

Quaero@H1

An interface to High pT HERA data

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Thanks to the H1 Collaboration, Martin Wessels, Emmanuelle Perez,
Eckhard Elsen, Andre Schoening, Cristi Diaconu, ...

Motivation 1

Searches for new physics publish 1d or 2d parameter limits for a model

A new model or limit requires a reanalysis of the data

QUAERO



Publishing HEP data via an interface that can be used to quickly test a new model against those data

Motivation 2

Quaero was introduced 2001 at D0 as a concept to make HEP data public available, why not try to add and conserve H1 data?

Adding HERA data to QUAERO gives the possibility to test models against HERA and Tevatron data at once

QUAERO



Publishing HEP data via an interface that can be used to quickly test a new model against those data

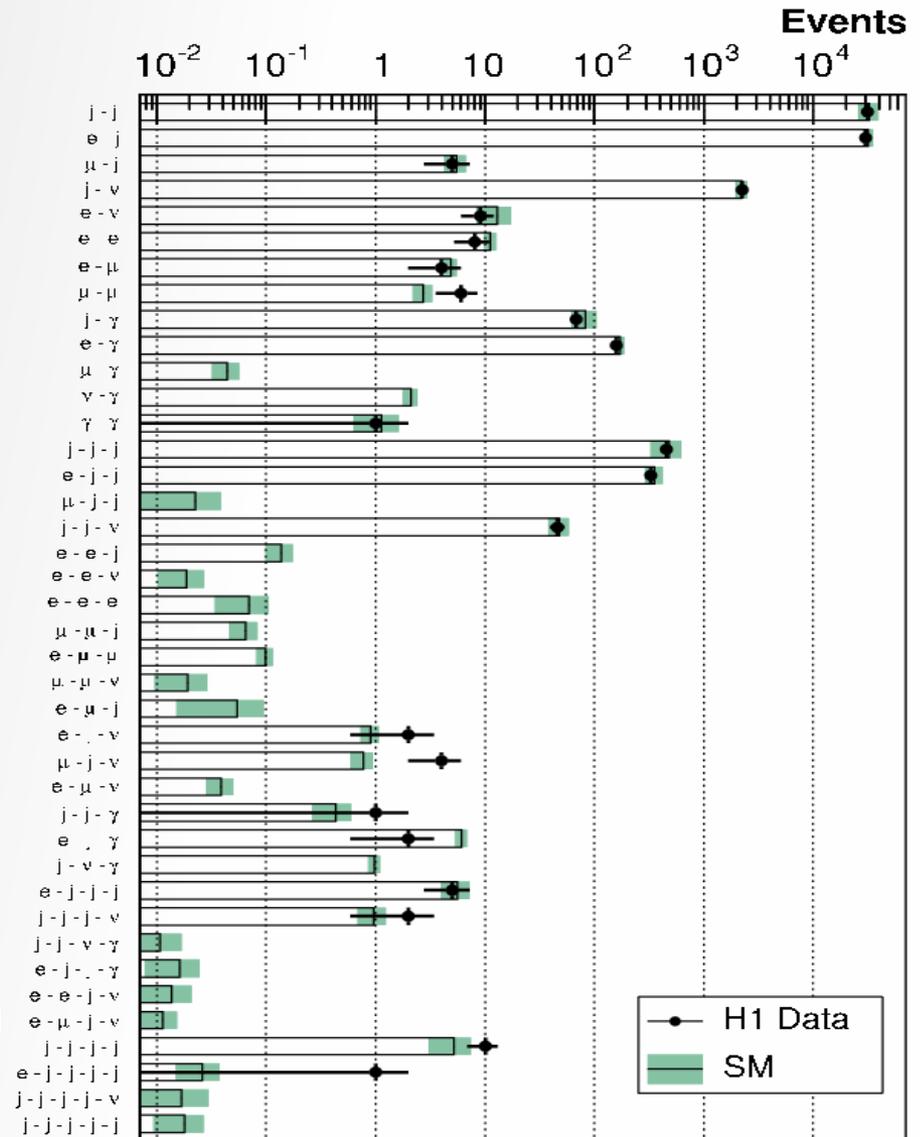
H1 General Search

Make use of H1 General Search data for model testing

H1 General Search provides most complete data set at HERA

H1 was the first modern HEP experiment that analyzed all final states

Data could be combined with D0 or later with CDF and LHC data



H1 General Search

M_{all} and ΣP_T distributions can be used in QUAERO

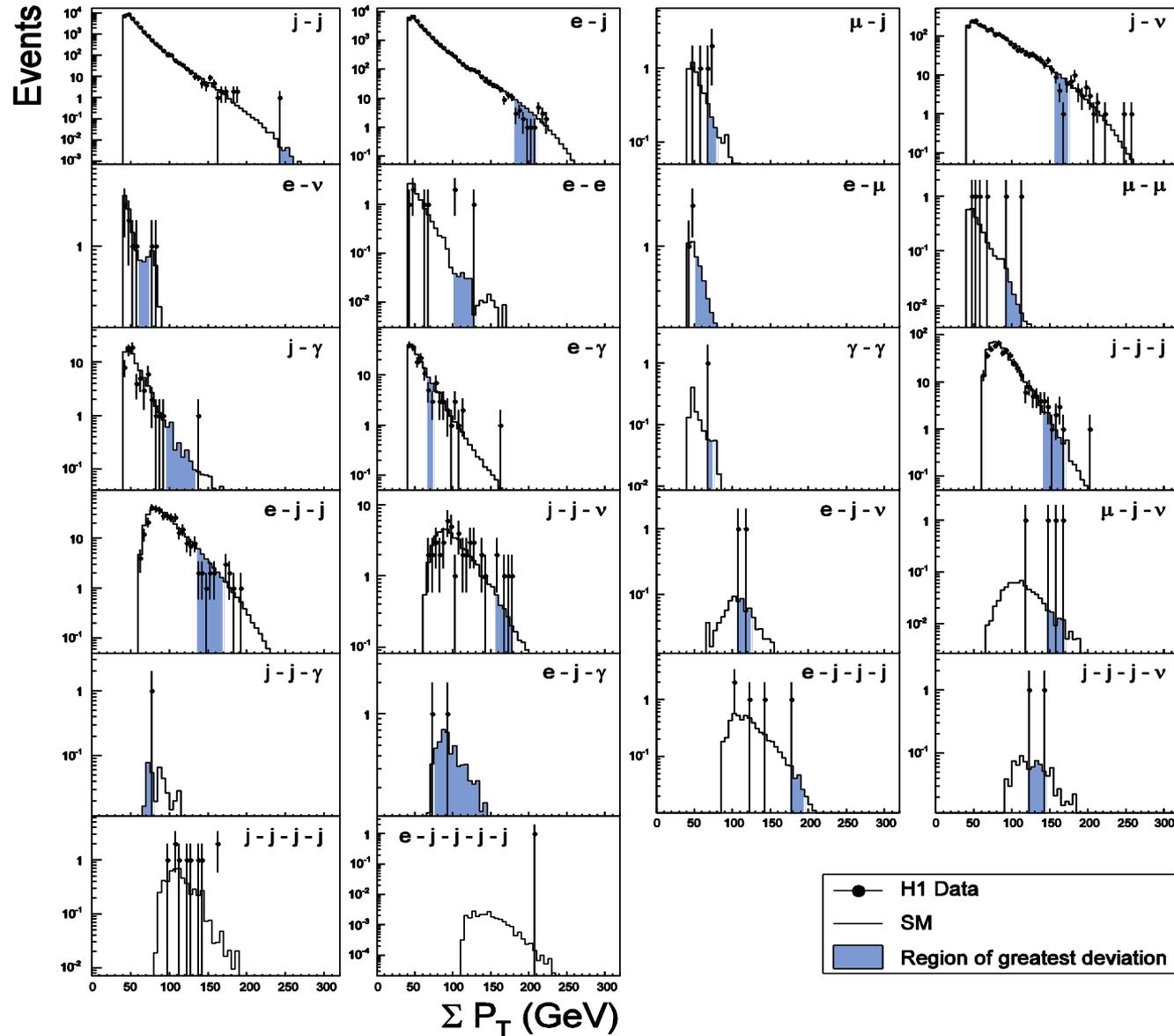
