DISCUSSION

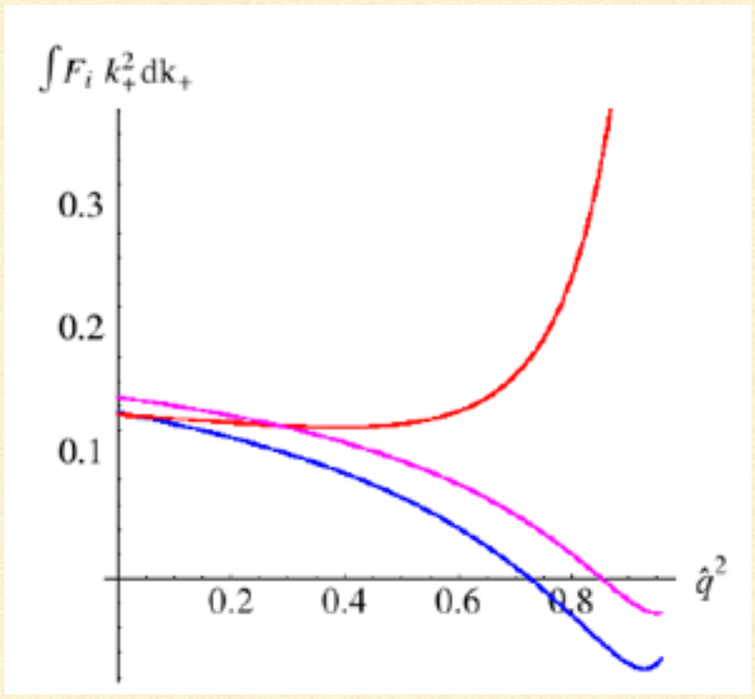
- Leptonic experimental situation
- Theoretical situation for $B \to l \nu \gamma$: extending/redeveloping formalism from $K \to l\nu(\gamma)$ to $B \to l\nu(\gamma)$ need $\langle 0|J_{em}\, J_{ew}|B\rangle \sim B \to \rho$ form factor(s). Measure them?
- (apart from confirming Fermilab/MILC) is more precision on f_B per se needed?
- are expt E_γ cuts + PHOTOS sufficient to extract $|V_{ub}|f_B$?
- Experimental analyses V_{ub} inclusive
- NNVub project: status & perspectives

