DILEPTONS AND PHOTONS: THERMAL RADIATION AND BEYOND

Outline:
- Status
- Sections / Figures

Overleaf: ***https://www.overleaf.com/17973257zjnpjnhccgky#/68100198/***
GIT: *https://gitlab.cern.ch/miweber/HLLHC-WG5-photons-dileptons*
Mailing list: *hllhc-wg5-photons-dileptons@cern.ch*

MICHAEL WEBER (SMI)
ON BEHALF OF THE «ELECTROMAGNETIC RADIATION» SUBGROUP
30.10.2018

CONTRIBUTORS

Coordinators: Michael Weber (Stefan Meyer Institute Vienna, Austrian Academy of Sciences)
Contributors: Raphaelle Bailhache (Goethe-University Frankfurt), Rupa Chatterjee (VECC Calcutta), Torsten Dahms (Excellence Cluster Universe, Technical University Munich), Taku Gunji (Center for Nuclear Study, Graduate School of Science, the University of Tokyo), Min He (Nanjing University of Science and Technology), Spencer Klein (Lawrence Berkeley National Laboratory), Ana Marin (GSI Darmstadt), Dmitri Peresunko (National Research Centre Kurchatov Institute, Moscow), Ralf Rapp (Texas A&M University), Klaus Reygers (Heidelberg University), Taesoo Song (University of Gießen), Antonio Uras (Université de Lyon, CNRS/IN2P3, IPN-Lyon), Gojko Vujanovic (Ohio State University and Wayne State University)

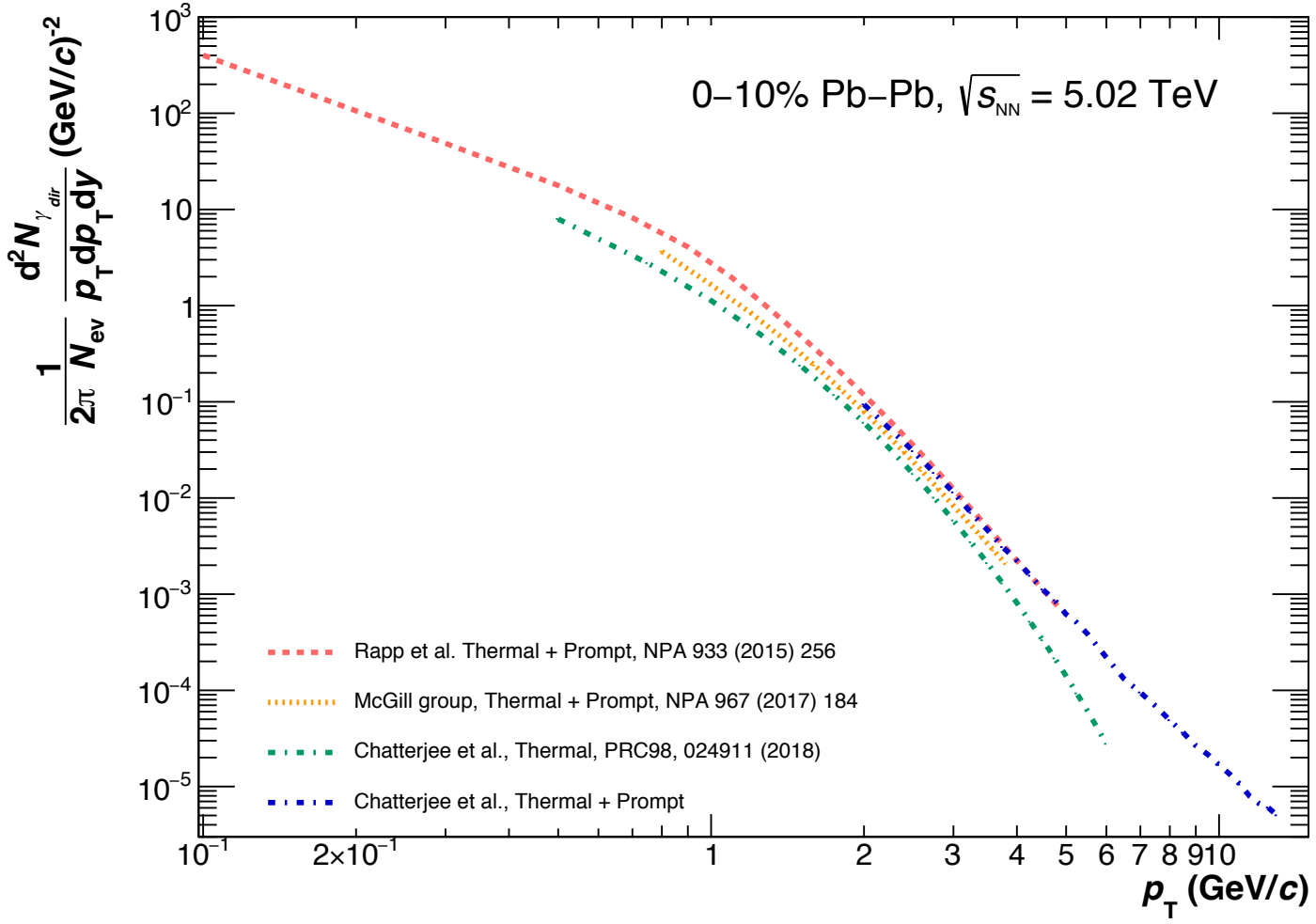
… THANKS A LOT!

YELLOW REPORT STATUS

	Photons	Dielectrons	Dimuons
Spectra	Rgamma (Pb-Pb)	ALICE LoI Fast simulation	ALICE LoI
Temperature		ALICE LoI Fast simulation	
Flow	v2 for Pb-Pb	ALICE LoI	
Other		**p-Pb projections**	
Beyond thermal radiation		**Photon mediated production (ATLAS acceptance)**	
		Dark photons	

