The Heidelberg Ion Therapy Center - a technical overview

from GSI to HIT – selected design topics

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HIT Betriebs GmbH am
Universitätsklinikum Heidelberg
mit beschränkter Haftung

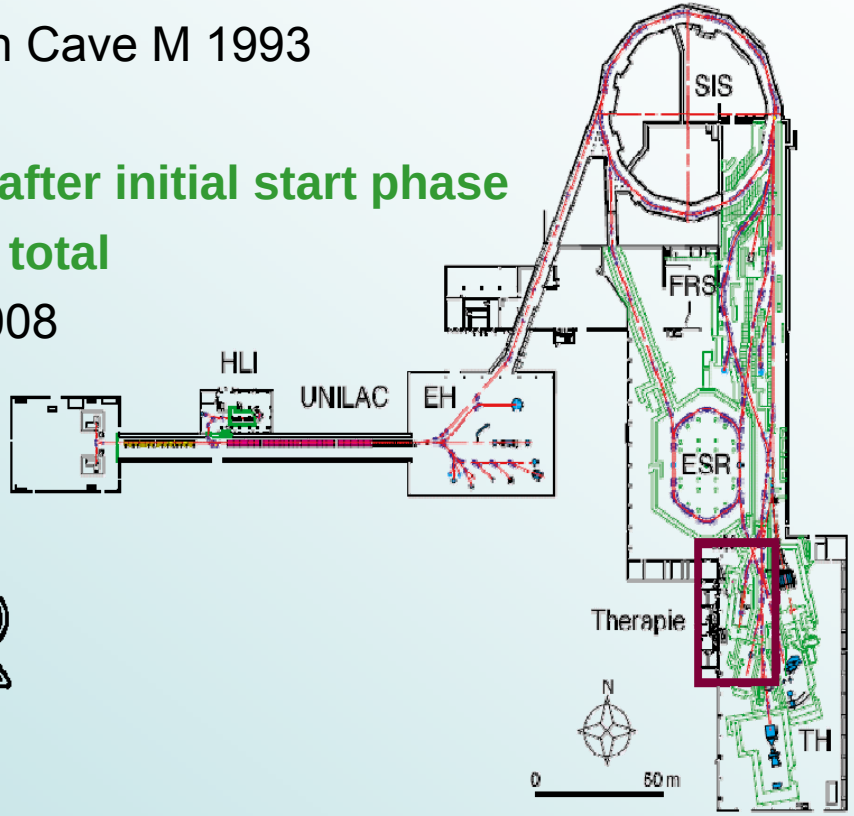
http://www.hit-centrum.de

The GSI pilot project

The GSI pilot project demonstrated the effectiveness of particle therapy for a limited number of patients and indications in a research environment.

The GSI pilot project: Cave M

- located at the Helmholtz Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, particle **accelerator facility for basic research**
- first installations in Cave M 1993
- first patient 1997
- **50 patients/year after initial start phase**
- **> 400 patients in total**
- last patient july 2008