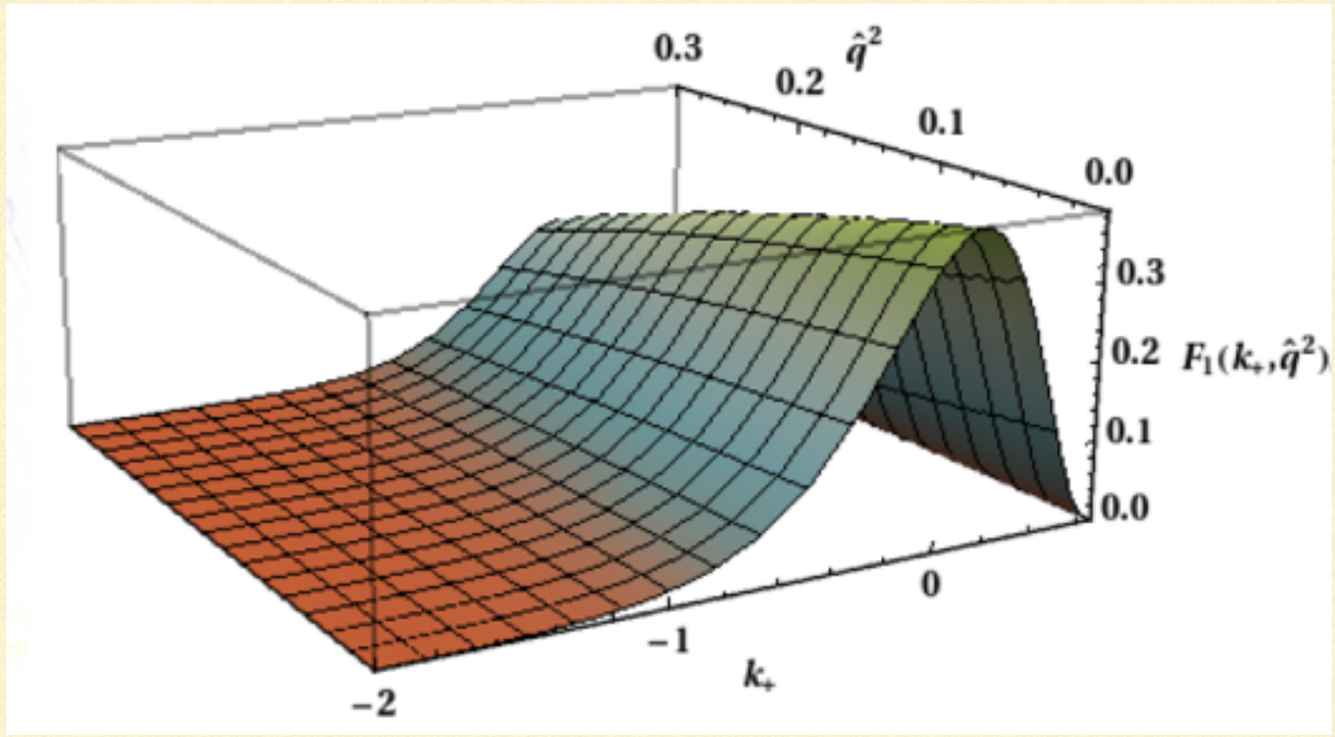
SHAPE FUNCTIONS IN GGOU

$$W_i(q_0, q^2) \sim \int dk_+ \; F_i(k_+, q^2, \mu) W_i^{pert} \left[q_0 - \frac{k_+}{2} \left(1 - \frac{q^2}{m_b M_B} \right), q^2, \mu \right]$$

3 SFs, one for each form factor

No subleading SFs, but SF depend on q^2 through moments





In the past each SF parametrized by simple 2-parameter functional forms

THE NNVub PROJECT

K.Healey, C. Mondino, PG, 1604.07598

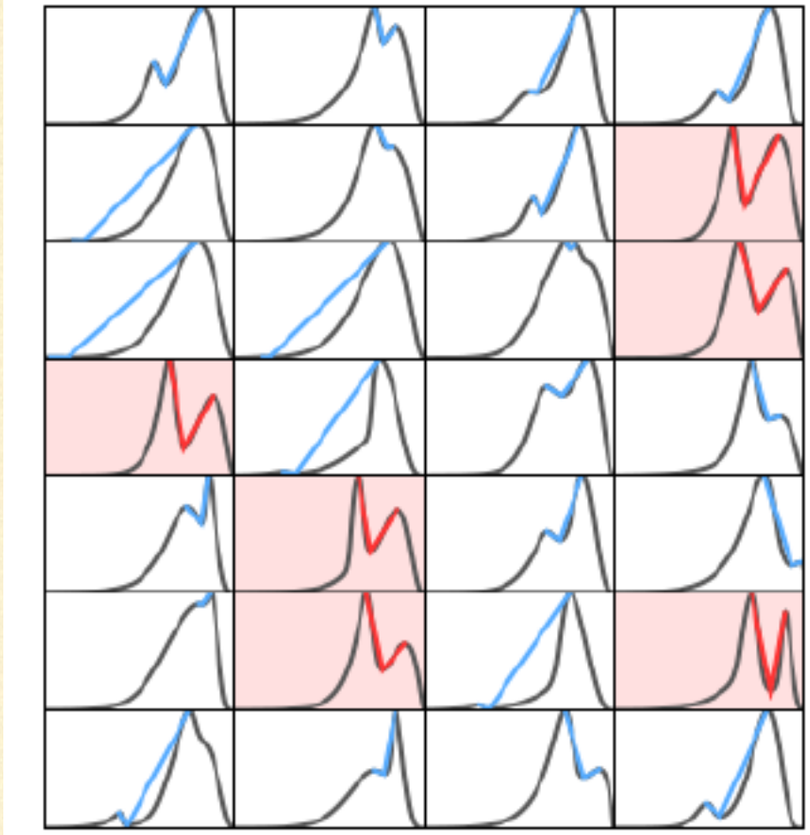
- Use Artificial Neural Networks to parametrise SFs without bias and extract V_{ub} from theoretical constraints and data, together with HQE parameters in a model independent way (without assumptions on functional form). Similar to NNPDF. Applies to b→ulv, b→sγ, b→sl+l-

