



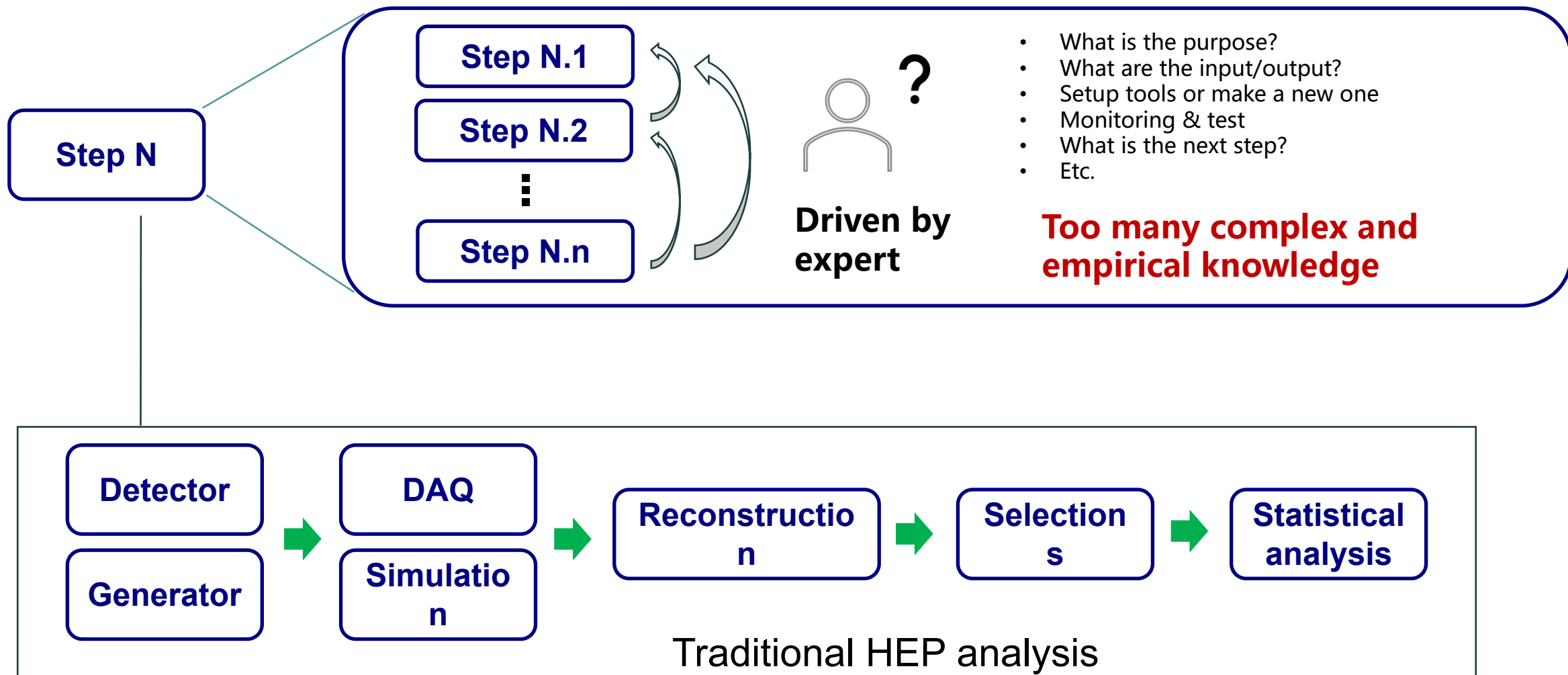
Towards automatic discovery: how can DrSai help on XYZ studies

Tong Liu for the DrSai group

Outline

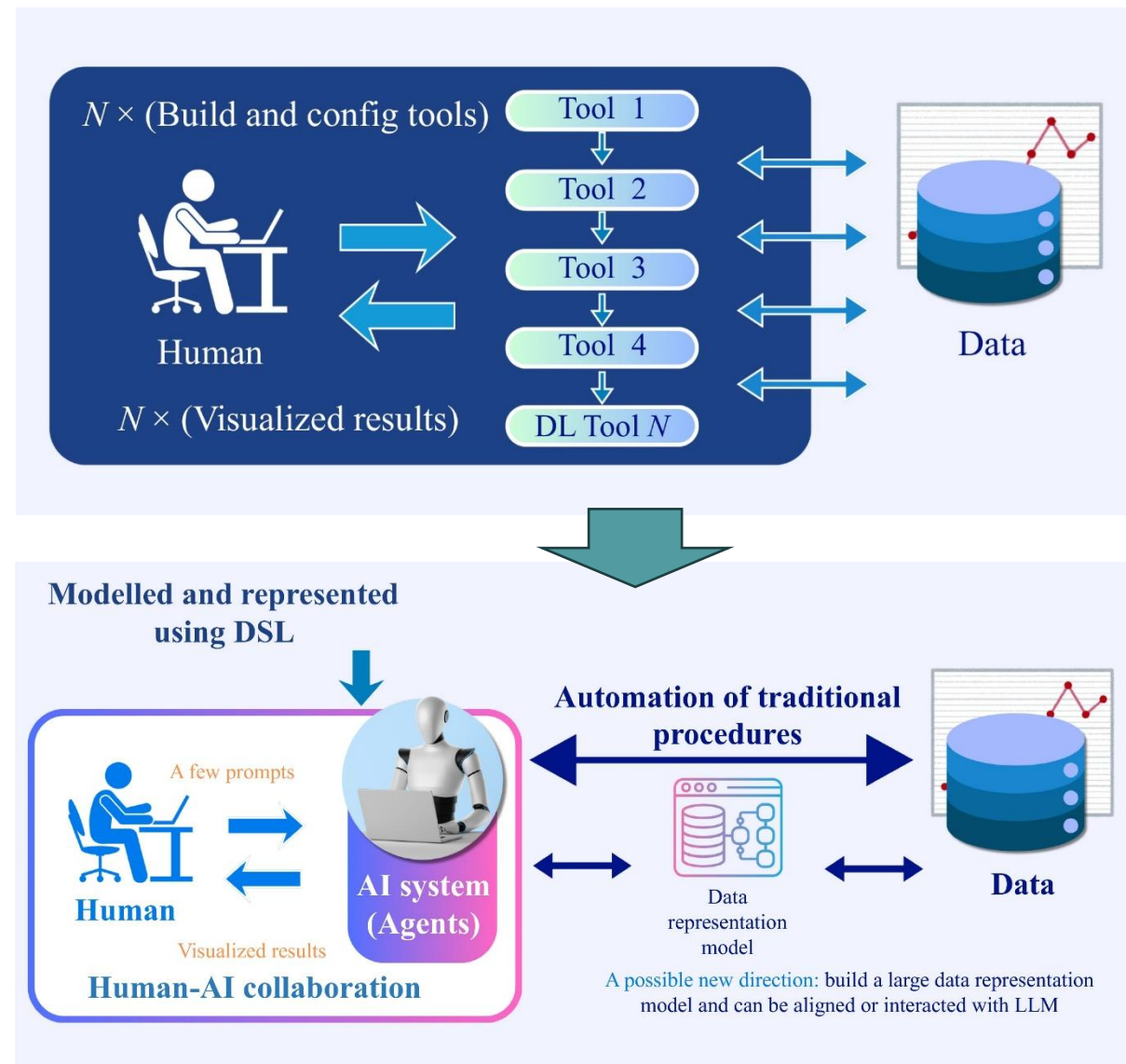
- Motivation
- History and Status of DrSai
- The first analysis with DrSai:
 - Exclusive R value measurement at 1.9 GeV
- Summary and outlook

Motivation



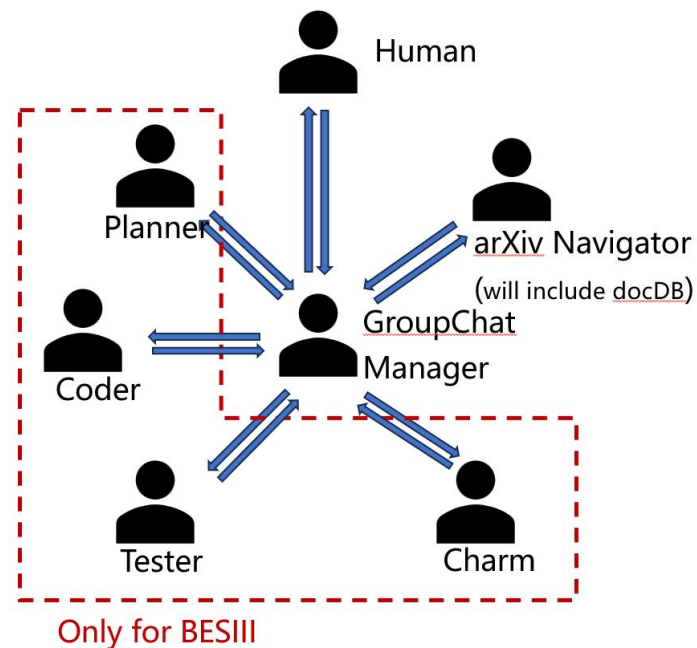
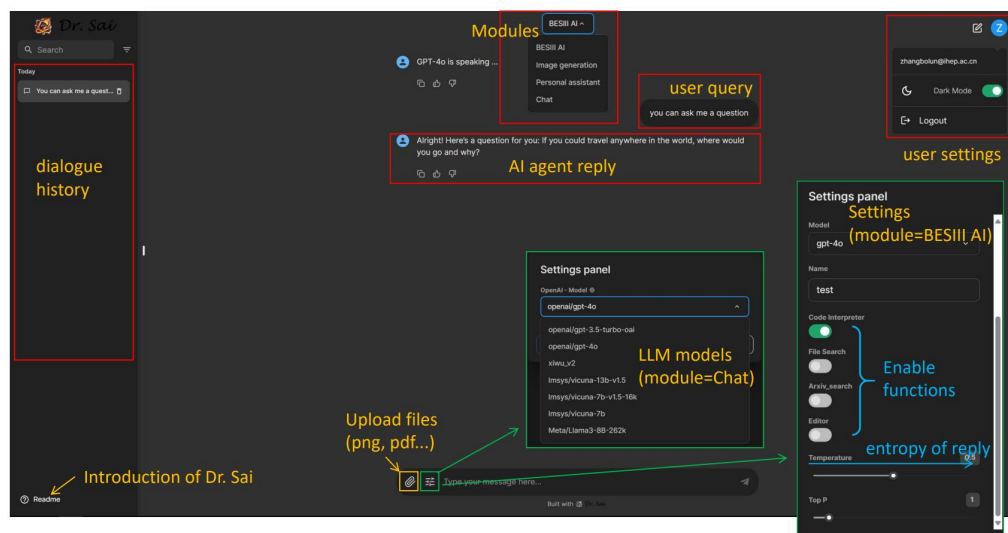
Motivation

- LLM is smart enough to build an AI partner for experts
 - The AI partner designs and conducts the entire workflow based on human commands and feedback.
 - Human-AI collaboration, free humans from repetitive work
 - Make analysis more efficient



