Fibre Connections HU/QSNET/QTF

Ullrich Schwanke
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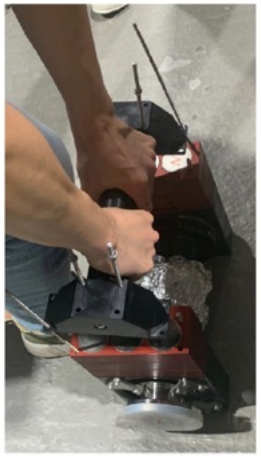
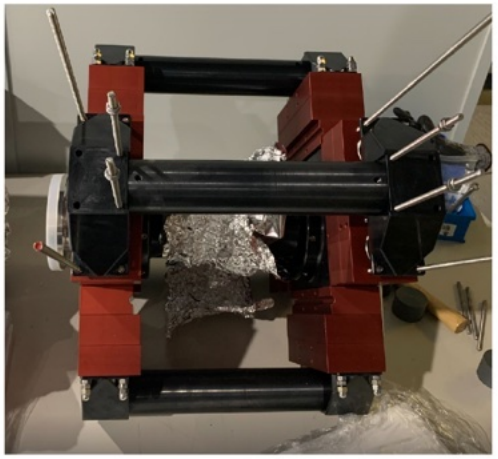
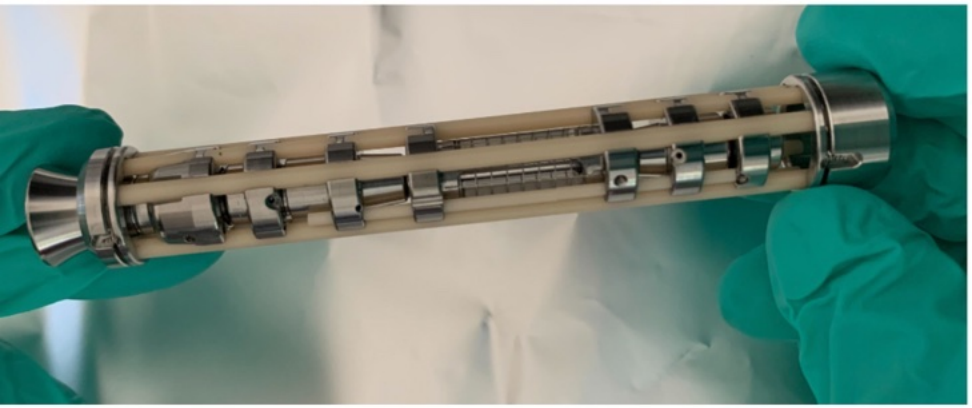
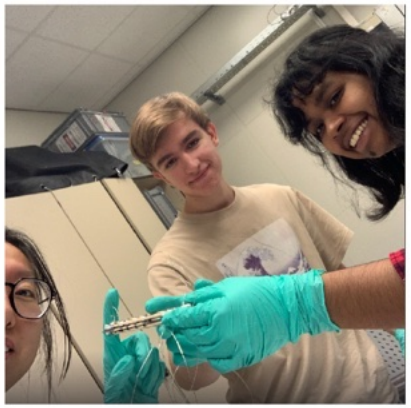
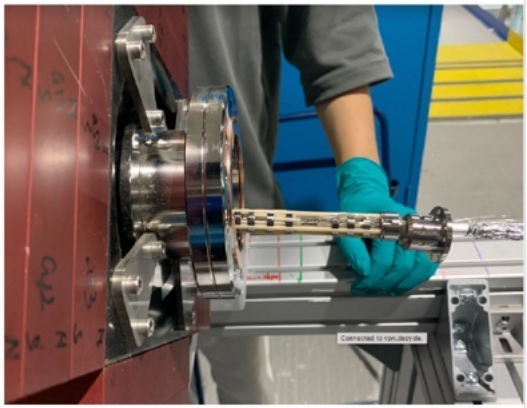
Connecting Clocks

