 2.3.5 of the XLSS paper, and it is outside of the scope of the present report.

Similarly the computation of fluxes, and the extended source classification was also done at ingestion time, as described in sections 2.3.2 and 2.3.4 of the XLSS paper.

During the ingestion, caution was used so that the sequence numbering of sources in jul07 started where nov06 ended, and numbering in subaru started where jul07 ended, so the three tables were ready to be concatenated.

I remind here the (pointing) field numbering convention:

- the original observation of a B field is numbered n (e.g. field B04 is 4)
- the original observation of a G field is numbered 1000+n (e.g. field G07 is 1007)
- however field G16 was observed in two chunks (G16a and G16b) which are numbered 1116 and 1216
- additionally field G12 was bad, and was reobserved in AO5 as G12bis, which is numbered 1112
- some AO1-2 B fields were also bad and were reobserved in AO5. They are numbered 500+n (e.g. field B13bis is 513)
- the 7 SXDS fields (full exposures) are numbered 2000+n (e.g. S01 is 2001)
- the first 10 ks of the SXDS field exposures (Saclay S0nc) are numbered 2100+n (e.g. S01c is 2101)
- the next 10 ks of the SXDS field exposures (Saclay S0nd) are numbered 2200+n (e.g. S01d is 2201)

2.1.1. Fixing the coordinate bug

A problem was discovered early in 2008, and affected all coordinates in all database tables coming from Xamin.

Dataset	XAMIN version	Δx	Δy	$\Delta\alpha$	$\Delta\delta$	corr	cor2
nov06	IDL	0.5 pix	0.5 pix	+1.25″	-1.25″	unchanged	corrected
jul07	Python 3.1	0.5 pix	0.5 pix	+2.50″	-2.50″	corrected	n/a
subaru[a]	Python 3.2	0	0	0	0	corrected	n/a
subaru[b]	Python 3.1	0.5 pix	0.5 pix	+2.50″	-2.50″	corrected	n/a

Table 2. XAMIN versions and position offsets due to the coordinate bug for the various X-ray datasets : the offsets on pixel or sky positions are to be interpreted e.g. as $x_{corrected} = x_{orig} + \Delta x$ or $y_{corrected} = y_{orig} + \Delta y$. For an explanation of "corr" and "cor2" coordinates see text.

a full exposures (fields S01-S07; database SQL condition: `field between 2001 and 2007`)
b 10ks chunks (fields S01c-S07c and S01d-S07d; SQL: `field > 2100`)

Due to some confusion about the subscripts of an array starting at 0 ("C convention") or at 1 ("FITS convention") an offset of 0.5 pixel was introduced by XAMIN. However this bug affected differently data processed with different XAMIN versions.

Prior to the generation of the INTERIM catalogue, all coordinates in the database tables nov06*, jul07* and subaru* have been corrected in the *appropriate* way. Note that the coordinates contained in the XAMIN FITS catalogues available as associated data products have **not** been corrected: they contain the original XAMIN results, which are affected by the bug up to XAMIN version 3.1 inclusive.

Table 2 reports the correction for the various tables, and represents also the reference information for the XAMIN version used to generate a particular dataset.

The corrections marked as Δx, Δy are applied to the pixel positions contained in the individual band tables, and otherwise considered of little or no use.

The corrections marked as $\Delta\alpha$, $\Delta\delta$ (note signs !) are applied to the *raw* sky coordinates (i.e. those not astrometrically corrected) in individual band and band merged tables. Note that since this is a rigid shift it has no effect on band merging, which has not been repeated (band merging was redone for subaru full exposures because new data processed with XAMIN 3.2 were supplied to fix another bug resulting in incorrect zero exposure times).

The astrometrically corrected coordinates (with the corr or cor2 suffix in physical tables) have been subsequently corrected with the procedure described in 2.4 starting from the offset-corrected raw coordinates.

However it was not advisable to modify astrometrically corrected coordinates which had been published in the XLSS paper (Pierre et al., 2007). For such reason in the nov06* tables a second set of astrometrically corrected coordinates, suffixed cor2, was introduced, while the original set, suffixed corr, remains the published one (corrected per section 2.3.3 of the XLSS paper from original non-offset corrected raw coordinates).

For jul07* and subaru* there is a single set of corrected coordinates (corr), which was unconditionally overwritten with the new values. Functionally this contains cor2 values (i.e. latest astrometry).

This has an effect on source naming too, which is explained in 3.3.2.

2.2. Optical, IR and other data

For CFHTLS release T004, we used as input two files elaborated by M.Polletta, one for the D1 field, and a comprehensive one for the W1 fields and "our" northern (ABC) fields (therefore superseding previous database table cfhtnorth), where duplicated sources in adjacent files had been natively removed. They have been ingested in temporary tables, and only the objects within 9″ from an X-ray source are kept online (the correlation was done however within 6″). It shall be noted that the d1t4 table uses the standard CFHTLS undefined magnitude marker (99), while the w1t4 follows the convention by M.Polletta, and replaces the undefined magnitude with the *negative* value of the limiting magnitude in the band for the specific W1 field. For the three northern field, where only $g'r'z'$ photometry is available u^* and i' are set to zero.

Earlier release tables existing in the database (d1, w1, d1t3, w1t3), used for the XMDS catalogues (see e.g. Chiappetti (2008), hereafter Report IV), are **not** considered for the INTERIM catalogue.

For SWIRE the latest release ("DR6") data have been supplied by IPAC in Jan 2008, with an update in Mar 2008 to remove some duplicated sources incorrectly left in. The files have been pre-processed by M.Polletta for simplification in the number of columns, classification of extended objects, and flagging of poor fluxes. With respect to the public Spring 05 release, DR6 is less conservative and does not exclude sources below significance thresholds. Also DR6 natively includes MIPS data in all its bands (24, 70 and 160 μm). Data have been ingested in temporary tables, and only the objects within 10″ from any X-ray source are kept online (the correlation was done however within 6″). Technically there is an hidden table swiredr6_ext which contains both "aperture 2" and Kron fluxes (for IRAC, only PRF fluxes for MIPS), while table swiredr6 is a *view* which selects "aperture 2" or Kron according to the fact the source is pointlike or extended following a recipe defined by M.Polletta.

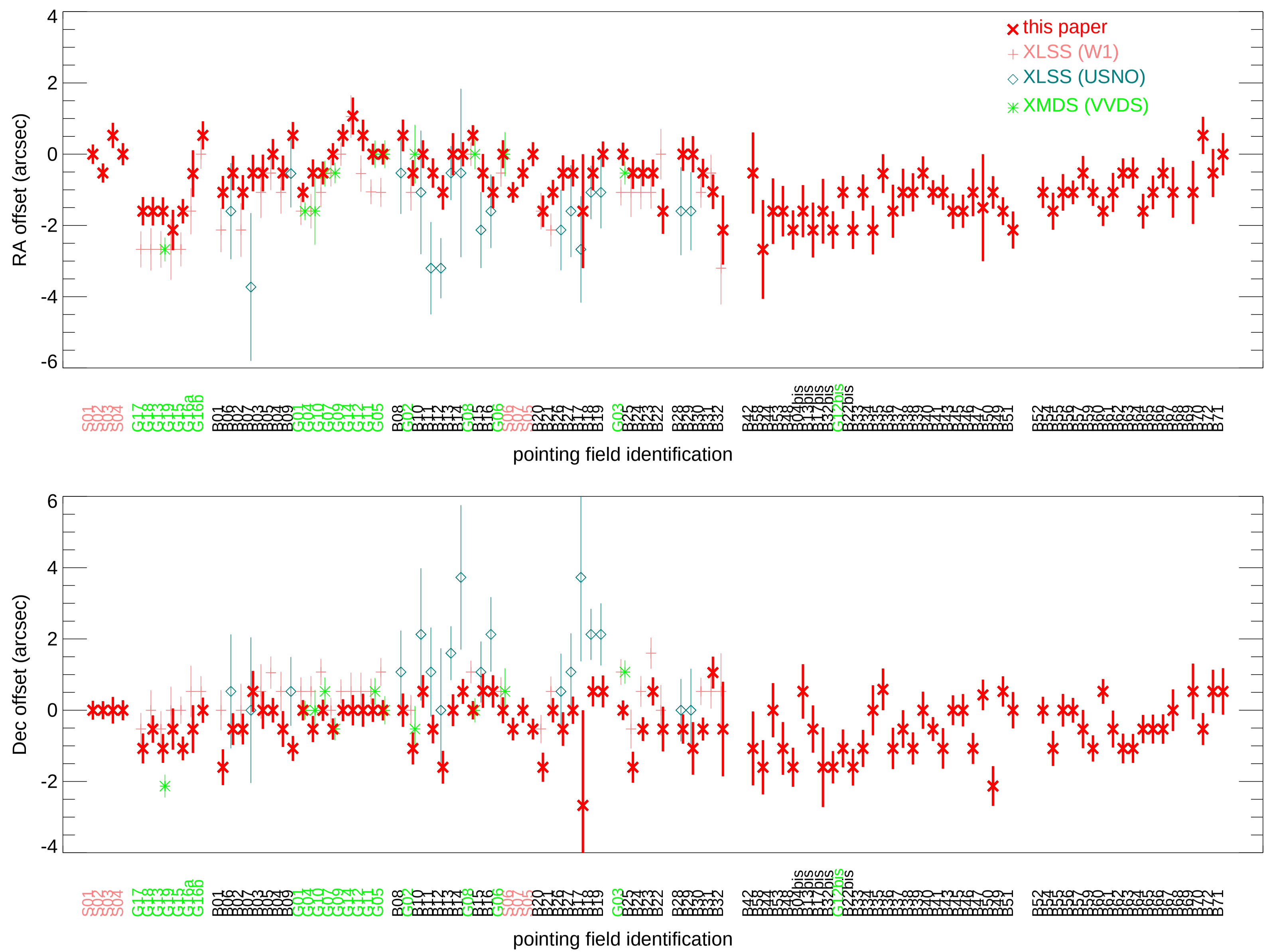

Fig. 1. The astrometric correction offsets in RA (top panel) and Dec (bottom panel). Thick red X report the corrections used in the present report, based on W1 T004 data. Light blue diamonds and light pink crosses indicate the corrections (based respectively on the USNO-A2 catalogue and on W1 T003 data) published in the XLSS paper. Green asterisks indicate the corrections published in the XMDS/VVDS 4σ catalogue (Chiappetti et al., 2005) (unpublished XMDS corrections are not reported but are available on the master catalogue web site). Offsets of different origin are displaced horizontally for clarity. The X-axis gives the XMM pointings in chronological order of execution, with different families (G,B,S see text) marked in a different colour and with different observation "seasons" separated by a blank space.

Earlier release tables existing in the database (`swire` and `swires05`), used for the XMDS catalogues (see Report IV), are **not** considered for the INTERIM catalogue.