History of DrSai v1

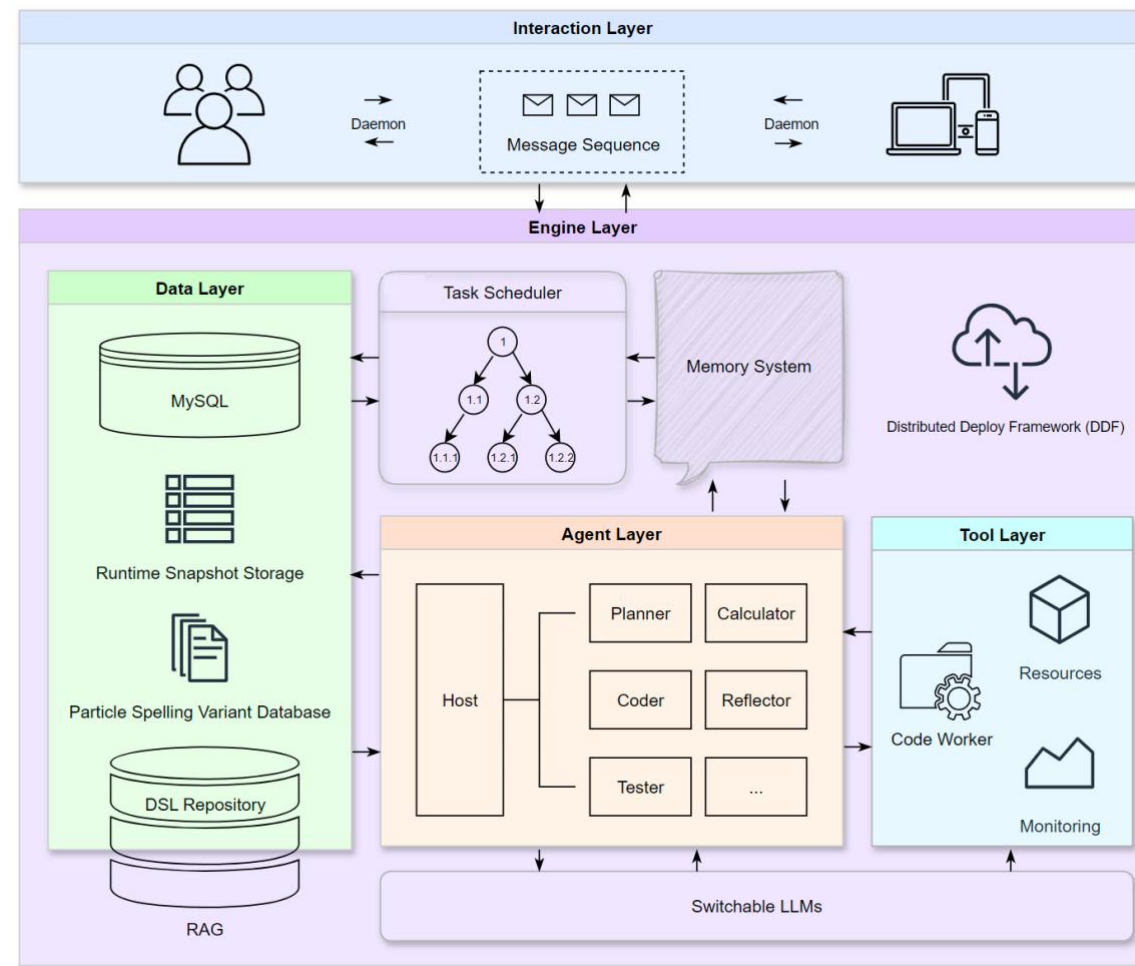
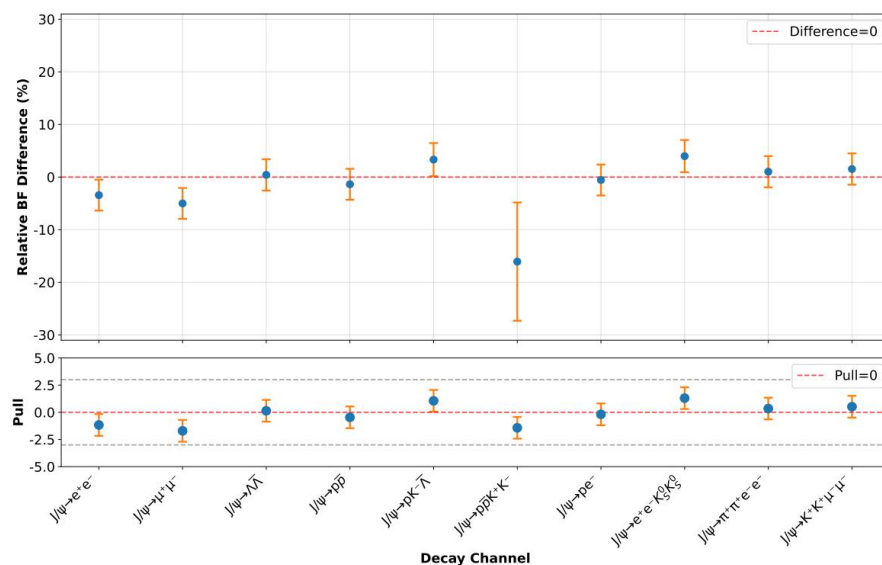
- Developed based on open-source multi-agents framework: AutoGen.
- Deploy workers to wrap-up the tools
- Tested LLMs on intent understanding, orchestration, tool invocation, etc.
- Verified feasibility



More details in [the talk at ICHEP2024](#)

History of DrSai v2

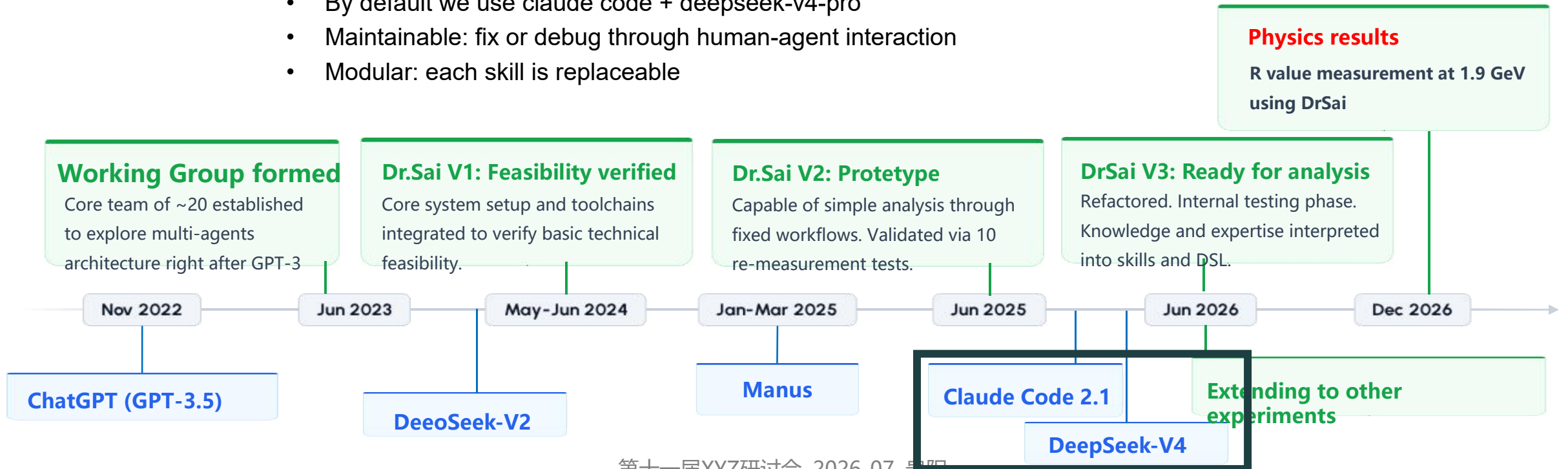
- Make BESIII analysis agent-based
 - Based on AutoGen framework
- Analysis represented via DSL (preliminary)
- Validated by re-measuring J/ψ BFs
 - Good consistency with input



arXiv:2604.22541

Now we release DrSai v3

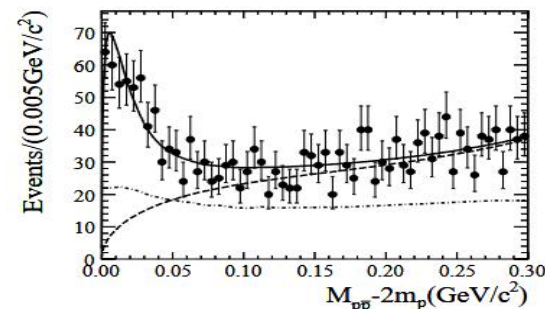
- https://code.ihep.ac.cn/liutong2016/DrSai_v3
- Industrial AI is developing fast, and works well
 - Domain-specific agents seems no further necessary for HEP
 - **DrSai_v3: General-purpose Agent + skills**
 - Skill: turns AI's understanding into actionable, reusable capabilities.
 - Portable: not tied to any framework or base model
 - By default we use claude code + deepseek-v4-pro
 - Maintainable: fix or debug through human-agent interaction
 - Modular: each skill is replaceable



Updates on DrSai v3

- Based on AutoGen → **General-purpose Agent + Skills**
- Skills: modular and reusable, knowing how to do something, not just knowing about it**
- Use **DSLs** to represent the analysis pipeline
 - A **DSL-yaml** as work "note", updated as the work proceeds
 - A **DSL-ruby** (HepScript) for more stable coding and help users check/confirm code logic
- GraphRAG**: improve code generation
 - Take each class/package as a node
 - Define edges - contains, extends, depends
- Agentic RAG**: knowledge from previous work → strategy for new work
 - Previous works are chunked by physical meaning

CPC 34, 421 (2010)



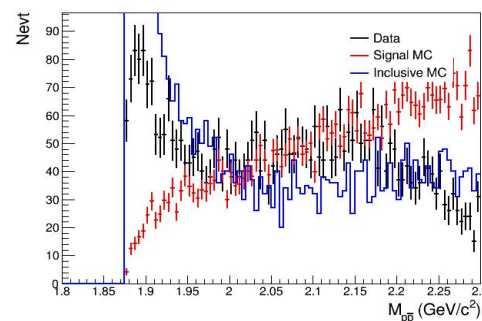
DrSai



```

metadata:
  name: ppbar_threshold
  BSM: 000
  dataType: None
  comment: "Observation of a ppbar mass threshold enhancement in psi' to
  selection:
    - analysis_1: "psi' to pi+ pi- 3/pi, 3/pi to gamma p p-bar"
  analysis_1:
    dir:
      dir_data: None
      dir_sigMC: None
      dir_incMC: None
      dir_dmc: None
    sample:
      data: None
      incMC: None
      sigMC:
        num_events: 50000
        process: "psi' to pi+ pi- 3/pi, 3/pi to gamma p p-bar"
    otherMC: []
  base_selection:
    comment: "Events require at least one photon and four charged track
    - p1: Identified with highest confidence level"
    - p2: Identified with highest confidence level"
    - p3: "no PID required"
  tag:
    common: gamma pi+ pi- p p-bar
    basic_pid:
      - p1: Identified with highest confidence level"
      - p2: Identified with highest confidence level"
      - p3: "no PID required"
  build:
    - var: 4C
    - setting: setChisqCut(100,0.005)
  
```

DSL



DrSai



Updates on DrSai v3

- DSL-yaml as work "note": represent the analysis pipeline
 - Use existing work to extract knowledge for preliminary DSL-yaml generation
 - YAML format, parsed by LLM, high readability
 - Interactive work, revisable at any time (manually or via LLM).
 - Finally obtain "note" that contain all the information of this analysis
 - Write MEMO automatically

```

metadata:
  name: pip psi
  BAM: "000"
  dataType: 4260
  comment: "Absolute branching ratio of J/psi to lepton pair via radiative return at 4.26 GeV. The signal yield of e+e- -> pip
  pim J/psi, J/psi -> ep em (mup mum) is determined by fitting the invariant mass distribution of the lepton pair. The signal y
 ields N signal are determined with the fit to data. The efficiencies are given by signal MC samples."
  selections:
    - analysis_1:
        - "e+e- -> pip pim J/psi"
        - "J/psi -> ep em"
    - analysis_2:
        - "e+e- -> pip pim J/psi"
        - "J/psi -> mup mum"

analysis_1:
  dir: .
  dir_data: None
  dir_sigMC: None
  dir_incMC: None
  dir_draw: None
  sample:
    data: None
    incMC: None
    sigMC:
      - num events: 50000
      - process: e+e- -> pip pim J/psi, J/psi -> ep em
  base_selection:
    comment:
      tagged_data: "nCharge>3, nCharge<5"
      tag:
        common: pip pim ep em
        other:
      basic_pid:
        - pi: "momentum less than 0.7 GeV/c"
        - e: "momentum larger than 1 GeV/c, EMC deposition 126 x 76 an 0.8 GeV"
        - mu: "momentum larger than 1 GeV/c, EMC deposition 126 x 76 an 0.4 GeV"
      kmfit:
        - var: 4C
          setting: setChisqCut(200,0.005)
        - var: 5C (4C, M_jpsi)
          setting: setChisqCut(9999,0.005)
      further_selection:
        chisq:
          - {var: chisq4C, optimize: 1D, strategy: FoM, default: (0,200), Nbin_region: "100, (0,200)"}
        costTheta:
          - {var: polarAngle_pip, optimize: False, strategy: FoM, default: (-0.8,0.8)}
          - {var: polarAngle_pim, optimize: False, strategy: FoM, default: (-0.8,0.8)}
        theta:
          - {var: openAngle_pip_pim, optimize: False, strategy: FoM, default: (0.2, 3.2)}
        Mass:
          - {var: "Mjpsi: p4_ep + p4_em", optimize: False, strategy: FoM, default: (3.09,3.11), Nbin_region: "100, (3.,3.2)"}
        RM_pi:
          - {var: "maxRMpi: max(RM(pi+), RM(pi-)), ecms=4.25795", optimize: False, strategy: FoM, default: (3.6,4.2), comment: "di
            agnostic only, NRM=100(3.6,4.2), sideband defined as (3.05,3.08)U(3.12,3.15)"}
      fit:
    analysis_2:
  systematic_uncertainties:
  result:

```

Start a new analysis using DrSai v3

- Say “analysis with DrSai, see config.yaml”

- A yaml-like style configuration
- Or generate config.yaml via human-AI interaction

- config.yaml contains:

- Directories
- Confirmation
- subAgents-parallel
- sysErr estimation
- BOSS package generation
- Physical processes
- Samples (data, incMC, list)

```
# ===== Global Fields =====

outdir: ./logR # directory for analysis output.
runBOSS_outdir: ./logR/proj # directory for BOSS job projects. omitted → interaction
workarea: /workfs2/bes/liutong2016/boss713/workarea/Analysis/R # BOSS package workarea. omitted → interaction

confirm_mode: minimal # detailed (ask at every step) | minimal (interact only for required items)
parallel: yes # yes | no. Whether to enable parallel agent execution.

# If both yes, LLM will combine the outputs
sysErr: yes # yes | no. Whether to generate systematic error code via RAG
sysErr-ruby: yes # yes | no. Use the systematic error analysis benchmark developed for HepScript

genBOSSCode: direct # ruby | direct. BOSS code generation method.
# ruby - generate BOSS code via Ruby/HepScript
# direct - generate directly

# ===== entries Mode and Entries =====

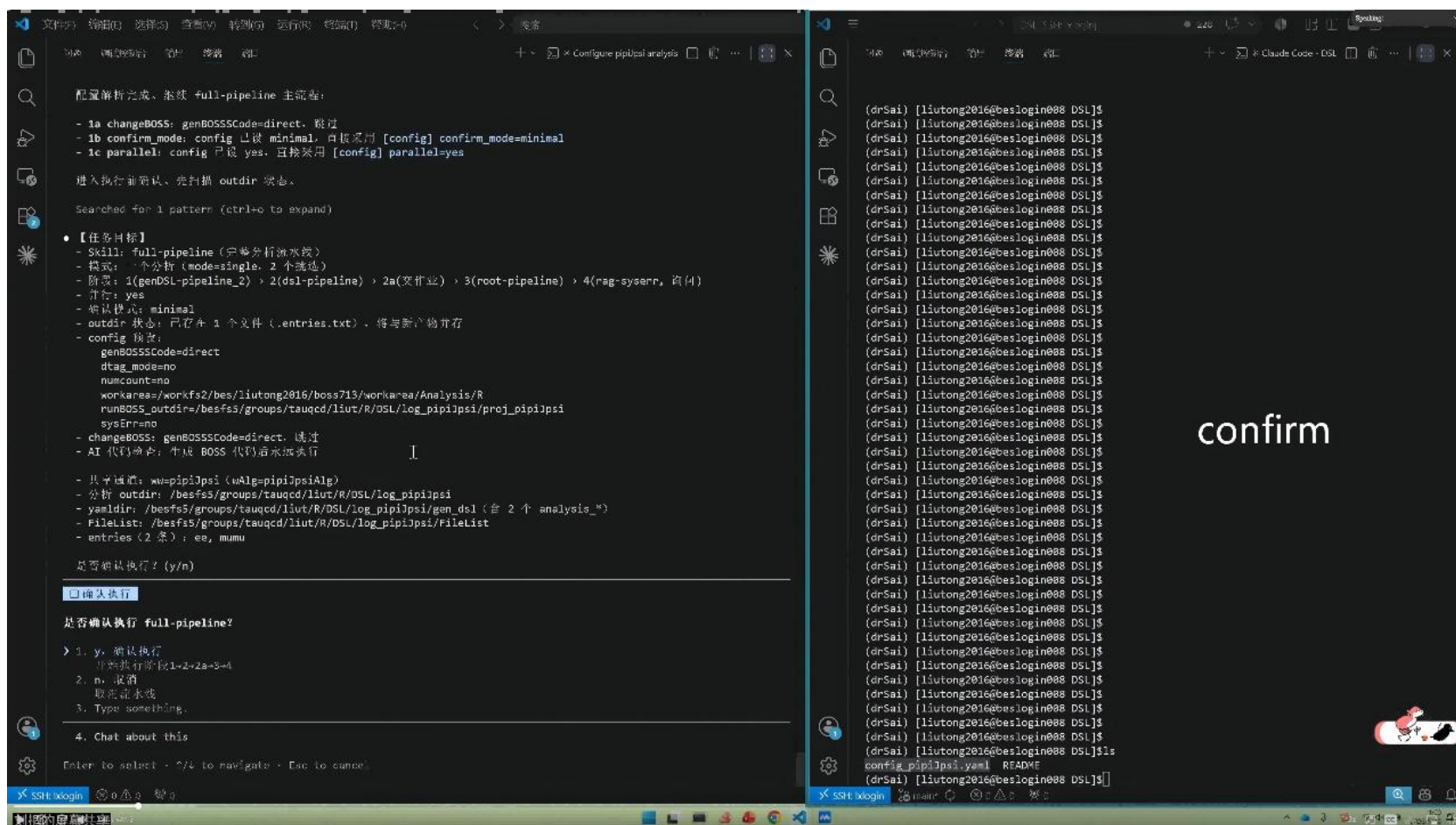
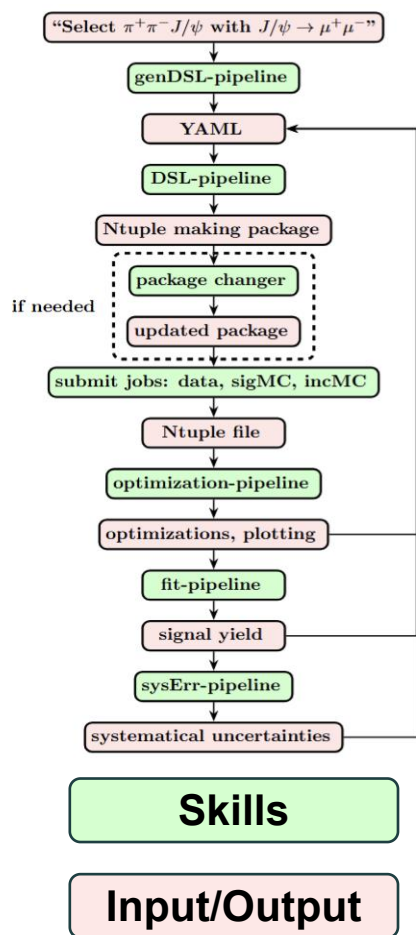
mode: single # single | multi
# single - one analysis
# multi - multiple independent analyses

ww: Rvalue # Optional. Valid only when mode=single and entries≥2
# Ignored in other modes (multi / single+entries=1)

entries:
# Format per line: process threshold_cut=<GeV> description
# - process - channel name & algorithm base name, used for subdirectory and analysis package naming.
# - threshold_cut - energy threshold for KKMC+BesEvtGen (GeV). If missing, full-pipeline will interactively p
rompt at load time (default 3.0).
# - description - brief description of the analysis procedure: final-state particles, etc.
- "bhabha threshold_cut=0.001022 select e+e- at 1.9 GeV"
- "dimu threshold_cut=0.2113 select mu+mu- at 1.9 GeV"
- "pipi threshold_cut=0.280 select pi+pi- at 1.9 GeV"
- "pipipi0 threshold_cut=0.415 select pi+pi-pi0, pi0->gamma gamma at 1.9 GeV"
```

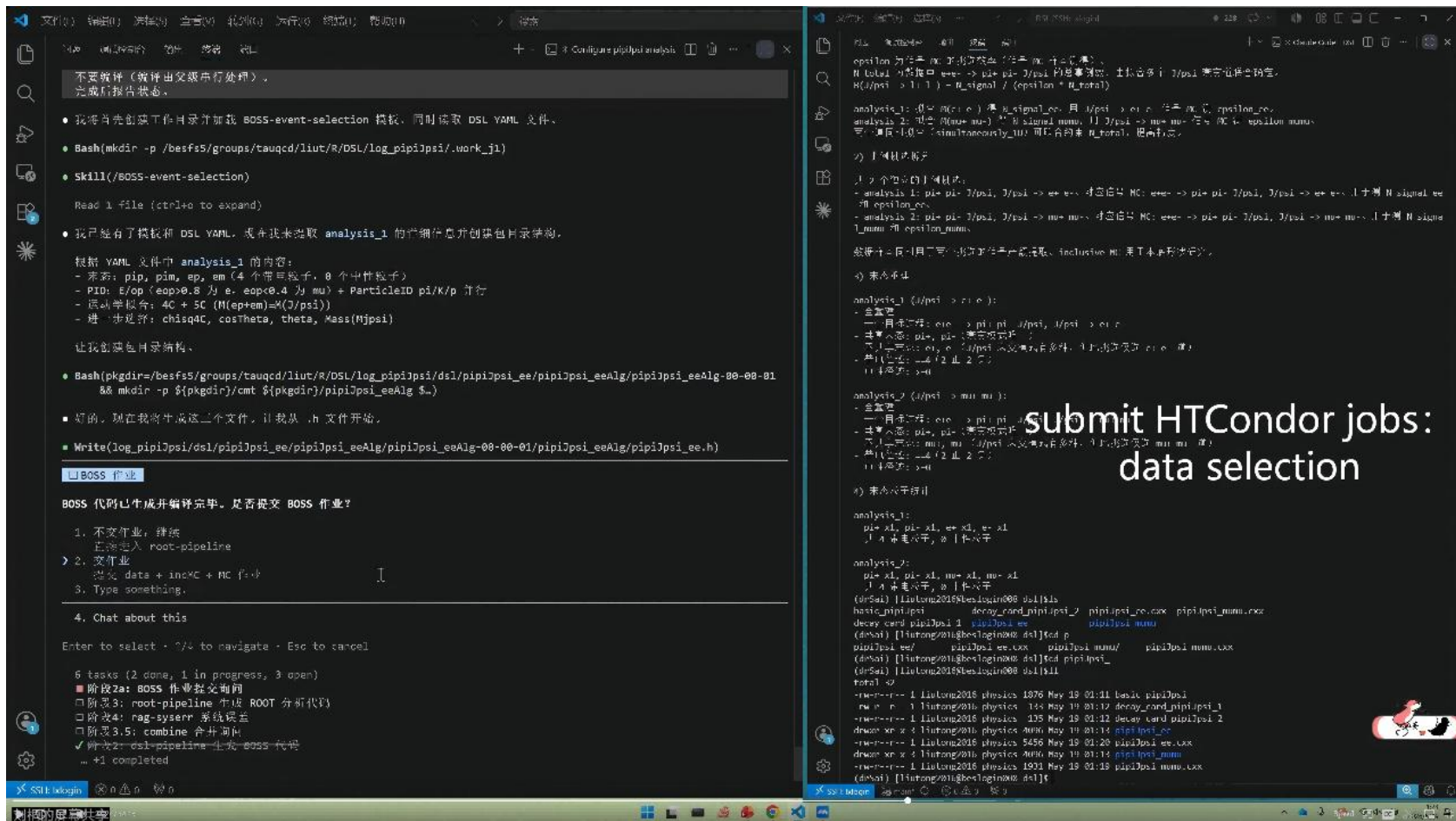
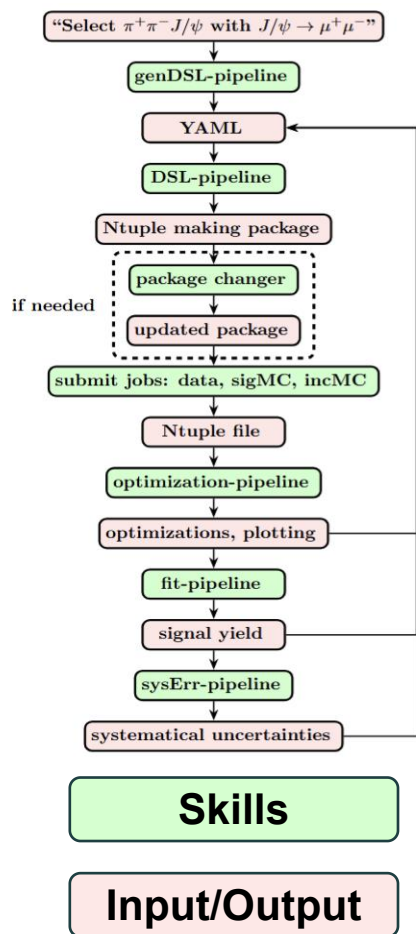
Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



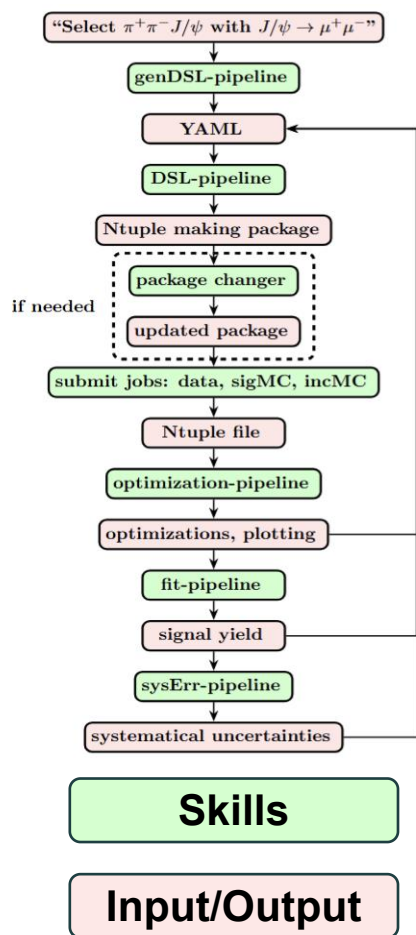
Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



文件(F) 编辑(E) 选择(S) 查看(V) 转到(G) 运行(R) 终端(T) 帮助(H)

问题 调试控制台 输出 终端 窗口

运行阶段

aligname

队列类型

产生模式

GeneratePsi flag

CMSEnergy

ThresholdCut

Ana InputEcms

Decay card 母粒子

Decay card 路径

xs_user.dat

RunIdList

ana 分析模式

sim+rec+ana

pipiJpsi_ee

普通队列

B (KKMC + BesEvtGen)

GeneratePsi4260

4.26 GeV

3.376 GeV

4.26 GeV

psi(4260)

/besfs5/groups/tauqcd/liut/R/DSL/log_pipiJpsi/dsl/decay_card_pipiJpsi_1

需要复制

-31561,0,-31981

普通分析 (dtag_mode=no)

确认提交

是否按此参数生成 pipiJpsi_ee MC 作业并提交?