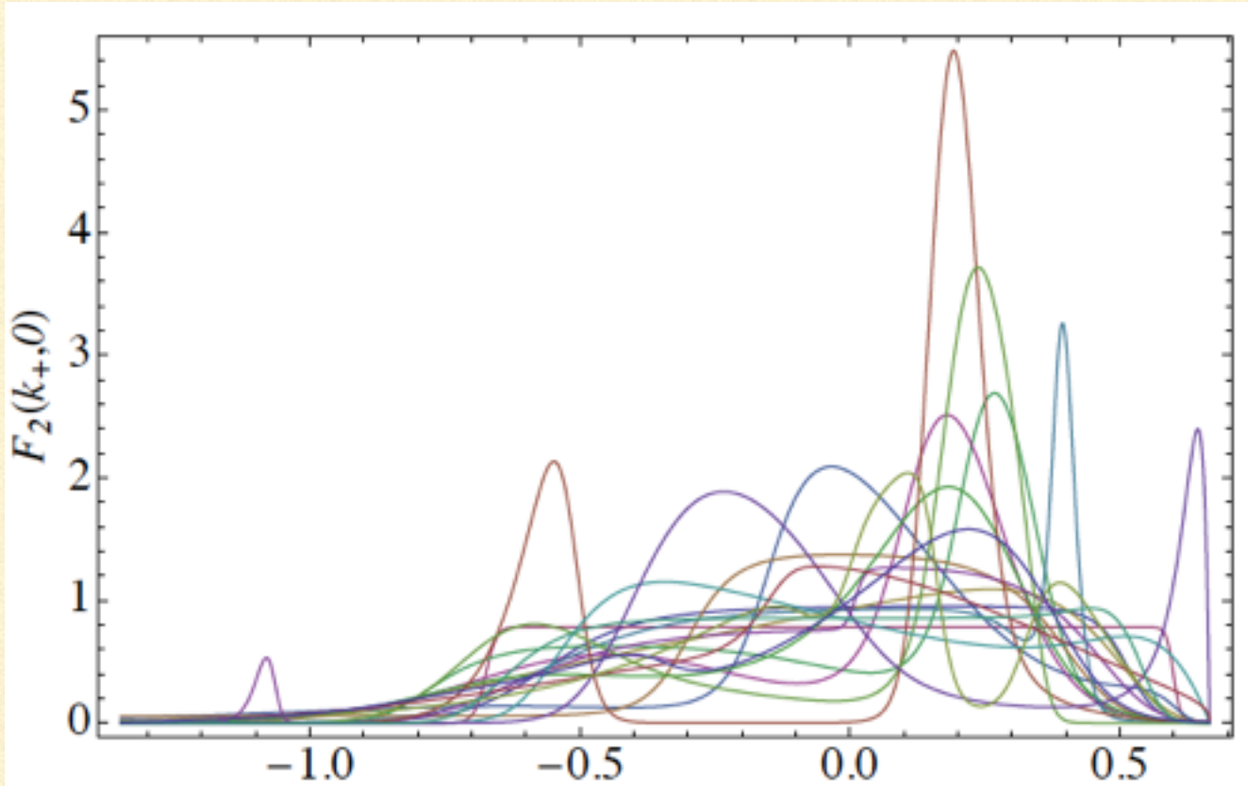
- Belle-II will measure some kinematic distributions, thus constraining directly the shape functions. NNVub will provide a flexible tool to analyse data.