Available
In preparation
Not for yellow report

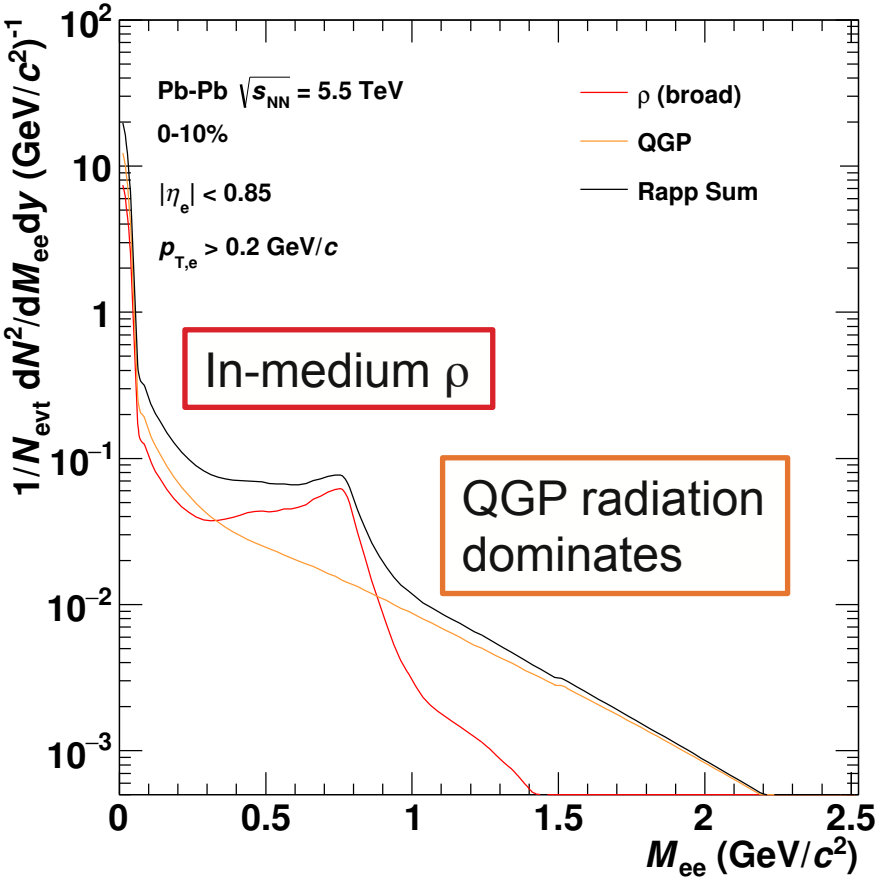
THERMAL PHOTONS AT LHC



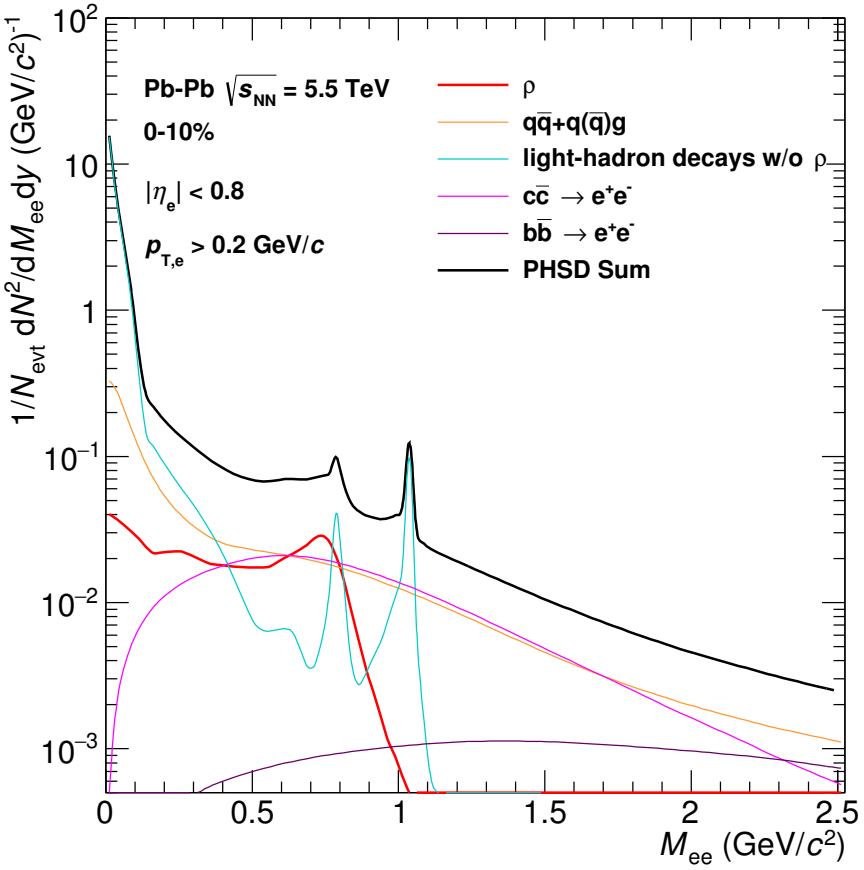
Ralf Rapp, Rupa Chatterjee

DILEPTON EXPECTATIONS

Ralf Rapp



pHSD (transport model)