1. y. 确认

按此参数生成并提交

2. n. 修改

需要修改参数

3. 能量能散= 4.25795 0.001329

4. Chat about this

Enter to select · 1/4 to navigate · ctrl+g to edit in Vim · Esc to cancel

6 tasks (2 done, 1 in progress, 3 open)

阶段2a: BOSS 作业提交询问

阶段3: root-pipeline 生成 ROOT 分析代码

阶段4: rag-syserr 系统误差

阶段3.5: combine 合并询问

阶段2: dsl-pipeline 生成 BOSS 代码

+1 completed

文件(F) 编辑(E) 选择(S) ...

DSL [SSH: login]

228

Speaking:

问题 调试控制台 输出 终端 窗口

4000

1.84

0.0002

81849

81970

1.501

96166

18700

1.87

0.0002

81971

82104

2.002

143788

18720

1.872

0.0002

82543

82656

2.014

123672

18740

1.874

0.0002

82657

82783

2.019

127664

18750

1.875

0.0002

82835

82909

1.485

97954

18760

1.876

0.0002

82105

82203

2.035

114514

18770

1.877

0.0002

82784

82834

1.341

82978

18780

1.878

0.0002

82204

82261

2.021

91678

18820

1.882

0.0002

82262

82310

2.033

95556

18860

1.886

0.0002

82311

82358

2.031

100978

19000

1.900

0.0002

82359

82404

2.022

89628

19400

1.940

0.0002

82405

82462

2.040

94025

19700

1.970

0.0002

82463

82530

2.229

112591

dataSample

Ecms

beamSpread

Run_Low

Run_High

Luminosity

4260

4.25795

0.001329

-29677,0,-30367

-31561,0,-31981

3.30263

0.81692437

0.86068587

828.4

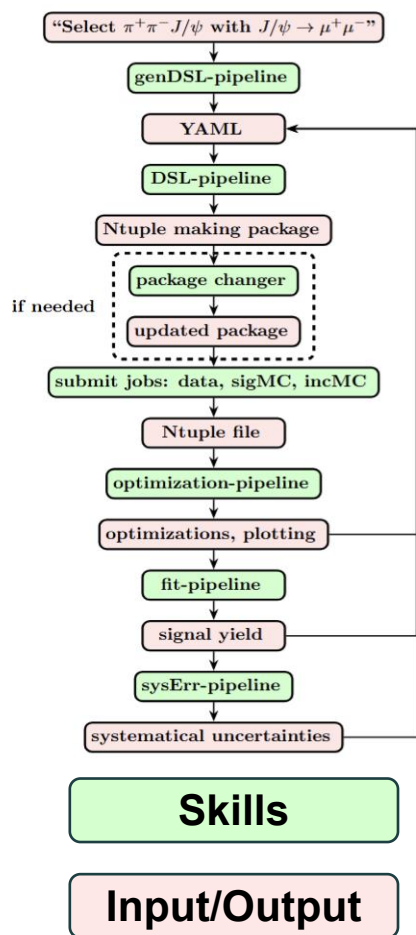
-0.000777929

-0.00116252

MC jobs: sim-rec-ana

Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



The screenshot shows a Claude Code interface with a terminal window. The terminal displays the following content:

```

Claude Code v2.1.145
deepseek-v4-pro[1m][1w] · API Usage Billing
/besfs5/groups/taucsd/liut/R/DSL

> 继续pipilpsi, 外核各作业

Skill(/checkBOSS_jobs)
  Successfully loaded skill

• 请先找到 pipilpsi 的配置文件, 确定作业类型和日志目录。

Searched for 2 patterns, read 1 file, listed 2 directories (ctrl-o to expand)

• 看到项目有 data, incMC, MC 三种作业类型 (各有 ee 和 mumu 两个通道), 我来检查所有作业状态。

Listing 3 directories.. (ctrl-o to expand)
  $ ls /besfs5/groups/taucsd/liut/R/DSL/log_pipilpsi/proj_pipilpsi/MC/txt/ 2>/dev/null | head -30;
  echo "---"; ls /besfs5/groups/taucsd/liut/R/DSL/log_pipilpsi/proj_pipilpsi/MC_mumu/txt/
  2>/dev/null | head -30

+Proofing.. (1m 23s · 1.7k tokens · almost done thinking)
  Tip: Use /btw to ask a quick side question without interrupting Claude's current work

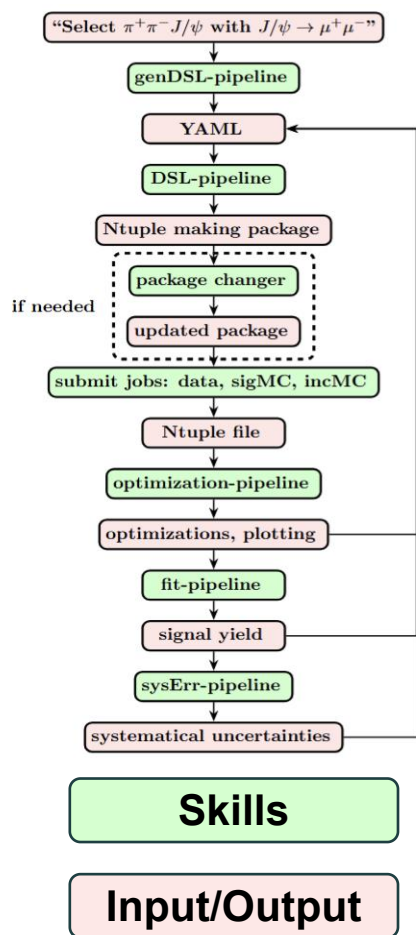
> |

>> auto mode on (shift-tab to cycle) · esc to interrupt
  
```

On the right side of the terminal, there is a list of job status updates, each preceded by a user identifier: [liutong2016@beslogin005 DSL]\$. The text "monitor jobs' status" is overlaid on the right side of the terminal window.

Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



The terminal window shows the following commands and outputs:

```

# Bash (env: /home/llutong2016/conda/miniconda3/envs/drSai/bin:/usr/bin:/bin)
PATH=/home/llutong2016/conda/miniconda3/envs/drSai/bin:/usr/bin:/bin
/home/llutong2016/conda/miniconda3/envs/drSai/bin/python3.12/site-packages/hepapi/
components/haiddf/hclient.py:180: UserWarning: [HclientConfig] encountered 1 unknown
keys when updating config, this keys will be ignored: ['model']
... +? lines (ctrl+o to expand)
[ timeout 5m]
[ Allowed by auto mode classifier]

# Phase 2a 完成, 现在教学 (key, j) 对, 准备并行生成。

# Bash (python3 -c "
import yaml...)
[ chisq_0
  cosTheta_0
  cosTheta_1
  ... +2 lines (ctrl+o to expand)
  Allowed by auto mode classifier]

# 5 个文件需要生成: chisq_0, cosTheta_0, cosTheta_1, theta_0, Mass_0, 并行 dispatch 5 个 Agent.

# Running 5 agents... (ctrl+o to expand)
[ gen+check draw_chisq_0.cxx - 12 tool uses - 29.8k tokens
  _ Bash: Check if prompt files exist at the script's expected location
  _ gen+check draw_cosTheta_0.cxx - 18 tool uses - 29.5k tokens
  _ Update: DD_cosTheta_0.py
  _ gen+check draw_cosTheta_1.cxx - 8 tool uses - 29.4k tokens
  _ Update: DD_cosTheta_1.py
  _ gen+check draw_theta_0.cxx - 7 tool uses - 29.4k tokens
  _ Update: DD_theta_0.py
  _ gen+check draw_Mass_0.cxx - 6 tool uses - 29.4k tokens
  _ Update: DD_Mass_0.py
  (ctrl+b to run in background)

* Generate draw_theta_0.cxx via DD_theta_0.py... (27x 37s - 19.6k tokens - thought for 4s)
[ Tip: Use /btw to ask a quick side question without interrupting Claude's current work

> |

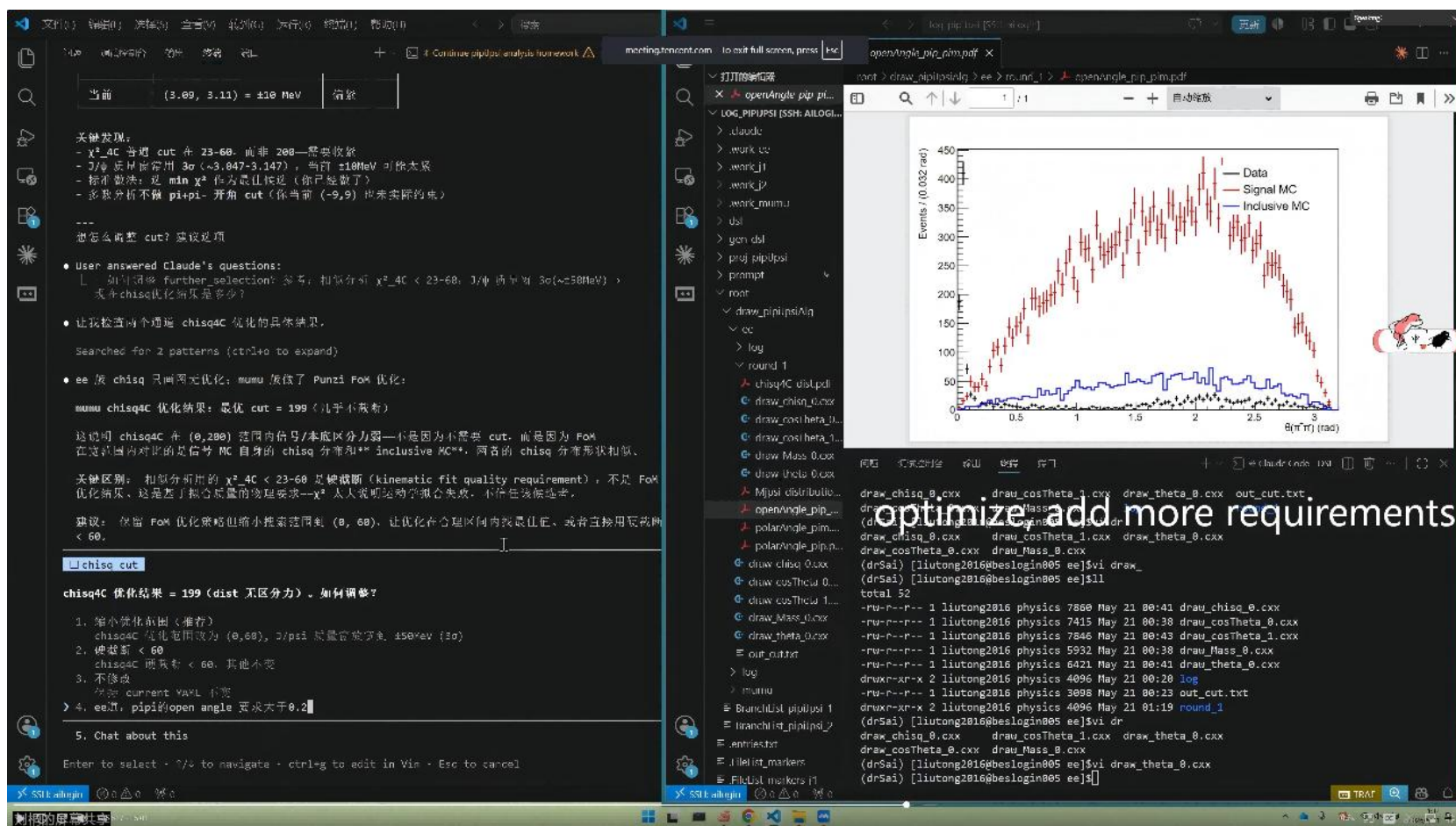
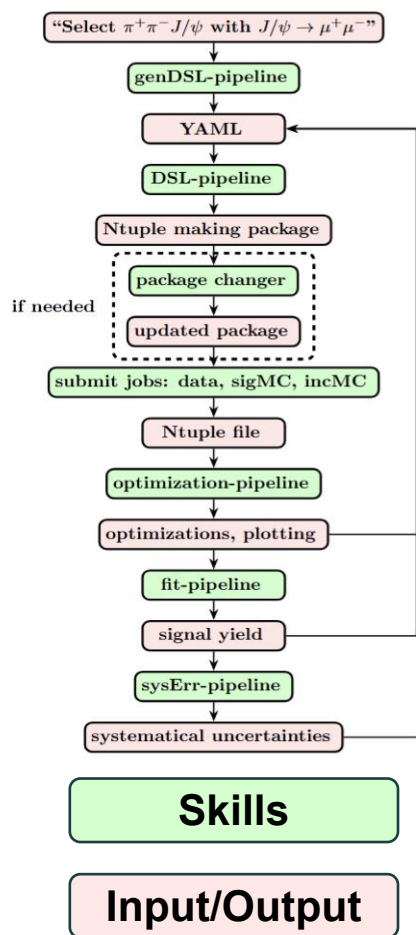
# auto mode on (shift-tab to cycle) - esc to interrupt - ctrl-t to show tasks - i to manage
# % to select - Enter to view

# main
general-purpose gen-check draw_chisq_0.cxx 2m 18s
general-purpose gen-check draw_cosTheta_0.cxx 2m 18s
general-purpose gen-check draw_cosTheta_1.cxx 2m 18s
general-purpose gen-check draw_theta_0.cxx 2m 18s
general-purpose gen-check draw_Mass_0.cxx 2m 18s
  
