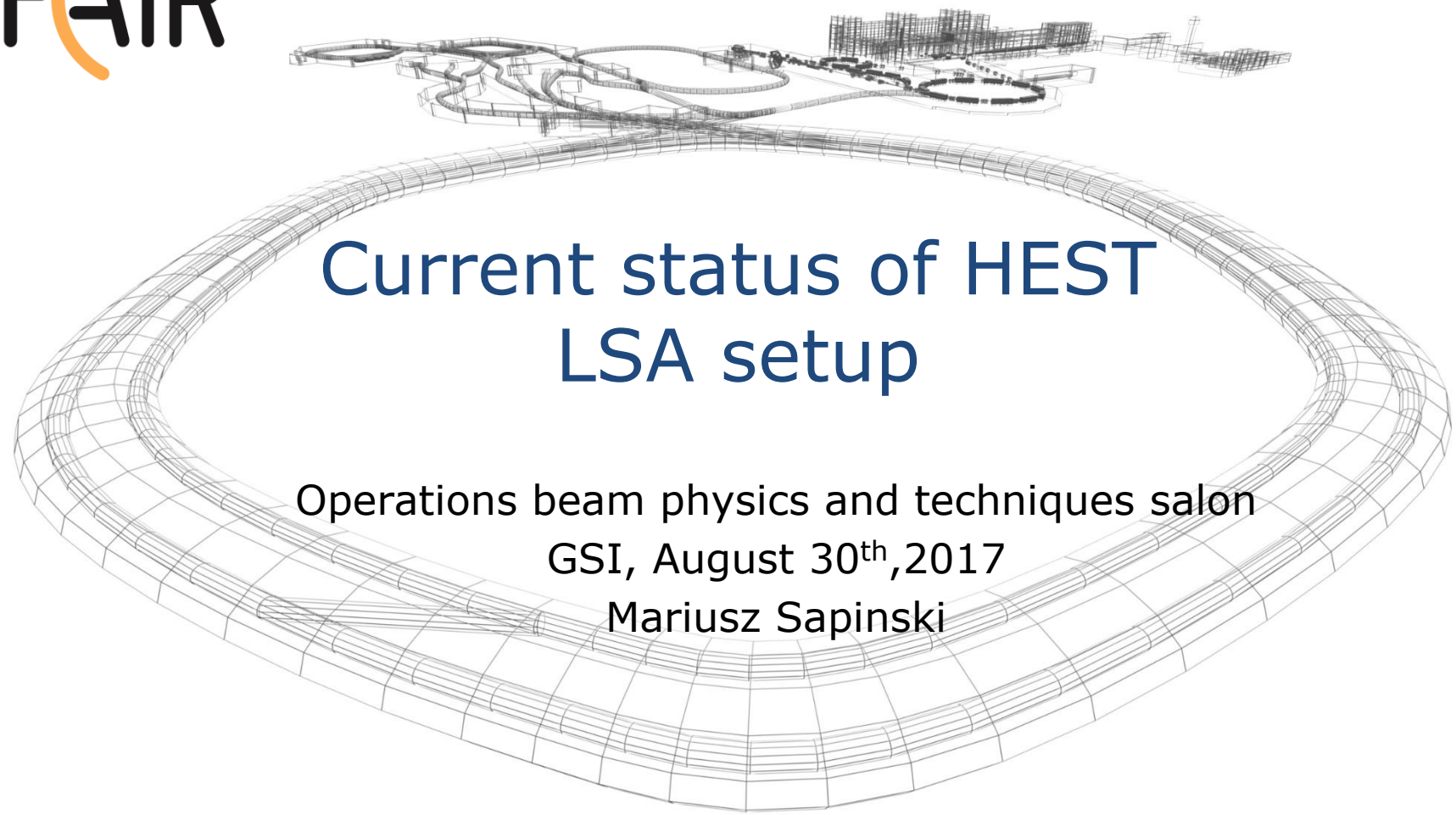


Current status of HEST LSA setup

Operations beam physics and techniques salon

GSI, August 30th,2017

Mariusz Sapinski

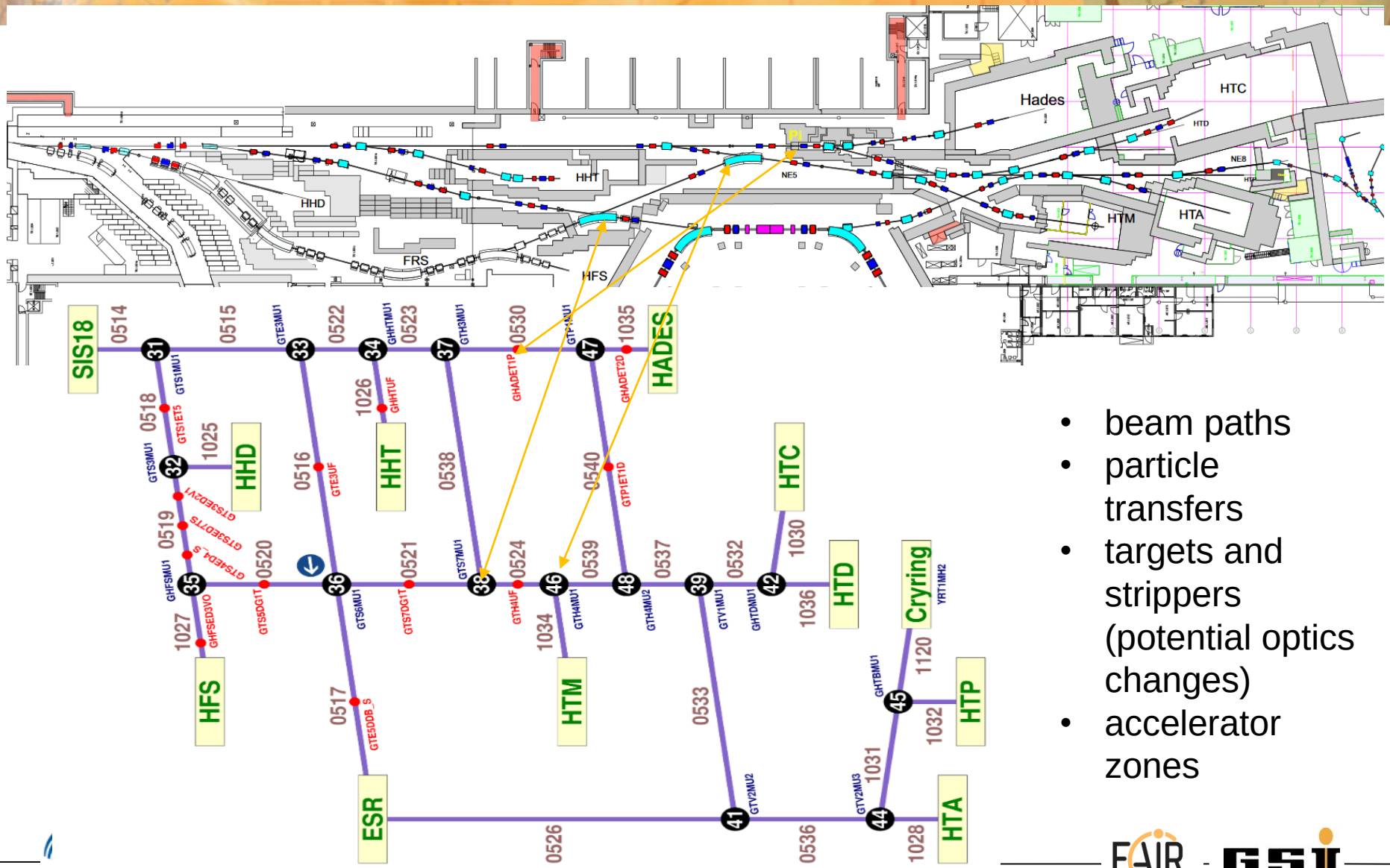
Outlook

- Introduction to HEST
- Beam paths
- MIRKO files
- LSA import requirements
- MIRKO and MAD-X
- Documentation
- Sonstige

Key people:

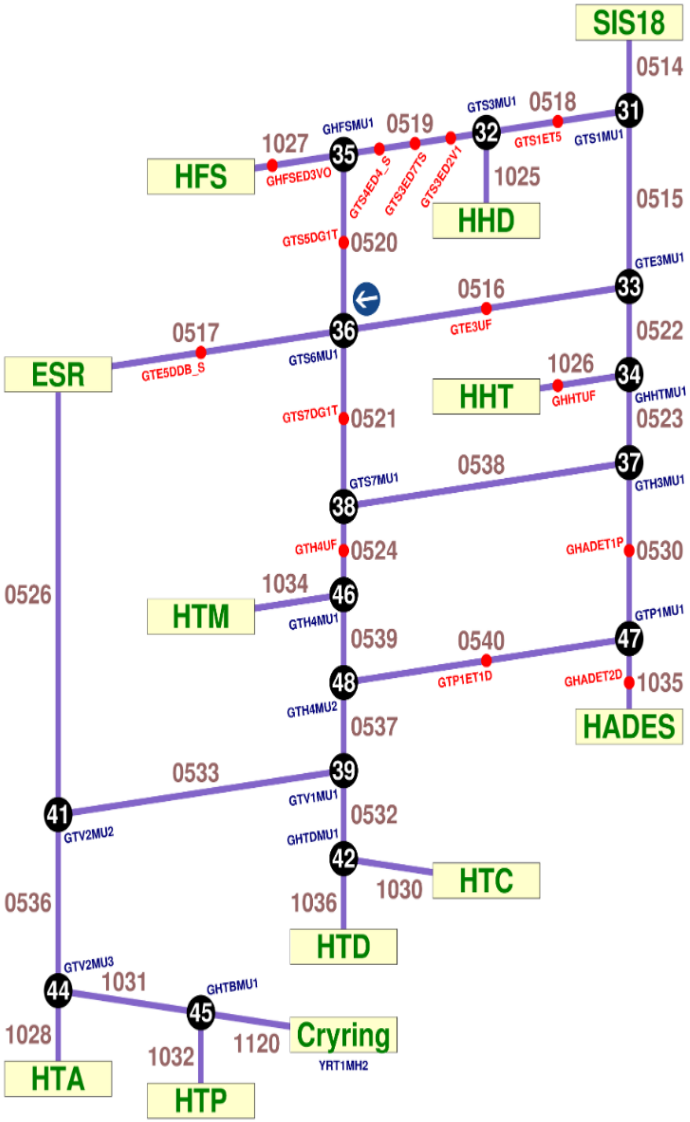
1. Sebastian Ratschow – optics expert for beamlines
2. Bernd Schlei – LSA implementation and import
3. Vera, Stefan Sorge, Sabrina
4. Stephan – author of MIRKO export, trace of his name is in all MIRKO files
5. Benno Franczak – MIRKO author

HEST overview



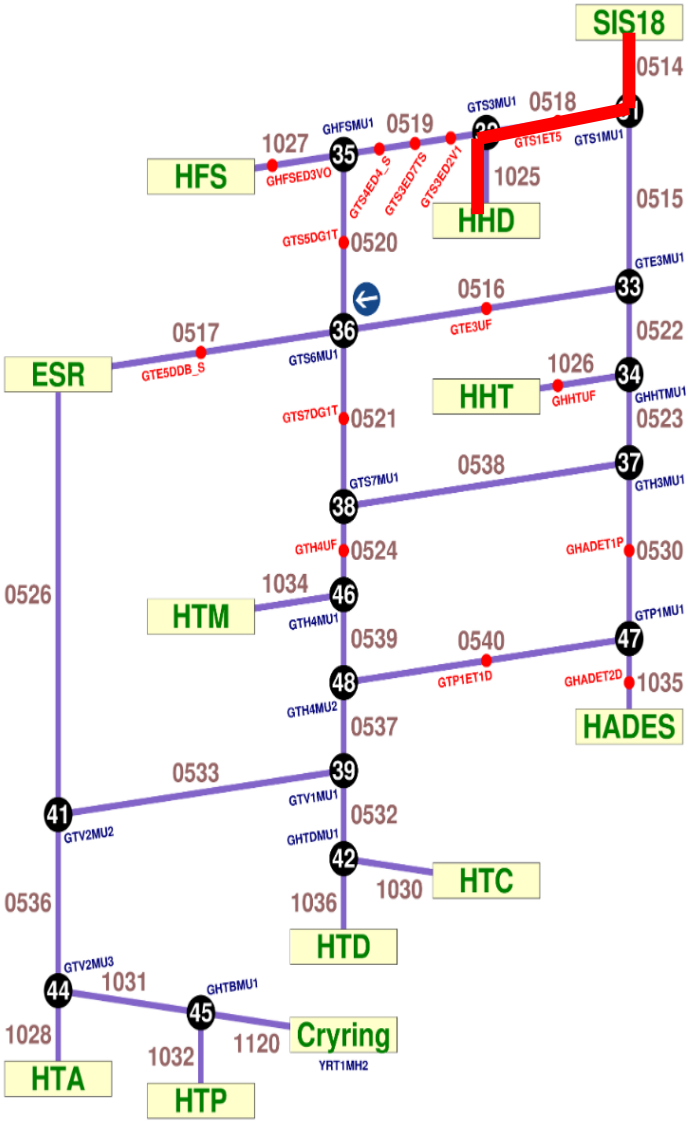
- beam paths
- particle transfers
- targets and strippers (potential optics changes)
- accelerator zones

HEST – beam paths



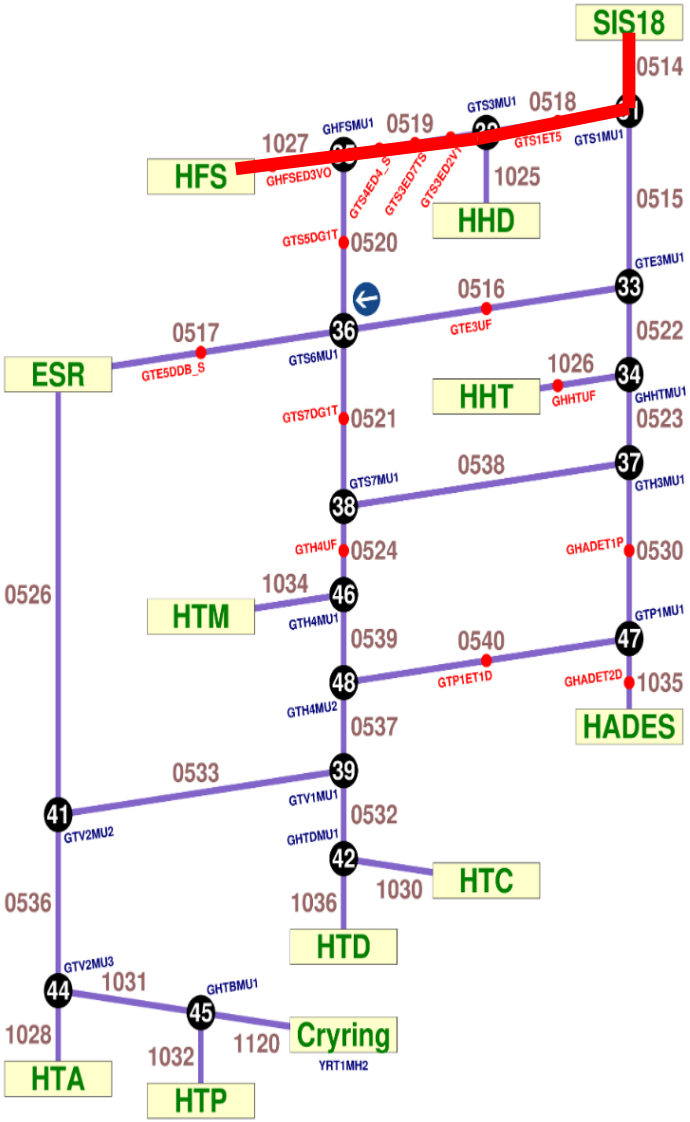
Beam paths as currently defined by Bernd – mostly correct, some are missing, some have never been used (so not needed).