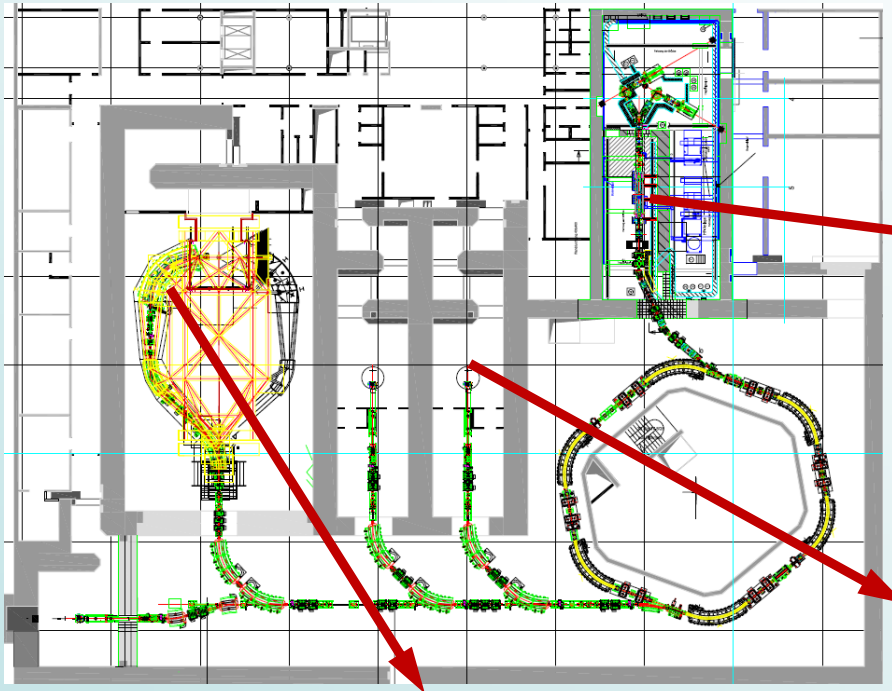
GSI vs HIT

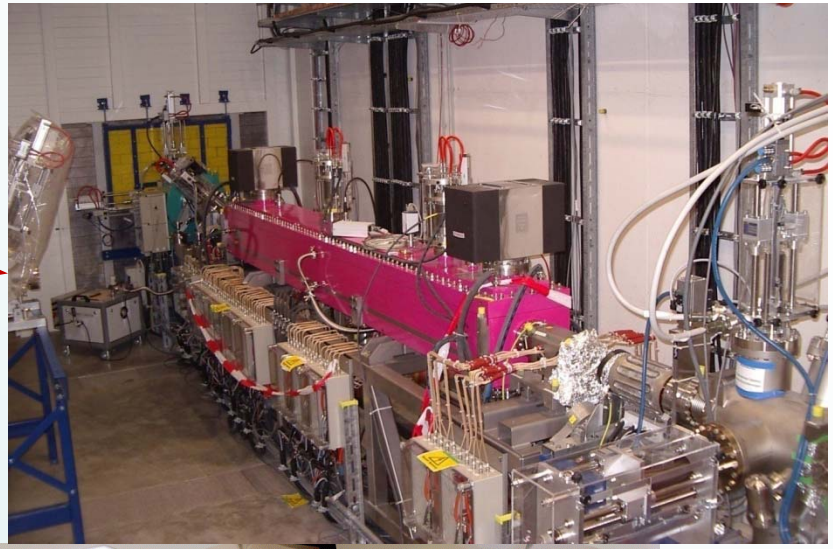
The GSI pilot project demonstrated the effectiveness of particle therapy for a limited number of patients and indications in a research environment.

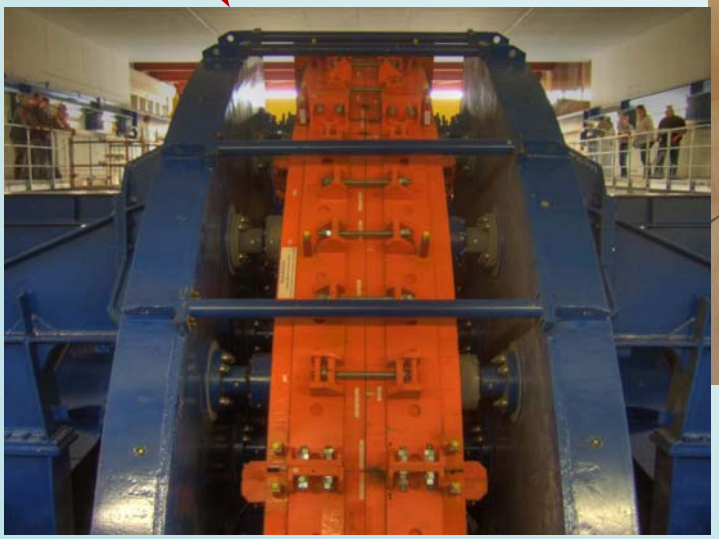
The mission for HIT is to demonstrate and evaluate the effectiveness of particle therapy for a large number of patients and indications in a defined clinical environment.

HIT

- 12.5.2004 laying of the foundation stone
- 5.10.2005 begin of accelerator commissioning
- Dec. 2006 beam in the synchrotron
- March 2007 beam at H1/H2
- April 2008 beam reaches defined quality standard
- Nov 2009 first patient?