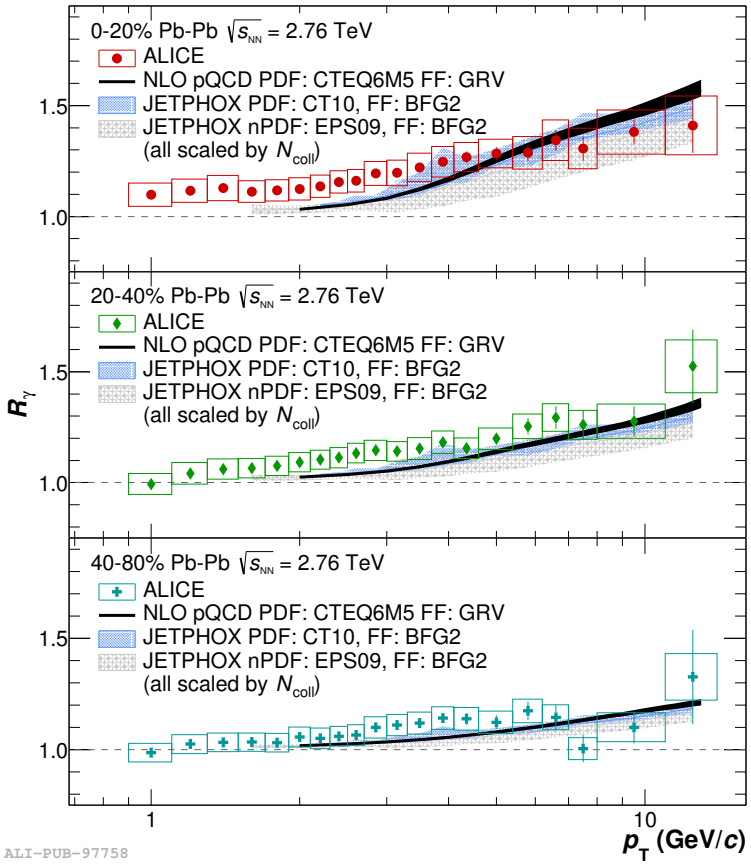


Ralf Rapp, Taesoo Song

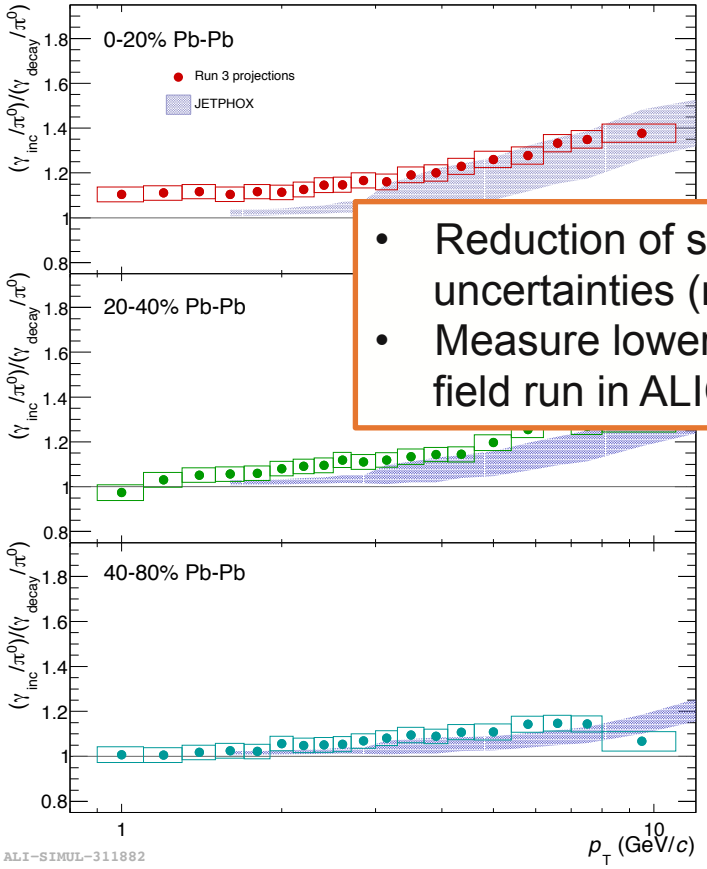
REAL PHOTONS IN ALICE

$$R_\gamma \equiv \frac{\gamma_{\mathrm{incl}}}{\pi^0_{\mathrm{param}}} \Big/ \frac{\gamma_{\mathrm{decay}}}{\pi^0_{\mathrm{param}}} = \frac{\gamma_{\mathrm{incl}}}{\gamma_{\mathrm{decay}}}$$

Run1



Run3/4

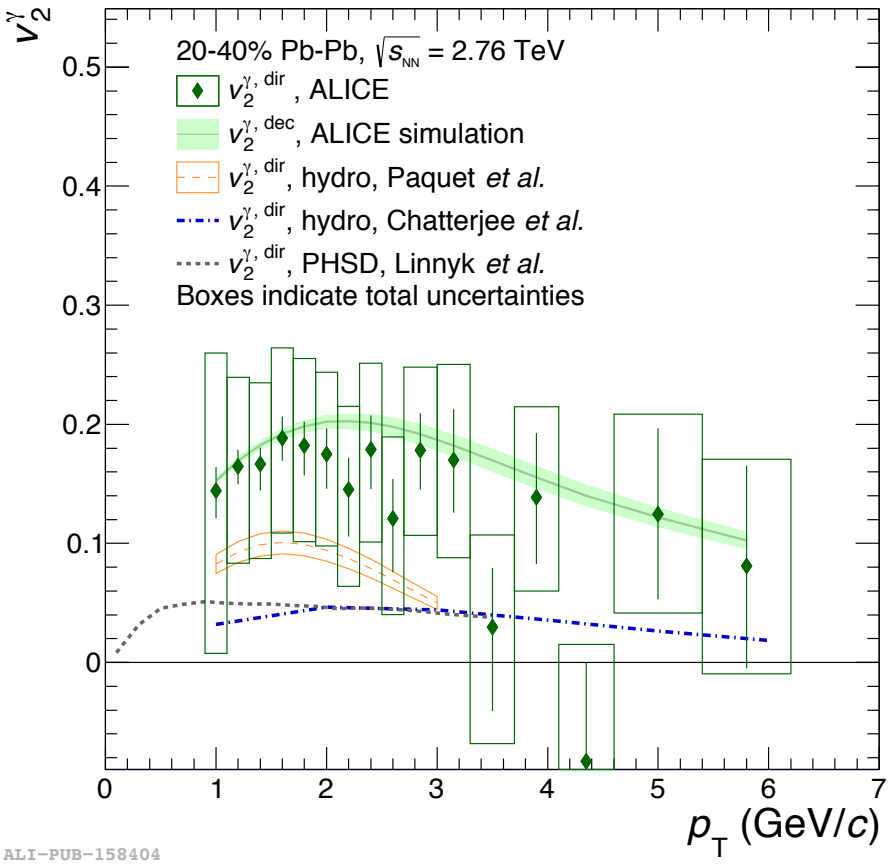


- Reduction of systematic uncertainties (material budget)
- Measure lower in pT (low B field run in ALICE)

