Beam Delivery System Summary

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ALCPG/GDE meeting

October 25, 2007

Plan of the talk

- S4 recommendations
  + integration & value engineering
  → EDR plans
- EOI process
- GWP structure in BDS
- GWP description
- Resources allocation and issues
- Short term plans

There will be no technical information in this talk, only planning information

S4 outcome: Focus of EDR work

As of April - May 2007

- Integrated design of IR, development of IR superconducting magnets, *build engineering prototype of FD magnets*, design study to ensure IR mechanical stability, design of push-pull arrangements
- development of crab cavity systems, *test phase control system with two single cell cavities, build single multi-cell cavity*
- design, *construction, commissioning and operation of ATF2 test facility*
- development of laser wires for beam diagnostics, *prototype laser wires at ATF2*
- development of intra-train feedback, *prototype at ATF2*
- development of beam dump design and *study of beam dump window survivability*
- development of collimator design, *verification of collimation wake-fields with measurements and verification of collimation beam damage*
- development and *tests of MDI type hardware such as energy spectrometers, IP feedback BPMs, beamcals, etc.*
- and the design work, which does not involve hardware development but use results of the above listed work

(*hardware in italic*)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	EDR			Approval		Construction							Commiss.
Constraints				LHC physics	total length frozen		tunnel & optics layout frozen		optics details frozen		tunnels ready for install-n		
Beam dumps	beam dump conceptual design and critical tests			pre approval		beam dump final engineering			b.dump design frozen	beam dump construction		beam dump installed	
crab cavity	design, build & test of conceptual phase control system; cavity fabrication; conceptual cryostat design; LLRF develop and test with single cells			design of cryostat; cavity integration; beam test of one cavity		beam tests of two cavities		final engineering		production		installed	
ATF2	ATF2 construction and installation. Start of commissioning		Commissioning	Beam size and optics results	Beam stability results	2nd phase, e.g. SC FD; smaller emittance & beam size		Instrumentation developments and tests at beamline					
Final Doublet	Engineering design; full length prototype; stability design study and initial stability tests			Stability tests & design optimization		final design		production		lab tests	installation and pre-commissioning		
Detectors	Conceptual design; selection of two concepts; continue design			Design optimization		final design and start of production		Construct, assemble and pre-commission on surface				Lower down & commiss.	
IR integrated	Conceptual eng. design of IR vaccum chambers; supports; pacman and moving shielding; cryogenic; service platform; detector moving system; cranes; etc.			Detailed eng. design of integrated IR with finalized choice of two detectors for final design		final design and start of production		production			installation and pre-commissioning		
Magnets	Optimization of number of styles; conceptual design of most magnets; definition of interfaces; Detailed design of low field and other special magnets; Vibration -wise design			Design and cost optimization; layouts with real space allocation, and detailed interfaces.		final design & needed prototypes		production			installation and pre-commissioning		
Collimation	Tests of collimation wakefields and beam damage tests; conceptual eng. design			Detailed eng. design; optimization & integration into beamline		final design & pre-production prototypes		production			installation and pre-commissioning		
Instrumentation	Develop laser wires; test feedback BPMs with secondary beam; conceptual eng. design			Detailed eng. design; optimization & integration into beamline		final design & pre-production prototypes		production			installation and pre-commissioning		
Vacuum systen	Physics and conceptual eng. design. Detailed design of IR vacuum chamber.			Detailed eng. design; optimization & integration of beamlines		final design		production			installation		