For UKIDSS the latest release available when the ingestion was done was DR3plus. Data have been extracted at WSA within a radius of 10″ from a supplied list of positions, and then ingested *overwriting* any previous data (the DR1 UKIDSS data had not been used by anybody yet, so it was simpler this way). They have been taken from the DXS and UDS surveys, cover a larger area than before, and more bands (about half of the sources have both J and K, and one third has also H).

The tables referring to external catalogues (SIMBAD, NED, USNO) have been recently updated with pointers to objects in the surrounding of all X-ray sources, and can be accessed in correlation with the INTERIM catalogue, although not members of it.

The tables referring to published papers, although sometimes correlated with one or more of the three original X-ray tables (`nov06`, `jul07`, `subaru`) are presently not correlated with INTERIM.

2.3. Database technicalities

Each physical X-ray table is actually a family of X-ray tables (that's why I use an indication like e.g.`nov06*`). There are two *individual band* tables (e.g. `nov06b` and `nov06cd` which contain detail data coming from the original XAMIN FITS catalogue (plus corrections in 2.1.1 and 2.4) for the separate detections in the B (0.5-2 keV) and CD (2-10 keV) bands), and one *band merged* table (e.g. `nov06`) with the most relevant information. Band merging is described in section 2.3.5 of the XLSS paper.

The optical and IR tables are usually single physical tables, unless otherwise stated in 2.2.

The database contains also *correlation tables* which link one X-ray table to a single other table. They have just two columns, with the *sequence pointers* in the two tables (e.g. a correlation table may say that X-ray object 8 is associated with optical object 5968, that X-ray object 2 is associated with optical objects 834 and 835, and that X-ray object 11 is associated with none). The association is precomputed using a predefined criterion (usually a distance within a given radius, but not necessarily). Correlation tables allow to speed up two-table queries.

The database contains also *views* which are a way to see the result of a query on a subset of a table (rows or columns), or on more than one table, as if it were a real table.

In particular are views the *unions* which concatenate the three main X-ray tables in a "combo" (see 3.1), and the four *virtual tables* INTERIM, INTERIMB, INTERIMCD, INTERIMOPT which are the preferred and recommended way for the user to access the catalogue.

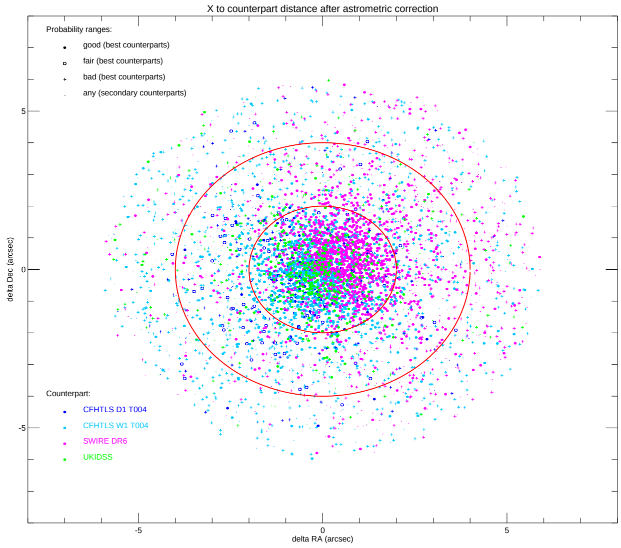

Fig. 2. Distances in RA and Dec between the X-ray corrected position and the counterpart position. Different symbols indicate the identification quality. A circle is plotted when the counterpart is the best one, and the chance probability is good or fair (filled in case of good probability). A cross is plotted for the best counterpart when the probability is bad. A dot is plotted for secondary (ambiguous) counterparts, irrespective of probability, but only if it is good or fair. Different colours (as shown on figure) indicate the origin of the counterpart position for the distance calculation. Two fiducial radii of 2 and 4″ are also shown.

Virtual tables are based on a GCT (which extend the concept of correlation tables to associations of more than two tables).

The database tables pointed from the GCTs used for the present working catalogue (i.e. *member tables*) are those above the dividing line in Table 1.

The tables below the line are accessed only as a result of a two-table query between a virtual table and one of them at a time.

2.4. Astrometry

Astrometric correction offsets were generated using SAS task EPOSCORR in a manner analogous to what described in section 2.3.3 of the XLSS paper, but using a different (and homogenous) optical reference catalogue.

The optical reference files were generated taking all objects in `w1t4` within 6″ from the X-ray source position, brighter than $i' = 25$ (or $r' = 25$ for the ABC fields), and having a chance probability (as defined in 3.5) $p < 0.03$. In case of more possible counterparts the one with the smallest probability was taken.

The new astrometric offsets are reported with their numeric values in `http://cosmos.iasf-milano.inaf.it/~lssadmin/Website/LSS/List/.lssastroreport.html` Appropriate colour coding in such page shows which XMM fields have been corrected using W1 or ABC optical fields, or a mixture. Field B68 (bad) has no counterparts and cannot be corrected

With respect to earlier preliminary corrections (for subaru and jul07) the new astrometric correction is in general smaller and with much smaller error bars. Such earlier corrections (starting from raw coordinates affected by the 2.5″ bug) have been abandoned. The corrected coordinates corresponding to the abandoned correction are no longer available, however they were compared with the new corrected coordinates. Paradoxically the deviation between old and new coordinates can be small when the old correction was large and the new one is small but give matching results, or be large when both corrections were small but the 2.5″ offset was such to induce a change in optical references.

For nov06 the new astrometric correction is not only smaller than the earlier one, but in general follows the same trend, as if a rigid shift acted. Also the new offset are often equal or comparable within the errors with the XMDS generated ones (Chiappetti , 2006a) which are totally independent. So it looks like the 1.25″ bug affecting the nov06 was recovered better than the larger 2.5″ bug for the other table (where the scatter in the earlier astrometric corrections was larger).

The astrocorr (or Xastrocorr in the XLSS paper) flag, used at some time to cope with different optical references used in the astrometric correction, is now irrelevant for the newer corrections (with the exception of B68, astrocorr=0 i.e. not corrected), which all derive from the same W1 T004 (with ABC extension) reference. Therefore it is identically astrocorr=4 for jul07 and subaru. For nov06 it can assume the values 4 *or 5* but this has no meaning for the cor2 coordinates (they all come from W1 T004), except to remind whether the published corr coordinates came from older W1 data or USNO.

Fig. 1 shows the astrometric correction offsets for the individual pointings, and offers a direct comparison with Fig.4 of Report I, or Fig.7 in the XLSS paper.

Fig. 2, comparable with Fig. 9 of Chiappetti et al. (2005) or Fig. 1 of Chiappetti (2007), gives instead the distances in RA and Dec between the X-ray corrected position and the counterpart position. The best or secondary counterpart is selected based on probability, as described in 5.2. The catalogue (colour-coded in figure) from which to extract the counterpart position (if a given counterpart is present in more than one) is the one giving the smallest distance (there is virtually no difference if one uses instead the smallest probabiity).

The results in term of positional accuracy are as follows. 89% of the sources have both RA and Dec offsets lower than 4″, and 70% have both within 2″. If one restricts to the best counterparts with good probability, as defined in 4.1, one has more than 97% within 4″, and 83% within 2″ (95% and 68% respectively including those with good or fair probability).

No. of entries	kept	versus	Reason
7	XLSS	XLSS	off-axis
306	XLSS	good	off-axis
92	XLSS	bad	field quality
62	good	XLSS	off-axis
172	good	good	off-axis
142	good	bad	field quality
50	bad	bad	off-axis

Table 3. Statistics of overlap removals: indicates whether the objects kept or rejected were in a field used in the XLSS catalogue (by definition good), in another *good* field or in a field flagged *bad*. When the reason for the choice is indicated as "field quality" this does not imply that the off-axis angle of the taken object in the good field be necessarily worse than the one of the rejected objects.

In terms of true distance 84% of the total is within 4″, which makes 93% of the good-or-fair associations (the circles in Fig. 2) and 97% of the good ones (the filled circles in Fig. 2).

There is some evidence from Fig. 2 of a systematics of the deviations between X-ray positions and positions in the various catalogues. The average deviation for the optical and UKIDSS catalogues clusters around a point in the third quadrant (e.g. -0.35,-0.21 for W1), while the one for SWIRE clusters around a point in the first quadrant (0.92,0.36).

3. The procedure

The final procedure leading to the INTERIM catalogue was executed after the insertion of the latest (Xamin 3.2) data for the subaru full exposures (fixing the "zero exposure bug") and after the correction of the coordinate bug (see 2.1.1).

3.1. Table concatenation

The first step of the procedure was to generate a "combo", concatenating nov06, jul07 and subaru (technically this applied not just to the band-merged table, but also to individual band tables and dependent correlation tables), defining a *view* named combo which allows to access, as if it were a single table, the concatenation of: (a) all sources in nov06, (b) all sources in jul07, (c) all sources in the full exposures (field < 2100) of subaru.

By "all sources" I mean all fields (good and bad), and all detection likelihoods (including the "spurious" ones $ML < 15$). Only the duplicated detections in the subaru 10ks chunks are excluded (they remain available via the subaru table).

The combo view has nominally two sets of coordinates (corr and cor2), which are different only for the entries coming from nov06 (see 2.1.1 for explanation).

The combo* tables are presently not released to the users, but are used as starting point for the remainder of the procedure.

3.2. Overlap removal

The procedure for removal of redundant sources detected in the regions where pointings overlap is analogous to the one described in section 2.3.6 of XLSS paper. Namely :

- only *merged* sources which are *non-spurious* ($ML > 15$) are considered
- the search radius is $6''$
- for each couple of nearby sources, the one with the smallest off-axis angle is preferred *except that if one source is detected in a good field and the other in a bad field, the source in the good field prevails unconditionally*, i.e. the off-axis angle is used only when both fields are good, or both fields are bad
- overlaps between 3 or more fields were manually arbitrated

This should allow to minimize the differences with the XLSS published catalogue (which used only good fields) or with any future catalogue (which will use the hopefully good repeats of former bad fields), and at the same time use all the pointings available so far to maximize the coverage.

A simple statistics is presented in Table 3.

The removal procedure removes 768 entries, leaving 6395 sources in the GCT for the INTERIM catalogue.

Note that in a few cases this implies that a source published in the XLSS catalogue is now superseded by a different choice. The implication of this on source naming are discussed in 3.3.2 below.

3.3. The INTERIM *X-ray catalogues*

For analogy with the published XLSS catalogue (see Table 11 of the XLSS paper) I provide three virtual tables for the X-ray data: a merged catalogue INTERIM (analogous of XLSS), and two single-band ones INTERIMB and INTERIMCD, analogous of XLSSB and XLSSCD.

