Report on B2TiP activities

Christoph Schwanda (HEPHY Vienna)

JENNIFER Consortium General Meeting
September 22, 2016, QMUL, London UK

B2TiP concept

- The “Belle II Theory Interface Platform” is a joint theory-experiment effort to define the Belle II physics program
- B2TiP is organized in 9 working groups
- The charge of each WG is to identify the “golden modes”, perform simulation studies and finally produce a chapter of the B2TiP report
- The activity is driven by a series of workshops

B2TiP WG structure

WG1	Semileptonic & Leptonic B decays
WG2	Radiative & electroweak penguins
WG3	α (ϕ_2) and β (ϕ_1)
WG4	ϕ_3
WG5	Charmless hadronic B decays
WG6	Charm physics
WG7	Quarkonium-like states
WG8	Tau, low multiplicity and electroweak physics
WG9	New Physics (models)

B2TiP workshop series

1. October 30-31, 2014 @ KEK
2. April 27-29, 2015 @ Krakow
3. October 28-29, 2015 @ KEK
4. May 23-25, 2016 @ Pittsburgh
5. November 15-17, 2016 @ MIAPP Munich (editorial meeting)

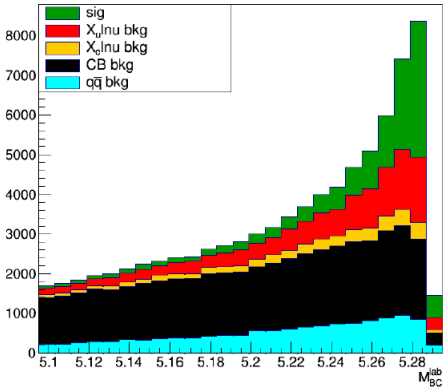
plus the kickoff meeting June 16-17, 2014 @ KEK and a few focused meetings

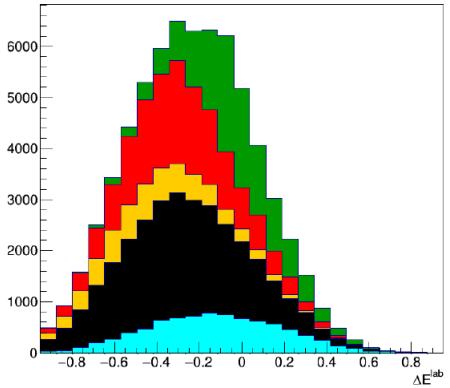
Achievements (by B2TiP Pittsburgh May 2016)

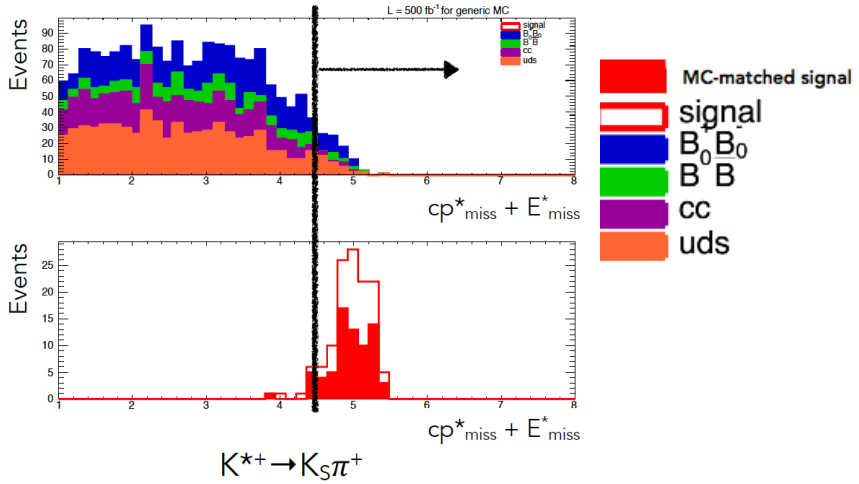
- Identified priority modes and benchmarks for each group
- Developed advanced physics analysis framework: capable of full analysis
- FEI (B reconstruction), flavour tagging, missing energy software ready
- 5/ab MC delivered, O(30) analysts preparing sensitivity studies
- Accurate feasibility studies performed
- Performance of the detector and software measured and iterating
- Working versions of trigger tools for low multiplicity analyses available

- Semileptonic & Leptonic WG 1&2 : 4 Full simulation studies *including beam background*@**B2TiP Pitt**

BR Stat Error [%] in 700 fb^{-1}	Belle/ *Babar	**B2BII MC**	**Belle II MC5**
B → π l ν untagged, M. Lubej	1.9	-	**1.3**
Bs → K l ν untagged @Υ(5S) A. Zupanc	-	**7.5**	-
B → τ ν Had tag, M. Merola	38		**34**
B → K^{*+} ν ν Had tag Cut&Count, E. Manoni	***<2.9·10^-4**		**<3.7·10^-4**







- **Analysis tools**: Rest-of-Event, Untagged SL, FEI/Full-recon, optimized γ/π^0 selection

WG3 Time Dependent CP Violation

- *Full simulation studies of 5 modes* @ **B2TiP Pitt.** Belle II *sensitivity improvements*.

