Firebird and IBExpert White Paper

DBEncryption Plugin for Firebird 3.0 and 4.0

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IBExpert has developed an encryption plugin for Firebird 3.0 and Firebird 4.0. The Firebird 3.0 plugin is currently available for Windows (32/64 bit) and Linux (32/64 bit).

The Firebird 4.0 plugin is currently available for Windows (32/64 bit), Linux is Work in Progress. Introduced in version 2019.04.14, the IBExpert Developer Studio includes the 32-bit embedded version, free to use in embedded mode. Server versions (32 bit and x64) require the IBExpert Server Tools.

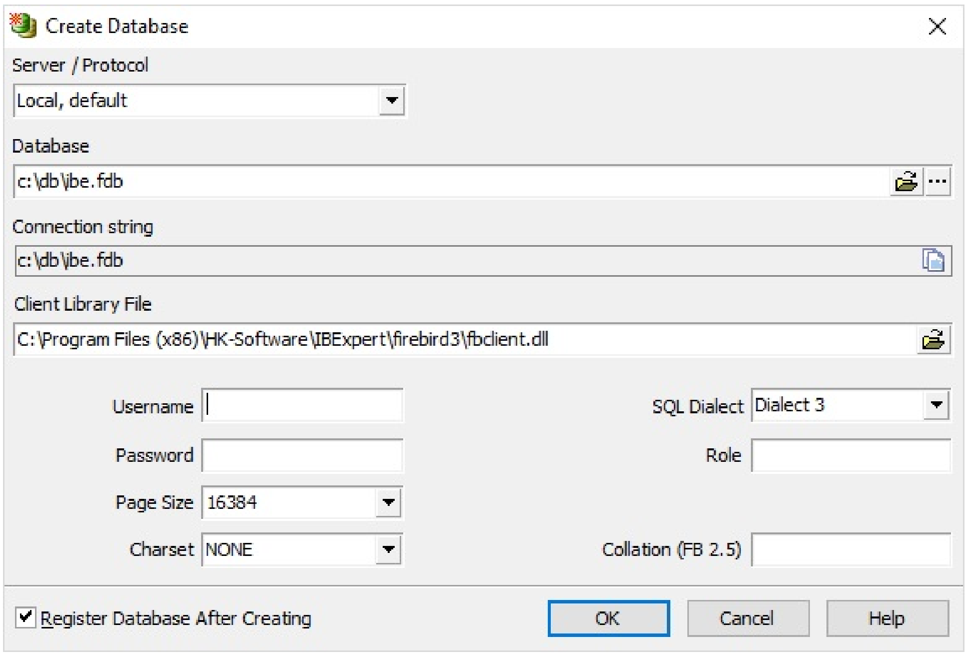
Important: each program, which needs to access an encrypted server, has to recognize and know the encryption, regardless of whether an embedded or server version.

Installation

1. Install the latest IBExpert customer version, it includes all files and configs you need. The first run of IBExpert should be done using Admin rights, so that it can generate the correct license key for using *dbcrypt* plugin.

Encrypt database

2. Create a database using *Local*, default as *Server / protocol* to use the included embedded version.


Create Database

Server / Protocol: Local, default

Database: c:\db\ibe.fdb

Connection string: c:\db\ibe.fdb

Client Library File: C:\Program Files (x86)\HK-Software\IBExpert\firebird3\fbclient.dll

Username		SQL Dialect	Dialect 3
Password		Role	
Page Size	16384		
Charset	NONE	Collation (FB 2.5)	