The naming and meaning of the columns in such catalogues are as far as possible identical to the ones listed in Tables 4 and 5 of the XLSS paper. A detailed explanation is available on line at http://cosmos.iasf-milano.inaf.it/~lssadmin/Website/LSS/List/INTERIM.html. This is a summary of the differences :

- all *non-raw* sky coordinates refer to the latest astrometrical correction (cor2) described in 2.4
- the Xastrocorr flag is set to 4 or 5 as described in 2.4
- the catalogue names are as described in 3.3.2
- there is an additional column Xlssflag to provide a match with the XLSS catalogue, as explained in 3.3.1

The number of sources in the merged catalogue is 6395 (5555 in INTERIMB and 2402 in INTERIMCD).

Technically the INTERIM* tables are realized as *union of joins*. This way they do not require the "combo" tables (although they were necessary to build the underlying GCTs), and a speed improvement of two orders of magnitude for the database queries can be achieved.

3.3.1. Comparison with XLSS

Of the 6395 sources, 3443 derive from nov06, 2086 from jul07 and 866 from subaru. 5839 of the total refer to detections in good fields. More specifically, of the 3443 from nov06, 3339 come from good fields, and 104 from bad fields. However XLSS contained 3385 sources taken exclusively from nov06 good fields.

The differences are due to the effect of the overlap removal procedure when the overlaps between XLSS fields and AO5 or SXDS fields, and the latest astrometrically corrected coordinates are taken into account.

More specifically 3310 XLSS sources are preserved in INTERIM. The other 75 are replaced

- 41 by a source in another pointing not in XLSS (which should mean also not in nov06 since all good nov06 fields are in XLSS)
- 27 by a source in another nov06 (good) pointing which was not used in XLSS
- 7 are a mixture of the above (more than 2 sources involved)

The new column Xlssflag can assume the values:

- 0, when the INTERIM source is new (not in XLSS at all, typically in fields not used at the time of the XLSS catalogue);
- 1, when the XLSS source is confirmed in INTERIM;
- 2, when the XLSS source was replaced (in two cases an INTERIM source replaces two XLSS sources)

In addition INTERIM contains 8 new sources in the nov06 good fields which appear not to be in XLSS. They come out because, using the cor2 coordinates, they are no longer closer than $6''$ to an XLSS source (the distance is marginally above the threshold) and therefore they are no longer removed by the overlap removal procedure. These are flagged as Xlssflag=0 too.

The impact of the above changes on catalogue names is described in 3.3.2.

Limited information on the original XLSS source associated to replaced sources Xlssflag=2 is available via table INTERIMOPT as described in 3.4.4.

While of course the XLSS sources preserved in INTERIM maintain their positions and fluxes, changes occur for the cases marked Xlssflag=2. First of all 30 of them have the same "classification" (i.e. pointlike detection in both bands or in the soft band), 29 have an improved classification (INTERIM has a pointlike detection in both bands where XLSS had a detection in either the soft or hard band, in one case even an hard extended one). Only 6 cases are "degraded" (INTERIM has a soft-band detection instead of one in both bands) and 3 discrepant (INTERIM has a soft-band detection instead of a hard one).

In 44 cases the INTERIM source has a better detection likelihood than the XLSS one. In the remaining 24 the INTERIM likelihood is worse, but in 13 cases both are anyhow above 40 (i.e. about the 3σ level), in 6 cases they are both below (poor significance sources), while only in 5 cases an INTERIM object with a likelihood between 23 and 39 replaces an XLSS one with a better likelihood (between 46 and 94).

The distribution of the distance between INTERIM and XLSS positions is virtually flat between 1 and 6″.

The INTERIM and XLSS fluxes are sort of similar, although it is difficult to quantify this in lack of error bars. For the 51 soft-band detections in about 60% of the cases the flux difference is less than 30%. For the 28 hard-band detections this occurs in about 50% of the cases.

3.3.2. Source naming

There is an IAU requirement that once a source in a catalogue has been assigned a name (even if this is a "coordinate name"), the name cannot change even if the actual coordinates are improved (modified), unless a completely new catalogue is issued.

Since a new issue of the XMM-LSS catalogue (2XLSS ?) makes sense only after the complete reprocessing of all data with the latest XAMIN version (which is planned for Spring 2009), the above requirement has been met as follows :

- confirmed XLSS sources (Xlssflag=1) have the same Xseq as in the published catalogue, the same Xcatname of the form XLSS Jhhmmss.s-ddmmss, and (slightly) different coordinates (based on the cor2 set)
- new sources (Xlssflag=0) or changed sources (Xlssflag=2) will have an *unofficial*, provisional Xcatname of the form XLSSU Jhhmmss.s-ddmmss. Note that the prefix XLSSU is registered with the IAU
- the single-band catalogue names Bcatname and CDcatname are neither official, nor registered with the IAU. So they use the prefixes XLSSB or XLSSCD in all cases. For confirmed sources (Xlssflag=1) it is however guaranteed that the names remain the same as in the XLSS catalogue
- the generation of the original name is possible because the original corr coordinates are stored in the underlying tables, although not visible to the user for any other purpose
- For *a subset* of the (Xlssflag=2) XLSSU sources it is possible to know the name of the original XLSS source as described in 3.4.4.

As for the XLSS catalogue, there is a limited number of cases where the band merging is ambiguous, and a source in a band happens to be associated with two different objects in the other band. This is discussed at the end of section 2.3.7 of the XLSS paper (column Xlink and eventual addition of an a|b suffix to the catalogue name to disambiguate it). There are only 4 new cases in addition to the 8 already in XLSS, and none of them requires disambiguation.

3.4. The X-ray/optical catalogue

The INTERIMOPT virtual table provides a synoptic view of the X-ray sources from INTERIM, together with the nearby optical-IR candidates. It is mimicked on the XLSSOPT table described in the XLSS paper, but provides information on the *latest* (T004) CFHTLS D1 and W1 fields (and on "our" ABC fields), on SWIRE and on UKIDSS, using the tables described in 2.2.

3.4.1. Optical pre-identification

Unlike the brute force approach used originally for the XMDS (Chiappetti (2006a) aka Report I, i.e. considering all possible combinations of counterparts given by the individual correlation tables with X-ray sources, and then doing a radical cleanup of spurious combinations), I elaborated a variant of the incremental addition used in the latest XMDS versions (Chiappetti (2008) aka Report IV) described below. Another difference with XMDS is that the latter uses all available database tables, while INTERIM limits to the most recent CFHTLS, SWIRE and UKIDSS only.

- a preliminary step is to create a GCT and initialize it. The member tables of such GCT are the three "combo" tables (combo, combob, combocd) used for INTERIM, a clone of combo used to keep track of X-ray duplications, and d1t4, w1t4, swiredr6 and ukidss. The GCT is initialized copying into it the content of the GCT underlying INTERIM (i.e. the list of all X-ray sources in the band-merged catalogue together with the pointers to the single-band catalogues).
- immediately afterwards a correlation of the "combo" table with itself within 30″ is used to insert a "clone pointer". This is not used for the optical identification work, but could be useful in the future to study how many X-ray sources are there surrounding another X-ray source, and to assist in the comparison with XLSS (see 3.3.1). Note that if one X-ray source has more than one nearby objects, additional *placeholder records* are inserted in the GCT (with all other table pointers set to -1). These placeholder records are **not** visibile in the INTERIMOPT catalogue.
- then one *inserts a pointer* to the first optical table (d1t4) using the existing correlation table, and limit-

ipacflag	meaning	count
0	records not in the IPAC files, i.e. no SWIRE counterpart	11549
1	SWIRE-W1 association confirmed by IPAC	5602
2	SWIRE-D1 association confirmed by IPAC	51
3	SWIRE with no optical association confirmed by IPAC	995
11	our SWIRE-W1 association and IPAC's are to different objects	57
12	we associate SWIRE-D1 while IPAC associates SWIRE-W1	13
13	IPAC associates a W1 which we do not associate	217
14	IPAC associates a D1 which we do not associate	8
21	The W1 object is associated to SWIRE by IPAC, but we prefer another W1	none
22	The W1 object is associated to SWIRE by IPAC, but we prefer a D1	2
23	The W1 object is associated to SWIRE by IPAC, but ignored by us	95
24	The D1 object is associated to SWIRE by IPAC, but ignored by us	5

Table 4. Values, explanation and statistics of the ipacflag The flags 21 to 24 indicate entries with no SWIRE counterpart but whose optical counterpart was associated to a SWIRE object by IPAC. An X-ray source with a counterpart set with such flag has always also a corresponding entry with a flag 11 to 14, which allows to reconstruct the IPAC choice. The reverse is not true, however when an X-ray source has a counterpart set with a flag 11 to 14, usually it has more than one, indicating an ambiguity in the association of *one* SWIRE object with more optical ones.

ing to the objects within 6″. If the X-ray source has one optical counterpart only, the pointer is *inserted* in the existing primary record (placeholders are ignored). If it has more, the pointer of the closest candidate is inserted, while *additional records are added* copying from the primary one and replacing the pointer. A record in the GCT is also called a *counterpart set*.

- then one *inserts a pointer* to the next table entry into existing counterpart sets when the object in such table is closer to one of the existing counterparts in other optical tables within a predefined radius. E.g. in the case of w1t4 objects are compared with d1t4, while swiredr6 objects are compared first with w1t4, then d1t4, and UKIDSS objects are compared with all other tables (in order W1, D1, SWIRE). The objects within 6″ from each X-ray source are considered, while a correlation radius of 0.5″ is used when comparing positions of the same origin (i.e. D1 and W1), and 1″ when comparing to other optical or SWIRE catalogues.
- In all cases the pointer is *inserted* in an existing record when there is a single match with the X-ray position and all the positions in the pre-existing catalogues. *Additional records are added* in all other cases (typically an independent counterpart of the X-ray source with no counterpart in previous catalogues, but could also be an ambiguous association of more sources in the current catalogue with a previously defined counterpart set)
- Finally the chance probability of the association of a counterpart with the X-ray source are computed as described in 3.5

3.4.2. The INTERIMOPT table

INTERIMOPT loosely mimics XLSSOPT as described in Table 10 of the XLSS paper, but provides a number of additional columns (see http://cosmos.iasf-milano.inaf.it/~lssadmin/Website/LSS/List/INTERIM.html or the main database interface for details). It provides essential information on the X-ray sources, the position and $u^*g'r'i'z$ magnitudes of the optical candidates (as for XLSSOPT), the position and fluxes of the SWIRE candidates and the position and magnitudes of the UKIDSS candidates, together with all distances from the X-ray position and chance probabilities (see 3.5).

INTERIMOPT contains 18594 counterpart sets, which on average means that an X-ray source has 3 possible optical or IR *not validated* associations within 6″. De facto 50% of the X-ray sources have from none to two possible counterparts, and only 16% more than 4.

