Predictions from analytic parametrisations at $t = 0$

J.R. Cudell

September 4, 2002

in collaboration with :
V.V. Ezhela, P. Gauron, K. Kang, Yu.V. Kuyanov, S.B. Lugovsky, E. Martynov, B. Nicolescu, E.A. Razuvaev, N.P. Tkachenko

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(COMPETE collaboration)

COmputerised
Models and
Parameter
Evaluation for
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COmputerised Models and Parameter Evaluation for Theory and Experiment

Collaboration to create phenomenological knowledge bases in particle physics. So far, results for forward hadronic scattering (this talk) and $\sigma^{e^+e^-}$.

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Talk based on the ideas and methods of the following papers:

- *Benchmarks for the forward observables at RHIC, the Tevatron-run II and the LHC*, hep-ph/0206172, accepted by Phys. Rev. Letters.
- *Review of particle physics*, Particle Data Group (K. Hagiwara et al.), Phys. Rev. D **66**, 010001 (2002).
- *Hadronic scattering amplitudes: medium-energy constraints on asymptotic behaviour*, Phys. Rev. D **65**, 074024 (2002).

Questions

- What are the best models describing soft forward data?
- What should be measured?
- What are the best predictions?

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Outline

+ Motivation
+ Tools
+ Results on models and data
+ Predictions

Motivation

Cure the high degree of arbitrariness in the phenomenology

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- Excessive focus on pp and $\bar{p}p$ scattering;
- Excessive focus on total cross sections;
- Fundamental physical constraints mixed with ad-hoc properties;
- Dataset varies from author to author;
- Cut-off in energy $\sqrt{s_{min}}$ varies from author to author;
- No attention paid to the stability of the parameters when some data are excluded or when $\sqrt{s_{min}}$ is varied.

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- No attention paid to the stability of the parameters when some data are excluded or when $\sqrt{s_{min}}$ is varied.

$\Rightarrow$ Provide a common test ground for a variety of models and judge them according to the same criteria.

Tools

- Theoretical (non perturbative):
  - ⋆ analyticity, crossing symmetry, unitarity, positivity;
  - ⋆ Regge relation between poles and resonance masses.

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- Experimental (COMPAS database):
  - ⋆ use both σ_{tot} and ρ;
  - ⋆ all data pp, $\bar{p}p$, $\pi^{\pm}p$, $K^{\pm}p$, $\Sigma^{-}p$, γp, $\gamma\gamma$.

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- Computer technology:
  - ⋆ all fits running through a common minimization procedure under Mathematica, crossed-checked by MINUIT fortran codes;
  - ⋆ artificial intelligence criteria;
  - ⋆ web predictor at http://www.ihep.su/˜tka4ehko/CS/MODELS and web interface at http://sirius.ihep.su/˜kuyanov/OK/eng/intro.html.

Theoretical tools

Theoretical tools

Analyticity:

$$\sigma_{tot}(s) = \frac{1}{s}\Im m\left[A(s,0)\right] \Leftrightarrow \rho(s) = \frac{\Re e\left[A(s,0)\right]}{\Im m[A(s,0)]},$$

but this works only if one knows either function exactly. Experimental and theoretical uncertainties → infinite number of possibilities.

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Unitarity

Polynomial boundedness of absorptive part in Lehmann ellipse ⇒

$$\sigma_{tot}(s) \le C \log^2 \frac{s}{s_0} \quad as \quad s \to \infty \quad \text{(Froissart-Martin)}$$

$C \simeq \frac{\pi}{m_\pi^2} \simeq 60$ mb (Lukaszuk-Martin) ⇒ 1 barn at the Tevatron.

Regge trajectories

The leading meson trajectories are seen in a Chew-Frautschi plot$\Rightarrow$ Their intercepts can be measured directly

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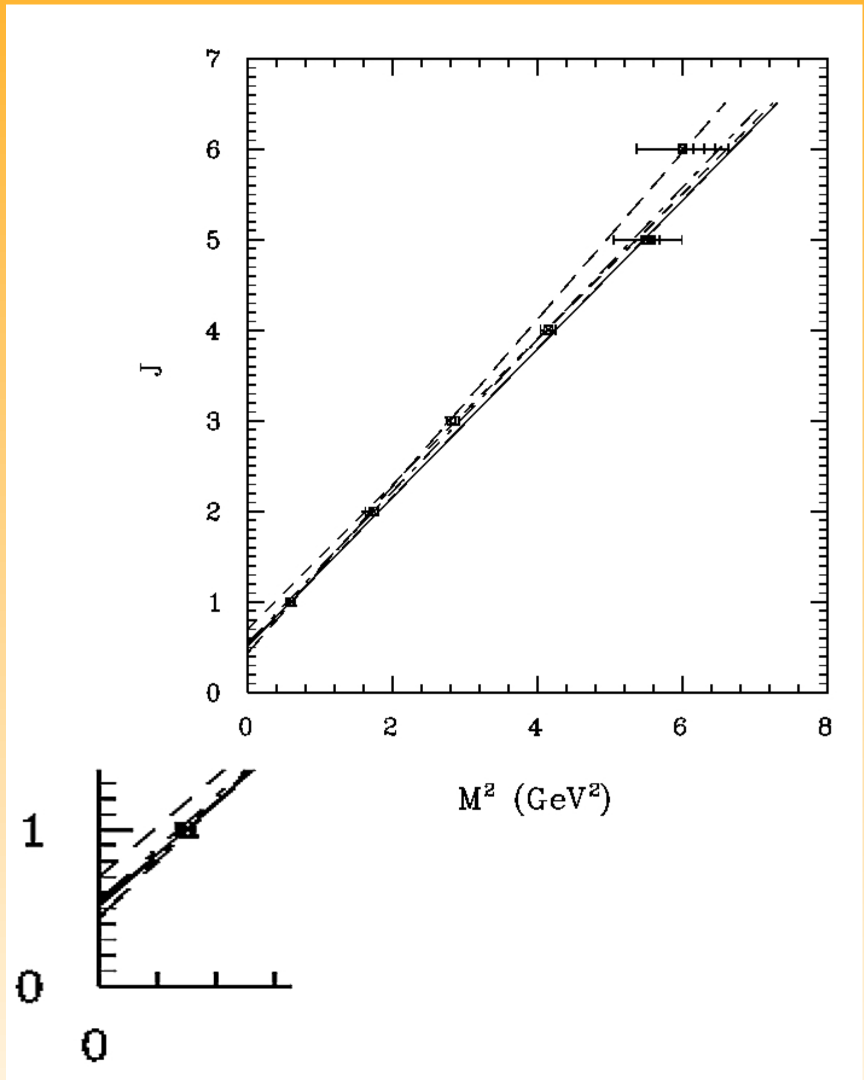

Intercepts≈ 0.5
Are the trajectories degenerate?
Are they linear?

Positivity

All total cross sections must be positive.

Zweig's rule $\rightarrow$ the pomeron contribution must be positive.

Small violation of Zweig's rule are possible
$\rightarrow$ only the $C = +1$ part of cross sections must be bigger than the $C = -1$ part.

Experimental data

- Need for renewed updates to the database;

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Problems:

⋆ Huge gap between the ISR and the S$p\bar{p}$S;

⋆ Contradictory data, $e.g.$ at the Tevatron;

⋆ Poor quality of some of the ρ data.