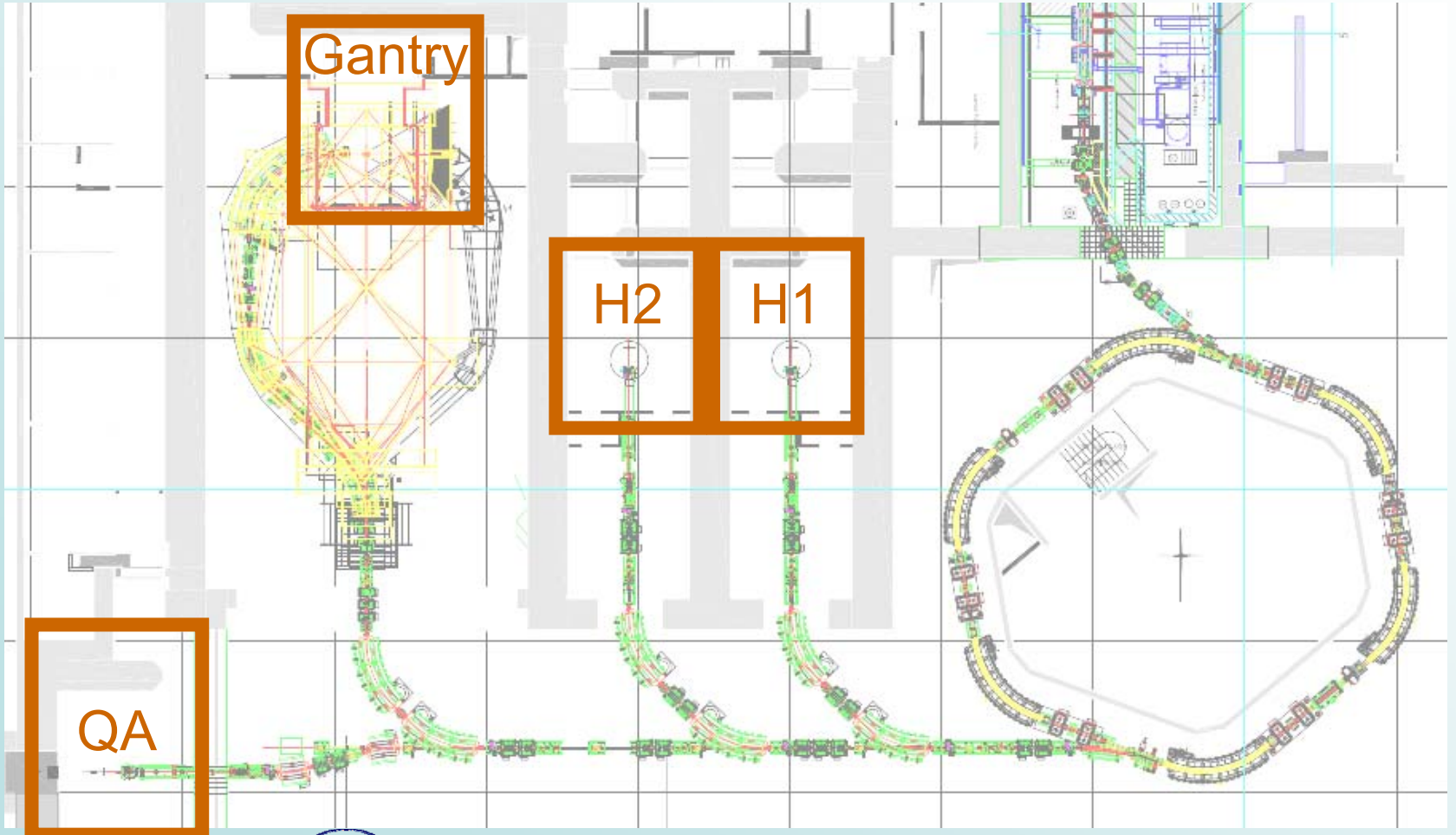
HIT

HIT

Selected topics (that required particular attention during planning and implementation):

1. **going from one treatment room to multiple treatment rooms**
2. **efficient beam control: the spill pause**
3. **MDD: risk management process**

1) Multiple treatment rooms



1) Multiple treatment rooms: spill abort system

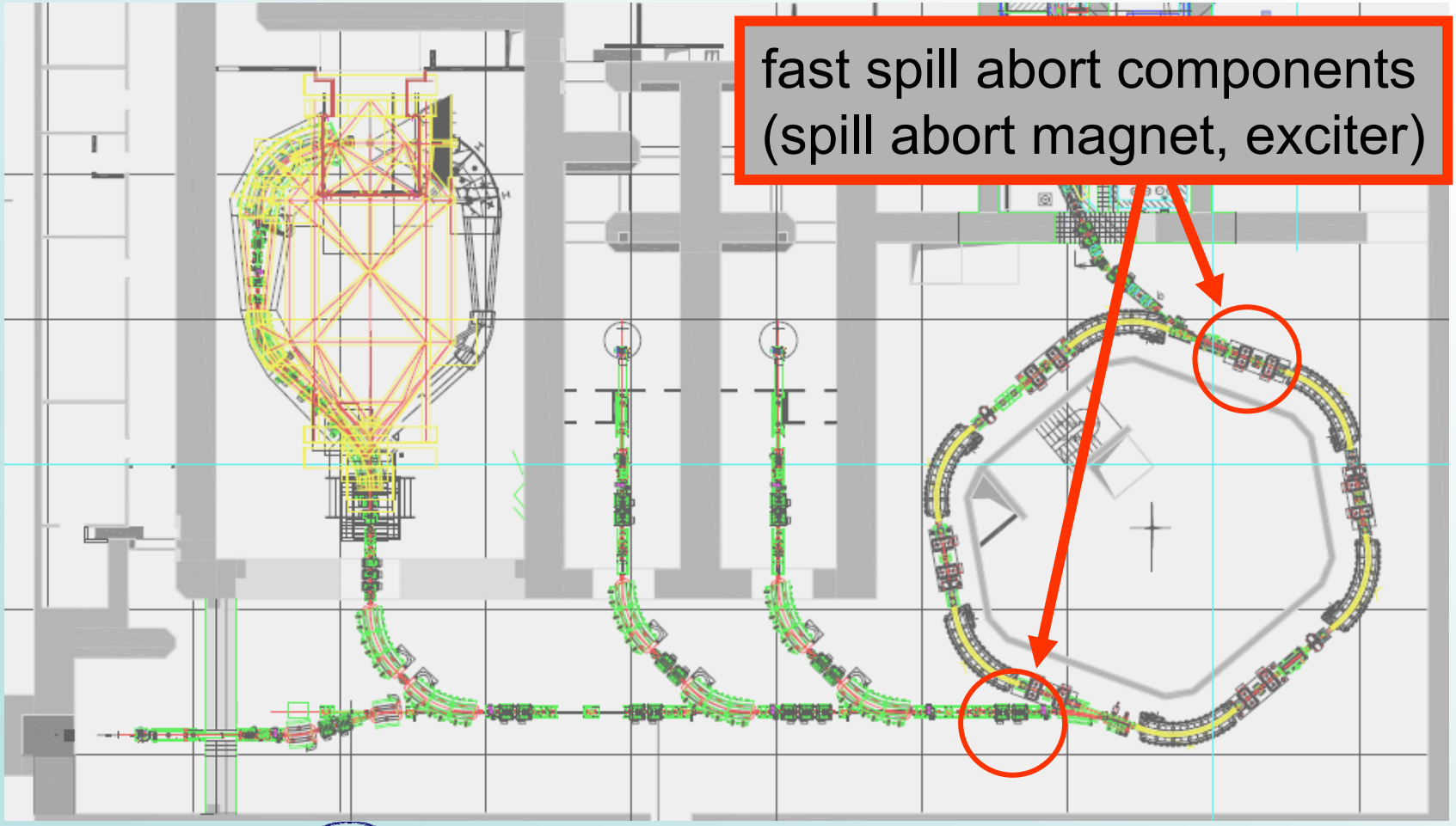
One key element for patient safety during raster scanning is the

