Scrutiny Process Activities -- Status Report

Frank Nerling, Klaus Götzen, Ralf Kliemt
Helmholtz-Institute Mainz, GSI Darmstadt

PANDA „FastSim“ Tools

Tools provided via PandaRoot release „scrut14“

→ *ready to use, close to final version ...*

New features:

- Covariance matrices for charged and neutrals
  => 4C fit possible
- Neutral cluster merging
- Energy loss by Bremsstrahlung (electrons)

Prepared detector setup options (by flags):

0: Nominal set-up -- default
1: MVD+GEM
2: EMC Barrel
3: Barrel DIRC
4: Disc DIRC
5: FS (FwdTS, Fwd EMC, RICH, Fwd MDT)

Scenarios proposed:

a) Nominal Set-up:	1,2,3,4,5
b) w/o EMC:	1,3,4,5
c) w/o FS:	1,2,3,4
d) w/o Disc DIRC:	1,2,3,5
e) STT only:	2,3,4,5

Our Focus: Charmonium-like Exotics

List of channels / charmonia:

- $J/\psi + X$, $J/\psi \rightarrow e^+e^- / \mu^+\mu^-$
- $\eta_c + X$, $\eta_c \rightarrow K^+K^-\pi^0 / K_sK^{+/-}\pi^{-/+}$

→ with **various recoils**: $X = \pi^-\pi^+$, $\pi^0\pi^0$ (also: π^0, γ, η, $\eta\eta$, KK)

→ at **different energies**: E_{cms} = 4.5, 5.5 GeV

→ and the various **detector options** (1+4)

Proposed FoM: Significance

Signifikance = S / sqrt(S+B) → *for the exclusive pbarp system:*

$$Significance\,(t) = \sqrt{L \cdot t} \cdot \frac{\sigma_s \cdot \varepsilon_s \cdot f_{BR}}{\sqrt{\sigma_s \cdot \varepsilon_s \cdot f_{BR} + \sigma_b \cdot \varepsilon_b}}$$

"known"

- σ_s = total signal cross-section *(assumption)*
- σ_b = total pbarp cross-section *(known: 60mb)*
- f_{BR} = BR factor for given decay *(known)*
- **L** = Luminosity *(known for assumed lumi modes)*

"input"

- ε_s = reconstr. efficiency for signal evts. *(measured from data)*
- ε_b = reconstr. efficiency for bckgrd evts. *(measured from data)*