HEST – beam paths



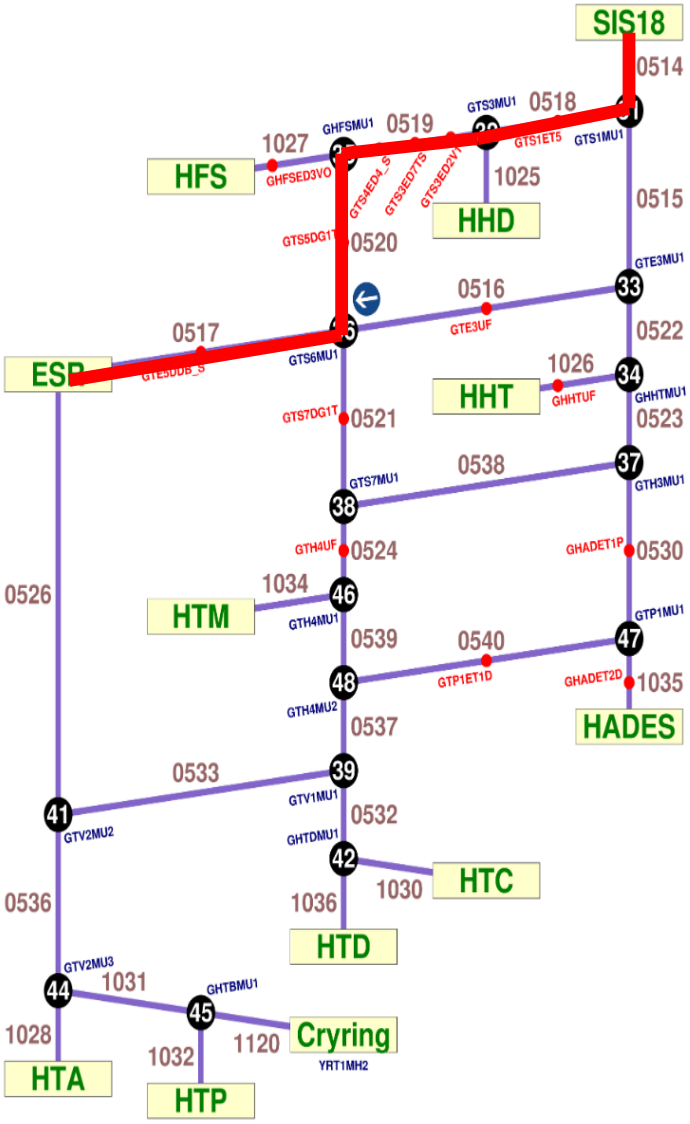
1. SIS18_HHD

HEST – beam paths



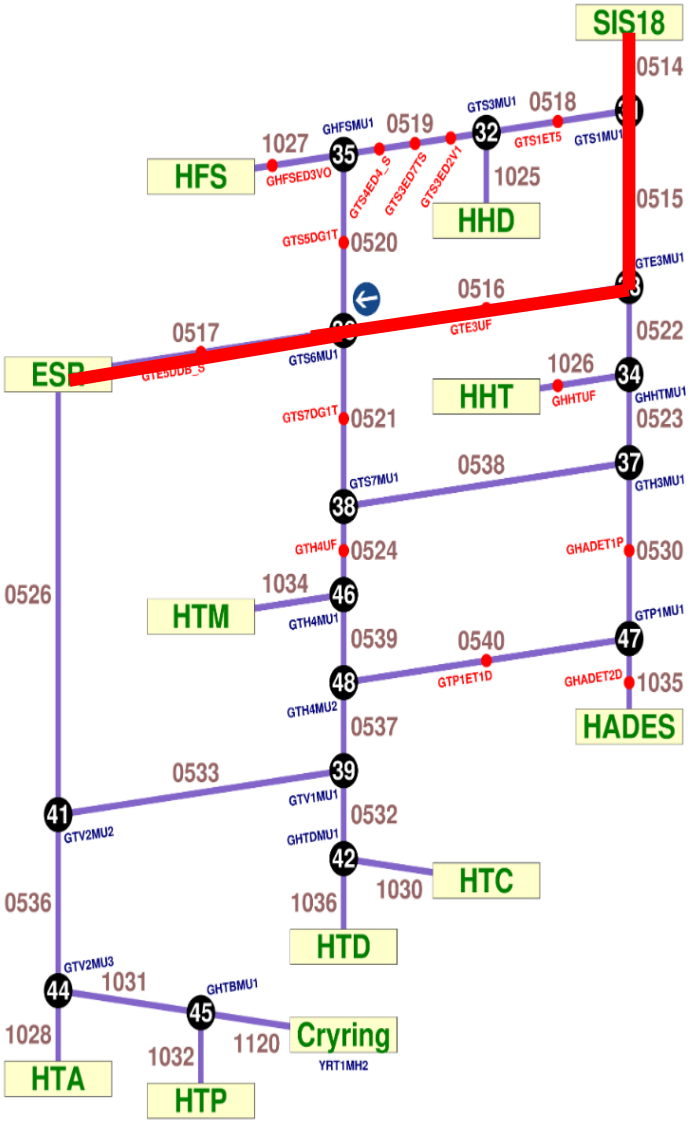
1. SIS18_HHD
2. SIS18_HFS

HEST – beam paths



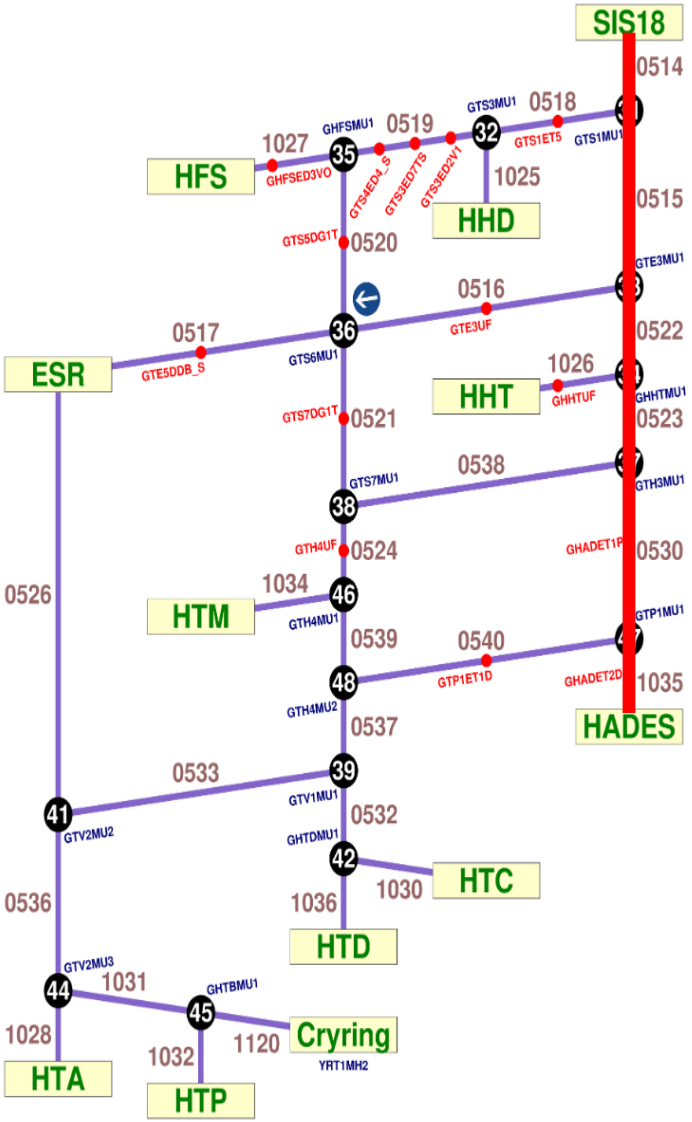
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR

HEST – beam paths



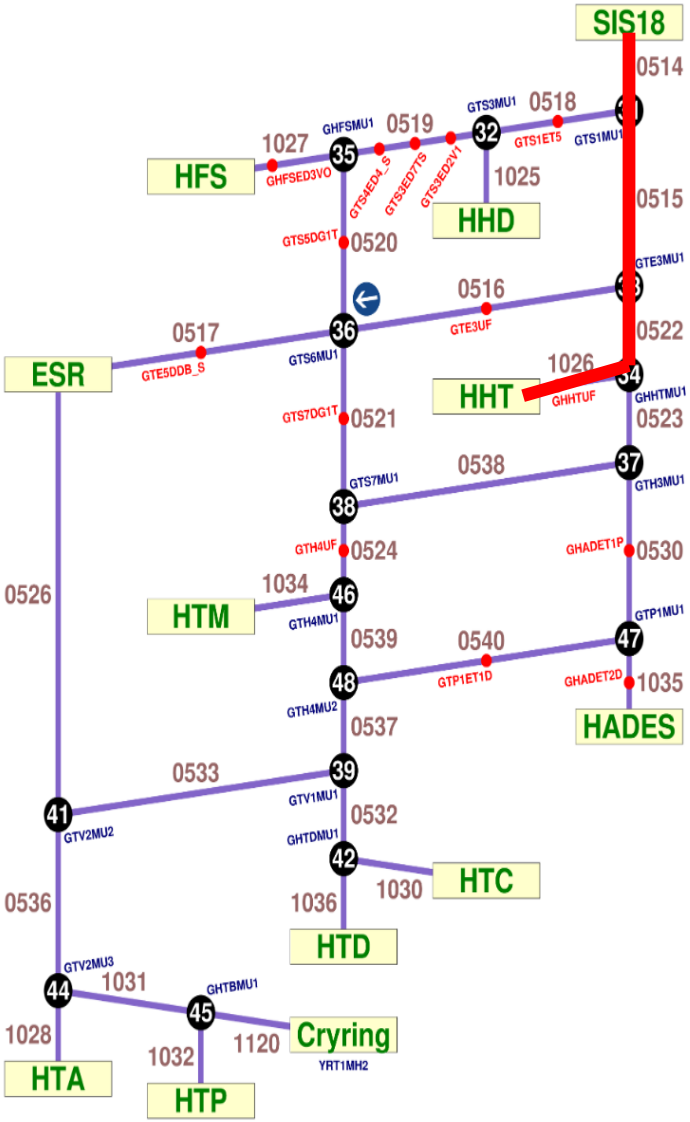
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR

HEST – beam paths



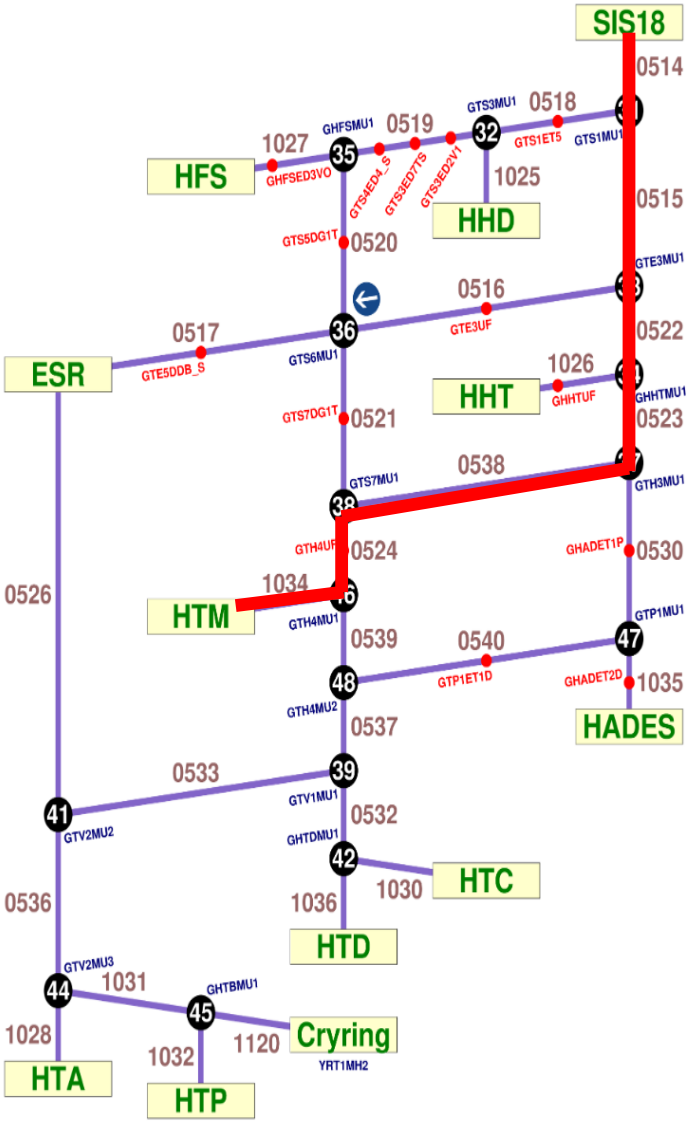
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES

HEST – beam paths



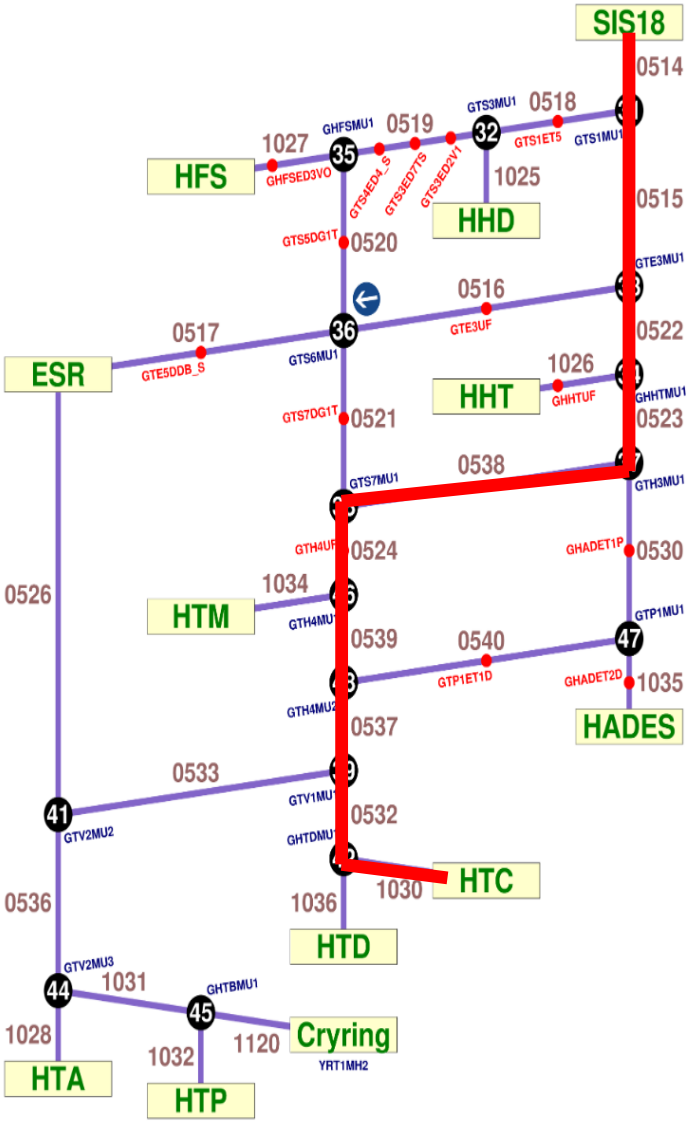
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT

HEST – beam paths



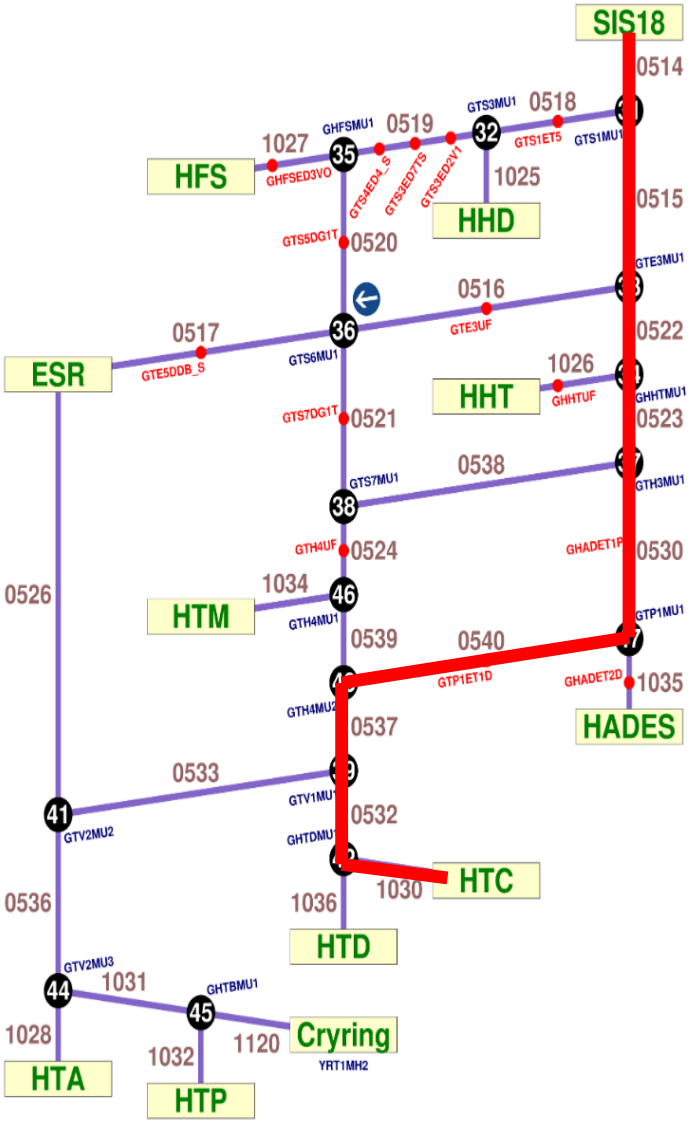
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM

HEST – beam paths



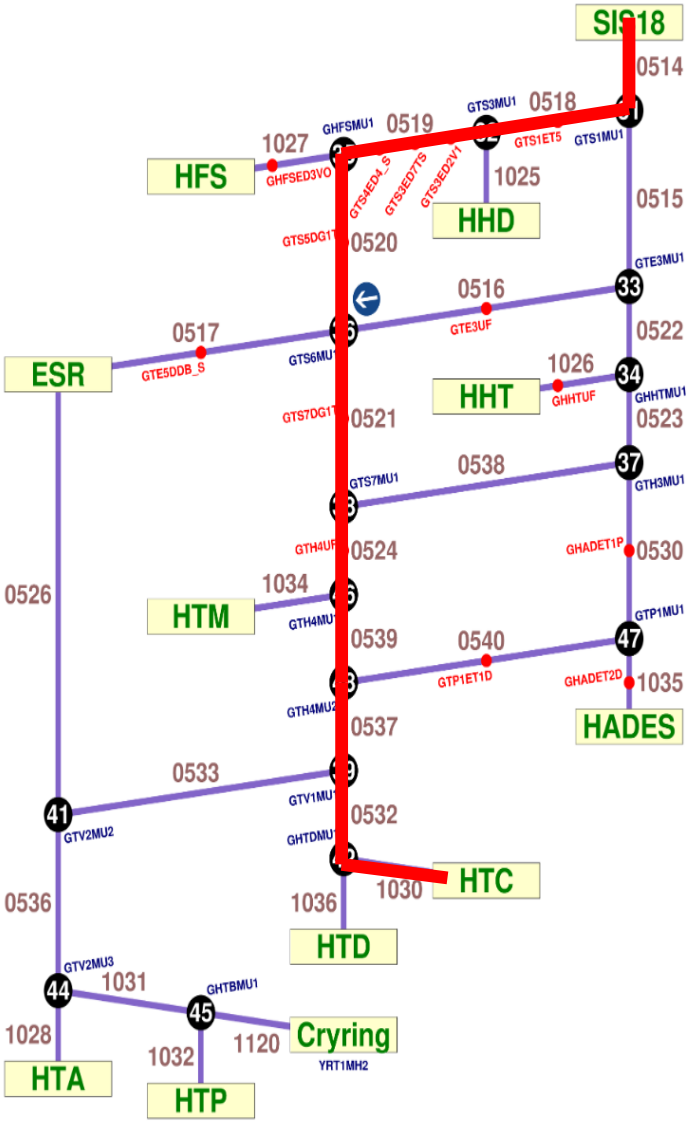
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC

HEST – beam paths



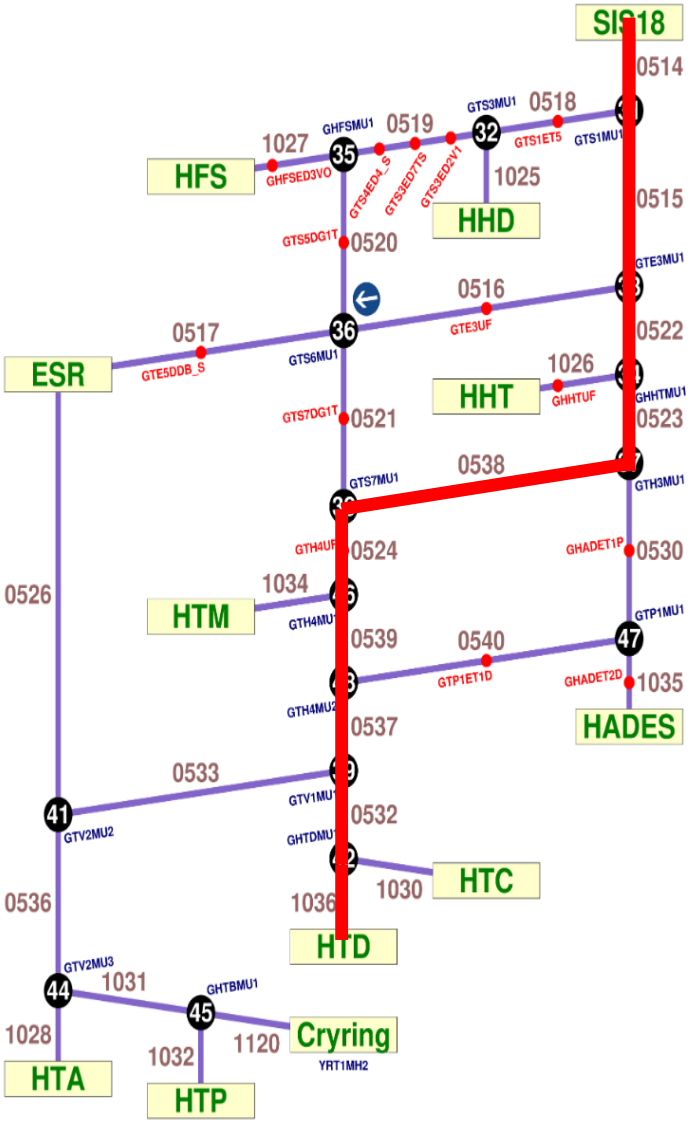
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC

HEST – beam paths



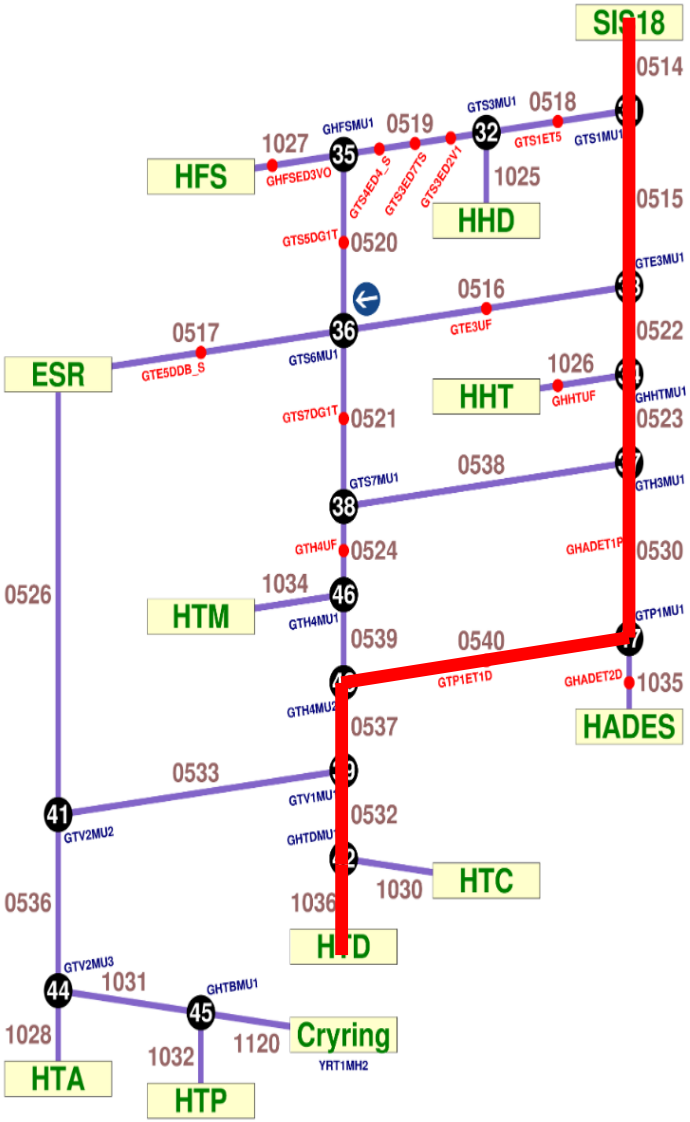
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC

HEST – beam paths



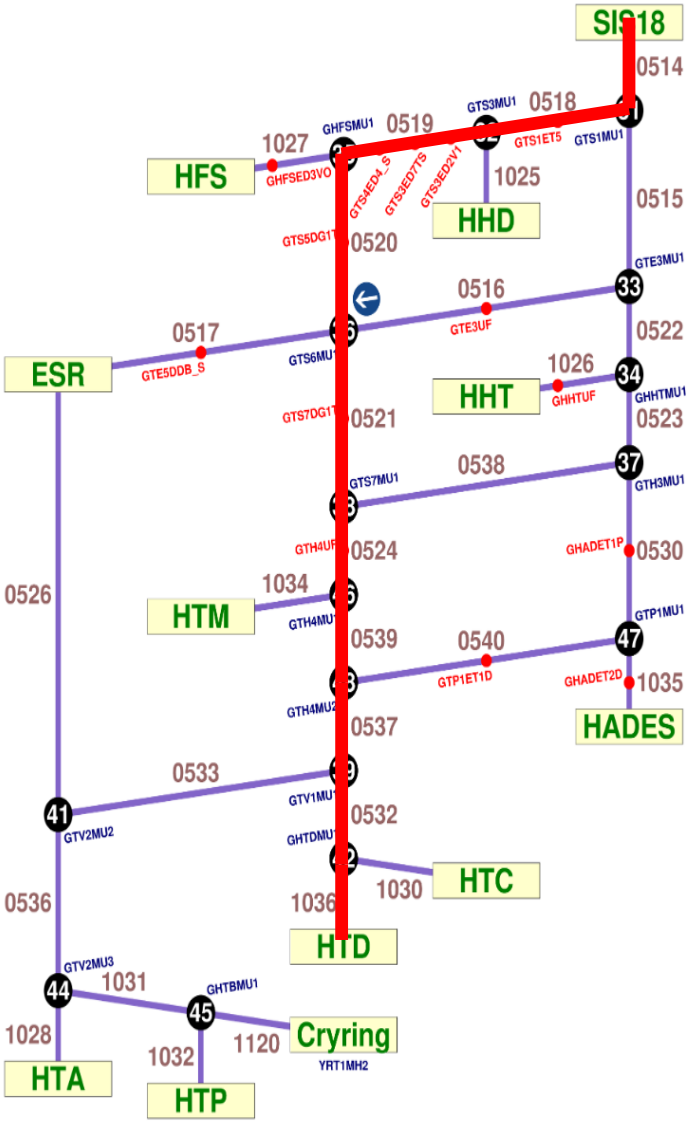
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD

HEST – beam paths



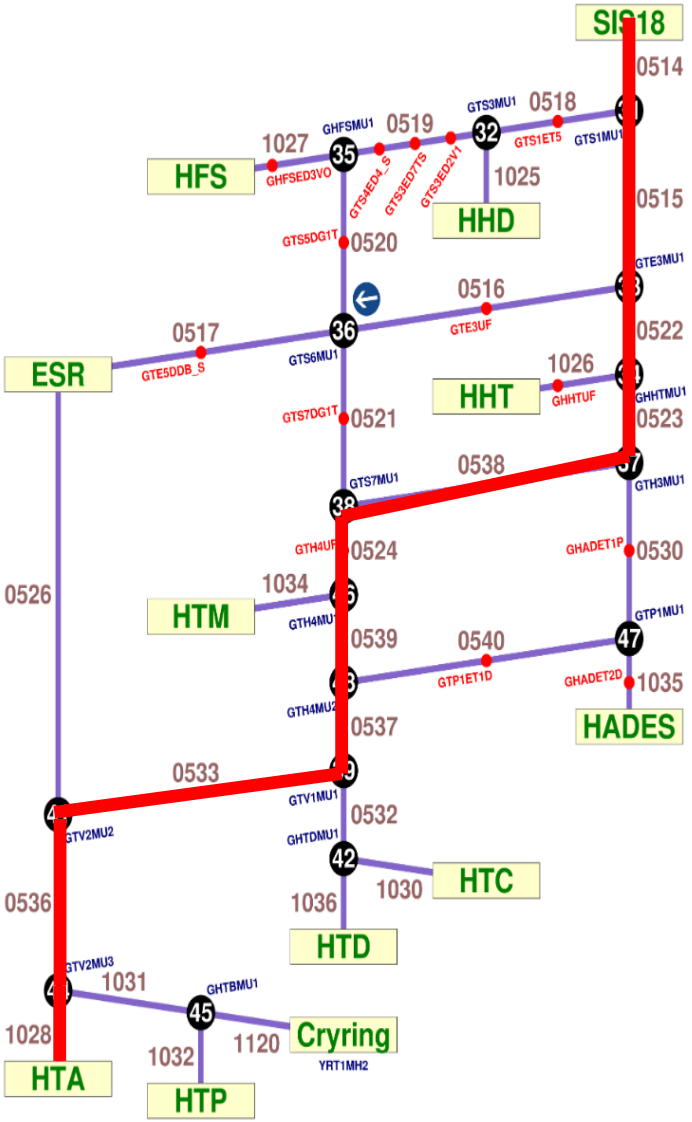
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD

HEST – beam paths



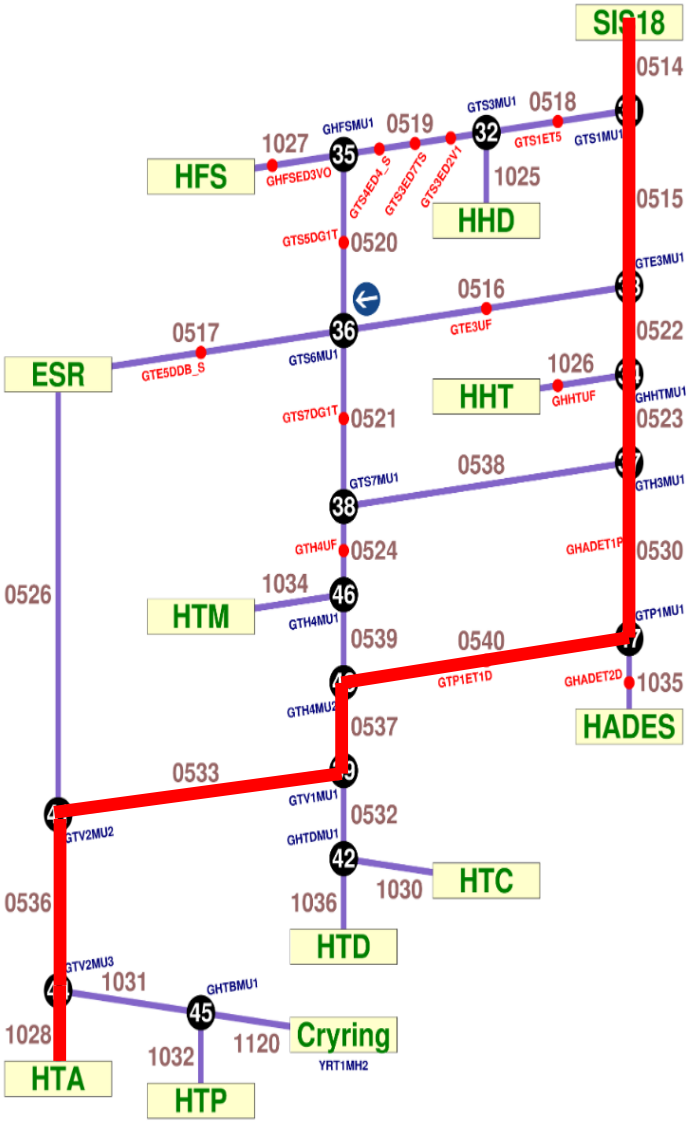
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD

HEST – beam paths



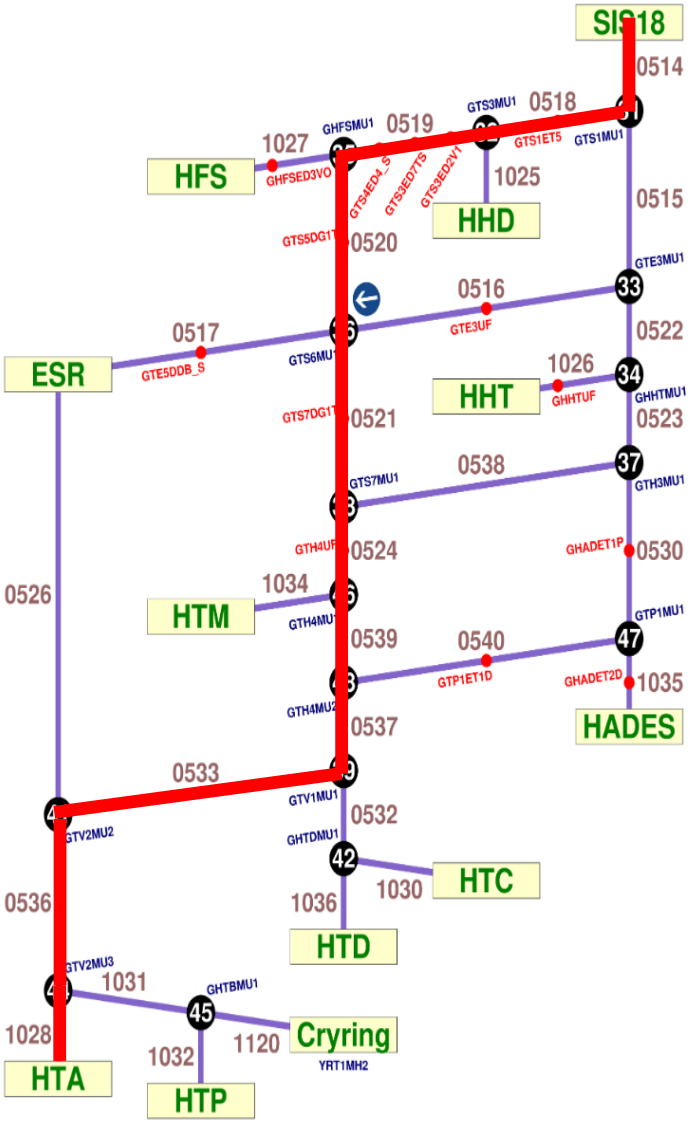
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA

HEST – beam paths



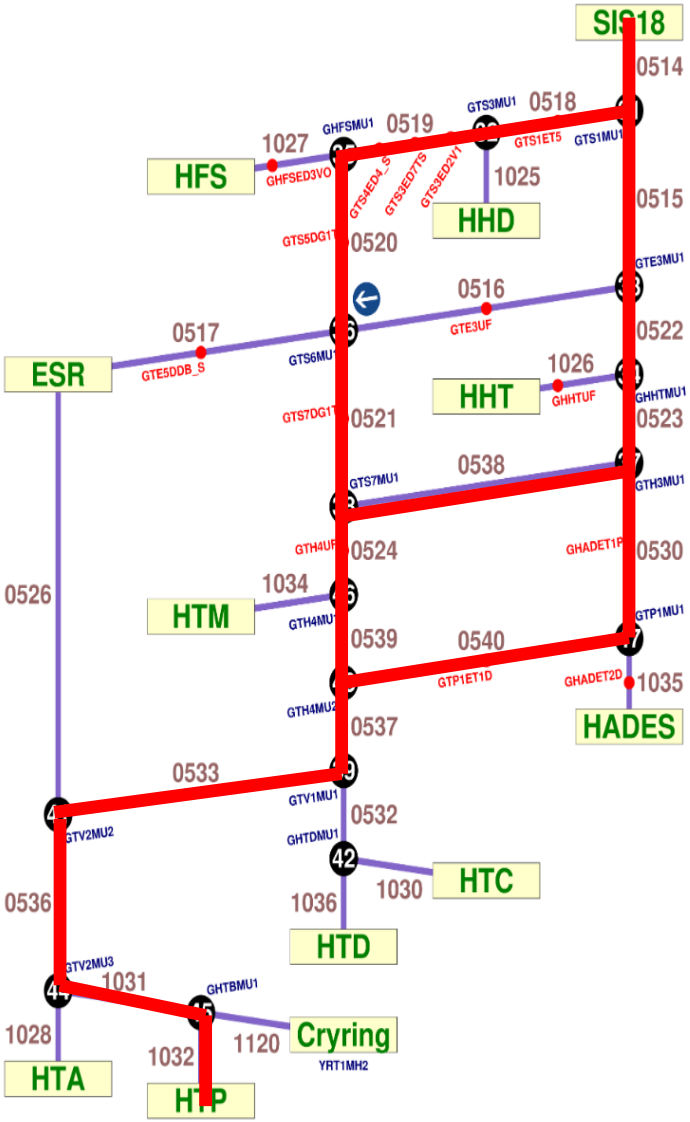
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA

HEST – beam paths



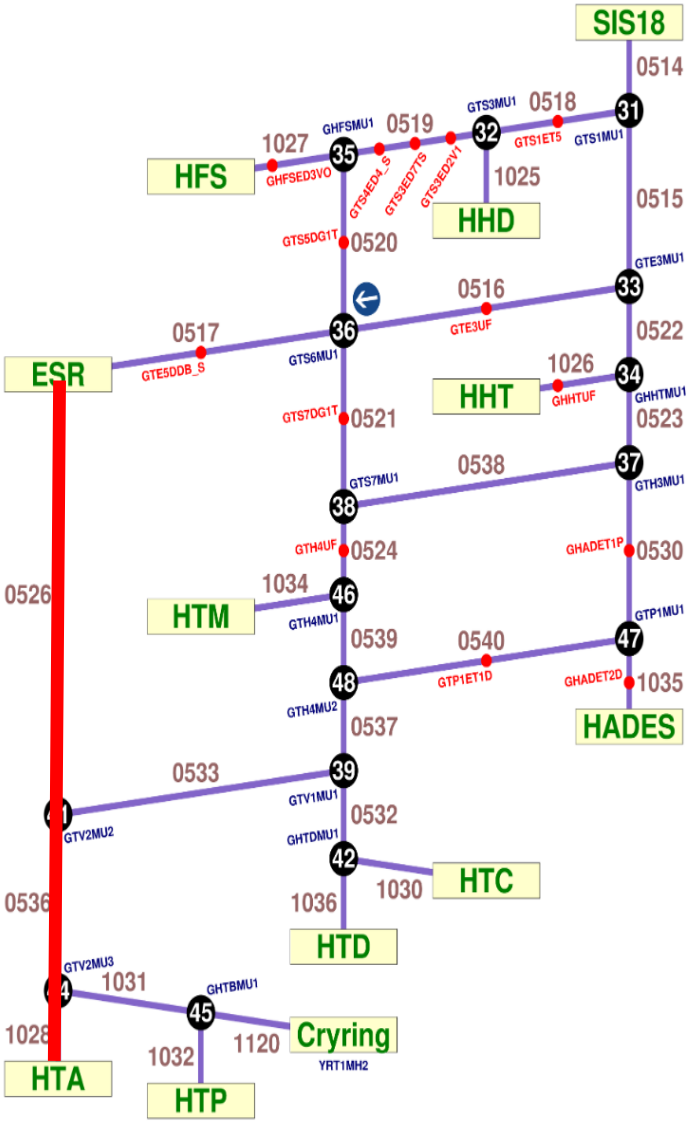
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA
16. SIS18_TS_HTA