fast spill abort system

spill abort magnet < 250 µs

exciter < 2 ms

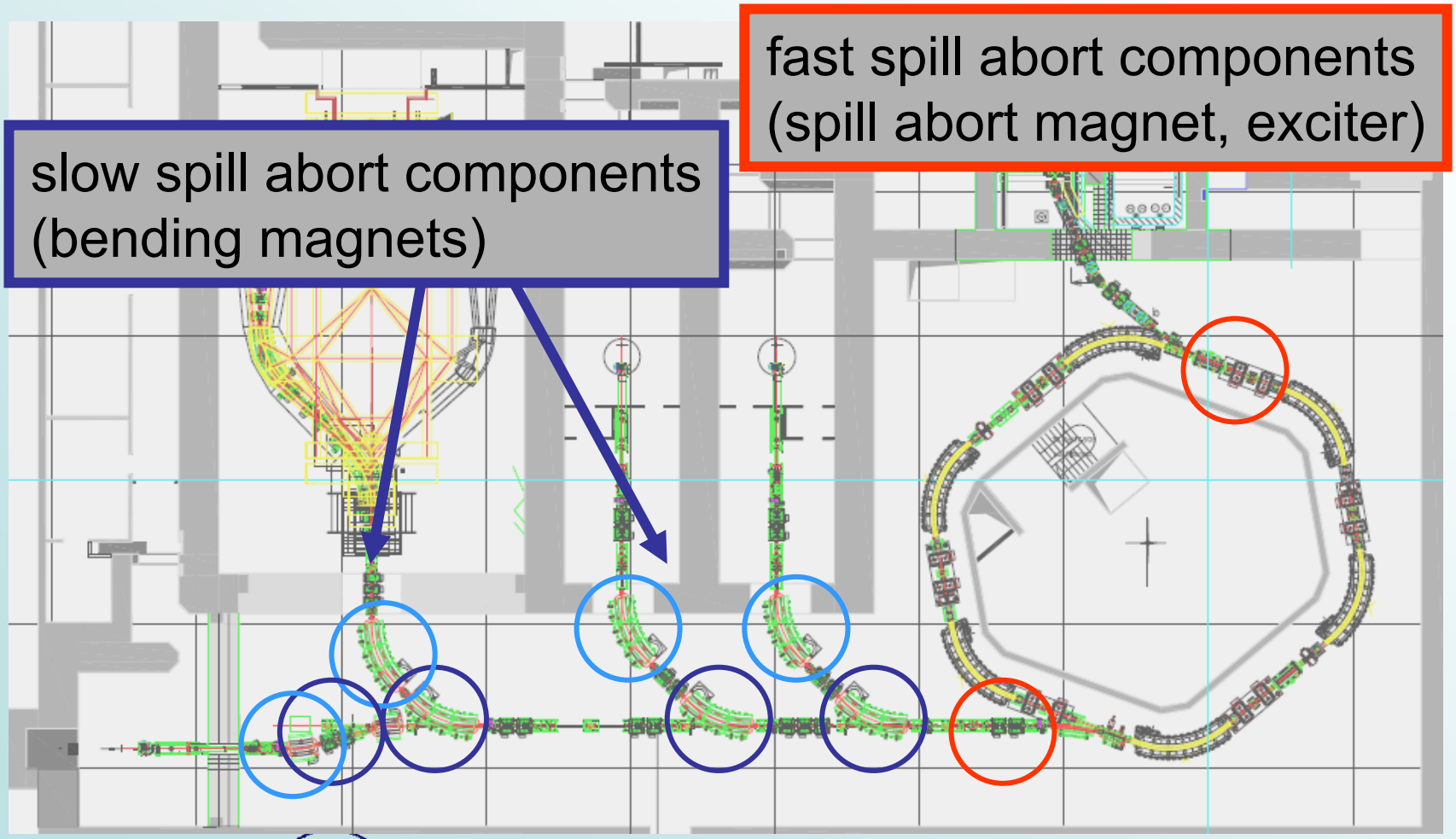
1) Multiple treatment rooms: spill abort system