Computer tools

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Classification of models

$$\sigma_{tot}^{ab}(s) = Y^{ab}(s) + H^{ab}(s)$$

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- contribution Y^{ab} of the highest meson trajectories (ρ, ω, a and f)

$$Y^{ab} = Y_+^{ab}\,(s)^{\alpha_+ - 1} \pm Y_-^{ab}\,(s)^{\alpha_- - 1} \rightarrow RR$$

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$$Y^{ab} = Y_+^{ab}(s)^{\alpha_+ - 1} \pm Y_-^{ab}(s)^{\alpha_- - 1} \rightarrow RR$$

- rising $C = +1$ term H^{ab} from the pomeron contribution

$$H^{ab} = P^{ab} + X^{ab}(s)^{\alpha_{\mathcal{P}} - 1} \rightarrow PE$$
$$H^{ab} = P^{ab} + B^{ab} \ln(s/s_0) \rightarrow PL$$
$$H^{ab} = P^{ab} + B^{ab} \ln^2(s/s_0) \rightarrow PL2$$

Possible constraints on the parameters:

- ⋆ degeneracy of the reggeon trajectories ($\alpha_+ = \alpha_-$) $\longrightarrow$ $_d$
- ⋆ universality of rising terms (B^{ab} independent of the hadrons)$\longrightarrow$ $_u$
- ⋆ factorization for $\gamma\gamma$ and γp ($H_{\gamma\gamma} = \delta H_{\gamma p} = \delta^2 H_{pp}$)$\longrightarrow$ $_{nf}$ if absent
- ⋆ quark counting rules (Σp from pp, Kp and πp)$\longrightarrow$ $_{qc}$
- ⋆ Johnson-Treiman-Freund relation for the cross section differences$\longrightarrow$ $_c$

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- ⋆ quark counting rules (Σp from pp, Kp and πp)$\longrightarrow_{qc}$
- ⋆ Johnson-Treiman-Freund relation for the cross section differences$\longrightarrow_c$

256 possibilities among which:

- Donnachie-Landshoff $= (RR)_d E$
- Cudell-Kang-Kim $= RRE$
- Gauron-Nicolescu $= (RR)_d PL2_u$
- Desgrolard-Giffon-Lengyel-Martynov-Predazzi$= RRPL$
- Bourrely-Soffer-Wu or other eikonals $= RRL2$ asymptotically

Dataset

Reaction	Number of data points for $\sqrt{s} \geq 5$ GeV
σ_{pp}	112
$\sigma_{\overline{p}p}$	59
σ_{π^+p}	50
σ_{π^-p}	106
σ_{K^+p}	40
σ_{K^-p}	63
σ_{Σ^-p}	9
$\sigma_{\gamma p}$	38
$\sigma_{\gamma\gamma}$	30
ρ_{pp}	74
$\rho_{\overline{p}p}$	11
ρ_{π^+p}	8
ρ_{π^-p}	30
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$\sqrt{s_{min}}$	Total number of data points
3 GeV	904
4 GeV	742
5 GeV	648
6 GeV	569
7 GeV	498
8 GeV	453
9 GeV	397
10 GeV	329

Criteria for A.I. decisions: ACCURRSS scheme

$$sets = \{observable\,(\sigma \; or \; \rho), beam, target\}$$

A pplicability: range in energy over which a model M is valid (global fit with CL $> 50\%$).

$$A^M = \frac{1}{N_{sets}} \sum_j w_j^M \log\left(\frac{E_j^{M,high}}{E_j^{M,low}}\right) \text{with } w_j^M = \min\left(1, \frac{1}{\chi^2/nop}\right);$$

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C onfidence-1: within the area of applicability of M: $C_1^M = CL(\%)$

C onfidence-2: within the considered range of energy: $C_2^M = CL(\%)$

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C onfidence-1: within the area of applicability of M: $C_1^M = CL(\%)$

C onfidence-2: within the considered range of energy: $C_2^M = CL(\%)$

U niformity: variation of the χ^2/nop from set to set:

$$U^M = \left\{\frac{1}{N_{sets}} \sum_j \frac{1}{4w_j^M}\left[\frac{\chi^2}{N_{nop}} - \frac{\chi^2(j)}{N_{nop}^j}\right]^2\right\}^{-1}$$

R igidity: number of parameters compared to the number of data points where the model is applicable:

$$R_1^M = \frac{N_{nop}^M}{1 + N_{par}^M}$$

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$$R_2^M = \frac{2}{N_{par}(N_{par} - 1)} \cdot \sum_{i>j=1}^{N} \Theta(90.0 - C_{ij})$$

where C_{ij} is the correlation matrix element in $\%$ calculated in the fit at the low edge of the applicability area.

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S tability-1: stability of the parameter values P_i when one varies the minimum energy of the fit.

$$S_1^M = \frac{N_{steps} N_{par}^M}{\sum_{steps,ij} (P_i - P_i^{step})(W^t + W^{step})_{ij}^{-1} (P_j - P_j^{step})}$$

where $step = 1$ GeV shift of $\sqrt{s_{min}}$ and W^t and W^{step} are the error matrices.

S tability-2: stability of the parameter values P_i when one removes the ρ data ($o = 1$ with ρ, $o = 0$ without).

$$S_2^M = \frac{2N_{par}^M}{\sum_{o,ij}(P_i - P_i^o)(W^t + W^o)_{ij}^{-1}(P_j - P_j^o)}$$

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Rank→ number of points attributed to one model when comparing its indicators to those of the other models. Higher rank=better model.

Results

- Models
  - ⋆ excluded models;
  - ⋆ best models.

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  - ⋆ excluded models;
  - ⋆ best models.
- Data
  - ⋆ quality of the parts of the data sample;
  - ⋆ the Tevatron data;
  - ⋆ the cosmic ray data.

Excluded models

χ^2/dof, ρ **data excluded.**

Model	$\sqrt{s_{min}}$ in GeV				
	3	4	5	6	7
RRE	1.38	1.15	0.91	0.87	0.89
RRPL	1.33	0.98	0.85	0.83	0.87
RRL2	1.33	1.05	0.88	0.85	0.91
$RRPL2_u$	1.26	0.97	0.81	0.79	0.82
$(RR)^d$ P $L2_u$	1.27	0.99	0.82	0.80	0.83

χ^2/dof, ρ data included.

Model	$\sqrt{s_{min}}$ in GeV				
	4	5	6	8	10
RRE	1.38	1.12	1.10	1.05	1.02
RRPL	1.11	0.98	0.98	0.94	0.91
RRL2	1.34	1.11	1.10	1.06	1.00
RRPL2_u	1.14	0.97	0.97	0.92	0.92
$(\mathrm{RR})^d$ P L2_u	1.26	0.99	0.99	0.93	0.93

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$(RR)^d$ P L2_u	1.26	0.99	0.99	0.93	0.93

– All models based on one simple-pole are excluded by the ρ data $if\ \sqrt{s_{min}} \leq 10\ GeV$. (21 models survive out of 256)

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– All models based on one simple-pole are excluded by the ρ data *if* $\sqrt{s_{min}} \leq 10$ GeV. (21 models survive out of 256)

+ For $\sqrt{s_{min}} = 5$ GeV, 4 models survive: RRPL2_u, RRP$_{nf}$L2_u, (RR)$_d$PL2_u and RRPL.

Other excluded models

– String picture: J. A. Feigenbaum, P. G. Freund and M. Pigli, Phys. Rev. **D 56** (1997) 2596 [hep-ph/9703296].