Quaero can use any 4-vector variable and 2d correlations

H1 decided to include the histograms

Neutrino channels are not distinguished in quaero@h1

(e.g. histograms of jet-muon-neutrino and jet-muon are added)

H1 General Search - ΣP_T Distributions



Model testing with QUAERO

Quaero
A General Interface to HEP Data
[Details](#)

Signal

[Pythia](#) [Suspect](#) [MadEvent](#)

no file...lected

Requestor

Email: Model:



Submit jobs at:

<http://mit.fnal.gov/~knuteson/Quaero/quaero/>

How does QUAERO@H1 work?

The user provides commands to the build in event generators

Event generator makes HERA events with the right luminosity

H1 detector response, analysis efficiencies and cuts are simulated using Turbosim

Systematic error is integrated numerically and results from different experiments are combined

The observable(s) with the most difference is used to determine the likelihood ratio $L = p(D | H) / p(D | SM)$

H1 analysis simulation: Turbosim@H1

- ✓ Data: histograms are taken from the H1 General Search
 - ✓ SM: histograms are taken from the H1 General Search
 - ✓ New Model: Simulated using signal MC and Turbosim@H1
- ➔ H1 Monte Carlo events and H1 General Search analysis code are used to produce a large **lookup table** between generator level and analysis objects