Overall tentative schedule

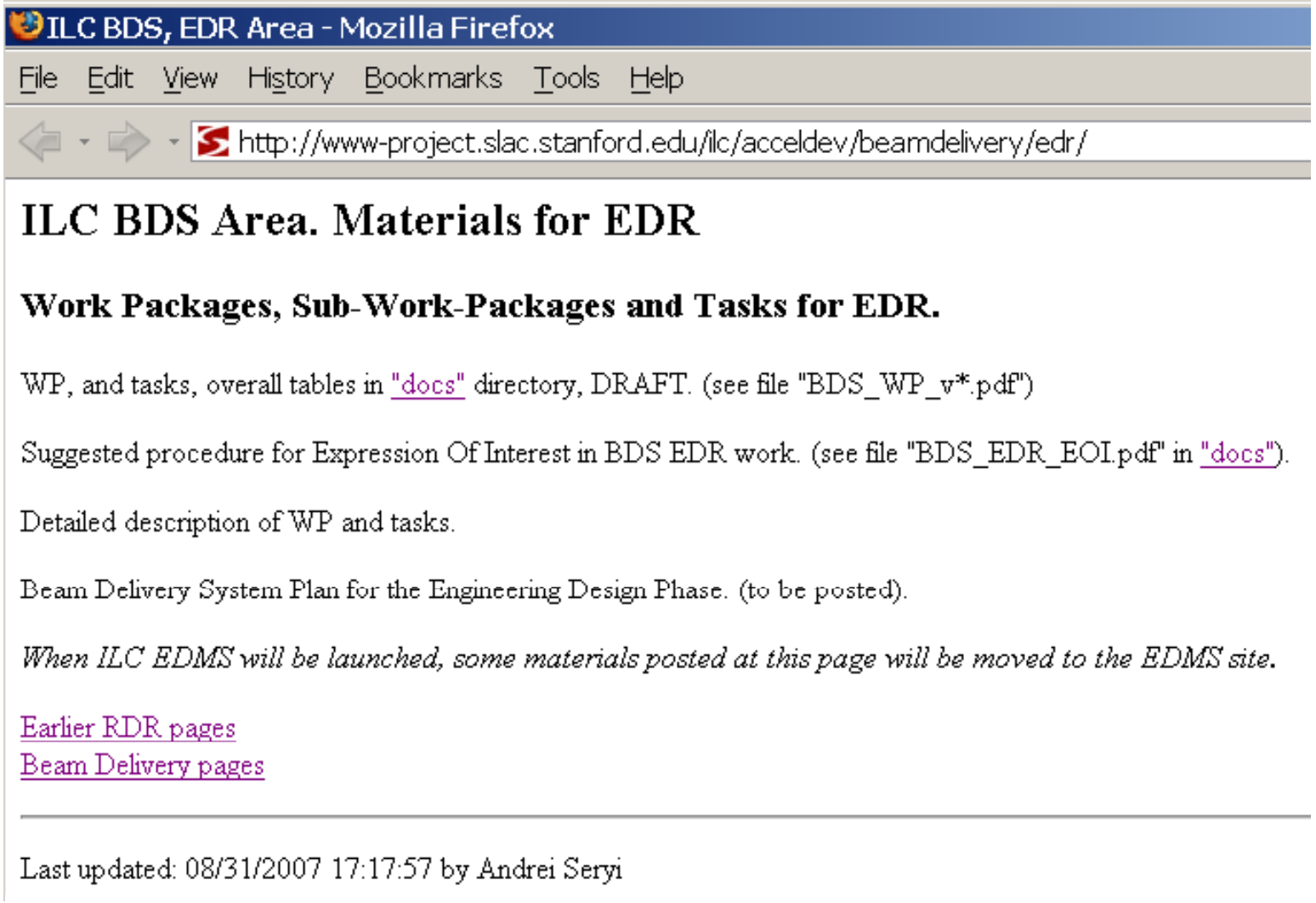
As of April - May 2007

Beam Delivery in the ED phase…

- The Engineering Design Report will document
  - **the baseline design, including detailed engineering and justification of design criteria; …**
- The cost containment effort is critical, including performance/cost optimization, and an understanding of the performance/cost derivatives (value engineering)…
- Initial phase will be accelerator -physics (AP) driven in order to evaluate the performance / risk trade-off for cost reduction…
- The Value Engineering is the process whereby the total estimated cost of achieving an objective is compared with the lowest possible cost of achieving that objective…

Quotes from Draft "ILC Project Management Plan for the Engineering Design (ED) Phase", by International Linear Collider Project Management Team, Marc Ross, Nicholas Walker, Akira Yamamoto (Project Managers)

WP list and EOI solicitations



http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/edr/

EOIs received

GWP02&03&04&09_BDS_EDR_EOI_FONT_UK.doc
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GWP06_BDS_EDR_EOI_Dumps_UK.doc
GWP07_BDS_EDR_EOI_Coll.doc
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GWP07_CollWakeComputerEOI_PT.doc
GWP07_CollWakeTheoryEOI_PT.doc
GWP08_2008-09-10 BDS Magnet Power System Design EOI Draft 2.doc
GWP08_BDS_EDR_EOI-JINR-1-2.doc
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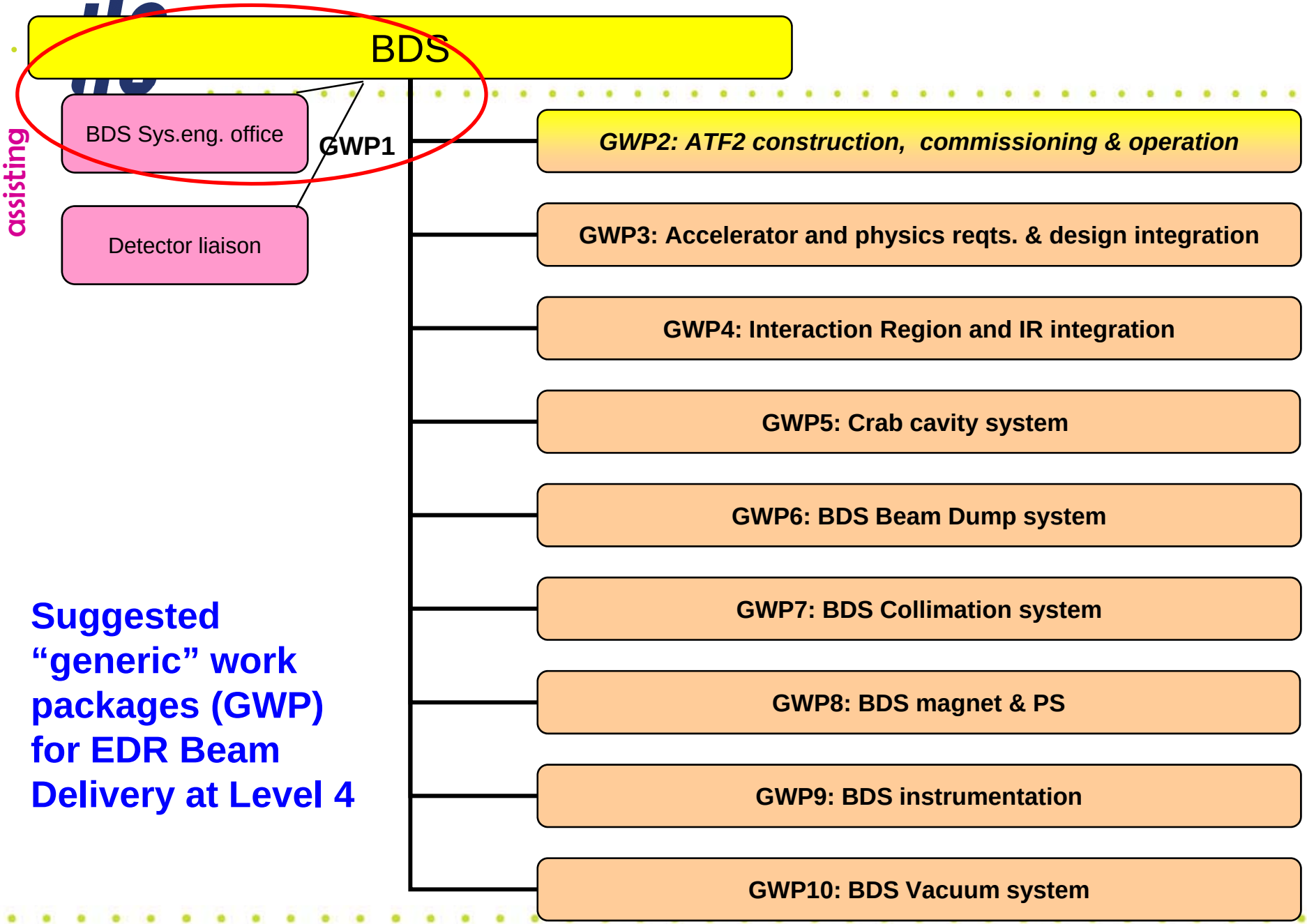
EOIs do not include <u>all</u> expressions of interests discussed at SLAC, BNL, FNAL, <u>for ongoing work</u> planned via ART