Ana Marin, Dmitri Peresunko

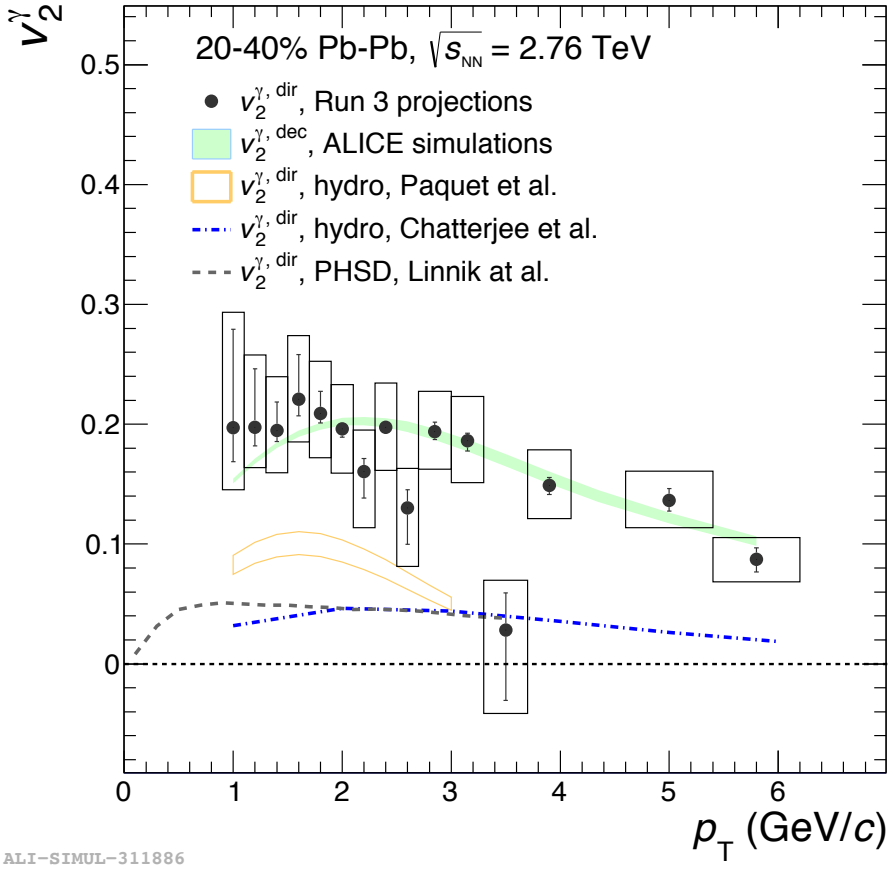
ELLIPTIC FLOW

Run1



ALI-PUB-158404

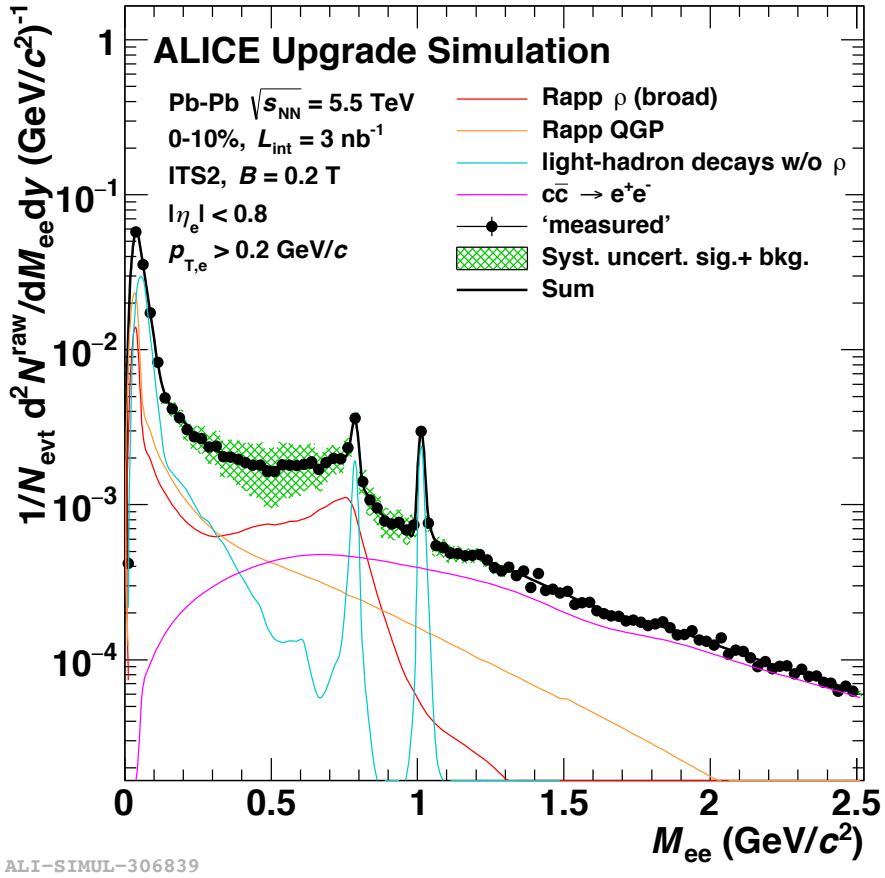
Run3/4



ALI-SIMUL-311886

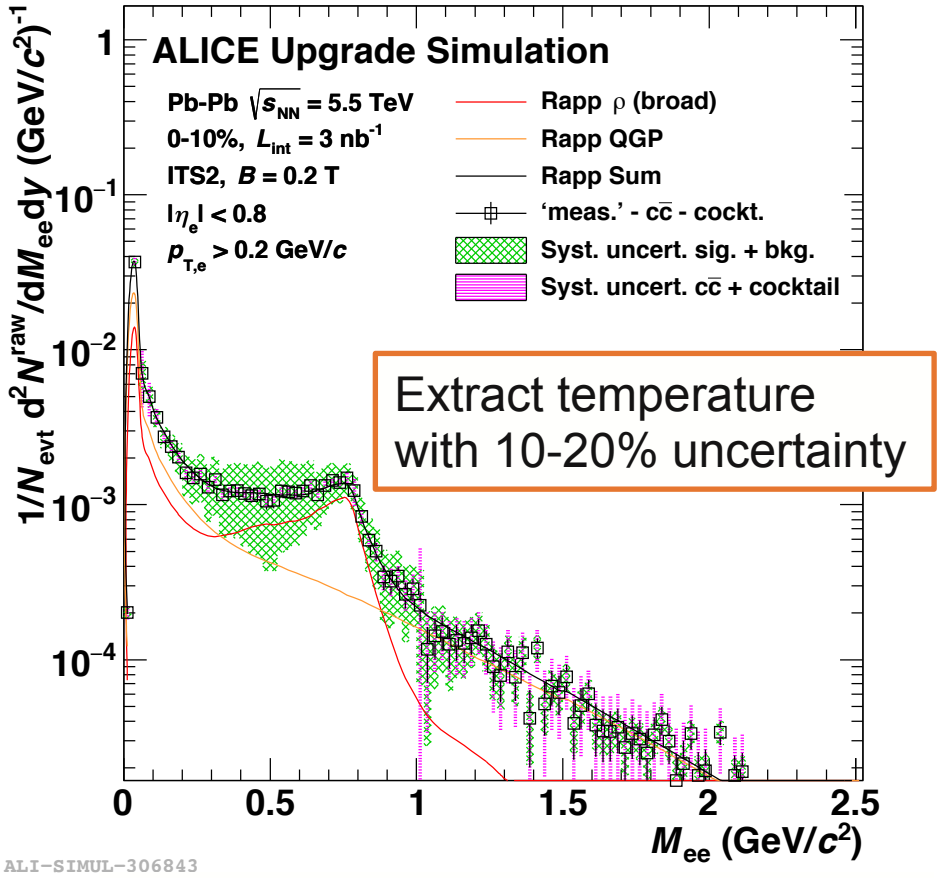
Ana Marin, Dmitri Peresunko

DIELECTRONS IN ALICE



Applying cuts on the pair DCA to reduce contribution of **heavy-flavour sources**

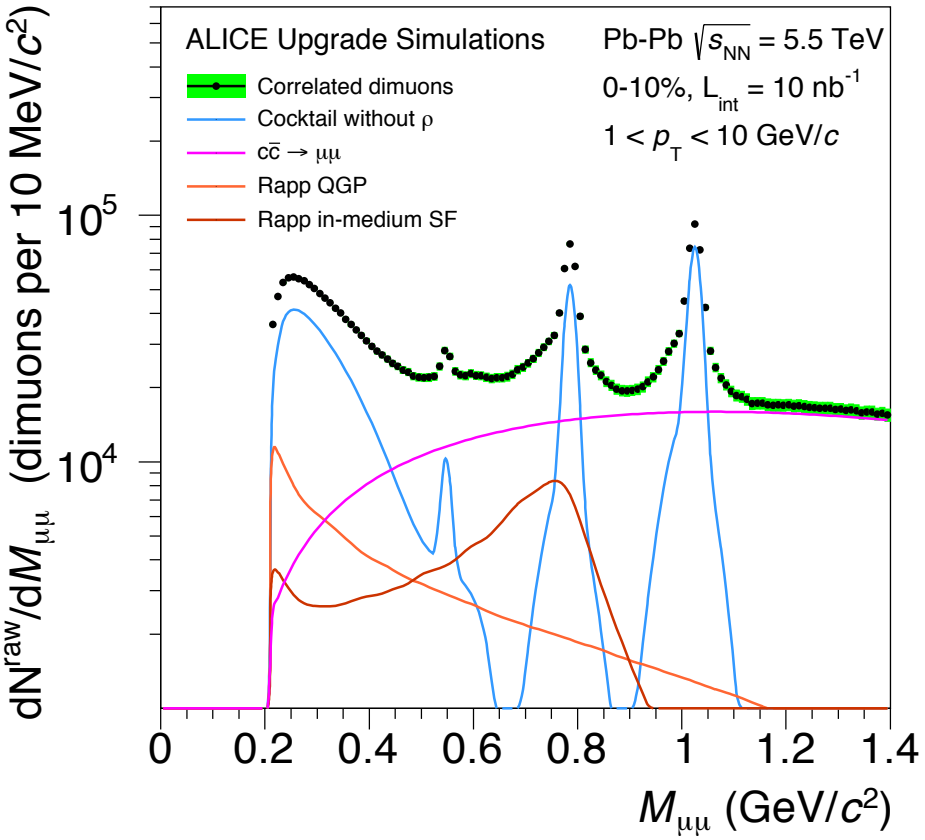
Excess (after subtraction)