This lookup table is used as an ultrafast detector
Simulation ➔ Turbosim

Large lookup table

	Parton cluster					→	Reconstructed cluster					
	zvtx	object	p_T	η	ϕ		object	p_T	η	ϕ		
1	2.98	e+	67.111	0.536	61.2	;	->	e+	72.969	0.531	61.37	;
2	18.04	e+	16.555	-0.038	47.21	;	->	j	18.955	0.003	46.05	;
3	5.46	j	86.379	1.689	50.96	;	->	j	81.975	1.686	50.95	;
4	29.48	j	46.449	1.464	-7.56	;	->	j	27.835	1.896	-21.23	;
								j	23.815	1.008	10.42	;
5	-5.72	j	15.606	0.225	-153.94	;	->	;				;
6	-10.73	j	38.434	0.194	17.88	;	->	mu+	36.603	0.193	17.66	;
7	-3.16	e+	11.556	-0.72	-64.11							
		mu+	9.506	-0.777	-59.12	;	->	j	22.364	-0.81	-60.98	;
8	-9.13	e+	30.031	0.004	12.62							
		ph	16.402	-0.055	10.59	;	->	e+	46.904	-0.028	10.96	;
9	3.13	mu+	24.717	1.161	-27.75	;	->	;				
10	-5.47	mu+	47.093	2.045	54.12	;	->	mu+	54.087	2.041	54.09	;

... and another million lines

Validation of Turbosim using was done using 1 Million independent events
 → Turbosim has been found in agreement with the full simulation + analysis

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Example analyses

R-parity violating SUSY (H1)

Leptoquarks (D0 and H1)

Excited quarks (H1)

Data samples:

H1 General Search Run 1

(all channels but histograms)

D0 quaero samples Run 1

(3 channels but 4-vectors)

R parity violating SUSY example

If muon sneutrino is LSP diagrams like this are possible

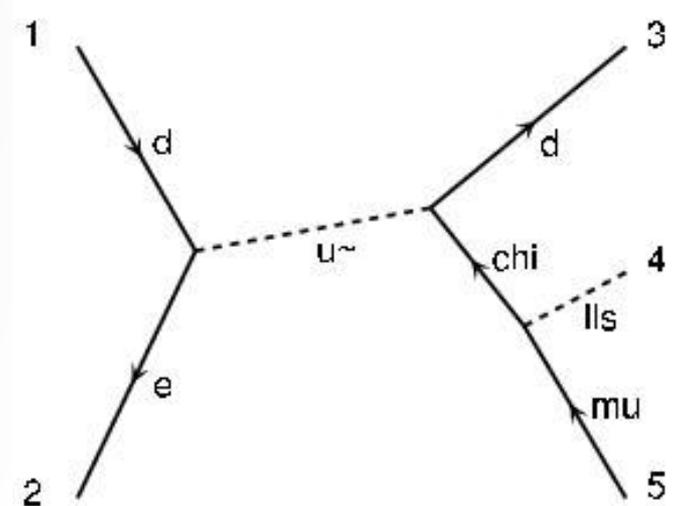
Considered to explain H1 isolated Lepton events ([jet-muon- \$\nu\$ in HERA 1](#))

Signal generated with Madevent

LEP limits and kinematics of the jmv events suggest up-squark mass of approx. 200 GeV and muon-sneutrino mass of 50 GeV