The ART funded work is included in the charts shown on next pages

Reminders were sent out recently and more EOIs are expected

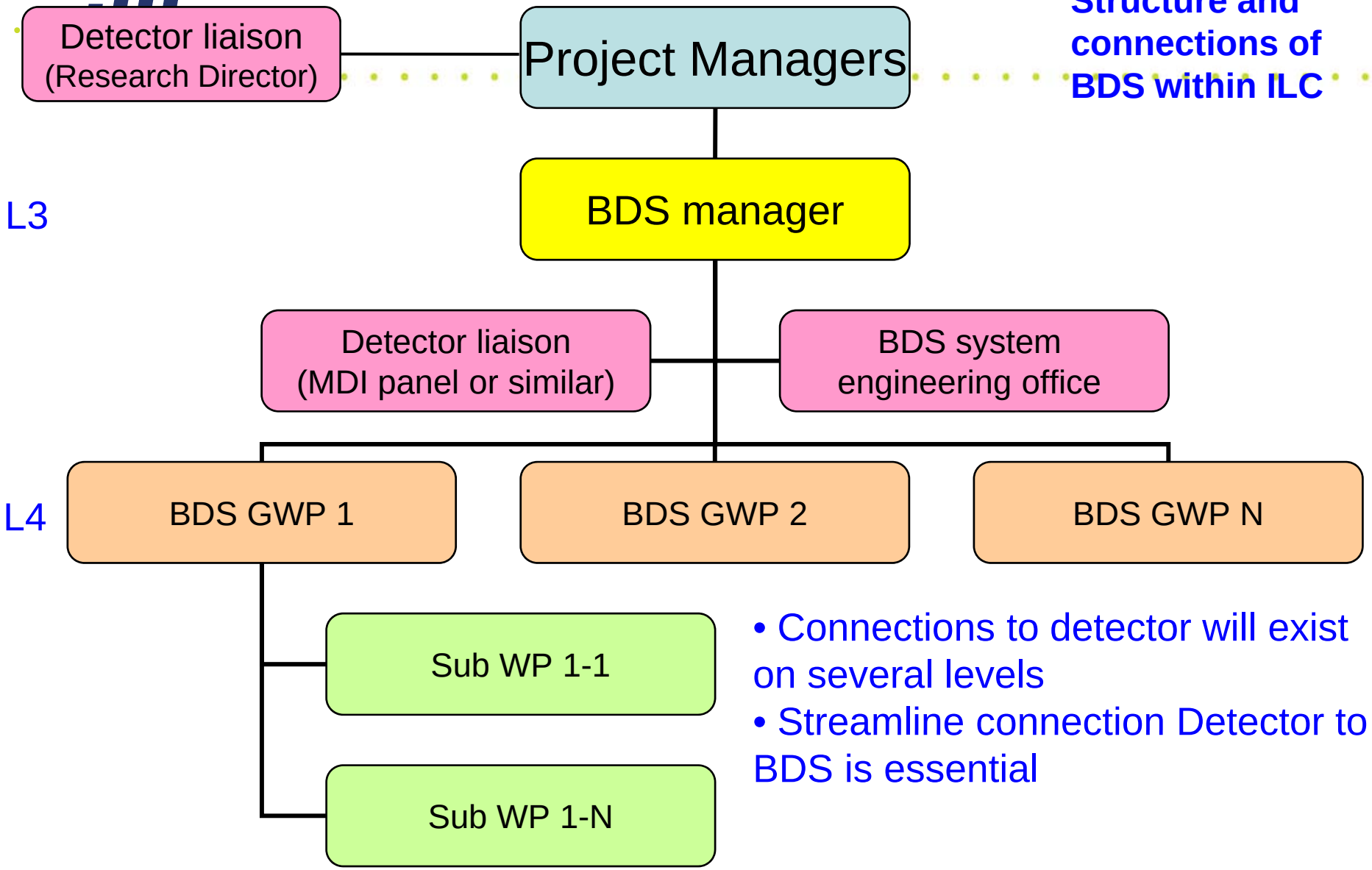
Structure of GWP in BDS

- There are ten GWP in BDS, among which there are nine technical GWP while the first one is primarily managing and integration:
  1. **BDS group managing and integration**
  2. **ATF2 construction, commissioning and operation**
  3. **Accelerator and physics requirements and design integration**
  4. **Interaction Region and IR integration**
  5. **Crab cavity system**
  6. **Beam dump system**
  7. **BDS Collimation system**
  8. **BDS magnets and power supplies**
  9. **BDS instrumentation**
  10. **BDS vacuum system**



Suggested "generic" work packages (GWP) for EDR Beam Delivery at Level 4

Structure and connections of BDS within ILC



- Connections to detector will exist on several levels
- Streamline connection Detector to BDS is essential

GWP.1 Beam Delivery group managing and integration

- Performs managing role for BDS, system integration and also the CFS interface role
- System Engineer (=SE=deputy of BDS manager) assisted by the System Engineering Office @ SLAC
- SE will be the deputy leader of GWP03, and will also have tight connection to other GWP as well
- Charge to SE: iterative consolidation of the detector and accelerator physics requirements relevant for CFS produced in other GWP and in particular GWP03 and following up on their implementation by CFS group
- Charge to System Engineering Office: documenting the interface requirements, consolidating the overall system design, and consolidating the overall cost estimation
- GWP1 also includes Level 4 leaders and deputy leaders of the technical GWPs, which will provide technical and cost information and report to the BDS manager
- Deliverables: organized structure of Beam Delivery Group capable to meet EDR goals; developed plans toward EDR in BDS; documented and optimized interface specifications, in particular for CFS; updated cost estimate for BDS; execution plan for BDS.

GWP.2 ATF2 construction, commissioning and operation

- ATF2 is a scaled model of ILC beam delivery system, @ KEK
- This GWP is of special kind, because it contains similar branches as BDS area itself (like CFS, vacuum, magnets, instrumentation, etc) and in large extent is parallel to BDS structure
- The ATF2 is a project within ATF collaboration which is defined by its own MOU structure and organization
- The BDS manager is simultaneously the Deputy of ATF Spokesperson responsible for ATF2, which makes the connection to this GWP streamlined and efficient
- Deliverables: creation of Beam Delivery test facility, where studies of optics tuning, beam stabilization, instrumentation prototyping, etc. will be performed during EDR and beyond EDR timeframe, and which will also give feedback relevant for optimization of the ILC Beam Delivery design.
- Plus, concrete deliverables on hardware, e.g. laser wire w. micron scale resolution and so on.