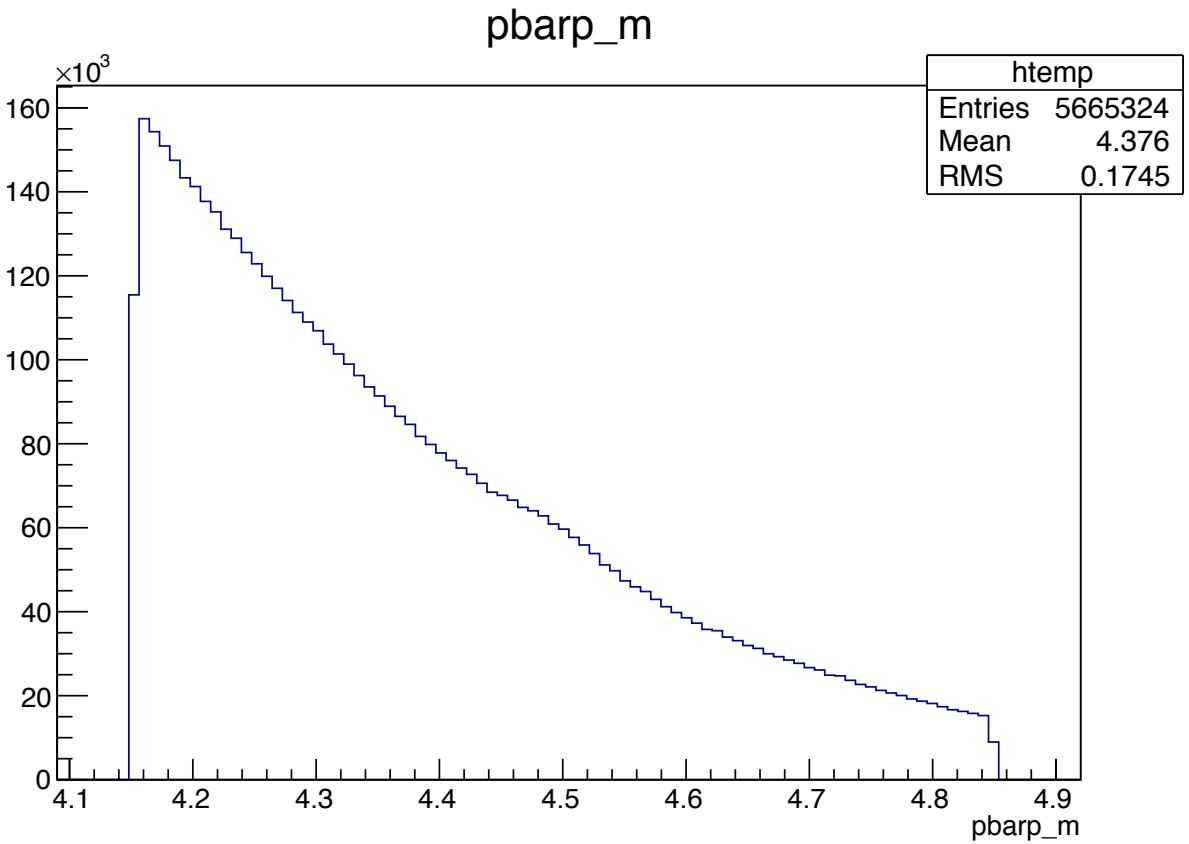
=> time dependent significance

Figure of Merit: Time needed to achieve 5σ significance

An example – pbarp mass, signal + bkgd

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

→ 100M DPM evts
→ 100k signal evts



An example – eta_c mass, signal

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

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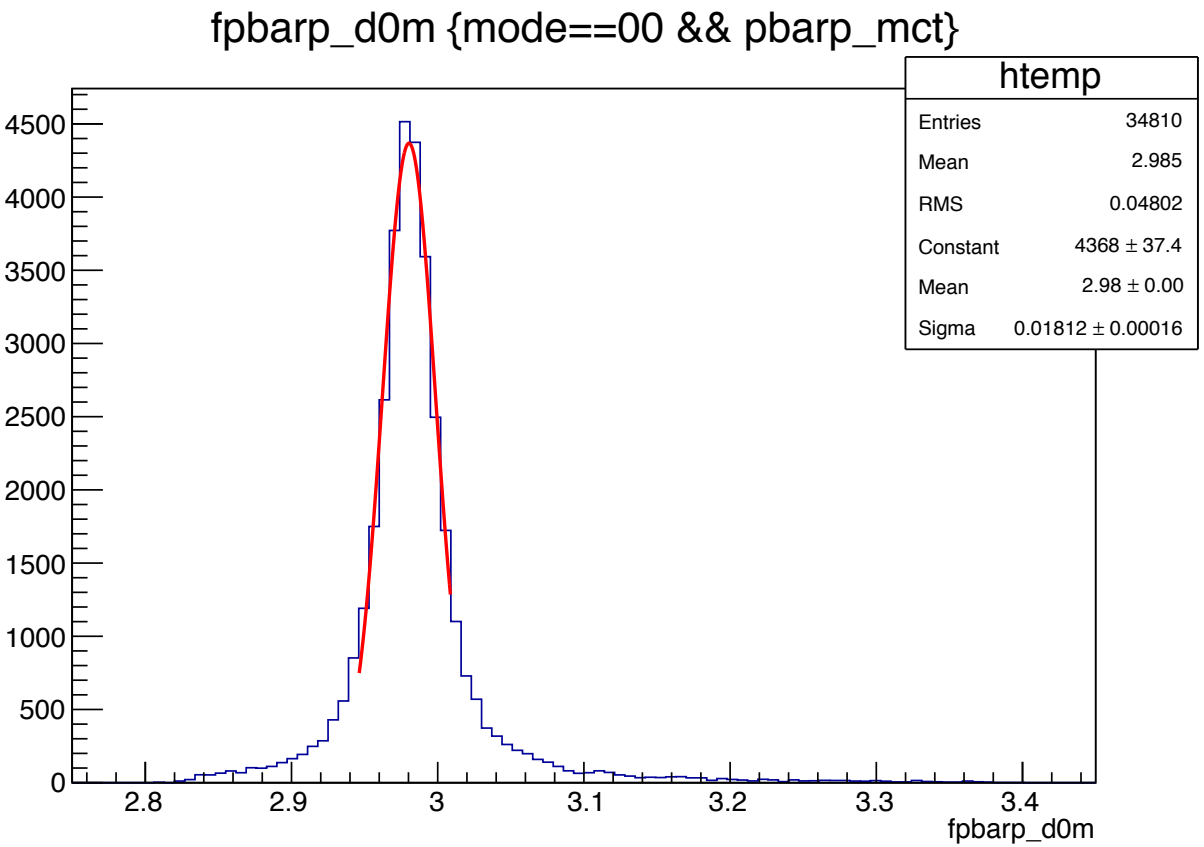