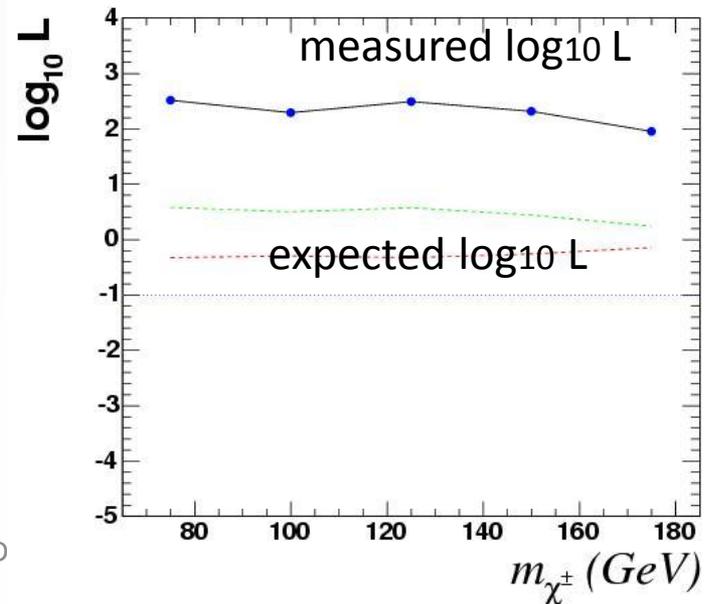
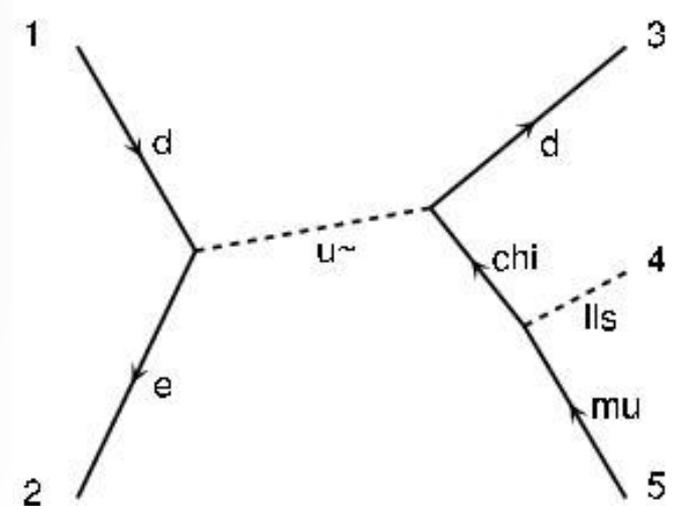
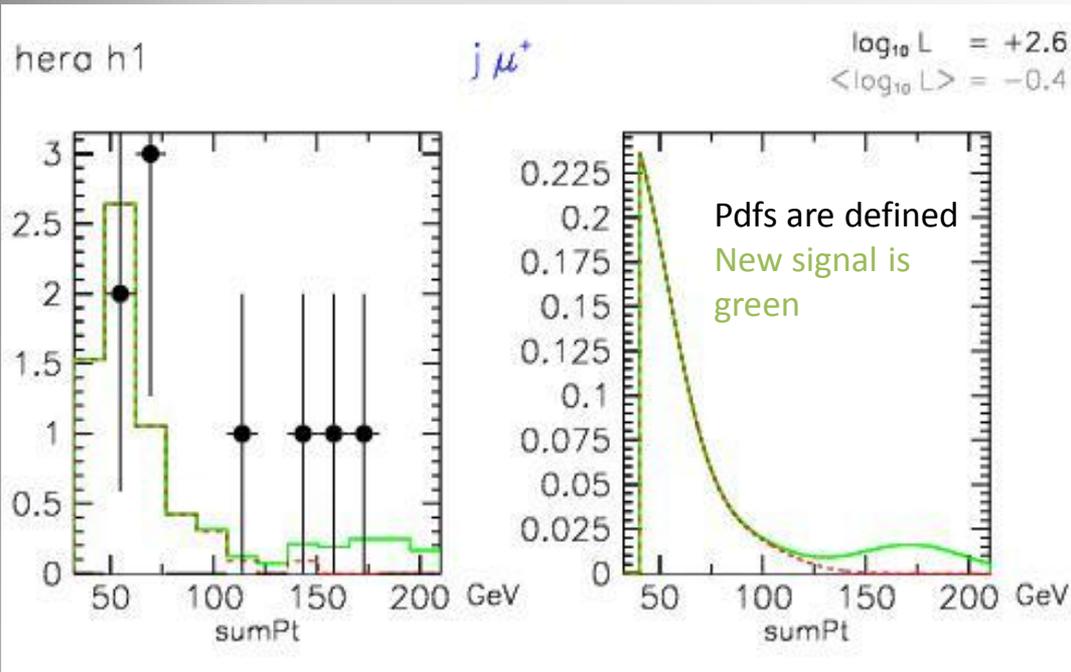
jmv events suggest signal cross section of 0.1pb which constrains the R-parity violating coupling