HEST – beam paths



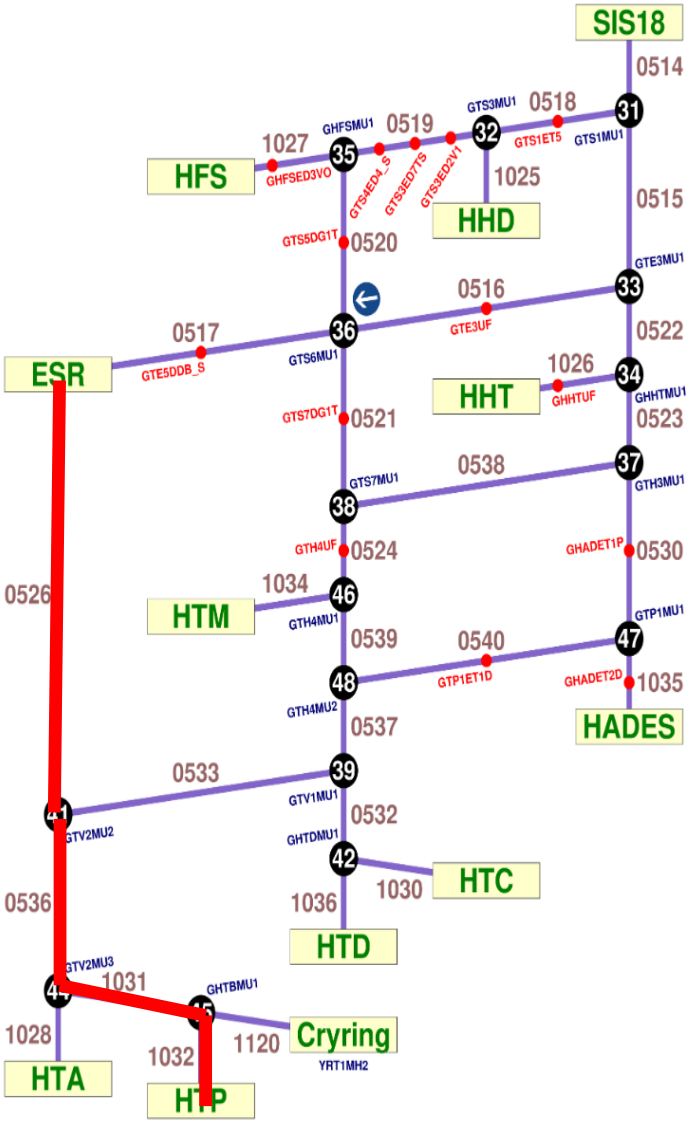
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA
16. SIS18_TS_HTA
17. 19. 20. SIS18_TH/TP/TS_HTP

HEST – beam paths



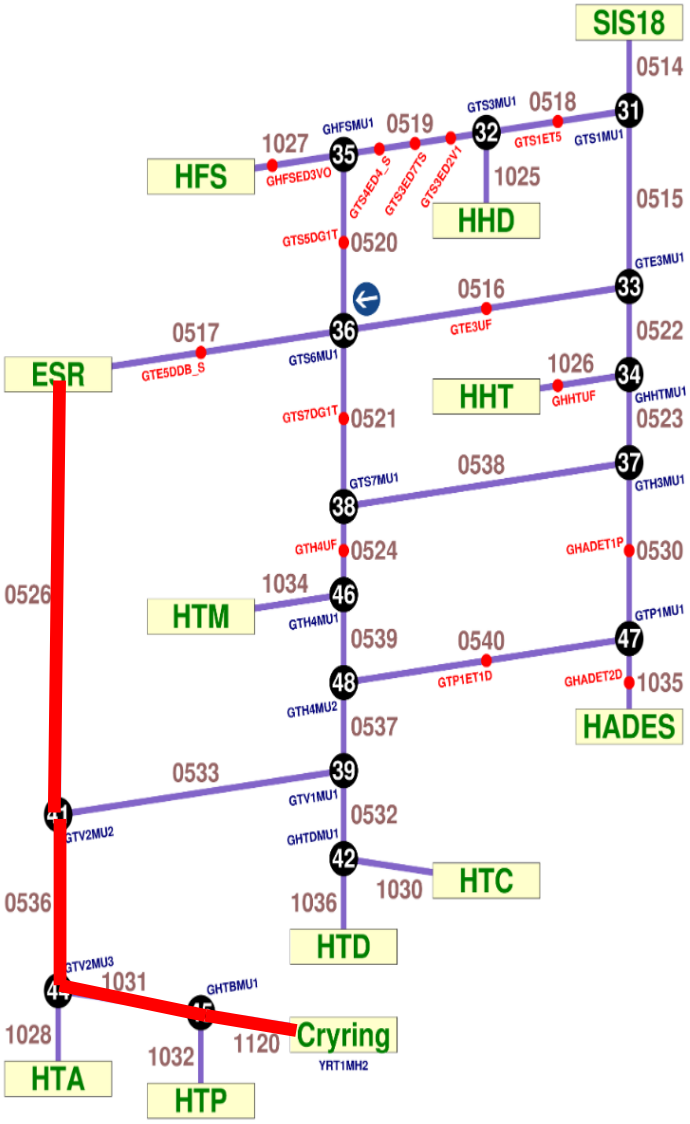
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA
16. SIS18_TS_HTA
17. 19. 20. SIS18_TH/TP/TS_HTP
21. ESR_HTA

HEST – beam paths



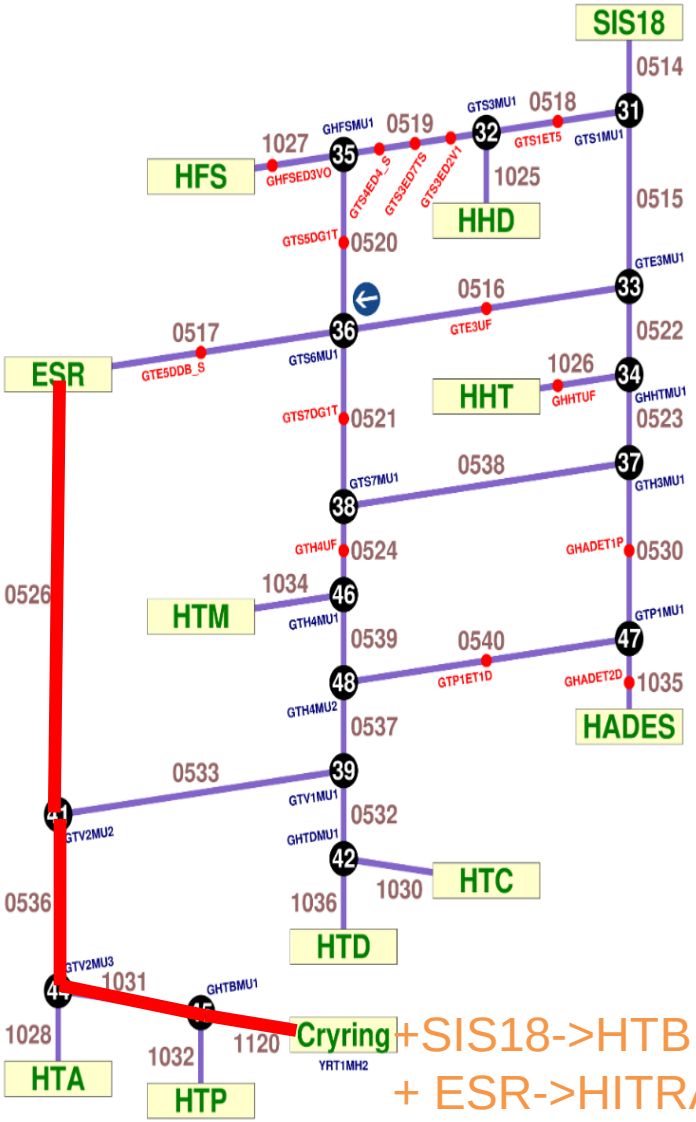
1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA
16. SIS18_TS_HTA
17. 19. 20. SIS18_TH/TP/TS_HTP
21. ESR_HTA
22. ESR_HTP

HEST – beam paths



1. SIS18_HHD
2. SIS18_HFS
3. SIS18_TS_ESR
4. SIS18_TE_ESR
5. SIS18_HADES
   +SIS18_PIONTARGET_HADES
6. SIS18_HHT
7. SIS18_HTM
8. SIS18_TH_HTC
9. SIS18_TP_HTC
10. SIS18_TS_HTC
11. SIS18_TH_HTD
12. SIS18_TP_HTD
13. SIS18_TS_HTD
14. SIS18_TH_HTA
15. SIS18_TP_HTA
16. SIS18_TS_HTA
17. 19. 20. SIS18_TH/TP/TS_HTP
21. ESR_HTA
22. ESR_HTP
23. ESR_CRYRING

HEST – beam paths



MIRKO:

1.	SIS18_HHD	SHD_.MAK
2.	SIS18_HFS	SF_S.MAK
3.	SIS18_TS_ESR	SE_F.MAK
4.	SIS18_TE_ESR	SE_S.MAK
5.	SIS18_HADES	SH_.MAK
	+SIS18_PIONTARGET_HADES	SH_P.MAK
6.	SIS18_HHT	?
7.	SIS18_HTM	SM_.MAK
8.	SIS18_TH_HTC	SC_.MAK
9.	SIS18_TP_HTC	SC_P.MAK
10.	SIS18_TS_HTC	SC_F.MAK
11.	SIS18_TH_HTD	SD_.MAK
12.	SIS18_TP_HTD	SD_P.MAK
13.	SIS18_TS_HTD	?
14.	SIS18_TH_HTA	SA_.MAK
15.	SIS18_TP_HTA	SA_P.MAK
16.	SIS18_TS_HTA	?
17. 19. 20.	SIS18_TH/TP/TS_HTP	?/SP_P/?
21.	ESR_HTA	?
22.	ESR_HTP	?
23.	ESR_CRYRING	

MIRKO and LSA import

- MIRKO optics files for (almost?) all beam paths exist and were verified with beam over the years.
- LSA requires translation of these files to LSA_import format.
- LSA_import format (called also CSV optics files) – defined by Bernd Schlei – is a format of 2 files used to fill LSA tables.

LSA import

Optics-DB-Imports

Some DB-Tables relevant for HEST - part 2

LSA_2016_SIS18.OPTIC_STRENGTHS

*	STRENGTH	FLOAT (126)
PF*	OPTIC_ID	NUMBER
	BEAM	VARCHAR2 (30 BYTE)
P *	LOGICAL_HARDWARE	NUMBER
	STRENGTH_L	NUMBER

OPTIC_STENGTHS_PK (OPTIC_ID, LOGICAL_HARDWARE)

OPTST_OPT_FK (OPTIC_ID)

OPTIC_STENGTHS_LOGICAL_HW_FK (LOGICAL_HARDWARE)
OPTIC_STENGTHS_PK (OPTIC_ID, LOGICAL_HARDWARE)
OPTST_OPT_FK (OPTIC_ID)

LSA_2016_SIS18.TWISS_OUTPUTS

PF*	OPTIC_ID	NUMBER
P *	ELEMENT_ID	NUMBER
*	K0L	NUMBER
*	K1L	NUMBER
*	K2L	NUMBER
*	K3L	NUMBER
*	BETX	NUMBER
*	BETY	NUMBER
*	DX	NUMBER
*	DY	NUMBER
*	X	NUMBER
*	Y	NUMBER
*	ALFX	NUMBER
*	ALFY	NUMBER
*	MUX	NUMBER
*	MUY	NUMBER
*	DPX	NUMBER
*	PX	NUMBER
*	PY	NUMBER
P *	BEAM	VARCHAR2 (30 BYTE)
*	DPY	NUMBER
	HKICK	NUMBER
	VKICK	NUMBER
*	K1SL	NUMBER
*	K2SL	NUMBER
*	K4L	NUMBER
*	K5L	NUMBER
*	K3SL	NUMBER

TWISS_OUTPUTS_PK (OPTIC_ID, ELEMENT_ID, BEAM)

TWISSO_OPT_FK (OPTIC_ID)

TWISSO_ELEM_FK (ELEMENT_ID)
TWISSO_OPT_FK (OPTIC_ID)
TWISS_OUTPUTS_PK (OPTIC_ID, ELEMENT_ID, BEAM)

CSV File Format for OPTIC_STRENGTHS Table

```
OPTIC_STRENGTHS ; OPTICS_NAME
DEVICE_NAME; STRENGTH_L
DEVICE#1 ;      KNL#1
.                .
.                .
DEVICE#n ;      KNL#n
```

by Bernd Schlei
Mai 3, 2017

CSV File Format for TWISS_OUTPUTS Table

```
TWISS_OUTPUTS ; OPTICS_NAME
ELEMENT_NAME;TYPE;S;BETX;BETY;ALFX;ALFY;MUX;MUY;DX;DY;DPX;DPY;K0L;K1L;OPTIONAL
ELEMENT#1     ;     ; ;     ; ....                                    ;OPT_VALS#1
.                                                .
.                                                .
ELEMENT#n     ;     ; ;     ; ....                                    ;OPT_VALS#n
```

Provide CSV-Files as Input to appropriate DB-Importers!

LSA import

Optics-DB-Imports

Mandatory Elements To Be Stored

… in the CSV-File for TWISS_OUTPUTS Imports

Provide ALWAYS Center Positions

LSA Element Type	Components or Location
SBEND, RBEND	Main Bending Magnets
QUADRUPOLE	Lattice and Correction Quadrupoles
HKICKER, VKICKER	Orbit Correctors (Exclusively)
TKICKER	Injection Bumpers, Fast Extraction Kickers, Septa
SEXTUPOLE, OCTUPOLE, MULTIPOLE	Lattice and Correction Multipoles
SOLENOID	Solenoids
HMONITOR, VMONITOR, MONITOR	Position Measuring Devices
RCOLLIMATOR	Aperture Restrictions
M.<BEND#n>.START	Start Position of Bending Magnet n
M.<BEND#n>.END	End Position of Bending Magnet n
M.<ACC_ZONE#n>.START	Start Position of Accelerator Zone n
M.<ACC_ZONE#n>.END	End Position of Accelerator Zone n
M.BEAM_PATH.START	Start Position of Beam Path
M.BEAM_PATH.END	End Position of Accelerator Zone n

by Bernd Schlei
Maj 3, 2017

Provide all mandatory entries in the CSV-Files!