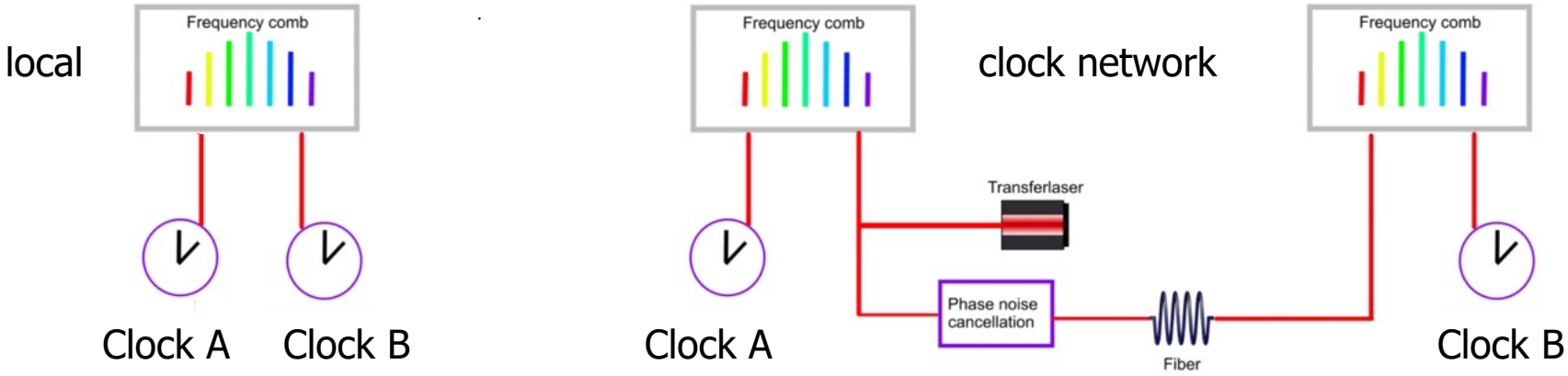




- **Let's assume for a moment our clock runs and we can plug the clock laser into a frequency comb.....**

