Studies on τ decays at Belle II

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on behalf of the Belle II collaboration

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Outline

- Motivation
- Experimental requirements

  $\rightarrow$ Direct searches for lepton flavor violation

  $\rightarrow$ Precision tests of SM

Why τ decays?

Weight: heaviest charged leptons, massive enough to **decay into hadrons**

- $M_\tau \sim 17 \times M_{\mu,} \sim 3500 \times M_e$

lifetime: 290 fs, **not** a **long-lived particle**!

particular signs: allows a clean theoretical analysis of the *hadronization*, determination of standard model (SM) parameters...

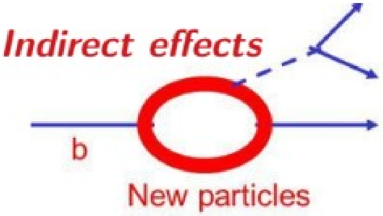
→ **probe non-SM physics** in mass-dependent couplings

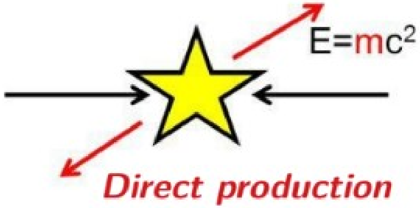
→ does the third lepton generation preferentially couple to non-SM physics?

Lepton as discovery tools

Leptons are powerful tools to explore beyond SM physics

- QED precise computations
- Clean physics event





- **precision measurements** of the tau properties
  - ***tau lepton mass***, lifetime, branching ratios
  - ***tests*** for deviations from SM predictions
- **searches** for forbidden decays of tau
  - observation of lepton flavor violation (LFV) in tau decays: $\tau \to \ell\alpha$, $\tau \to \ell\Phi$

The challenges

High precision measurements of the SM properties

- ***Control of systematic sources*** $\rightarrow$ excellent understanding of the experiment performance and background description required to improve results **mainly systematically limited**

e.g. tau mass, branching fractions measurement

$<$ fractions of permille level

World's **leading sensitivities** for direct searches

- ***Largest statistics*** $\rightarrow$ attain highest luminosity, collect (unique) data sets suitable to study rare processes

  $+$ devise new techniques to **increase** the signal **efficiency** while keeping background under control

e.g. LFV decays, $\tau \rightarrow \ell \Phi$

$< 10^{-8}$ level

Lepton flavor violation

- Neutral lepton flavor violation in the Standard Model (SM) due to ***neutrino masses and oscillations***
- ***Charged Lepton Flavor Violation (LFV)*** via SM weak interaction charged currents + neutrino mixing $< O(10^{-50})$, below current and future experiments reach → **observation of LFV decays is *per se* a proof of non-SM physics!**

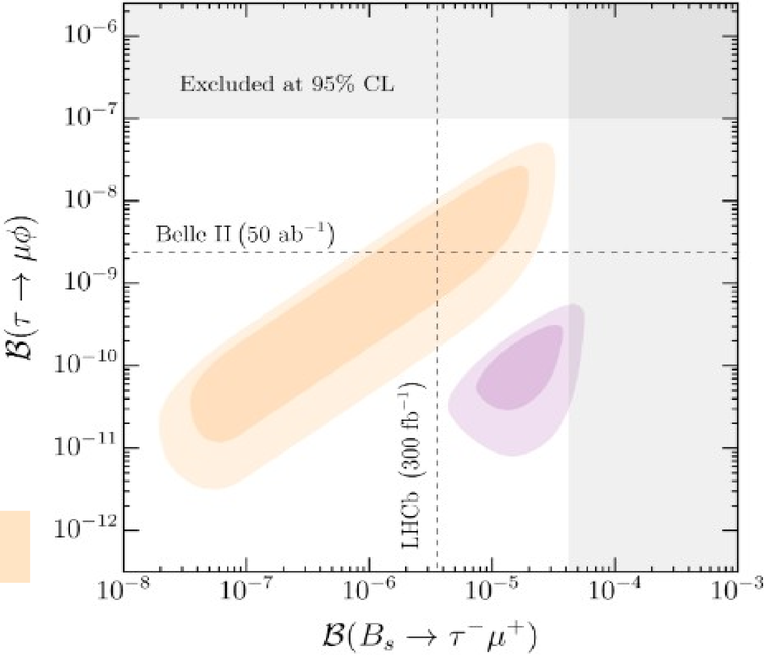
- Hints of Lepton Flavor Universality (LFU) violation and deviation from SM predictions in rare B decays (***flavor anomalies***):
  - $b \to cl\nu$: $\boldsymbol{\tau}$ Vs light leptons
  - $b \to sll$: $\boldsymbol{\mu}$ Vs. ***e***

See M.Bordone's talk and D. Guadagnoli's talk on Monday

New interaction that violates flavor (Z' boson, leptoquark)

→ ***Special role of the third family***

C. Cornella, et al., JHEP08 (2021) 050



Simplified U_1 model (with $\beta^{b\tau}_R = 0$)

Experimental requirements: B-factories

- Profit from **clean environment** at lepton colliders + **hermetic detector: Belle II** at **SuperKEKB** asymmetric-energy e^+e^- collider

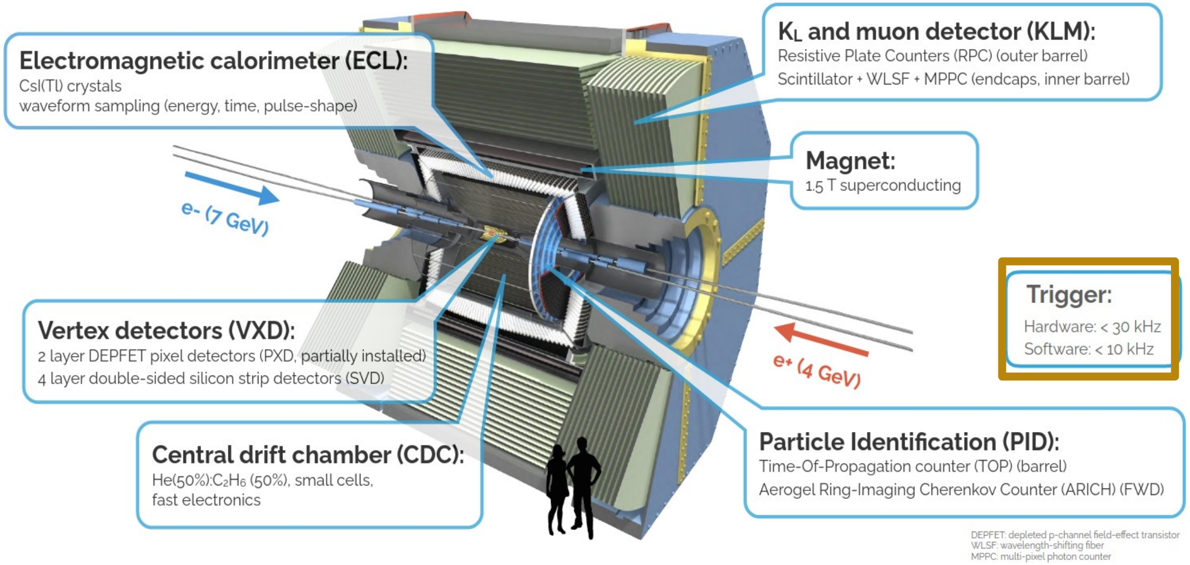
  → operates mainly at $\sqrt{s} = 10.58$ GeV: $\sigma_{bb} \sim \sigma_{\tau\tau} \sim 1$ nb, B & **τ factory**

  → known initial state

  → efficient reconstruction of **neutrals** (π^0, η), **recoiling system** and **missing energy**

  → specific **low-multiplicity triggers**: single track/muon/photon (previously not available at Belle)

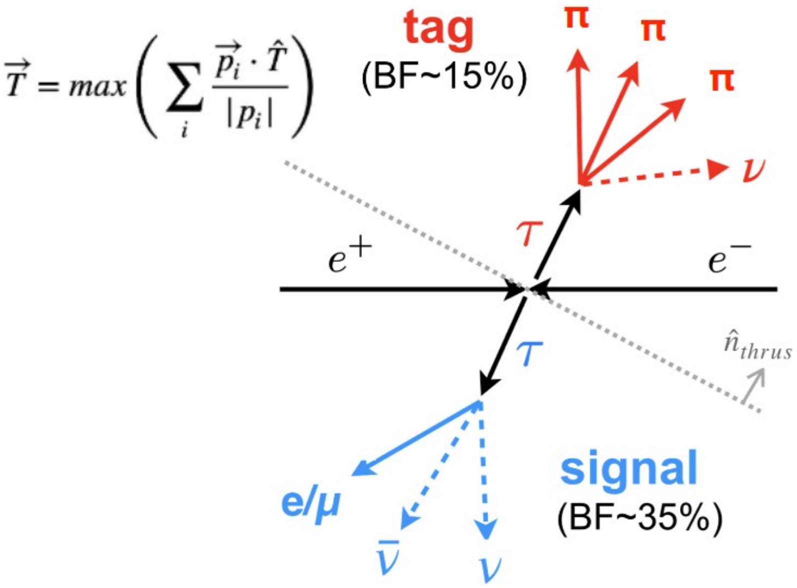
Unprecedented luminosity, 4.7×10^{34} $cm^{-2}s^{-1}$ world record



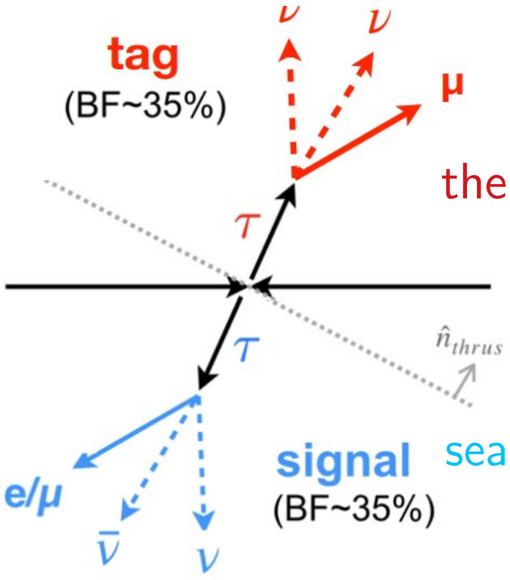
- Currently on first shutdown since July 2022
- **Accumulated 424 fb^{-1}** (~ Babar, ~ half of Belle) and unique energy scan samples