1) Multiple treatment rooms: requirements

→ shared access to fast spill abort systems

1) Multiple treatment rooms: spill abort system

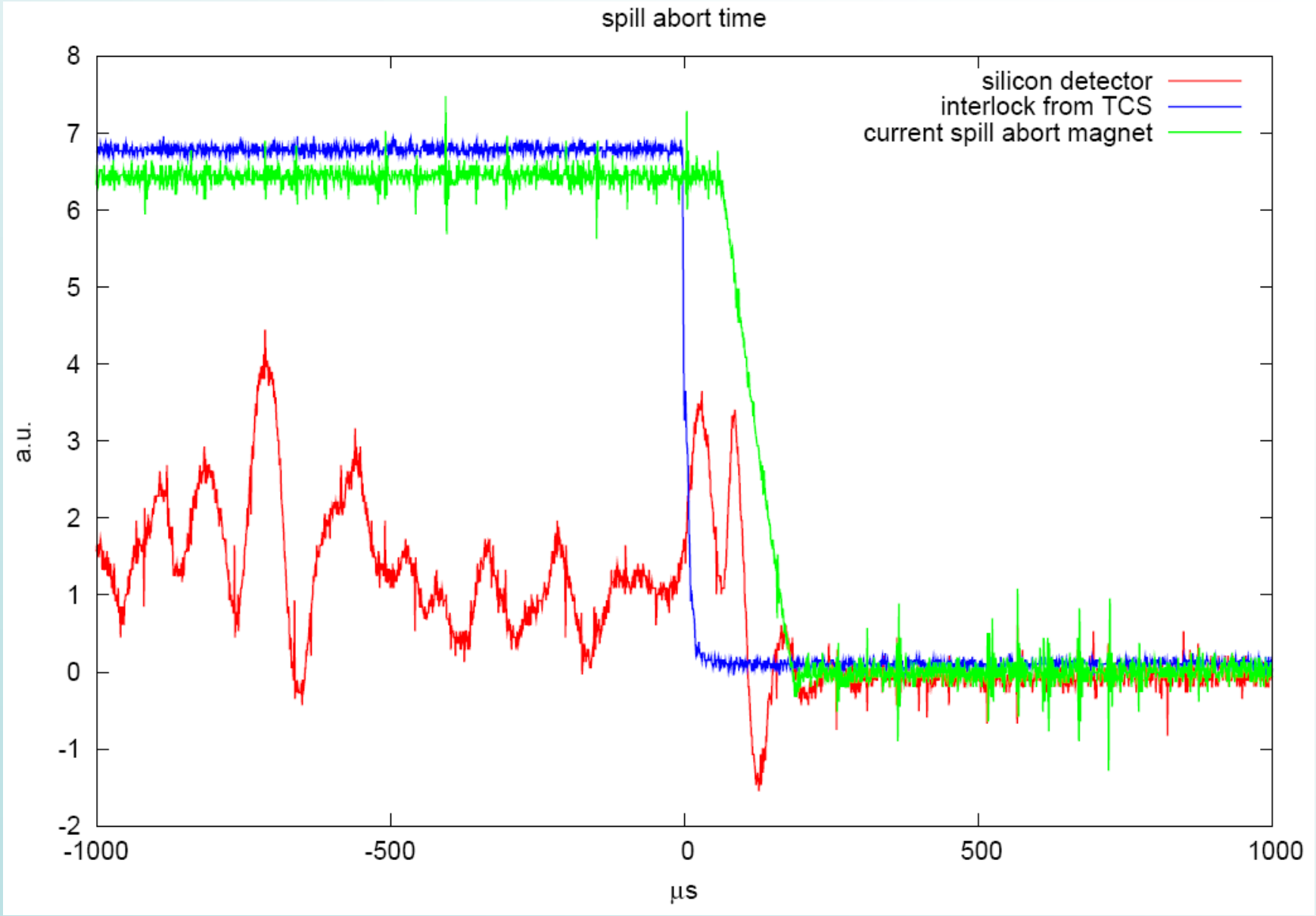


1) Multiple treatment rooms: requirements

→ shared access to fast spill abort systems

→ slow spill abort systems in safe state

→ access controlled by safety SPS („Arbitration and Safety Dispatcher“, „ASD“, Siemens PT)


spill abort time
silicon detector
interlock from TCS
current spill abort magnet
a.u.
µs
8
7
6
5
4
3
2
1
0
-1
-2
-1000
-500
0
500
1000

