SLS VERTICAL EMITTANCE TUNING

Objectives, Organization, Timeline

Erk JENSEN/CERN

TIARA Kick-Off Meeting, CERN, 23-24 February 2011

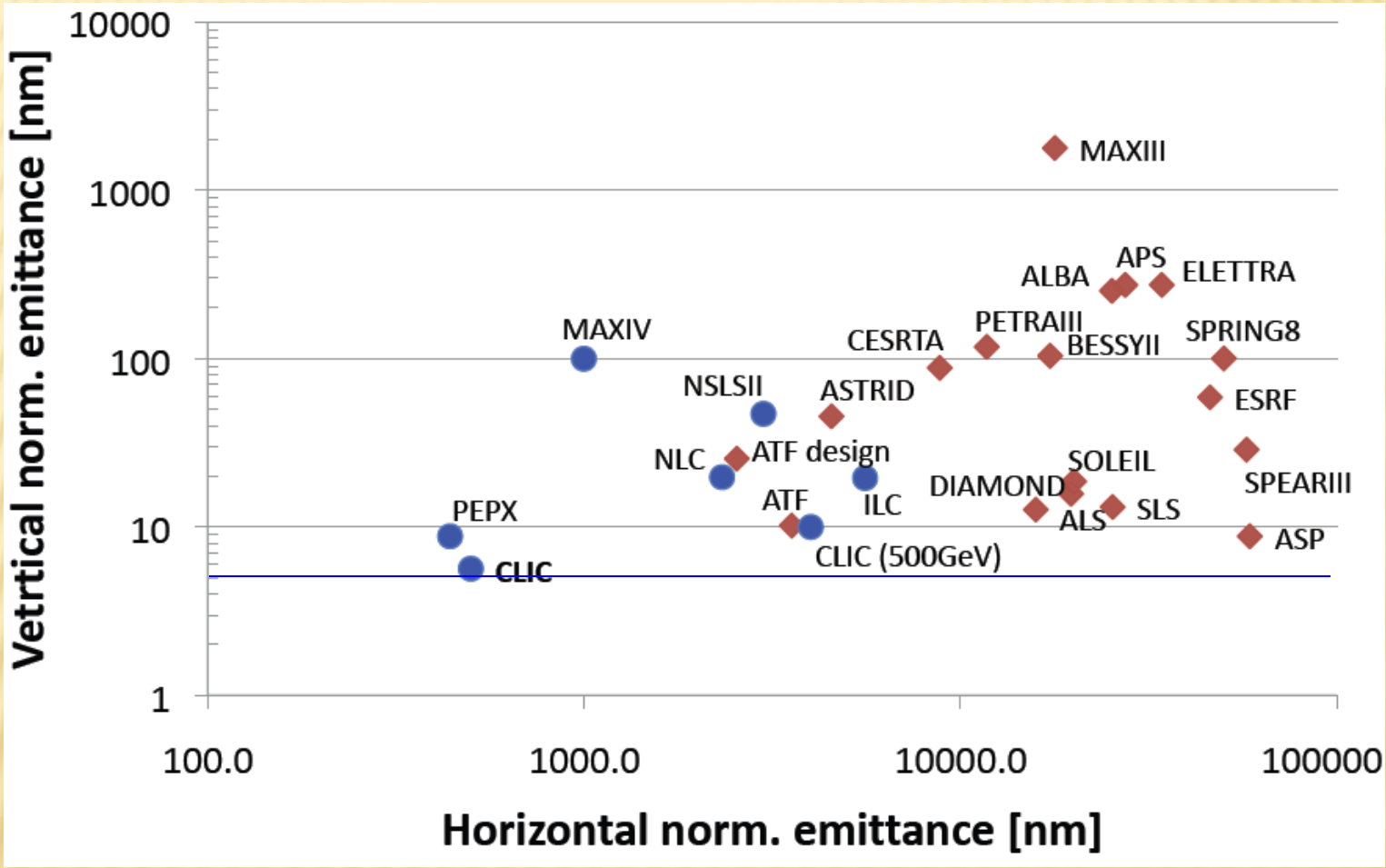
THE MAIN MESSAGE:

- This is a Kick-Off Meeting: TIARA has started officially on January 1st, 2011!
- SVET project active during 30 months:
  January 1st, 2011 – June 30th, 2013

WP6 (SVET)

- **SVET: "SLS Vertical Emittance Tuning"**
  - Russian "Свет" means "light"
- **Objectives:**
  - Convert the Swiss Light Source (SLS) to a ***R&D Infrastructure***,
  - Demonstrate ultra-small emittances as required for future Linear Collider Damping Rings (5 nm normalized, <1 pm @ 2.86 GeV)
  - Enable to extend tests to lower energies (IBS dominated regime).