Tau topologies and signatures

- Tau pairs in $\mathbf{e^+e^- \to \tau^+\tau^-}$ events produced back-to-back in CM system
- Possible to separate them in **two opposite hemispheres** defined by the plane perpendicular to the **thrust axis**



(1x3)-prong Vs
(1x1)-prong



the other tau

search process

- Usually tag side reconstructed in a specific topology to suppress background, mainly from continuum $\mathbf{e^+e^- \to q\bar{q}}$

  → allows to reach excellent purity

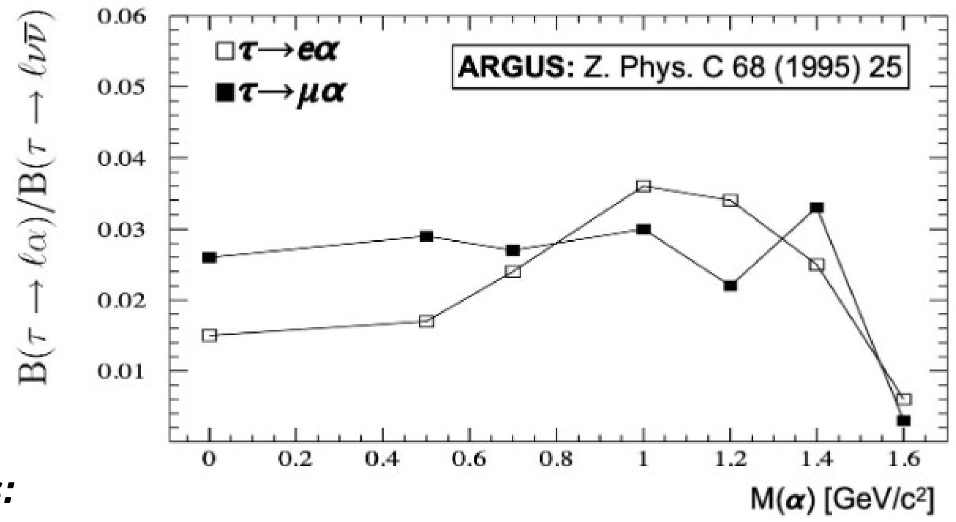
Direct searches:
new invisible boson in tau decays, $\tau \to \ell \alpha$

$\tau \rightarrow l\alpha$: motivation and strategy

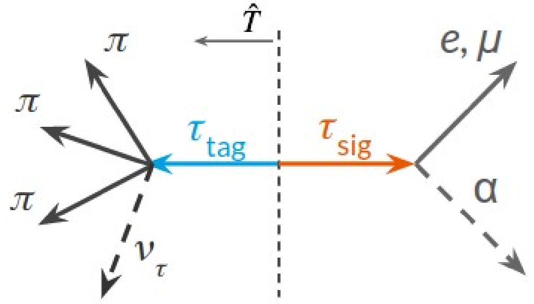
- τ decays to **new LFV bosons** decaying invisibly predicted in many models [1]

See L.Calibbi's talk

- Previous searches at **ARGUS** [2](~ 0.5/fb) → Belle II analysis relies **120 x luminosity**
- Search for the process $e^+e^- \rightarrow \tau_{sig}(\rightarrow \ell\alpha)\,\tau_{tag}(\rightarrow 3\pi\nu)$, with ℓ=e or ℓ=μ



- Split event in two hemispheres based on the ***thrust axis:***
  - use 3x1-prong decays (3 track on the tag side, 1 track on the signal side)
  - exploit the **shape differences**: *2-body* decay of signal (peaking in some kinematics features) over *3-body* decay of irreducible background from $\tau_{SM} \rightarrow \ell\nu\nu$

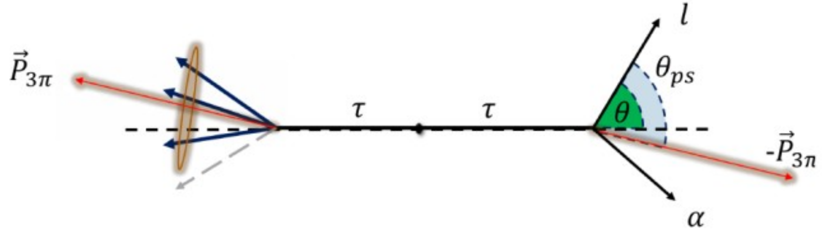


$$\vec{T} = max\left(\sum_i \frac{\vec{p}_i \cdot \hat{T}}{|p_i|}\right)$$

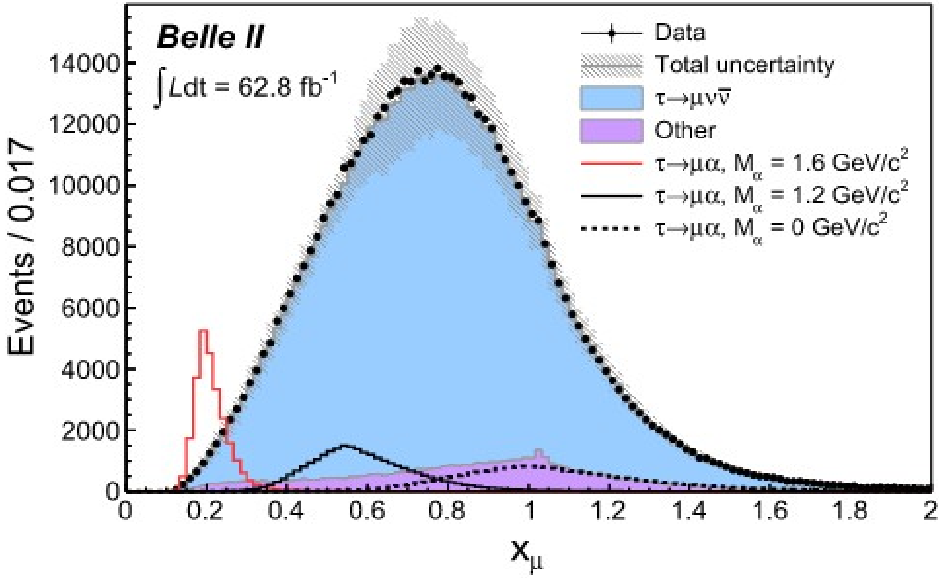
[1] M. Bauer, et al. Phys. Rev. Lett. 124, 211803 (2020)
[2] ARGUS Collaboration, Z. Phys. C 68, 25 (1995)

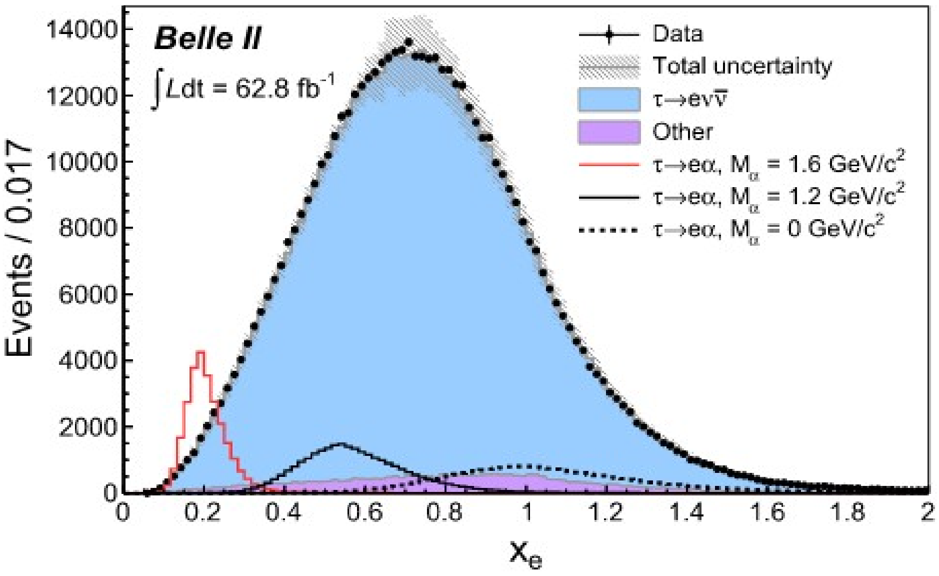
$\tau \to l\alpha$: *pseudo-rest* frame

- Shape differences more prominent in the rest frame: approximate $\boldsymbol{\tau}_{\mathbf{sig}}$ pseudo-rest frame as $E_{sig} \sim \sqrt{s}/2$ and $\hat{p}_{sig} \approx -\vec{p}_{\tau_{tag}}/|\vec{p}_{\tau_{tag}}|$
- Discriminating variable: **normalized lepton energy** x_l
  - Bump hunt above broad spectrum from $\boldsymbol{\tau}_{\mathbf{SM}} \boldsymbol{\to} \ell \boldsymbol{\nu\nu}$