1) Multiple treatment rooms: requirements

→ shared access to fast spill abort systems

→ slow spill abort systems in safe state

→ access controlled by safety SPS („Arbitration and Safety Dispatcher“, „ASD“, Siemens PT)

→ queuing system for efficient beam utilisation

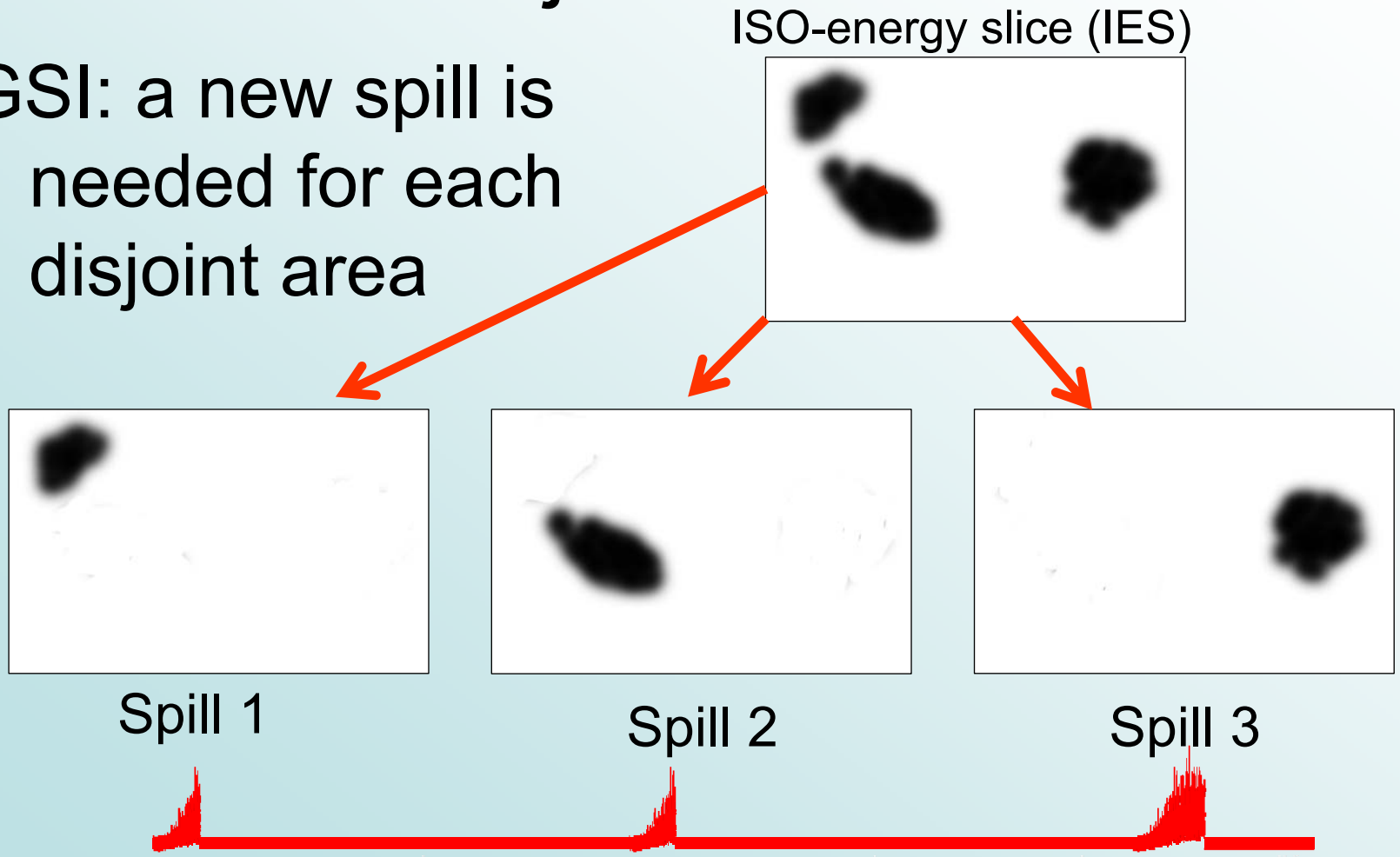
→ central data base of beam characteristics (LIBC), central PACS archive, central configuration…

2) Efficient beam control: spill pause

Parameter	GSI	HIT
delivery	fully active (raster scanning, active energy variation)	fully active (raster scanning, active energy variation)
ions	carbon	protons and carbon (2 ion sources); planned: helium-3, oxygen (3 ion sources)
intensity	2 x 10^6/s to 2 x 10^8/s (4 x 10^6/spill to 4 x 10^8/spill)	2 x 10^6/s to 8 x 10^7/s (carbon) (10 x 10^6/spill to 4 x 10^8/spill) upgrade to 3.2 x 10^8/s in progress (protons intensities x 40)
energy	2-30 cm range in water	2-30 cm range in water
focus	2.5-10 mm FWHM	3.5-13 mm FWHM (carbon)
spill pause	**no**	**yes**