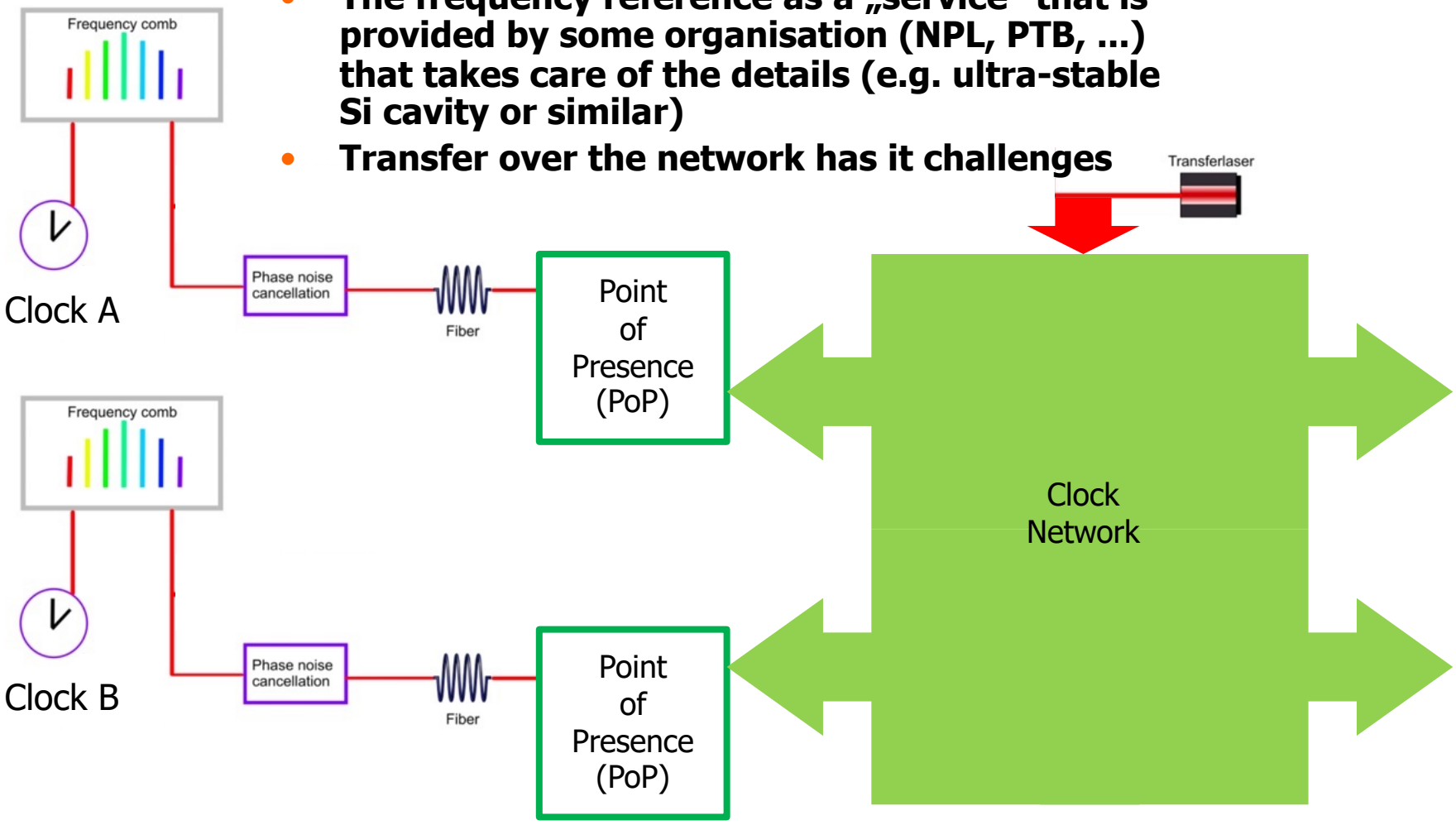
Connecting Clocks



- **… then we „only" need a frequency reference and we're done**
- **Local: direct comparison of clock lasers**
- **Clock network: use of a transfer laser around 1550/1542 nm**
  - **Lowest attenuation (0.2 db/km)**
  - **Matched to ultra-stable Si cavity**

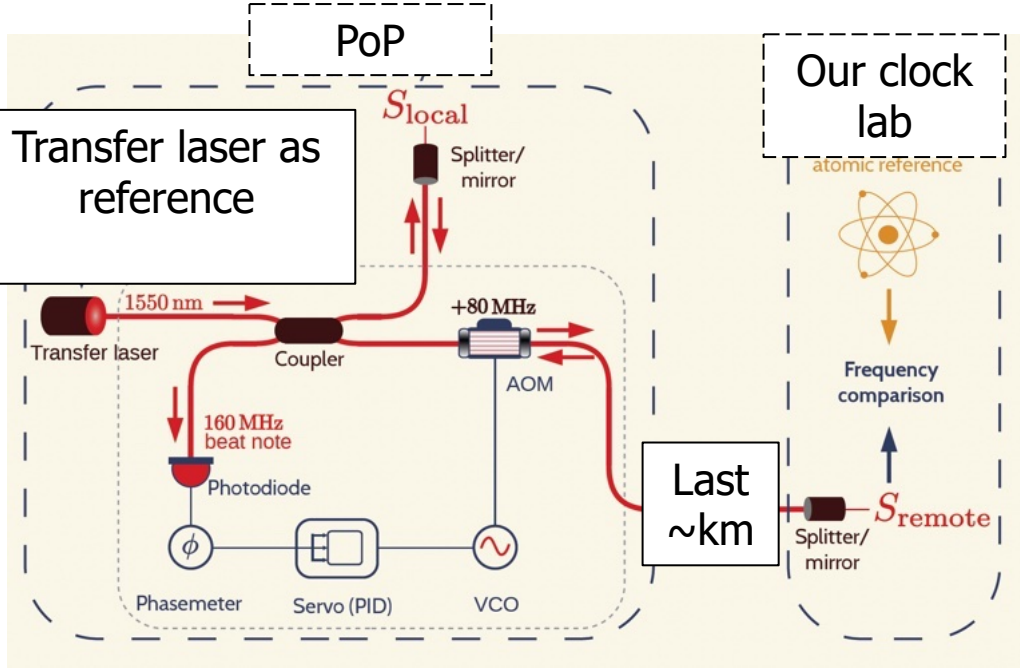
User's Perspective (1/2)