$$x_\ell \equiv \frac{E^*_\ell}{m_\tau c^2/2},$$

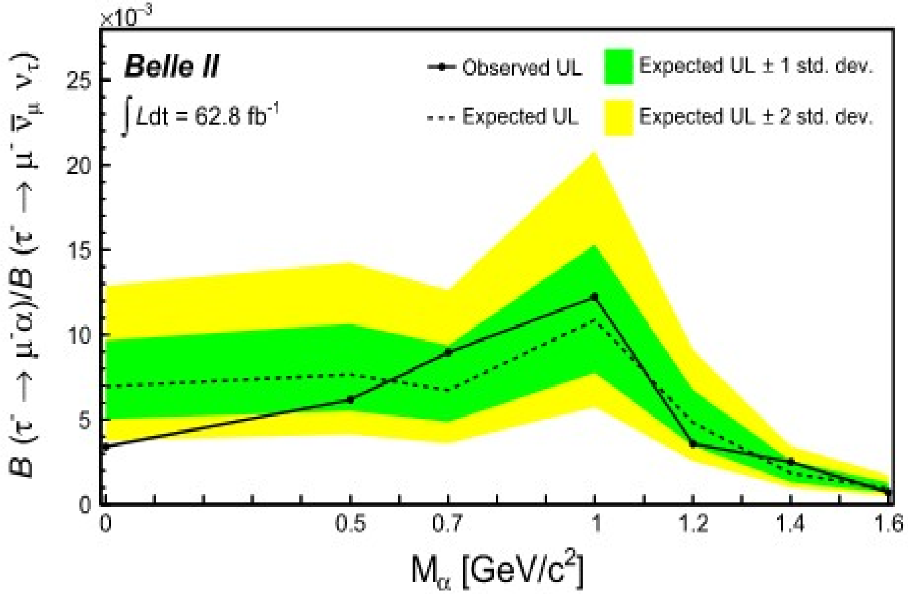


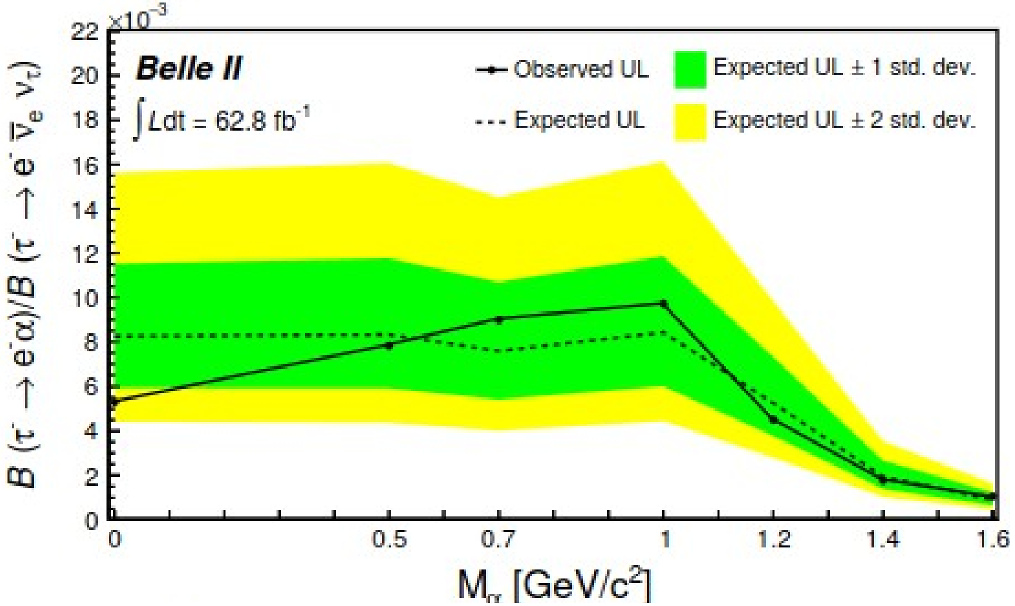


$\tau \to l\alpha$: results

Phys. Rev. Lett. 130, 181803

- No significant excess found in ***62.8 fb^{-1}***
- Set 95% CL upper limits on BF ratios of ***BF($\tau_{sig} \to \ell\alpha$)*** normalized to BF($\tau_{SM} \to \ell\nu\nu$)





Between 2-14 times more stringent than previous limits

Direct searches:

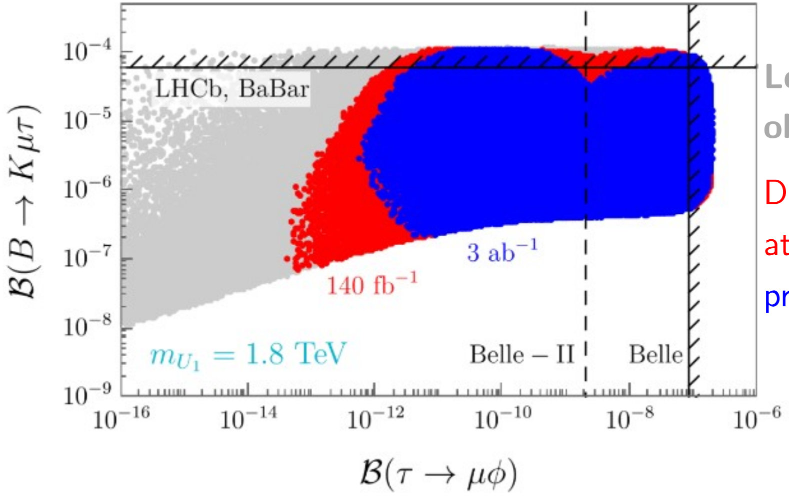
LFV decays $\tau \to \ell\Phi$

$\tau \to \ell\Phi$: novel analysis technique

- New mediators [1] may enhance LFV $\tau \to \ell\Phi$ decays and accommodate for flavor anomalies in LFU tests

- Previous searches at Belle (854/fb) [2] with tagged approach ($\boldsymbol{\tau_{tag} \to \ell/h(\nu_l)\nu_\tau}$)

	$\mathcal{B}^{90}_{\rm UL}(e\phi)$ $(\times 10^{-8})$ exp. / obs.	$\mathcal{B}^{90}_{\rm UL}(\mu\phi)$ $(\times 10^{-8})$ exp. / obs.
Belle	4.3 / 3.1	4.9 / 8.4



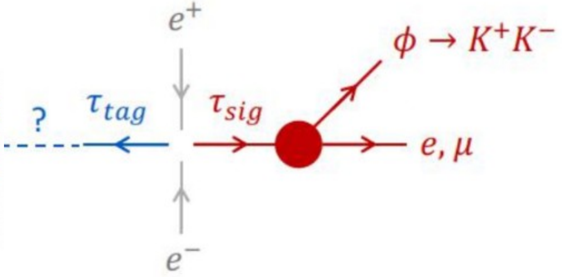
Low-energy observables

Direct searches at LHC (and projections)

→ **Increase signal efficiency:** reconstruct explicitly only **signal side** as a lepton (e, μ) + Φ (→ K+K-, BR~50%), no requirement on the **tag side** (**untagged reconstruction**)

- Exploit signal and event features in **BDT classifiers** to suppress background

  → $\varepsilon_{\rm sig}$ **= 6.5% (6.1%)** for muon(electron) mode, ~ **2 x Belle**

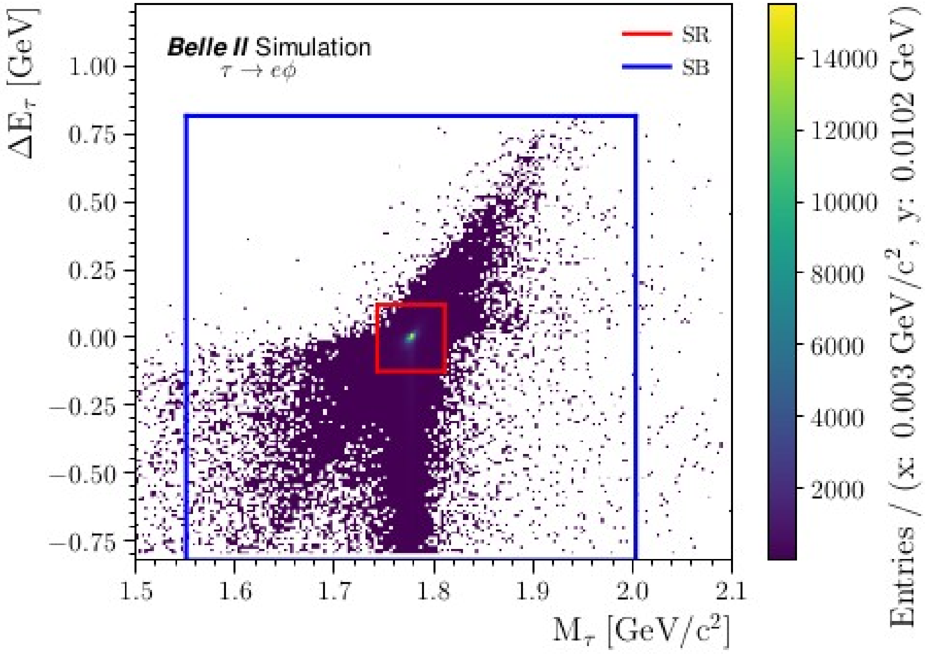


[1] Andrei Angelescu, et al., Phys. Rev. D 104, 055017 (2021),
[2] Y. Miyazaki et al., Belle, Phys. Lett. B 699 (2011)

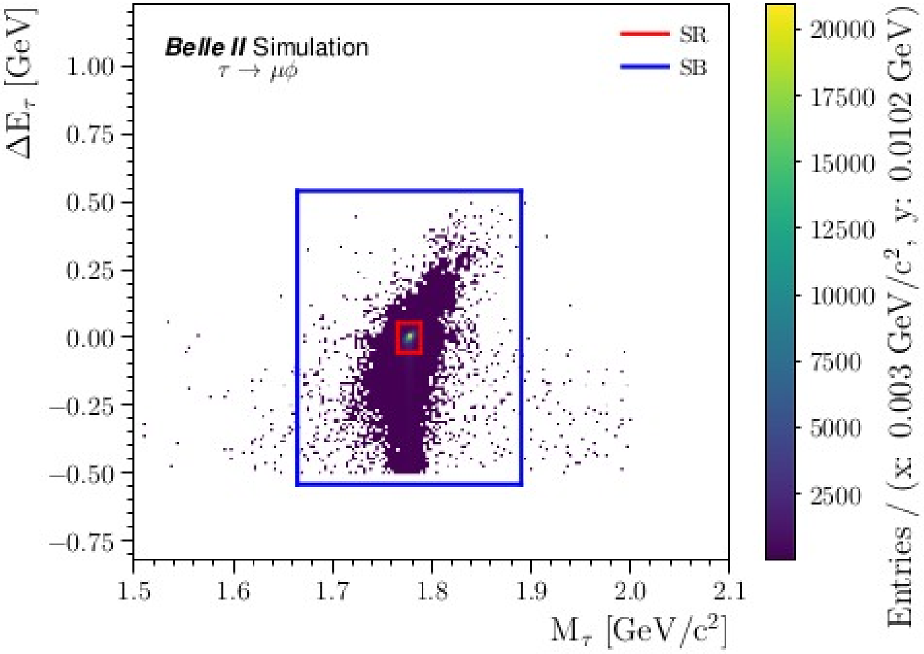
$\tau \to \ell\Phi$: signal regions

- Exploit kinematics of the signal as *neutrinoless* decays
  - M_τ expected to peak at known tau mass
  - $\Delta E_\tau = E^*_{sig} - \sqrt{s}/2$ peaks at 0 → up to initial/final state radiation (ISR, FSR) effects
- Define **analysis** and **signal** box regions in the the (M_τ , ΔE_τ) plane, in units of fitted signal resolutions