2) efficient beam control: disjoint areas

GSI: a new spill is needed for each disjoint area

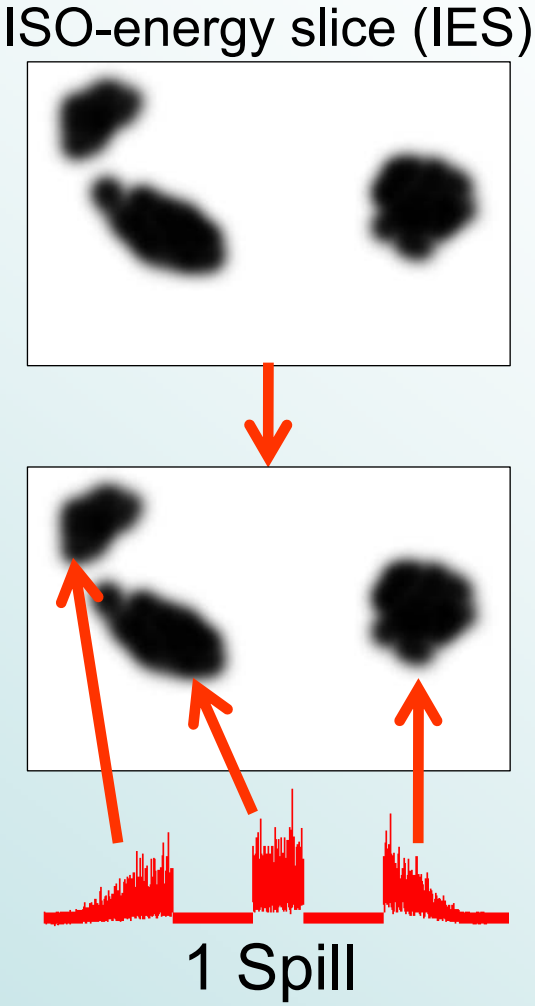


2) efficient beam control: disjoint areas

HIT: beam can be moved to a new position within a spill

→ spill pause functionality

→ Gating!



3) Legal aspects - the MDD

GSI: research project, in operation before commencement of German version of MDD (1997, transition period until 1998)

HIT: clinical facility, MDD fully applicable

→ it must be shown that the essential performance requirements are met

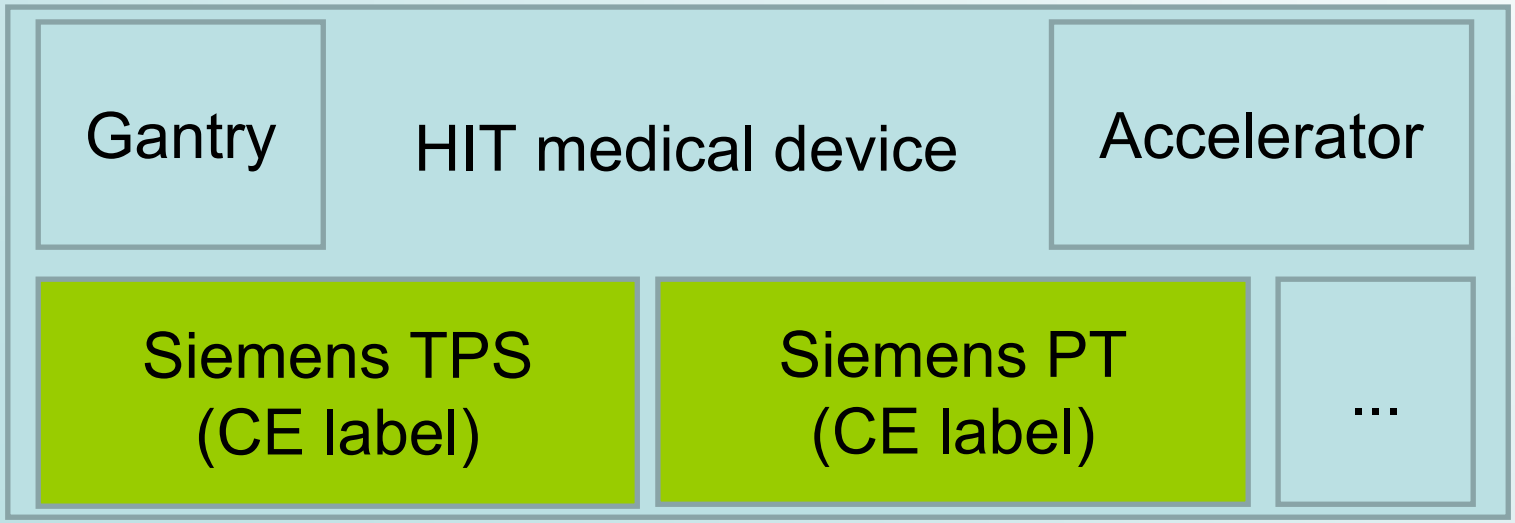
(e.g. system must either maintain a sufficient precision of irradiation or enter a safe state in case of an error)

→ risk management

3) Legal aspects - the MDD

HIT: “Eigenherstellung” (inhouse manufactured device):

The **whole** HIT facility is a medical product; the CE labeled Siemens PT and TPS products are incorporated in the HIT medical device.