INTERIMOPT provides also a flag comparing our optical-SWIRE association with the one provided by IPAC in early 2008 (see 3.4.3), and information to associate replaced XLSS source with the original source (see 3.4.4).

3.4.3. Comparison with the CFTHLS-SWIRE correlation made at IPAC

Files with the correlation between SWIRE DR6 and CFHTLS T004 release full area (including ABC fields) were made available in early 2008 by IPAC to the XMM-LSS Consortium for usage under the MoU rules (so called swireXt004 datasets). Such files contained about half-million sources and were not ingested in the database. It shall be noted that they are: (a) *SWIRE oriented* : the correlation is done starting from the SWIRE objects; (b) *single source* : only one (the closest ?) CFHTLS counterpart is returned (or none); (c) *W1 preferred* : such counterpart is looked for in W1, and only if none found in D1; (d) presumably they used a larger correlation radius than us.

Our INTERIMOPT catalogue is instead: X-ray oriented, multiple source and D1 preferred. Therefore if an X-ray source has one or more D1 counterparts, they are associ-

Probability	m	density $n(brighter\ than\ m)$	a	b	tables
probXO	i'	$n(< i') = 10^{a+bi'}$	-9.32415	0.293833	for d1t4
			-9.23183	0.290519	for w1t4 excluding ABC fields
	r'	$n(< r') = 10^{a+br'}$	-9.18619	0.279706	for w1t4 ABC fields
probXS	F_λ	$n(> F_\lambda) = 10^{a+b*log(F_\lambda)}$			in order swires05 swire
	$\lambda = 3.6\mu m$		-1.68062	-0.944191	for swires05 then swire
	$\lambda = 4.5\mu m$		-1.73693	-0.976644	then in order of λ for swire
	$\lambda = 5.8\mu m$		-2.04933	-0.829700	
	$\lambda = 8.0\mu m$		-1.49944	-1.07201	
	$\lambda = 24\mu m$		0.102480	-1.53410	
probXU	J	$n(< J) = 10^{a+bJ}$	-8.67503	0.268272	taken best if both bands present
	K	$n(< K) = 10^{a+bK}$	-8.96264	0.321560	

Table 5. Parameters used for probability computation

ated. If they then correspond to W1 objects these are associated, and finally if they correspond to SWIRE objects, these are associated. So we can come out with different CFHTLS-SWIRE associations than in the IPAC file.

A flag column in INTERIMOPT, named ipacflag, provides information whether our association and IPAC's matches. It can assume the values listed in Table 4. More than 98% of the X-ray sources with at least one SWIRE counterpart show a match between our and IPAC's choices (the cases with ipacflag between 1 and 3).

3.4.4. Information on replaced XLSS sources

Table INTERIMOPT provides, in addition to the Xlssflag described in 3.3, two columns which allow to keep track of the XLSS X-ray source replaced by an INTERIM source. They are called Xalternate and Xaltname.

They should represent respectively the Xseq sequence number and Xcatname catalogue name in the XLSS catalogue. They are set to NULL and not applicable when Xlssflag is not equal to 2.

They appear here in INTERIMOPT because the underlying GCT is the only place which keeps track of possible duplicates and nearby nov06 X-ray sources.

However not all Xlssflag=2 entries from the GCT are listed in INTERIMOPT, because unfortunately in 5 cases the old XLSS source is not the primary (closest) duplicate. Xalternate and Xaltname are presently available only for the other 63.

3.5. Computing probabilities

I computed the probability of chance coincidence between the X-ray source and its counterparts, based on the X-ray to optical (or IR) distance, the optical or IR intensity, and the density of sources brigther than a given intensity.

I computed three probabilities : *probXO*, *probXS* and *probXU*. They are based on a formula like

$$probability = 1 - exp(-\pi\ n(brighter\ than\ m)\ r^2)$$

where r is the X-ray to counterpart distance (unlike what done for the XMDS since Chiappetti (2007) and in Report IV the distance has not been *capped* to $2''$), and the density $n(brighter\ than\ m)$ is computed from simple linear fits as reported in Table 5. The same table indicates also the magnitudes or fluxes used to look up the density for the appropriate band.

The coefficients are the same used for XMDS in Report IV (with the exception of those for the r' magnitude in the northern ABC fields, which are used only here).

X-ray to CFHTLS probability, called *probXO*, is computed for sources with a CFHTLS counterpart in order d1t4, then w1t4. In the case of undefined CFHTLS magnitudes, the field limiting magnitude was used (read directly from w1t4, or fixed to $i' = 25$ for D1).

X-ray to SWIRE probability *probXS* is computed in wavelength order.

X-ray to UKIDSS probability *probXU*, in the case both (J and K) magnitudes are present, is the best (smallest) of the two.

A probability of 99 ("undefined") is assigned whenever it cannot be computed.

The density of CFHTLS sources has been derived separately from the *totality* of the sources in the D1 T004 and W1 T004 data (ingested in a temporary table), with a coarse fit to the data (see Fig. 3 top panel). For the r' magnitudes two fits have been done separately, one for the W1 area proper, and one for the ABC fields alone. Both are shown in Fig. 3 top panel, however only the fit for the ABC fields is reported in Table 5 and has been used for probability computation.

The density of SWIRE sources has been derived in each waveband from the *totality* of sources in the DR6 catalogue (using IRSA Gator in count-only mode, which was not possible for data retrieval for the lack of the so-called "xpf" files) using aperture 2 fluxes; see Fig. 3 middle panel for 3.6μm (other bands not shown).

The density of UKIDSS sources has been derived separately for J and K bands from the *totality* of DXS data, using WSA in count-only mode: see Fig. 3 bottom panel.

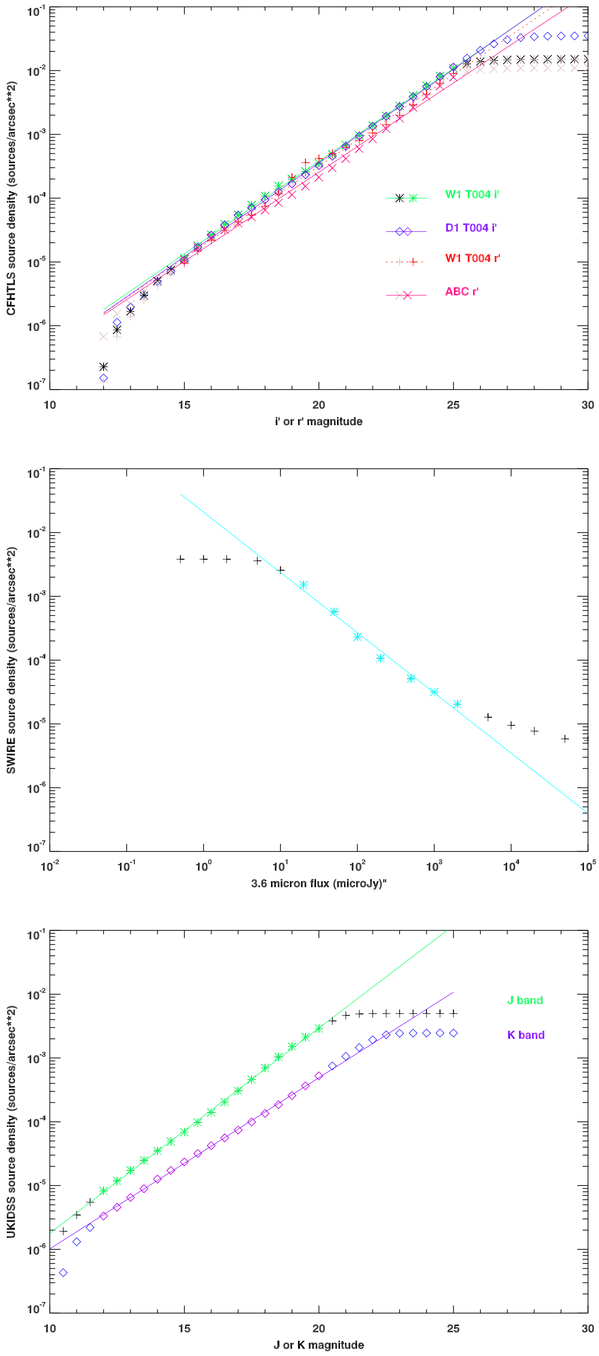

Fig. 3. Source count density for the CFHTLS D1 (asterisks) and W1 (diamonds) fields i' band, as well as for the W1 (crosses) and ABC (X) fields r' band (top panel) ; for SWIRE DR6 at $3.6\mu m$(aperture 2) fluxes (middle panel); and for UKIDSS J band (crosses) and K band (diamonds) (bottom panel) The ranges used to produce the fits shown, whose parameters are given in Table 5 are shown in (lighter) colour.

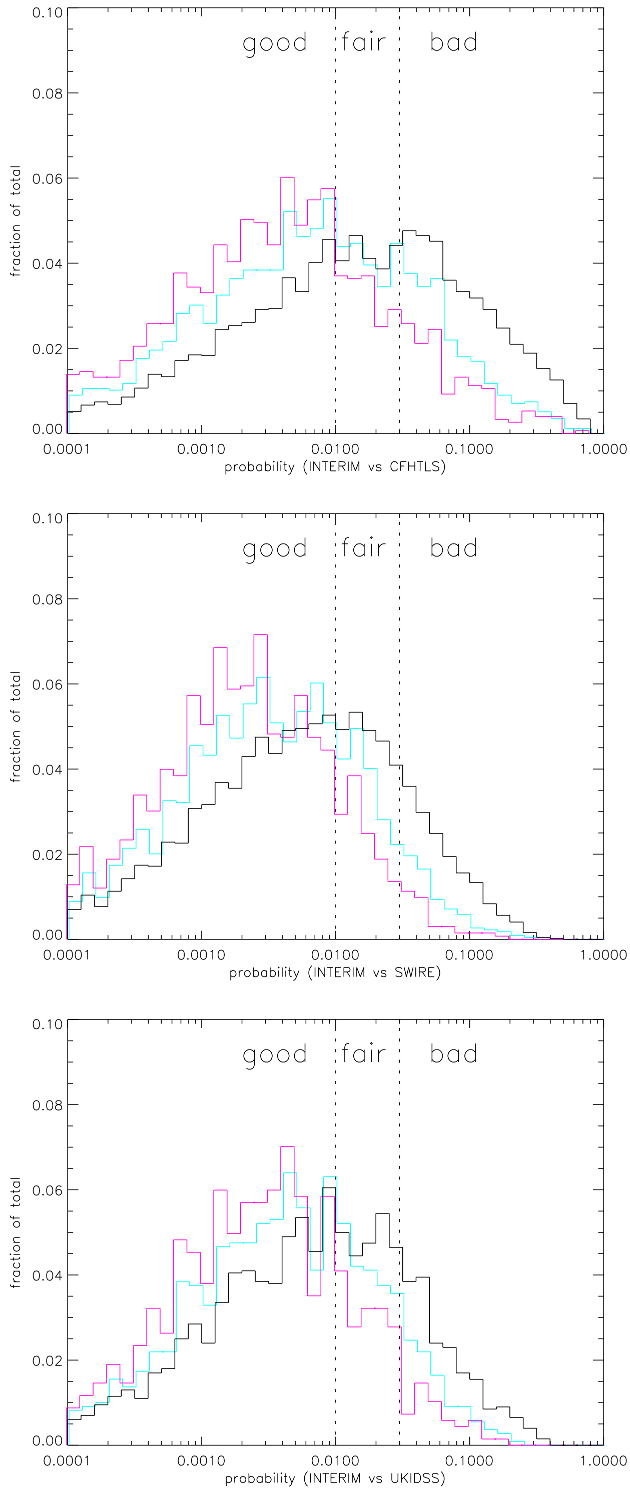

Fig. 4. Histograms of the three *uncapped* probabilities ($probXO$, $probXS$, and $probXU$) normalized to the total number of best counterparts with not undefined probability in the total sample (black), with a detection likelihood of at least 40 (3σ) in the best band (cyan), or of at least 75 (4σ, magenta). The dashed fiducial lines identify the loci with good, fair, or bad probability.