[✓] Register Database After Creating

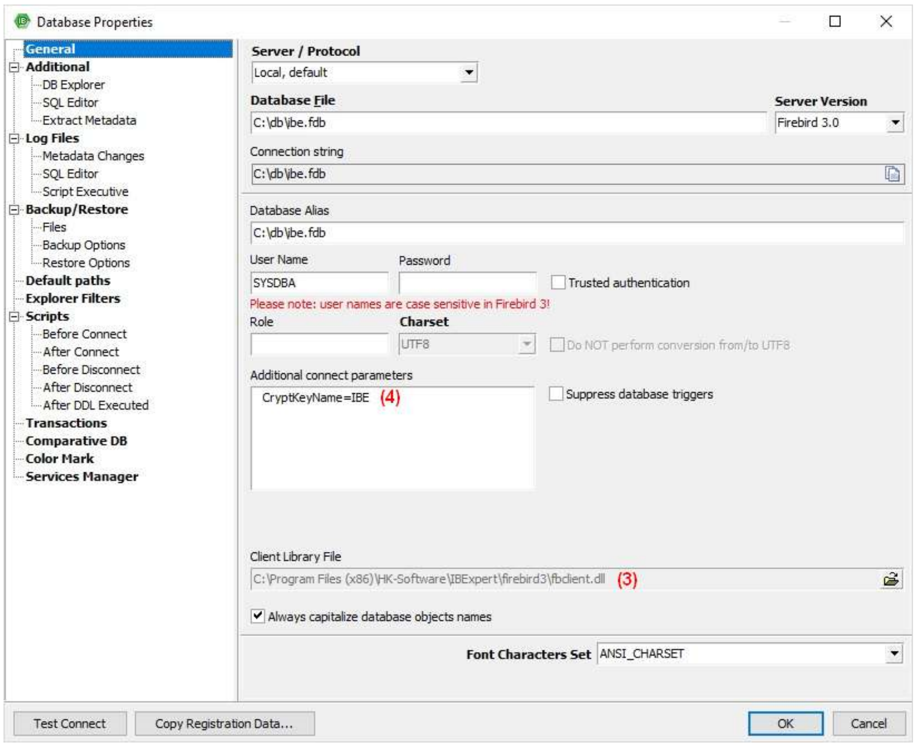
3. If you want to use it with Firebird 3.0:

Specify C:\Program Files (x86)\HK-Software\IBExpert\firebird3\fbclient.dll as the client library in the *IBExpert Database Registration*.

If you want to use it with Firebird 4.0:

Specify C:\Program Files (x86)\HK-Software\IBExpert\firebird4\fbclient.dll as the client library in the *IBExpert Database Registration*.

4. In the Database Registration's *Additional* connect parameters add this key: CryptKeyName=IBE



Server / Protocol: Local, default

Database File: C:\db\ibe.fdb

Server Version: Firebird 3.0

Connection string: C:\db\ibe.fdb

Database Alias: C:\db\ibe.fdb

User Name: SYSDBA

Password:

☐ Trusted authentication

Please note: user names are case sensitive in Firebird 3!

Role:

Charset: UTF8

☐ Do NOT perform conversion from/to UTF8

Additional connect parameters: CryptKeyName=IBE (4)

☐ Suppress database triggers

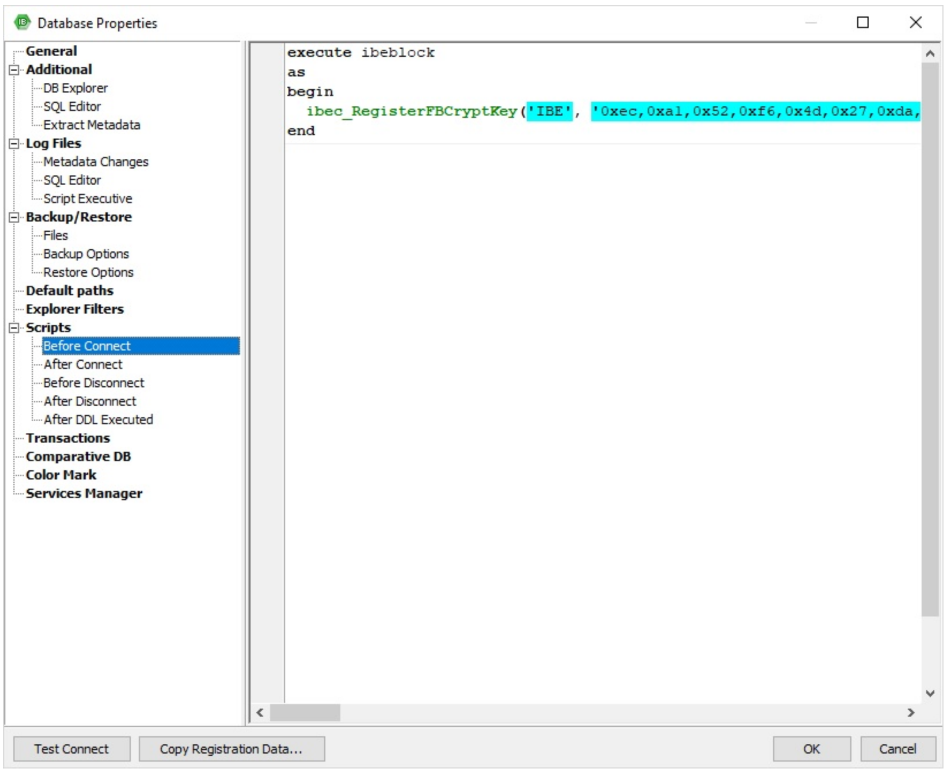
Client Library File: C:\Program Files (x86)\HK-Software\IBExpert\firebird3\fbclient.dll (3)