SMALL EMITTANCES



THE MAIN PLAYERS

- **PSI:** Masamitsu Aiba, Michael Boege, Andreas Streun, …
- **CERN:** Yannis Papaphilippou, Fanouria Antoniou, (?) BE-BI…
- **INFN/LNF:** Marica Biagini, Simone Liuzzo, Fabio Marcellini, Mario Serio, …
- **Max-IV Laboratory** (via PSI): Åke Andersson, …

WHAT IT TAKES: STEP 1

- **Step 1:** With the existing hardware:
- Ensure optimum measurement accuracy (beam size, position, emittance, coupling, …)
- Minimize magnetic field errors
  - alignment of girders/magnets
  - alignment of BPM's
- Minimize betatron coupling (using exisiting skew quads)
- **Result:** Show what is possible & where improvements are needed.
  Interim report due in May, 2011 (Milestone),
  final report due: Month 9, September 2011

WHAT IT TAKES: STEP 2

- **Step 2:** With those results:
- Specify the necessary improvements of
  - Beam position monitors,
  - Beam profile (emittance) monitors,
  - Emittance control knobs,
  - Magnet trimming coils and supplies
- **Result:** Specification of upgrades
  (Specifications due: Month 18, June 2012)

WHAT IT TAKES: STEP 3

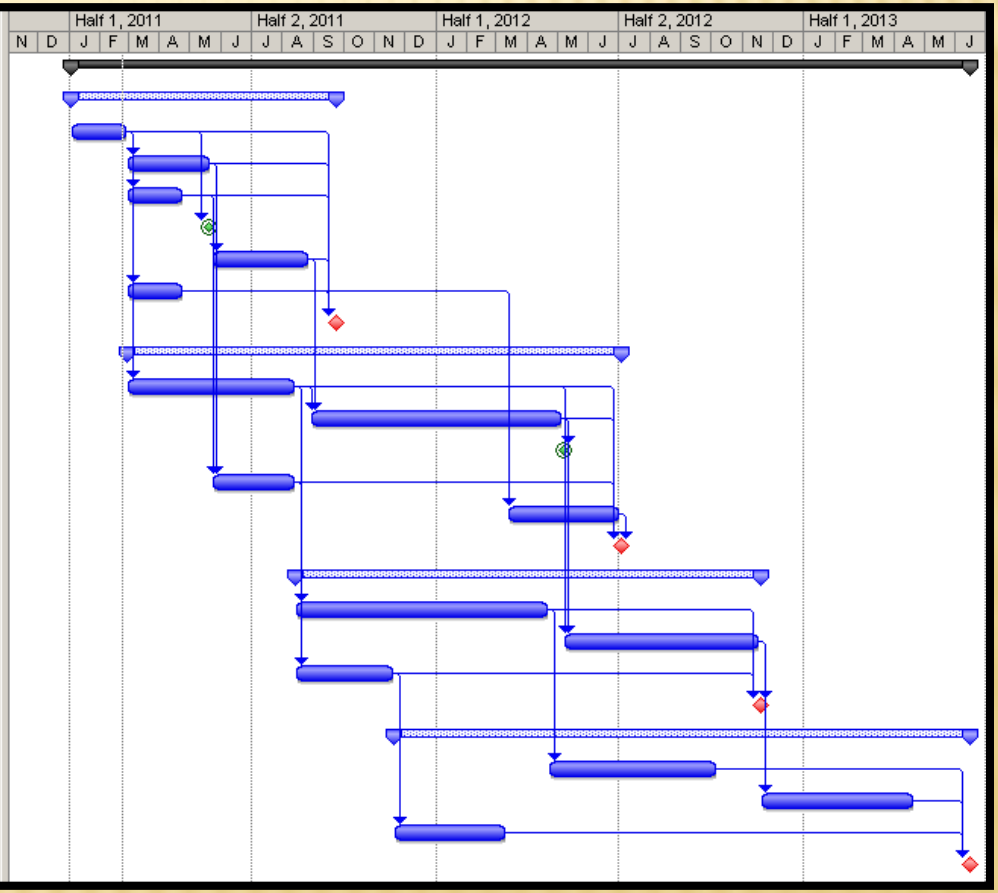
- **Step 3:** Implementation of upgrade:
  - Down-select most important hardware to be implemented (financial constraints), planned:
    - improved BPM's and/or alignment
    - correction knobs and feedback algorithms (automated coupling control)
    - improved resolution/sensitivity beam profile monitor (laser based?)
    - knob allowing energy scaling
  - Fabricate hardware,
  - Install hardware in SLS
- **Result:** An improved SLS, allowing to reach smaller vertical emittances at different energy levels.
(Implementation due: Month 24, December 2012)

WHAT IT TAKES: STEP 4

- **Step 4:** Commissioning:
  - Commission improved BPM and/or alignment system
  - Verification of the automated coupling control
  - Commission new beam profile monitor
  - (the commissioning at lower energy is not formally included due to financial/time constraints)
- **Result:** Final report on obtained results, due Month 30, June 2013