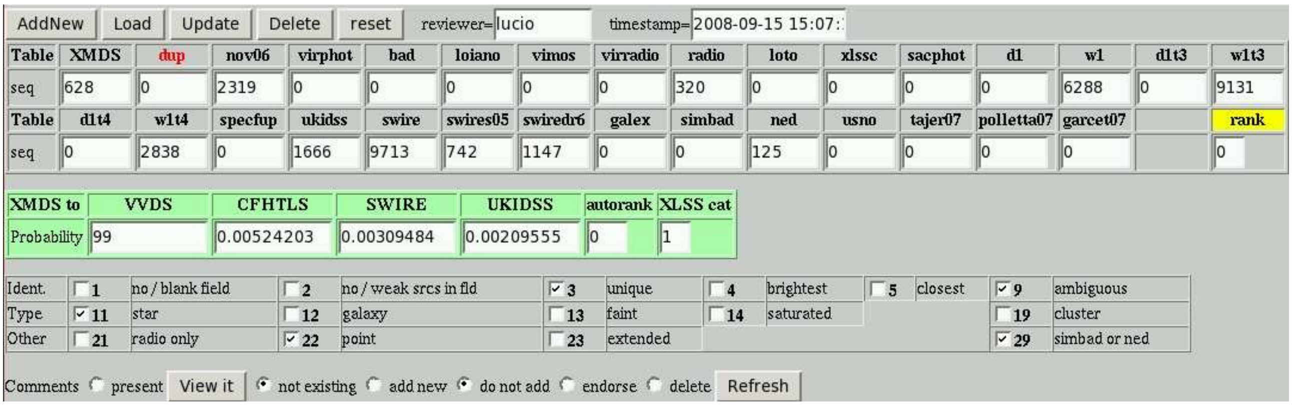

Fig. 5. Appearance of the XMDS *validation interface* with a counterpart set loaded. The interface for XMM-LSS could be similar but simpler.

The computation of density is based on source counts, but requires the knowledge of a sky area, which I computed as in Report IV, using a grid of cells 0.01×0.01 degrees and counting how many cells contain at least one object. I obtained for D1 an area of 1.02 deg^2, for W1 proper 12.91 deg^2, for the ABC fields (using r') 2.97 deg^2, for SWIRE 9.70 deg^2 and for UKIDSS DXS 17.53 deg^2.

3.6. Data Products

Currently there are no data products associated to the `INTERIM` tables, with the exception of the SIMBAD and NED pointers associated to the X-ray tables concatenated in the "combo". However it will be possible (and it has been done for demo purposes for a dozen of X-ray sources) to load thumbnail images from the CFHTLS, SWIRE and potentially UKIDSS as described in Report IV, namely :

– CFHTLS thumbnails i.e. $40 \times 40''$ i' band images centered on X-ray sources with a W1 T004 counterpart (from the T003 public image archive at CADC). *I have presently no information on the fact whether this is possible for the ABC fields, which are not in the public archive.*
– SWIRE thumbnails i.e. a family of up to 7 images (in the IRAC and MIPS bands) centered on X-ray sources with a SWIRE counterpart (in any release). Size is $30''$for IRAC and $60''$for MIPS.
– UKIDSS thumbnails could in principle be retrieved from WSA, but they use an unusual WCS (`RA---ZPN DEC--ZPN` currently unsupported by the tool described in 4.2).

These products could be used to support a future identification and validation program using a tool like the one proposed in 4.2.

4. Perspectives for future work

I propose that the `INTERIM` catalogue constitutes the test bed to define the procedure for the validation of optical identifications in a way similar to what I did for the XMDS (see Report IV), and which could be done in a collaborative way by a team of volunteers using methods and tools as described below.

Such validated identification could be the starting point for systematic computation of photometric redshift for all sources.

4.1. Ranking on probabilities

It should be possible to select the best or preferred counterpart of an X-ray source ranking the probabilities in `INTERIMOPT` (see 3.5) in a way like this (used for XMDS, see Report IV).

– good if $p < 0.01$
– fair if $0.01 < p < 0.03$
– bad if $p > 0.03$ (however undefined if $p = 99$)

An overall rank could be assigned automatically using the above definition and some agreed criterion to combine the results in the different bands and for the different counterpart sets.

A statistics of the probability ranges is presented in 5.2 (see also Fig. 4).

4.2. Identification support tools

While the ranks could be tentatively assigned in an automatic way, there will necessarily be a number of ambiguous cases requiring visual inspection with appropriate tools.

I propose to adapt such tools from those existing for the XMDS.

4.2.1. The validation interface

The *validation interface* will be a tool which will allow to confirm or alter the automatic ranking, and at the same time to edit the GCT underlying the `INTERIMOPT` catalogue. Fig. 5 shows a screenshot of the XMDS validation

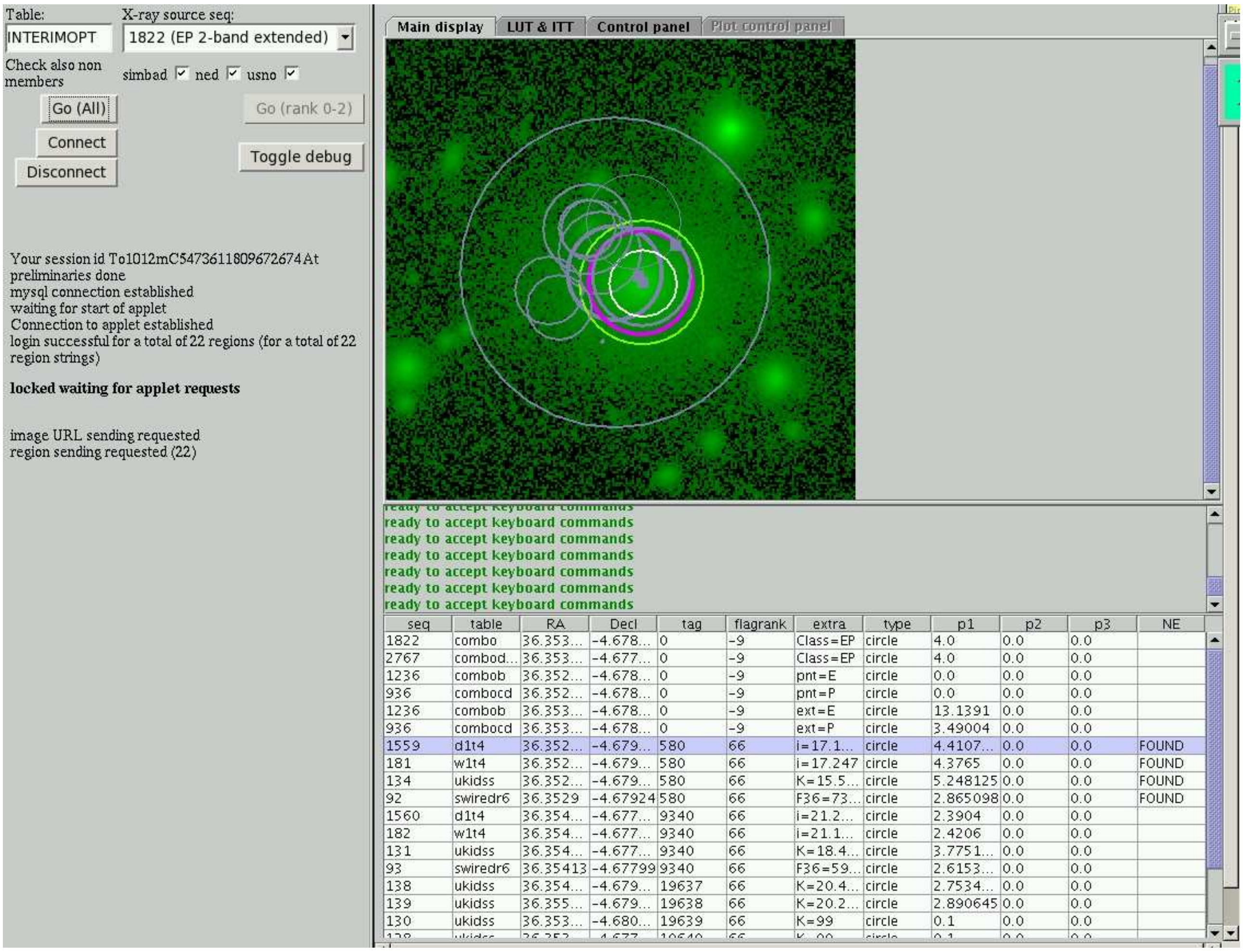

Fig. 6. Present appearance of the graphical interface. The left (servlet) frame (provisional) shows the selection of source `Xseq=1822`. In the right (applet) frame the corresponding CFHTLS image is loaded in the top display panel, while the regions for the counterpart sets are also shown in the bottom table. Counterpart set #580 is highlighted in "dimming mode". The bottom table shows that it consists of D1, W1, SWIRE and UKIDSS objects. The column labelled "tag" shows the same number for all objects associated in a counterpart set.

interface. The one for `INTERIMOPT` will be simpler, since there will be substantially less member tables.