Electron mode: $\tau \to e\Phi$



Muon mode: $\tau \to \mu\Phi$

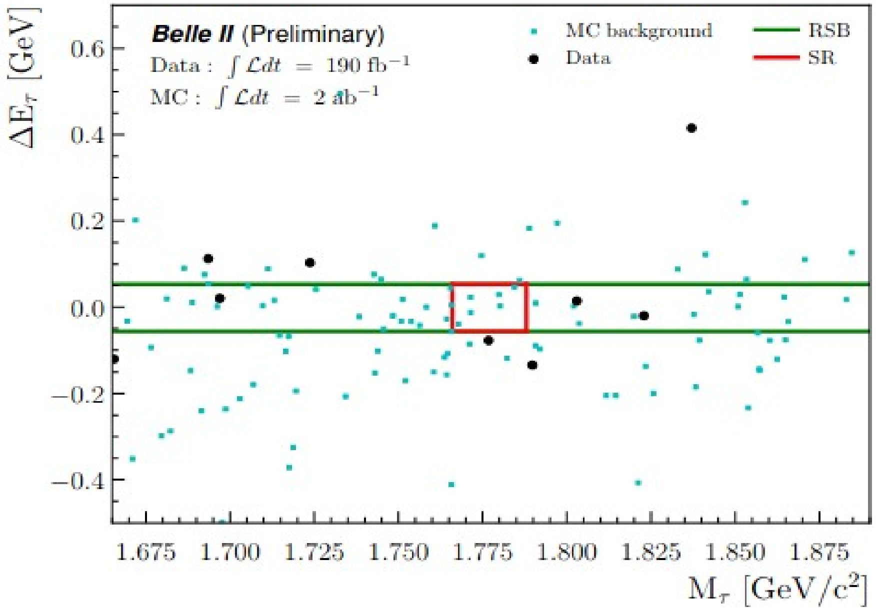


$\tau \to \ell\Phi$: yields extraction

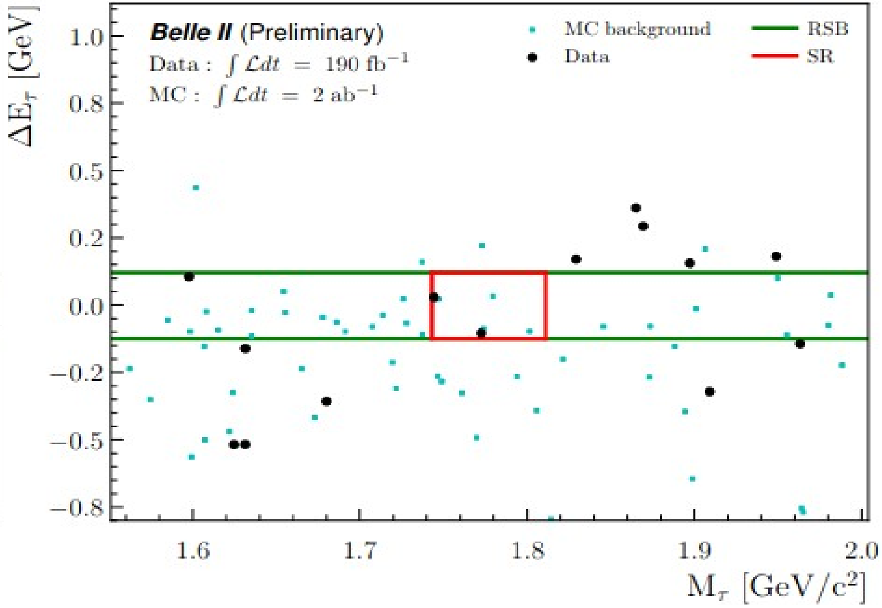
- Poisson counting experiment approach in **signal regions** in M_τ and $\Delta E_\tau = E^*_{sig} - \sqrt{s}/2$ plane
  - → expected background evaluated from data **reduced sidebands** with scaling from simulation

Result	Region	Mode $e\phi$	Mode $\mu\phi$
N_{exp}	SR	$0.23^{+0.55}_{-0.21}$ stat	$0.36^{+0.39}_{-0.23}$ stat
N_{obs}	SR	$2.0^{+2.6}_{-1.3}$ stat	$0.0^{+1.8}_{-0.0}$ stat

Muon mode: $\tau \to \mu\Phi$



Electron mode: $\tau \to e\Phi$



$\tau \to \ell\Phi$: results

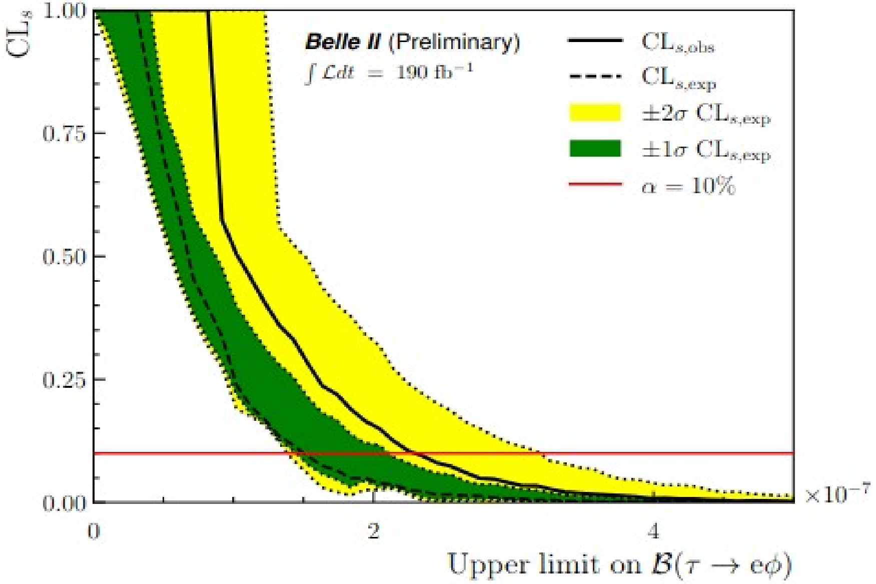
Conf. paper arXiv: 2305.04759

- No significant excess in **190 fb^{-1}**
- Set 90% CL upper limits on the BF with CL$_s$ method: $\mathcal{B}_{\rm UL}(\tau \to \ell\phi) = \frac{s}{L \times 2\sigma_{\tau\tau} \times \varepsilon_{\ell\phi}}$,

Electron mode: $\tau \to e\Phi$

Observed: $BF_{UL}(\tau \to e\Phi) = 23 \times 10^{-8}$

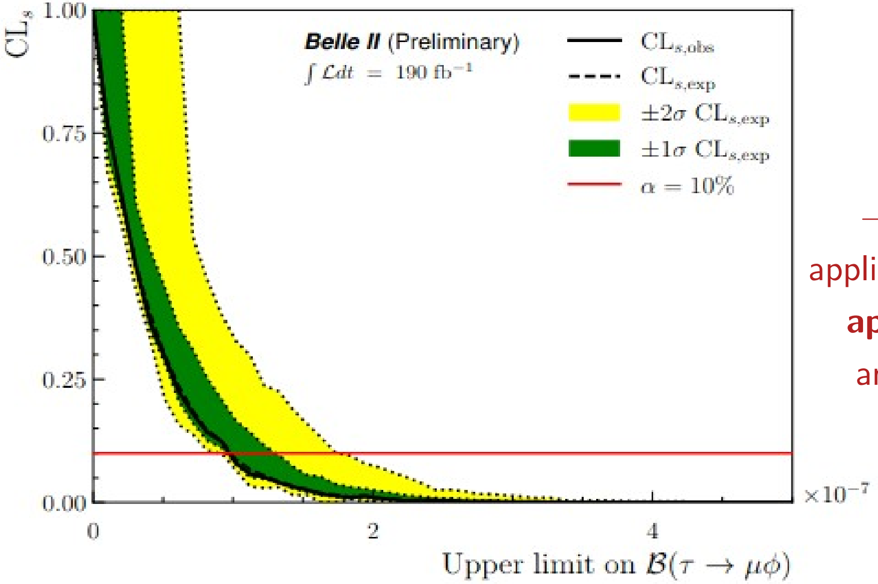
Expected: $BF_{UL}(\tau \to e\Phi) = 15 \times 10^{-8}$



Muon mode: $\tau \to \mu\Phi$

Observed: $BF_{UL}(\tau \to \mu\Phi) = 9.7 \times 10^{-8}$

Expected: $BF_{UL}(\tau \to \mu\Phi) = 9.9 \times 10^{-8}$



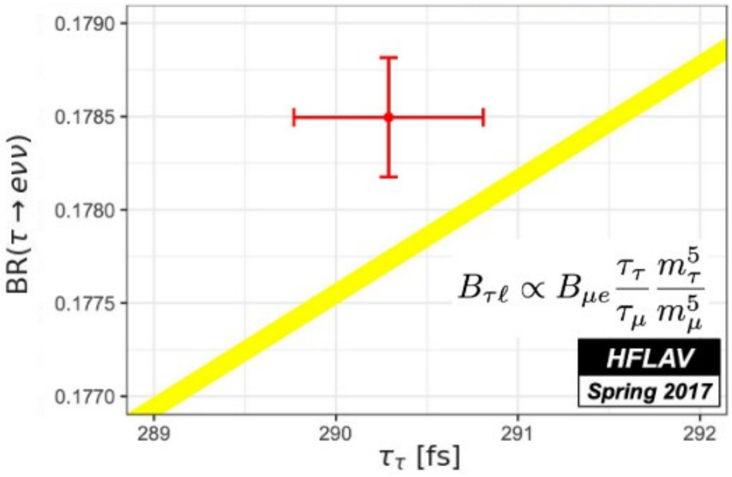
Results not competitive yet

→ successful first application of **untagged approach** in τ-pair analysis at Belle II

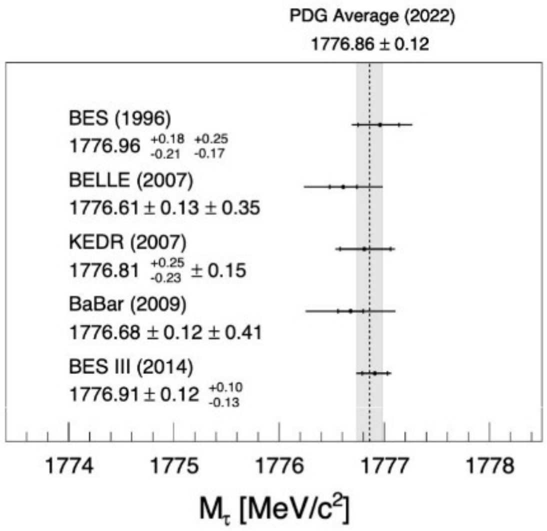
Precision measurement: tau lepton mass

Measurement of the τ mass

- Lepton properties are **fundamental parameters** of the SM and need to be measured with the **highest precision**
  - tau mass known with $\sim 10^3$ worse precision than the muon mass
  - Uncertainties important in lepton flavor universality **tests of SM**