Quaero selects final states and derives likelihood ratio automatically



R parity violating SUSY example

Quaero output for $m_{\chi}=150$ GeV



Conclusion:
 Data better fit by this hypothesis :
 $\log_{10} L = + 2.5$

Quark coupling
relevant for H1

Leptoquarks

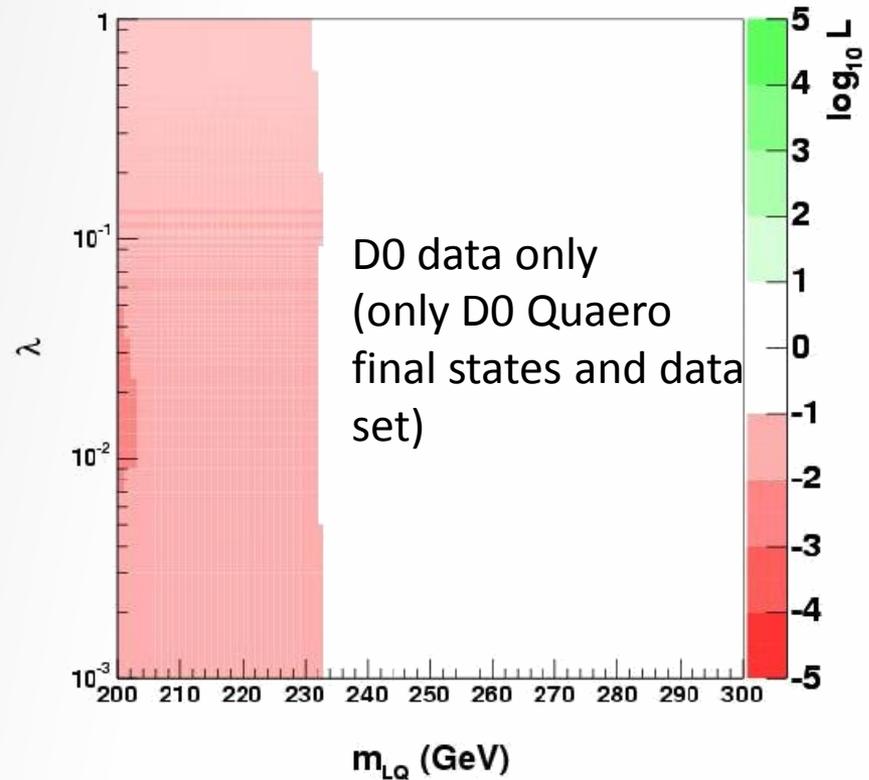
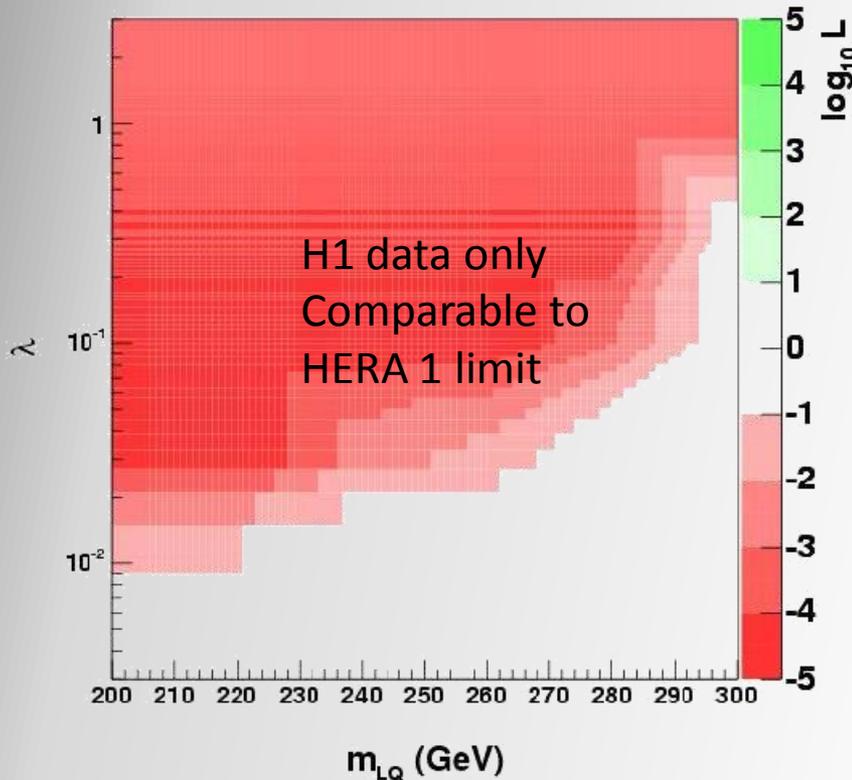
$$\mathcal{L} = \lambda LQ \bar{u}_R e_L + \text{h.c.}$$

$$+ ig_s G_\mu^* (LQ^* \overleftrightarrow{\partial}^\mu LQ)$$

Gluon coupling
relevant for D0

Coupling λ of LQ-e-q vertex and mass M_{LQ} scalar LQ was varied

95% CL upper limit corresponds roughly to $\log_{10} L = 1$



Leptoquarks

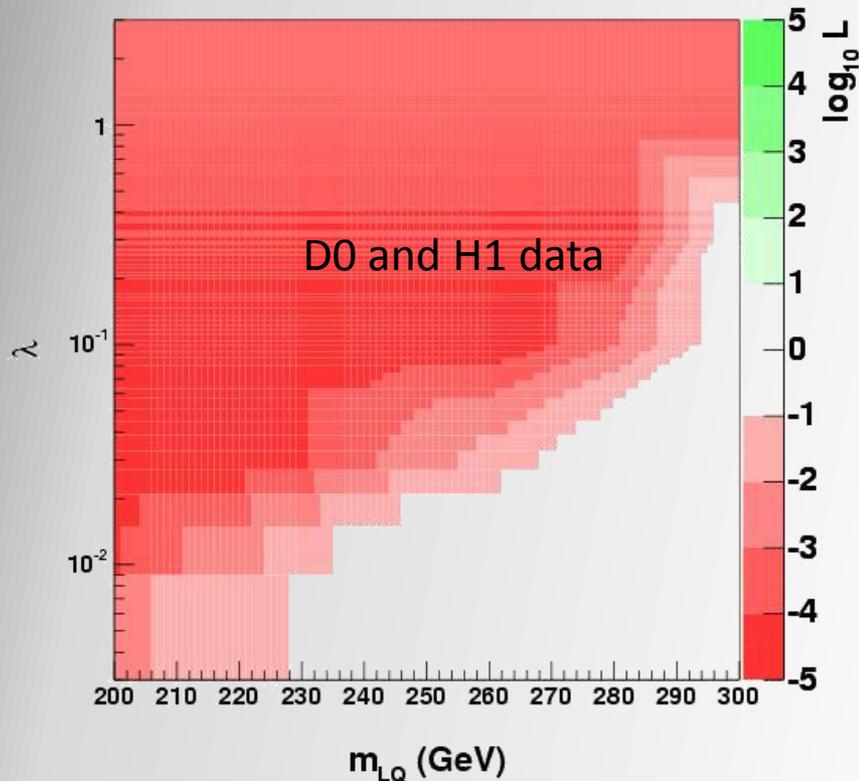
Relevant for H1

$$\mathcal{L} = \lambda LQ \bar{u}_R e_L + \text{h.c.}$$

$$+ ig_s G_\mu^* (LQ^* \overleftrightarrow{\partial}^\mu LQ)$$

Relevant for D0

Coupling λ of LQ-e-q vertex and mass M_{LQ} scalar LQ was varied



Combination makes use of Tevatrons λ independent exclusion of leptoquarks with low mass