3) Legal aspects - the MDD

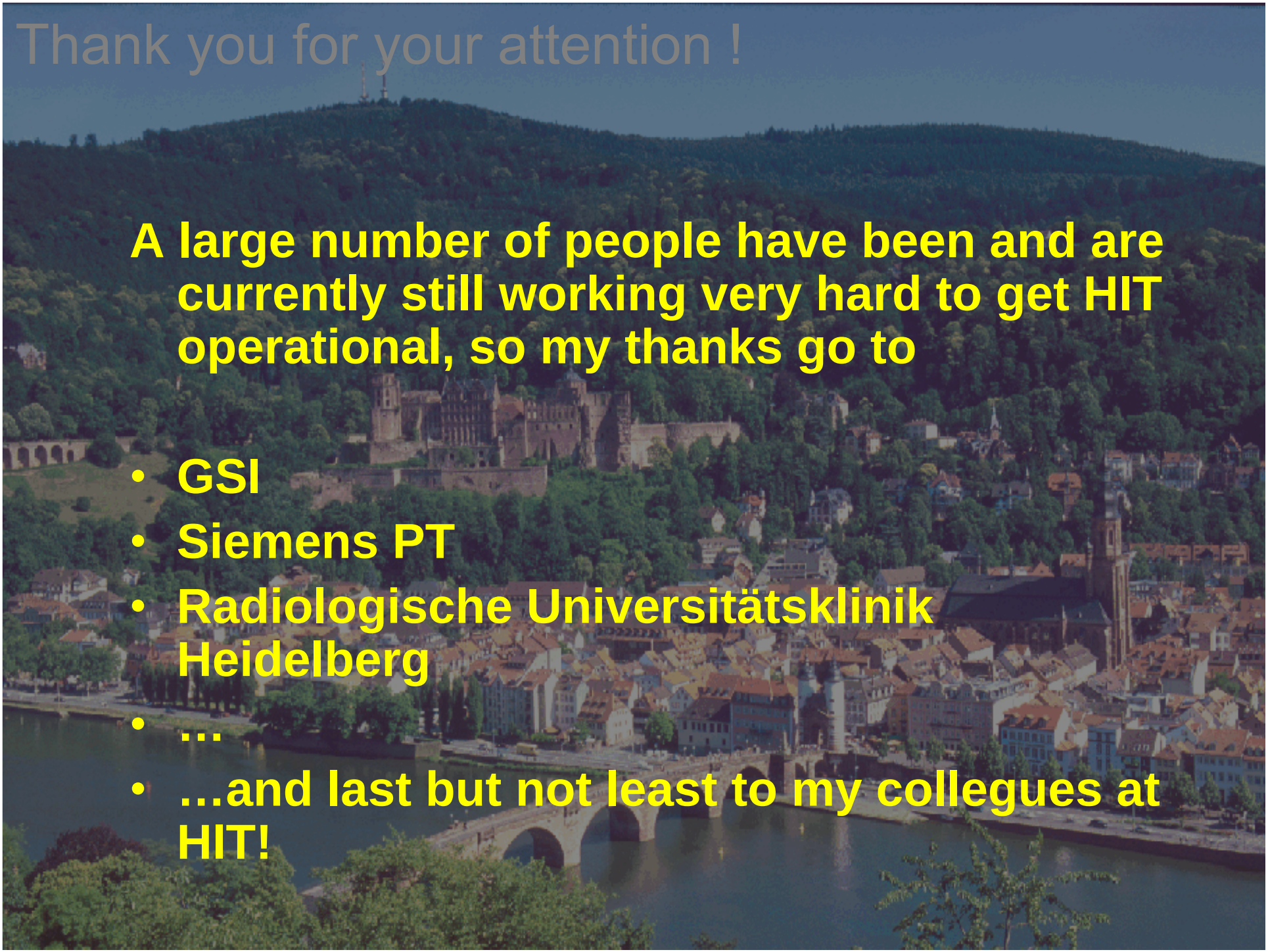
Risc management done by HIT GmbH

- full time risk manager
- ~1130 risk mitigations
- ~25 man years for risk assessment and for implementing risk mitigations
- main focus on accelerator
- risk management interface to Siemens product

Summary

Status September 2009:

- arbitration and safety system ASD working and has operated reliably for many months - the same holds for the other central resources (e.g. LIBC database)
- spill pause functionality fully usable
- risk management process nearly complete


Thank you for your attention !
A large number of people have been and are currently still working very hard to get HIT operational, so my thanks go to
• GSI
• Siemens PT
• Radiologische Universitätsklinik Heidelberg
• …
• …and last but not least to my collegues at HIT!