– Two-component pomeron: H. J. Lipkin, Phys. Rev. **D 11** (1975) 1827; H. J. Lipkin, [hep-ph/9911259].

χ^2/dof, ρ data excluded

Model	$\sqrt{s_{min}}$ in GeV			
	3	5	7	9
FFP-97	101	3.28	2.3	2.34
Lipkin TCP	4.63	2.54	2.86	3.48

Best model(s)

without ρ, $\sqrt{s_{min}} = 5$ GeV:

	A	C_1	C_2	U	R_1	R_2	S_1
RRE	2.6	92	81	51	25	0.88	0.18
RRPL	2.0	54	100	33	19	0.67	0.22
RRL2	2.6	98	87	85	27	0.90	0.20
RRPL2_u	2.5	68	100	34	26	0.91	0.01
(RR)^{d}PL2_u	2.5	55	100	44	28	0.88	0.11

Best model(s)

without ρ, $\sqrt{s_{min}} = 5$ GeV:

	A	C_1	C_2	U	R_1	R_2	S_1
RRE	2.6	92	81	51	25	0.88	0.18
RRPL	2.0	54	100	33	19	0.67	0.22
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RRPL2_u	2.5	68	100	34	26	0.91	0.01
$(RR)^d$PL2_u	2.5	55	100	44	28	0.88	0.11

with ρ, $\sqrt{s_{min}} = 9$ GeV:

	A	C_1	C_2	U	R_1	R_2	S_1	S_2
RRPL	2.3	67	82	26	29	0.75	0.21	1.14
RRL2	1.7	63	63	11	21	0.90	1.4	2.7
RRPL2_u	2.2	68	85	23	30	0.90	0.22	0.10
$(RR)^d$PL2_u	2.0	50	83	16	32	0.88	0.30	0.67

$\Rightarrow$ "league competition" between models, with equal weight to all indicators.

and the winners are:

(for $\sqrt{s} \geq 10$ GeV, and including ρ data.)

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Model Code	A	C_1	C_2	U	R_1	R_2	S_1	S_2	Rank
$\mathrm{RRPL2}_u$	42	26	42	42	34	28	12	4	230
$\mathrm{RRP}_{nf}\mathrm{L2}_u$	44	36	44	40	15	31	10	2	222
$\mathrm{RRL}_{nf}{}^*$	30	42	26	24	34	18	18	30	222

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$\mathrm{RRPL2}_u$	42	26	42	42	34	28	12	4	230
$\mathrm{RRP}_{nf}\mathrm{L2}_u$	44	36	44	40	15	31	10	2	222
$\mathrm{RRL}_{nf}{}^*$	30	42	26	24	34	18	18	30	222
$(\mathrm{RR}_c)^d\ \mathrm{PL2}_u$	34	20	36	20	28	24	28	14	204
$(\mathrm{RR})^d\ \mathrm{PL2}_u$	40	8	40	22	34	22	16	12	194
$\mathrm{R}^{qc}\mathrm{R}_c\ \mathrm{L}^{qc}$	14	32	18	10	42	6	24	38	184
$(\mathrm{RR}_c)^d\mathrm{P}^{qc}\mathrm{L2}_u$	20	16	10	36	19	36	22	22	181
$(\mathrm{RR})^d\mathrm{P}^{qc}\mathrm{L2}_u$	18	14	8	38	8	38	30	26	180
$\mathrm{RR}_c\ \mathrm{L2}^{qc}$	6	30	6	4	6	44	44	40	180
$(\mathrm{RR})^d\ \mathrm{PL2}^*$	38	2	28	32	25	31	14	8	178
$(\mathrm{RR})^d\ \mathrm{PL2}_u$	36	0	34	18	30	26	20	10	174
RRPL^*	2	34	32	44	15	16	6	24	173
$\mathrm{RR}_c\ \mathrm{L}^{qc}$	24	38	24	8	10	4	32	32	172
$\mathrm{RRL2}^{qc}$	10	28	4	2	2	42	40	42	170
$\mathrm{R}^{qc}\mathrm{R}_c\ \mathrm{L2}^{qc}$	12	18	0	6	22	40	38	34	170
RRL^{qc}	28	6	20	30	44	12	4	18	162
RRPE_u	22	44	12	16	4	20	34	6	158
$\mathrm{R}^{qc}\mathrm{RL}^{qc}$	16	24	14	12	19	14	36	20	155
RRL2	8	22	2	0	0	34	42	44	152
$\mathrm{RR}_c\mathrm{PL}$	4	12	38	14	12	0	26	36	142
RRL	26	10	16	26	39	8	8	0	133

Quality of the dataset: $\chi^2/point$

Reaction/Model	RRPL2u	RRPL	RRE
σ_{pp}	0.872	0.866	0.889
$\sigma_{\overline{p}p}$	1.20	1.01	1.12
σ_{π^+p}	0.785	0.779	1.43
σ_{π^-p}	0.888	0.895	0.883
σ_{K^+p}	0.706	0.723	1.01
σ_{K^-p}	0.614	0.619	0.719
σ_{Σ^-p}	0.376	0.376	0.385
$\sigma_{\gamma p}$	0.602	0.752	0.586
$\sigma_{\gamma\gamma}$	0.517	0.947	0.552
ρ_{pp}	1.74	1.57	1.76
$\rho_{\overline{p}p}$	0.548	0.468	0.599
ρ_{π^+p}	1.45	1.59	2.71
ρ_{π^-p}	1.16	1.268	2.11
ρ_{K^+p}	1.16	1.11	0.833
ρ_{K^-p}	0.966	1.24	1.77

No model can fit the real part of the pp and πp amplitudes (see next talk by Selyugin). These data are those that exclude simple poles.

The Tevatron data

χ^2/dof using the database of the 2002 Review of Particle Physics $+$new ZEUS data $+$ best model RRPL2$_u$.

The Tevatron data

χ^2/dof using the database of the 2002 Review of Particle Physics +new ZEUS data + best model RRPL2_u.

Data with a change in χ^2	all	E710/E811 only	CDF only
total	0.966	0.964	0.951
total cross sections			
$\overline{p}p$	1.15	1.12	1.05
K^-p	0.62	0.62	0.61
$\gamma\gamma$	0.64	0.64	0.63
elastic forward Re/Im			
$\overline{p}p$	0.52	0.52	0.53
pp	1.83	1.83	1.80
π^-p	1.10	1.09	1.14
π^+p	1.50	1.52	1.46
K^-p	0.99	1.01	0.96
K^+p	1.07	1.10	0.98
values of the parameter B			
	0.307(10)	0.301(10)	0.327(10)

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K^-p	0.62	0.62	0.61
$\gamma\gamma$	0.64	0.64	0.63
elastic forward Re/Im			
$\overline{p}p$	0.52	0.52	0.53
pp	1.83	1.83	1.80
π^-p	1.10	1.09	1.14
π^+p	1.50	1.52	1.46
K^-p	0.99	1.01	0.96
K^+p	1.07	1.10	0.98
values of the parameter B			
	0.307(10)	0.301(10)	0.327(10)

$\Rightarrow$ Preference for the CDF data. *Similar conclusion in the case of simple poles.*

Cosmic ray data

Data samples:

- original experimental (R. M. Baltrusaitis *et al.*, Phys. Rev. Lett. **52** (1984) 1380; M. Honda *et al.*, Phys. Rev. Lett. **70** (1993) 525.);
- corrected by Nikolaev et al. (B. Z. Kopeliovich, N. N. Nikolaev and I. K. Potashnikova, Phys. Rev. **D 39** (1989) 769; N. N. Nikolaev, Phys. Rev. **D 48** (1993) 1904 [hep-ph/9304283].) ;
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	Experiment		+30 mb Nikolaev et al.		-20 mb Block et al.	
Model	χ^2	χ^2/N_{dp}	χ^2	χ^2/N_{dp}	χ^2	χ^2/N_{dp}
$\mathrm{RRPL2}_u$	1.62	0.23	14.31	2.04	3.30	0.47
RRPL	2.93	0.42	25.56	3.64	2.34	0.33
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$\Rightarrow$ original experimental analysis favoured

Predictions

- RHIC
- Tevatron run II
- LHC
- cosmic rays

RHIC, Tevatron Run II and the LHC

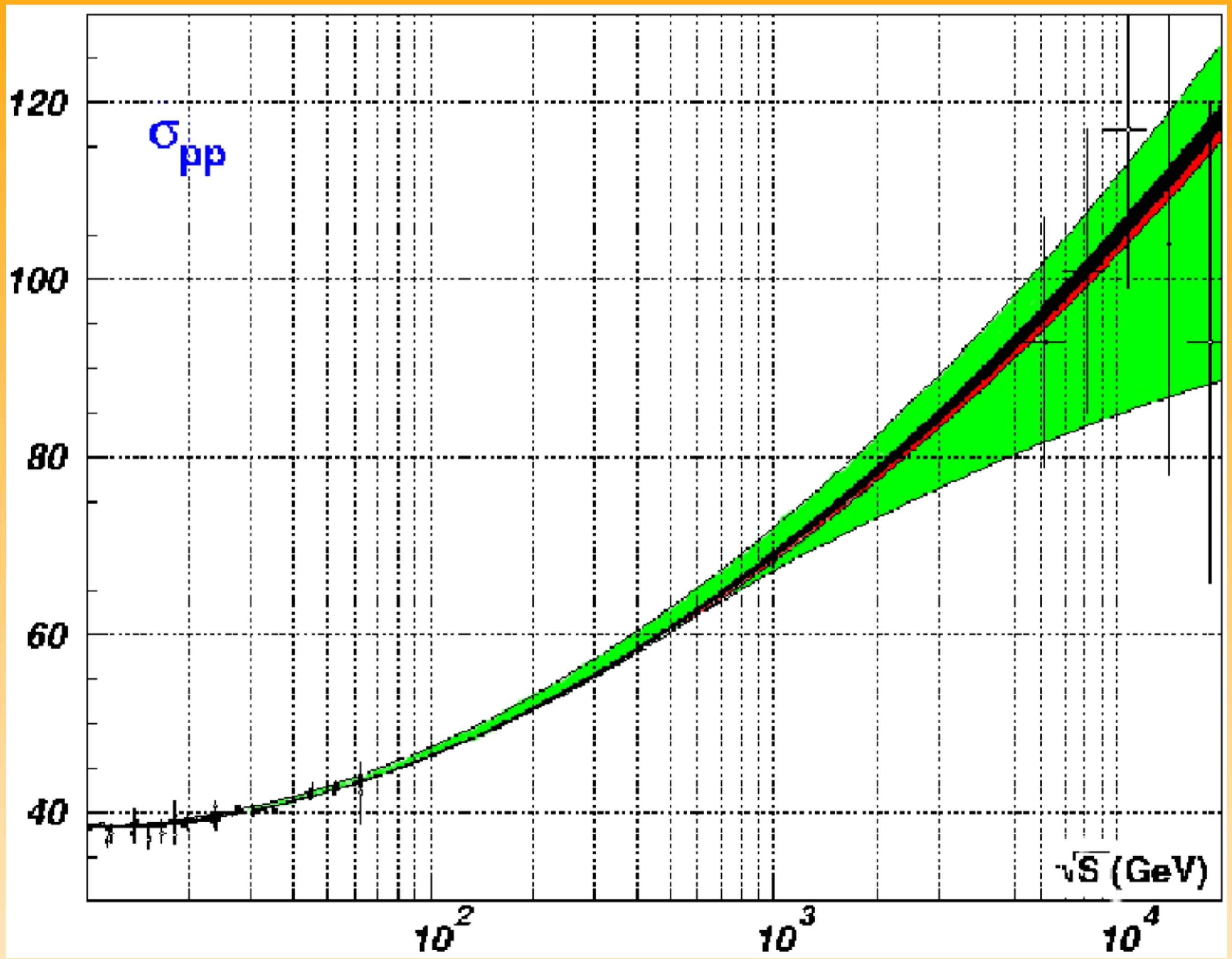
RRPL2$_u$ *value*
$\pm$*statistical*
$\pm$*Tevatron disagreement*

$\sqrt{s}$ (GeV)	σ (mb)		ρ	
100	46.37 ± 0.06	$^{+0.17}_{-0.09}$	0.1058 ± 0.0012	$^{+0.0040}_{-0.0021}$
200	51.76 ± 0.12	$^{+0.39}_{-0.21}$	0.1275 ± 0.0015	$^{+0.0051}_{-0.0026}$
300	55.50 ± 0.17	$^{+0.57}_{-0.30}$	0.1352 ± 0.0016	$^{+0.0055}_{-0.0028}$
400	58.41 ± 0.21	$^{+0.71}_{-0.36}$	0.1391 ± 0.0017	$^{+0.0056}_{-0.0030}$
500	60.82 ± 0.25	$^{+0.82}_{-0.45}$	0.1413 ± 0.0017	$^{+0.0057}_{-0.0030}$
600	62.87 ± 0.28	$^{+0.94}_{-0.48}$	0.1416 ± 0.0018	$^{+0.0058}_{-0.0031}$
1960	78.27 ± 0.55	$^{+1.85}_{-0.96}$	0.1450 ± 0.0018	$^{+0.0057}_{-0.0030}$
10000	105.1 ± 1.1	$^{+3.6}_{-1.9}$	0.1382 ± 0.0016	$^{+0.0047}_{-0.0027}$
12000	108.5 ± 1.2	$^{+3.8}_{-2.0}$	0.1371 ± 0.0015	$^{+0.0046}_{-0.0026}$
14000	111.5 ± 1.2	$^{+4.1}_{-2.1}$	0.1361 ± 0.0015	$^{+0.0058}_{-0.0025}$