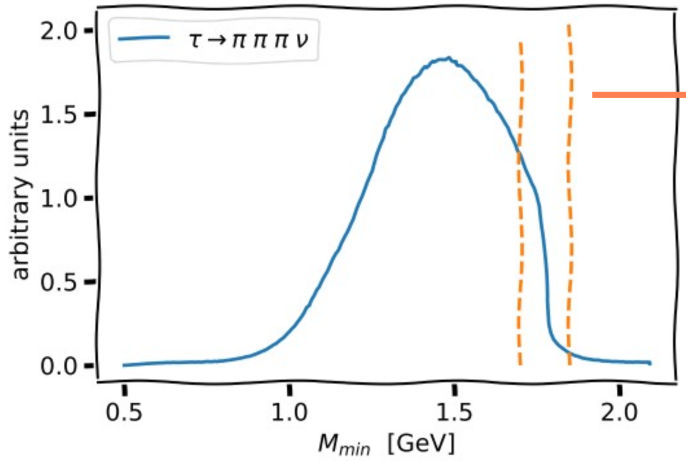


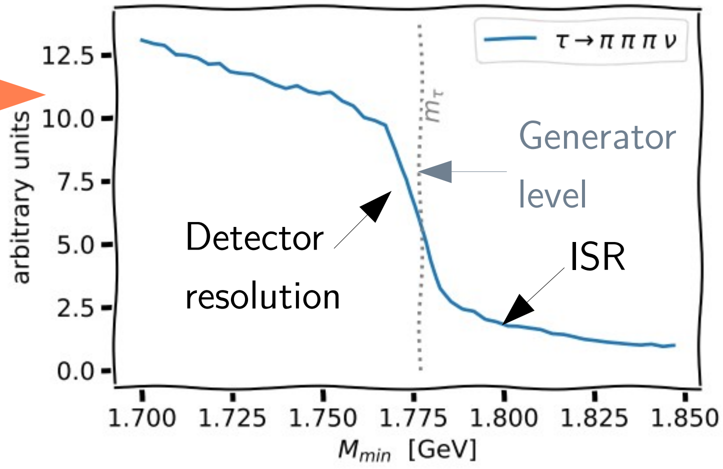
- Two possible ways to measure the mass:
  - **pair-production cross section scan**, used by BESIII (most precise PDG result so far)
    - vary collision energy around the tau pair production threshold
  - **pseudomass method**, developed by ARGUS, exploited at B-factories (and in the presented study here!)
    - Exploit the kinematics of the three charged pions in $\tau_{sig} \to 3\pi\nu_\tau$ decays

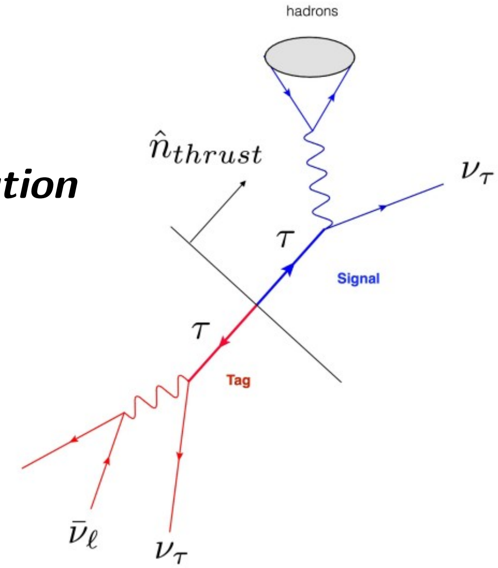


τ mass: pseudomass technique

- Reconstruct $\mathbf{e^+e^- \rightarrow \tau_{tag}\tau_{sig}}$ events with $\tau_{tag} \rightarrow \ell\nu_l\nu_\tau/\pi(\pi^0)\nu_\tau$ and $\tau_{sig} \rightarrow 3\pi\nu_\tau$ as four tracks and no additional high energy photons in the event
- Access m_τ with *pseudo-mass* technique M_{min}: $\sqrt{M_{3\pi}^2 + 2(\sqrt{s}/2 - E_{3\pi}^*)(E_{3\pi}^* - P_{3\pi}^*)} \leq M_\tau$
- Fit to the end point with an empirical function, smeared edge due to ***detector resolution effects*** and larger ***tails because of ISR***



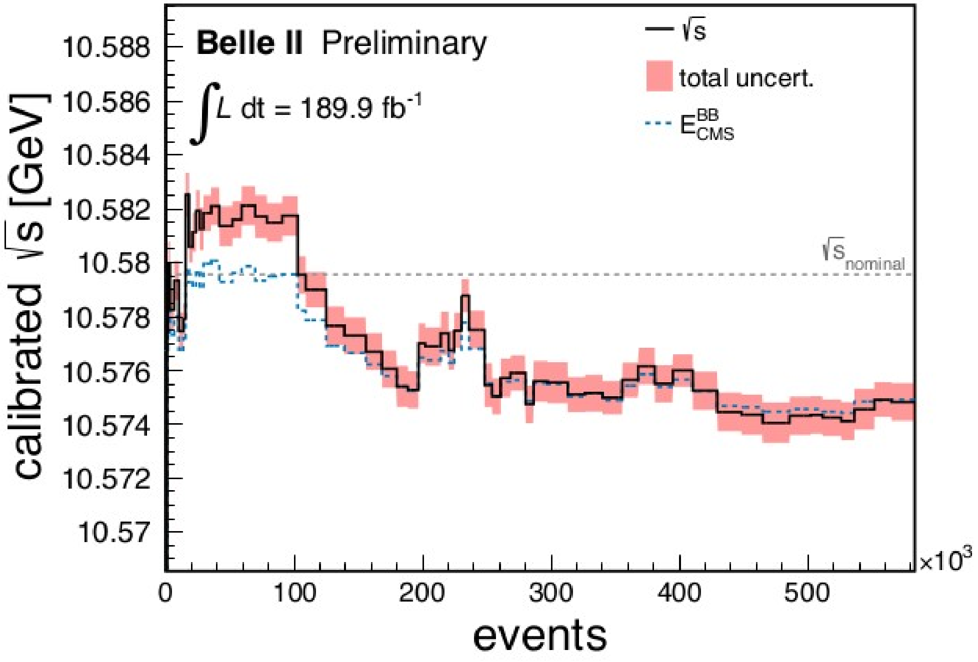




τ mass: precision challenge

- Excellent control of systematic uncertainties thanks to precise understanding of beam energies and tracking: $M_{\min} = \sqrt{M_{3\pi}^2 + 2(\sqrt{s}/2 - E_{3\pi}^*)(E_{3\pi}^* - P_{3\pi}^*)} \leq M_\tau$

Beam energy calibration with B-meson hadronic decays method and Υ(4S) lineshape measurement to get √s



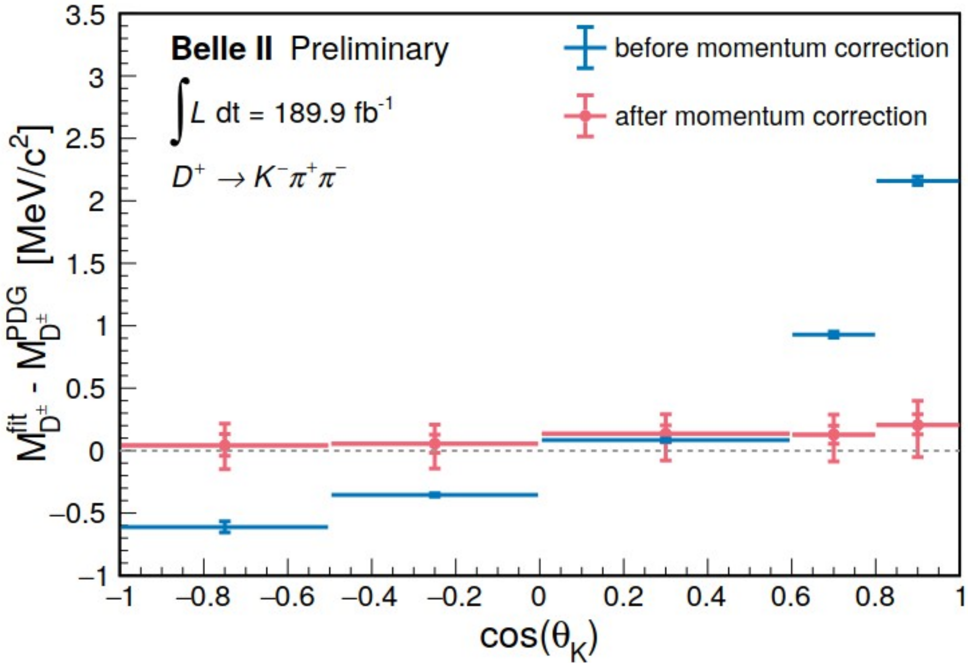
Source	Uncertainty [MeV/c^2]
Knowledge of the colliding beams:	
Beam energy correction	0.07
Boost vector	$\lesssim$ 0.01
Reconstruction of charged particles:	
Charged particle momentum correction	0.06
Detector misalignment	0.03
Fitting procedure:	
Estimator bias	0.03
Choice of the fit function	0.02
Mass dependence of the bias	$\lesssim$ 0.01
Imperfections of the simulation:	
Detector material budget	0.03
Modeling of ISR and FSR	0.02
Momentum resolution	$\lesssim$ 0.01
Neutral particle reconstruction efficiency	$\lesssim$ 0.01
Tracking efficiency correction	$\lesssim$ 0.01
Trigger efficiency	$\lesssim$ 0.01
Background processes	$\lesssim$ 0.01
Total	0.11

Systematic evaluation: momentum scale

- Bias in the measured particle momenta due to imperfect magnetic field or mis-modeling in material budget impact the endpoint position $\rightarrow$ bias the mass extraction

$$M_{\text{min}} = \sqrt{M^2_{3\pi} + 2(\sqrt{s}/2 - E^*_{3\pi})(E^*_{3\pi} - P^*_{3\pi})}$$

