Belle (II) physics analysis at Trieste

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Disclaimer

This is a start-up/contentless talk. Its purpose is

- To let you know that we have recently formed a small team which is exploring a few analysis options
- To get your feedback

Us

Currently **one staff scientist** and **two postdocs** are interesting in doing analysis.

Diego Tonelli

- **Many measurements of CP violation in CDF and LHCb**

Chiara La Licata

- **Electro-weak physics at CMS**

Ilya Komarov

- **Heavy-flavour physics at LHCb**

We expect that other group members now busy with construction/commissioning will contribute soon

Our plans

We lack $e^+e^- \rightarrow Y(4S)$ analysis background and Belle II physics-grade data are not yet there. We thought we could learn a lot by pursuing an analysis of Belle data with B2BII: need a topic that is

- **Interesting physics-wise.**

- Potentially leading to a competitive result with respect to Babar and LHCb current and future results.

- Commensurate with our timing and personpower constraints (2 postdocs) and compatible with Belle's needs.

- **Promising and attractive in Belle II perspective**.

Hadronic B decays

An essential sources of our knowledge of CP violation in quarks, since they give direct access to CKM parameters α and γ.

- Most of the simple things are done/in progress, but a number of interesting channels remain to be fully exploited.
- For modes with neutrals in the final state, Belle(II) reach is either unique or competitive to LHCb.
- Belle seem to be lagging behind on some channels w.r.t. to what done by Babar.
- Some of us have a long standing interest and background on these modes.

The first candidate: $B^+ \rightarrow K^{*+} \rho^0$

Motivation: experimental test of B→VV helicity structure

`Phys.Rev.D78:094001,2008  Phys.Rev.Lett.96:141801,2006`

Final states: $\boldsymbol{\pi^+ K^0 \pi^+ \pi^-}$ and $\boldsymbol{\pi^0 K^+ \pi^+ \pi^-}$

Observables: Br, A_{CP} and f_L (partial angular analysis needed - integrated over ϕ)

Experimental challenges:

- Low BF (~10^{-5})
- Wide ρ^0 partially overlapping with $f_0(980)$

B→ K*ρ. Current status

Table of measured branching fractions in different experiments

	BaBar					Belle				
	stat (%)	syst (%)	N_{sig}	Data	f_L, A_{CP}	stat (%)	syst (%)	N_{sig}	Data	f_L, A_{CP}
$K^{*+}\ \rho^0$	22	9	152	100%	+					
	arXiv:1012.4044v1									
$K^{*0}\ \rho^+$	18	16	194	50%	+	19	13	85	30%	+
	arXiv:hep-ex/0607057					arXiv:hep-ex/0505039				
$K^{*+}\ \rho^-$	22	13	167	100%	+					
	arXiv:1112.3896									
$K^{*0}\ \rho^0$	12	14	376	100%	+	38	40	78	85%	-
	arXiv:1112.3896					arXiv:0905.0763v2				

Note: No competition from LHCb, except for $B^0 \rightarrow K^{*0}\ \rho^0$ (right now LHCb has no results here, but potentially they have better performance).

B→ K*ρ. Prospects

Table of measured branching fractions in different experiments.

Projected values are shown in green

	BaBar					Belle					Belle II one
	stat (%)	syst (%)	N_{sig}	Data	f_L, A_{CP}	stat (%)	syst (%)	N_{sig}	Data	f_L, A_{CP}	stat (%)
$K^{*+}\ \rho^0$	22	9	152	100%	+	**16**			**100%**		**7**
		arXiv:1012.4044v1									
$K^{*0}\ \rho^+$	18	16	194	50%	+	19	13	85	30%	+	
		arXiv:hep-ex/0607057					arXiv:hep-ex/0505039				
$K^{*+}\ \rho^-$	22	13	167	100%	+	**17**			**100%**		**8**
		arXiv:1112.3896									
$K^{*0}\ \rho^0$	12	14	376	100%	+	33-38	24-40	78	85%	-	**4**
		arXiv:1112.3896					arXiv:0905.0763v2				

Sounds like there might be potential for doing useful physics here.

Possible extensions of $B^+ \rightarrow K^{*+}\ \rho^0$ analysis: inclusion of other K*ρ modes and full angular analysis.

$B^+ \to (D \to h_{K/\pi} h_{K/\pi} \pi^0)\ K/\pi$

Motivation: sensitivity to ϕ_3 through ***CP*** violating observables.

Final states: final states of two types: ADS ($K\pi\pi^0$ + K/π) and quasi-GLW ($KK\pi^0$ + K/π and $\pi\pi\pi^0$ + K/π). ADS part is already covered, so we aim to focus on qGLW part.

Observables: ratio of suppressed to favoured branching fractions ($R_{DK/D\pi}$) and direct ***CP*** asymmetry

Attractive because it appears rather straightforward, and the fact that Belle has already published the ADS results could offer a valuable consistency check.
On the other hand, the relevance of qGLW results alone might not obviously justify the effort and/or someone might already be working at these.

$B^+ \to (D \to 3\ body)\ K/\pi$

Table of measured direct asymmetry in different experiments

Projected values are shown in green

	LHCb 3fb^{-1} of pp collisions. (2011+2012)		BaBar 70% of data		Belle 100% of data		Belle II One year
	A_{CP}	N_{sig}	A_{CP}	N_{sig}	A_{CP}	N_{sig}	A_{CP}
$(D \to K\pi\pi^0)K^{-(+)}$	-0.2±0.27± ±0.04	1478 (1442)	—		0.41±0.30± ±0.05	3844	**±0.13(stat)**
$(D \to \pi\pi\pi^0)K^{-(+)}$	0.054±0.091± ±0.011	139(125)	-0.02±0.15± ±0.03	~85(~85)	**±0.091 (stat)**		**±0.04(stat)**
$(D \to KK\pi^0)K^{-(+)}$	0.30±0.20± ±0.02	49(27)	—		**±0.20 (stat)**		**±0.08(stat)**

LHCb, full Run I data [arXiv:1504.05442]

BaBar, 70% of data [arXiv:0703037v1]

Belle, 100% of data [arXiv:1310.1741v2]

Note : This is an analysis that measures many observables, we only show A_{CP} to compare sensitivities across experiments.

$B^+ \to (D \to 3\ body)\ K/\pi$

Presence of a neutral particle in the final state makes the Belle(II) reach competitive with LHCb: the full Belle data set should offer comparable resolution to LHCb 2011-2012 dataset. 3 months of expected Belle II performance are expected to match one year of LHCb*. Thus, making $B^+ \to (D \to hh\pi^0)\pi/K^+$ analysis with

- full Belle statistics: will allow to reach LHCb sensitivity level
- one year of Belle II: will be the world best measurement

**Given that in 2016 LHCb has already produced the same amount of B as in Run I, and assuming Belle II luminosity to be x40 times higher than at Belle.*

Not the end. The beginning.

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P.S. Technical question right away. What’s the best way to work with Belle/Belle II environment from Italy?