```

generate plotting/optimizing code

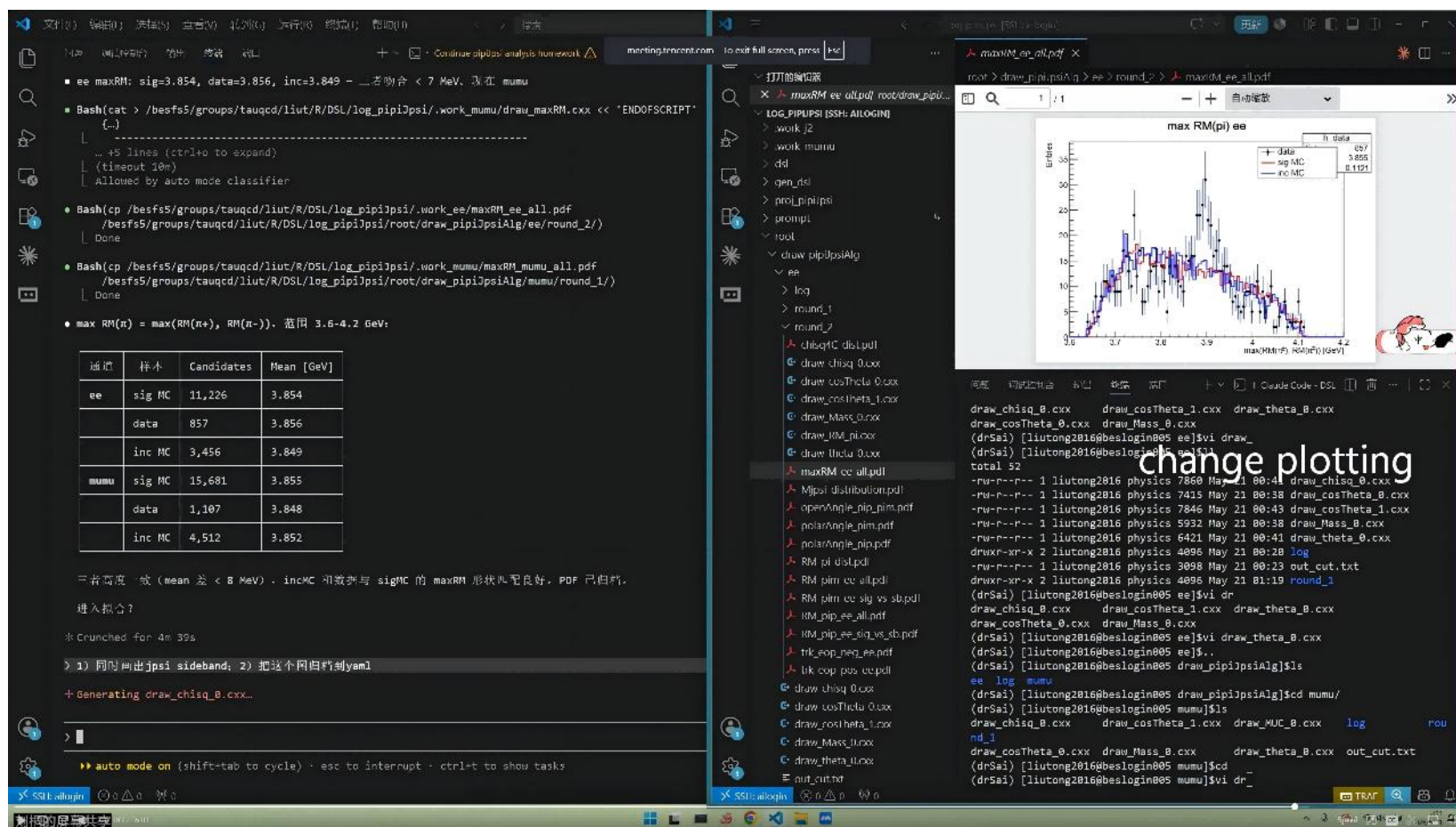
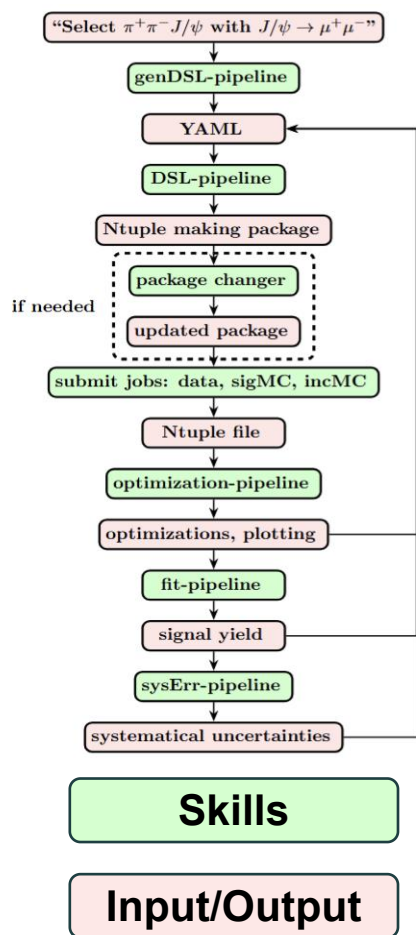
Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



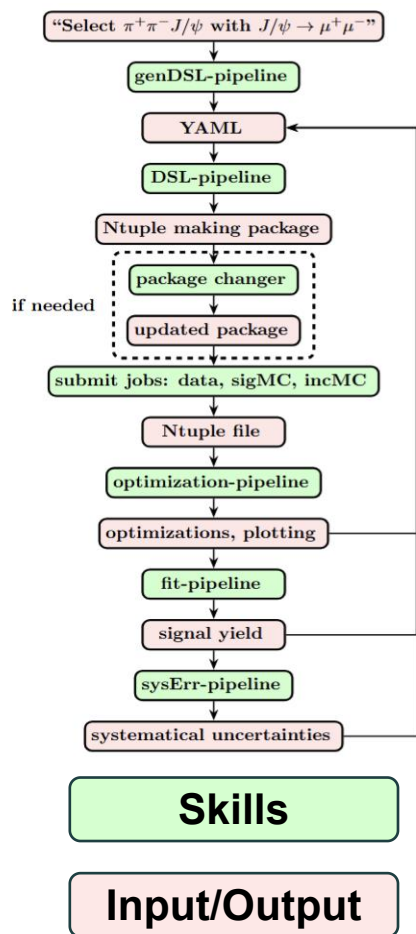
Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai_v3.0.0, Continuously updated



Terminal output showing the execution of the fit pipeline:

```

+ r(6) << endl;
332 if (r.Get())
333 cout << "chi2/ndf = " << r->Chi2() << "/" << r->Ndf() << " = " << r->Chi2()/r
->Ndf() << endl;
334

• Bash(root -l -q -b fit_maxRM.cxx 2>&1)
  Processing fit_maxRM.cxx...
  Signal region total: 1964
  Sideband total: 920
  ... +55 lines (ctrl+o to expand)
  (timeout 5m)

Read 1 file (ctrl+o to expand)

• 拟合完成。总结当前结果:

```

参数	值	备注
N_{sig}	9.4 ± 0.4	信号很小
M_0	3.894 ± 0.003 GeV	在指定范围 [3.8, 4.0]
Γ	100 MeV	触碰到上限, 拟合希望更宽
a	~ 0	阈值项被推到零
b	4.75	但 $a=0$ 不起作用
c, d	307, -74.8	本底基本上是线性的
χ^2/ndf	18.5	

三个反复出现的问题:

1. Γ 总是碰到上限 (无论设 100 还是 200 MeV), 说明该结构非常宽
2. N_{sig} 始终很小 (9-20 个), BW 只抓到局部涨落的极少事件
3. 数据主体是平滑本底, BW 信号贡献极小

你看要不要放宽 Γ 上限 (比如到 300 MeV), 或者考虑换一种信号参数化方式?

* Sautéed for 4m 47s

auto mode on (shift+tab to cycle)

update fit

```

(drSai) [liutong2016@beslogin005 draw_pipiPsiAlg]$cd fit/
(drSai) [liutong2016@beslogin005 fit]$ls
fit_maxRM.cxx fit_maxRM_ee_mumu.pdf fit_maxRM_ee_mumu.png
(drSai) [liutong2016@beslogin005 fit]$catr
(drSai) [liutong2016@beslogin005 fit]$vi f
fit_maxRM.cxx fit_maxRM_ee_mumu.pdf fit_maxRM_ee_mumu.png
(drSai) [liutong2016@beslogin005 fit]$vi fit_maxRM.cxx
(drSai) [liutong2016@beslogin005 fit]$ll
total 72
-rw-r--r-- 1 liutong2016 physics 12541 May 21 07:20 fit_maxRM.cxx
-rw-r--r-- 1 liutong2016 physics 28485 May 21 07:20 fit_maxRM_ee_mumu.pdf
-rw-r--r-- 1 liutong2016 physics 29044 May 21 07:20 fit_maxRM_ee_mumu.png
(drSai) [liutong2016@beslogin005 fit]$

```

Figure showing the signal region fit results:

Signal region

$N_{sig} = 19 \pm 0$

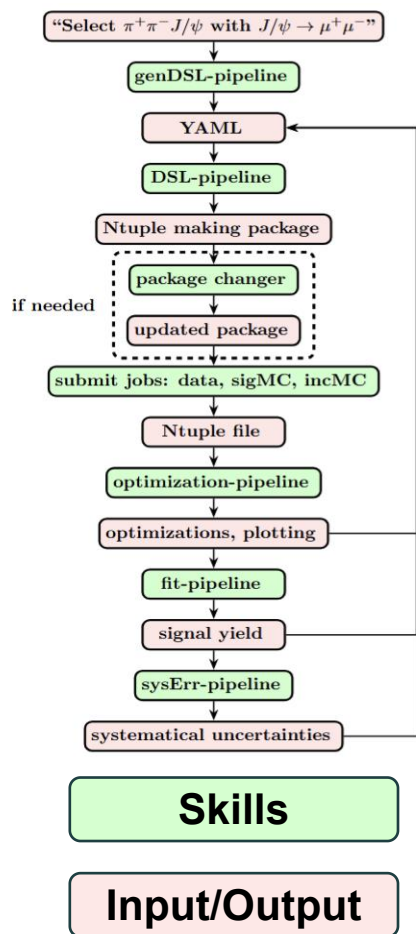
$M_0 = 3.8615 \pm 0.0027$ GeV

$\Gamma = 100.0 \pm 0.1$ MeV

$\chi^2/ndf = 727.4/46 = 15.81$

Eg: rediscovery of $Z_c(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

- A demo with DrSai v3.0.0, Continuously updated



文件(F)

编辑(E)

查看(V)

转到(G)

运行(R)

终端(T)

帮助(H)

< →

搜索

问题

调试控制台

输出

终端

窗口

+ × □ · Pipilpsi final fit with BW

类别	来源	估计值	方法
探测器效率	径迹重建 (4 tracks)	4.0%	1%/track, 参考 BAM-00348
	π PID	2.0%	控制样本, 变化 PID cut
	e PID (E/p+EMC)	1.0%	Bhabha 控制样本
	μ PID (MUC)	1.0%	$\mu\mu$ 控制样本
MC	运动学拟合 (4C)	0.5%	helix 参数修正有无效率差之半
	MC 统计 (50k)	0.1%	可忽略
	产生子模型 (VVPIPI vs PHSP)	1.0%	模型效率差
其他	ISR 修正	0.5%	KKMC $\pm$ ISR
	积分亮度	1.0%	Bhabha 标准方法
	分支比 $B(J/\psi \rightarrow 11)$	0.5%	PDG 值
选择截断	chisq4C 变化	-	$\pm 2\sigma$ 变动
	$\cos\theta$ cut (0.8→0.7)	-	BAM-00348 方法
	J/ψ 质量窗变化	-	窗口 $\pm 1\sigma$ MeV
拟合系统	信号模型 (BW M0, Γ)	-	参数在拟合误差内变化
	本底形状替代	-	多项式替代 $a/(x-3.6)^b$
	拟合范围变化	-	边界 $\pm 2\sigma$ MeV
	Sideband 归一化	-	$\pm 20\%$ 变动

输出文件: `log_pipiJpsi/gen_dsl/DSL_pipiJpsi.yaml` (YAML 校验通过)

* Worked for 10m 31s

chisq4C 变化, 拟合范围变化 不需要

- Symbioting.