Stat. Precision with 710 fb^{-1}	S_{CP}		A_{CP}		Δt [ps] resol.	
	Belle	**Belle II MC5**	Belle	**Belle II MC5**	Belle	**Belle II MC5**
$B \to K_S K_S K_S$, P. Jäger	0.27	**0.19**	0.17	**0.11**		
$B \to \eta'(\eta \to \gamma\gamma) K_S$, S. Lacaprara	0.15	**0.12**	0.10	**0.09**		
$B \to \Phi(KK) K_S$, A. Gaz					NA	0.75
$B \to J/\psi\ K_S$, L. Li Gioi					0.92	0.71
$B \to \pi^0 \pi^0 (\to ee\gamma)$, F. Abudinen					NA	1.5

Analysis tools: mdst K_S, flavour tagging, tag-vertex, continuum suppression.
Homework: K_L, e tracks, QED background, B2BII direct cross-check
Theory: Penguin pollution needs precision $\Gamma(B^+)/\Gamma(B^0)$.

- WG4 (Φ_3/γ) and 6 (Charm) *4 full simulation based studies* @ **B2TiP Pitt**
  - Φ_3 from $B \rightarrow D[K_S\pi\pi] K^{\pm}$, I. Watson
  - D semileptonics, J. Bennett
  - D tagging, G. de Pietro
  - D mixing and CPV, A. Schwartz, G. Casarosa

Preparation for first data

L1 Trigger Menu for Low Multiplicity Physics evaluated with L1 emulator.
https://d2comp.kek.jp/record/314/files/BELLE2-NOTE-PH-2015-011.pdf

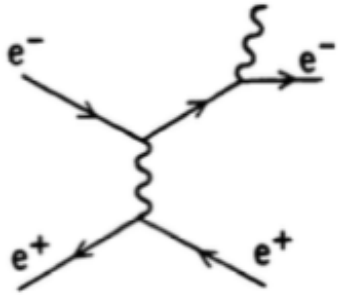
Preparing for systematic uncertainty measurements
https://d2comp.kek.jp/record/345/files/BELLE2-NOTE-PH-2016-001.pdf

B2TiP report status
(as a B2TiP May 2016)