- **The frequency reference as a „service" that is provided by some organisation (NPL, PTB, …) that takes care of the details (e.g. ultra-stable Si cavity or similar)**
- **Transfer over the network has it challenges**



User's Perspective (2/2)

- **The location of the nearest PoP could be…**
  - **In your clock lab**
  - **In the cellar of your institute**
  - **In a building on your campus**
  - **In a building in in the centre of your town**
- **Phase noise cancellation (PNC) on the link segment between the PoP and your clock might be a user responsibility**



- **Important: One must be able to place PNC equipment (AOM, PID) in the PoP**
- **Standardization of the PNC equipment might be an issue/advantage in networks with several clocks**
- **See Jonas' talk for more details**

Example: QTF Backbone

https://www.ptb.de/cms/en/qtf-de-backbone.html 80%

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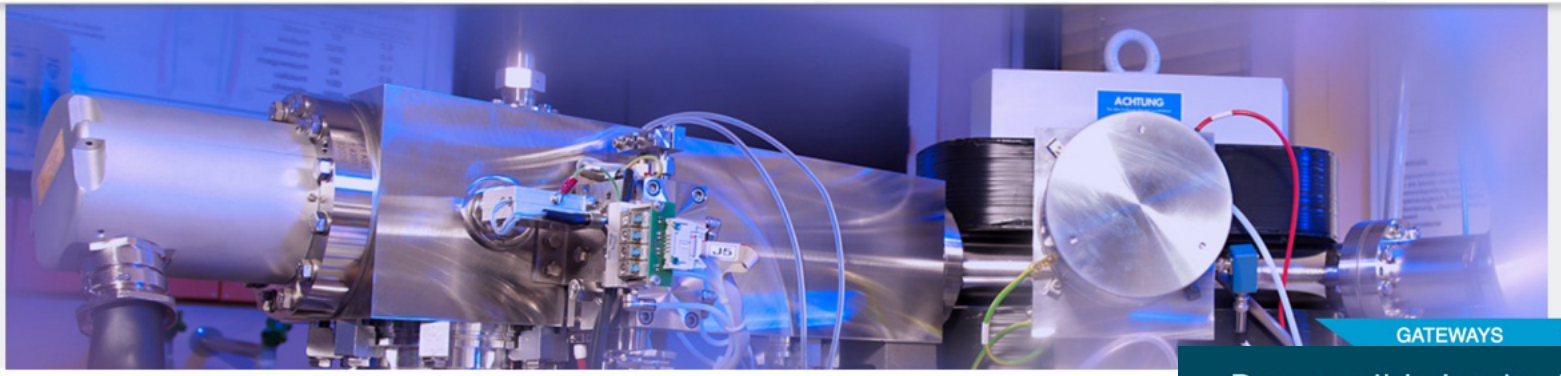

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Initiative für den Aufbau eines gemeinsamen Glasfasernetzes für Quantentechnologien und Zeit- & Frequenzsignale

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Example: QTF Backbone

- **Note: QTF Backbone is just an example; Steve will address related international initiatives later**
- **QTF: Quantum channel, Time and Frequency distribution**
- **Clocks comparison strictly needs only F, but there are related activities (e.g. QKD)**
- **Plans on renting four fibers (two fiber pairs); 4000 km fiber total**
- **The frequency reference is distributed as an optical carrier**
- **The QTF backbone would be a versatile research infrastructure**
- **Status: A recent proposal was turned down by the German Federal Ministry of Education and Research**
- **Total construction time scale is 10 y**
- **For Berlin, a PoP is envisaged in the city centre**

