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# SuperB: Physics

# Re-organisation of physics

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- Change of physics convenors:

Adrian Bevan  
Dave Brown  
Marco Ciuchini  
Achille Stocchi



Adrian Bevan  
Dave Brown  
Marco Ciuchini  
John Walsh

- Many thanks to Achille for his years of tireless work on guiding the physics effort.

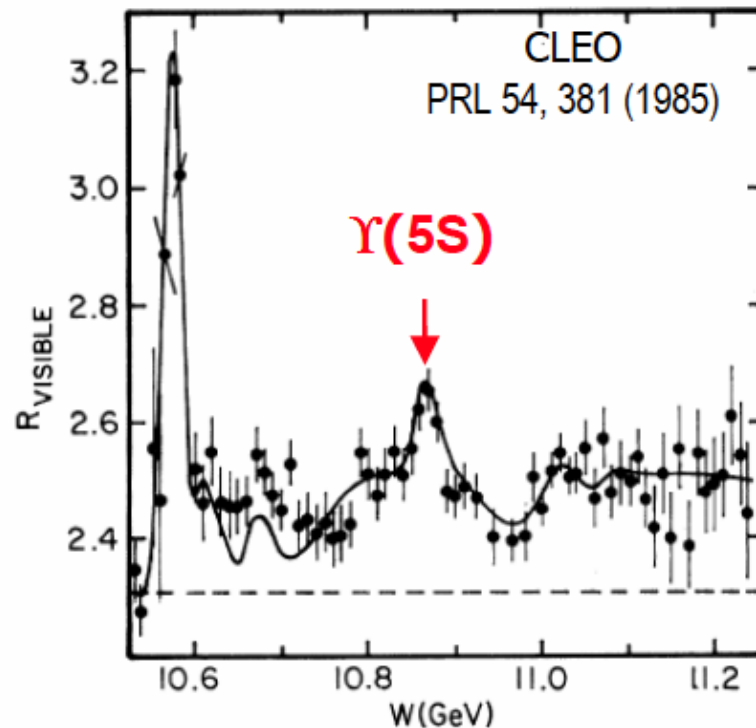


We welcome John  
onto the team!



# $B_s$ Working group created

- This meeting we created a new working group on  $B_s$  physics: Alexey Drutskoy (ITEP) will convene this group.
  - Review of  $B_s$  physics in one of the parallel sessions.



Related question: What is an easy upper limit on accelerator energy?

14 GeV – unlikely to be realistic option.

~11.4 GeV – could be interesting.

Need to understand in more detail the physics case and start dialogue with machine people to understand cost/benefit/feasibility.



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## Conclusions

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- Extensive physics program can be proposed at Super B factories with statistics of  $1 \text{ ab}^{-1}$  at Y(5S). Important SM tests can be done.
- Because we don't know which BSM model is correct, we should develop comprehensive program with all possible BSM searches.
- It is important to have good vertex resolution and option with large  $e^+e^-$  CM boost to measure time dependent CP violation.

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# Experimental Groups

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- **B<sub>d</sub> Physics**
  - Mixing and CPV
  - Rare/Radiative/Semi-leptonic
- **Tau**
  - LFV
  - Tau properties
  - $V_{us}$
- **D Physics**
  - SG3.1 Mixing and CPV
  - Direct CPV
  - FCNC
- **B<sub>s</sub>**
  - ASL + ... list to be determined
- **Other Physics**
  - Spectroscopy
  - Dark Forces
  - Electroweak physics

This structure has been proposed in order to take the physics effort forward for the TDR and eventually for the physics book.

Need to confirm names of convenors who can lead this effort.



# Theory / Tools

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- **Phenomenology**
  - Model independent / CKM / EFT
  - MSSM
  - SUSY-GUT
  - Extra dimensions
  - Little Higgs
  - SM4
  - +others (please give input to Marco)
- **Non-perturbative methods**
  - Lattice
  - HQE
  - QCD-SR
- **Tools**



# Comparison document Task Force

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- Met on Wednesday lunchtime:
  - Discussed physics sensitivity
  - NP potential and complementarity
  - Involving "other experiments" in our Elba meetings
- Compiling tables for golden observables
- Starting to remake NP sensitivity plots
- Will discuss in detail at Elba