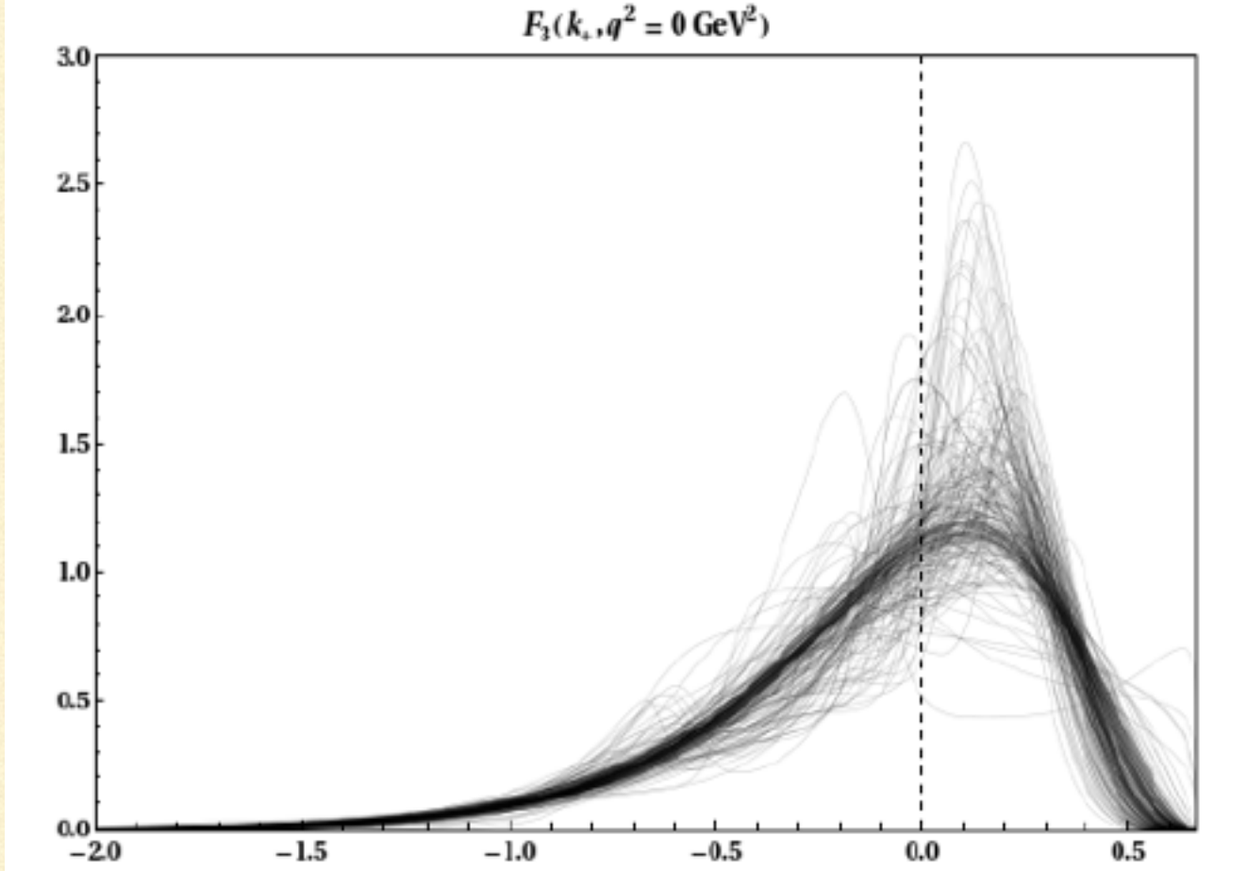
- NN provide unbiased parameterization of a continuous function: in the limit of infinite nodes they are universal approximators, highly non-linear functions
- Weights are trained to reproduce desired response: random weights undergo random modifications, retaining only those that improve response (e.g. better χ^2): genetic algorithm → replicas
- Used in pattern recognition, computationally intensive, data-driven

Selection of NN replicas trained on the **first three moments only.** They are not sufficient. But we know photon spectrum in bsgamma: single peak dominance, not too steep