LSA import

Optics-DB-Imports

Mandatory Entries To Be Stored

CSV File Format for OPTIC_STRENGTHS Table

```
Integral Strength                    : LSA Device
Dipole Angle                         : D
Strength of quadrupole family  1: Q#1
.                .
.                .
Strength of quadrupole family f : Q#f
```

→

```
OPTIC_STRENGTHS ; OPTICS_NAME
DEVICE_NAME; STRENGTH_L
DEVICE#1 ;       KNL#1
.                  .
.                  .
DEVICE#n ;       KNL#n
```

by Bernd Schlei
Mai 3, 2017

See *.twiss File generated by MIRKO / jMirko.

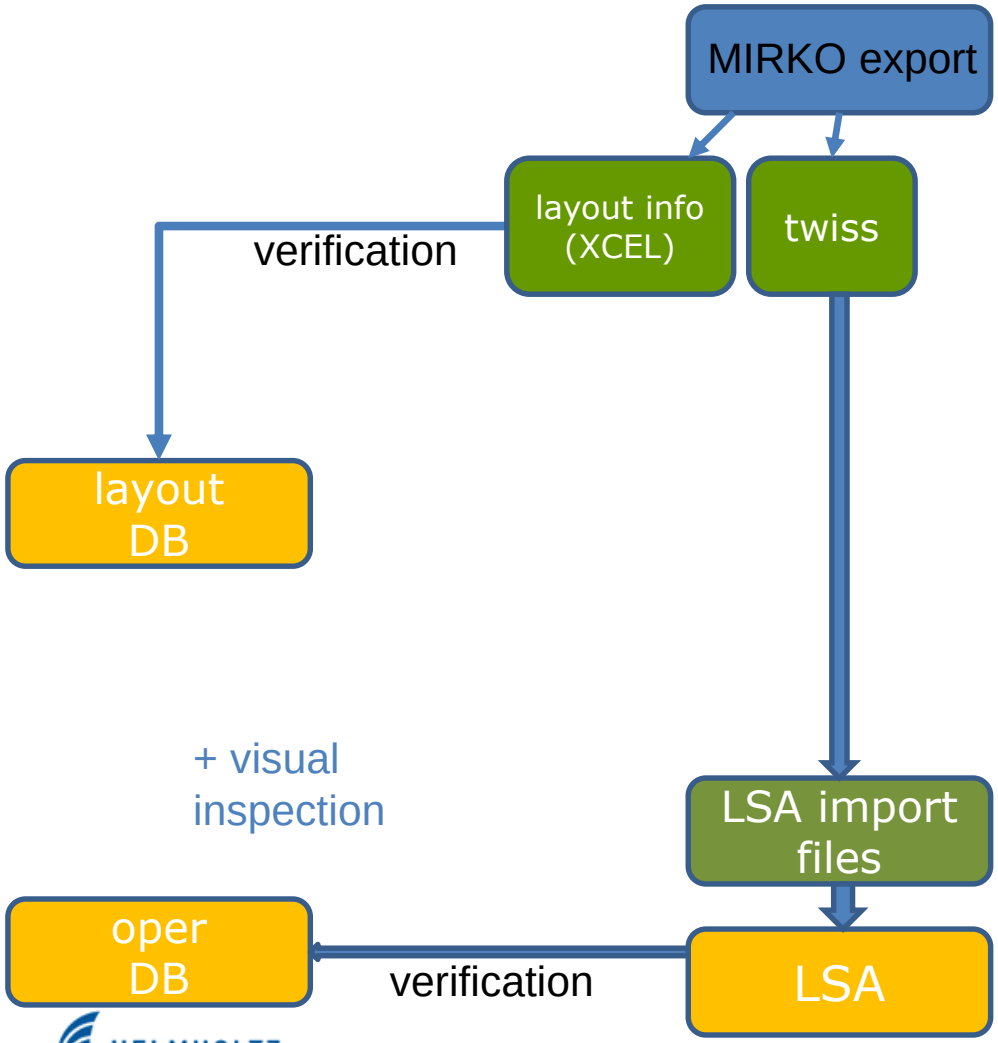
E.g, “s” is the CENTER of the Element.

CSV File Format for TWISS_OUTPUTS Table

```
TWISS_OUTPUTS ; OPTICS_NAME
ELEMENT_NAME;TYPE;S;BETX;BETY;ALFX;ALFY;MUX;MUY;DX;DY;DPX;DPY;K0L;K1L;OPTIONAL
ELEMENT#1      ;      ; ;      ;  ....                                  ;OPT_VALS#1
.                                                    .
.                                                    .
ELEMENT#n      ;      ; ;      ;  ....                                  ;OPT_VALS#n
```

Provide all mandatory elements in the CSV-Files!

LSA import



current status:

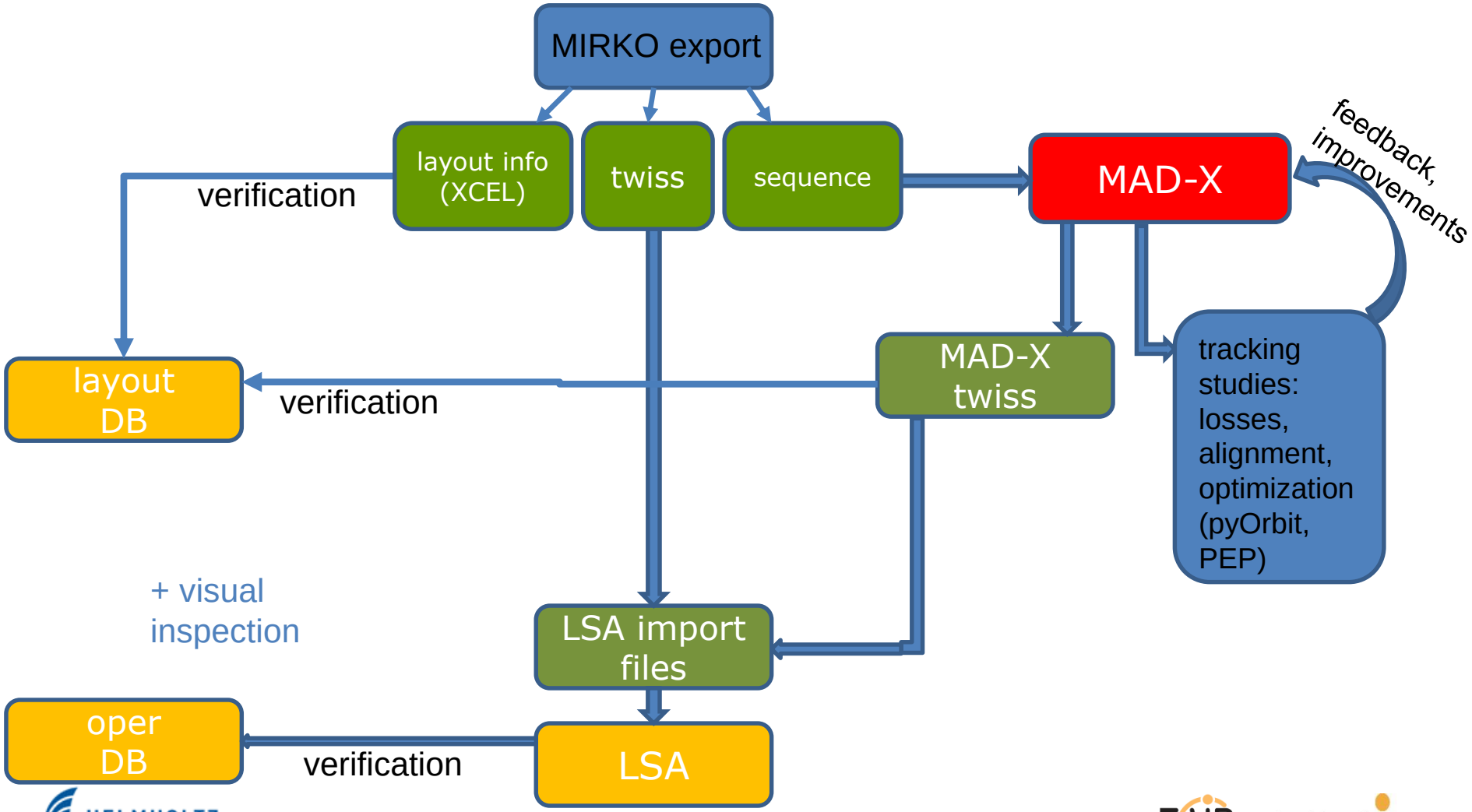
- work in progress: python scripts reading MIRKO twiss and producing LSA_import
- exercise is ongoing with HHD beamline
- final LSA hierarchy still in development (Bernd)
- some issues with MIRKO files are difficult to code (manual corrections)
- synergy with others? SIS18/ESR?

this is a good basic plan BUT:

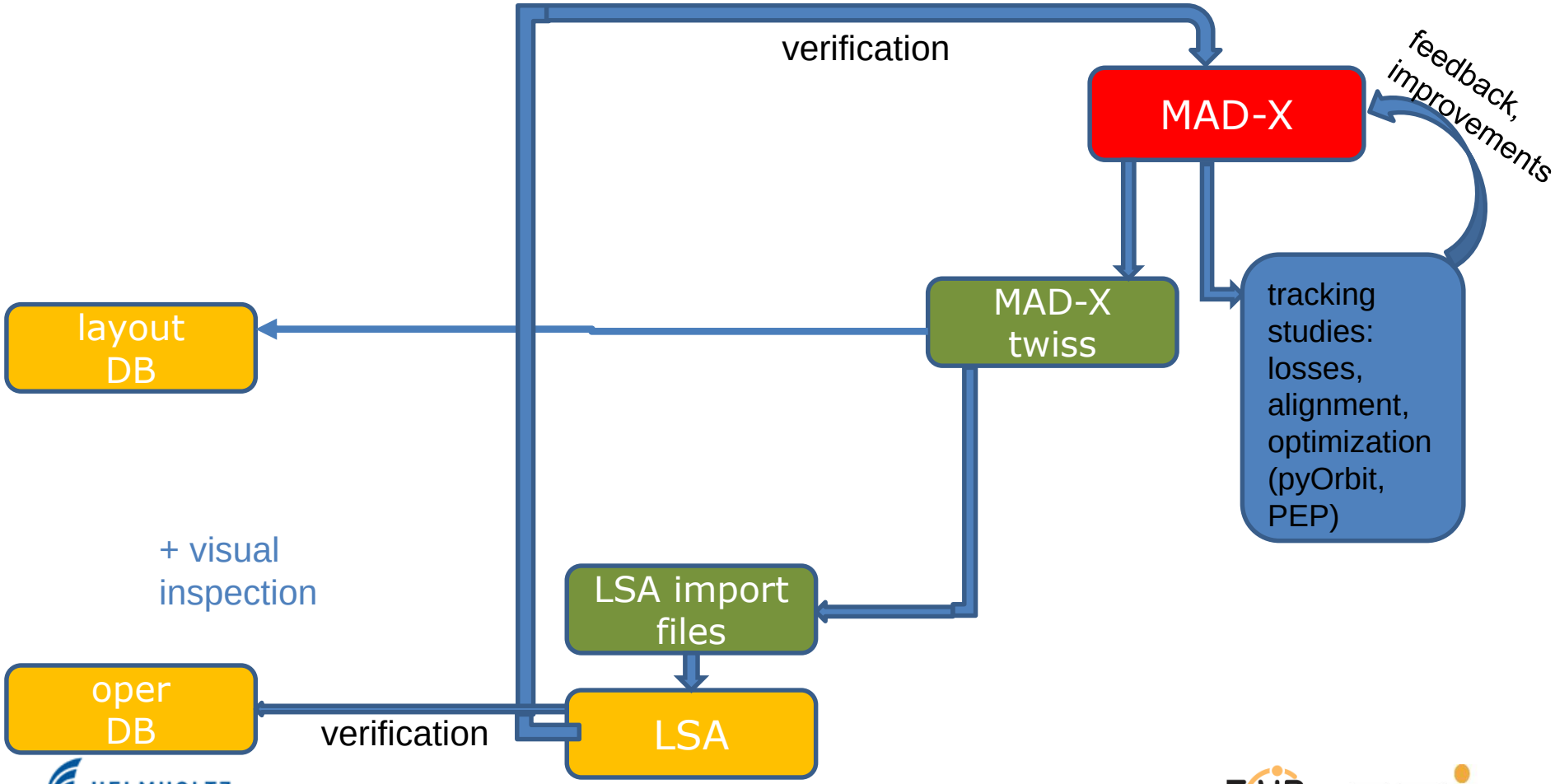
MIRKO vs MAD-X

- MIRKO runs only on Windows (except Controls version).
- For me it crashes very often
  (tried on 2 computers, Win 7 and 10).
- People in our division tend to use MADX (however there is a vast experience with MIRKO in project division).
- Colleagues from CERN also use MAD-X – large knowledge and used database.

LSA import via MAD-X

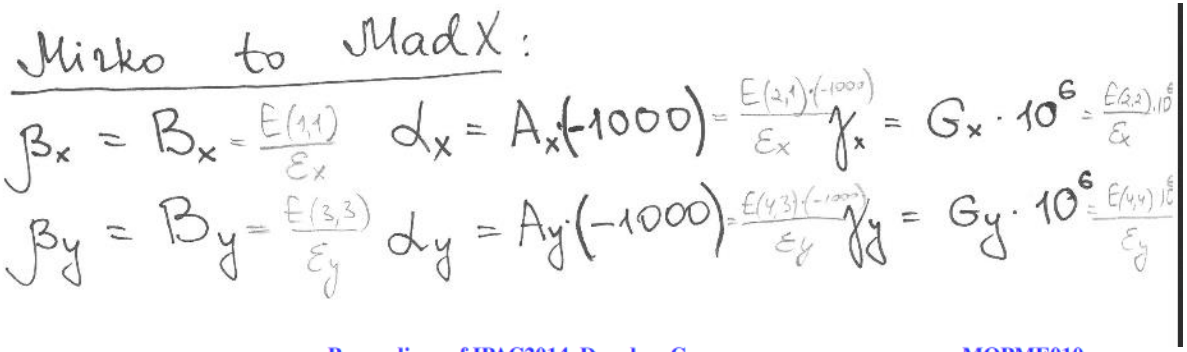


LSA import via MAD-X



Step 1

- Export MIRKO files to MAD-X sequence, compare the resulting optics calculations.
- Stephan wrote MIRKO export functions, however they are some bugs.
- Vera has experience:
- Colleagues from HIT did the exercise.
- However it is not straightforward, depends for instance on MIRKO version.