GWP.3 Accelerator and physics requirements and design integration

- Responsible for producing technical information, accelerator and detector physics driven, essential for determining requirements to design, performing system optimization, determination interfaces to CFS and detector
- Performs integration of design on the level of parameters and specification
  - **Include study of optics, tolerances, tuning and feedbacks, apertures & magnet types standardization, etc. – to set & optimize specifications for various systems**
    - e.g. field homogeneity & stability, alignment & vibration reqts., air & water T stability
- Detector and particle physics requirements to be analyzed & optimized
  - **(such as luminosity & background) on parameters such as IR apertures, internal and external detector field, value of final drift L*. The projected operating range of different IP beam parameters and also different energies from Z pole to nominal energy will be studied in terms of performance.**
- Also to be studied:
  - **Upgrade path to higher luminosity and to 1TeV CM. Design study of the alternative crossing angle configurations (head-on and 2mrad) –optics design and performance optimization. Gamma-gamma & fixed target option –evaluation of optics & up-front CFS tunnels and layouts modifications.**
- Deliverables: documented layouts, specifications and performance dependencies relevant for determining CFS requirements and performing overall system optimization and integration.

GWP.4 Interaction Region and IR integration

- Includes the IR system engineering and integration, IR magnet design and its prototypes, design of IR cryogenics, design of IR shielding, design of the system to move the detectors, stability study of IR magnets, design of IR magnet movers and supports, evaluation of alternative magnet solutions for IR, etc.
- Very tightly connected to detector hardware design. GWP4 leaders will work closely with representatives of two emerging detector proto-collaborations to create a technically-optimal and cost-optimal IR design
- Deliverables: documented descriptions of interfaces between machine and detector systems,
  - **including relevant parameters of such interfaces (location, geometries, stability, etc); documented descriptions of requirements to CFS systems, to safety and other systems, and also documented divisions of responsibilities.**
- Documenting such interfaces must allow non-simultaneous publication of the machine EDR and of the Detector EDR
- Also include design report for the IR magnets with assessment of prototype magnetic and mechanical stability performance, with design of the cryogenic system, power supply and quench protection system, supports, movers, shielding and interfaces to forward instrumentation and IR vacuum chamber, and the updated cost.

GWP.5 Crab cavity system

- Include optimization and validation of appropriate RF cavity and coupler designs, development of a phase stable RF control system, design of the cryostat, prototyping the crab cavity and its couplers, development of a suitable HPRF system, measuring the phase stability with two single-cell SRF cavities, preparing the crab cavity beam tests at ILCTA and subsequently performing them.
  - **The ILCTA tests include studying the RF characteristics of a single cavity in a beamline, followed by a beam test with two cavities to assess phase stability and rotational alignment performance. The activity will also include integration into a beamline, design optimization and cost estimation.**
- Deliverables of this work package will include documented specifications, design and performance of the crab cavity system, including the LLRF control system and its HPRF components, including analysis of prototypes and beam test results, and a full system cost estimation.

GWP.6 Beam dump system

- The beam dump system work package will include physics and engineering design of the 17MW beam dump and its subsystems, including the water vessel, three-loop water system with catalytic recombiner and filters, shielding, double window and the mechanism of its remote exchange.
  - **Design will also include the beam sweepers that raster the beam on the window and doughnut collimators that protect the dump window.**
  - **The work will include building a prototype of the windows and performing its irradiation tests, and prototyping the front-end of the window remote exchange mechanism.**
- Deliverables of this work package will include a design report containing detailed description of specifications, design and performance, including analysis of beam tests and prototypes performance, as well as the cost estimate.

GWP.7 Collimation system

- Include physical design of collimators (spoilers, absorbers, protection collimators, and synchrotron masks), including analysis of wakefields, survivability and mitigation of generated muons, and engineering integrated design of the devices, optimization of their location in the beamline, design of their interfaces and local shielding.
  - **Include measurements of the wakefields for relevant spoiler configuration and performing beam damage tests.**
  - **Include evaluation of alternative ideas – muon doughnuts & using bent crystals for cleanup collimation & halo measurements**
- Deliverables: documented specifications, design and performance of the collimation system and of the individual devices, including effects on the beam, on local radiation conditions and muon background, justified by documented and analyzed results of the wakefields measurements experiment and beam damage experiment, and the cost estimate.

GWP.8 BDS magnets and power supplies

- Include specification and conceptual design of DC magnets and more detailed design of pulsed magnets (kickers, septa and beam sweepers), design of magnetized muon walls, design & prototyping of magnet movers and low field dipoles, design and optimization of DC and pulsed power supply system, development and possible prototyping of High Availability PS module, in particular the bipolar
  - **Include minimization of the number of magnet families, optimization of stringing, of the use of correctors, evaluation and optimization of the upgrade path to 1TeV CM, optimization of cable plant and location of the power supplies.**
  - **Evaluation of alternative designs such as HTS for extraction line**
- Deliverables: documented design of the magnets, power supplies and cable plant, description of specification and performance, analysis of performance of low field dipole prototype, description of the procurement and execution plan during construction, and the cost estimate.

GWP.9 BDS instrumentation

- Include definition and optimization of specifications, location, sizes, apertures and interfaces of various diagnostics in BDS (BPMs, OTR monitors, deflecting y-t cavities, SR light profile monitor, ion chambers & PMTs, Gamcal, etc.).
  - **Also include defining specifications for the alignment system.**
  - **Development: prototype and beam test of E-spectrometers, feedback hardware, laser wires & large aperture BPMs**
  - **Evaluation of alternative ideas such as Compton edge energy spectrometer, alternative design of IR BPM, etc**
- Deliverables: documented specifications, design and performance of the BDS instrumentation subsystems, including description of their use for beamline operation and tuning, documented analysis of prototyped instrumentation hardware and of its performance at the test facilities ESA and ATF2, as well as analysis of relevant instrumentation hardware used in FLASH user facility, and the cost estimate.