... and HERA's λ dependent exclusion at high mass

Excited Quark

$$\mathcal{L} = \frac{1}{2\Lambda} \bar{q}_R^* \sigma^{\mu\nu} \left(g_s f_s \frac{\lambda^a}{2} G_{\mu\nu}^a + g f \frac{\tau}{2} \cdot \vec{W}_{\mu\nu} + g' f' \frac{Y}{2} B_{\mu\nu} \right) q_L$$

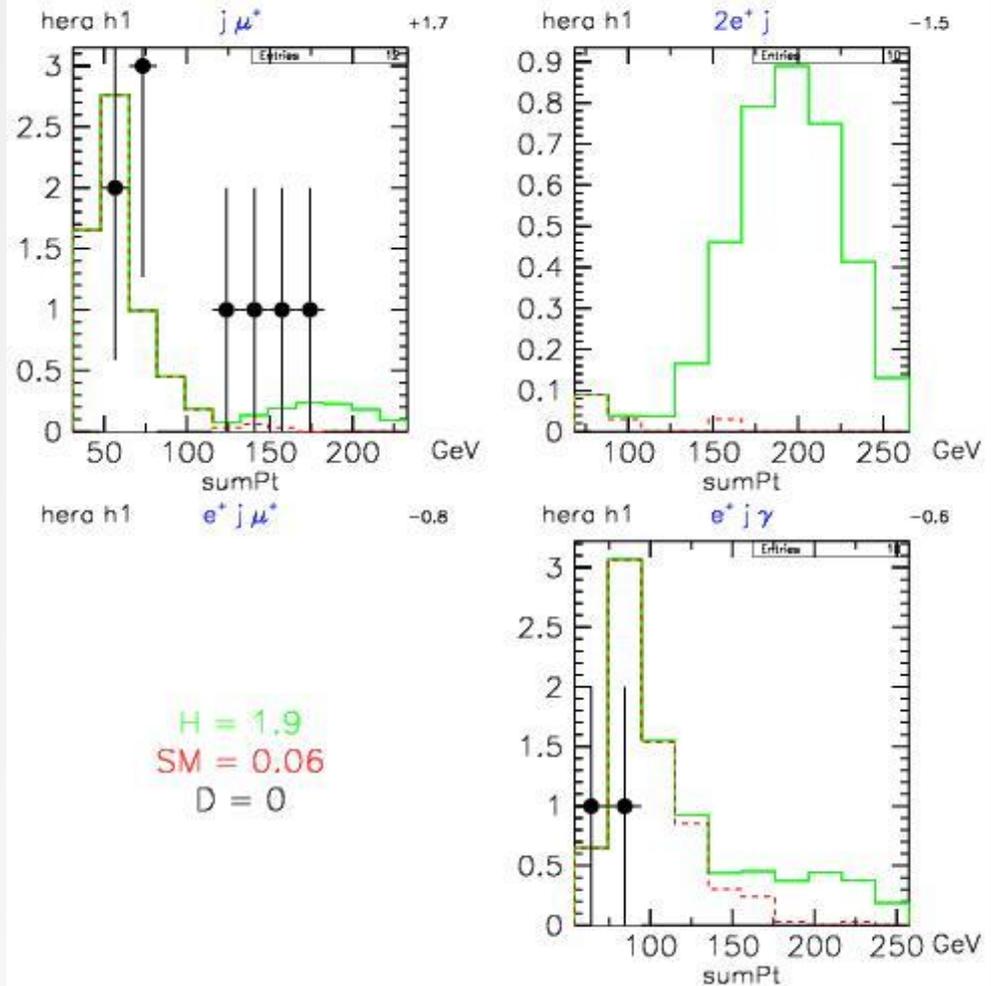
(Baur, Spira, Zerwas)

Usual HERA scenario, Lambda is compositeness scale, q* is first generation q* doublet