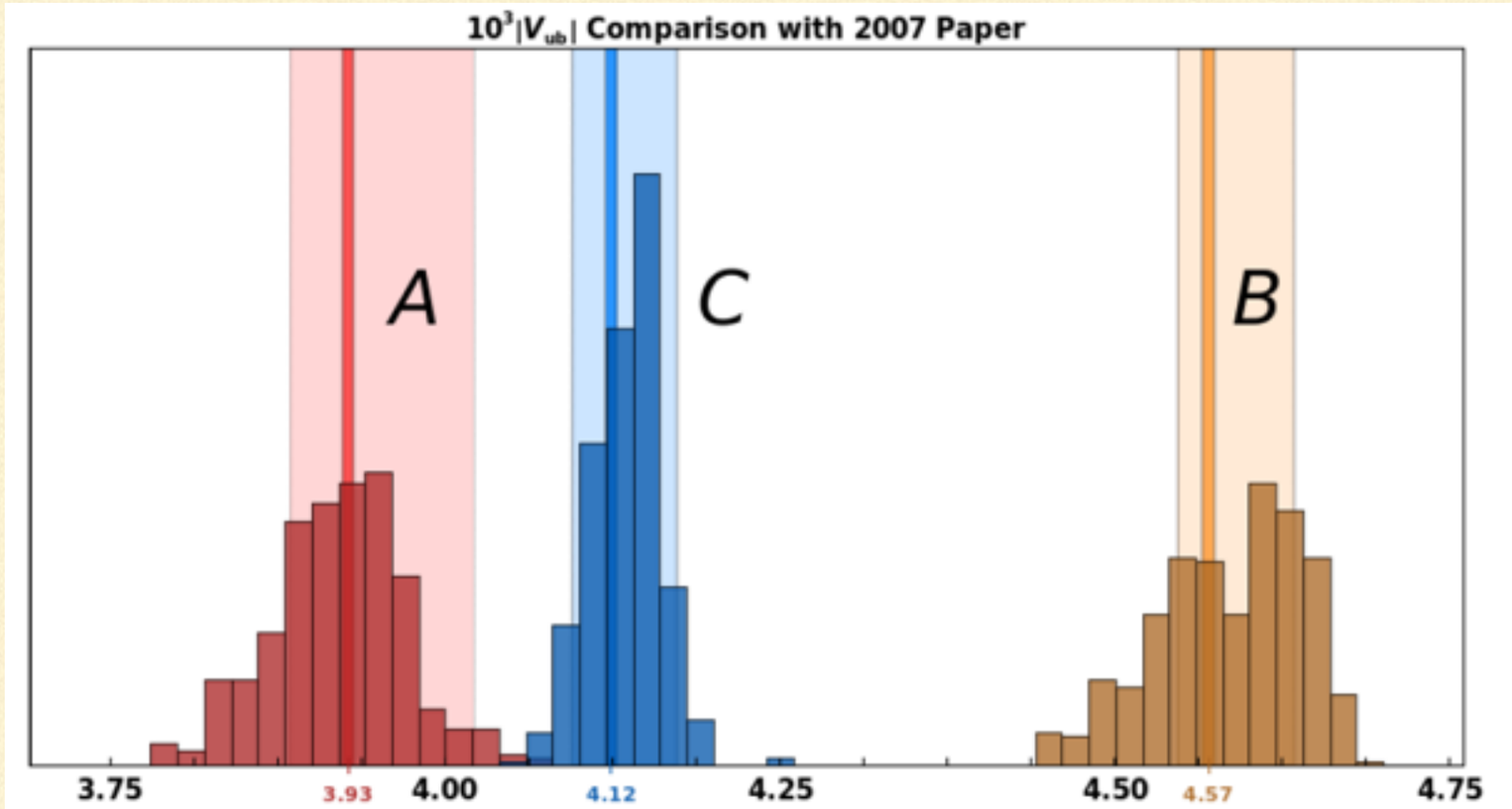
Beware: sampling can be biased by implementation, e.g. random initialization, or selection