RHIC, Tevatron Run II and the LHC

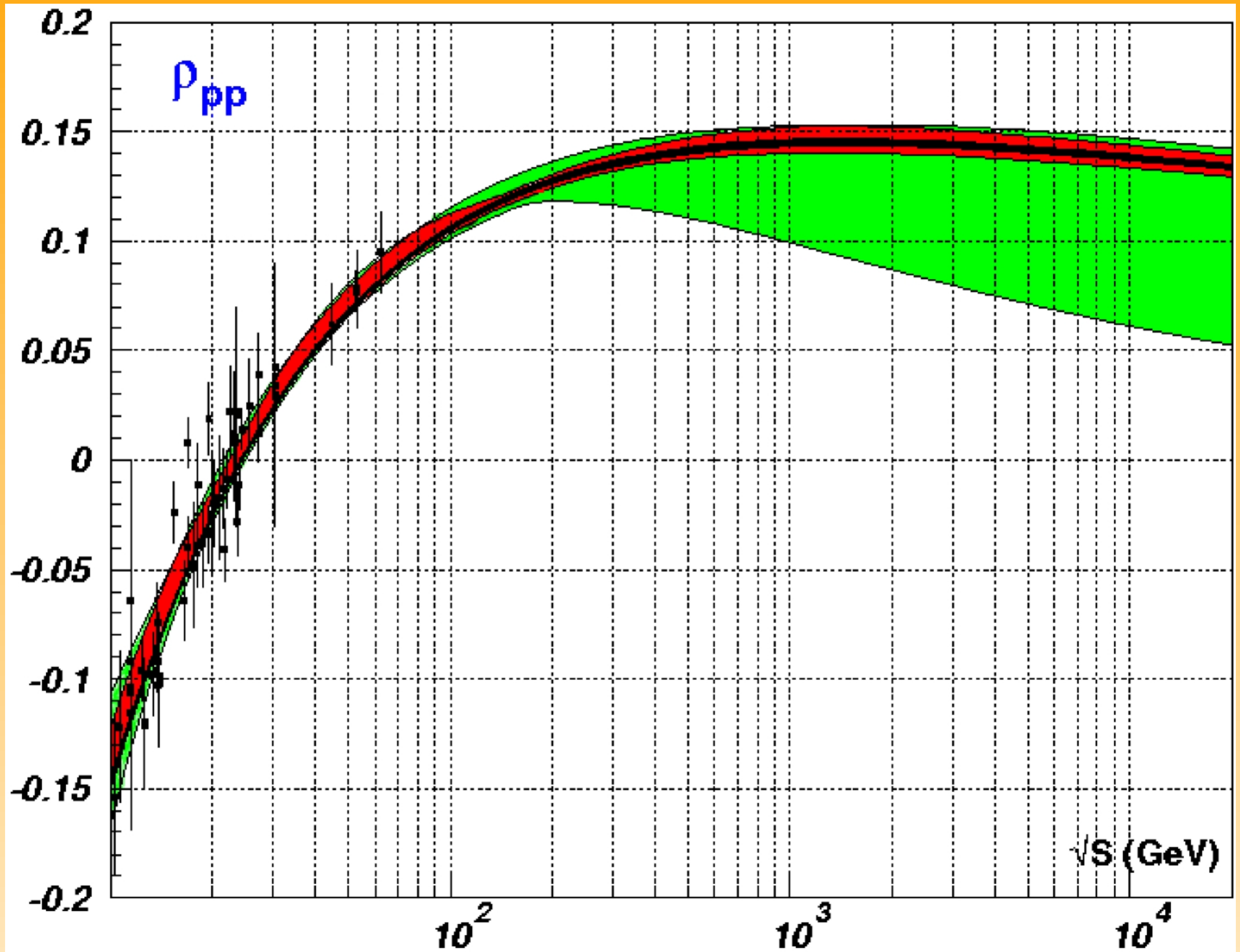
Theoretical error

$\sqrt{s}$ (GeV)	σ (mb)		ρ	
100	46.369 ± 0.068	$^{+0.301}_{-0.047}$	0.1047 ± 0.0013	$^{+0.0034}_{-0.0007}$
200	51.70 ± 0.13	$^{+0.48}_{-0.08}$	0.1260 ± 0.0017	$^{+0.0008}_{-0.0006}$
300	55.39 ± 0.18	$^{+0.49}_{-0.08}$	0.1335 ± 0.0019	$^{+0.0013}_{-0.0039}$
400	58.25 ± 0.22	$^{+0.43}_{-0.06}$	0.1373 ± 0.0021	$^{+0.0016}_{-0.0065}$
500	60.62 ± 0.26	$^{+0.34}_{-0.04}$	0.1395 ± 0.0022	$^{+0.0019}_{-0.0086}$
600	62.64 ± 0.30	$^{+0.24}_{-0.01}$	0.1409 ± 0.0023	$^{+0.0021}_{-0.0102}$
1960	77.78 ± 0.63	$^{+0.48}_{-1.39}$	0.1435 ± 0.0027	$^{+0.0028}_{-0.0202}$
10000	104.1 ± 1.4	$^{+1.3}_{-7.0}$	0.1368 ± 0.0028	$^{+0.0030}_{-0.0298}$
12000	107.5 ± 1.5	$^{+1.4}_{-7.9}$	0.1358 ± 0.0028	$^{+0.0030}_{-0.0306}$
14000	110.4 ± 1.6	$^{+1.5}_{-8.7}$	0.1348 ± 0.0028	$^{+0.0030}_{-0.0311}$



theoretical uncertainty from 21 allowed models
Tevatron uncertainty

statistical uncertainty



theoretical uncertainty from 21 allowed models
Tevatron uncertainty

statistical uncertainty

Cosmic rays

σ_{tot} for $\gamma p \rightarrow hadrons$, RRPL2$_u$

p_{lab}^{γ} (GeV)	σ (mb)	
$1.0 \cdot 10^6$	0.262 ± 0.010	$^{+0.013}_{-0.011}$
$1.0 \cdot 10^7$	0.333 ± 0.016	$^{+0.021}_{-0.017}$
$1.0 \cdot 10^9$	0.516 ± 0.029	$^{+0.042}_{-0.032}$

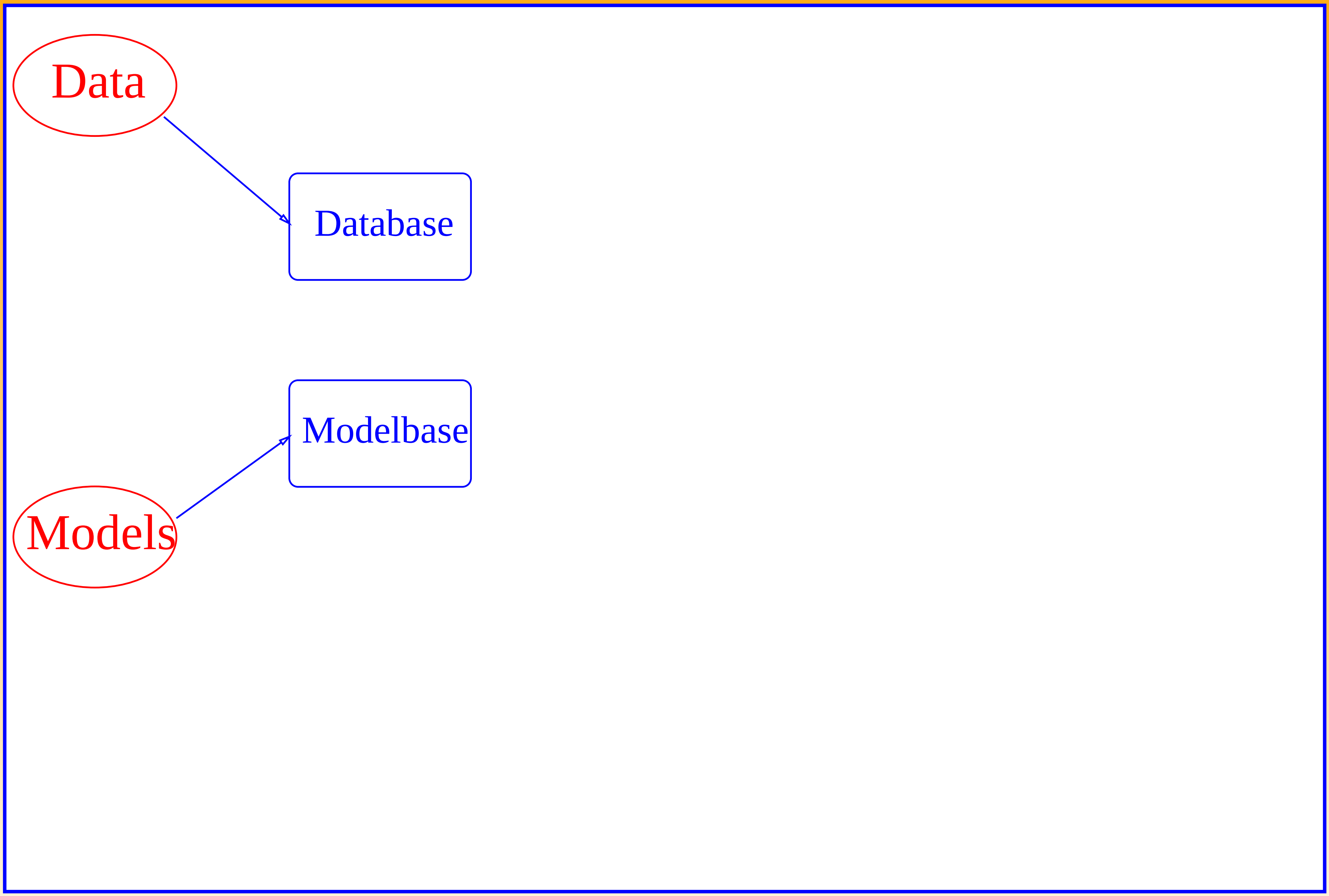
σ_{tot} for $\gamma\gamma \rightarrow hadrons$, RRPL2$_u$