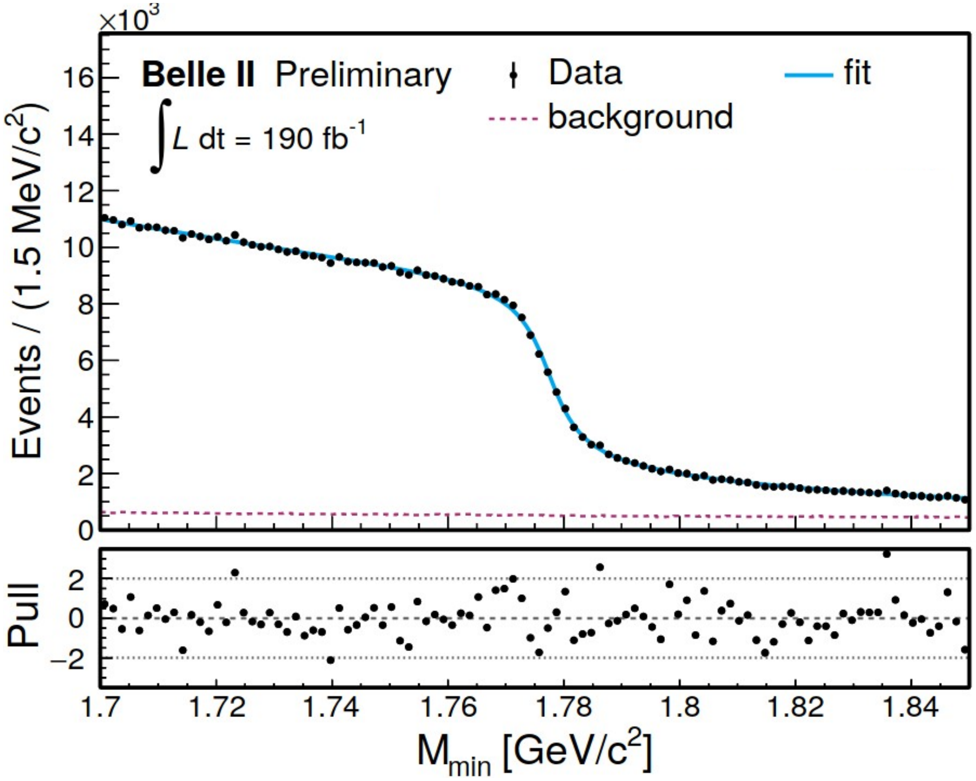
- Use $D^0 \rightarrow K^+ \pi^-$ as standard candle:
  - extract **scale factors** for kaon and pions by comparing D^0 mass peak w.r.t PDG mass.
  - corrections dependent on $\cos\theta_{track}$ and charge
- Cross check the corrections on other known mass peaks
- Consider several systematic effects in the SF determination:
  - PDG mass uncertainty, peak position modeling, additional kinematics dependence, detector misalignment

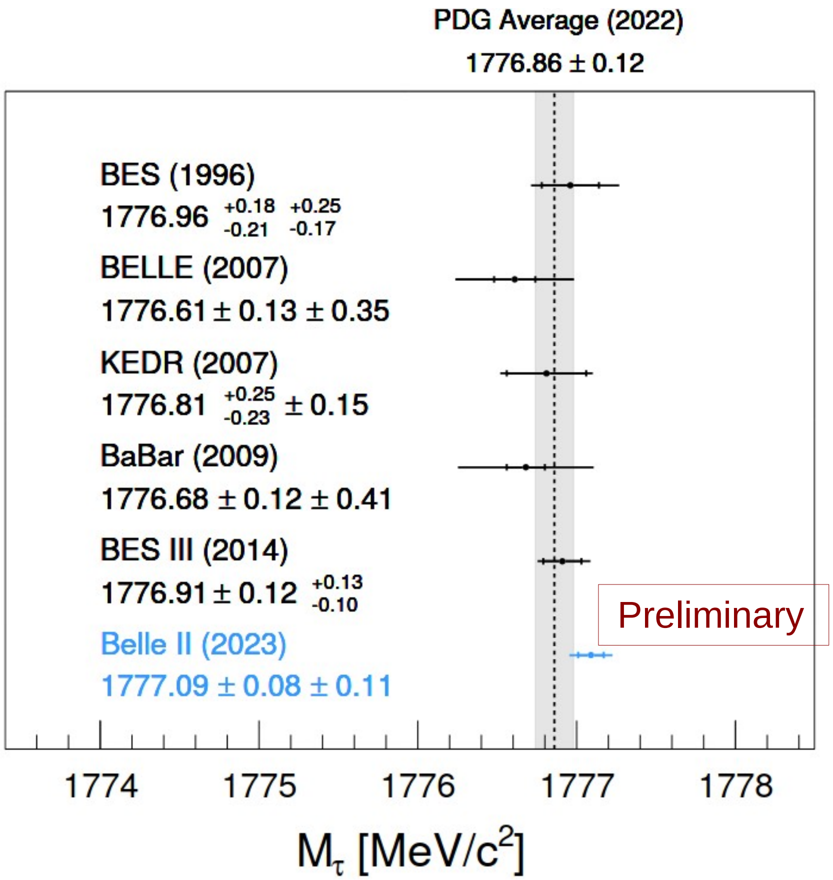


impact on tau mass: **0.06 MeV** $\rightarrow$ below fractions of permille level!

World's most precise measurement

- World's most precise measurement of $\mathbf{m_\tau = 1777.09 \pm 0.08_{stat} \pm 0.11_{sys}}$ **MeV/c^2**





→ Proof of high precision capability of Belle II!

Lepton Flavor Universality (LFU) tests

- LFU in SM assumes all three leptons have equal coupling strength (g_l) to the charged gauge bosons of the electroweak interaction

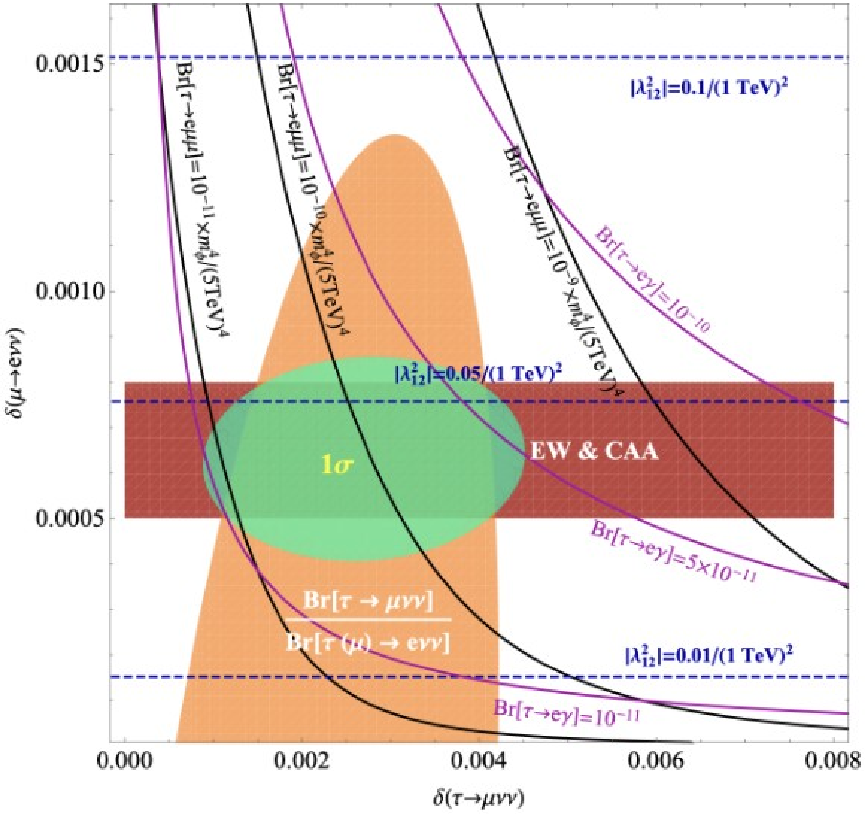
$$\left.\frac{\mathcal{A}(\tau \to \mu\nu\bar{\nu})}{\mathcal{A}(\mu \to e\nu\bar{\nu})}\right|_{\mathrm{EXP}} = 1.0029(14),$$

$$\left.\frac{\mathcal{A}(\tau \to \mu\nu\bar{\nu})}{\mathcal{A}(\tau \to e\nu\bar{\nu})}\right|_{\mathrm{EXP}} = 1.0018(14),$$

$$\left.\frac{\mathcal{A}(\tau \to e\nu\bar{\nu})}{\mathcal{A}(\mu \to e\nu\bar{\nu})}\right|_{\mathrm{EXP}} = 1.0010(14),$$

- Many models predict **new forces** violating LFU (singly-charged scalar Φ [1]):

$$\delta(\ell_i \to \ell_j \nu\nu) = \frac{\mathcal{A}_{NP}(\ell_i \to \ell_j \nu_i \bar{\nu}_j)}{\mathcal{A}_{SM}(\ell_i \to \ell_j \nu_i \bar{\nu}_j)} = \frac{|\lambda_{ij}^2|}{g_2^2}\frac{m_W^2}{m_\phi^2} = A_{EXP}/A_{SM} - 1$$



[1] arXiv: 2012.09845

$\tau \to l\nu\nu$ LFU test

- Tau decays allow high precision tests of LFU by measuring R_μ

$$\left(\frac{g_\mu}{g_e}\right)^2_\tau \propto \mathbf{R}_\mu = \frac{\mathscr{B}[\tau^- \to \mu^-\bar{\nu}_\mu\nu_\tau]}{\mathscr{B}[\tau^- \to e^-\bar{\nu}_e\nu_\tau]} \text{ with } \left(\frac{g_\mu}{g_e}\right)_\tau = \sqrt{R_\mu \frac{f(m_e^2/m_\tau^2)}{f(m_\mu^2/m_\tau^2)}}$$

- Previous best results from BaBar (467/fb) [1]
  - Reconstruct (3x1)-prong decays in tau pair events
  - **0.4% precision** dominated by systematic contribution of particle identification (PID)

$$\frac{\mathcal{B}(\tau^- \to \mu^-\overline{\nu}_\mu\nu_\tau)}{\mathcal{B}(\tau^- \to e^-\overline{\nu}_e\nu_\tau)} = (0.9796 \pm 0.0016 \pm 0.0036)$$

Babar systematics:

Systematic uncertainties:	
Particle ID	0.32
Detector response	0.08
Backgrounds	0.08
Trigger	0.10
$\pi^-\pi^-\pi^+$ modelling	0.01
Radiation	0.04
$\mathcal{B}(\tau^- \to \pi^-\pi^-\pi^+\nu_\tau)$	0.05
$\mathcal{L}\sigma_{e^+e^-\to\tau^+\tau^-}$	0.02
Total [%]	0.36

[1] Phys. Rev. Lett. 105, 051602

$\tau \to l\nu\nu$ LFU test

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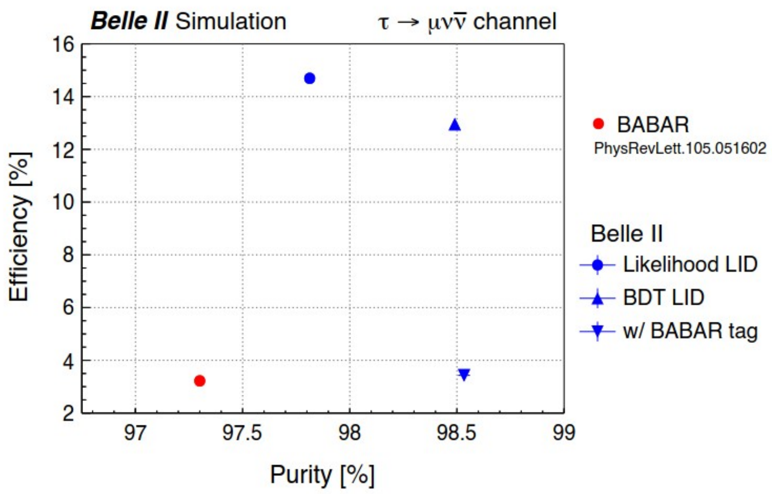
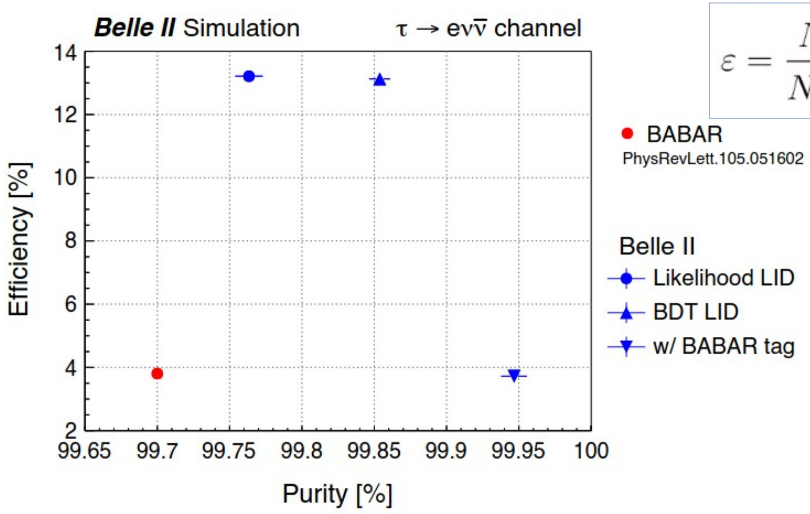
Total [%]	0.36

- Major improvement at Belle II
  - Several dedicated ***low-multiplicity triggers*** based on calorimeter cluster properties
  - Drop ***hadron identification*** variable and exploit E/p and pT selections to separate leptons from pions

    → Eventually explore ***additional topologies*** (add the (1x1)-prong signature)

$\tau \rightarrow l\nu\nu$ LFU test prospects at Belle II

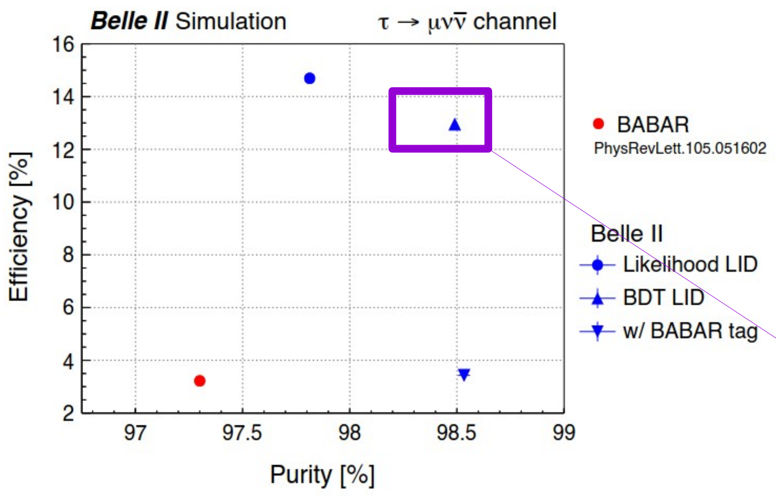


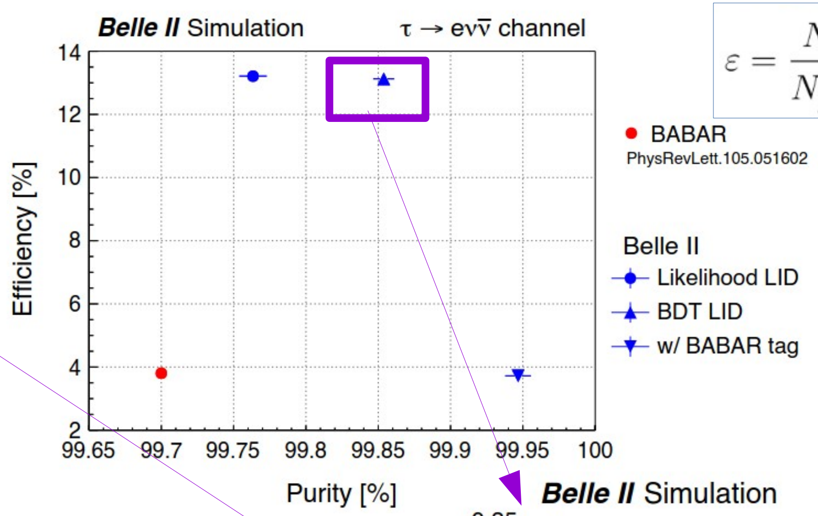


$$\varepsilon = \frac{N^{signal}_{selected}}{N^{signal}_{generated}} \qquad P = \frac{N^{signal}_{selected}}{N^{total}_{selected}}$$

- improved trigger performance and better lepton identification through BDT classifiers (pion mis-ID rate $< 1\%$)
- Main showstopper to add (1x1) decays is the development of dedicated trigger line

τ→ lνν LFU test prospects at Belle II





$$\varepsilon = \frac{N^{signal}_{selected}}{N^{signal}_{generated}} \qquad P = \frac{N^{signal}_{selected}}{N^{total}_{selected}}$$

- improved trigger performance and better lepton identification through BDT classifiers (pion mis-ID rate $< 1\%$)
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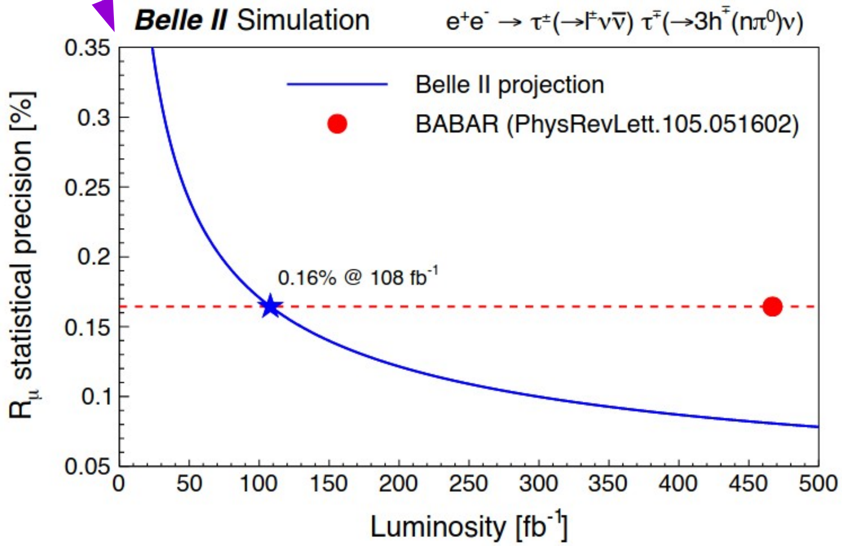
→ **With less than ¼ of BaBar data possible to reach the same statistical precision**



Conclusions

- Belle II has ***unique sensitivity*** for direct searches for LFV τ decays and ***world's leading precision*** capabilities in SM tests

$\rightarrow$ Main handles for world's best results are new **inclusive technique** in τ-pair reconstruction, dedicated **triggers** and excellent control of **systematic uncertainties**

- Search for invisible LFV scalar in $\tau \rightarrow l\alpha$ Phys. Rev. Lett. 130, 181803
- Search for LFV $\tau \rightarrow l\Phi$ decays Conf. paper arXiv: 2305.04759
- Measurement of the τ lepton mass

$\rightarrow$ 424 fb^{-1} already on tape, more results on larger statistics and with improved analyses in the pipeline

SM	LFV
τ lifetime measurement	$\tau^- \rightarrow 3\ell$
$\tau \rightarrow \pi/K + \nu_\tau$ and $\lvert V_{us}\rvert$	$\tau^- \rightarrow \ell\gamma$
τ EDM and MDM	$\tau^- \rightarrow \ell\rho$
CPV: $\tau \rightarrow K_S\pi\nu_\tau$, $\tau^- \rightarrow 3h^-\nu$	$\tau^- \rightarrow \ell K_S$
	$\tau^- \rightarrow \Lambda\pi$

What's next?

Thanks for your attention!