Fig. 5 shows a panel divided in several functional areas:

– a top button row will allow to pre-load the counterpart sets for a given X-ray source `Xseq` identifier (and later select a single one for display and edit), or to add a blank entry to be manually filled, or to commit the update using the form, or to mark records for deletion. In the current scheme normal users ("*reviewers*") cannot delete or replace records, but only mark as deleted or add as new. Records will be timestamped and signed with the id of the author. A privileged reviewer will have the authority to commit deletions and edits.
– under the buttons, a couple of rows in a form will show the pointers to all member tables for a counterpart set, and the assigned rank. This allows full editing, i.e. manual re-ranking or even removing, adding or changing to pointer to a particular table.
– a further row (green-bordered) in the form shows the probabilities and additional information (in the current scheme these data are read-only and cannot be modified via this interface)
– further rows may allow to set optional flags
– the bottom row will allow to add, view or edit textual *comments* which can be attached as a special kind of data product to each X-ray source Comments will be timestamped and signed with the id of the author, and could be endorsed by the privileged reviewer.

A similar interface could be used to assign ranks to preferred counterpart sets and to reject unwanted ones.

4.2.2. The graphical interface

A second tool exists already in prototypal form. Demo access can occur through URL `http://sax.iasf-milano.inaf.it/~lucio/temp/Java/TestWeb/combo25.html`,

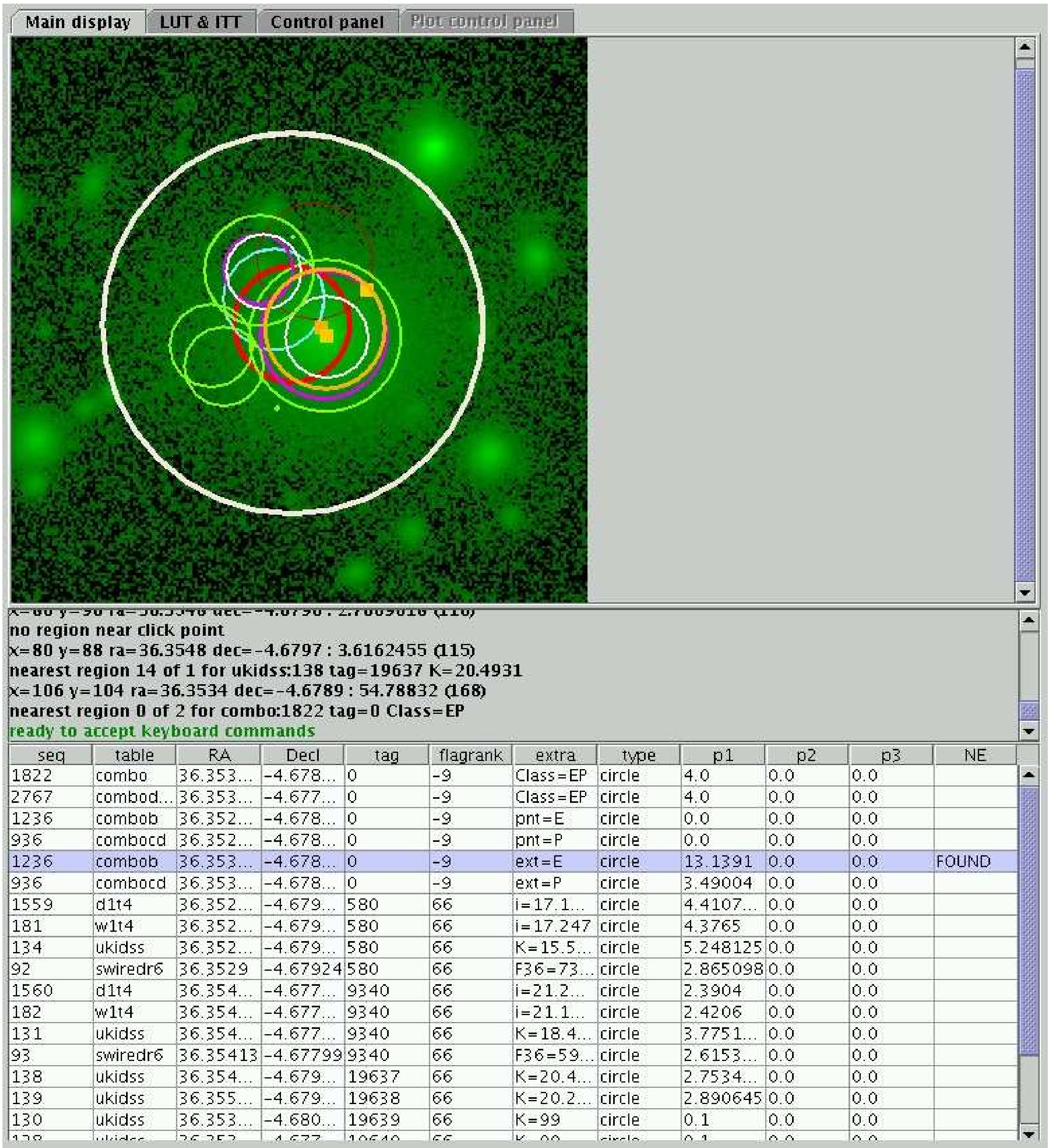

Fig. 7. Particular of the applet frame for the same source as in Fig. 6, but with the 0.5-2 keV band core radius highlighted in "primary highlight mode" (thick pink) in the display panel. Each database table corresponds to a different colour: red for X-ray merged with conventional 4″ radius; magenta for CFHTLS; white for SWIRE; green for UKIDSS; yellow for external catalogues. Radii for optical counterparts are function of magnitude/flux. The yellow squares mark SIMBAD and NED positions, while the yellow circle is an USNO A2 source.

which currently displays two horizontally adjacent frames (see Fig. 6).

The left frame is a provisional interface, which could be later be integrated in the main database interface. Presently it allows to :

– connect to the database
– select a source in a limited list (the real tool will allow to select any source INTERIMOPT or even in any table)

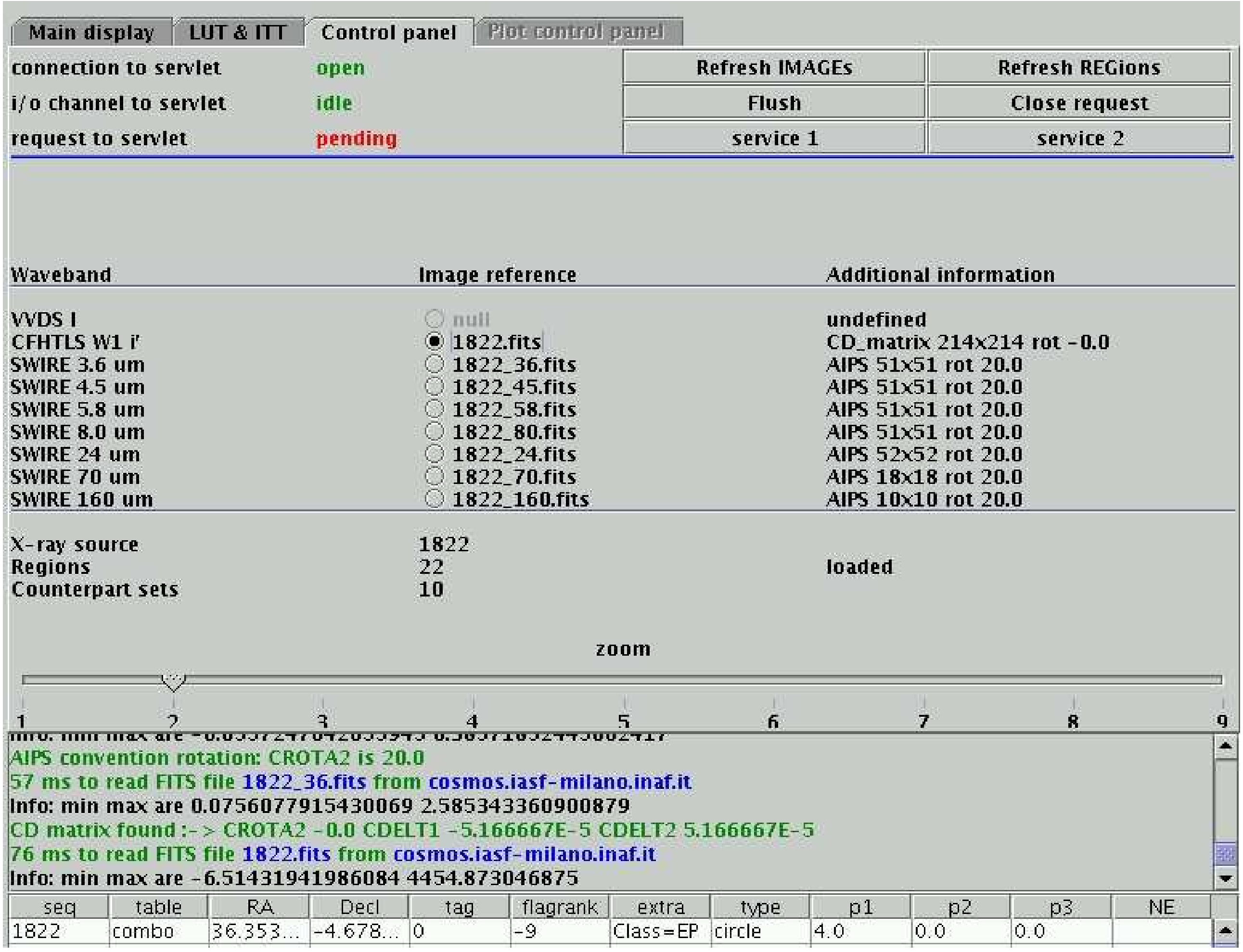

Fig. 8. Particular of the applet frame top portion with the tab in the top tabbed pane replaced by the control panel. This lists the available images with some information. It also contains buttons to load images and regions and a slider to set the image zoom. Below it the message area shows some messages. The bottom portion with the region table (shown entirely in the other figures) is truncated.

– tick whether one wants access also to some non-member tables (currently SIMBAD, NED and USNO are supported)
– issue a "go" request for the relevant data products and regions.
– finally disconnect from the database

The right frame contains an *applet*, which presently shall be manually started after database connection. The applet can display an image (and control its look and zoom), onto which regions are overlaid. The regions (corresponding to counterparts in all counterpart sets, or to objects in the external non-member tables) are also listed in a graphical table, and one can interactively highlight one or more of them selecting them with the mouse in the image or in the table.

Figures 6 and 7 show the typical arrangement of the applet with a top *tabbed pane*, a central *message area* and a bottom *region table*. The tabbed pane can contain the image display (as shown), or a *LUT&ITT panel* (not shown, used to control the colour table and scaling for the image), or a *control panel* (shown in Fig. 8).

One image can be selected from the available data products (among those described in 3.6). Regions corresponding to all possible counterparts in all counterpart sets in INTERIMOPT are displayed in the top panel, and listed in the bottom table.

It is possible to highlight a single object (clicking on it in the display panel or in the table), or all objects in a counterpart set, or all objects in a given database table (clicking on the appropriate column in the table).

This will assist in telling *which is which*, and ultimately in confirming which counterpart sets are to be preserved or rejected, in conjunction with their ranks and probabilities.