An example – pi0 mass, signal

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

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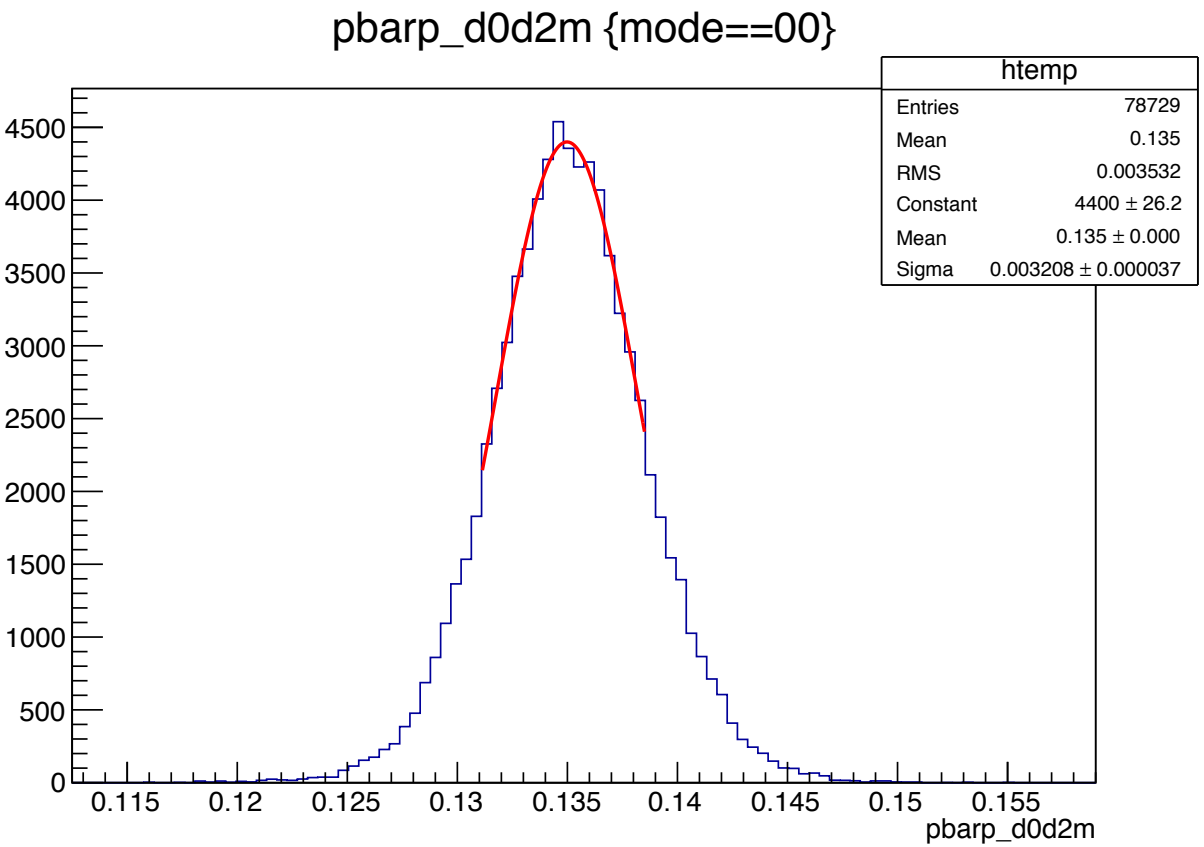
→ 100k signal evts