GWP.10 BDS vacuum system

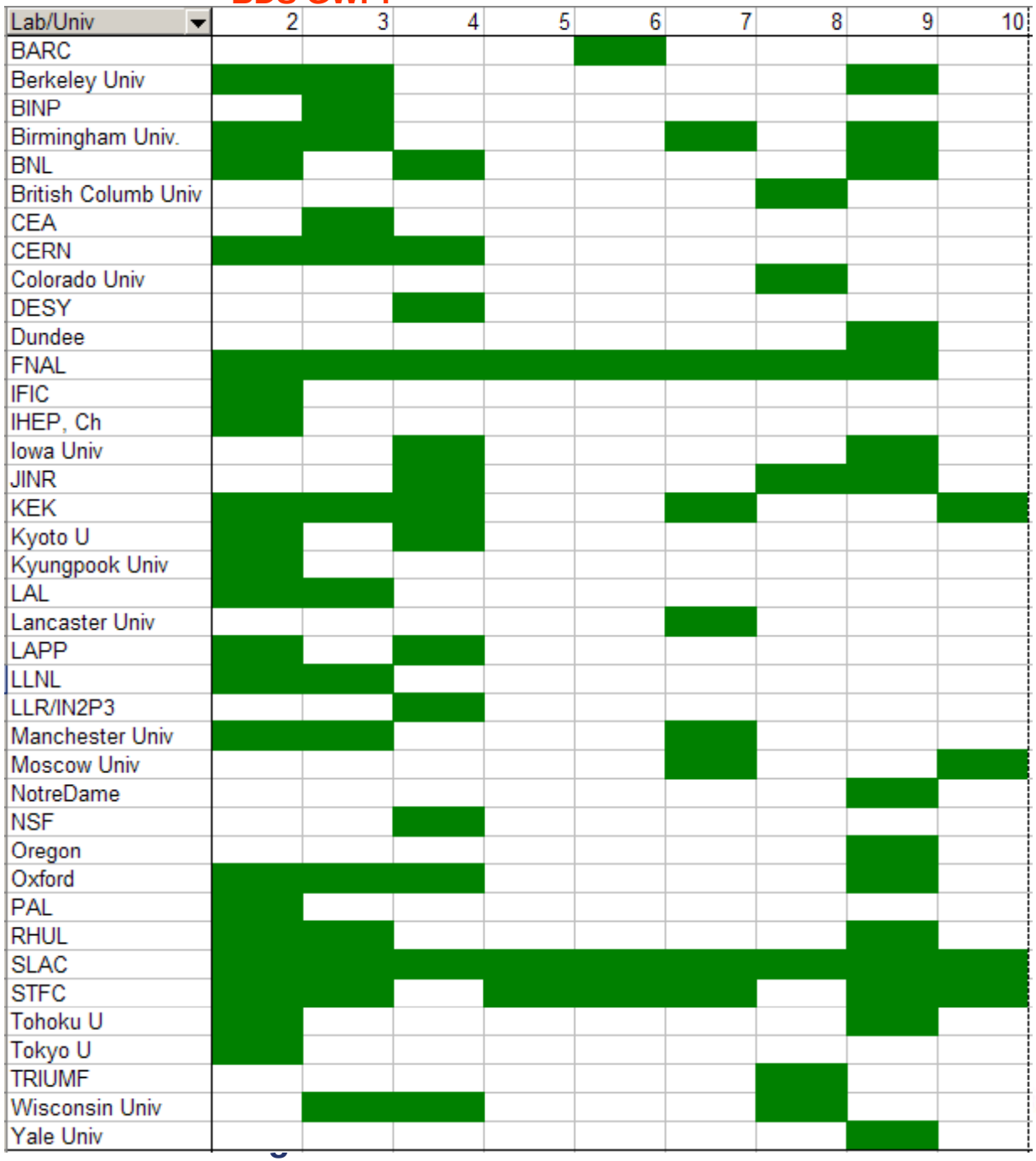
- Include developing the general layouts with locations of ports, bellows, valves, gauges; creating conceptual design schemes of RF shields, chambers in moderately complicated areas such as laser wires and regions of beamline separations (such as beam switch yard or areas of intersections with diagnostic laser beams); and creating more detailed designs of chambers in very complicated areas such as Interaction Region
  - **Also include optimization of vacuum chamber aperture, pressure; physical design of vacuum system in terms of SR, beam-gas, desorption and impedances; engineering integrated design of vacuum system and definition of interfaces with magnets and diagnostics**
- Deliverables: documented specifications and design of vacuum system, its components, and special areas, and the cost estimate

Distribution of efforts on GWPs according to received EOIs

TENTATIVE!
May include tentative information and unfunded work.
More EOIs are known to come.
Distribution involve guesses.