based on training speed







Comparison with 2007 paper, same inputs



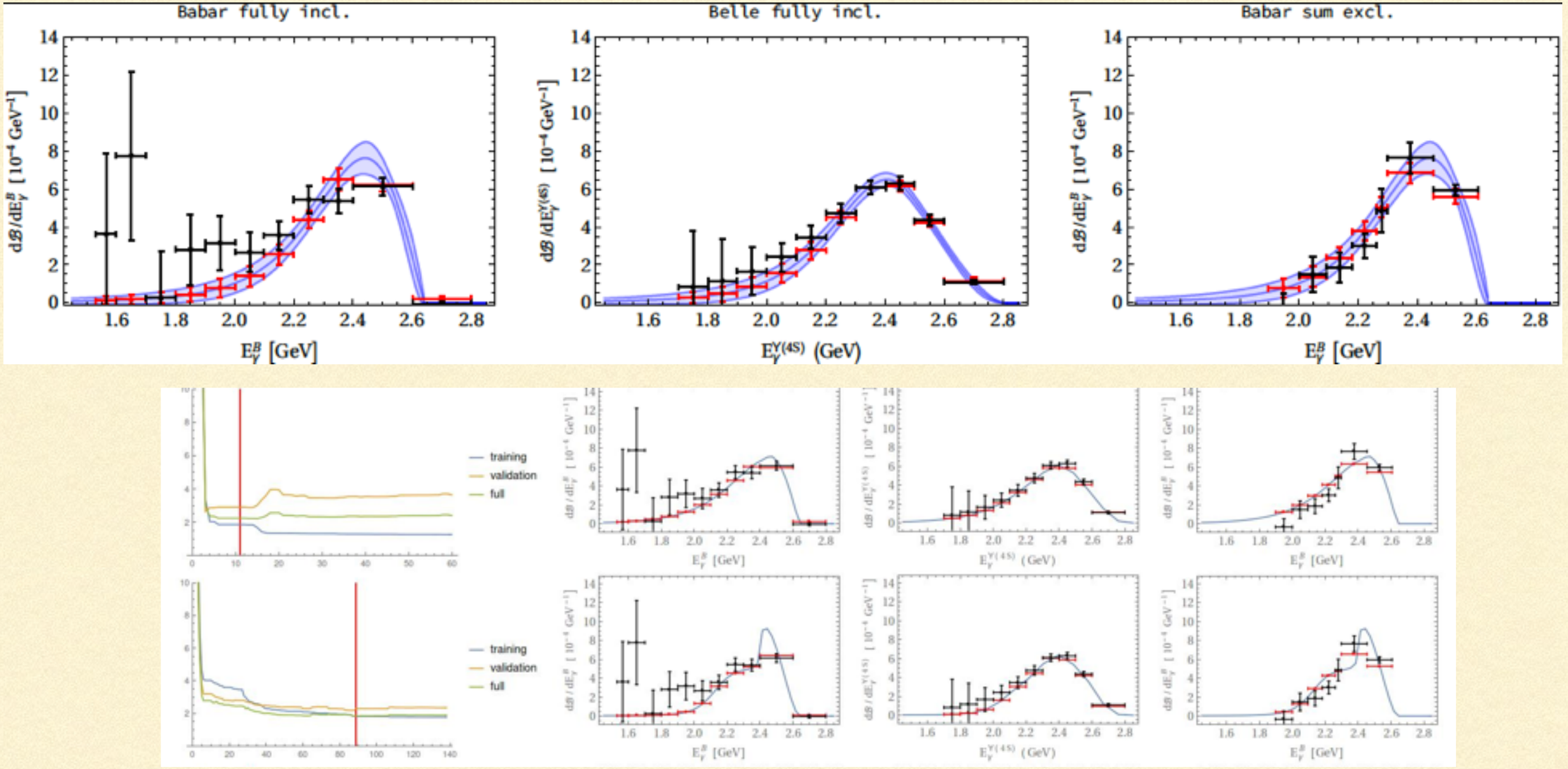
NNVub GGOU(HFAG 2014)