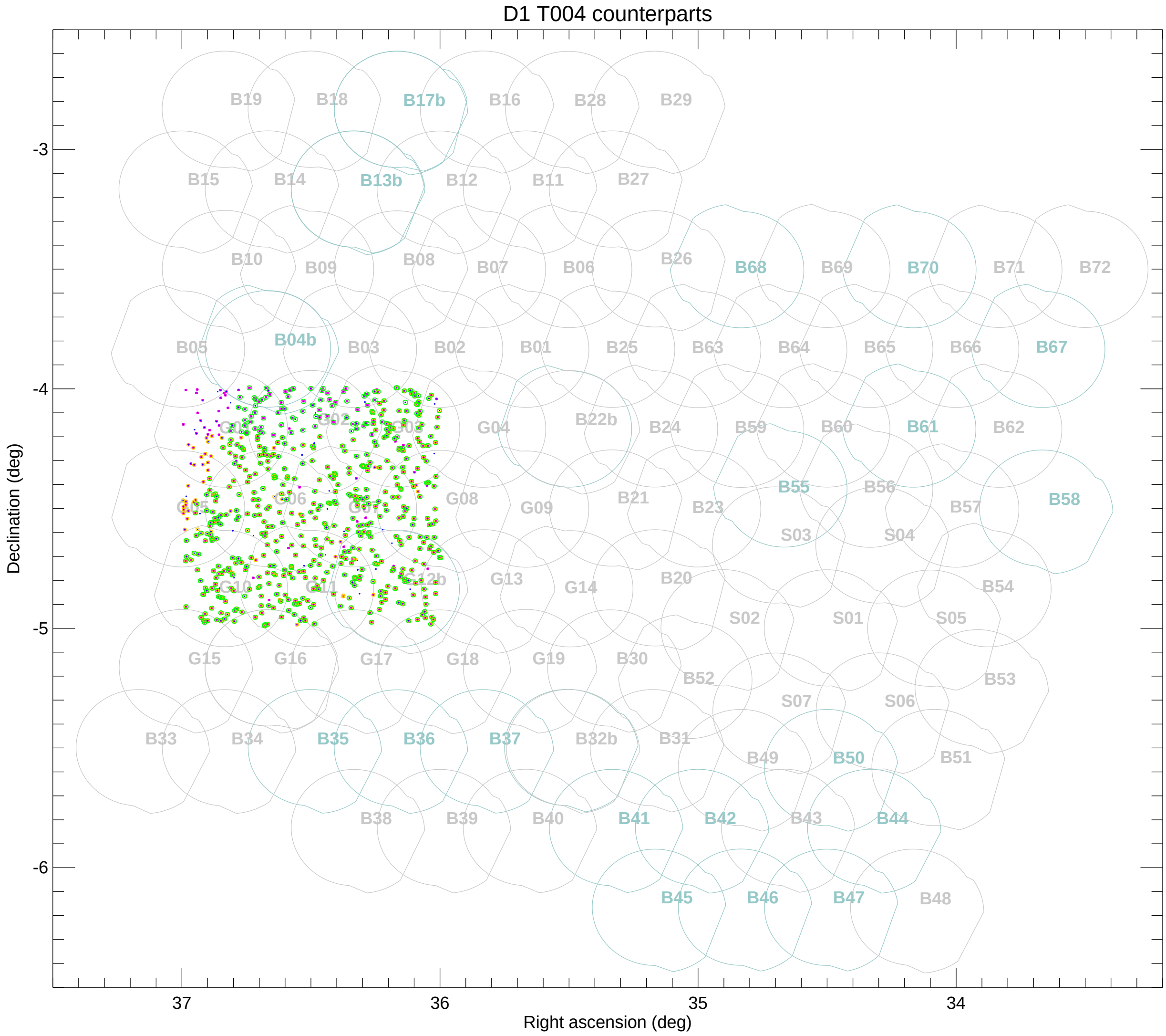

Fig. 9. Positions of the X-ray sources with a CFHTLS D1 counterpart. For symbols see 5 in text. The CFHTLS D1 covers the central part of the XMDS (G) fields. In this and in the next 3 figures the EPIC FoV footprint appears in light gray for good fields, and in azure-gray for bad fields.

5. Catalogue statistics

5.1. The X-ray catalogue

The INTERIM table contains a total of 6395 X-ray sources, of which 2194 are detected in both energy bands, 3444 only in the soft band, and 757 only in the hard band.

There are 8 extended sources classified C1, and 14 classified C2 detected in both bands (of these only 2 C1 are detected as *extended in both bands*). There are 50 extended sources classified C1, and 84 classified C2 detected only in the soft band. There are 6 extended sources nominally classified C1, and 48 classified C2 detected only in the hard band.

The number of pointlike sources is 2172 (99%) detected in both bands, 3310 (96%) in the soft band and 703 (93%) in the hard band.

Of the pointlike sources, 59% of those with a detection in both bands are detected, in the best band, with a likelihood above 75 (which, according to the calibration with the XMDS reported in Report IV, should correspond to the 4σ level), and 79% above likelihood 40 (3σ level). For 88% of the sources the best band (highest detection likelihood) is the soft band.

For the detections only in the soft band, only 13% are above 4σ, and 33% above 3σ. In the hard band the percentages are 4% above 4σ, and 12% above 3σ.

These results throw some doubt on the significance of detections in a single band.

5.2. The joint X-ray/optical catalogue

INTERIMOPT contains nominally 18594 counterpart sets.

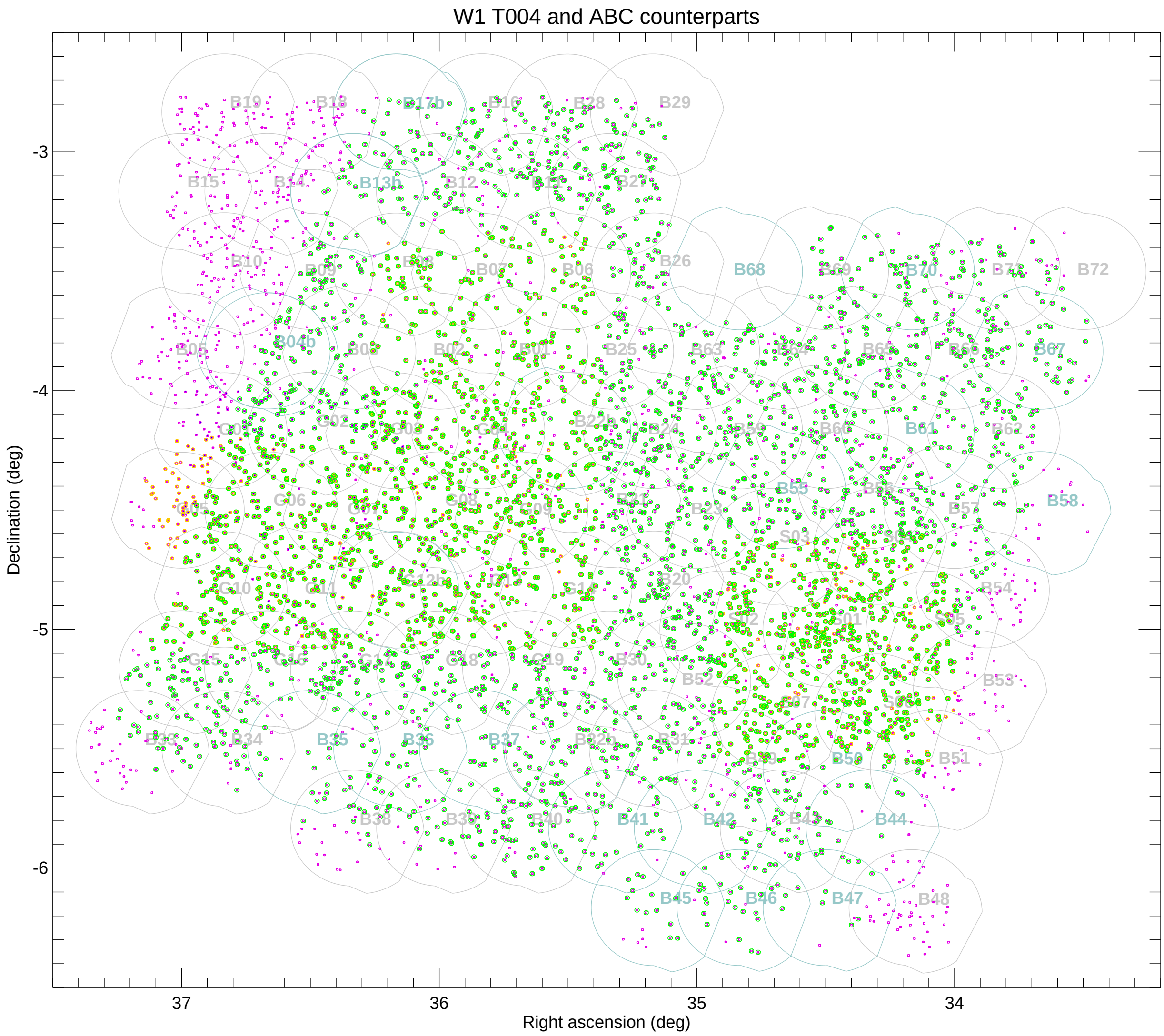

Fig. 10. Positions of the X-ray sources with a CFHTLS W1 counterpart. For symbols see 5 in text. The CFHTLS W1 extended with the northern ABC fields covers almost all of our fields.

It is very useful to evaluate whether in a given region we do not find counterparts in a given table because either they do not exist or the region has not been observed. I include 4 figures (from Fig. 9 to Fig. 12) which give the sky areas covered by the various surveys used by us overplotted on the footprint of the FoV of our fields. Each figure lists *only* the *best* (see below) sources with a counterpart in a *given* table (i.e. a non null entry in the GCT). The symbols used indicate in which other tables there is *also* a counterpart.

Such symbols are concentric circles of different colours, corresponding from the inner to the outer to :

– a small blue dot indicates a CFHTLS D1 source
– a small magenta circle a CFHTLS W1 (or ABC) source
– a larger orange circle an UKIDSS DR3plus source
– a larger green circle a SWIRE source

For each X-ray source we have taken as "*best*" counterpart the one with the smallest chance probability in *any* catalogue.