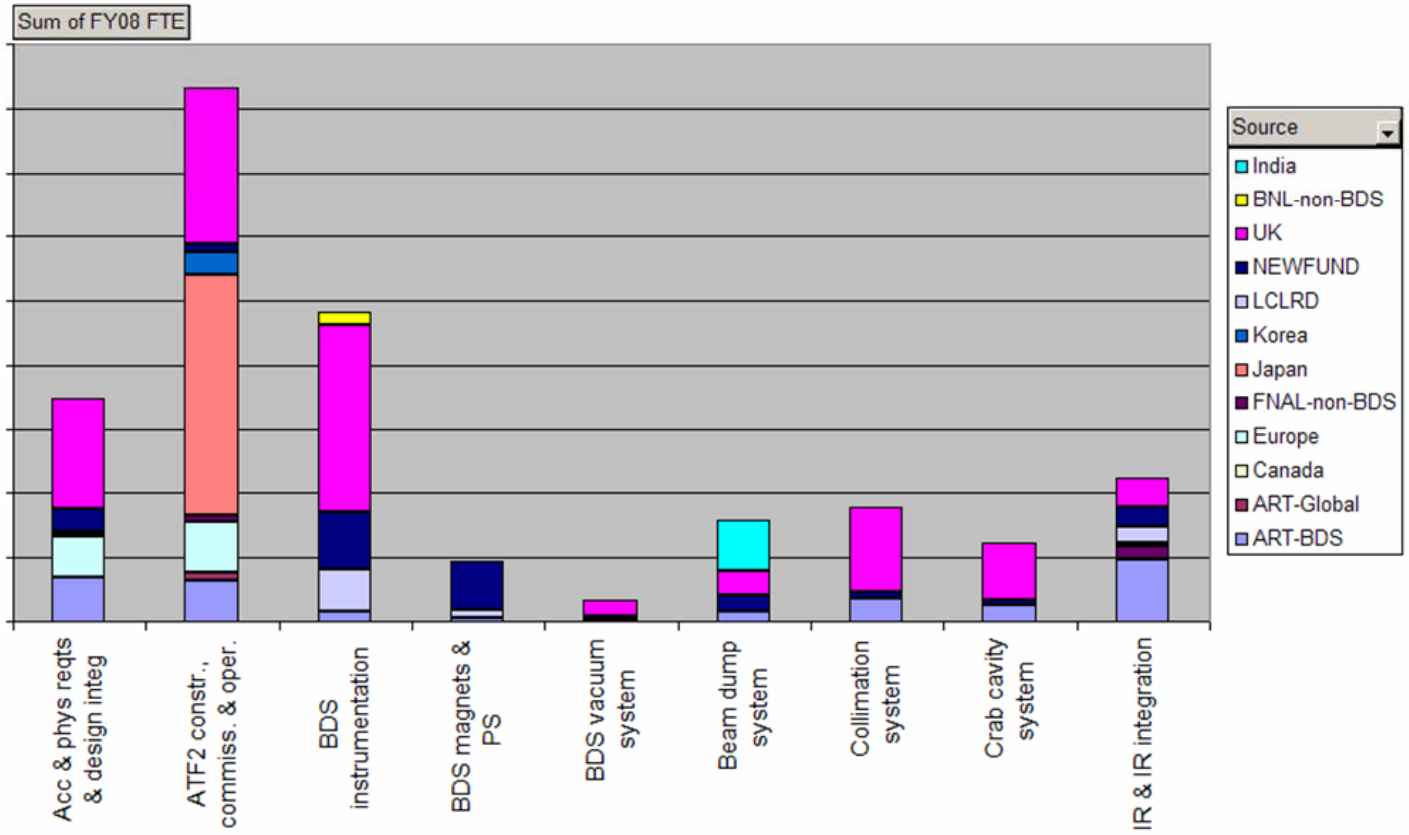
GWP1 is not shown on the chart

BDS GWP:



Distribution of resources on GWP

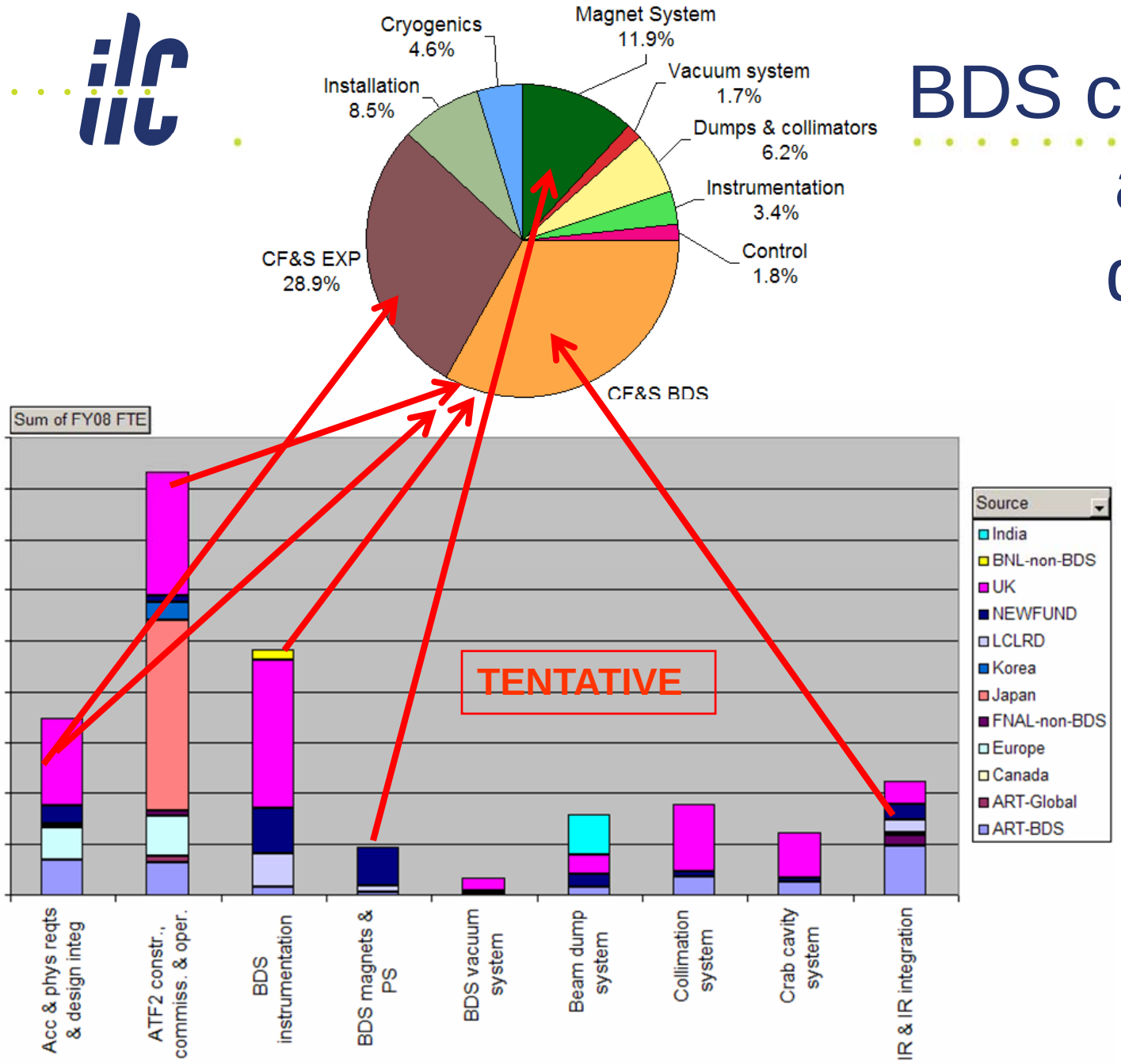
TENTATIVE!
May include tentative information and unfunded work.
More EOIs are known to come. Distribution involve guesses.