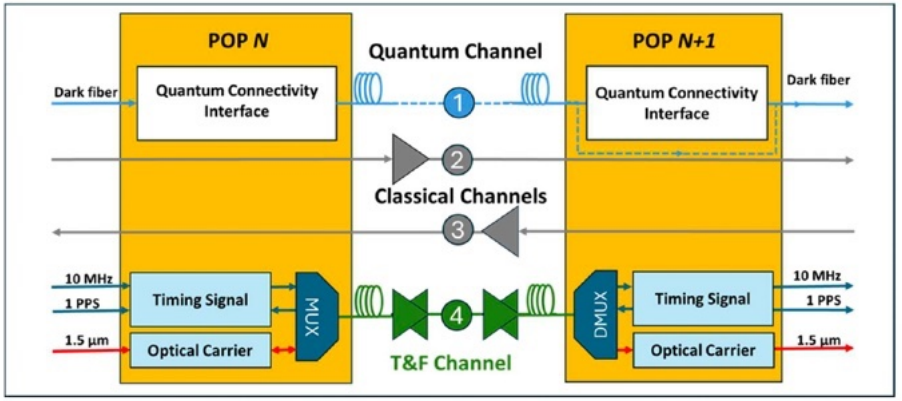


Figure 1: Network Layer: Four fibre approach connecting two PoPs with separate dark fibres for quantum communication and time and frequency dissemination.

Both Berlin and Heidelberg are part of phase 1

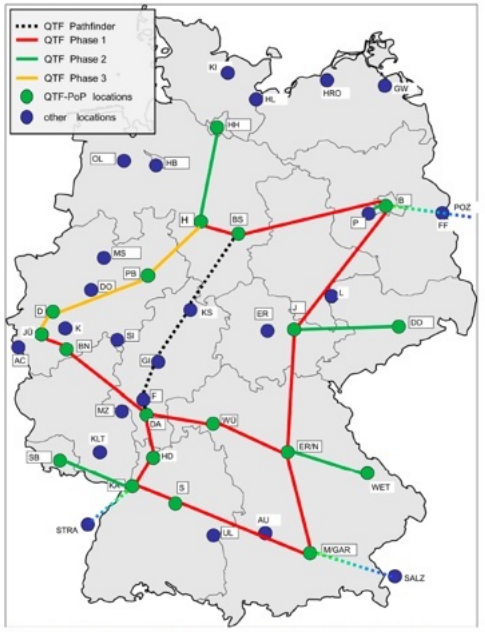
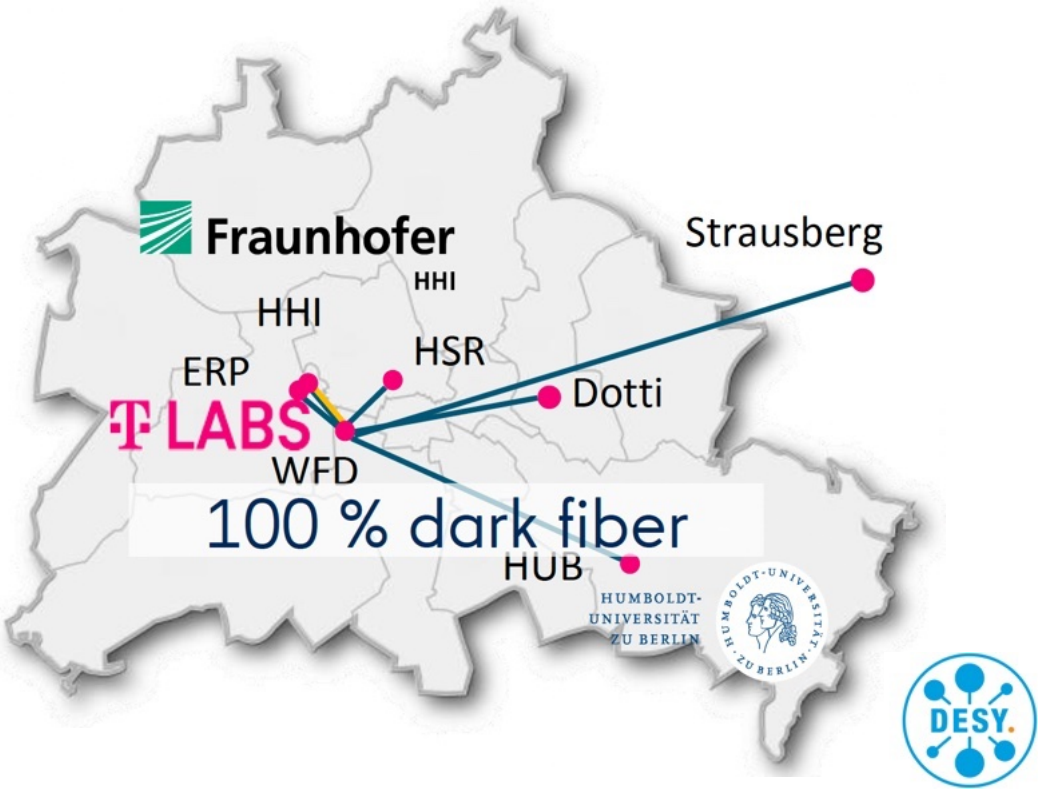