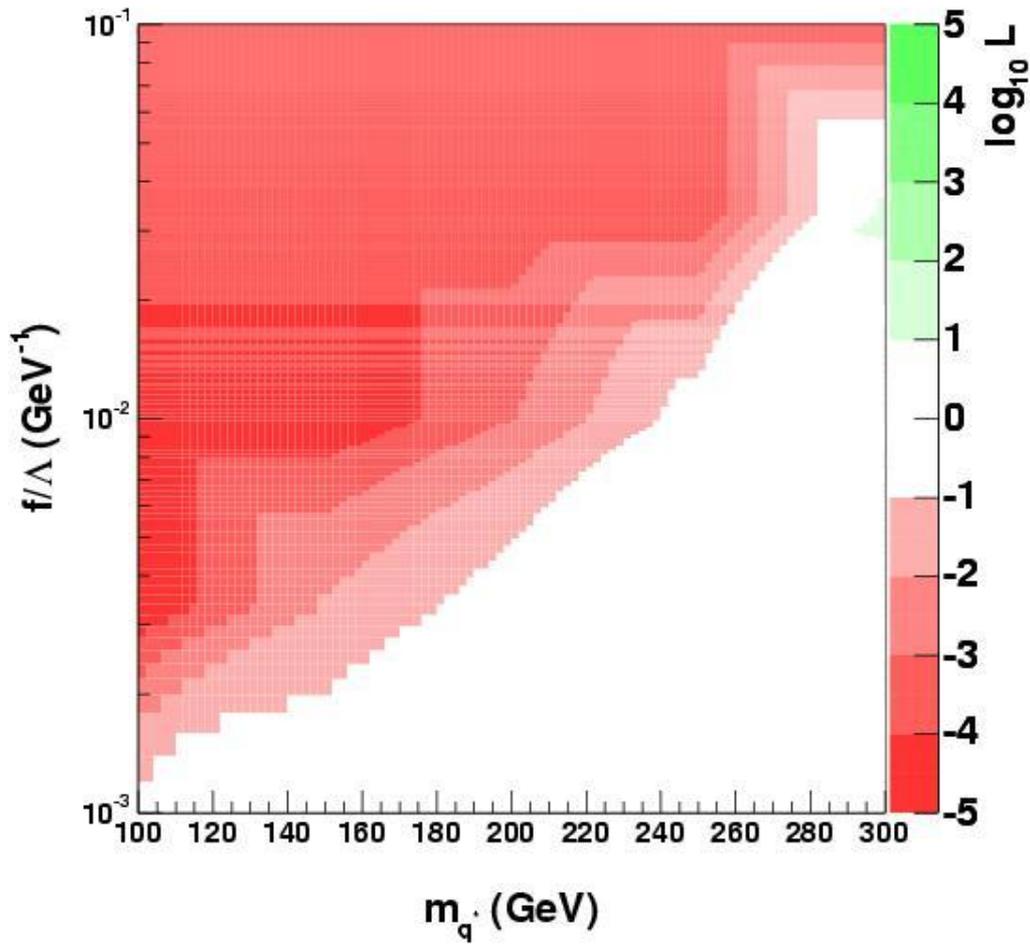
Generated with MadEvent
Input, usual choice for parameters
f=f', f_s=0, m_u*=m_d*