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A MAD-X MODEL OF THE HIT ACCELERATOR

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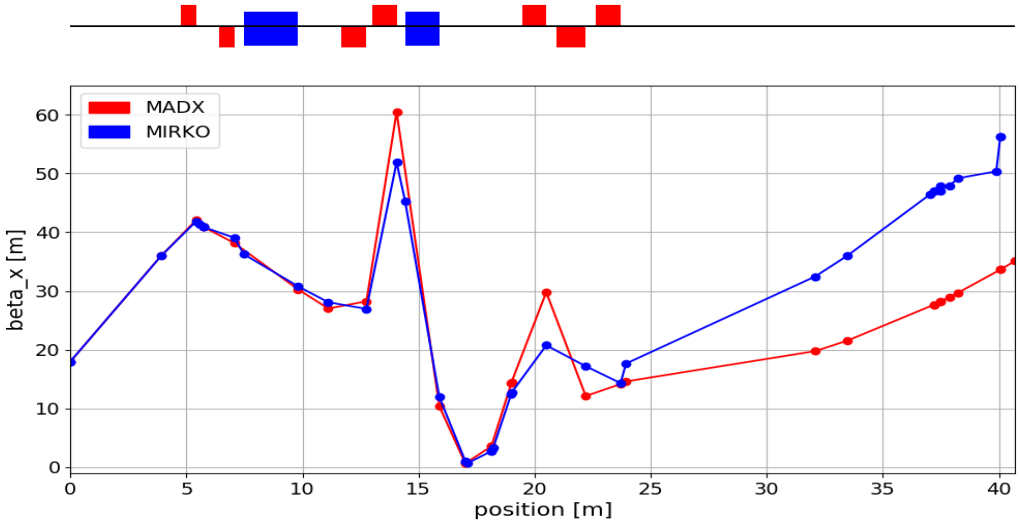
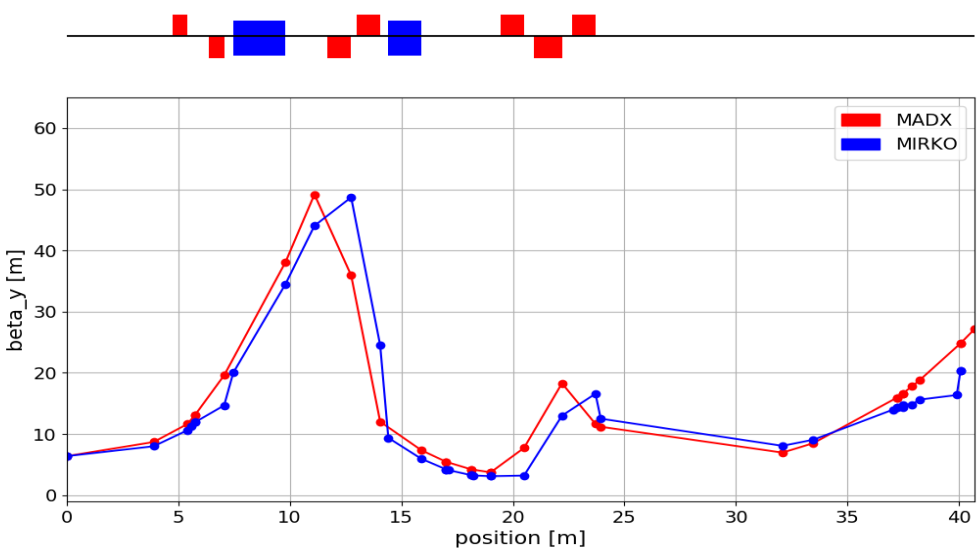
Abstract

For a medical accelerator facility like the Heidelberg Ion-Beam Therapy Centre (HIT) an online simulation tool with read and write access to the control system and the database is essential for effective beam alignment and beam spot size adjustment at the patient position. Since the commissioning of HIT the simulation programme Mirko from GSI Darmstadt has been in use for the simulation of the beam lines and the synchrotron. While Mirko fully complies with the demands and is still in regular use, the long-term support of the HIT-Mirko derivate cannot be guaranteed. We have therefore started to set up a new simulation environment based on the MAD-X programme from CERN. In a first step we built a MAD-X model of the HIT accelerator using the MAD software: the simulation is decoupled from the analysis and presentation of the data. This modularization makes it easy to perform customized post-processing and redirect the data to third party applications as desired, enabling us to develop our own GUI application on top.

Our long term goal is to have a replacement for Mirko in case its support cannot be continued. The basic idea is to set up a complete MAD model of the HIT accelerator, develop a graphical user interface with the Python scripting language and use the same DLL-interface to the control system as Mirko does.

SIMULATION OF THE HIT BEAM LINES


MADX
MIRKO
beta_x [m]
position [m]
0
10
20
30
40
50
60
0
5
10
15
20
25
30
35
40


MADX
MIRKO
beta_y [m]
position [m]
0
10
20
30
40
50
60
0
5
10
15
20
25
30
35
40

Documentation

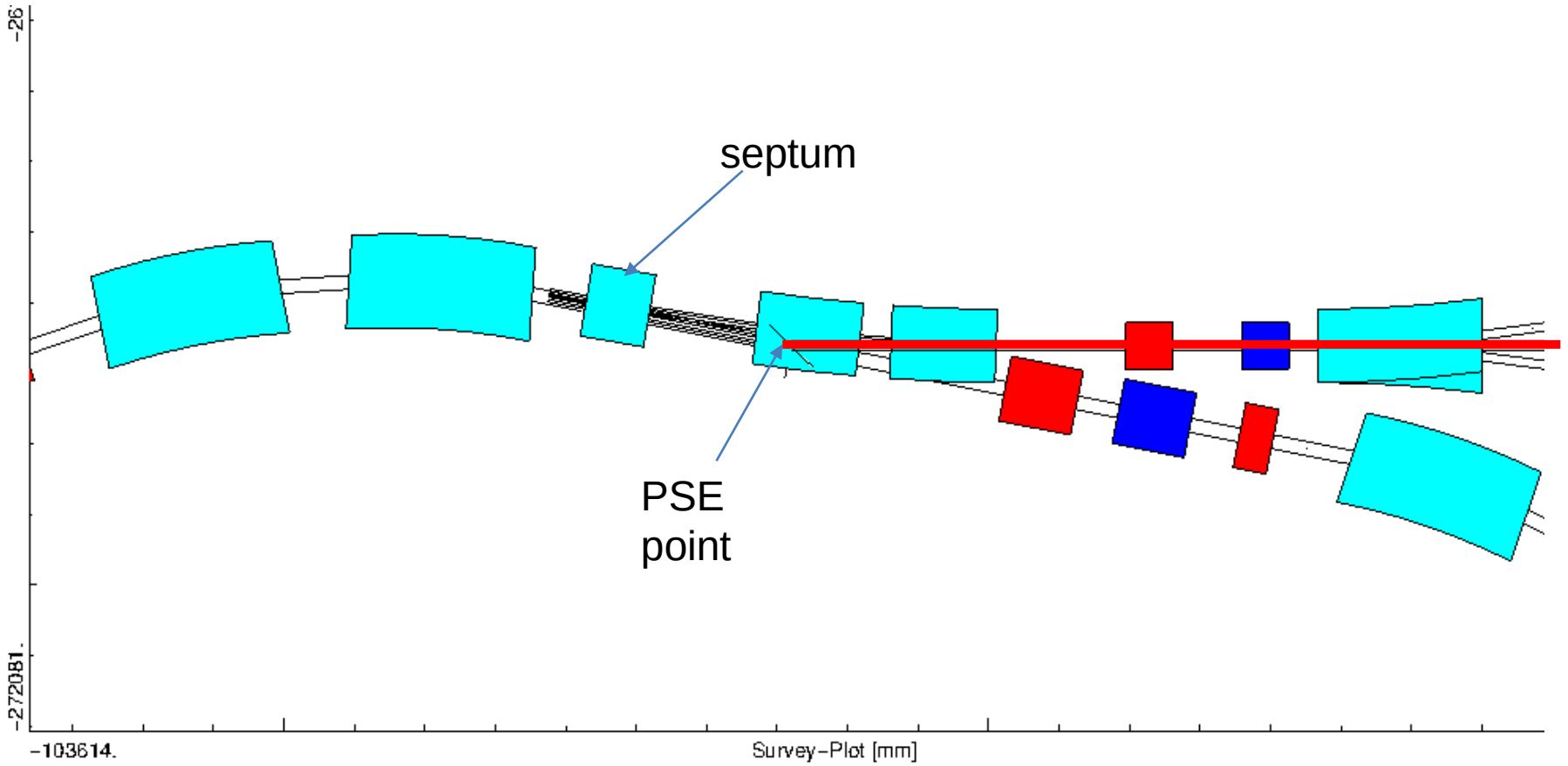
- for the moment:
  - an unofficial webpage (not TYPO3) - http://web-docs.gsi.de/~sapinski/HEST/
- next:
  - TYPO3 webpage
  - svn repository for all optics files (BBE)

Some conclusions and sonstige

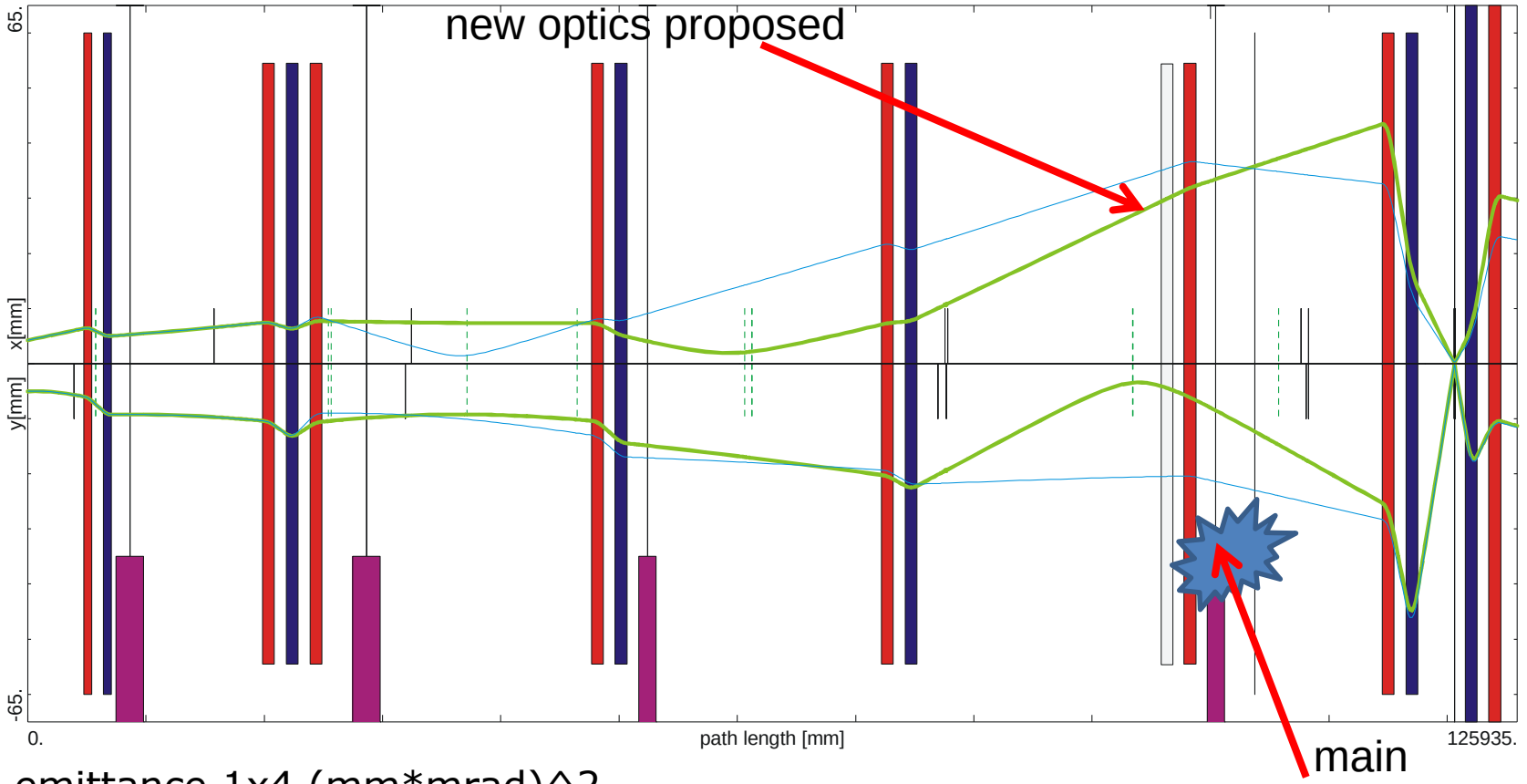
1. LSA configuration is a tedious task, but it can be completed for 2018 run.
2. Which beam optics to test during first dry run? (ESR-Cryring?).
3. I find working with MIRKO difficult – switch to MAD-X (means no maintain MIRKO files anymore, ok?).
4. It would be good to have some information from the experiments about their plans for the future (HEST mini-workshop @ GSI?).