Experimental cuts (in GeV or GeV^2)	$\lvert V_{ub}\rvert \times 10^3$	$\lvert V_{ub}\rvert \times 10^3$[15]
$M_X < 1.55, E_\ell > 1.0$ Babar [44]	$4.30(20)(^{26}_{27})$	$4.29(20)(^{21}_{22})$
$M_X < 1.7, E_\ell > 1.0$ Babar [44]	$4.05(23)(^{19}_{20})$	$4.09(23)(^{18}_{19})$
$M_X \leq 1.7, q^2 > 8, E_\ell > 1.0$ Babar[44]	$4.23(23)(^{26}_{28})$	$4.32(23)(^{27}_{30})$
$E_\ell > 2.0$ Babar [41]	$4.47(26)(^{22}_{27})$	$4.50(26)(^{18}_{25})$
$E_\ell > 1.0$ Belle [45]	$4.58(27)(^{10}_{11})$	$4.60(27)(^{10}_{11})$

Inputs for constraints from sl fit by Alberti et al, 2014 with full uncertainties and correlations

The b→sγ spectrum

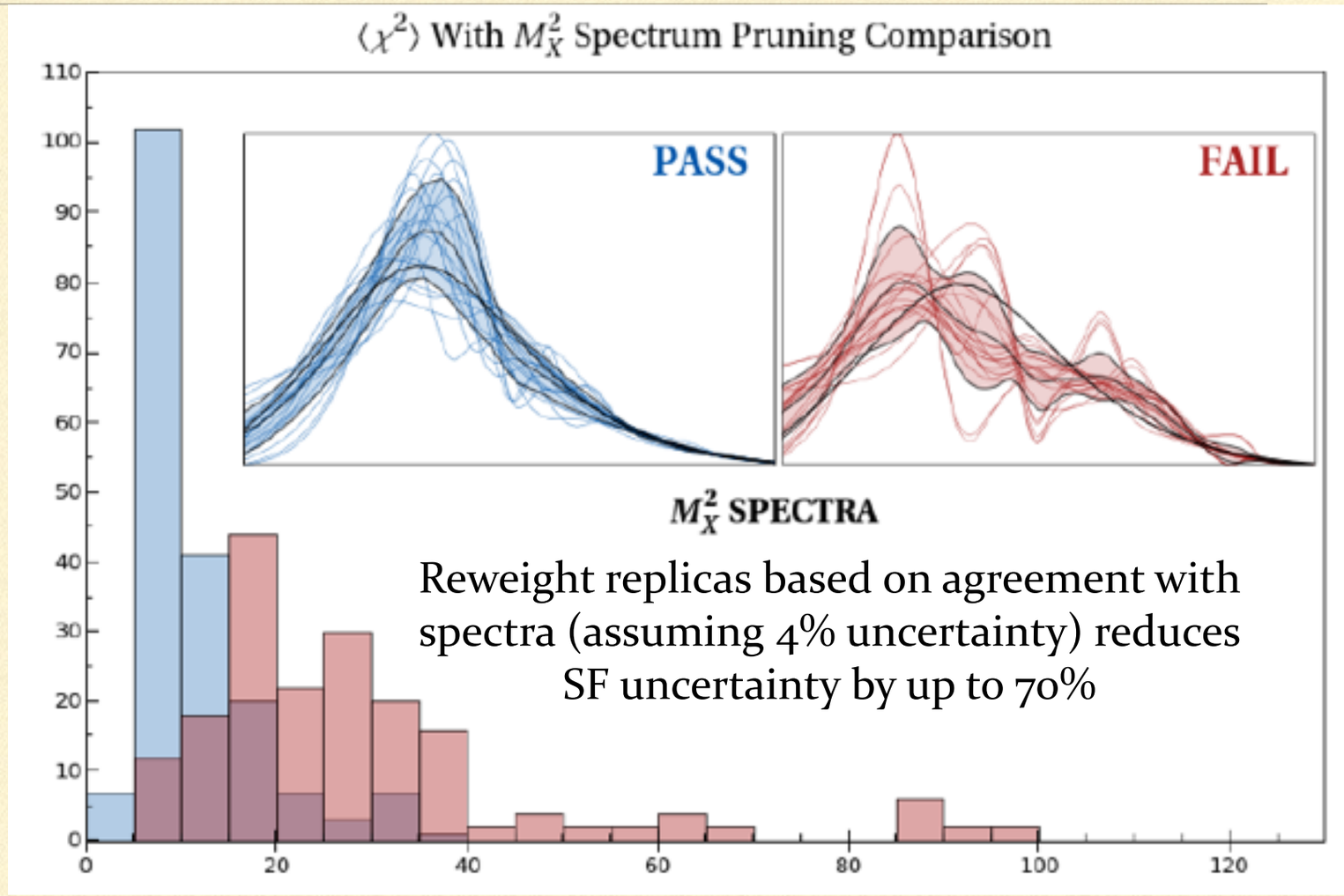
E. Lunghi, M.Misiak, S.Schacht, PG
in progress



Up-to-date theoretical description of spectrum to get i) leading SF at $q^2=0$ for V_{ub}, ii) HQE elements to compare with s.l. fit iii) reliable extrapolation to low cuts.

PROSPECTS

- Learning @ Belle-II from kinematic distributions, e.g. M_X spectrum
- OPE parameters checked/ improved in $b \to u l \nu$ (moments): global NN+OPE fit
- include all relevant information with correlations
- check signal dependence at endpoint
- full phase space implementation of α_s^2 and α_s/m_b^2 corrections
- model/exclude high q^2 tail