→ Leaves 2 parameter model:
f/Lambda and m_q*

Right Plot:
Quaero output for
f/Lambda = 0.01 and m_q* = 200 GeV



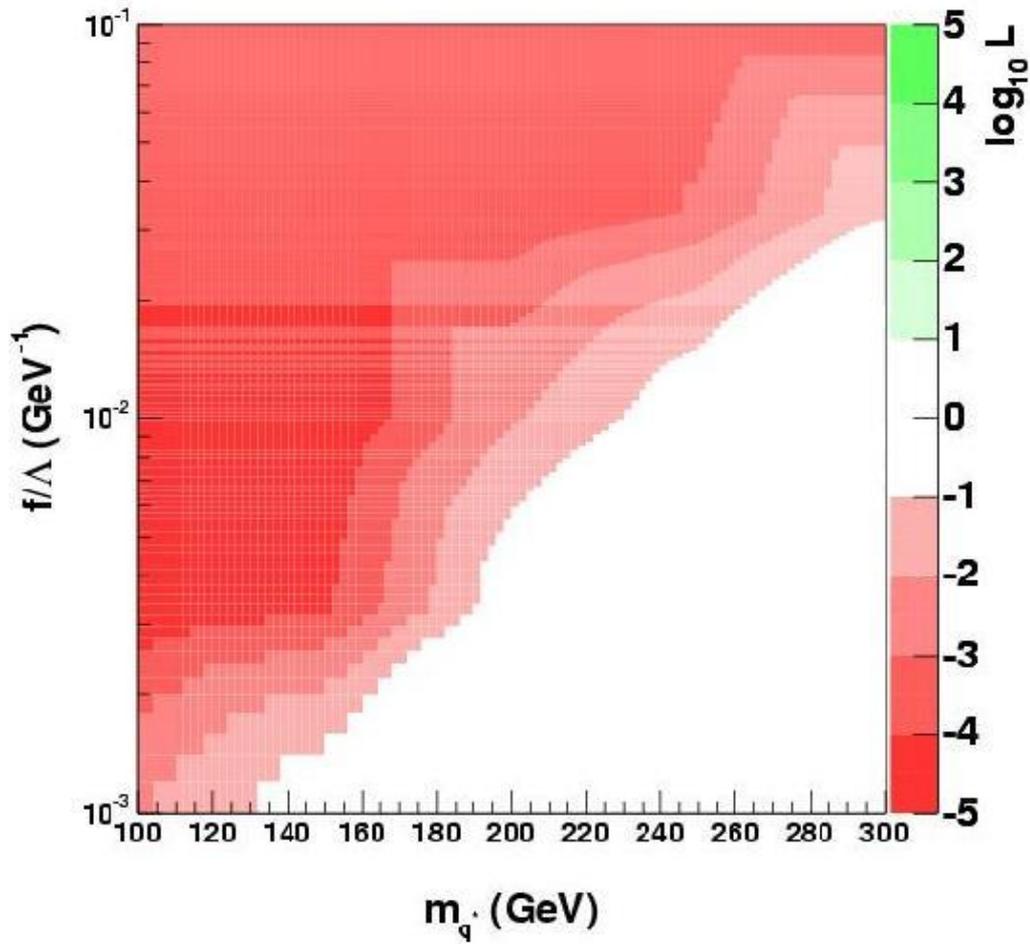
Excited Quark



Result for the parameter choice:

$$f=f', f_s=0, m_{u^*}=m_{d^*}$$

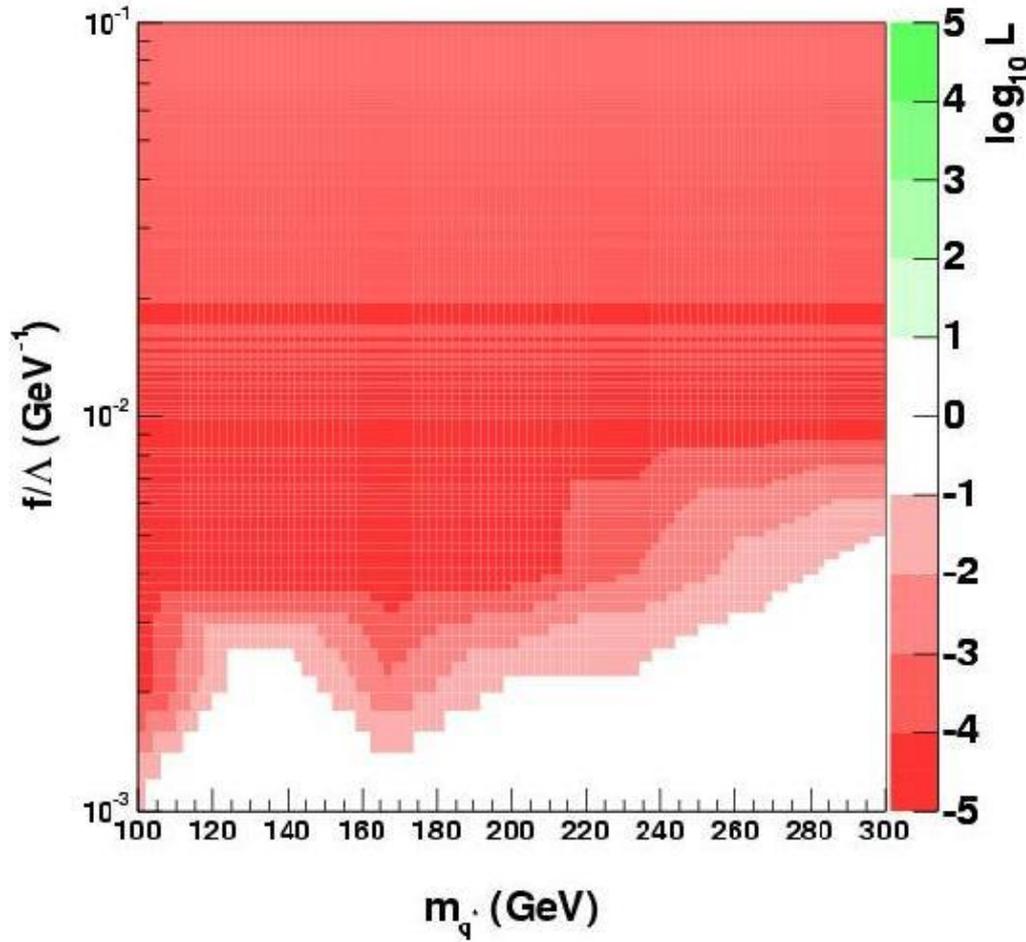
Excited Quark



Result for the parameter choice:

$$f = -f', f_s = 0, m_{u^*} = m_{d^*}$$

Excited Quark



Result for the parameter choice:

$$f=f', f_s=0, m_{u^*}=2*m_{d^*}$$

SUMMARY

- The histograms and the analysis simulation of the H1 General Search are incorporated into Quaero@H1
- ➔ Automated test of specific hypothesis against H1 data
- A Leptoquark, q^* and Susy example analysis shows the performance of the framework
- New data from H1 would be very easy to incorporate

More information in [hep-ph/0612201](https://arxiv.org/abs/hep-ph/0612201)

Excited Quark