WP6 (SVET): GANTT CHART

WBS	Task Name
6	**WP6 Upgrade of SLS vertical emittance tuning system (SVET)**
6.1	**6.1 SLS_NOW: Experimental tests at SLS with existing systems**
6.1.1	6.1.1 EPS_Limit: emittance limit
6.1.2	6.1.2 EPS_Sens: emittance sensitivity
6.1.3	6.1.3 MON-RES: profile monitor resolution
MS25	MS25 M_INSTR: Interim report on existing beam instrumentation
6.1.4	6.1.4 COUPLING: coupling theory
6.1.5	6.1.5 MAG_Scale: magnet scaling
D6.1	D6.1 D_SLS_NOW: Report on existing hardware situation and limitations
6.2	**6.2 SPEC: Specification of necessary upgrades**
6.2.1	6.2.1 ORB_C_SPEC: Orbit Control Specifications
6.2.2	6.2.2 KNOB_SPEC: emittance knobs
MS26	MS26 M_KNOBS: Specification of emittance knobs ready
6.2.3	6.2.3 MON_SPEC: Monitor specification
6.2.4	6.2.4 ENERGY: Specification of knob for energy scaling
D6.2	D6.2 D_SPEC: Specifications ready
6.3	**6.3 IMPL: Implementation of the specified upgrade**
6.3.1	6.3.1 ORB_C_IMPL: Orbit Control upgrade
6.3.2	6.3.2 COUPL_IMPL: Coupling automation
6.3.3	6.3.3 MON_IMPL: Monitor installation
D6.3	D6.3 D_IMPL: Hardware ready and installed
6.4	**6.4: COMM**
6.4.1	6.4.1 ORB_C_COMM: Orbit Control Commissioning
6.4.2	6.4.2 COUPL_COMM: Coupling control
6.4.3	6.4.3 MON_COMM: Monitor commissioning
D6.4	D6.4 FINAL_R: Commissioning report



WP6 (SVET): RESOURCES

- Person-months:

	CERN	INFN	PSI	total	direct k€	total k€
pm	16.5	11.5	45.5	73.5	556.83	785

- Material:

	CERN	INFN	PSI		direct k€	total k€
k€			215		215	258

- Travel:

	CERN	INFN	PSI	total	direct k€	total k€
units	16	9	11	36	22.5	34.5

- travel unit=625 €

k€	k€
794.33	1077.57

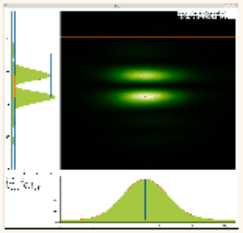
ALREADY ONGOING AT KICK-OFF:

- PSI is in the process of opening a post-doc position.
- We need a communication platform (collaboration web-space)
- We need clear indication for the necessary form and dissemination procedure for different reports (TIARA reports?, templates?, …)
- http://www.eu-tiara.eu/rtd/index.php?id=42

WP6: SVET R&D Infrastructure


View of SLS at PSI

Objective



The main objective of SVET is to upgrade the Swiss Light Source (SLS) at PSI to enable R&D on ultra-low emittances.

The CLIC damping ring aims at delivering an e+/e- beam with ultra-low vertical normalized emittance of 5 nm for achieving the required collider luminosity. This corresponds to a geometrical emittance of less than 1 pm at 2.86 GeV, which has never been reached in any lepton storage ring, especially for bunch currents equivalent to the ones of the CLIC DR, i.e. in a regime where collective effects and especially intra-beam scattering (IBS) are predominant. The SuperB e+e- factory aims at comparable vertical emittances of down to 4 pm at 7 GeV at bunch currents in the order of 2 A, i.e. again in IBS dominated regime. These ultra-low emittances are also extremely important for present and future light sources such as the Swiss Light Source storage ring (SLS) at PSI and MAX-IV at Maxlab in Sweden.

In order to obtain and control these ultra-low emittances, not only low magnetic error tolerances and extremely good control of the geometric alignment of the magnets are required, but also a combination of diagnostics for precise beam size, position and emittance measurement as well as on-line correction techniques. The suppression of betatron coupling and controlled excitation of vertical dispersion in order to adjust the vertical emittance to an optimum value with respect to brightness and lifetime are necessary. All these issues will have to be addressed in a dedicated R&D program, which will comprise three fields of activity:
a) Suppression of betatron coupling and vertical dispersion by utilizing skew quadrupoles, b) measurement of small vertical beam size and emittance by means of high resolution beam profile monitors,
c) measurements of IBS contributions to emittance and of the particle distribution in the IBS-halo.

SLS has achieved a vertical geometric emittance of around 3 pm at 2.4 GeV, one of the smallest vertical emittances ever obtained and only a factor 5 larger than the ultimate vertical emittance limit given by the quantum nature of synchrotron radiation. In this respect, SLS represents the ideal test-bed for deploying diagnostics and testing experimental approaches