Extract temperature with 10-20% uncertainty

After **subtraction** of **long-lived light-** **and (keep ρ) heavy-flavour sources**

DIMUONS IN ALICE



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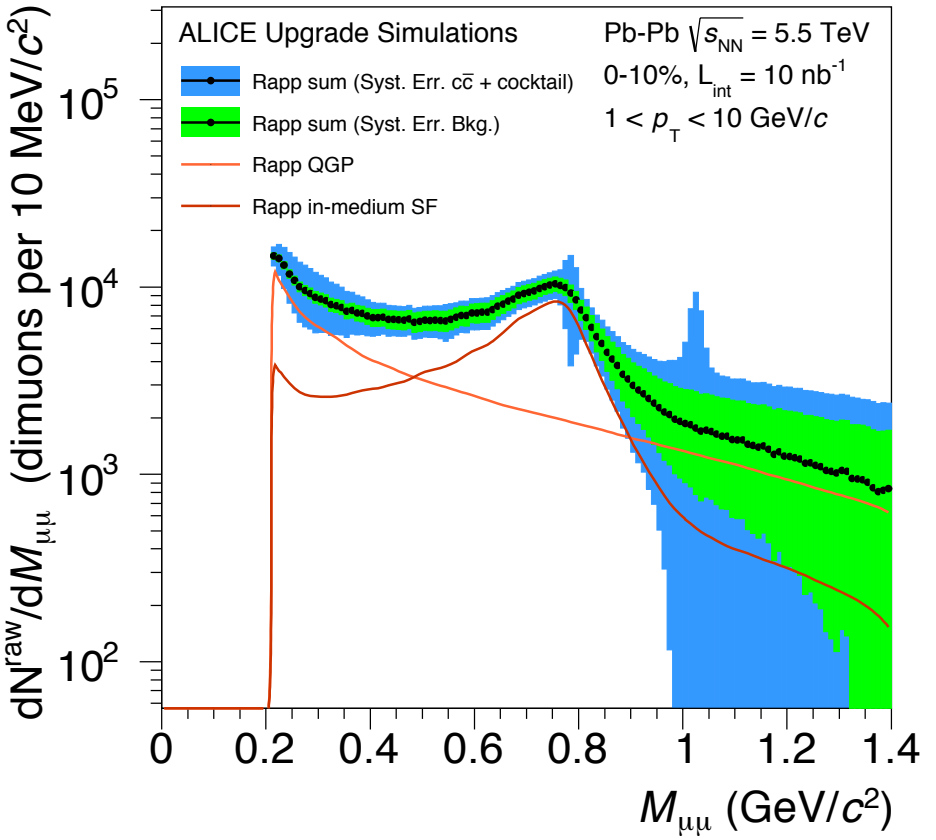
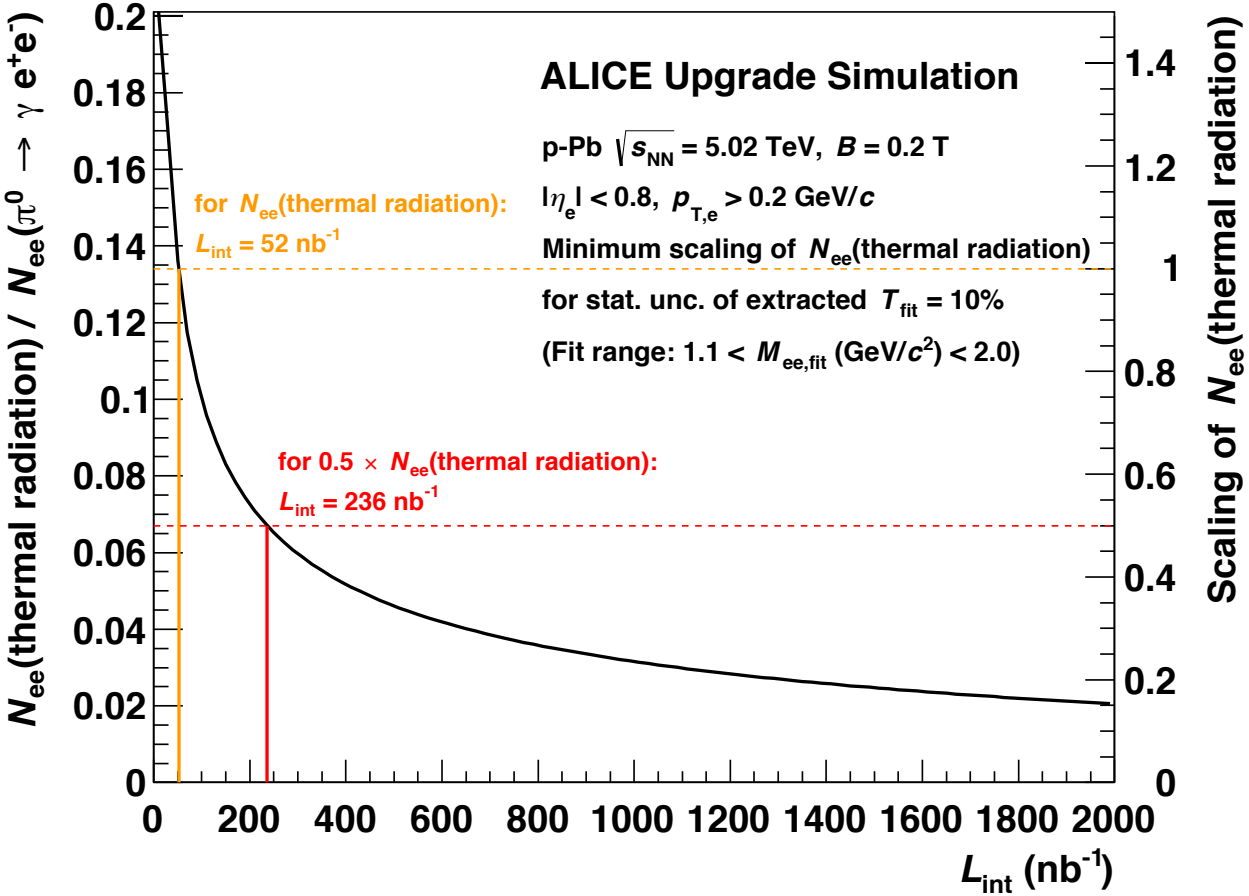


After **subtraction** of **long-lived light- and (keep ρ) heavy-flavour sources**