349 X-ray sources correspond to *blank fields* i.e. have no CFHTLS, SWIRE or UKIDSS counterpart within 6″.

1225 X-ray sources have a *single counterpart*, while the rest has potentially more counterparts.

I have attempted a rough characterization using the criteria defined in 4.1. The results are summarized in Table 6 which has to be interpreted as follows:

Looking at the row "best and single", 122 (10%) of the single counterparts are detected in all 3 catalogues (CFHTLS, SWIRE and UKIDSS) with a good probability in all three. 305 (25%) are detected in 2 of the 3 catalogues (and not detected in the other), and with a good probability in all the catalogues where they are detected. 176 (14%) are detected in only one catalogue with a good probability. 22 (less than 2%) are detected in two or three

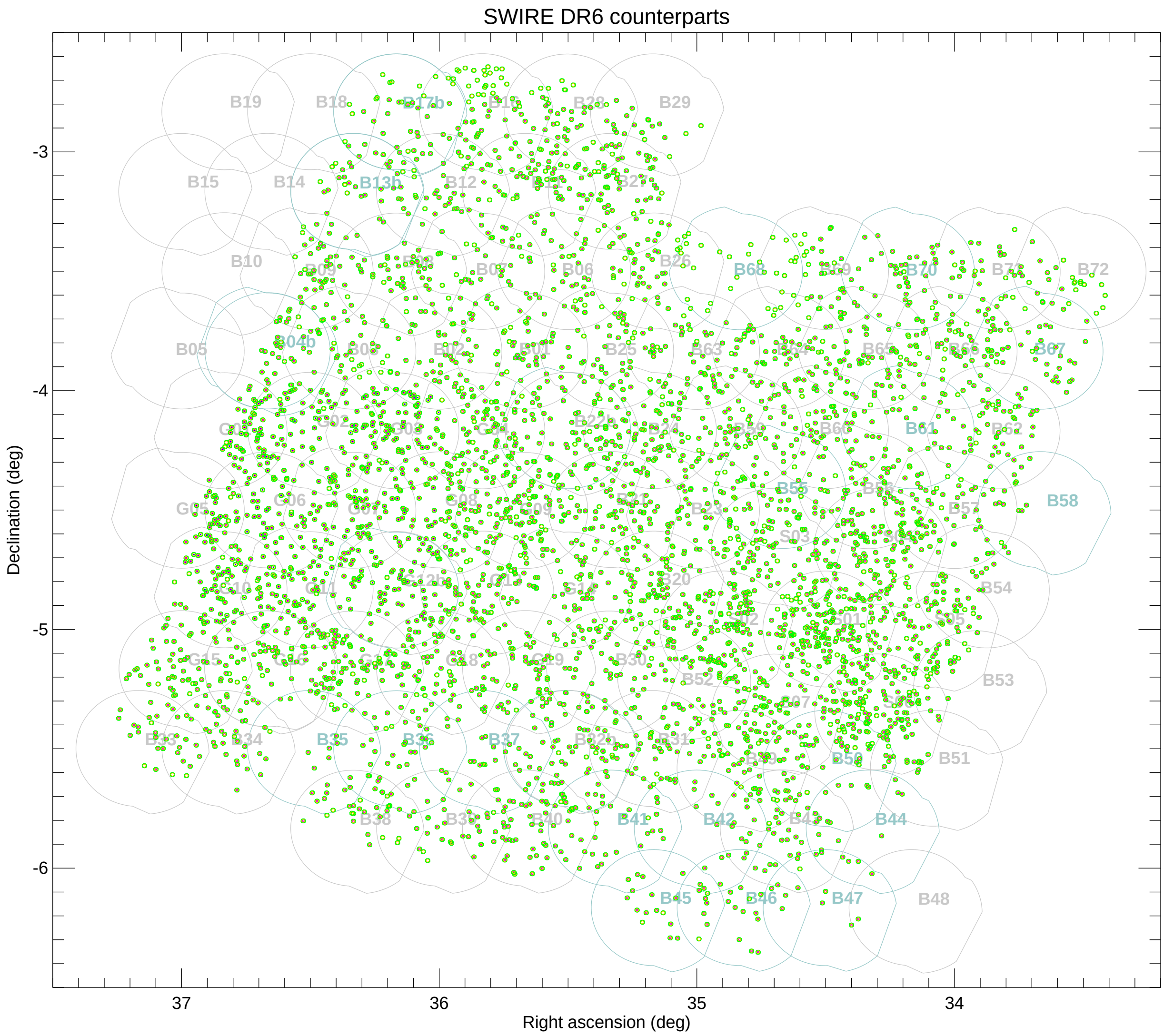

Fig. 11. Positions of the X-ray sources with a SWIRE counterpart. For symbols see 5 in text. SWIRE covers almost all the fields, except the E and W edges.

Probability class		good $p < 0.01$				fair $0.01 < p < 0.03$				bad $p > 0.03$
in how many catalogues ?	n/a	all 3	2	1	some	all 3	2	1	some	all
Counterpart set										
Blank field	349									
Best and single		122	305	176	22	21	79	61	76	363
Best		685	885	416	197	353	445	231	581	1028
Secondary		31	51	211	33	72	127	350	321	11003

Table 6. Basic statistics ot the INTERIMOPT catalogue

catalogues, and in one of them with a good probability (the other can be fair or bad). Similarly for the cases having all or at least fair probability (21, 79, 61 and 76). Finally 363, despite being the only possible counterpart, are detected in a number of catalogues from 1 to 3, but always with a bad probability.

Similarly 685 of the best *non-single* counterparts are detected in all 3 catalogues with a good probability in all three, etc. etc. up to 1028 cases which, despite being the best counterpart, are detected always with a bad probability.

Considering the secondary counterparts, 11003 (more than 90%) are always bad and could surely be rejected. There are however e.g. 31 cases where the secondary counterpart has a good probability in all three catalogues (although however worse than the best counterpart), which

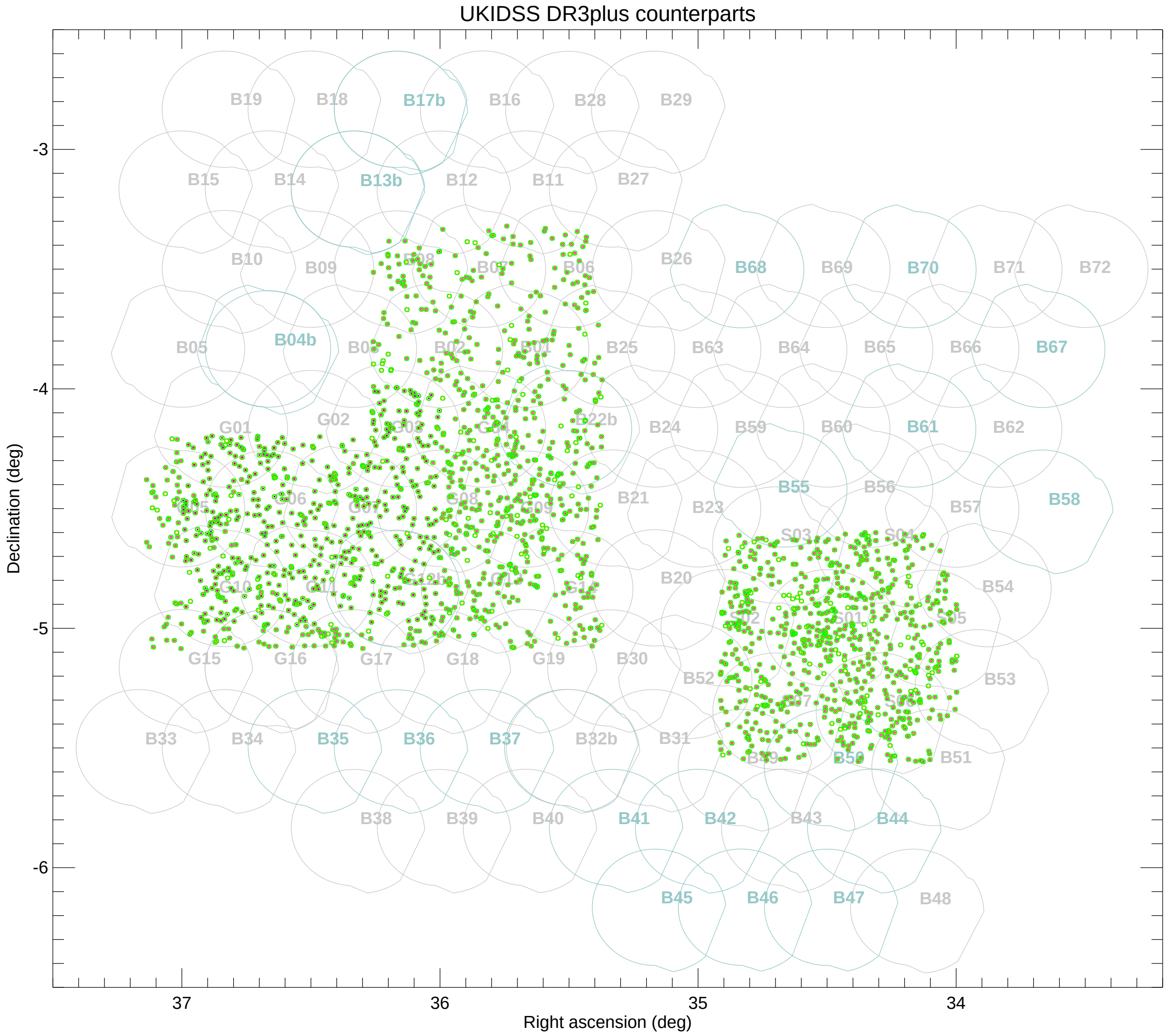

Fig. 12. Positions of the X-ray sources with a UKIDSS counterpart. For symbols see 5 in text. UKIDSS DR3plus covers so far two disjoinct areas (DXS and UDS), one of which covers the SXDS fields.

probably indicates intrinsically ambiguous cases. Similarly for at least those of the remaining 10% which have at least one good probability (the 2.7%).

Summarizing, 43.9% of the sources have a best counterpart with a good probability, 28.9% a fair one, and 5.5% are blank fields.

One can also view things in a different way, and evaluate how many of the good, fair or bad best counterparts are detected below a given significance (using the Report IV calibration between likelihood and number of σ).

46% of the best good counterparts are detected above 4σ; 19% of the fair ones; 6% of the bad ones and 21% of the blank fields. Or conversely, of the 1819 X-ray sources above 4σ, 71% have a good counterpart, 20% a fair one, 5% a bad one and 4% are unidentified.

Similarly at 3σ 65% of the best good counterparts are detected above such level; 44% of the fair ones; 18% of the bad ones and 33% of the blank fields. Or conversely, of the 3015 X-ray sources above 3σ, 61% have a good counterpart, 27% a fair one, 8% a bad one and 4% are unidentified.

Fig.4 gives the distribution of the probabilities in their three ranges. This figure shall be compared with Fig.2 of Report IV, bearing however in mind that Report IV uses *capped probabilities* (which are worse i.e. higher for objects closer than the capping distance of $2''$, which result in the histograms shown here to be less peaked and with a tail at low probabilities). While the two figures are similar, one can note that, in particular for the CFHTLS catalogue, there seems to be a worse tuning with INTERIM then with the XMDS catalogue. The match is better for the 3σ and 4σ samples, strengthening the idea that INTERIM extends to lower significances than the XMDS catalogue.

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