SSH: ailogin

制約的自覺性 2 / 44:02

刘桢的屏幕共享

 $\frac{1}{2}$

弟

VS Code interface showing a project structure on the left and a JSON configuration file in the main editor. The configuration file is named `fit_maxRM_ee_mumu.png` and contains parameters for momentum, EMC deposition, and systematic uncertainties. A large watermark text "systematic uncertainties recommended by RAG" is overlaid on the right side of the editor.

Project Structure (Left Panel):

- LOG_PIPUPSI [SSH: AILIGIN]
 - claude
 - .work_ee
 - .work_j1
 - .work_j2
 - .work_mumu
 - dsl
 - gen_dsl
 - proj_pipupsi
 - prompt
 - root
 - draw_pipupsiAlg
 - ee
 - fit
 - check_sigMCOox
 - fit_maxRM_ee_mumu.pdf
 - fit_maxRM_ee_mumu.png
 - fit_maxRM_ee
 - log
 - mumu
 - BranchList_pipupsi_1
 - BranchList_pipupsi_2
 - entries.txt
 - FileList_markers
 - FileList_markers.j1
 - FileList_markers.j2
 - FileList
 - FileList.j1
 - FileList.j2

Configuration File Content (Right Panel):

```

other:
  basic_pid:
    - pi: "momentum less than 0.7 GeV/c"
    - e: "momentum larger than 1 GeV/c, EMC deposition larger than 0.8 GeV"
    - mu: "momentum larger than 1 GeV/c, EMC deposition less than 0.8 GeV"
  kmfit:
    - var: 4C
      setting: setChisqCut(200,0.005)
    - var: 5C (4C, M_jpsi)
      setting: setChisqCut(9999,0.005)
  further_selection:
    chisq:
      - {var: chisq4C, optimize: 1D, strategy: FoM, default: (0,200), Nbin_region: "100, (0,200)"}
    cosTheta:
      - {var: polarAngle_pip, optimize: false, strategy: FoM, default: (-0.8,0.8)}
      - {var: polarAngle_pim, optimize: False, strategy: FoM, default: (-0.8,0.8)}
    theta:
      - {var: openAngle_pip_pim, optimize: False, strategy: FoM, default: (-99,99)}
    Mass:
      - {var: "Mjpsi: p4_mup + p4_mum", optimize: False, strategy: FoM, default: (3.09,3.11), Nbin_region: "100, (3.,3.2)"}
    RM_pi:
      - {var: "maxRMpi: max(RM(pi+), RM(pi-)), ecms=4.25795", optimize: False, strategy: FoM, default: (3.6,4.2), comment: "diagnostic only, NRM=100(3.6,4.2), sideband defined as (3.05,3.08)U(3.12,3.15)"}
    fit:

  systematic_uncertainties:

result:
(drSai) [liutong2016@beslogin005 gen_dsl]$
  
```

-
- ```

graph TD
 A["Select $\pi^+\pi^- J/\psi$ with $J/\psi \rightarrow \mu^+\mu^-$ "] --> B[genDSL-pipeline]
 B --> C[YAML]
 C --> D[DSL-pipeline]
 D --> E[Ntuple making package]
 E --> F["package changer"]
 F --> G["updated package"]
 G --> H["submit jobs: data, sigMC, incMC"]
 H --> I[Ntuple file]
 I --> J[optimization-pipeline]
 J --> K[optimizations, plotting]
 K --> L[fit-pipeline]
 L --> M[signal yield]
 M --> N[sysErr-pipeline]
 N --> O[systematical uncertainties]
 O --> P[Skills]
 P --> Q[Input/Output]
 Q --> C
 Q --> K
 Q --> M
 Q --> O

```
- The flowchart illustrates the genDSL pipeline for signal yield extraction. It begins with selecting  $\pi^+\pi^- J/\psi$  events where  $J/\psi \rightarrow \mu^+\mu^-$ . The process then follows a series of steps: genDSL-pipeline, YAML, DSL-pipeline, Ntuple making package, package changer, updated package, submit jobs (data, sigMC, incMC), Ntuple file, optimization-pipeline, optimizations, plotting, fit-pipeline, signal yield, sysErr-pipeline, and finally systematical uncertainties. The process concludes with Skills and Input/Output. Feedback loops are shown from the Input/Output stage back to the YAML, optimizations, plotting, signal yield, and systematical uncertainties stages.





| Signature               | Final states (preliminary, published)                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 charged               | $\pi^+\pi^-, K^+K^-, K_S K_L, p\bar{p}$                                                                                                                                                               |
| 2 charged + $\gamma$ 's | $\pi^+\pi^-\gamma, \pi^+\pi^-\pi^0, \pi^+\pi^-\eta, K^+K^-\pi^0, K^+K^-\eta, K_S K_L \pi^0, K_S K_L \eta, \pi^+\pi^-\pi^0\eta, \pi^+\pi^-\pi^0\pi^0, \pi^+\pi^-\pi^0\pi^0, \pi^+\pi^-\pi^0\pi^0\pi^0$ |
| 4 charged               | $\pi^+\pi^-\pi^+\pi^-, K^+K^-\pi^+\pi^-, K_S K_S \pi^+\pi^-, K_S K_L \pi^+\pi^-, K_S K_S \pi^+\pi^-$                                                                                                  |
| 4 charged + $\gamma$ 's | $\pi^+\pi^-\pi^+\pi^-\pi^0, \pi^+\pi^-\pi^+\pi^-\pi^0, \pi^+\pi^-\pi^+\pi^-\pi^0\pi^0, \pi^+\pi^-\pi^+\pi^-\pi^0\pi^0\pi^0, K^+K^-\pi^+\pi^-\pi^0, K^+K^-\pi^+\pi^-\pi^0\pi^0$                        |
| 6 charged               | $\pi^+\pi^-\pi^+\pi^-\pi^+\pi^-, K_S K_S \pi^+\pi^-\pi^+\pi^-, K_S K_S \pi^+\pi^-\pi^+\pi^-$                                                                                                          |
| 6 charged + $\gamma$ 's | $3(\pi^+\pi^-\pi^0)\pi^0$                                                                                                                                                                             |
| Neutral                 | $\pi^0\gamma, \eta\gamma, \pi^0\pi^0\gamma, \pi^0\eta\gamma, \pi^0\pi^0\pi^0\gamma, \pi^0\pi^0\eta\gamma$                                                                                             |
| Other                   | $n\bar{n}, \pi^0 e^+ e^-, \eta e^+ e^-$                                                                                                                                                               |
| Rare decays             | $\eta', D^*(2007)^0, f_1(1285)$                                                                                                                                                                       |

## CMD-3 analysis

| Channel                                                                       | This work (KNT18) | HLMTNT11 [9]      | Difference |
|-------------------------------------------------------------------------------|-------------------|-------------------|------------|
| Chiral perturbation theory (ChPT) threshold contributions                     |                   |                   |            |
| $\pi^0\gamma$                                                                 | $0.12 \pm 0.01$   | $0.12 \pm 0.01$   | 0.00       |
| $\pi^+\pi^-$                                                                  | $0.87 \pm 0.02$   | $0.87 \pm 0.02$   | 0.00       |
| $\pi^+\pi^-\pi^0$                                                             | $0.01 \pm 0.00$   | $0.01 \pm 0.00$   | 0.00       |
| $\eta\gamma$                                                                  | $0.00 \pm 0.00$   | $0.00 \pm 0.00$   | 0.00       |
| Data based channels ( $\sqrt{s} \leq 2$ GeV)                                  |                   |                   |            |
| $\pi^0\gamma$                                                                 | $4.46 \pm 0.10$   | $4.54 \pm 0.14$   | -0.08      |
| $\pi^+\pi^-$                                                                  | $502.99 \pm 1.97$ | $505.77 \pm 3.09$ | -2.78      |
| $\pi^+\pi^-\pi^0$                                                             | $47.82 \pm 0.89$  | $47.51 \pm 0.99$  | 0.31       |
| $\pi^+\pi^-\pi^+\pi^-$                                                        | $15.17 \pm 0.21$  | $14.65 \pm 0.47$  | 0.52       |
| $\pi^+\pi^-\pi^0\pi^0$                                                        | $19.80 \pm 0.79$  | $20.37 \pm 1.26$  | -0.57      |
| $(2\pi^+2\pi^-\pi^0)_{\text{no } \eta}$                                       | $1.08 \pm 0.10$   | $1.20 \pm 0.10$   | -0.12      |
| $3\pi^+3\pi^-$                                                                | $0.28 \pm 0.02$   | $0.28 \pm 0.02$   | 0.00       |
| $(2\pi^+2\pi^-\pi^0)_{\text{no } \eta\omega}$                                 | $1.60 \pm 0.20$   | $1.80 \pm 0.24$   | -0.20      |
| $K^+K^-$                                                                      | $23.05 \pm 0.22$  | $22.15 \pm 0.46$  | 0.90       |
| $K_S^0 K_L^0$                                                                 | $13.05 \pm 0.19$  | $13.33 \pm 0.16$  | -0.28      |
| $K\bar{K}\pi$                                                                 | $2.80 \pm 0.12$   | $2.77 \pm 0.15$   | 0.03       |
| $K\bar{K}2\pi$                                                                | $2.42 \pm 0.09$   | $3.31 \pm 0.58$   | -0.89      |
| $\eta\gamma$                                                                  | $0.70 \pm 0.02$   | $0.69 \pm 0.02$   | 0.01       |
| $\eta\pi^+\pi^-$                                                              | $1.32 \pm 0.06$   | $0.98 \pm 0.24$   | 0.34       |
| $(\eta\pi^+\pi^-\pi^0)_{\text{no } \omega}$                                   | $0.63 \pm 0.15$   | -                 | 0.63       |
| $\eta 2\pi^+2\pi^-$                                                           | $0.11 \pm 0.02$   | $0.11 \pm 0.02$   | 0.00       |
| $\eta\omega$                                                                  | $0.31 \pm 0.03$   | $0.42 \pm 0.07$   | -0.11      |
| $\omega(\rightarrow \pi^0\gamma)\pi^0$                                        | $0.88 \pm 0.02$   | $0.77 \pm 0.03$   | 0.11       |
| $\eta\phi$                                                                    | $0.45 \pm 0.04$   | $0.46 \pm 0.03$   | -0.01      |
| $\phi \rightarrow \text{unaccounted}$                                         | $0.04 \pm 0.04$   | $0.04 \pm 0.04$   | 0.00       |
| $\eta\omega\pi^0$                                                             | $0.42 \pm 0.10$   | -                 | 0.42       |
| $\eta(\rightarrow \text{npp})K\bar{K}_{\text{no } \phi \rightarrow K\bar{K}}$ | $0.01 \pm 0.01$   | -                 | 0.01       |
| $p\bar{p}$                                                                    | $0.07 \pm 0.00$   | $0.06 \pm 0.00$   | 0.01       |
| $n\bar{n}$                                                                    | $0.06 \pm 0.01$   | $0.07 \pm 0.02$   | -0.01      |
| Estimated contributions ( $\sqrt{s} \leq 2$ GeV)                              |                   |                   |            |
| $(\pi^+\pi^-\pi^0)_{\text{no } \eta}$                                         | $0.53 \pm 0.05$   | $0.60 \pm 0.05$   | -0.07      |
| $(\pi^+\pi^-4\pi^0)_{\text{no } \eta}$                                        | $0.25 \pm 0.25$   | $0.28 \pm 0.28$   | -0.03      |
| $K\bar{K}3\pi$                                                                | $0.08 \pm 0.03$   | $0.08 \pm 0.04$   | 0.00       |
| $\omega(\rightarrow \text{npp})2\pi$                                          | $0.10 \pm 0.02$   | $0.11 \pm 0.02$   | -0.01      |
| $\omega(\rightarrow \text{npp})3\pi$                                          | $0.20 \pm 0.04$   | $0.22 \pm 0.04$   | -0.02      |
| $\omega(\rightarrow \text{npp})K\bar{K}$                                      | $0.01 \pm 0.00$   | $0.01 \pm 0.00$   | 0.00       |
| $\eta\pi^+\pi^-\pi^0$                                                         | $0.11 \pm 0.05$   | $0.11 \pm 0.06$   | 0.00       |