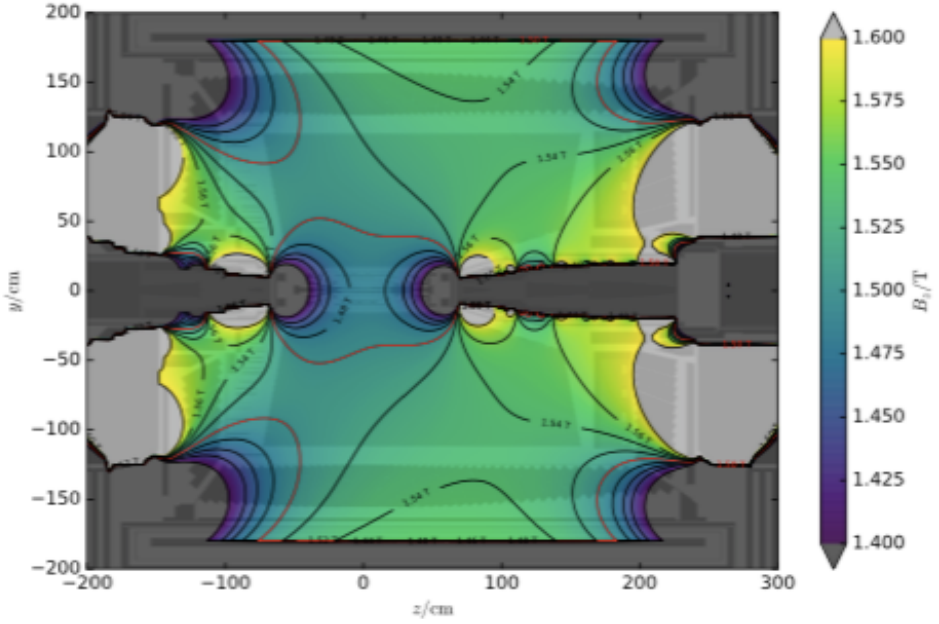
Section	Exp editor(s)	Theory editor(s)	Support Documents	Draft/Outline	Svn	~ Draft status (April 2016)	Review status	Pages, Figures, Tables
Full Document			1, 2, 3					
1. Introduction & Data sets	Urquijo	Kou				60%, theory part missing		
2. Belle II Detector	Urquijo, Krizan	-				50%, update from Krizan coming		
3. Simulation	Ferber	-				80%		
4. Reconstruction	Bennett	-	1, 2			30%, need input on tracking, neutrals, v0, beamspot, eID		
5. Analysis software	Li Gioi, Zupanc, Goldenzweig	-	1			Rough outline (base on several theses)		
6. Theory overview	-	Nierste				40%		
7. WG1: Semileptonic & Leptonic B	De Nardo, Zupanc	Kronfeld, Tackmann, Watanabe	1			Rough outline		
8. WG2: Radiative and EWP B	Ishikawa, Yamaoka	Feldman, Haisch	1			20%		
9. WG3: Time dependent CPV B	Gaz, Li Gioi	Zupan, Mishima				Outline		
10. WG4: Phi 3	Libby	Blanke, Grossman	1			20%		
11. WG5: Hadronic B	Goldenzweig	Beneke, Chiang	1			20%		
12. WG6: Charm	Casarosa, Schwartz	Petrov, Kagan				Outline		
13. WG7: Quarkonium	Fulsom, Shen, Mizuk	Hanhart, Kiyo, Polosa, Prelovsek	1, 2, 3, 4, 5			30%, charmonium only, no simulation		
14. WG8: Low multiplicity & tau	Ferber, Hayasaka	Passemar, Hisano	1, 2, 3, 4			20%		
15. WG9: New physics	Bernlochner, Sato	Nierste, Silvestrini, Kamenik, Lubicz				Detailed outline		
16. Summary	Urquijo	Kou						

Simulation chapter

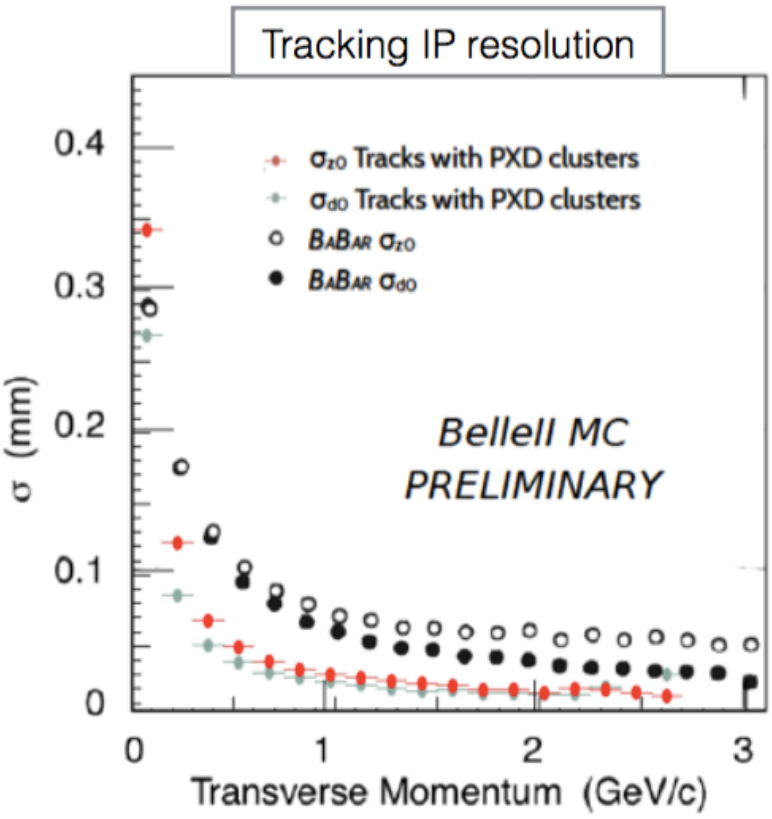
- Generators
- Magnetic field
- Background simulation