TF: Adrian Bevan, Dave Brown, Alberto Cervelli, Marco Ciuchini, Alexey Drutskoy, Marcello Giorgi, Alberto Lusiani, Brian Meadows, Alejandro Perez, Luca Silvestrini, Achille Stocchi, Cecilia Tarantino &

John Walsh

LNf April 2011

# Some Golden Modes



No result



Moderate



Precise



Very Precise

Observable	Babar/Belle	LHCb (10fb <sup>-1</sup> )	SLHCb (100fb <sup>-1</sup> )	SuperB (75ab <sup>-1</sup> )	Some Comment	Theo
$\gamma$	Moderate	Precise	Very Precise	Very Precise		Very Precise
$V_{ub}/V_{cb}$	Precise	Moderate	Moderate	Very Precise	Excl. needs Lattice & Inclusive @ 2% ?	Precise
$\beta$	Precise	Very Precise	Very Precise	Very Precise	Theo. error to be controlled on data (ex: $J/\psi\pi^0$ )	Very Precise
$S(J/\psi\phi)$	No result	Very Precise	Very Precise	No result	At 1° theo error controlled with data ?	Very Precise
$B \rightarrow \tau \nu, \mu \nu$	Moderate	No result	No result	Precise	Very precise if detector is improved	Precise
S-Penguins	Moderate	Moderate	Moderate	Very Precise	SLHCb (very) precise for $B \rightarrow \phi K, B_s \rightarrow \phi\phi$ Not possible for $K_s\pi^0, k_s k_s, \eta k_s, \omega K_s..$	Moderate
$A_{CP}(B \rightarrow X_s \gamma)$	Precise	Moderate	Moderate	Very Precise	Control syst. Is an issue	Very Precise
$Br(B \rightarrow X_s \gamma)$	Precise	Moderate	Moderate	Very Precise	Syst. Controlled with data ?	Moderate
$Br(B \rightarrow X_s    )$ <i>Angular var.</i>	Moderate	No result	No result	Very Precise		Very Precise
$Br(B \rightarrow K^*    )$ , <i>Angular var.</i>	Moderate	Precise	Very Precise	Very Precise	Could theory control @20%? Angular analysis are clean ?	Moderate
$Br(B \rightarrow K^{(*)} \nu \nu)$	No result	No result	No result	Precise	Stat. limited. With more stat. angular analyses also possible	Very Precise
$Br(B \rightarrow K_s \pi^0 \gamma)$	Moderate	No result	No result	Very Precise		Very Precise
$Br(B_s \rightarrow \phi \gamma)$	No result	Precise	Very Precise	No result	As precise as $Br \rightarrow K_s \pi^0 \gamma$ ?	Very Precise
$Br(B_s \rightarrow \mu \mu)$	No result	Precise	Very Precise	No result		Very Precise
$\tau \rightarrow \mu \gamma$	Moderate	No result	No result	Precise	profit of polarized beams	Very Precise
CPV charm	No result	Precise	Very Precise	Very Precise	CPV in SM negligible. So clean NP probe	Very Precise

**THEORY**

Moderately Clean

Clean

Clean

Clean

From A.Stocchi





# TDR

- Timescale: Comparable with detector TDR
  - Start with Physics White Paper & update.
  - Freeze out TDR when the time comes.

## Outline of the TDR (by section)

In general we should aim for a TDR structure with a broad outline of:

- Executive summary
  - This should highlight the channels studied using a realistic detector model
- Introduction
- Tau Physics
  - lepton flavour violation
  - tau  $g-2$
  - CP violation in tau production and decay
  - precision measurements of tau decays:
    - $|V_{us}|$
    - charged current universality
    - hadronic spectral functions and muonic  $g-2$
    - Lorentz structure?
  - precision measurements of tau properties
    - tau lifetime
    - tau mass
- B Physics:
  - At the Y(4S)
    - Rare Decays
      - Missing Energy Decays
        - $B \rightarrow e\ell \nu$  ( $e\ell = \tau/\mu$ )
        - $b \rightarrow K^{(*)} n \bar{u}$
      - Leptonic Penguins
        - $b \rightarrow s\ell$  inclusive
        - $b \rightarrow s\ell$  exclusive [ $K^{(*)} e e$  vs  $K^{(*)} \mu \mu$ ]
        - $b \rightarrow d\ell$
      - Radiative Penguins
    - At the Y(5S)
      - $b \rightarrow s\gamma$  (inclusive)
      - $b \rightarrow s\gamma$  (exclusive)
      - $b \rightarrow d\gamma$
  - CKM Side Measurements
    - $V_{cb}$
    - $V_{ub}$
    - $|V_{td}/V_{ts}|$ ??? Think about this and if it can be improved at SuperB
  - CP Violation: A short introduction (CKM, types of CPV etc) / formalism etc
    - $\Delta M$
    - $\Delta\Gamma$
  - CP Violation: theoretical uncertainties
  - Time dependent CP measurements
    - Tree level measurements
    - Penguin measurements
    - New physics searches
  - $\Gamma$
  - Direct CP Violation measurements
  - CPT
  - $K^{*}\gamma$ /triple products ... other modes could be of interest to (T-Odd CPV)
- At the Y(5S)
- Charm Physics
  - At the Y(4S)
  - At the  $\psi(3770)$
- Precision EW Physics
  - Introduction
  - $\sin^2\theta_W$  measurements for leptons, charm and beauty from  $A_{LR}$
  - precision probes of neutral current vector coupling universality
  - requirements on polarisation measurement precision
  - neutral current measurements with unpolarised beams (note: for completeness to show it doesn't get you anywhere)
  - Constraints on new physics

See: [http://mailman.fe.infn.it/superbwiki/index.php/SuperB\\_Physics\\_TDR](http://mailman.fe.infn.it/superbwiki/index.php/SuperB_Physics_TDR)

LNF April 2011



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  - New physics searches
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  - CPT
  - $K^{*} \gamma$  / triple products ... other modes could be of interest to (T-Odd CPV)

Will have latex ready for ELBa

See: [http://mailman.fe.infn.it/superbwiki/index.php/SuperB\\_Physics\\_TDR](http://mailman.fe.infn.it/superbwiki/index.php/SuperB_Physics_TDR)

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# Physics Computing Issues

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- Request #1:
  - We need to know if you are using a BaBar analysis package in next 2 weeks (need to pass this onto computing management)
  
- Request #2:
  - Want to know physics computing requirements for the rest of this year (production for TDR physics studies).
  
- Request #3:
  - Please let us know by Elba what physics tools (tagging etc.) need to be developed
    - for the TDR
    - for the physics book.
  
- Please e-mail us with this information asap.



# Elba Collaboration meeting

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- Will have strong physics focus:  
**Sessions envisaged (so far):**
  - Other Experiments (LHCb/Belle II/NA62/KLOE 2 confirmed)
    - MEG/BES III tbc.
  - TDR
  - Charm
  - tau
  - Spectroscopy & Dark Forces
  - $b \rightarrow sll$  theory session
  - Lattice
  - Interplay
  - + general sessions for other talks
- Want to know rough agenda from session organisers (and room sizes required in 3 weeks).
- Everyone is invited to participate in the physics activities:
  - Expect convenors to attend in person if possible.
  - Details will be circulated on wiki & mailing list soon.



# December Physics Workshop

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- 2<sup>nd</sup> workshop of the year
  - Aim to discuss  $b \rightarrow s\gamma$  theory issues.
- Want to understand general agenda structure by the end of Elba so we can invite external people to participate in this meeting.
  - Please remember our theory colleagues get booked up on the conference circuit a lot earlier than experimentalist do.
- Please let us know of other issues we should raise at this meeting if you know of them now.
  - (includes validation of tools and new benchmark studies)



# Physics meetings

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- Plan to have bi-weekly physics meetings (EVO) for the foreseeable future to support the TDR effort.
- Please complete the doodle poll at the following URL if you are a convenor or plan to participate in the physics effort and want to contribute.
  - <http://www.doodle.com/uxne7seawdd4f79b>
- Proposed meeting time: 8am (West coast) / 4pm (UK) / 5pm (Europe).
- Next meeting would be scheduled for 2 weeks from now (week starting 18<sup>th</sup> April). Announcement will be made on physics mailing list.



# The long term programme

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- 2 physics meetings a year between now and finishing the physics book.
  - Elba + December meeting (Rome region)
- Physics TDR should be completed on similar timescale to Detector TDR.
- This is a dynamic "Physics Case" document we aim to keep updated the longer term (freeze out a copy for TDR to archive / Physics Book as required).
- Book should be completed with full simulation input on as many golden modes as possible 18-24 months prior to data taking.
  - The TDR is just the beginning...