# The first analysis with DrSai: R@1.9 GeV

- Exclusive R value measurements at 1.9 GeV
  - Difference between inclusive and exclusive results
- Neglect small processes, still >30 channels, an excellent scenario for DrSai
  - Codes are generated with subAgents simultaneously
  - Strategies are suggested by RAG
  - Only human-AI interaction, no manual coding!

```

> |
>> auto mode on · 25 local agents · i to manage

• main
general-purpose BOSS code gen: bhabha (j2=1) 1/4 to select · Enter to view
general-purpose BOSS code gen: digam (j2=2) 6m 52s · ↓ 69.8k tokens
general-purpose BOSS code gen: dimu (j2=3) 6m 3s · ↓ 73.4k tokens
general-purpose BOSS code gen: eeee (j2=4) 6m 3s · ↓ 75.8k tokens
general-purpose BOSS code gen: eeeta (j2=5) 6m 3s · ↓ 61.9k tokens
general-purpose BOSS code gen: eeeta (j2=5) 6m 3s · ↓ 53.4k tokens
general-purpose BOSS code gen: eetaap (j2=6) 6m 3s · ↓ 50.9k tokens
general-purpose BOSS code gen: eekik (j2=7) 5m 17s · ↓ 31.8k tokens
general-purpose BOSS code gen: eepipi (j2=8) 5m 17s · ↓ 51.8k tokens
general-purpose BOSS code gen: eemumu (j2=9) 5m 17s · ↓ 54.7k tokens
general-purpose BOSS code gen: pi0 gamma (j2=10) 5m 17s · ↓ 56.5k tokens
general-purpose BOSS code gen: eta gamma (j2=11) 5m 17s · ↓ 55.8k tokens
general-purpose BOSS code gen: pi+pi- (j2=12) 5m 17s · ↓ 47.3k tokens
general-purpose BOSS code gen: pi+pi-pi0 (j2=13) 4m 22s · ↓ 48.4k tokens
general-purpose BOSS code gen: pi+pi-pi+pi- (j2=14) 4m 22s · ↓ 49.9k tokens
general-purpose BOSS code gen: pi+pi-pi0pi0 (j2=15) 4m 22s · ↓ 38.5k tokens
general-purpose BOSS code gen: pi+pi-pi+pi-pi0 (j2=16) 4m 22s · ↓ 39.7k tokens
general-purpose BOSS code gen: pi+pi-3pi0 (j2=17) 4m 22s · ↓ 35.7k tokens
general-purpose BOSS code gen: 6pi (j2=18) 4m 22s · ↓ 50.6k tokens
general-purpose BOSS code gen: 4pi2pi0 (j2=19) 3m 18s · ↓ 11.5k tokens
general-purpose BOSS code gen: pipi4pi0 (j2=20) 3m 18s · ↓ 30.3k tokens
general-purpose BOSS code gen: omega eta pi0 (j2=21) 3m 18s · ↓ 38.3k tokens
general-purpose BOSS code gen: K+K- (j2=22) 3m 18s · ↓ 29.2k tokens
general-purpose BOSS code gen: K_S0 K_L0 (j2=23) 3m 18s · ↓ 46.8k tokens
general-purpose BOSS code gen: KKpipi (j2=24) 3m 18s · ↓ 31.5k tokens
general-purpose BOSS code gen: KKpi (j2=25) 3m 18s · ↓ 49.4k tokens

```

| nCharge=2                       |                     |
|---------------------------------|---------------------|
| $\pi^+ \pi^-$                   |                     |
| $\pi^+ \pi^- \pi^0$             | BAM-546             |
| $\pi^+ \pi^- 2\pi^0$            |                     |
| $\pi^+ \pi^- 3\pi^0$            |                     |
| $\pi^+ \pi^- 4\pi^0$            |                     |
| $\pi^+ \pi^- \eta$              |                     |
| $\omega \eta \pi^0$             | BAM-00672           |
| $K^+ K^-$                       |                     |
| $K^+ K^- \pi^0$                 | BAM-376, BAM-655    |
| $K^+ K^- \pi^0 \pi^0$           | BAM-229, BAM-346    |
| $K^+ K^- \pi^0 \pi^0 \pi^0$     | KK3 $\pi \sim 0.08$ |
| $K^+ K^- \eta$                  | $\phi \eta$ dom.    |
| $K_S^0 K_L^0$                   |                     |
| $K_S^0 K_L^0 \pi^0$             | BAM-376, BAM-655    |
| $K_S^0 K_L^0 \pi^0 \pi^0$       |                     |
| $K_S^0 K_L^0 \pi^0 \pi^0 \pi^0$ | KK3 $\pi \sim 0.08$ |
| $K_S^0 K_L^0 \eta$              |                     |

| nCharge=4                                     |                              |
|-----------------------------------------------|------------------------------|
| $2(\pi^+ \pi^-)$                              |                              |
| $2(\pi^+ \pi^-) \pi^0$                        | BAM-416, BAM-596             |
| $2(\pi^+ \pi^-) 2\pi^0$                       |                              |
| $2(\pi^+ \pi^-) 3\pi^0$                       |                              |
| $2(\pi^+ \pi^-) \eta$                         | $\sim 0.11$                  |
| $K^+ K^- \pi^+ \pi^-$                         | BAM-229, BAM-346             |
| $K^+ K^- \pi^+ \pi^- \pi^0$                   | KK3 $\pi \sim 0.08$          |
| $K^+ K^- \pi^+ \pi^- \pi^0 \pi^0$             | $< 3(\pi^+ \pi^-) \sim 0.28$ |
| $K^+ K^- \pi^+ \pi^- \pi^0 \pi^0 \pi^0$       | $< 3(\pi^+ \pi^-) \sim 0.28$ |
| $K^+ K^- \pi^+ \pi^- \eta$                    | $< 0.11 ?$                   |
| $K_S^0 K_L^0 \pi^\mp$                         | BAM-376, BAM-655             |
| $K_S^0 K_L^0 \pi^\mp \pi^0$                   |                              |
| $K_S^0 K_L^0 \pi^\mp \pi^0 \pi^0$             | KK3 $\pi \sim 0.08$          |
| $K_S^0 K_L^0 \pi^\mp \pi^0 \pi^0 \pi^0$       | $< 3(\pi^+ \pi^-) \sim 0.28$ |
| $K_S^0 K_L^0 \pi^\mp \eta$                    |                              |
| $K_S^0 K_L^0 \pi^\mp \pi^-$                   |                              |
| $K_S^0 K_L^0 \pi^\mp \pi^- \pi^0$             | KK3 $\pi \sim 0.08$          |
| $K_S^0 K_L^0 \pi^\mp \pi^- \pi^0 \pi^0$       | $< 0.08$                     |
| $K_S^0 K_L^0 \pi^\mp \pi^- \pi^0 \pi^0 \pi^0$ | $< 0.08$                     |
| $K_S^0 K_L^0 \pi^\mp \pi^- \eta$              | $< 0.11 ?$                   |

| nCharge=0      |  |
|----------------|--|
| $\gamma \pi^0$ |  |
| $\gamma \eta$  |  |

| nCharge=6                                         |                                   |
|---------------------------------------------------|-----------------------------------|
| $3(\pi^+ \pi^-)$                                  | $\sim 0.28$                       |
| $3(\pi^+ \pi^-) \pi^0$                            |                                   |
| $3(\pi^+ \pi^-) \eta$                             | $< 2(\pi^+ \pi^-) \eta \sim 0.11$ |
| $K^+ K^- 2(\pi^+ \pi^-)$                          | $< 3(\pi^+ \pi^-) \sim 0.28$      |
| $K^+ K^- 2(\pi^+ \pi^-) \pi^0$                    | $< 3(\pi^+ \pi^-) \sim 0.28$      |
| $K^+ K^- 2(\pi^+ \pi^-) \eta$                     | $< 2(\pi^+ \pi^-) \eta \sim 0.11$ |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp$             | KK3 $\pi \sim 0.08$               |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp \pi^0$       | $< 0.08$                          |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp \eta$        | $< 0.08$                          |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp \pi^-$       | $< 3(\pi^+ \pi^-) \sim 0.28$      |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp \pi^0 \pi^0$ | $< 3(\pi^+ \pi^-) \sim 0.28$      |
| $K_S^0 K_L^0 \pi^\mp \pi^\mp \pi^\mp \pi^- \eta$  | $< 2(\pi^+ \pi^-) \eta \sim 0.11$ |

# The first analysis with DrSai: R@1.9 GeV

- Exclusive R value measurements at 1.9 GeV

- $R = \sigma^{had} / \sigma^{\mu\mu} = \Sigma R^c$
- $\sigma^{had} = \Sigma \sigma^c, R^c = \sigma^c / \sigma^{\mu\mu}$

- For each exclusive selection:

- $N_{ob,i} = \Sigma N_{ob,i}^c = L \Sigma \epsilon_i^c \sigma^c$
- Select all exclusive channels simultaneously, consider cross feed natually !

$N_{ob,i}^c$  and cross-feed  $\epsilon_i^c$

| 过程       | 信号MC效率 | cross feed 前三个 (算法: 误挑率% 绝对数)                                           |
|----------|--------|-------------------------------------------------------------------------|
| dimu     | 83.44% | KpKm: 90.78%(90,780) · pippim: 85.44%(85,441) · KpKmpi0: 0.49%(492)     |
| gammapi0 | 66.91% | gammaeta: 5.92%(5,920) · KpKm: 1.91%(1,907) · pippim: 1.75%(1,750)      |
| gammaeta | 57.16% | gammapi0: 9.27%(9,268) · KpKm: 2.01%(2,012) · pippim: 1.86%(1,859)      |
| KpKm     | 84.03% | dimu: 21.29%(21,291) · KpKmpi0: 5.54%(5,544) · KpKm2pi0: 0.39%(390)     |
| KpKmeta  | 16.87% | KpKm: 47.81%(47,814) · KpKmpi0: 24.65%(24,649) · KpKm2pi0: 8.74%(8,744) |
| KSKL     | 55.35% | KpKm: 34.67%(34,666) · pippim: 34.15%(34,149) · KSKLpi0: 8.52%(8,515)   |
| KSKLpi0  | 34.20% | KSKL: 46.18%(46,183) · KpKm: 36.08%(36,082) · pippim: 35.85%(35,847)    |
| KSKL2pi0 | 27.74% | KSKLpi0: 39.69%(39,686) · KSKL: 38.66%(38,664) · KpKm: 37.47%(37,472)   |
| KSKLeta  | 18.46% | KSKL: 39.49%(39,488) · KpKm: 38.70%(38,697) · pippim: 38.49%(38,490)    |
| 4pi      | 56.16% | KpKm: 4.84%(4,837) · pippim: 4.85%(4,847) ·                             |

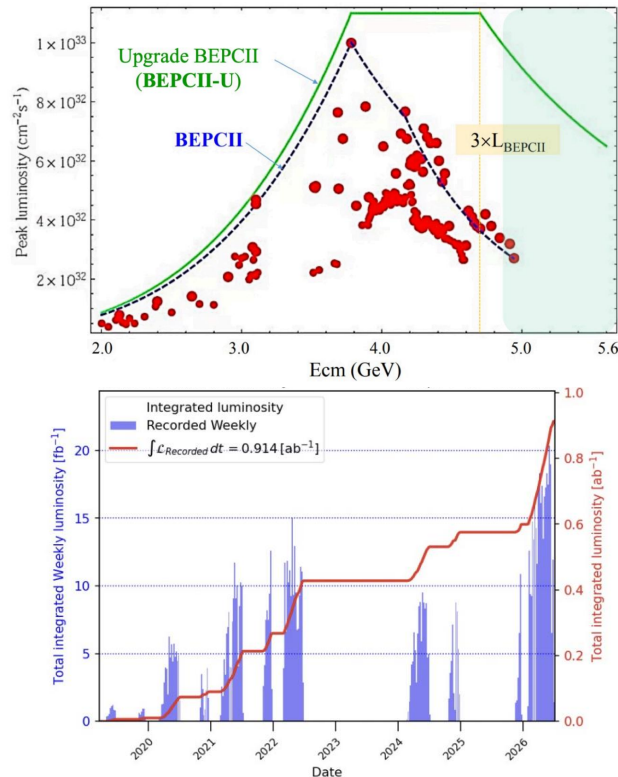


isospin sym.