An example – etac mass, signal + bkgd, after selection cuts

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

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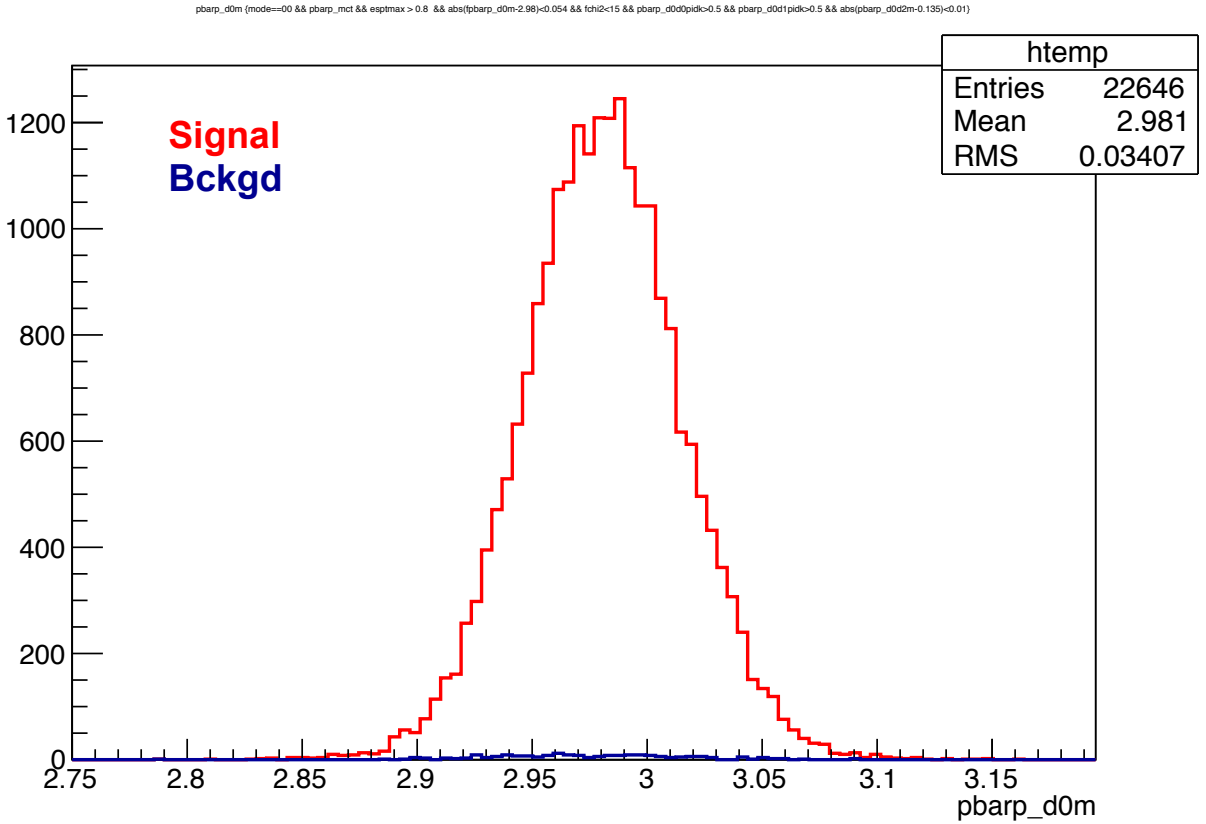
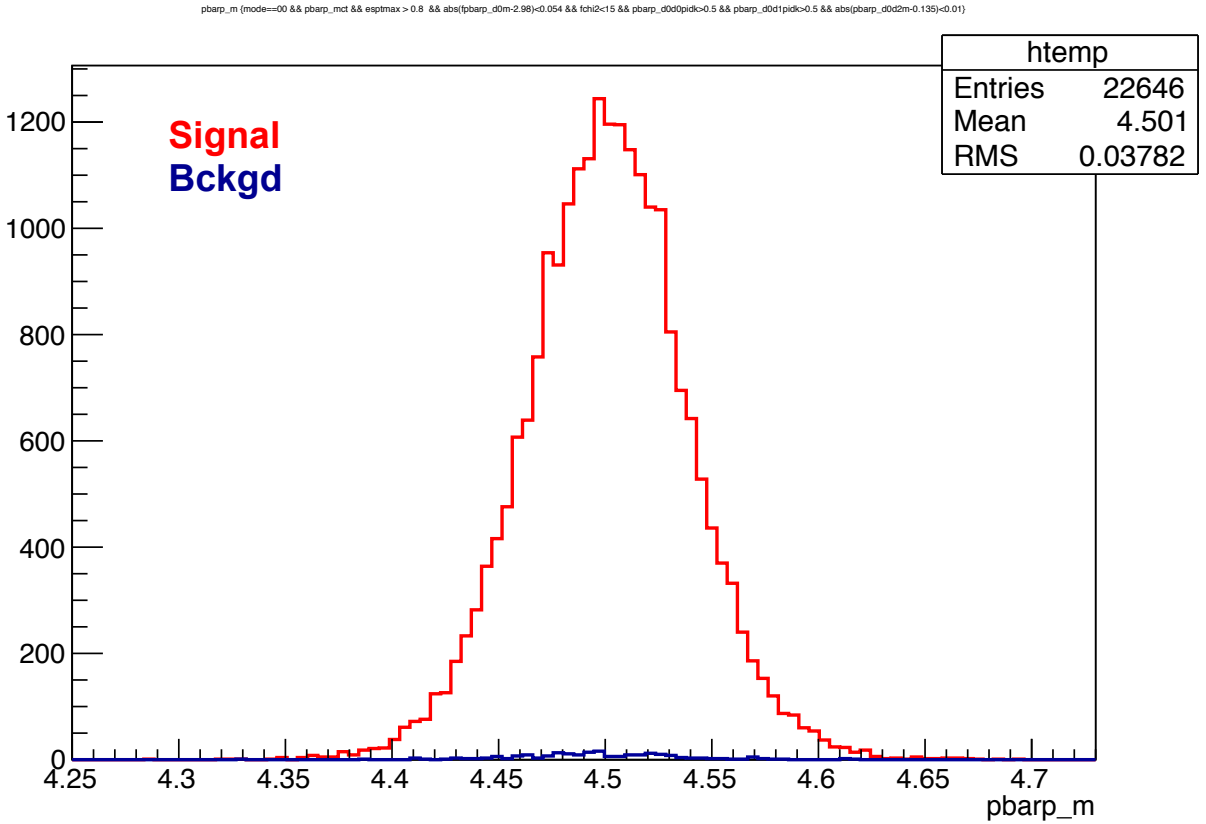