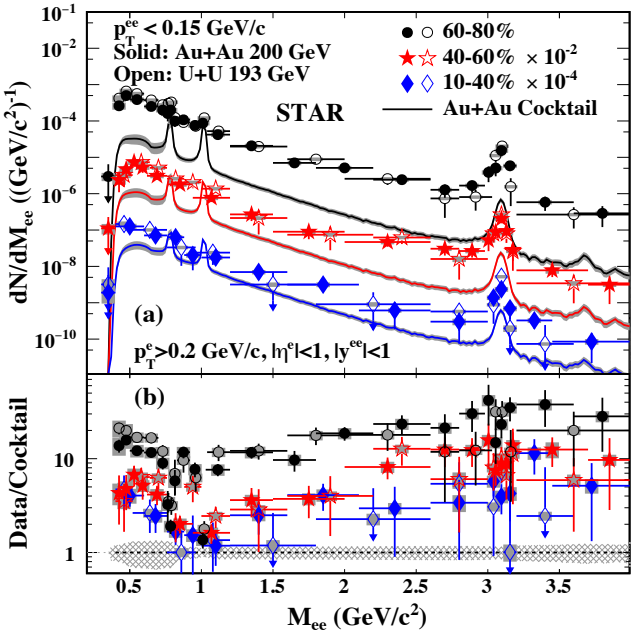
Antonio Uras

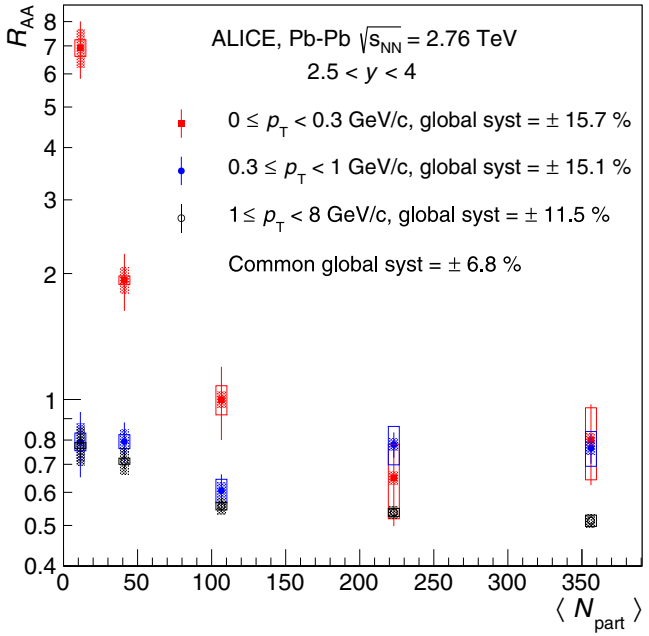
THERMAL RADIATION IN SMALL SYSTEMS?



- Statistical error of temperature fit for different scalings of Rapp input
- Extract minimum thermal photon to pi0 ratio (or Rapp signal scaling) that can be extracted with a stat. error = 10% as a function of integrated luminosity

PHOTON MEDIATED DILEPTON PRODUCTION





- Excess of dilepton pairs with low p_T in (peripheral) heavy ion collisions
  - STAR sees J/ψ + a mass continuum (**arXiv:1806.02295**)
  - ALICE sees only J/ψ
- Rate and kinematics are consistent with coherent photoproduction and γγ-> l^+l^- (***S. Klein, Phys. Rev. C97, 054903 (2018)***)

Spencer Klein

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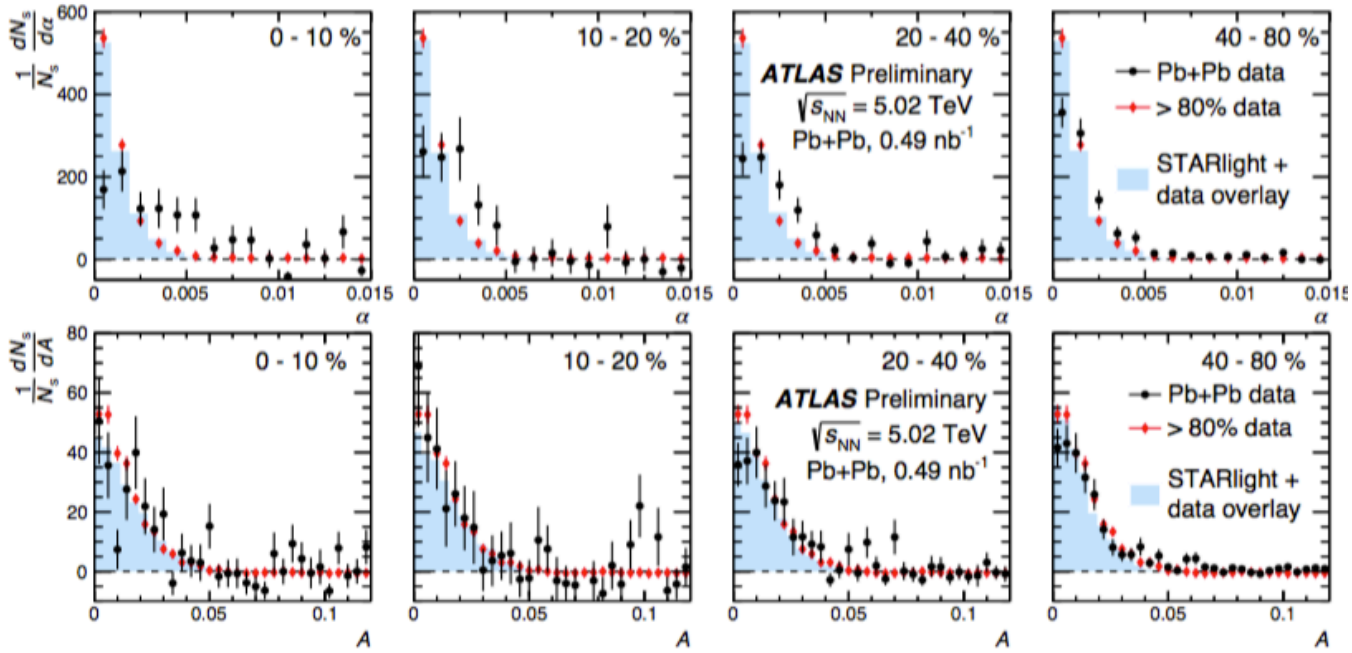


- Excess of dilepton pairs with low p_T in (peripheral) heavy ion collisions
  - STAR sees J/ψ + a mass continuum (**arXiv:1806.02295**)
  - ALICE sees only J/ψ
- Rate and kinematics are consistent with expectations from coherent photoproduction and γγ-> l^+l^- (***S. Klein, Phys. Rev. C97, 054903 (2018)***)
- ATLAS results on two-photon production of dimuons, evidence for an in-medium effect?

Spencer Klein

RUN3 EXPECTATION (ATLAS ACCEPTANCE)