☑ Always capitalize database objects names

Font Characters Set: ANSI_CHARSET

5. Still in the IBExpert Database Registration under *Scripts / Before Connect* add the following:

```
  execute ibeblock
  as
  begin
    ibec_RegisterFBCryptKey('IBE',

'0xec,0xa1,0x52,0xf6,0x4d,0x27,0xda,0x93,0x53,0xe5,0x48,0x86,0xb9,0x7d,0x
e2,0x8f,
0x3b,0xfa,0xb7,0x91,0x22,0x5b,0x59,0x15,0x82,0x35,0xf5,0x30,0x1f,0x04,0xd
c,0x75,', '');
   end
```



```
execute ibeblock
as
begin
  ibec_RegisterFBCryptKey('IBE', '0xec,0xa1,0x52,0xf6,0x4d,0x27,0xda,
end
```

6. Connect to the database and encrypt it with:

```
    ALTER DATABASE ENCRYPT WITH "DbCrypt" KEY IBE
```

7. Now remove `CryptKeyName=IBE` from the Database Registration.

And you are done.

Create encryption key

You can use the supplied *aesKeyGen.exe* to create the correct keys for database encryption.

Also take into account this:

KeyHolder.conf - when placed into server's plugins directory, this file works as a 'developer mode' switch enabling use of any client utility to work with encrypted databases. It must contain all known keys in the form "Key=Value", where the value's format is a sequence of bytes in C-compiler readable form. The current sample has the same keys as the sample application.

aesKeyGen.exe – a trivial utility performing a call to a random numbers generator and printing the result in a format compatible with **KeyHolder.conf**

rsaKeyGen.exe - this utility is needed if you want to build set of plugin components with unique pairs of RSA keys used to pass AES keys from the client to the **dbcrypt** plugin. Run:

```
rsaKeyGen >keysA2H.h rsaKeyGen >keysH2P.h
```

and copy the resulting files into the **crypt/db/lib** directory. This ensures that nobody except yourself has legal access to private keys in those pairs.

sample.exe is an example of **fbcrypt** API use.

Check database encryption

There are two different ways to check if the database is successfully encrypted. You can invoke *isql*:

```
isql -user SYSDBA -password masterkey
Use CONNECT or CREATE DATABASE to specify a database
SQL> connect C:\db\ibe.fdb;
Statement failed, SQLSTATE = HY000
Key not set
SQL>
```

Also, you can use *gstat* to check:

```
  gstat -e c:\db\ibe.fdb

  Database "C:\DB\IBE.FDB"
  Gstat execution time Wed Jan 26 14:54:09 2022

Database header page information:
        Flags                       0
        Generation                  12605
        System Change Number        0
        Page size                   16384
        ODS version                 12.0
        Oldest transaction          7477
        Oldest active               7937
        Oldest snapshot             7937
        Next transaction            7937
        Sequence number             0
        Next attachment ID          10980
        Implementation                HW=Intel/i386  little-endian  OS=Windows
CC=MSVC
```

```
        Shadow count            0
        Page buffers            0
        Next header page        0
        Database dialect        3
        Creation date           Mar 27, 2018 11:25:07
        Attributes              force write, encrypted, plugin DbCrypt

    Variable header data:
        Crypt checksum: sHv0fE/Tfw9DKwDLyYIQ0qQ/hkk=
        Key hash:       ask88tfWbinvC6b1JvS9Mfuh47c=
        Encryption key name:    IBE
        *END*
Gstat completion time Wed Jan 26 14:54:09 2022
```