R value

# DrSai for charmonium(-like) study

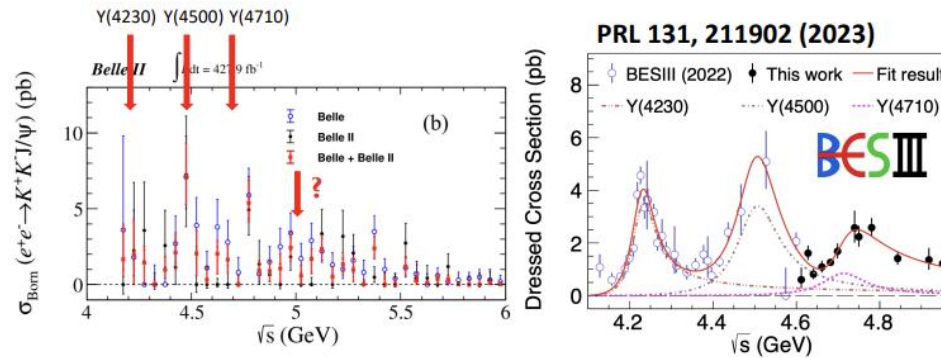
- Fully automatically repetition with a complete DSL
  - No human-AI interaction
  - repeat/update analysis with BESIII's upcoming XYZ-scan points, BelleII's increased statistics ...



PRD 113, 112010 (2026)

$e^+e^- \rightarrow K^+K^-J/\psi$  via ISR:

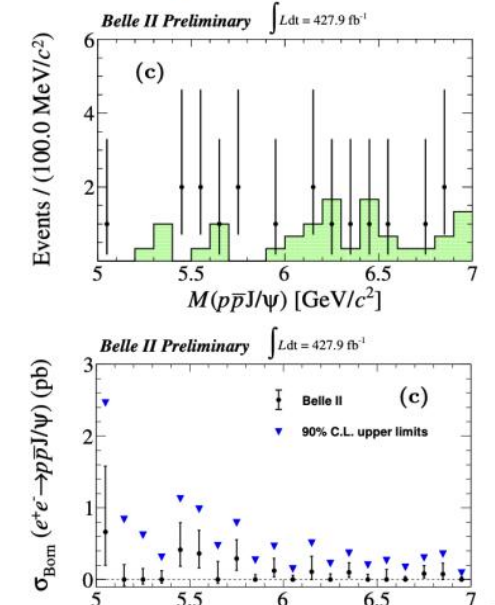
(from Sen Jia's talk)



- No clear signals were observed at Belle II.
- More data are needed.

$e^+e^- \rightarrow p\bar{p}/\psi$  via ISR:

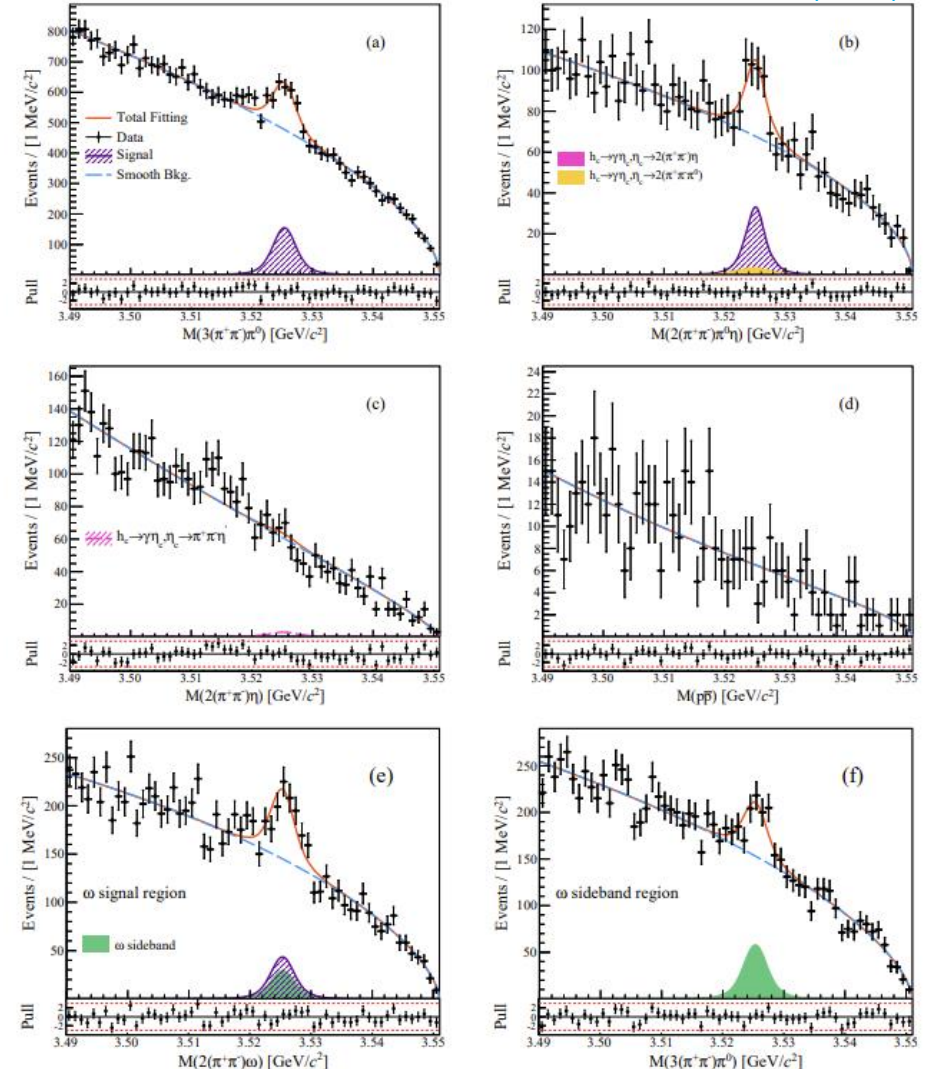
The cross section for  $e^+e^- \rightarrow p_c\bar{p}$  is estimated to be  $\lesssim \mathcal{O}(0.1 \text{ pb})$  [PLB 872 (2026) 140007].



# DrSai for charmonium(-like) study

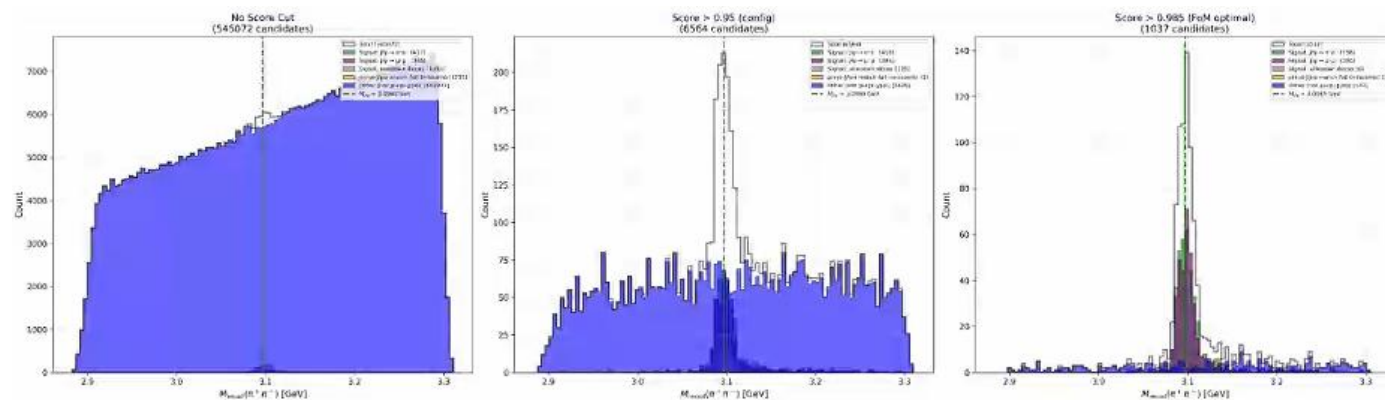
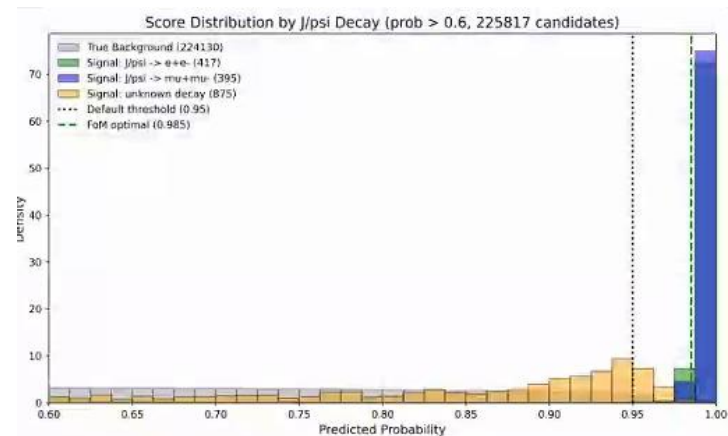
- A set of exclusive analyses, to search for unknown decay modes, and to improve the precision up to the current experimental sensitivity limits.
  - $\text{Br}(h_c \rightarrow \text{light hadrons})$  to be  $(8.8 \pm 0.8)\%$  and  $(48 \pm 7)\%$  with the perturbative QCD(PQCD) and non-relativistic QCD (NRQCD) [PRD 65, 094024 (2002)]
  - $\text{Br}(h_c \rightarrow \text{ggg}) = 57\%$  based on QCD calculations [PRD 66, 014012 (2002)]

PRD 109, 072018 (2024)



# DrSai for charmonium(-like) study

- More complex jobs:
  - PWA
    - With amplitudes written with AI
    - Based on available PWA packages
  - Build ML-based selection, no need of the knowledge of ML
    - Build user-friendly skills
    - To improve efficiencies of  $J/\psi, \eta_c \dots$



$e^+e^- \rightarrow \pi^+\pi^-J/\psi$  training

# Summary & Outlook

- We release DrSai v3: General-purpose Agent+DSL+Skills+RAG
  - [https://code.ihep.ac.cn/liutong2016/DrSai\\_v3](https://code.ihep.ac.cn/liutong2016/DrSai_v3)
- Training: May@IHEP, Aug.@Shenzhen
- AI partner and agent-based analysis is being realized today
  - Only human-AI interaction, no manual coding
    - Fully automatically repetition
    - Developing agents to replace more human-AI interactions.
  - 10~30 CNY per channel (deepseek-v4-pro)
  - Ability is tested, the first analysis is ongoing

**Agentic AI**

**在科研中的案例实训**

**时间:** 2026年5月21日 (周四)  
上午 9:00-12:00 下午 14:00-17:00  
**地点:** 北京主楼C305、东莞A1-301会议室  
济南103会议室  
**线上:** #腾讯会议: 644-777-502

**Quantum Computing AND Machine Learning WORKSHOP**

**DATE:** Aug 16 - 20, 2026  
**VENUE:** Sun Yat-sen University, Shenzhen Campus - Guangdong, China

**WORKSHOP OBJECTIVES**

- Exchange progress and practical experience in AI, quantum computing, and advanced computing for high-energy physics and related fields.
- Review key advances in AI and quantum technologies, and discuss their applications in high-energy physics.
- Strengthen the domestic community through cross-institution collaboration and a healthy research ecosystem.
- Organize challenge-style benchmark tasks to promote reproducible and comparable methods.

**ADVISORY COMMITTEE**

|               |      |              |        |               |      |
|---------------|------|--------------|--------|---------------|------|
| Jun Cao       | IHEP | Xiaocong Ai  | ZZU    | Huulin Qu     | SJTU |
| Gang Chen     | IHEP | Tianji Cai   | Tongji | Mangqi Ruan   | IHEP |
| Xingtao Huang | SDU  | Xun Chen     | SJTU   | Hongtao Yang  | USTC |
| Weldong Li    | IHEP | Conggao Li   | PKU    | Junhao Yin    | NKU  |
| Xiaonui Lyu   | UCAS | Teng Li      | SDU    | Rui Zhang     | NJU  |
| Fazhi Qi      | IHEP | Yingying Li  | IHEP   | Zhengde Zhang | IHEP |
| Shengsen Sun  | IHEP | Tao Lin      | IHEP   | Chen Zhou     | PKU  |
| Hongxi Xing   | SOMU | Hideki Okawa | IHEP   | Qidong Zhou   | SDU  |

**SCIENTIFIC PROGRAM COMMITTEE**

**LOCAL ORGANIZING COMMITTEE**

|              |      |
|--------------|------|
| Jingde Chen  | IHEP |
| Ke Li        | IHEP |
| Bingxuan Liu | SYSU |
| Tong Liu     | IHEP |
| Yang Liu     | SYSU |
| Liaoshan Shi | IHEP |
| YanJun Tu    | HGU  |
| Jin Zhang    | SYSU |

**INDICO - REGISTRATION**

<https://indico.ihep.ac.cn/event/29676/>  
Workshop category, registration, and updates

**INDICO QR**

Scan for registration Indico page

Fourth Quantum Computing and Machine Learning Workshop - 2026  
School of Science, Sun Yat-sen University, Shenzhen, Guangdong, China

SUN YAT-SEN UNIVERSITY

# Thank you!