Figure 5: Planning Network Phases: PoP Locations, all four implementation phases are shown on this map.

QTF-Backbone: Proposal for a large research infrastructure (2024)

Example: HU Berlin/DESY

- **Need single-mode fibers (e.g. of type G.652.D) for long-haul frequency transfer**
- **Most institutes (DESY/HU) are locally equipped with multi-mode fibers, so one has to install SM fibers that (i) end in the clock lab and (ii) grant us exclusive access (dedicated fibres)**
- **Teamed up with computing people and groups at the HU Institute of Physics (QKD, clocks, …) to ask for extra SM fibres**
- **Status: The Technical Department of Humboldt University recognises the need for more SM fibers and is about to charge a planning company that will work with us**



Both the TLABS of Deutsche Telekom and a tentative QTF-Backbone PoP reside in the city centre;distance to Adlershof Campus (DESY Zeuthen) is about 20 km (30 km)

Example: HU Berlin/DESY

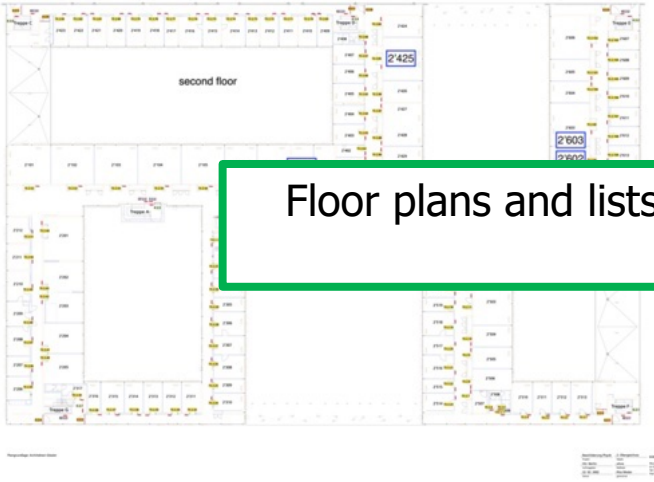
Verlegung zusätzlicher Singlemode-Glasfaserkabel im Institut für Physik (NEW 15) und zum Erwin-Schrödinger-Zentrum (ESZ) bzw. dem IRIS-Gebäude

Prof. Oliver Benso
Dr. Björn Leder, Prof. Tin

Document asking Humboldt University for the installation of O(100) extra SM fibres

28. November 2024
Version 1.0

Vorbemerkung: Dieses Dokument wendet sich an die Technische Abteilung der Humboldt-Universität zu Berlin und soll als Diskussionsgrundlage dienen. Alle genannten Zahlen und Konzepte sind vorläufig und können im Interesse einer optimalen Lösung und von Synergien mit der allgemeinen Netzwerkanbindung des Instituts für Physik adjustiert werden.