However, *gstat* output is a bit different in firebird 4:

```
Database header page information:
        Flags                   0
        Generation              375
        System Change Number    0
        Page size               16384
        ODS version             13.0
        Oldest transaction      42
        Oldest active           336
        Oldest snapshot         336
        Next transaction        336
        Sequence number         0
        Next attachment ID      102
        Implementation          HW=Intel/i386 little-endian OS=Windows
CC=MSVC
        Shadow count            0
        Page buffers            0
        Next header page        0
        Database dialect        3
        Creation date           Jan 25, 2022 10:14:24
        Attributes              force write, encrypted, plugin DbCrypt

    Variable header data:
        Crypt checksum: sHv0fE/Tfw9DKwDLyYIQ0qQ/hkk=
        Key hash:       ask88tfWbinvC6b1JvS9Mfuh47c=
        Encryption key name:    IBE
        Database GUID:  {117F0C3B-D795-46E7-B899-C47D4BDAA87A}
        Sweep interval:         20000
        *END*
```

```
Data pages: total 109, encrypted 109, non-crypted 0
Index pages: total 66, encrypted 66, non-crypted 0
Blob pages: total 0, encrypted 0, non-crypted 0
Generator pages: total 1, encrypted 1, non-crypted 0
Gstat completion time Wed Jan 26 14:51:31 2022
```

FPC and Lazarus example

To use the encryption plugin developed by IBExpert, you need to use the *cdecl* calling convention, as the following code shows:

```
  Tfbcrypt_key = function (AName : PChar; AData : PChar; ALength : DWORD)
: integer; cdecl;
  Tfbcrypt_callback = function (Provider : Pointer) : integer; cdecl;
```

To make the connection to the encrypted database, you need to use the following code:

```
  function PassCryptKey(const FBCryptPath, AKeyName, AKeyData : string) :
integer;
  var
    hFBCryptLib : THandle;
    fFBCryptKey : Tfbcrypt_key;
    fFBCryptCallback : Tfbcrypt_callback;
  begin
    Result := 0;
    hFBCryptLib       :=       LoadLibraryEx(PChar(FBCryptPath),       0,
LOAD_WITH_ALTERED_SEARCH_PATH);
    if (hFBCryptLib > HINSTANCE_ERROR) then
    begin
      Pointer(fFBCryptKey) := GetProcAddress(hFBCryptLib, 'fbcrypt_key');
      Pointer(fFBCryptCallback)      :=      GetProcAddress(hFBCryptLib,
'fbcrypt_callback');
      if (@fFBCryptKey <> nil) and (@fFBCryptCallback <> nil) then
      begin
        Result    :=    fFBCryptKey(PChar(AKeyName),    PChar(AKeyData),
Length(AKeyData));
        if Result = 0 then
          Result := fFBCryptCallback(nil);
      end
      else
        Result := -2; // fbcrypt_key or fbcrypt_callback function not found
    end
    else
```

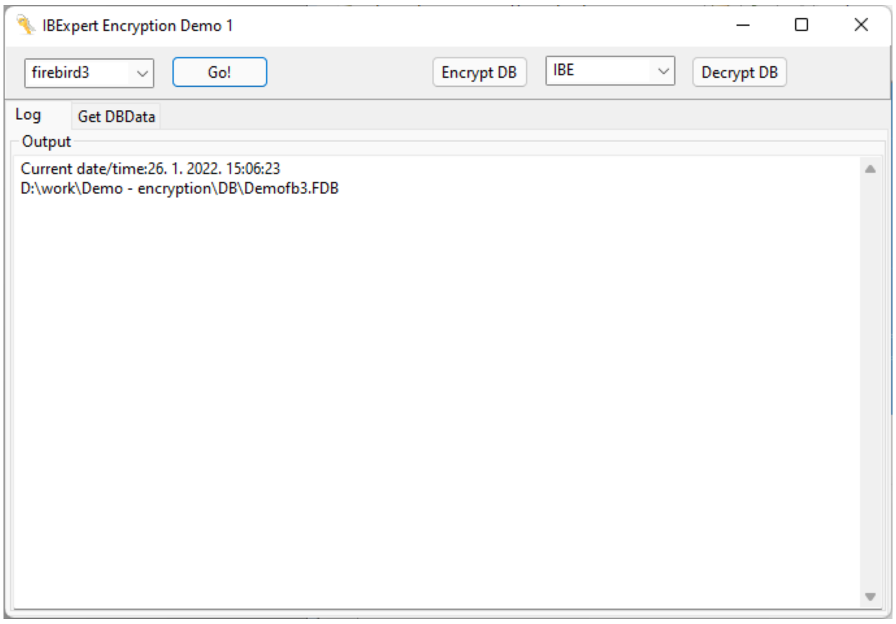
```
      Result := -1;  // Cannot find/load fbcrypt.dll
  end;
```