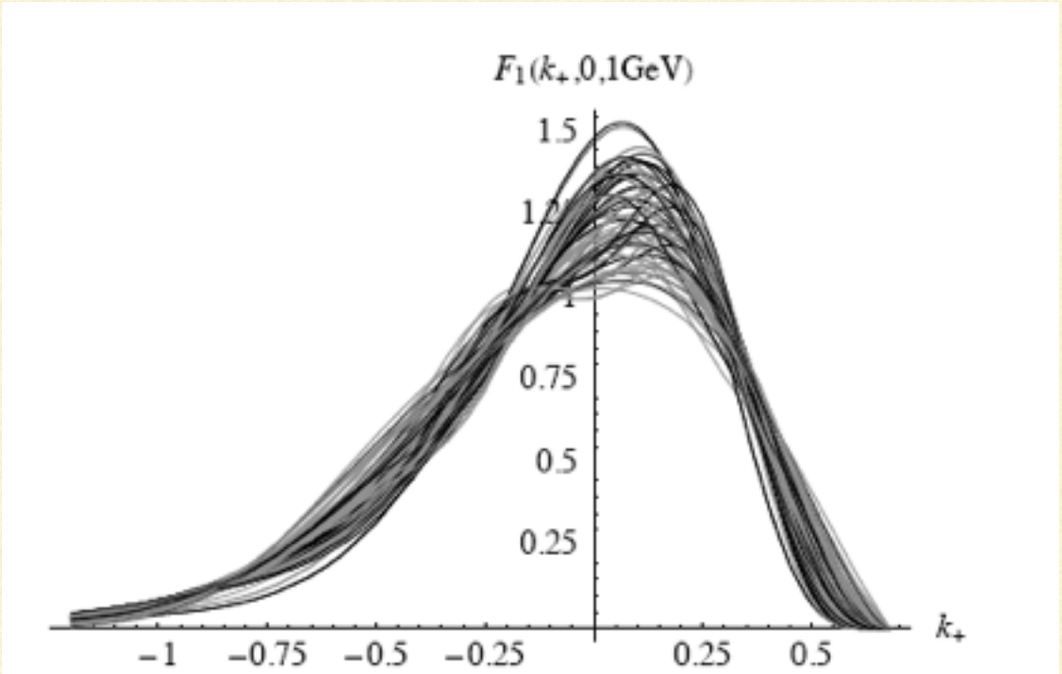


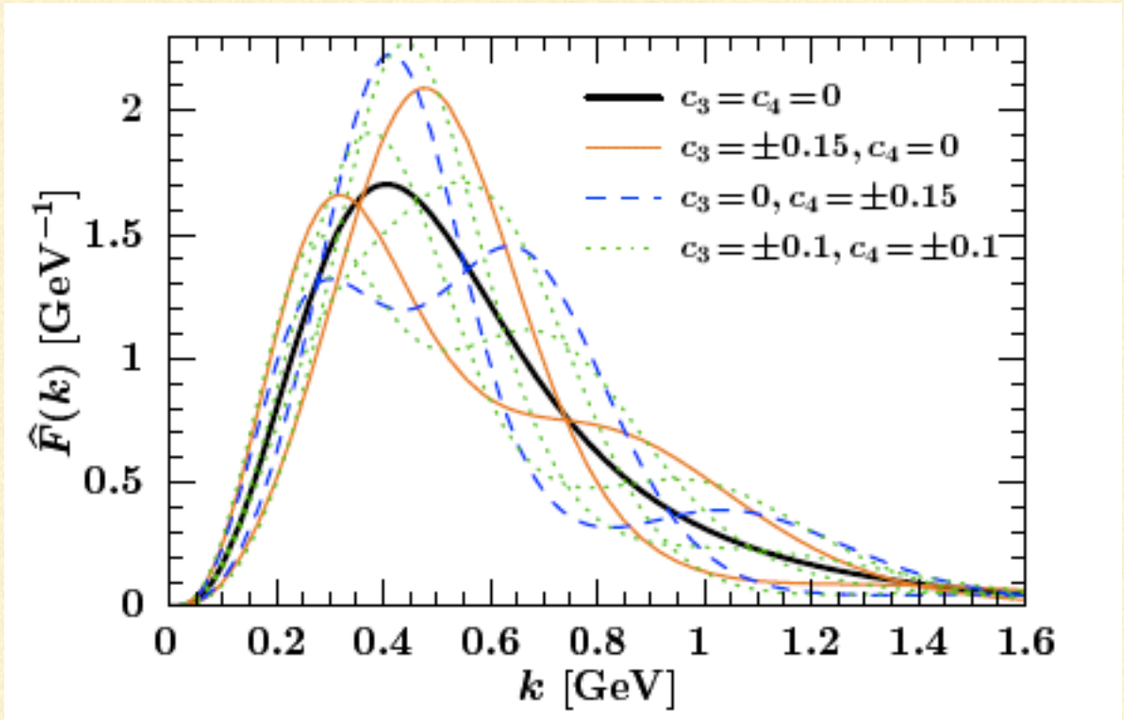
At Belle-II we can expect to bring inclusive V_{ub} at almost the same level as V_{cb}

DISCUSSION

- Higher order perturbative corrections: $O(\alpha_s^2)$ sizeable in BLNP? GGOU, DGE have $O(\beta_0\alpha_s^2)$, complete $O(\alpha_s^2, \alpha_s/m_b)$ available
- Learning from data in a unified framework is necessary (SIMBA, NNVub) : what are the fundamental limitations at Belle-II?
- will data be precise enough (with 4% uncertainty on M_X spectrum 70% reduction of SF uncertainty in NNVub) ?
- Weak annihilation constraints? upper cuts on q^2 ?
- can one validate/check hybrid models?
- can we gain something from considering inclusive b→c together with b→u?
- s sbar popping: prospects for B→KKlv ect?

FUNCTIONAL FORMS





About 100 forms considered in GGOU, large variety, double max discarded. Small uncertainty (1-2%) on V_{ub}

Only 2 parameters FF, is that good enough?

A more systematic method by Ligeti et al. arXiv:0807.1926 Plot shows 9 SFs that satisfy all the first three moments

see Florian's talk