European Design Study Towards a TeV Linear Collider

WP 6: Metrology and Stabilisation (METSTB)

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METSTB Overview

- **Task 1: Survey and Alignment**
  - Provide Metrology and Alignment process for the complete collider (3-step process)
  - Step 1: Rapidly perform collider reference survey with maximal automation (Metrology, RTRS=Rapid Tunnel Reference Surveyor)
  - Step 2: Survey collider components against reference (automated stake-out instrument(s))
  - Step 3: Adjust collider geometry allowing save insertion of beams (Alignment)
  - Provide rapid, accurate measure of geometry after adjustment with minimal reduction of up-time (Diagnostic function)

METSTB Overview

- **Task 2: Stabilisation**
  - Mechanically stabilise most critical components (**FF**, possibly other parts of BDS, i.e. chromaticity correction section)
  - Find optimal combinations of,
    - passive measures (damping, foundations, site choice)
    - sensors (optical, inertial),
    - actuators (piezo, electro-static, motor, ?),
    - feed-back algorithms (multiple sensors, frequency range, synch. with other feedback system)
    - vibration models (6D solid, internal degrees of freedom, vibration FEA)
  - Demonstrate system performance on realistic geometry FF-mock up
- **Synergies between tasks:**
  - Combine survey technology (FSI) with optical stabilisation sensors to give accurate absolute FF placement

METSTB Overview

- **Task 3: Ground Motion Spectra Cataloguing**
  - **Perform ground motion studies at potential LC sites around the world**
  - **Develop state-of-the-art spectrum measurement system with nm resolution**
  - **Develop software for analysis**
  - **Characterise vibration spectra with respect to identified vibration sources (e.g. ‘cultural’ noise)**
  - **Provide public database of spectra measurements for the LC community**

provides important input to simulations performed as part of WP6: ILPS

METSTB Overview

- Relevance for the LC
  - Survey and Alignment:
    - First use in tunnel construction, determine settling, place component pedestals
    - Second use in component placement
    - Continuous use during operation to track drifts and other position related problems
  - Stabilisation
    - First impact in choice of site. How much vibration can we suppress with active and passive measures?
    - How many feedback systems do we need and how do they interact?
    - Influence on FF magnet design (vibration modes and sources)
    - FF stability is critical for luminosity stabilisation
    - Accurate FF placement reduces time from beam on to max lumi
- Technological Importance

METSTB Participating Institutes

- DESY:
  - Task 1: Survey and Alignment
    - GeLiS (Rapid Tunnel Reference Surveyor) based on stretched wire and hydrostatic levelling system
    - Monitor tunnel/component motion
  - Task 3: Ground motion spectra
    - perform measurements
    - develop software
    - characterise spectra (in collaboration with TU Harbourg)

METSTB Participating Institutes

- LAPP: ??? This needs beefing up by Yannis
  - Task 2: Stabilisation
    - Inertial sensor development
    - Inherit CERN equipment to set up common stabilisation test bed
    - Develop feedback algorithms (engineering department at LAPP)
    - Expertise in ???
    - ???

METSTB Participating Institutes

- Oxford:
  - Task 1: Survey and Alignment
    - Develop complete sensing system for RTRS based on
      - FSI: Frequency Scanning Interferometry for absolute distance measurements
      - LSM: Laser Straightness Monitors
    - Culminate in prototype RTRS operational in DESY test tunnel
    - Aim to be usable in X-FEL
    - Develop automatic stake out instrument
    - Develop additional diagnostic functions for RTRS (vibration monitors, RTRS = remote controlled, mobile, multi-purpose diagnostics platform)
  - Task 2: Stabilisation
    - Optical sensor development (M-FSI = Michelson interferometry combined with FSI)
    - Fast, cost effective custom readout and DAQ
    - Push frequency reach of sensors up (Aim > 10 kHz)
    - Integrate into feedback systems and mock-up FF quad

METSTB: Deliverables & Milestones

- Task 1: Survey and Alignment: Oxford contributions only

Year	05				06				07			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Prototype train development:												
- Light amplification studies	==											
- Single Line studies in lab.	==	==	==	==								
- Custom readout development	==	==	==	==								
- Integration of FSI with LSM in lab			==	==	==							
- 3-car prototype-runs in test tunnel						==	==					
- 5-car prototype construction								==	==	==		
Calibrations			==	==	==	==						
Performance simulations	==	==	==	==								
Off-line software	==	==	==	==	==							
On-line software	==	==	==	==	==	==						
Stake out Instrument								==	==	==	==	
Diagnostics enhancements									==	==	==	==

METSTB: Deliverables & Milestones

- Task 2: Stabilisation (Oxford contributions only)

Year		05				06				07			
Quarter		1	2	3	4	1	2	3	4	1	2	3	4
M-FSI stabilisation prototype	**Ox**												
- Evaluate requirements and status quo	**Ox**	==											
- Michelson laser stabilisation design	**Ox**	==	==										
- Short single line M-FSI studies in lab.	**Ox**	==	==	==	==	==							
- Custom M-FSI readout and DAQ	**Ox**		==	==	==	==							
- Laser frequency stabilisation	**Ox**			==	==	==	==	==	==				
- Michelson phase measurement	**Ox**			==	==	==	==	==					
- Verify nm scale at LAPP/CERN/DESY	**Ox**				==								
- First line with feedback loop closed	**Ox**							==	==				
- Six DOF short line prototype in test bed	**Ox**								==	==	==		
- SIX DOF long line prototype in test bed	**Ox**										==	==	==

METSTB: Deliverables & Milestones

- Task 2: Stabilisation

Year		05				06				07			
Quarter		1	2	3	4	1	2	3	4	1	2	3	4
Inertial sensors	LAPP												

METSTB: Deliverables & Milestones

- Task 2: GM measurements

Year		05				06				07			
Quarter		1	2	3	4	1	2	3	4	1	2	3	4
Procurement	DESY	==	==										
Software developement	DESY		==	==	==	==	==	==	==				
Measurements (~3 / year)	DESY		==	==	==	==	==	==	==	==	==		
spectra characterisation	UHB			==	==	==	==	==	==	==	==	==	
Set up DB server(s)	DESY		==	==									
Prepare final report												==	==

METSTB: Budget 1: MANPOWER

total person years	TASK #1 Survey and Alignment		TASK #2 Stabilisation		TASK #3 GM Spectra		Total cost k€	
	tot	req	tot	req	tot	req	tot	req
Oxford	17.25		9.0	3.0			1881.5	164.6
DESY	6				9	3	904.5	198.0
LAPP			?	?			?	?
total MP	23.25		?	?	9	3	2786	362.6

METSTB: Budget 2: MATERIALS

k€	TASK #1 Survey and Alignment		TASK #2 Stabilisation		TASK #3 GM Spectra		Total Cost	
	tot	req	tot	req	tot	req	tot	req
Oxford	230		195	117			425	117
DESY	600				270	100	870	100
LAPP			?	?			?	?
total cost							1295	217

METSTB: Budget 3: TRAVEL

k€	TASK #1 Survey and Alignment		TASK #2 Stabilisation		TASK #3 GM Spectra		Total Cost	
	tot	req	tot	req			tot	req
Oxford	60.6	16	30	20.5			127.2	36.5
DESY	18	18			60	20	78	38
LAPP			?	?			?	?
total cost							205.2	74.5

BUDGET #4: Summary ???

k€	Total Budget	EU requested budget
MANPOWER	2786	362.6
MATERIALS	1295	217
TRAVEL	205.2	74.5
TOTAL	4286.2	654.1

need Jannis numbers here!!