Also, you should declare a private procedure to load the firebird client library and to pass the encryption key. For example:

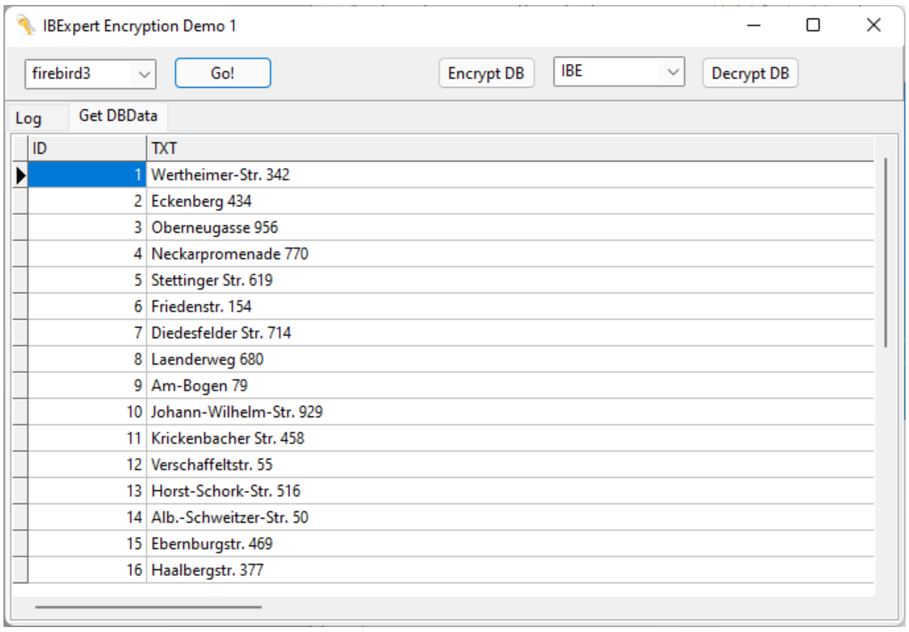
```
  procedure LoadLibrary(Filename: String);
  var
     KeyData : ansistring;
  begin
    with LibLoader do
    begin
      ConnectionType:='Firebird';
      LibraryName:=Filename;
      Enabled:=True;
    end;

    KeyData :=

chr($ec)+chr($a1)+chr($52)+chr($f6)+chr($4d)+chr($27)+chr($da)+chr($93)+c
hr($53)+chr($e5)+chr($48)+chr($86)+chr($b9)

+chr($7d)+chr($e2)+chr($8f)+chr($3b)+chr($fa)+chr($b7)+chr($91)+chr($22)+
chr($5b)+chr($59)+chr($15)+chr($82)+chr($35)
  +chr($f5)+chr($30)+chr($1f)+chr($04)+chr($dc)+chr($75);
    PassCryptKey(ExtractFilePath(Filename)+'fbcrypt.dll','IBE',KeyData);

  end;
```

We have provided a sample encryption key name and key data value in the previous code.