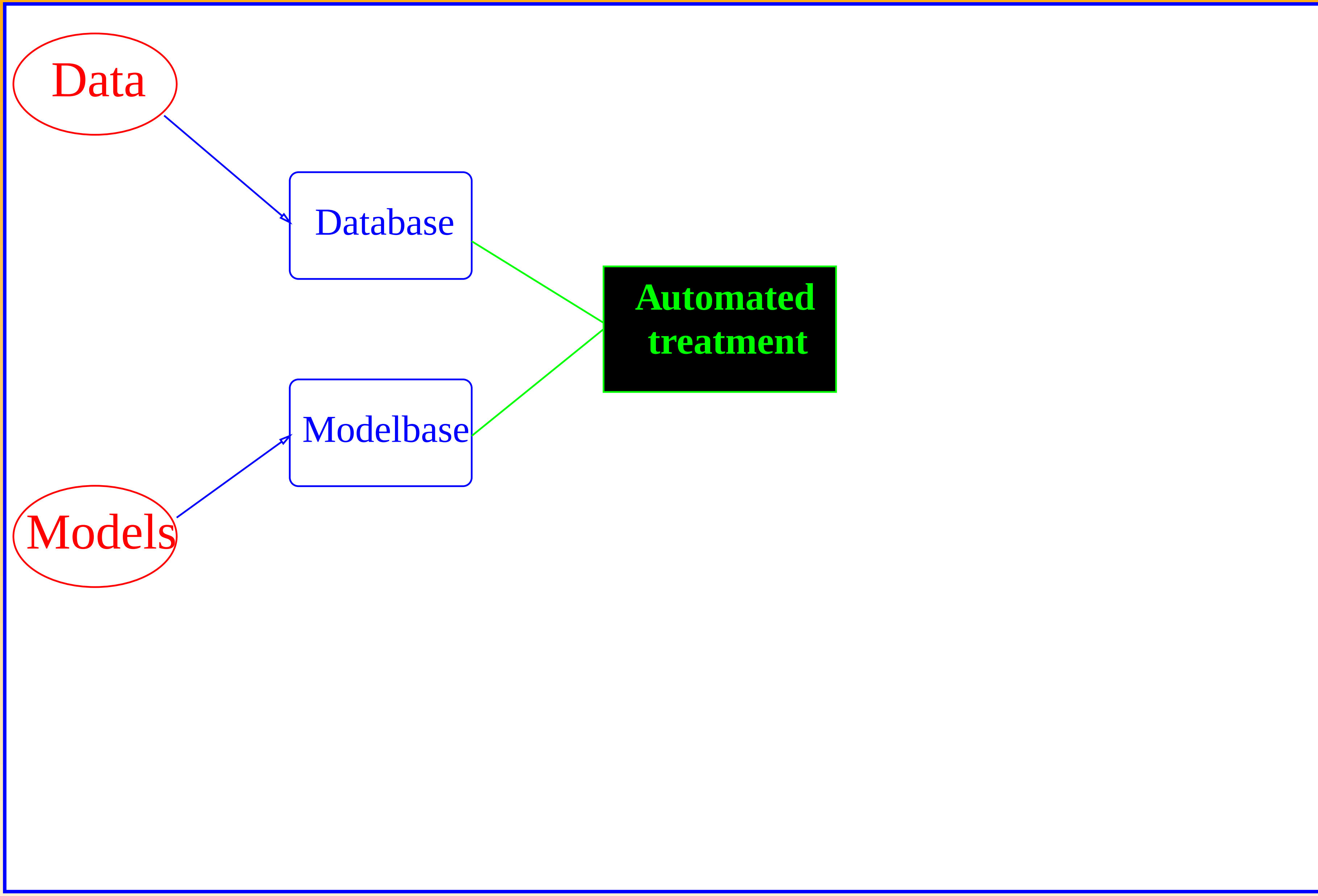
$\sqrt{s}$ (GeV)	σ (μ b)	
300	0.610 ± 0.035	$^{+0.037}_{-0.035}$
500	0.700 ± 0.047	$^{+0.050}_{-0.048}$
1000	0.840 ± 0.067	$^{+0.073}_{-0.069}$