Include graduate students

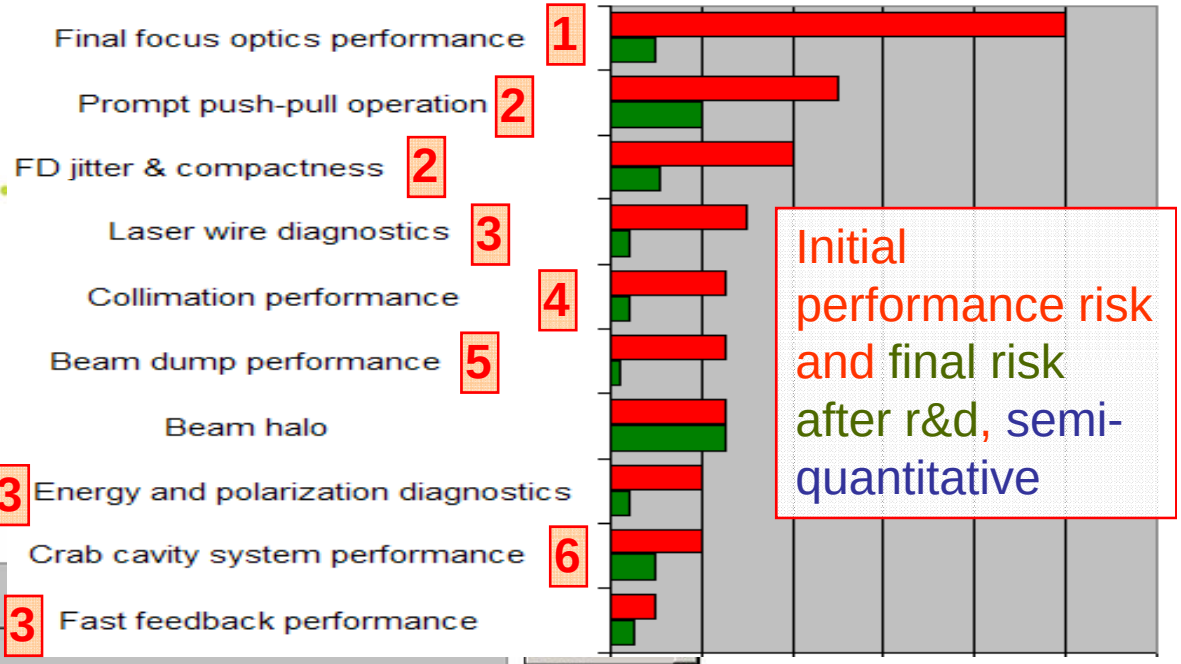
is not shown on the chart

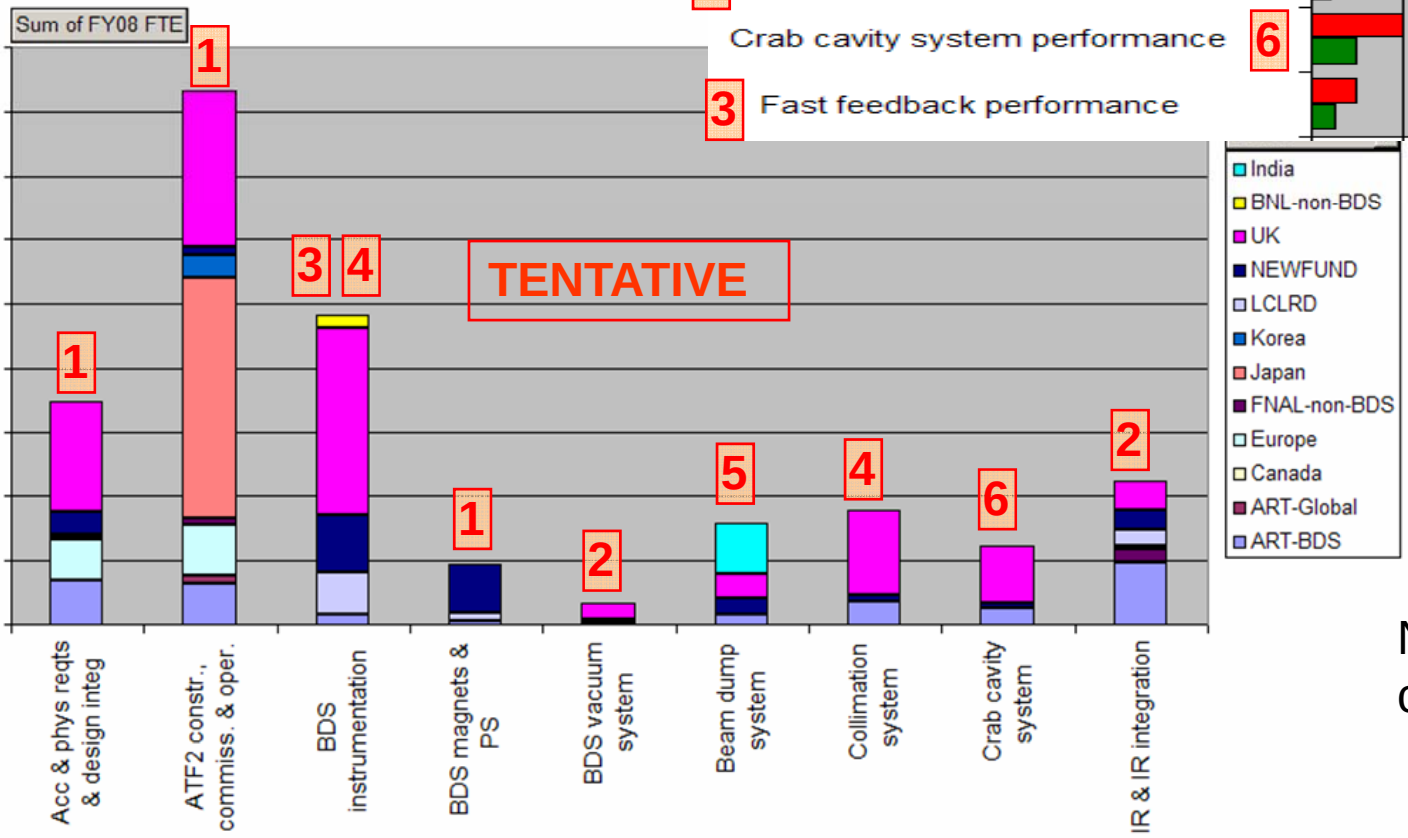
BDS cost drivers and efforts distribution