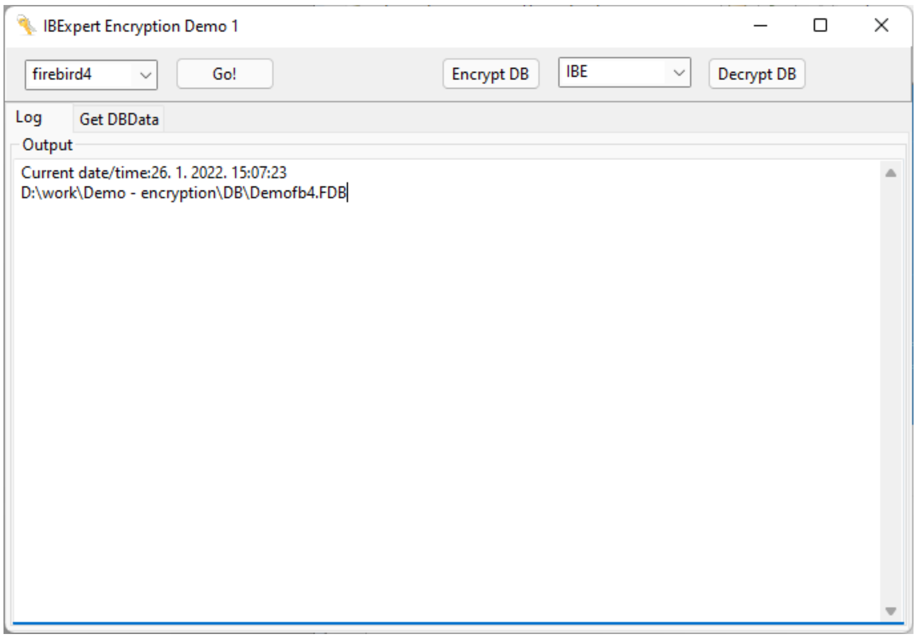
You can see screenshots of firebird 3 and firebird 4 database usage written using Lazarus 2.2.0.



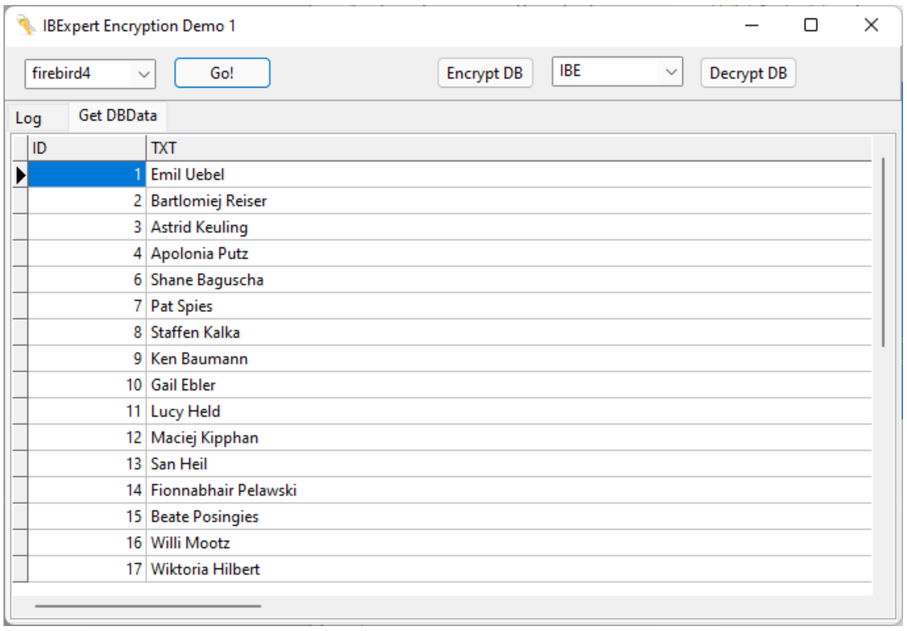
```
Current date/time:26. 1. 2022. 15:06:23
D:\work\Demo - encryption\DB\Demofb3.FDB
```



ID	TXT
1	Wertheimer-Str. 342
2	Eckenberg 434
3	Oberneugasse 956
4	Neckarpromenade 770
5	Stettinger Str. 619
6	Friedenstr. 154
7	Diedesfelder Str. 714
8	Laenderweg 680
9	Am-Bogen 79
10	Johann-Wilhelm-Str. 929
11	Krickenbacher Str. 458
12	Verschaffeltstr. 55
13	Horst-Schork-Str. 516
14	Alb.-Schweitzer-Str. 50
15	Ebernburgstr. 469
16	Haalbergstr. 377



```
Current date/time:26. 1. 2022. 15:07:23
D:\work\Demo - encryption\DB\Demofb4.FDB
```



ID	TXT
1	Emil Uebel
2	Bartlomiej Reiser
3	Astrid Keuling
4	Apolonia Putz
6	Shane Baguscha
7	Pat Spies
8	Staffen Kalka
9	Ken Baumann
10	Gail Ebler
11	Lucy Held
12	Maciej Kipphan
13	San Heil
14	Fionnabhair Pelawski
15	Beate Posingies
16	Willi Mootz
17	Wiktoria Hilbert