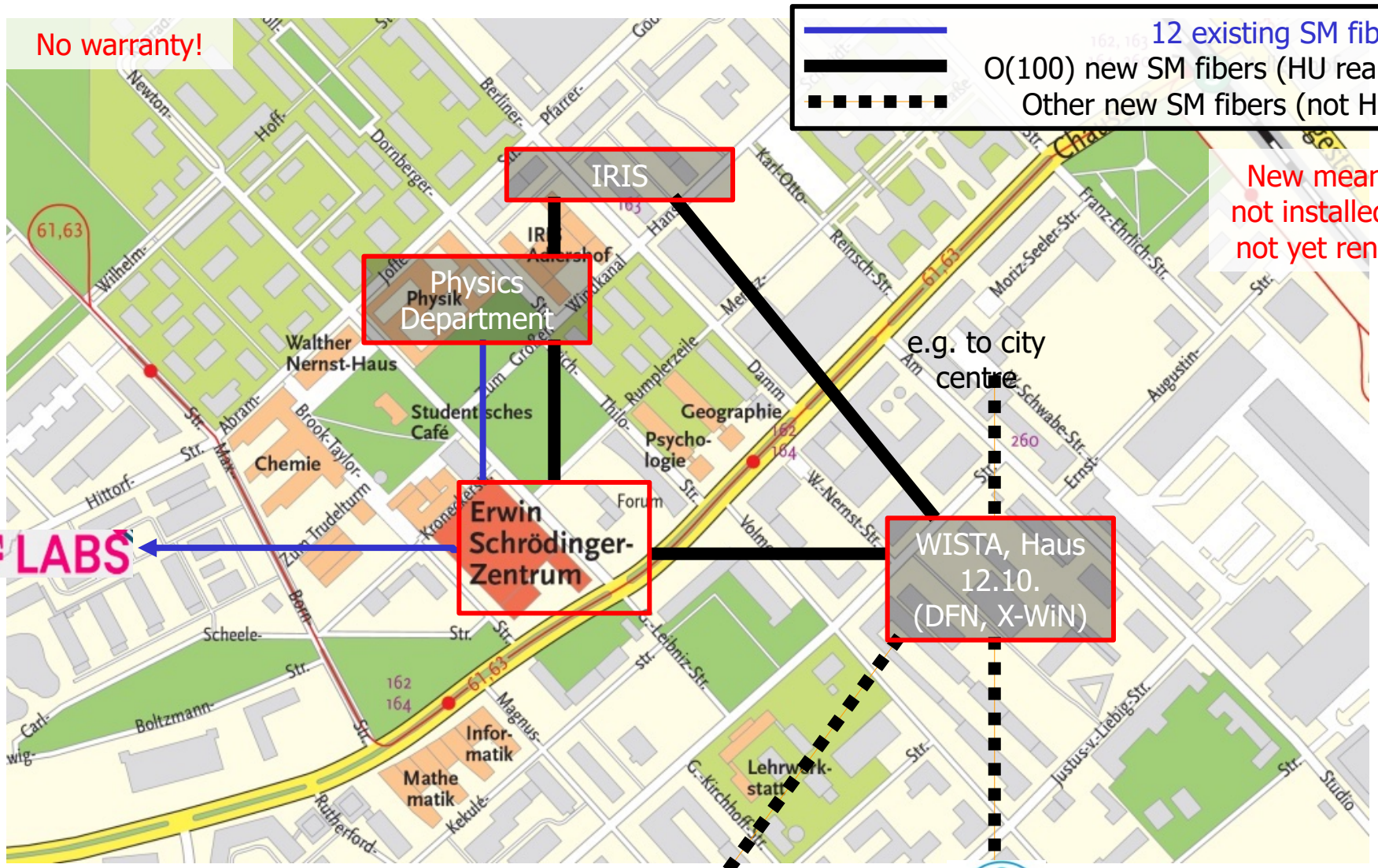


Floor plans and lists of laboratories that should be equipped with dedicated SM fibres

Tabelle 1: Liste der Laborräume, die mit SM-Glasfaserkabeln versorgt werden sollen.

Gebäude	Raumnummern	Arbeitsgruppe	Anzahl Räume
Institut	0'606	Krutzik/Peters	1
für	0'607	Benson	1
			1
			1
			1
			1
	2'601-603	Schröder	3
	3'201	Krutzik	1
			Summe: 10
IRIS-Gebäude	2.-115A, 2.-115B, 2.-115C	Krutzik	3
			Summe: 3

Example: Adlershof Campus



Discussion

- Plans for QSNET?
  - A clock network with star-like topology is relatively easy (e.g. NPL as centre)
- Plans and Status MPIK?
- Synergies (e.g. PNC hardware, see next talk)
- ...