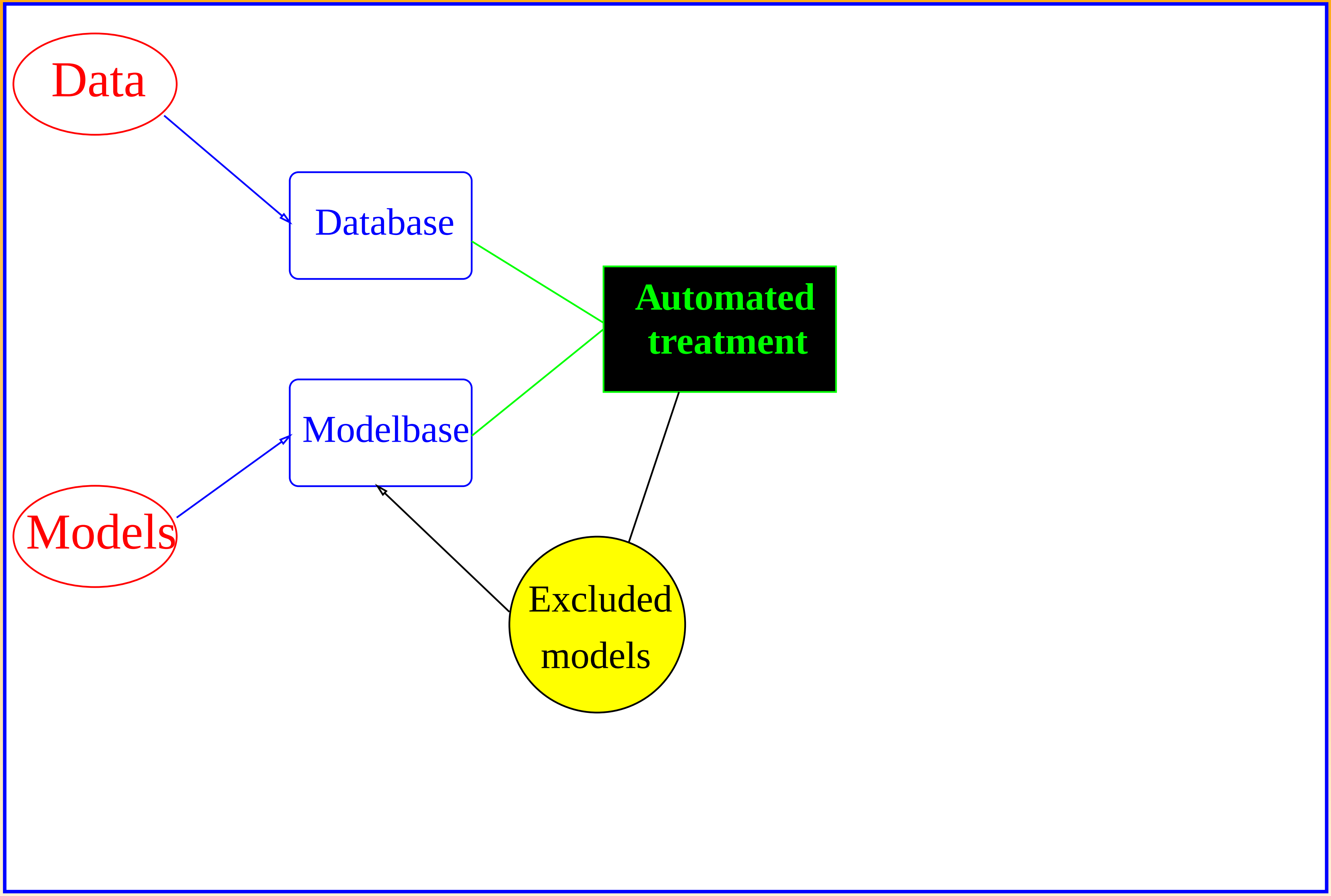
Conclusion

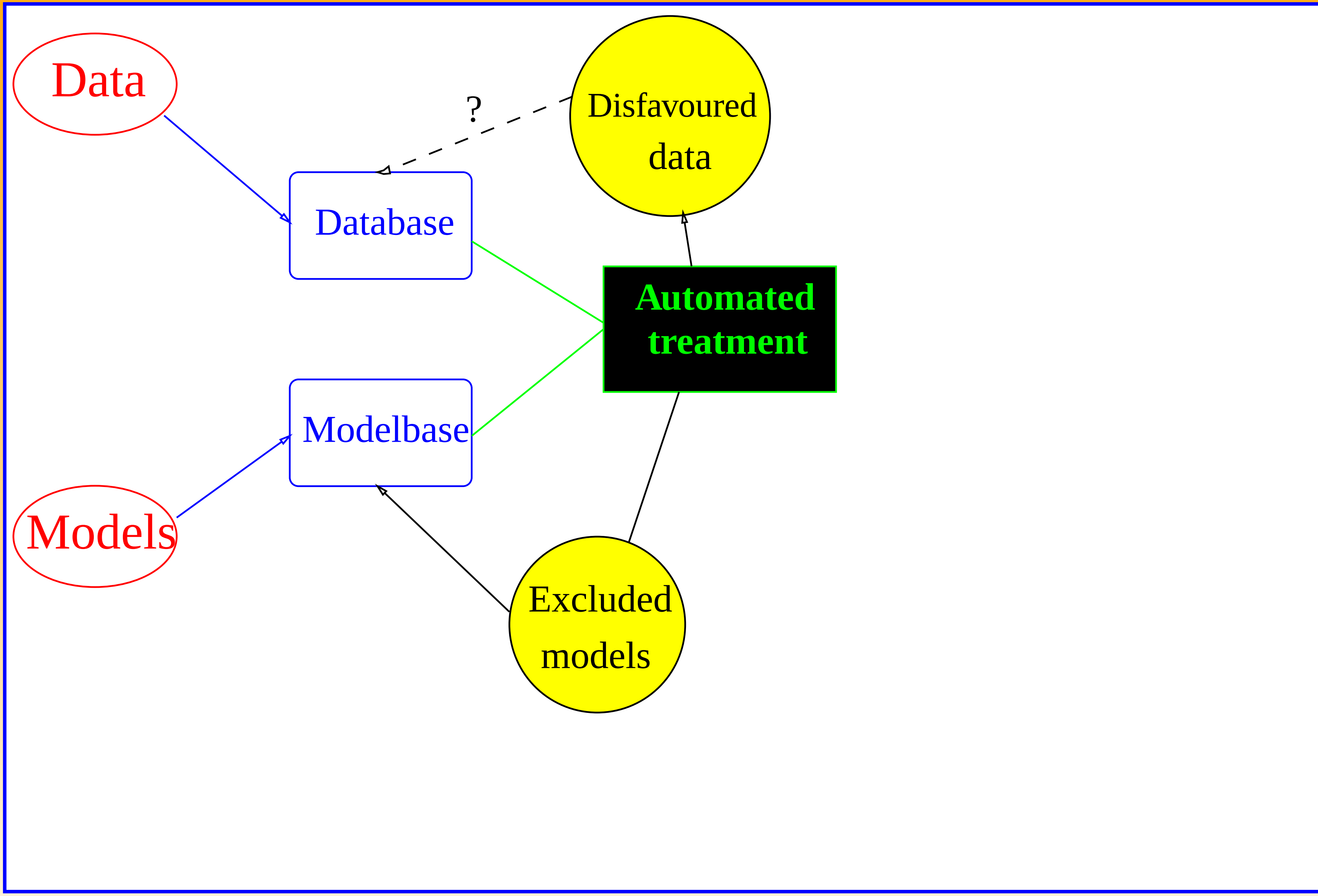
Data

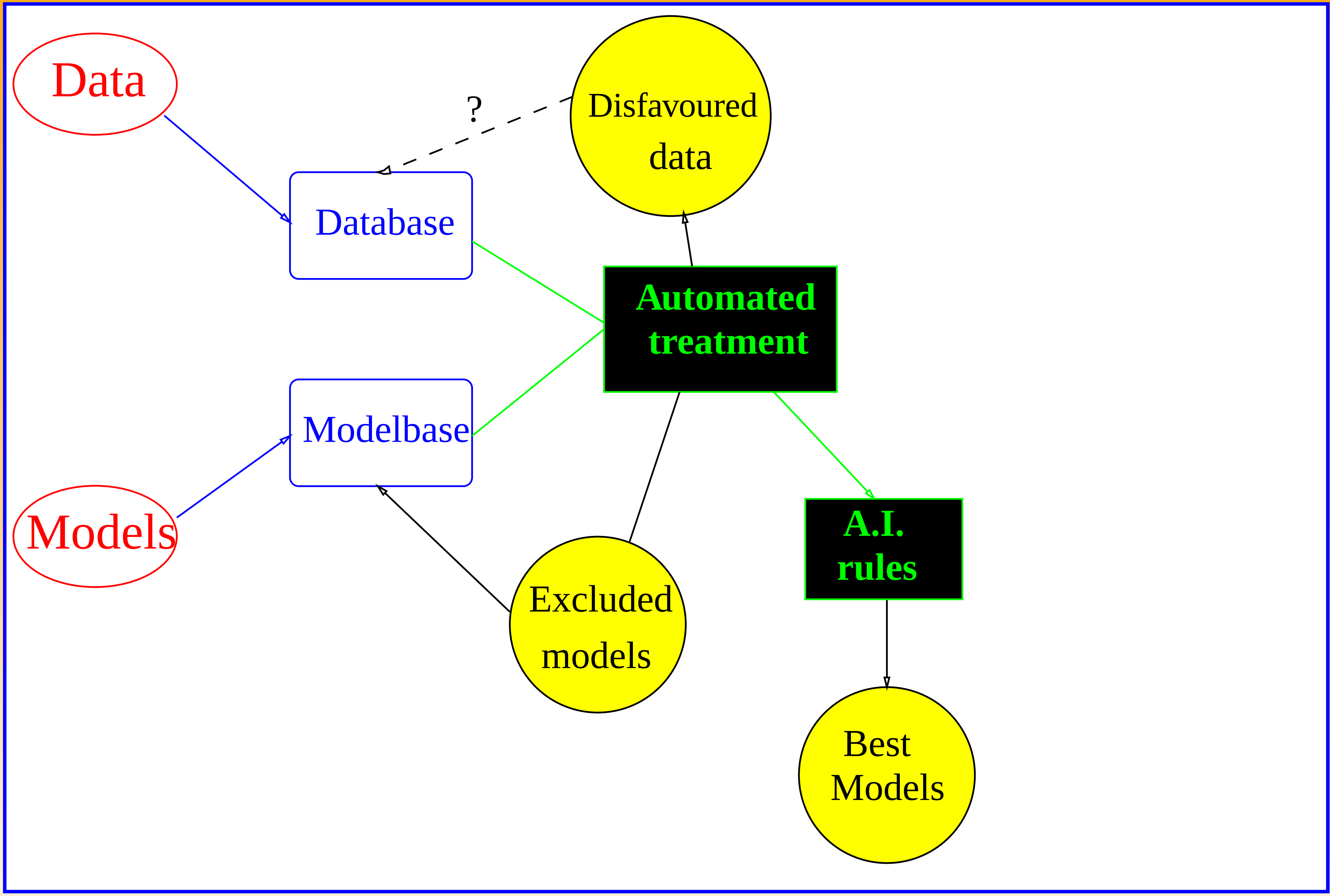
Models


Data
Database
Modelbase
Models


Data
Database
Automated treatment
Modelbase
Models


Data
Database
Automated treatment
Modelbase
Models
Excluded models


Data
Database
?
Disfavoured data
Automated treatment
Modelbase
Models
Excluded models


Data
Database
?
Disfavoured data
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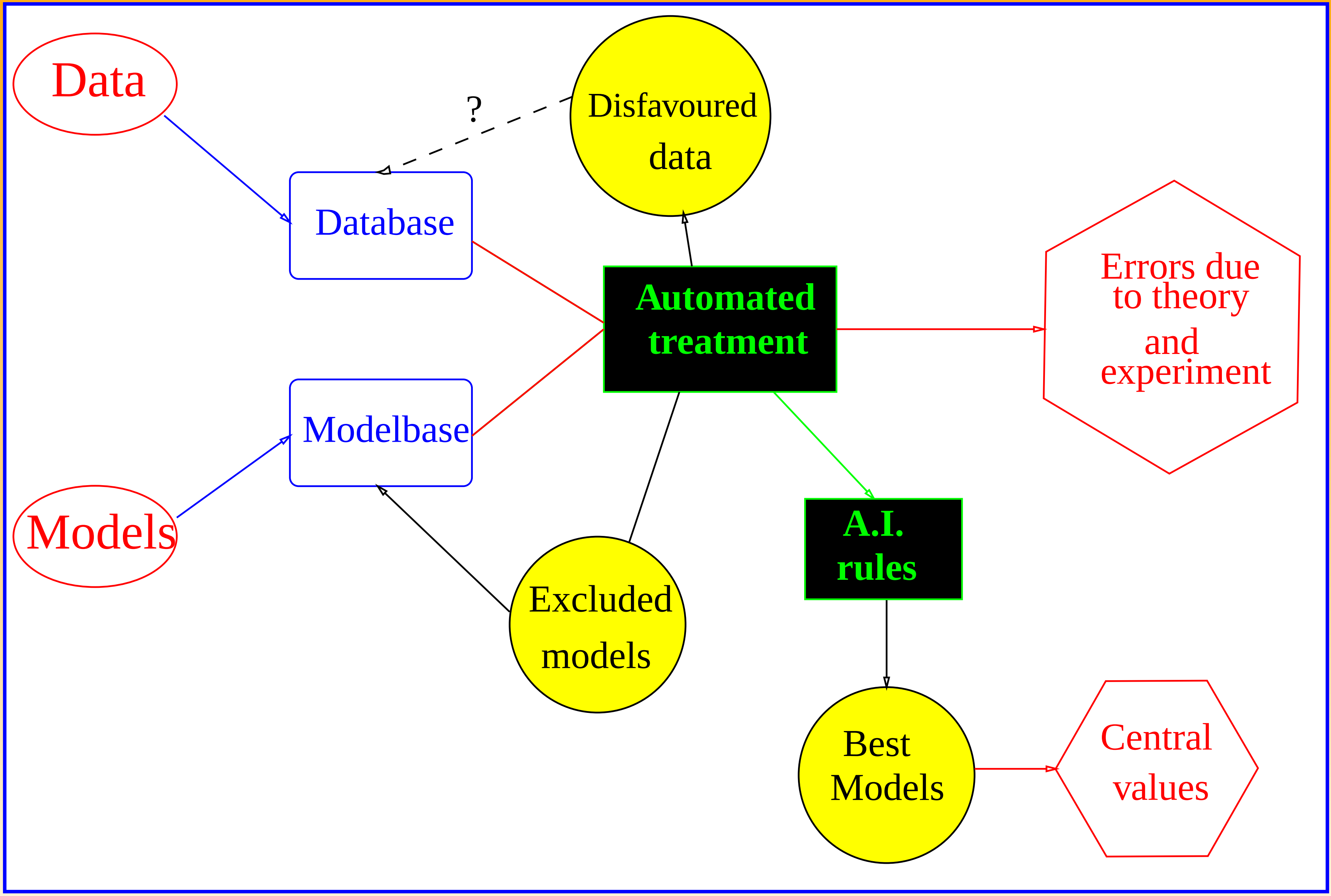
Modelbase
Models
Excluded models
A.I. rules
Best Models


Data
Database
?
Disfavoured data
Automated treatment
Errors due to theory and experiment
Modelbase
Models
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Best Models
Central values

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- ⋆ Predictions include an assessment of systematic errors due to experimental and theoretical disagreements.

Plans for the future

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- Further automatisation of procedure and integration of various parts into one object of knowledge;
- Solution of the ρ problem, inclusion of the correlations between σ_{tot} and ρ;
- Proper treatment of systematic errors;
- Link to other OKs $\leftrightarrow$ ρ
  - electromagnetic form factors $\leftrightarrow$ Coulomb interference region;
  - Regge trajectories $\leftrightarrow$ subleading trajectories;
  - Elastic scattering.