Correlation to major cost drivers is shown

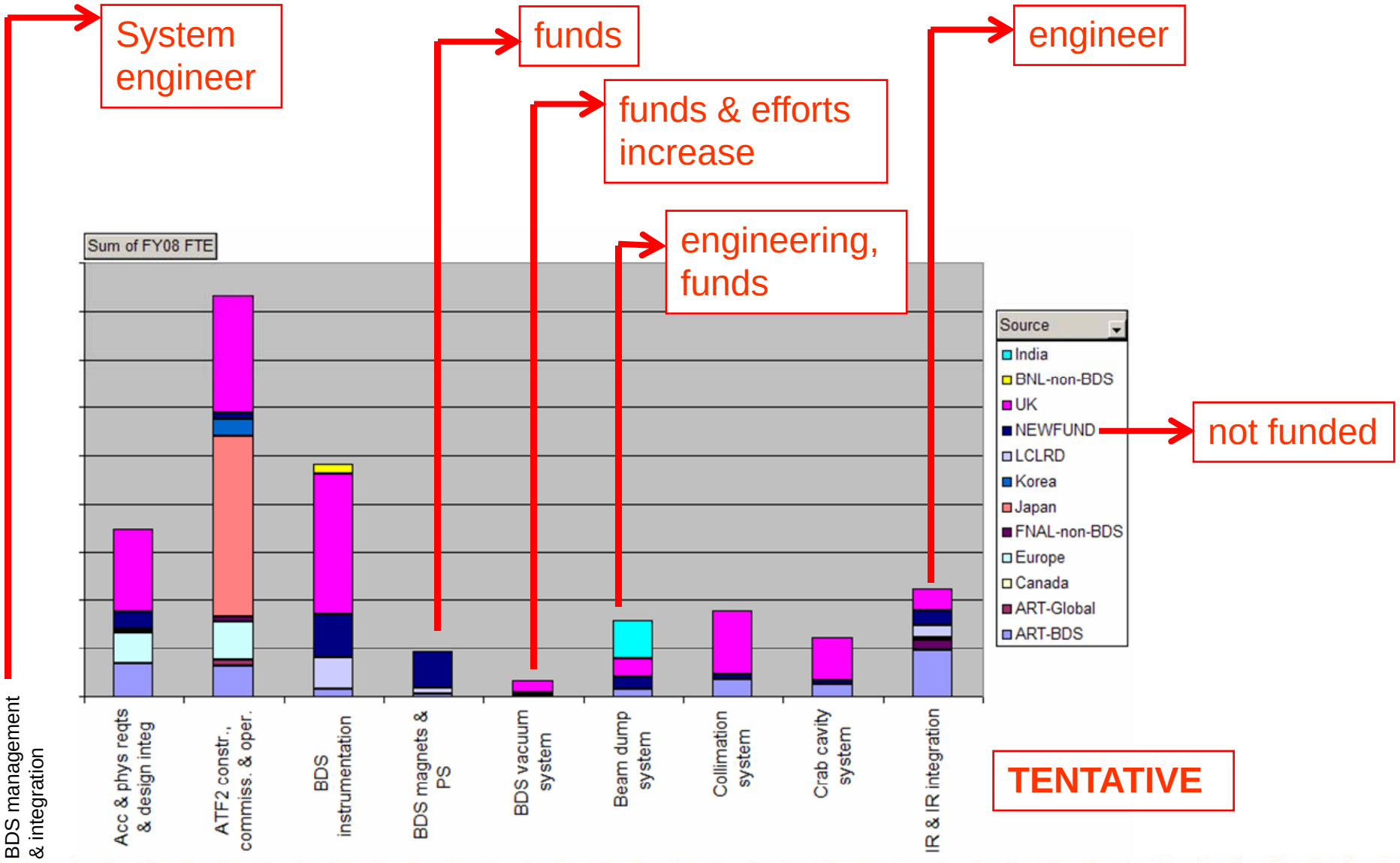
BDS performance risk drivers and efforts distribution





Numbers # show correspondence

Know resources issues & needs



During this GDE meeting

- Discussed most of GWPs
- In several cases, adjusted and clarified GWP descriptions and deliverables
  - **In particular for Instrumentation, magnets, crab cavity**
- Also met with PMO representatives to discuss the proposed GWP

Next steps

- Develop & implement the short term (to Sendai) plan
  - **Organize the groups for EDR structure and launch their work**
  - **Document RDR design in EDMS**
  - **Address questions identified by KOM**
    - In particular, focus on evaluation of performance requirements and optimization of design if found possible

BDS EDR Meetings, tentative:

- BDS GWP coordination, integration & management meeting
  - **Cycle: morning-evening in SLAC**
- BDS integration meeting with CFS and other relevant groups
  - **Primarily: ~8am SLAC, ~weekly**
- ATF2 construction, commissioning & operation
  - **Ongoing weekly, late evening SLAC time. Cycle through different time?**
- Acc. & physics requirements and design integration
  - **Primarily: late afternoon UK, ~8am SLAC. Bi-weekly. Cycle ~monthly: UK morning**
- Interaction Region and IR integration
  - **Bi-weekly and cycle through morning & late afternoon of SLAC time**
- Crab cavity system
  - **Ongoing monthly, late afternoon UK, ~9am SLAC. => Bi-weekly, & focus on EDR**
- BDS beam dump system
  - **Cycle: am UK & India, pm SLAC – pm UK & India, am SLAC. Bi-weekly.**
- BDS Collimation system
  - **Primarily: late afternoon UK, ~8am SLAC. Bi-weekly**
- BDS magnet & PS
  - **Cycle: late afternoon SLAC - morning in Japan; evening SLAC morning in Moscow**
- BDS instrumentation
  - **Primarily: late afternoon UK, ~8am SLAC. Bi-weekly**
- BDS Vacuum system
  - **Primarily: morning in UK, late afternoon in Japan**

Summary

- EOI collection process was launched
- GWP structure is suggested based on received EOIs
- Resources and funding issues identified, solutions are being investigated
- Ready to launch onto EDR work as soon as PM will sign-off on GWP structure