An example – pbarp mass, signal + bkgd, after selection cuts

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

$\varepsilon_s = 22.6\%$, $\varepsilon_b = 2.0 \times 10^{-6}$

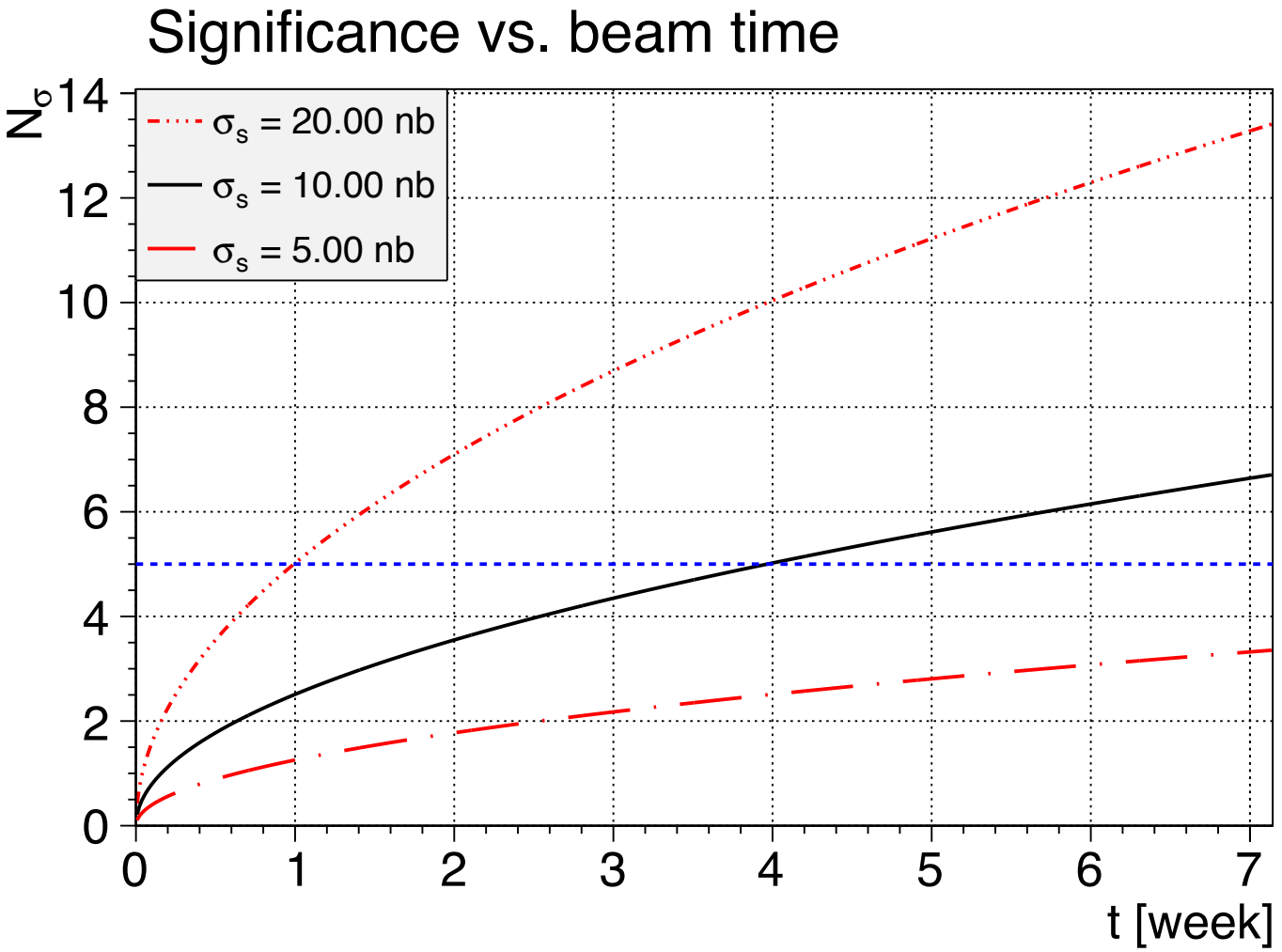
→ 100M DPM evts
→ 100k signal evts



Proposed FoM: Significance

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

σ_s = ~10 nb, σ_b = 60 mb
f_{BR} = 3.5 %, L = 2 x 10^{32}
ε_s = 22.6% , ε_b = 2.0 x 10^{-6}