SPARE slides

HEST – extraction from SIS18

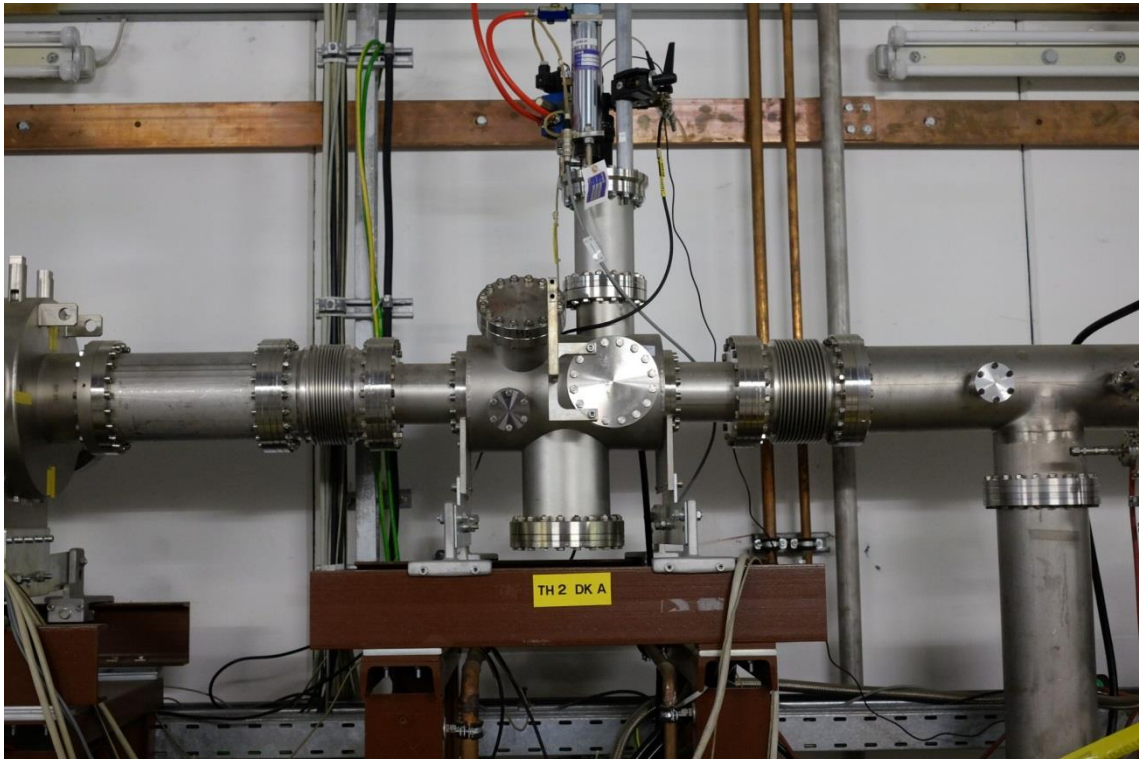


improvement 2: decrease beam size in TH3MU1 (I)



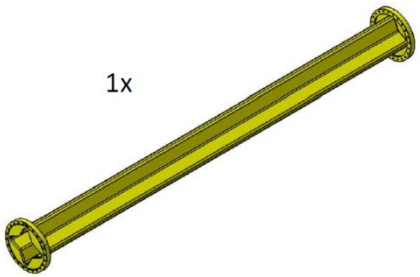
- emittance 1x4 (mm*mrad)^2
- beam spot at target ca. 0.23x0.3 (mm)^2 (radius)
- green: alternative focusing scheme, blue: 2014 focusing scheme
- where is the catch?

Changes to vacuum chambers – TH2DKA

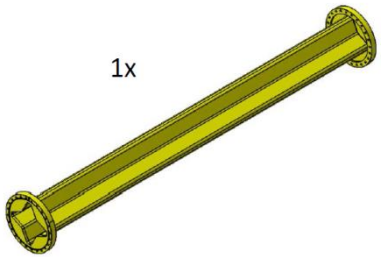


- Aperture limitation – losses.
- BI removed the chamber.
- Larger-aperture chamber is in production.
- End of mechanical works expected mid-April.
- Similar aperture limitation is in TH2DK3, it will also be replaced.

Changes to vacuum chambers – HADQD11/12



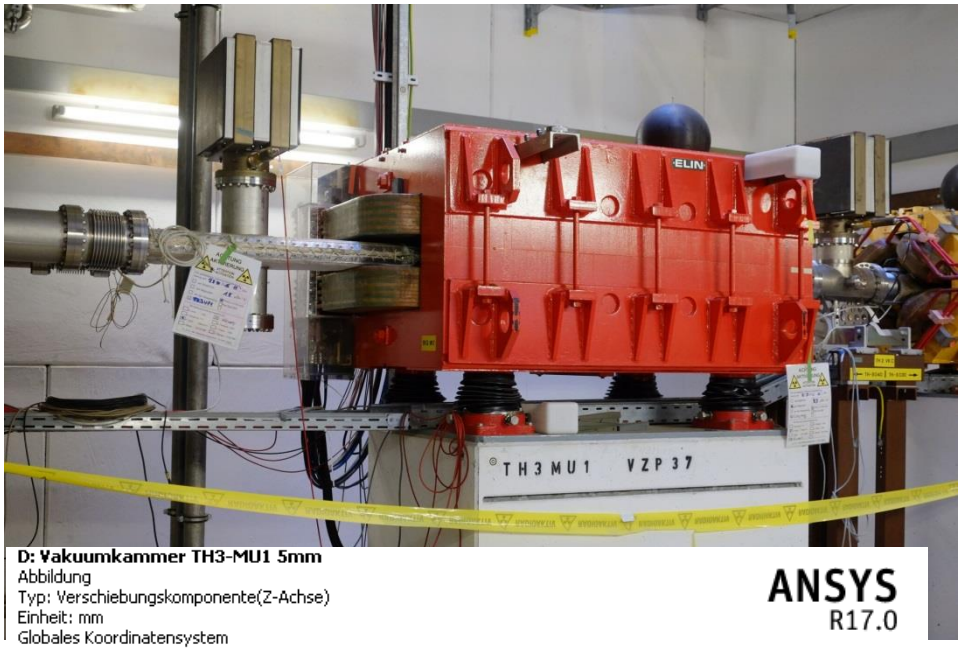
VC-1033284-A-000_-_Sternkammer
- 2x VC-1033243-P-000_-_CF-Flansch DN200



VC-1033245-A-000_-_Sternkammer
- 2x VC-1033243-P-000_-_CF-Flansch DN200

- Critical change for new optics.
- Design slowed down by thinking what to do with 5 vacuum ports and foil separating HADES and HEST vacuums.
- Design finished, approval process to be completed this week.
- Vertical and horizontal aperture increase from 60 to >90 mm.
- Expected delivery – September the latest, montage – to be discussed.

Changes to vacuum chambers – TH3MU1



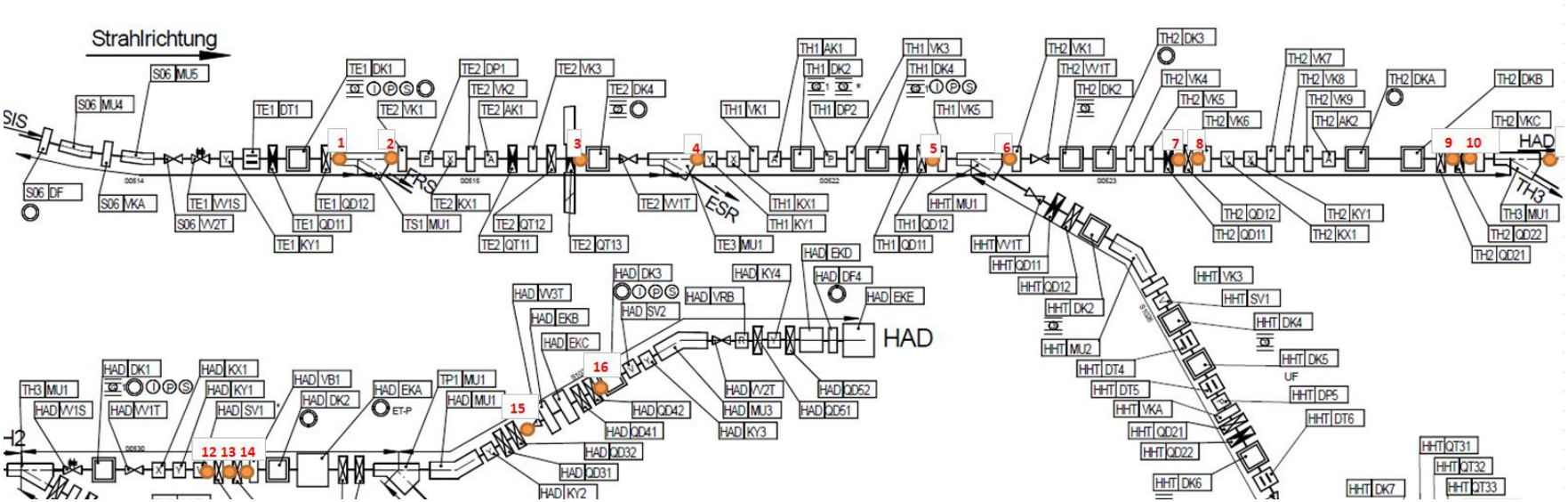
- FEM study finished.
- Change not critical for new optics.
- Important if new optics does not work (but there is no reason why it should not).
- For the moment pending.

Changes to vacuum chambers – TH2QD21/22

- These chambers are never baked.
- Increase aperture by exchange to normal-diameter chambers.
- Chamber from HADQD11 can be reused.
- Second chamber found in storage.
- Installation together with new chambers in HADQD11/12.

Instrumentation-BLM system

- Locations of 16 BLMs agreed (with HADES).
- B. Walasek-Hoehne coordinating from BI side.
- FLUKA simulations to optimize positions started.
- Some electronics already acquired, final installation – beginning 2018.

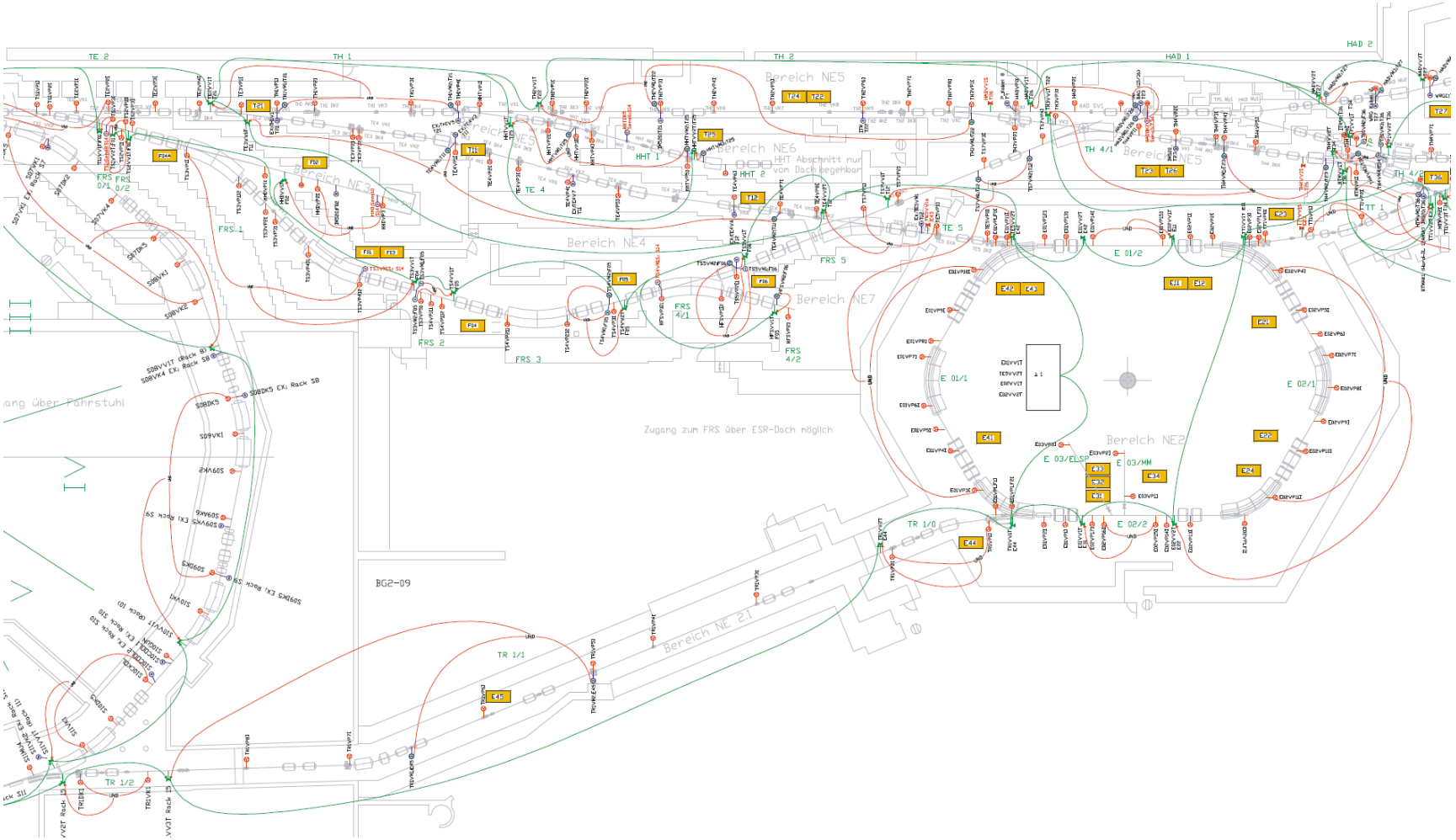


Responsibilities

- Define where responsibility of MK ends and those of experiment starts
  - list of experiment liason person defined
  - definition of responsibilities is often not easy,
    for instance DKs and magnets can be in experimental zones
- Proposal (based on drawing on next page):
  - SIS-18 MK responsibility end: S06VV2T – last element belonging to SIS-18 (?)
  - HHD – whole line under HEST MK?
  - Cave-M: HTMVV2T (?)
  - HADES: HADVV3T (?)
  - Cave C: HTCVV2TT33 (?)
  - CryRing: HTBVV2T (?)
  - comments? ideas?

- Cave A: HTAVV1T (?)
- Entrance ESR: TE5VV2T (?)
- Exit ESR: TT1V1T (?)

Responsibilities



partial drawing (up to date?)