**Goals**

1. to conceive and develop cutting-edge detector technologies and systems to keep the Research Field Matter at the forefront of scientific discovery,
2. to exploit the scientific potential of our current and future facilities,
3. to explore novel detection methods that promise to open entirely new research directions in Matter
4. to strive to push the physical limits of space, energy, and time resolution, both in principle and in concrete systems, ready for experiment
5. MT-DTS will develop innovative detector and data acquisition concepts to cope with the extreme data rates and adverse environmental constraints
6. We do this in close interaction with the other MT Topics and Programs in the Research Field and beyond
7. Our success depends critically on the close collaboration between physicists and engineers, both within the Program MT and with MU and MML and beyond
8. We have identified two main thrusts for our research: combining precision space, time, and in some cases energy resolution in one detector system … approaching the limits of detector physics and
9. … coping with the deluge of data modern detectors provide.
10. … meeting the challenge of extreme data requires a radically new solution. We will strive to establish silicon photonics as a pioneering technology for the transmission of huge detector data streams
11. … to significantly enhance our infrastructure… the establishment of the Helmholtz Distributed Detector Laboratory (DDL)
12. to focus on the key challenges and on areas where we see opportunities for revolutionary changes and maximum impact:
13. to expand our activities in … superconducting sensors … approach the limits of energy resolution
14. to make the notoriously difficult regions of very soft and very hard X-rays accessible
15. Technologies to turn sensors and ASICs into a complete system
16. to develop engineering techniques for the construction of highly integrated detector modules
17. to address the challenge of transmitting data from detector to back-end systems with silicon photonics
18. to test technologies … in full demonstrator systems, with science application being the ultimate performance test.
19. We strive to combine technologies from ST1, ST2, and beyond in a given demonstrator system in order to use resources effectively and enhance demonstrator performance and impact
20. Cooperations exist with essentially all leading institutes in our fields of research
21. By offering exciting challenges and the opportunity to apply cutting-edge technology and enable forefront science in an international, diverse, and interdisciplinary environment, we keep attracting young talents to MT-DTS
22. Societal benefits are anticipated from … technologies for medical applications e.g. 3D-ultrasound computer tomography (3D-USCT) or heavy-ion therapy…
23. In PoF III, we organized a number of additional events especially directed at young researchers… two week-long schools concentrating on aspects of detector development (Heraeus seminars)… regular hands-on training events, e.g. for microTCA and related hardware.
24. we will actively encourage young researchers to spend time at centers contributing to MT, for example when working on system integration, commissioning, or test beam activities, to widen their professional experience and build networks.
25. well as novel sensor concepts

**Competences**

1. MT-DTS has a strong record in conceiving, designing, delivering …. key instruments for Matter
2. With program MT … detector instrumentation has blossomed
3. Key assets are … its broad technical competence, a diverse and interdisciplinary blend of permanent staff of physicists, engineers, and technicians, and a rich technical laboratory infrastructure
4. MT-DTS excels in sensors
5. our pioneering HVCMOS sensor
6. with numerous ASIC and system developments for various applications
7. The creation of MT-DTS has also propelled our DAQ competence. The MT-DTS DAQ platform ….
8. the ultrafast waveform sampling system KAPTURE for THz detectors with picosecond resolution and GHz repetition rates …
9. By integrating GPUs in DAQ systems, we have accelerated data processing for applications such as tomographic reconstruction by orders of magnitude.
10. We are advocating and pioneering silicon photonics for data transmission systems
11. Our multiplexing technology for readout of many-pixel superconducting sensors has attracted great interest
12. Next to its competence in advanced technologies, MT-DTS is a leader in systems development
13. proximity to the users and science applications in MU and MML is a major asset
14. commercialized by the spinoff company X-Spectrum
15. our system competence is demonstrated by … large fraction of the CMS vertex detector upgrade and our central role in the upgrades of the ATLAS and CMS tracker systems
16. the ALICE time projection chamber
17. mDOM Cherenkov detector modules recently selected for the IceCube-Gen2 upgrade
18. establishment of a game-changing technology for highly granular calorimeters, where we are recognized as world-leading experts

**Impact and risks**

1. We will actively scout technologies and identify promising technologies that have not yet emerged or are not yet a priority today
2. focus on the key challenges and on areas where we see opportunities for revolutionary changes and maximum impact
3. The combination of extreme granularity – and thus excellent spatial resolution – with sub-nanosecond timing resolution in one system is promising to induce a paradigm change in particle and heavy-ion physics detectors
4. By placing the focus on several paradigm-changing technologies, we anticipate creating huge opportunities
5. 4D sensors or silicon photonics, would qualify as high-risk, high-impact research, enabling experiments that may be realized only beyond PoF IV
6. To mitigate risk and maximize opportunity … with two alternative technologies
7. Several of the technical solutions we envisage face fierce competition. Here, the breadth of our science applications provides maximum opportunities to quickly introduce a given technology into experiments
8. The establishment of the DDL will create great opportunities for MT-DTS

**Work program**

1. The breadth of the MT-DTS application fields and the concerted design of readout ASICs in ST1 and data processing systems in ST2 enable MT-DTS to exploit many synergies
2. MT-DTS has successfully established strong collaboration with MT-ARD in beam diagnostics, where we are world-leading
3. The links between MT-DTS and the Programs MU and MML are very strong, and the strategies of all *Matter* Programs are closely aligned. Many MT-DTS staff members work part-time on experiments or projects within MU and MML
4. The work in MT-DTS is supported by a lightweight organizational structure. Each Subtopic is headed by two coordinators from different centers. Subtopics, in turn, are structured into work packages, led by two coordinators.
5. The demonstrator projects in ST3 form an effective link across MT-DTS and into MT-DMA as well as MU and MML, combining advanced sensors, ASICs, and system components into full working units delivering data for first scientific applications.
6. Established and effective MT-DTS management tools include regular phone conferences and meetings of the MT-DTS executive board and the work package coordinators.
7. There are dedicated topical meetings and workshops, complemented by the successful and high-profile MT annual meeting of all Topics.
8. All of this allows us to monitor progress, optimize the use of resources, identify promising research directions, and act expediently.
9. We have compiled a list of high-level milestones.

1. Each milestone would be a major achievement and large benefit for science in MU, MML (and MT)
2. Milestones are related to each other
3. Milestone projects are collaborations of two or more centers/partners
4. We have much more detailed plans than MS table suggests 🡪 examples
5. We have put a light-weight but effective organizational structure in place

PoF IV

Vision Milestones

Objectives

Structure