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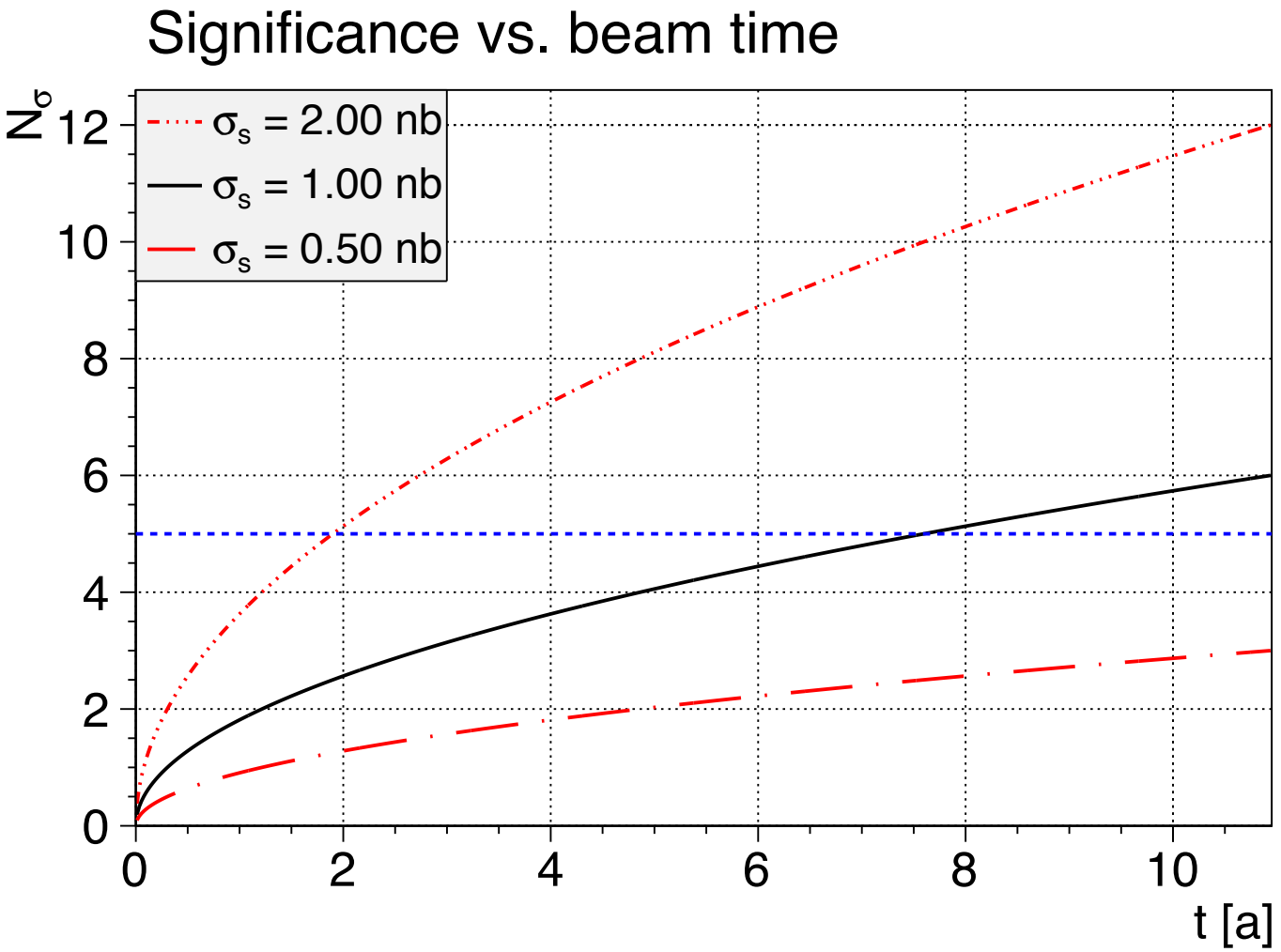
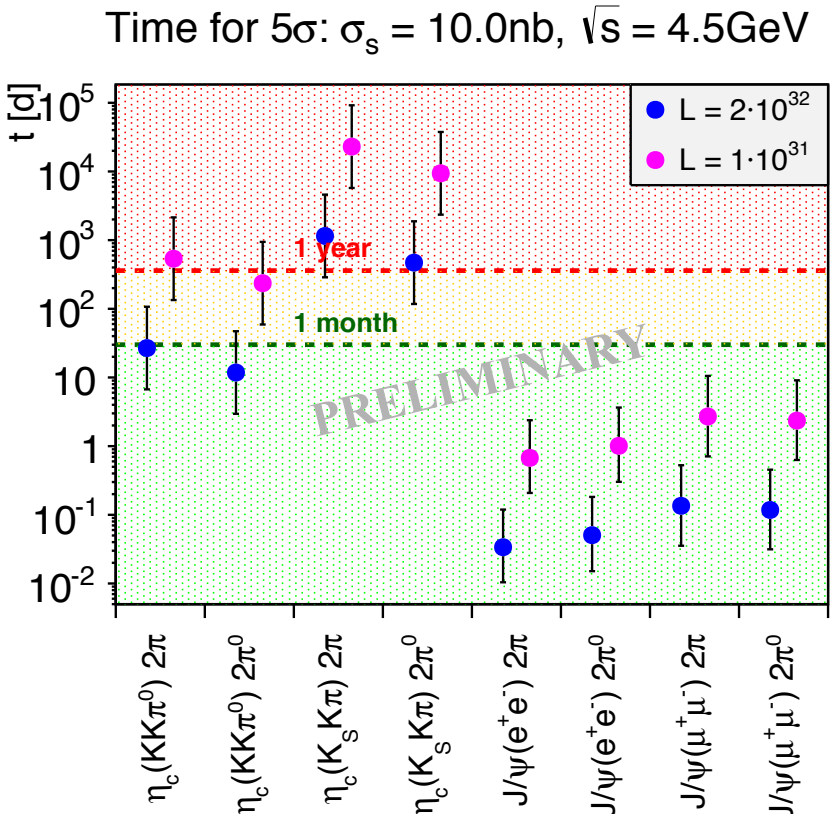