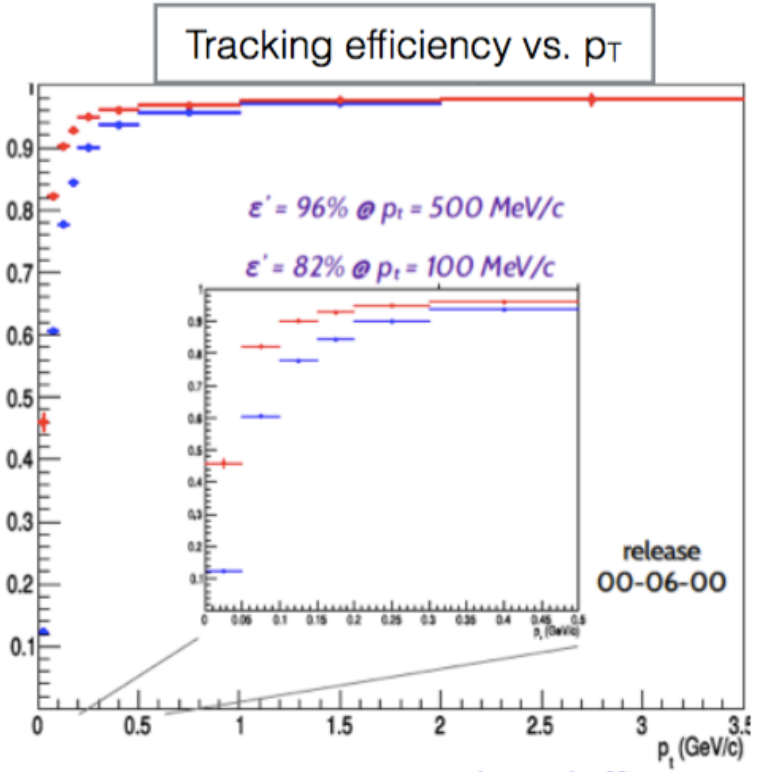


Physics process	Cross section [nb]	Cuts	Reference
$\Upsilon(4S)$	1.05 ± 0.10	-	[1]
$u\bar{u}(\gamma)$	1.61	-	KKMC
$d\bar{d}(\gamma)$	0.40	-	KKMC
$s\bar{s}(\gamma)$	0.38	-	KKMC
$c\bar{c}(\gamma)$	1.30	-	KKMC
$e^+e^-(\gamma)$	300 ± 3 (MC stat.)	$10^\circ < \theta^*_{e's} < 170^\circ$, $E^*_{e's} > 0.15$ GeV	BABAYAGA.NLO
$e^+e^-(\gamma)$	74.4	e's (p >0.5GeV) in ECL	-
$\gamma\gamma(\gamma)$	4.99 ± 0.05 (MC stat.)	$10^\circ < \theta^*_{\gamma's} < 170^\circ$, $E^*_{\gamma's} > 0.15$ GeV	BABAYAGA.NLO
$\gamma\gamma(\gamma)$	3.30	γ's (p >0.5GeV) in ECL	-
$\mu^+\mu^-(\gamma)$	1.148	-	KKMC
$\mu^+\mu^-(\gamma)$	0.831	μ's (p >0.5GeV) in CDC	-
$\mu^+\mu^-\gamma(\gamma)$	0.242	μ's (p >0.5GeV) in CDC, ≥ 1 γ (E_γ >0.5GeV) in ECL	-
$\tau^+\tau^-(\gamma)$	0.919	-	KKMC
$\nu\bar{\nu}(\gamma)$	0.25×10^{-3}	-	KKMC
$e^+e^-e^+e^-$	39.7 ± 0.1 (MC stat.)	$W_{\ell\ell} > 0.5$GeV	AAFH
$e^+e^-\mu^+\mu^-$	18.9 ± 0.1 (MC stat.)	$W_{\ell\ell} > 0.5$GeV	AAFH



Reconstruction chapter





- physical efficiency
- geometrical acceptance and detector efficiency factored out

*release-6 (December 2015)

- Tracking, calorimeter reconstruction, charged particle identification, neutral particle identification (γ, π^0, K_L)

Analysis tools

B2TiP timeline

- 2016 key dates
  - **May** B2TiP Pittsburgh – presentation of 1/ab to 5/ab studies
  - **June** MC6 production based on software release 7 (removal of legacy tracking, more beam background processes); to be used in some studies
  - **July** First draft of each chapter sent for soft review **– VERSION 1**
  - **September** Deadline for response from reviewers
  - **Oct 31 Hard deadline for delivery of chapters for review prior to the MIAPP B2TiP workshop – VERSION 2**
  - **Nov 15-17** B2TiP Editorial meeting
  - **Dec-Feb** Editing and review; we will discourage new contributions in this period – **FINAL VERSION**
- Journal submission: March 31, 2017

Summary

- B2TiP is an effort to identify physics opportunities at Belle II together with the theory community
- This process has converged in a series of 4 workshops so far
- The B2TiP document has evolved a lot between Pittsburg May 2016 and now – soft review process
- The final version is expected for the November 2016 workshop in Munich