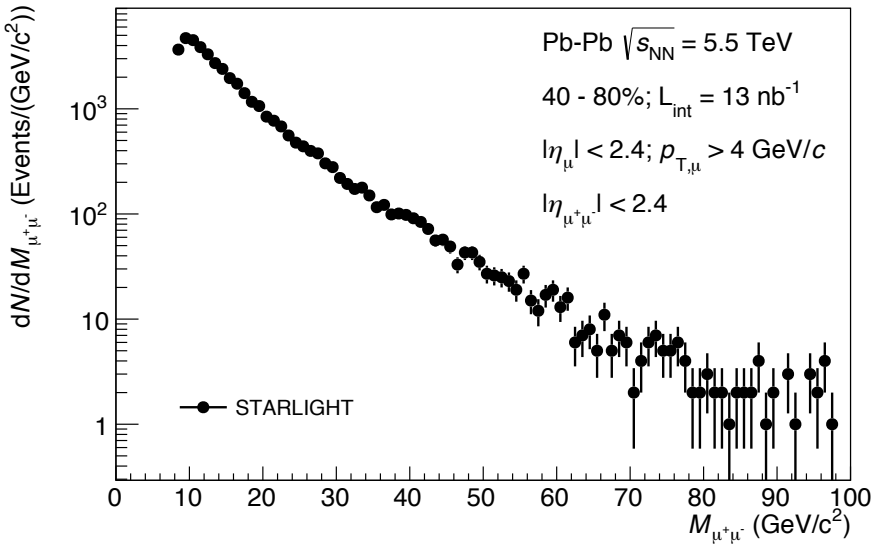
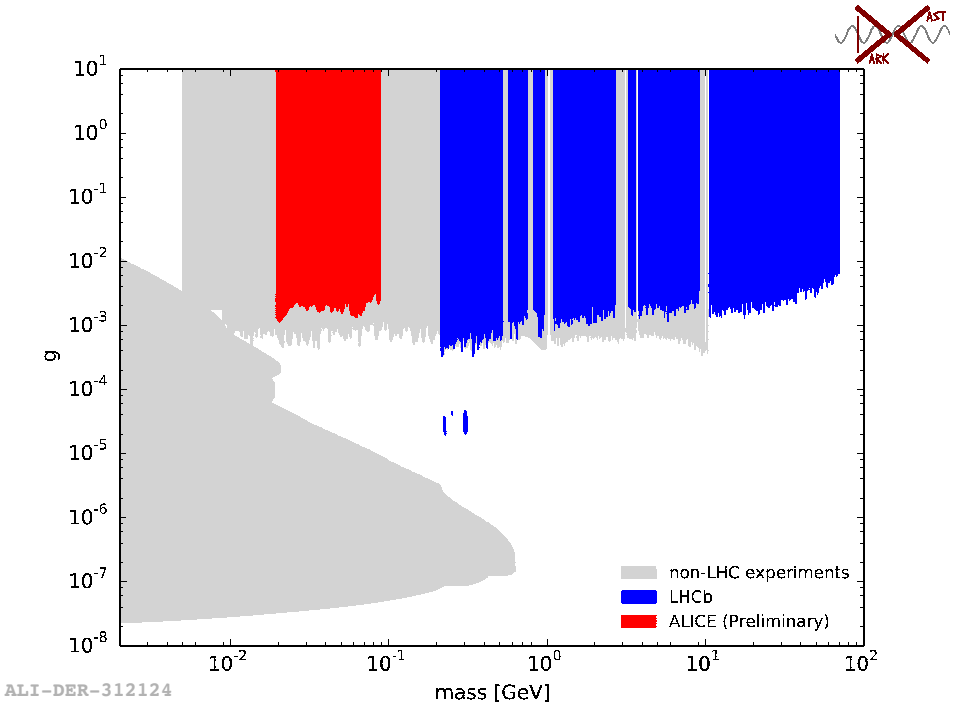
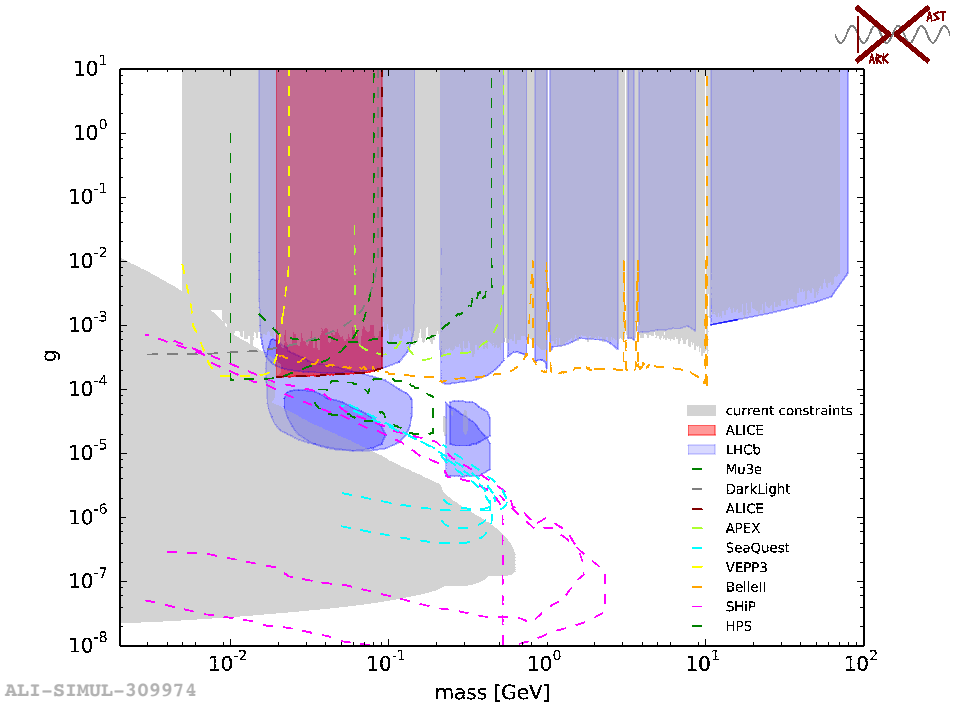


Fig. 8: Expected dimuon yield in ATLAS acceptance (both muons with $p_{\mathrm{T}} > 4$ GeV/c and $|\eta| < 2.4$), for 40–80% centrality Pb–Pb collisions and the expected Run3/4 integrated luminosity of 13 nb^{-1}. Masses up to 100 GeV/c^2 are accessible. The effective 8 GeV/c^2 minimum mass is because of the nearly back-to-back topology and the 4 GeV/c minimum muon p_{T} cut. This was calculated using STARlight [81,85].

DARK PHOTONS

Limits on coupling strength *g* as a function of mass





Existing world data

2021+

Taku Gunji

OUTLOOK

- **Limitations:**
  - **Statistical limitation** for more differential analyses, e.g.,
    - Virtual photon polarization
    - Two-photon correlations (HBT)
  - Measurements **at very low p_T**: O(MeV)

- **ALICE-ITS3 upgrade**
  - Reduction of material budget
  - Better standalone tracking

T (GQP)	Stat. error	Syst. (BG)	Syst. (Charm)
Improvement with ITS3	Reduced by **factor 1.5**	Reduced by **factor 1.3**	Reduced by **factor 2**

- **Lighter collision systems:**
  - Study trade-off between reduction of signal, but also background