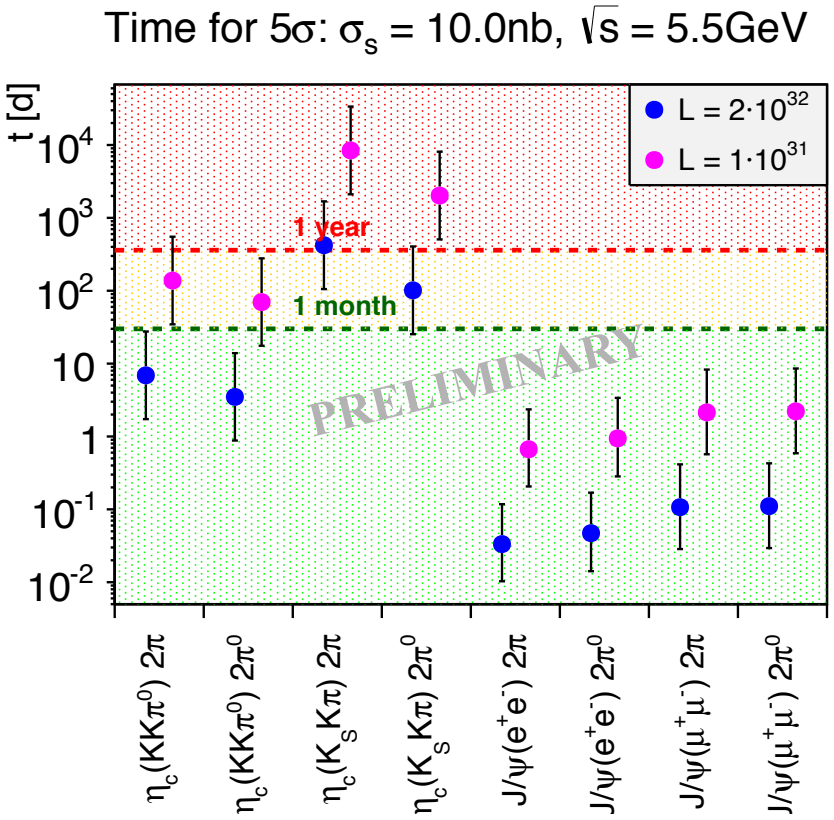
Present Results -- Summary

$\sigma_s = 10\text{nb}$

"high & low lumi"
4.5 GeV

"high & low lumi"
5.5 GeV



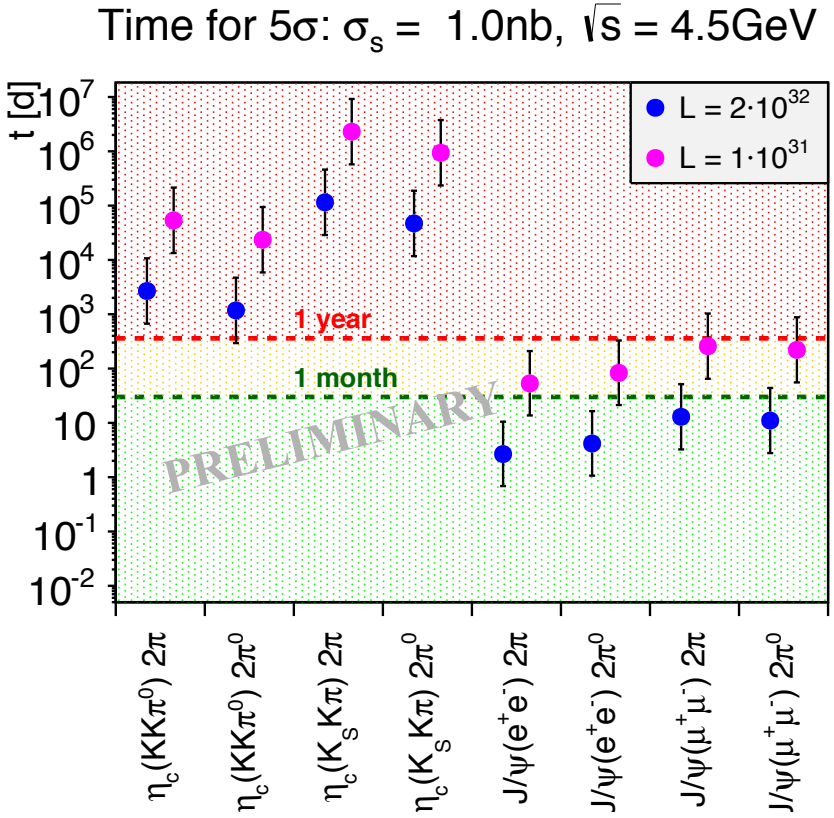


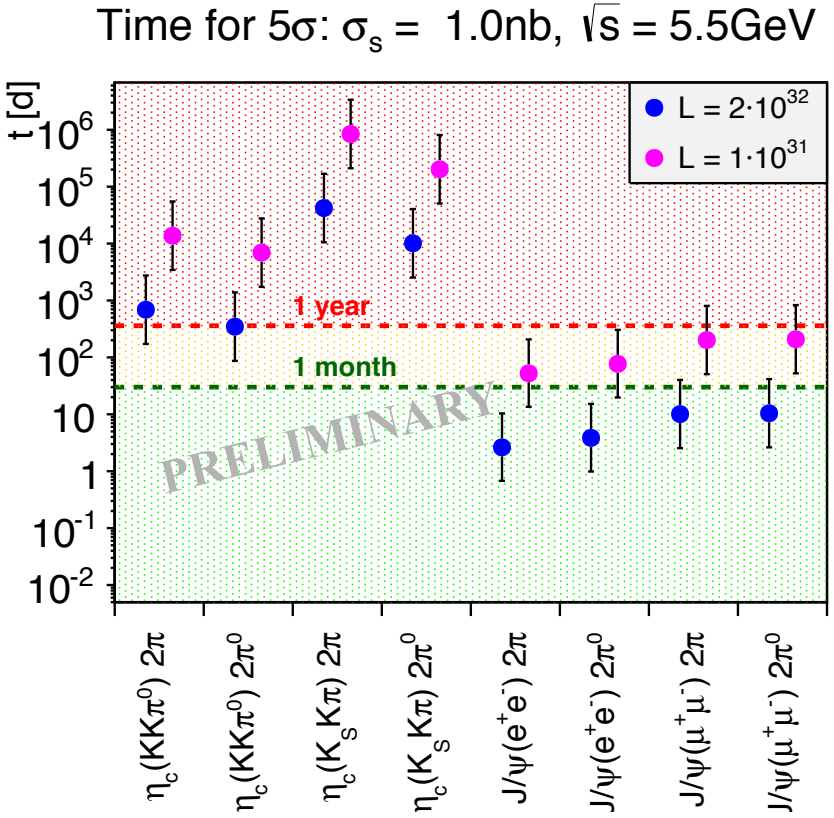
Present Results -- Summary

$\sigma_s = 1$nb

"high & low lumi"
4.5 GeV

"high & low lumi"
5.5 GeV





Overview & compatibility

Example: $\eta_c + \pi^-\pi^+ \rightarrow K^+K^-\pi^0 + \pi^-\pi^+$ at 4.5 GeV

	Time (month)	DetOpt a)	DetOpt b)	DetOpt c)	DetOpt d)	DetOpt e)
Physics Topic A	chan #1	0.9	7.0	24	8.0	32
	chan #2	1.0	2.8	8.5	36	28
	chan #3					
	…					
Physics Topic B	chan #1	0.8	6.5	13	21	9.0
	chan #2					
	chan #3					
	…					

arbitary nbrs for illustration

Summary & Outlook

- **FastSim tools provided („final“ version)**
- **Extraction of FoM proposed (significance)**
- **Analysis of channels involving two relevant charmonia started**
- **Provide comparable overview of feasibility**
  → *physics channel, detector setups, FoM vs. time*

Outlook:

- complete studies started
- extend to more recoils
- define further FoM