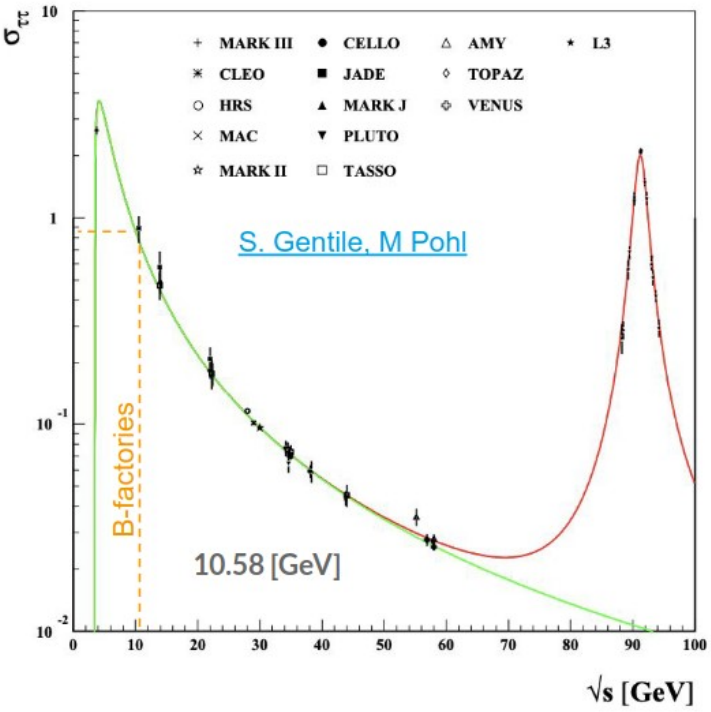
Backup

Tau signatures and physics requirements

- Experimental requirements:
  - good missing energy reconstruction
    - clean and well understood initial state
    - hermetic detector
  - excellent vertexing and tracking capabilities
  - ability to trigger low-multiplicity event
- These are all met at B factories!
  - tau pair production cross section comparable to that of B pairs

$\sigma(e^+e^- \to \Upsilon(4S)) = 1.11$ nb
$\boldsymbol{\sigma(e^+e^- \to \tau^+\tau^-) = 0.92}$ **nb**

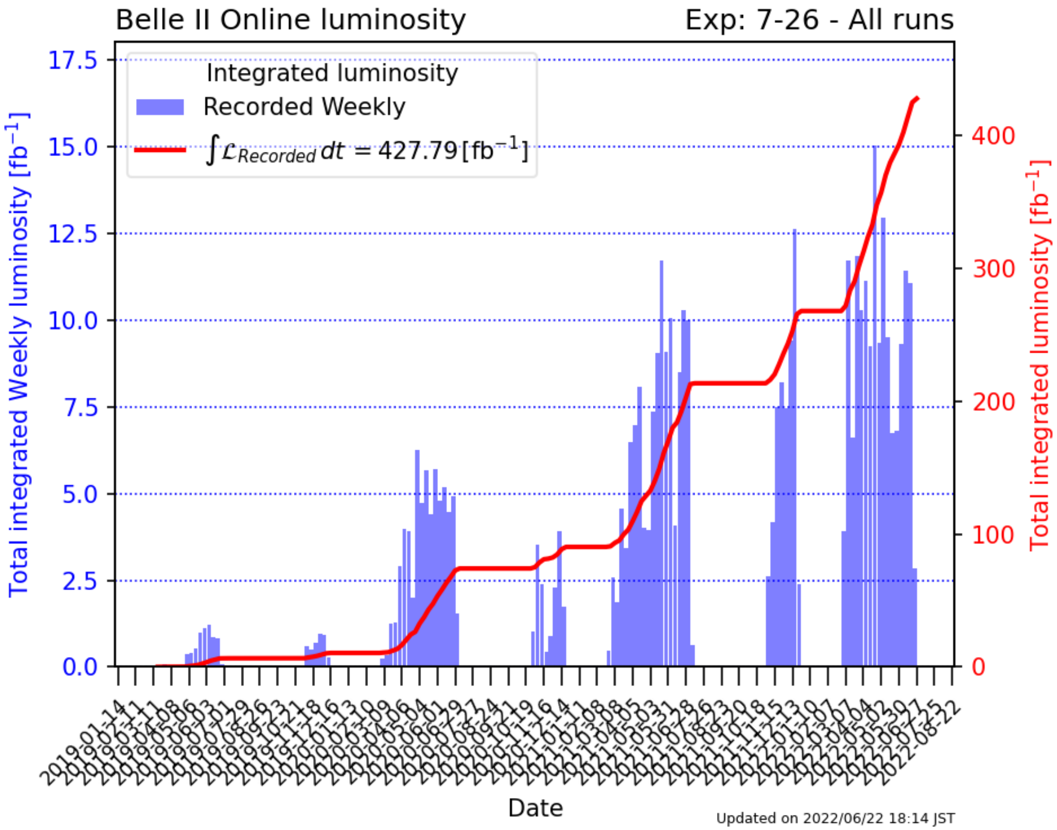
⇒ **B-Factories are also tau factories!**



Belle II Luminosity

Total Integrated luminosity for *good* runs:

- Total integrated luminosity: **424 fb^{-1}**
- Total integrated luminosity at the Υ(4S) resonance: **363 fb^{-1}**
- Total integrated luminosity below Υ(4S) resonance: **42 fb^{-1}**
- Total integrated luminosity above Υ(4S) resonance: **19 fb^{-1}**



Long-shutdown activity and plans

Belle II stopped taking data in Summer 2022 for a long shutdown

- replacement of beam-pipe
- replacement of photomultipliers of the central PID detector (TOP)
- installation of 2-layered pixel vertex detector
- improved data-quality monitoring and alarm system
- complete transition to new DAQ boards (PCIe40)
- replacement of aging components
- additional shielding and increased resilience against beam backgrounds

Currently working on pixel detector installation:

- > shipping to KEK in mid March
- > final test at KEK scheduled in April

$\rightarrow$ On track to resume data taking next winter with new pixel detector

Previous searches for LFV $\tau \to lV^0$ decays

BaBar Collaboration, B. Aubert et al.,
Improved Limits on Lepton Flavor Violating Tau Decays to lφ, lρ, lK, and lK̄*,*
Phys. Rev. Lett. 103 (2009).

Mode	$\varepsilon[\%]$	$N_{\rm bgd}$	$N_{\rm obs}$	$N_{\rm UL}^{90}$	$\mathcal{B}_{\rm exp}^{90}$	$\mathcal{B}_{\rm UL}^{90}$
$e\phi$	6.43 ± 0.16	0.68 ± 0.12	0	1.8	5.0	3.1
$\mu\phi$	5.18 ± 0.27	2.76 ± 0.16	6	8.7	8.2	19
$e\rho$	7.31 ± 0.18	1.32 ± 0.17	1	3.1	4.9	4.6
$\mu\rho$	4.52 ± 0.41	2.04 ± 0.19	0	1.1	8.9	2.6
eK^*	8.00 ± 0.19	1.65 ± 0.23	2	4.3	4.8	5.9
μK^*	4.57 ± 0.36	1.79 ± 0.21	4	7.1	8.5	17
$e\overline{K}^*$	7.76 ± 0.18	2.76 ± 0.28	2	3.2	5.4	4.6
$\mu\overline{K}^*$	4.11 ± 0.32	1.72 ± 0.17	1	2.7	9.3	7.3

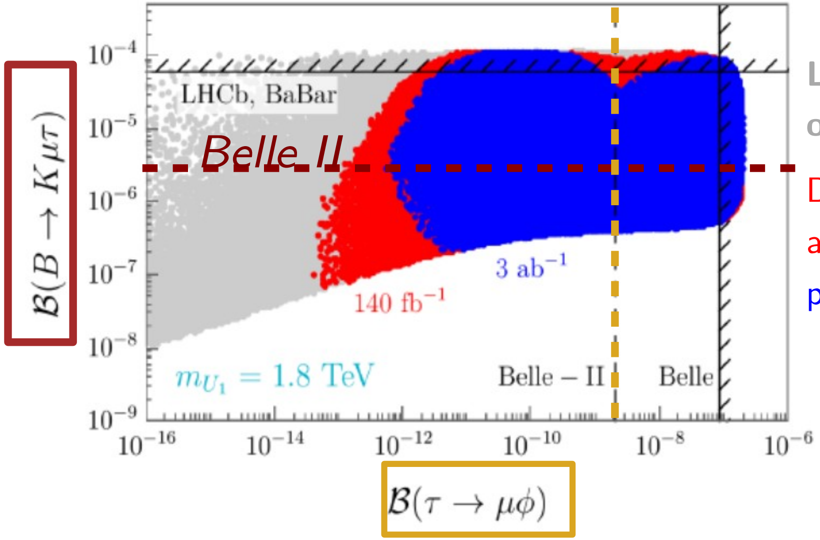
Belle Collaboration, Y. Miyazaki et al.,
Search for Lepton-Flavor-Violating tau Decays into a Lepton and a Vector Meson,
Phys. Lett. B 699 (2011).

Mode	ε (%)	$N_{\rm BG}$	$\sigma_{\rm syst}$ (%)	$N_{\rm obs}$	s_{90}	$\mathcal{B}_{\rm obs}$ ($\times 10^{-8}$)
$\tau^- \to \mu^-\rho^0$	7.09	1.48 ± 0.35	5.3	0	1.34	1.2
$\tau^- \to e^-\rho^0$	7.58	0.29 ± 0.15	5.4	0	2.17	1.8
$\tau^- \to \mu^-\phi$	3.21	0.06 ± 0.06	5.8	1	4.24	8.4
$\tau^- \to e^-\phi$	4.18	0.47 ± 0.19	5.9	0	2.02	3.1
$\tau^- \to \mu^-\omega$	2.38	0.72 ± 0.18	6.1	0	1.76	4.7
$\tau^- \to e^-\omega$	2.92	0.30 ± 0.14	6.2	0	2.19	4.8
$\tau^- \to \mu^-K^{*0}$	3.39	0.53 ± 0.20	5.5	1	3.81	7.2
$\tau^- \to e^-K^{*0}$	4.37	0.29 ± 0.14	5.6	0	2.17	3.2
$\tau^- \to \mu^-\bar{K}^{*0}$	3.60	0.45 ± 0.17	5.5	1	3.90	7.0
$\tau^- \to e^-\bar{K}^{*0}$	4.41	0.08 ± 0.08	5.6	0	2.34	3.4

LFV world's leading results

Simplified U1 vector leptoquark model

Phys.Rev.D 104 (2021) 5, 055017



Low-energy observables

Direct searches at LHC (and projections)

world largest dataset for ee→ ττ events: 5×10^{10}

- Set world's best limits on:

  1) *12 τ LFV modes:* ***τ → lll, τ → μ/eγ, τ → ℓV⁰***

  2) $B \to X_s ll'$ (l=e, μ,τ)

Fully constrain NP phase space

- **τ LFV** decays analyses established, improve sensitivity thanks to **better performance**

- **τ LFV: competitive limits** on pre-shutdown Belle II data set (~400/fb)
- **B LFV**: start full analysis

- **τ LFV**: update results on full data set
- **B LFV**: validation of inclusive tagging on data, **BR measurement**

Rule out/ Probe NP