THANK YOU

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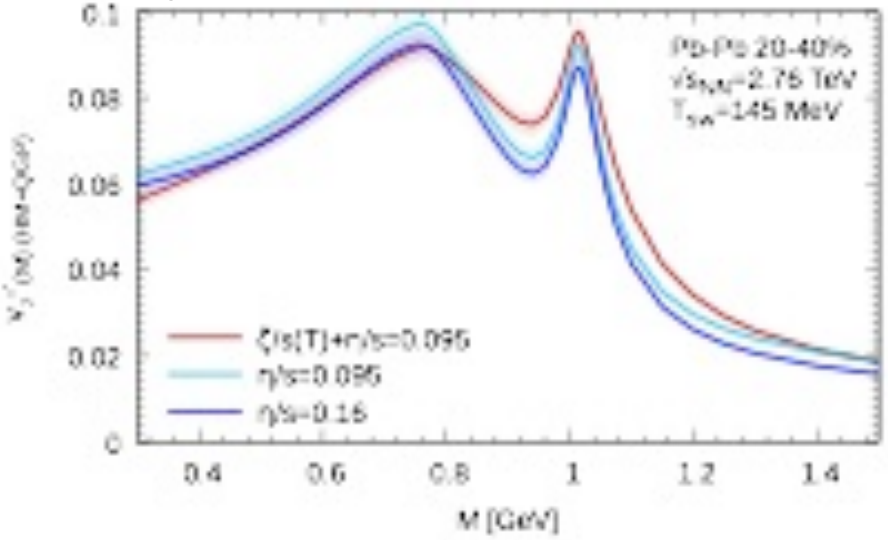
GIT: *https://gitlab.cern.ch/miweber/HLLHC-WG5-photons-dileptons*
Mailing list: *hllhc-wg5-photons-dileptons@cern.ch*

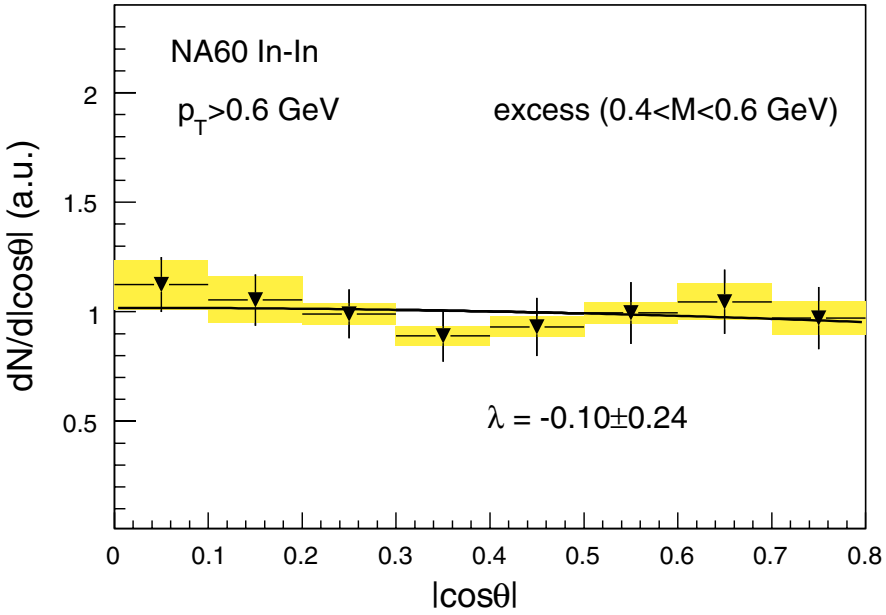
BACKUP

OTHER OBSERVABLES

Vujanovic et al., arXiv:1703.06164 [nucl-th]



NA60, PRL 102, 222301 (2009)



Elliptic flow:

- Sensitivity to shear and bulk viscosity (together with hadronic observables)
- **1% absolute uncertainty**

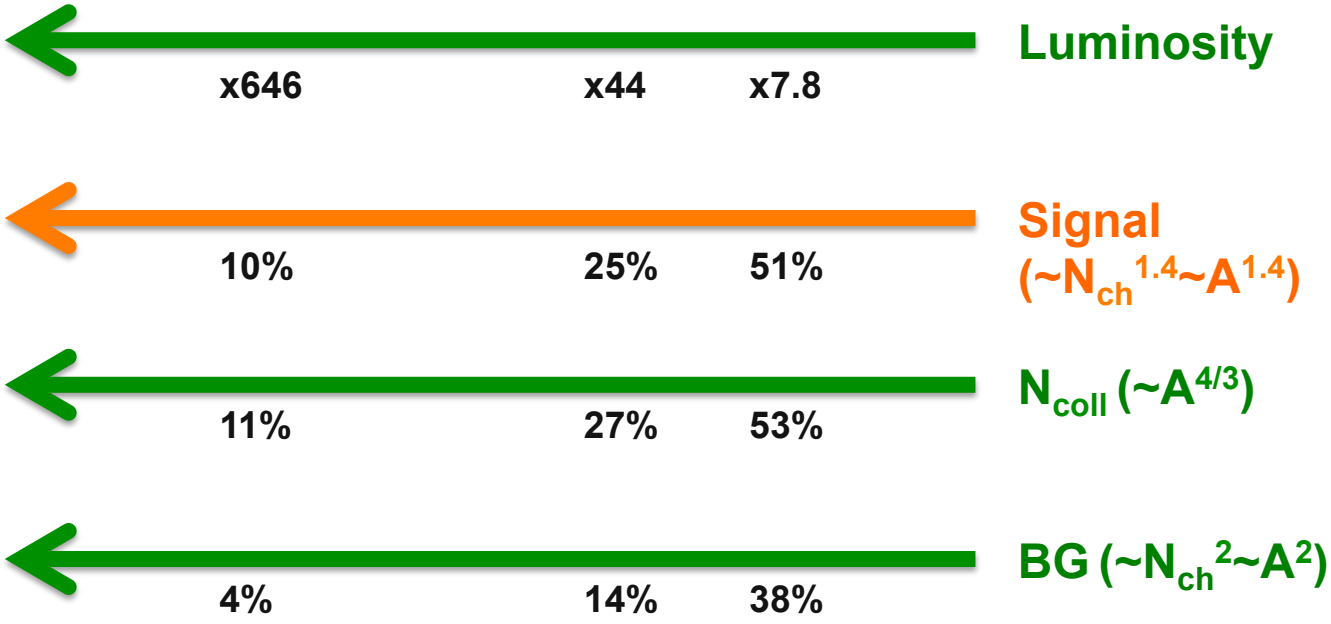
Photon polarization:

- Sensitive to photon source polarization (thermalization, gluon anisotropy, Drell-Yan,…)
- **No estimate for ALICE (NA60 used ~50k excess pairs)**

LIGHT IONS (SOME SIMPLE SCALINGS)

	$^{16}O^{8+}$	$^{40}Ar^{18+}$	$^{40}Ca^{20+}$	$^{78}Kr^{36+}$	$^{129}Xe^{54+}$	$^{208}Pb^{82+}$
γ	3760.	3390.	3760.	3470.	3150.	2960.
$\sqrt{s_{NN}}$/TeV	7.	6.3	7.	6.46	5.86	5.52
σ_{had}/b	1.41	2.6	2.6	4.06	5.67	7.8
$\langle L_{AA}\rangle$ cm^{-2}s^{-1}	4.54×10^{31}	2.45×10^{30}	1.69×10^{30}	1.68×10^{29}	2.95×10^{28}	3.8×10^{27}
$\langle L_{NN}\rangle$ cm^{-2}s^{-1}	1.16×10^{34}	3.93×10^{33}	2.71×10^{33}	1.02×10^{33}	4.91×10^{32}	1.64×10^{32}
$\int_{month} L_{AA}$ dt/nb^{-1}	5.89×10^{4}	3180.	2190.	218.	38.2	4.92
$\int_{month} L_{NN}$ dt/pb^{-1}	1.51×10^{4}	5090.	3510.	1330.	636.	213.

Optimistic Scenario (p=1.9)



To be checked in simulations